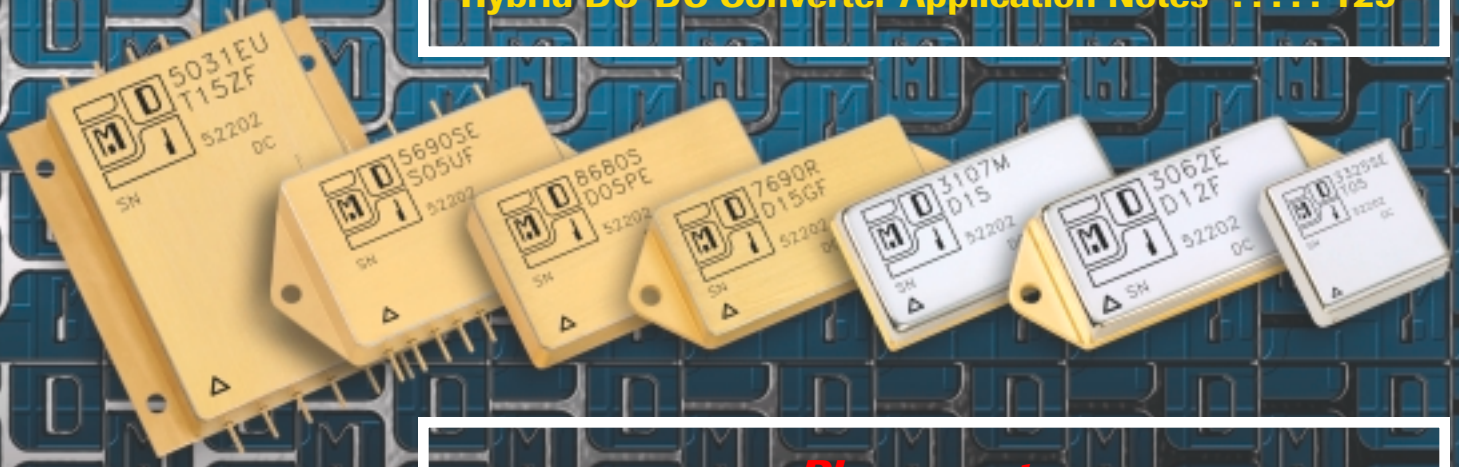
Hybrid DC-DC Converters

Power conversion for

•Military •Commercial Space •Aerospace

MDI Catalog CD



Please note:

Specifications and data for each hybrid series are presented as 2–page spreads.

MODULAR DEVICES, INC.

An ISO 9001:2000 registered company

1 to 5000 Watts

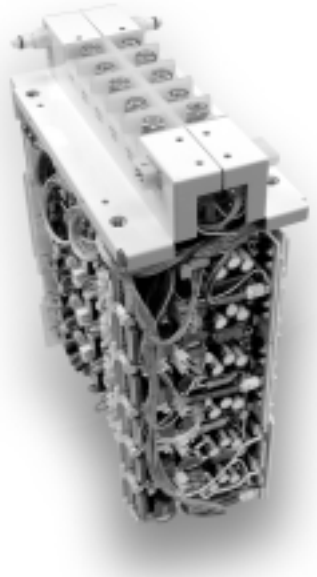
HYBRID • HYBRID ASSEMBLIES • SURFACE MOUNT

Your best choice for demanding applications and packaging...

Fully self-contained, system level products in standard, semi-custom, and custom packages to meet your most demanding requirements...

Whether your requirements call for one of our many standard parts, a standard part with a minor modification, an assembly of standard parts, or a completely new custom design — Modular Devices, Inc. is ready to assist you.

Modular Devices, Inc. (MDI) designs and manufactures a wide range of standard and custom power supplies for aerospace, military and industrial use. MDI has a complete thick film hybrid capacity on site, which permits us to produce unique power electronic functions for our customers quickly and efficiently. MDI can also meet challenging radiation and aerospace requirements. With its high technology power supply capability and custom hybrid facility, MDI is uniquely positioned to apply the best and most appropriate packaging technology to your diverse and challenging requirements.



5KW radiation hardened water cooled multi-output power supply for particle physics instrumentation.

MDI offers the optimum technology for each application.

Full Hybrid Power Supplies using thick film, chip and wire/surface mount components within hermetic hybrid enclosures allows ultimate power density. Low tooling and set up costs and availability of unique hybrid enclosures make power hybrid technology economical for small production runs. Careful computer aided thermal analysis and proven thermal management techniques assure high reliability. MDI's hybrid power supply technology incorporates the latest advances in high frequency techniques, power hybrid and miniature magnetic components. MDI's product capacity includes:

- Standard, off-the-shelf DC to DC converters to 80 watts, operating frequencies to 400 kHz, power densities to 40 W/in^3
- Custom variations of standard DC to DC converters to 120 watts
- Design and construction to military, commercial space, aerospace, and other requirements
- Wide temperature range to 200ºC

Modified Standard Hybrids Converters: The following pages show MDI's standard hybrid DC/DC converter lines. Many other converter types are available. In addition, MDI can readily alter input and output voltages for customer applications.

Assemblies of Hybrids: MDI can combine multiple hybrid converters into a custom or semi-custom high density assembly using standard or modified hybrid converters and NC

milled housings. Packaging formats can be VME, SEM E or custom. The hybrid modules can also be combined with other discrete circuitry to provide additional circuit functions. This allows rapid configuration of higher level functions from available modules with short lead times and minimal development costs.

By implementing the power converter function with assemblies of hybrid converters, it is possible to achieve the same functions at different input voltages (e.g., 28 VDC and 120 VDC, or 28 VDC and 270 VDC) by just changing out the hybrid modules. Sequencing, redundant outputs, programmable outputs and other functions are available.

Surface Mount Power Supplies: MDI's design capabilities have successfully produced many surface mount power supplies for unique applications.

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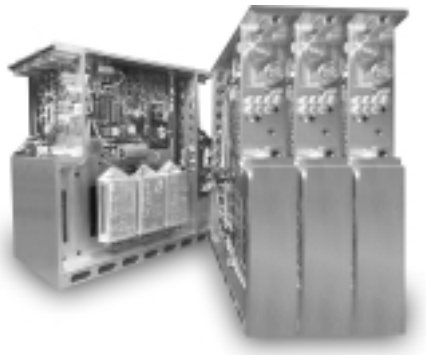
Space Power Supplies

HYBRID • HYBRID ASSEMBLIES • 100K+™ FUNCTIONAL BLOCKS

Six 80-watt converters with auxiliary circuits are packaged in standard VME assembly.

A trio of high power density radiation hardened converters with input/output control, telemetry, sync and nuclear event protection.



Typical Slice design of a multi-function satellite power system using Proton Rad Hard 100K+™ converters.

9006

Your choice in power technologies and packaging...

Aerospace units derived from space heritage designs offering realistic development costs and lead times...

Modular Devices, Inc. (MDI) designs and manufactures many types of power supplies and DC-DC converters for space application. Our products have been used in applications such as the Space Station, Space Shuttle, and numerous satellites. MDI is organized to handle space level quality assurance requirements, materials control, documentation, and testing. MDI space power supplies offer these advantages:

- Designs drawn from space heritage units
- Wide selection of input voltage ranges to match spacecraft busses
- Complete choice of packaging technology (full hybrid, assemblies of hybrids) allows best choice for the application
- Designs are well characterized for radiation effects
- MDI's program management organization accommodates space level work statements
- Extensive on-site pre-qual testing is time and cost effective
- Patent pending 100K+™ technology.

Full Hybrid Power Supplies using thick film, chip and wire/surface mount components within hermetic hybrid enclosures allows ultimate power density. Careful computer aided thermal analysis and proven thermal management techniques assure high reliability. MDI's hybrid power supply technology incorporates the latest advances in high frequency techniques, power hybrid and miniature magnetic components. MDI's product capacity includes:

- Standard, off the shelf DC to DC converters to 80 watts, operating frequencies to 400 kHz, power densities to 40 W/in^3
- Custom variations of standard DC to DC converters to 120 watts
- Design and construction to military, aerospace, and other requirements
- Wide temperature range

Hybrid Assemblies are multiple full hybrid converters packaged in combination with discrete peripheral components. Advantages of this construction include:

- Low non-recurring costs
- Short lead time
- Ability to sequence outputs
- Output flexibility
- VME and other enclosures

100K+™ Functional Blocks use MDI's patent pending technology to produce many related power functions such as buck/boost regulators, solid state power switches, inrush limiter modules, etc. without the high cost and long delivery constraints of other suppliers.

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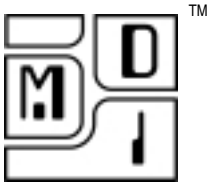

Product Locator Guide

MDI STANDARD DC/DC CONVERTER SELECTIONS

Maximum Power Output Input Description	**2.5** Watts	**5** Watts	**6.5** Watts	**10** Watts	**20** Watts	**30** Watts	**40** Watts	**80** Watts
8~40 VDC Low Input Voltage Range		Series **3061** p10	Series **3062** p12		Series **3113** p14	Series **3378** p16		Series **3114** p18
12 VDC Input Non–Isolated Proton Rad Hard				Series **5080** p20				
28 VDC Input Standard		Series **3080** p22			Series **3011** p24	Series **3**001 p26 **3138** p28		
28 VDC Input Full Feature Inhibit Inhibit Not			Series **26**90 p30 **6690** p40		Series **31**07 p32 **6107** p42	Series **26**80 p34 **6680** p44	Series **31**93 p36 **6193** p46	Series **3**031 p38 **6031** p48
28 VDC Input Spacecraft Bus Low Power / High Efficiency Proton Rad Hard	Series **4690** p50							
28 VDC Input Spacecraft Bus Proton Rad Hard			Series **5690** p52		Series **5107** p54	Series **5680** p56	Series **5193** p58	Series **5031** p60
50 VDC Input Spacecraft Bus Proton Rad Hard			Series **7690** p62		Series **7107** p64	Series **7680** p66	Series **7193** p68	Series **7031** p70
70 VDC Input Spacecraft Bus Proton Rad Hard			Series **8690** p72		Series **8107** p74	Series **8680** p76	Series **8193** p78	Series **8031** p80
100 VDC Input Spacecraft Bus Proton Rad Hard			Series **9690** p82		Series **9107** p84	Series **9680** p86	Series **9193** p88	Series **9031** p90
120 VDC Input Space Station		Series **3325** p92	Series **3070** p94		Series **3108** p96	Series **3060** p98	Series **3326** p100	Series **3051** p102
270 VDC Input Advanced Aircraft			Series **3020** p104		Series **3109** p106	Series **3000** p108	Series **3327** p110	Series **3041** p112

9006

MDI's Alphanumeric Part Numbering System

2	6	9	0	R	E	-	T	0	3	.3	G	F
1	2	3	4	5	6	-	7	8	9	10	11	12

Positions 1-4 indicate MDI Series and Output Power

Positions 5, 6 indicate Grade Level

- blank = Industrial
- EU = Engineering Unit
- M = Military hardware with full power output from -55°C to +85°C case temp, linearly derates to zero at 115°C
- E = Military hardware with full power output from -55°C to +125°C case temp, linearly derates to zero at 135°C
- R = Military/Aerospace hardware 100 KRAD with full power output from -55°C to +85°C case temp, linearly derates to zero at 115°C
- RE = Military/Aerospace hardware 100 KRAD with full power output from -55°C to +125°C case temp, linearly derates to zero at 135°C
- S = Space hardware 100 KRAD with full power output from -55°C to +85°C case temp, linearly derates to zero at 115°C
- SE = Space hardware 100 KRAD with full power output from -55°C to +125°C case temp, linearly derates to zero at 135°C
- V = For MIL-STD-1275 applications; Military/Aerospace hardware with full power output from -55° to +85°C case temp, linearly derates to zero at 115°C (special order).

Positions 7, 8, 9, 10 indicate output configuration and voltages

- S = Single Output, specified VDC
- D = Dual Output, ±specified VDC
- T = Triple Output, +specified VDC main, ±specified VDC dual

Positions 11, 12 indicate Package

Notes: 1) Total Dose for Space Station R, RE, S, SE = 25 KRADS.
2) Unless otherwise noted, all data refers to +25ºC case temperatures.

Visit www.mdipower.com for information on our

- Sequenced power converters for RF applications
- Booster Hybrid DC/DC converter 3439
- 100 KRad solid state switch 5533
- High-temperature converters

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Military Grade Hybrid Microcircuit

Screening Specifications (T_{case} = 85°C)

Test Procedure	MIL-STD-883 Method	MIL-STD-883 Condition	Detail Requirements	MDI Screening
Internal Visual	2017	—	—	Same
Temperature Cycling	1010	B	-55°C to +125°C 10 Cycles	Same
Mechanical Shock or Constant Acceleration	2002 and 2001	B1 Y1 Only A1 Y1 Only	1500 Gs 5000 Gs	Constant Acceleration 500 Gs standard[1]
Electrical Test	—	—	Functional Test	Same
Burn-in (85°C)	1015	—	85°C T_{case} 160 hrs[2] (Max. applied voltage and current)	Same (Nominal input voltage and 100% rated load)
Final Electrical Test	—	—	MDI ATP PDA = 10%	Same -55°C, 25°C, 85°C testing with data[2]
Fine Leak	1014	A1 or A2	Dependent on Vacant Interior Cavity of Hybrid	Same
Gross Leak	1014	C1	—	Same
External Visual	2009	—	—	Same

Note 1 — Higher acceleration test levels available: Consult factory.
Note 2 — Industrial Grade Converters: 24 hours burn-in, 25°C test data only.

Screening Specifications (T_{case} = 125°C)

Test Procedure	MIL-STD-883 Method	MIL-STD-883 Condition	Detail Requirements	MDI Screening
Internal Visual	2017	—	—	Same
Temperature Cycling	1010	B	-55°C to +125°C 10 Cycles	Same
Mechanical Shock or Constant Acceleration	2002 and 2001	B1 Y1 Only A1 Y1 Only	1500 Gs 5000 Gs	Constant Acceleration 500 Gs standard[1]
Electrical Test	—	—	Functional Test	Same
Burn-in (125°C)	1015	—	125°C T_{case} 160 hrs (Max. applied voltage and current)	Same (Nominal input voltage and 100% rated load)
Final Electrical Test	—	—	MDI ATP PDA = 10%	Same -55°C, 25°C, 125°C testing with data
Fine Leak	1014	A1 or A2	Dependent on Vacant Interior Cavity of Hybrid	Same
Gross Leak	1014	C1	—	Same
External Visual	2009	—	—	Same

Note 1 — Higher acceleration test levels available: Consult factory.

Space Grade Hybrid Microcircuit

Screening Specifications (T_{case} = 85°C)

Test Procedure	MIL-STD-883 Method	MIL-STD-883 Condition	Detail Requirements	MDI Screening
Nondestruct Bond Pull	2023	—	100% Wires 2% PDA	Same
Internal Visual	2017	—	—	Same
Temperature Cycling	1010	B	-55°C to +125°C 10 Cycles	Same
Mechanical Shock or Constant Acceleration	2002 and 2001	B1 Y1 Only A1 Y1 Only	1500 Gs 5000 Gs	Constant Acceleration 500 Gs standard[1]
Pind	2020	B	10 Gs, 60 Hz	Same
Electrical Test	—	—	Functional Test	Same
Burn-in (85°C)	1015	—	N/A (Maximum applied voltage and current)	85°C T_{case} 320 hrs (Nominal input voltage and 100% rated load)
Final Electrical Test	—	—	MDI ATP PDA = 2% or 1 device	Same -55°C, 25°C, 85°C testing with data
Fine Leak	1014	A1 or A2	Dependent on Vacant Interior Cavity of Hybrid	Same
Gross Leak	1014	C1	—	Same
Radiography	2012	—	Y Direction	Same
External Visual	2009	—	—	Same

Note 1 — Higher acceleration test levels available: Consult factory.

Screening Specifications (T_{case} = 125°C)

Test Procedure	MIL-STD-883 Method	MIL-STD-883 Condition	Detail Requirements	MDI Screening
Nondestruct Bond Pull	2023	—	100% Wires 2% PDA	Same
Internal Visual	2017	—	—	Same
Temperature Cycling	1010	B	-55°C to +125°C 10 Cycles	Same
Mechanical Shock or Constant Acceleration	2002 and 2001	B1 Y1 Only A1 Y1 Only	1500 Gs 5000 Gs	Constant Acceleration 500 Gs standard[1]
Pind	2020	B	10 Gs, 60 Hz	Same
Electrical Test	—	—	Functional Test	Same
Burn-in (125°C)	1015	—	125°C T_{case} 320 hrs (Maximum applied voltage and current)	Same (Nominal input voltage and 100% rated load)
Final Electrical Test	—	—	MDI ATP PDA = 2% or 1 device	Same -55°C, 25°C, 125°C testing with data
Fine Leak	1014	A1 or A2	Dependent on Vacant Interior Cavity of Hybrid	Same
Gross Leak	1014	C1	—	Same
Radiography	2012	—	Y Direction	Same
External Visual	2009	—	—	Same

Note 1 — Higher acceleration test levels available: Consult factory.

3.25–5 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Fully isolated, input to output
- Single, double and triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response
- No external filter caps required
- Hermetically sealed package

Specifications

INPUT: 16 to 24 VDC nominal
Range: 8 to 40 VDC continuous
Unit will start up at V_{in} > 9.5 VDC

OUTPUT: for V_{in} < 16 VDC, the output power linearly derates to 1/2 full output power at V_{in} = 8 VDC

ISOLATION:

Input to case:	500 VDC
Input to output:	500 VDC
Output to case:	100 VDC

ENVIRONMENT:

Storage temperature:	-55°C to +150°C
Shock:	50 G's
Acceleration:	500 G's
Vibration:	30 G's

Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C

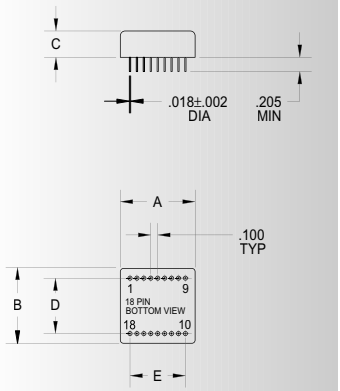
WEIGHT: 20 grams typical

SINGLE OUTPUT DEVICES		3061-S03.3 (3.3W)			3061-S05 (5W)			3061-S05.2 (5W)			3061-S12 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	V_{in} = 16 to 40 VDC	—	—	1A	—	—	1A	—	—	961mA	—	—	416mA
Efficiency	P_{out} = max rated load	62%	65%	—	67%	70%	—	67%	70%	—	74%	78%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

SINGLE OUTPUT DEVICES		3061-S15 (5W)			3061-S28 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	V_{in} = 16 to 40 VDC	—	—	333mA	—	—	178mA
Efficiency	P_{out} = max rated load	75%	79%	—	74%	78%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	1250mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3061	1	18	Solder Sealed Flangeless PCB Mount

CASE STYLE 1



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style	A	B	C	D	E	F	G
1	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —

DUAL OUTPUT DEVICES		3061-D05 (5W)			3061-D12 (5W)			3061-D15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	V_{in} = 16 to 40 VDC	±35mA	—	±500mA	±15mA	—	±208mA	±12mA	—	±166mA
Efficiency	P_{out} = max rated load	69%	72%	—	74%	78%	—	75%	79%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

LOW INPUT VOLTAGE

8-40 VDC

TRIPLE OUTPUT DEVICES		3061-T05 (3.25W)			3061-T12 (3.7W)			3061-T15 (3.7W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.5 -11.5	+5.0 +12.0 -12.0	+5.1 +12.5 -12.5	+4.9 +14.5 -14.5	+5.0 +15.0 -15.0	+5.1 +15.5 -15.5
Output current	V_{in} = 16 to 40 VDC	60mA ±20mA	— —	500mA ±75mA	100mA ±5mA	— —	500mA ±50mA	100mA ±5mA	— —	500mA ±40mA
Efficiency	P_{out} = max rated load	62%	65%	—	67%	70%	—	67%	70%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

3061-SXX output <24 VDC				3061-SXX output ≥24 VDC				3061-DXX				3061-TXX			
Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C
Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C
Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C
Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C
Pin 5	N/C	Pin 14	N/C	Pin 5	main out ret	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C
Pin 6	main out ret	Pin 15	inhibit not	Pin 6	N/C	Pin 15	inhibit not	Pin 6	output com	Pin 15	inhibit not	Pin 6	dual output ret	Pin 15	inhibit not
Pin 7	main out ret	Pin 16	N/C	Pin 7	N/C	Pin 16	N/C	Pin 7	output com	Pin 16	N/C	Pin 7	dual output ret	Pin 16	N/C
Pin 8	N/C	Pin 17	input ret	Pin 8	main output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret
Pin 9	main output	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	main output	Pin 18	input ret

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

3.75-6.5 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Power on soft start
- Fully isolated, input to output
- Single, double and triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response
- No external filter caps required
- Hermetically sealed package

Specifications

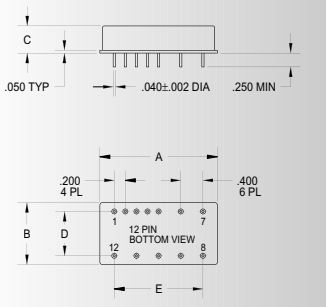
INPUT: 16 to 24 VDC nominal
Range: 8 to 40 VDC continuous
Unit will start up at V_{in} > 9.5 VDC
OUTPUT: for V_{in} < 16 VDC, the output power linearly derates to 1/2 full output power at V_{in} = 8 VDC
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		3062-S03.3 (6.5W)			3062-S05 (6.5W)			3062-S05.2 (6.5W)			3062-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	V_{in} = 16 to 40 VDC	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	64%	67%	—	69%	72%	—	69%	72%	—	76%	80%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

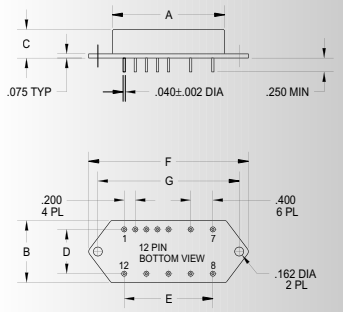
SINGLE OUTPUT DEVICES		3062-S15 (6.5W)			3062-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	V_{in} = 16 to 40 VDC	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	75%	79%	—	76%	80%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3062		2	12	Solder Sealed Flangeless PCB Mount
3062	F	3	12	Solder Sealed PCB Mount with Flange
3062	G	5	12	Seam Weld Flangeless PCB Mount
3062	GF	6	12	Seam Weld PCB Mount with Flange
3062	UF	8	12	Seam Weld Chassis Mount with Flange

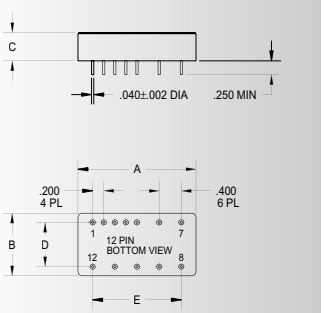
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

DUAL OUTPUT DEVICES		3062-D05 (6.5W)			3062-D12 (6.5W)			3062-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	V_{in} = 16 to 40 VDC	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	64%	67%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

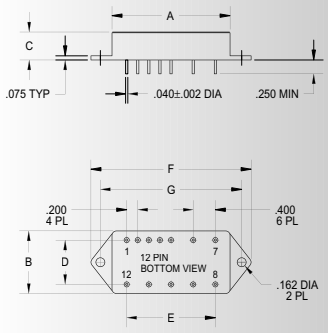
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

LOW INPUT VOLTAGE

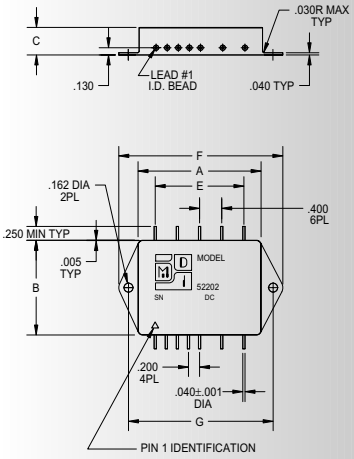
8-40 VDC

TRIPLE OUTPUT DEVICES		3062-T3.3/15 (3.75W)			3062-T3.3/12 (5W)			3062-T3.3/15 (5W)			3062-T05 (3.75W)			3062-T12 (5W)			3062-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	V_{in} = 16 to 40 VDC	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	64%	67%	—	64%	67%	—	64%	67%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



3062-SXX output <24 VDC				3062-SXX output ≥24 VDC				3062-DXX				3062-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

7.5–20 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Power on soft start
- Fully isolated, input to output
- Single, double and triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response
- No external filter caps required
- Hermetically sealed package

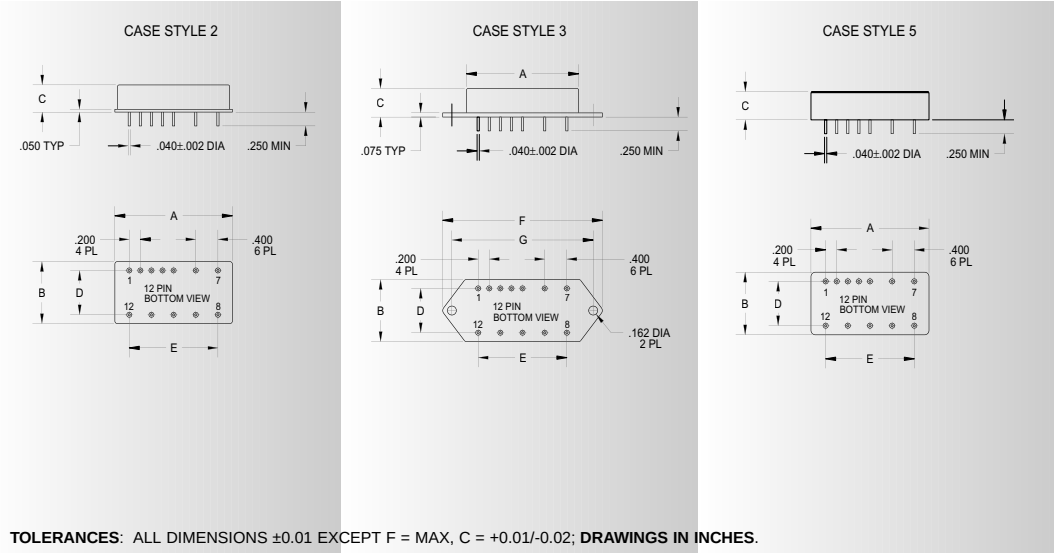
Specifications

INPUT: 16 to 24 VDC nominal
Range: 8 to 40 VDC continuous
Unit will start up at V_{in} > 9.5 VDC
OUTPUT: for V_{in} < 16 VDC, the output power linearly derates to 1/2 full output power at V_{in} = 8 VDC
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		3113-S03.3 (13.2W)			3113-S05 (20W)			3113-S05.2 (20W)			3113-S12 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	V_{in} = 16 to 40 VDC	—	—	4A	—	—	4A	—	—	3.85A	—	—	1.67A
Efficiency	P_{out} = max rated load	64%	67%	—	69%	72%	—	69%	72%	—	76%	80%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

SINGLE OUTPUT DEVICES		3113-S15 (20W)			3113-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	V_{in} = 16 to 40 VDC	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3113	2	12	Solder Sealed Flangeless PCB Mount
3113 F	3	12	Solder Sealed PCB Mount with Flange
3113 H	5	12	Seam Weld Flangeless PCB Mount
3113 HF	6	12	Seam Weld PCB Mount with Flange
3113 VF	8	12	Seam Weld Chassis Mount with Flange



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

DUAL OUTPUT DEVICES		3113-D05 (20W)			3113-D12 (20W)			3113-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	V_{in} = 16 to 40 VDC	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	71%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

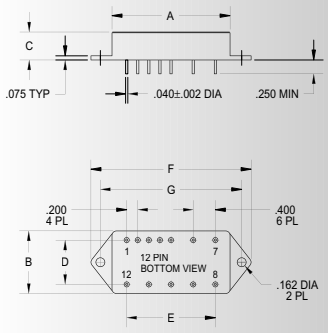
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

LOW INPUT VOLTAGE

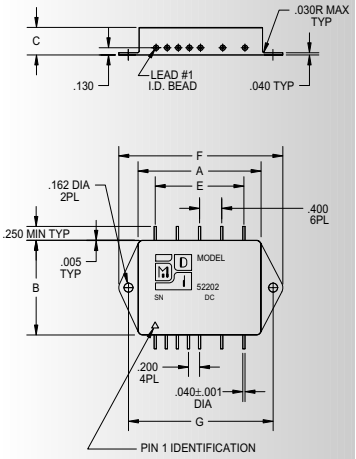
8-40 VDC

TRIPLE OUTPUT DEVICES		3113-T3.3/5 (7.5W)			3113-T3.3/12 (10W)			3113-T3.3/15 (10W)			3113-T05 (7.5W)			3113-T12 (10W)			3113-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	V_{in} = 16 to 40 VDC	150mA ±15mA	— —	1.5A ±250mA	150mA ±15mA	— —	1.5A ±208mA	150mA ±15mA	— —	1.5A ±167mA	60mA ±15mA	— —	1A ±250mA	30mA ±15mA	— —	1A ±208mA	30mA ±15mA	— —	1A ±167mA
Efficiency	P_{out} = max rated load	64%	67%	—	64%	67%	—	64%	67%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



3113-SXX output <24 VDC				3113-SXX output ≥24 VDC				3113-DXX				3113-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	dual output	Pin 6	input ret	Pin 12	dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

12.5-30 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Power on soft start
- Fully isolated, input to output
- Single, double and triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response
- No external filter caps required
- Hermetically sealed package

Specifications

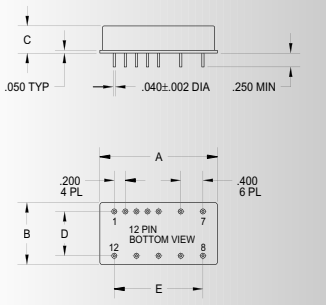
INPUT: 16 to 24 VDC nominal
Range: 8 to 40 VDC continuous
Unit will start up at V_{in} > 9.5 VDC
OUTPUT: for V_{in} < 16 VDC, the output power linearly derates to 1/2 full output power at V_{in} = 8 VDC
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		3378-S03.3 (20W)			3378-S05 (30W)			3378-S05.2 (30W)			3378-S12 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	V_{in} = 16 to 40 VDC	—	—	6.06A	—	—	6A	—	—	5.76A	—	—	2.5A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

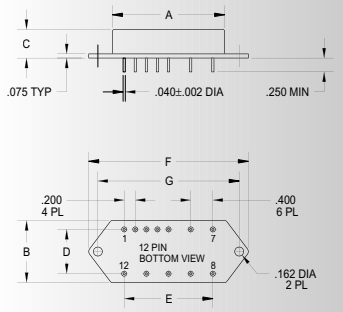
SINGLE OUTPUT DEVICES		3378-S15 (30W)			3378-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	V_{in} = 16 to 40 VDC	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3378	2	12	Solder Sealed Flangeless PCB Mount
3378 F	3	12	Solder Sealed PCB Mount with Flange
3378 I	5	12	Seam Weld Flangeless PCB Mount
3378 IF	6	12	Seam Weld PCB Mount with Flange
3378 WF	8	12	Seam Weld Chassis Mount with Flange
3378 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
3378 PE	12	12	Seam Weld Flangeless PCB Stud Mount

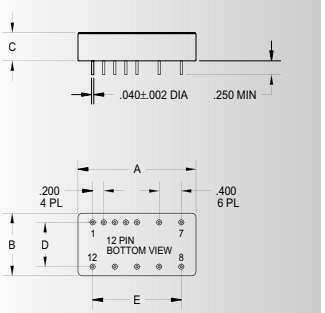
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		3378-D05 (30W)			3378-D12 (30W)			3378-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	V_{in} = 16 to 40 VDC	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

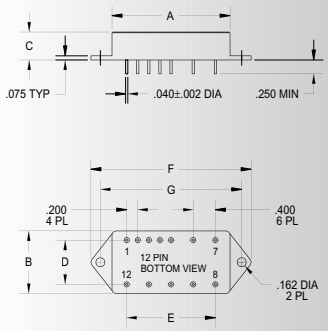
LOW INPUT VOLTAGE

8-40 VDC

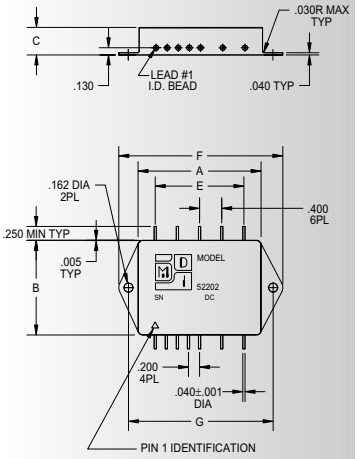
9006

TRIPLE OUTPUT DEVICES		3378-T3.3/5 (12.5W)			3378-T3.3/12 (17.5W)			3378-T3.3/15 (17.5W)			3378-T05 (12.5W)			3378-T12 (17.5W)			3378-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	V_{in} = 16 to 40 VDC	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

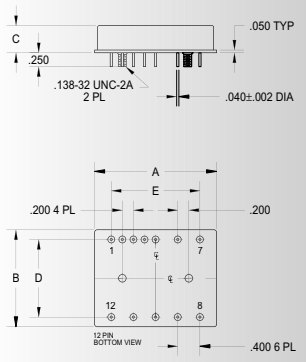
CASE STYLE 6



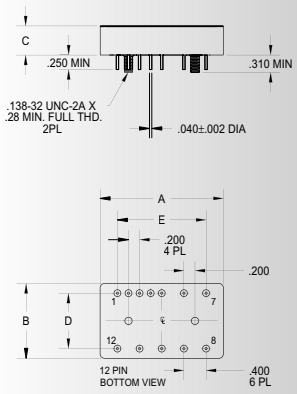
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



3378-SXX output <24 VDC				3378-SXX output ≥24 VDC				3378-DXX				3378-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

30–50 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Power on soft start
- Fully isolated, input to output
- Single, double and triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response
- No external filter caps required
- Hermetically sealed package

Specifications

INPUT: 16 to 24 VDC nominal
Range: 8 to 40 VDC continuous
Unit will start up at V_{in} > 9.5 VDC
OUTPUT: for V_{in} < 16 VDC, the output power linearly derates to 1/2 full output power at V_{in} = 8 VDC
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		3114-S03.3 (33W)			3114-S05 (50W)			3114-S05.2 (50W)			3114-S12 (50W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	V_{in} = 16 to 40 VDC	—	—	10A	—	—	10A	—	—	9.61A	—	—	4.17A
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	75%	79%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

SINGLE OUTPUT DEVICES		3114-S15 (50W)			3114-S28 (50W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	V_{in} = 16 to 40 VDC	—	—	3.3A	—	—	1.79A
Efficiency	P_{out} = max rated load	76%	80%	—	75%	79%	—
Line regulation	P_{out} = max rated load, V_{in} = 16 to 40 VDC	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3114	4	12	Solder Sealed PCB Mount with Flange
3114 LF	7	12	Seam Weld PCB Mount with Flange
3114 ZF	9	12	Seam Weld Chassis Mount with Flange
3114 PD	11	12	Solder Sealed Flangeless PCB Stud Mount

3114-SXX output <24 VDC				3114-SXX output ≥24 VDC				3114-DXX				3114-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

3114-SXX ZF output <24 VDC				3114-SXX ZF output ≥24 VDC				3114-DXX ZF				3114-TXX ZF			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+input	Pin 11	N/C	Pin 5	+input	Pin 11	N/C	Pin 5	+input	Pin 11	dual output ret	Pin 5	+input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

DUAL OUTPUT DEVICES		3114-D05 (50W)			3114-D12 (50W)			3114-D15 (50W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	V_{in} = 16 to 40 VDC	±266mA	—	±5A	±158mA	—	±2.08A	±127mA	—	±1.67A
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

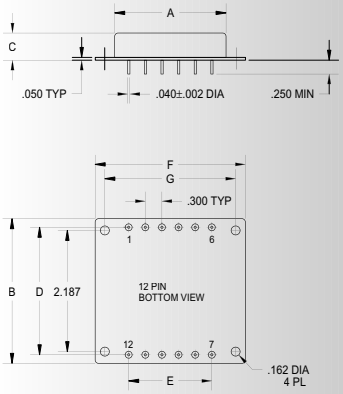
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

LOW INPUT VOLTAGE

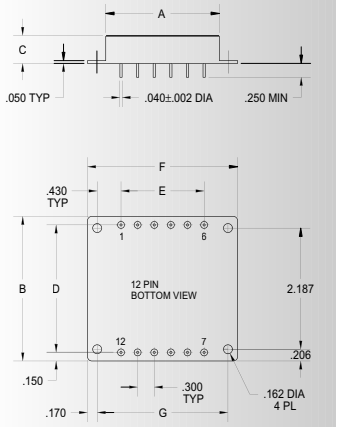
8-40 VDC

TRIPLE OUTPUT DEVICES		3114-T3.3/5 (29.75W)			3114-T3.3/12 (34.73W)			3114-T3.3/15 (34.75W)			3114-T05 (30W)			3114-T12 (35W)			3114-T15 (35W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	V_{in} = 16 to 40 VDC	750mA ±40mA	— —	7.5A ±500mA	750mA ±40mA	— —	7.5A ±416mA	750mA ±32mA	— —	7.5A ±333mA	90mA ±40mA	— —	5A ±500mA	90mA ±40mA	— —	5A ±416mA	90mA ±32mA	— —	5A ±333mA
Efficiency	P_{out} = max rated load	64%	67%	—	64%	67%	—	64%	67%	—	72%	75%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load V_{in} = 16 to 40 VDC	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

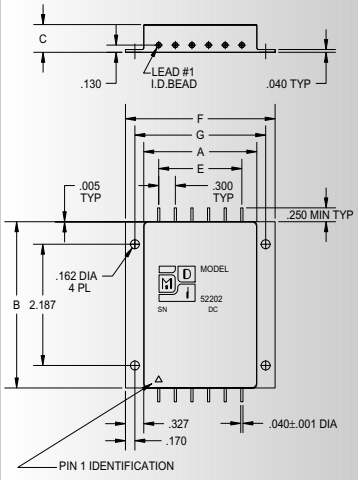
CASE STYLE 4



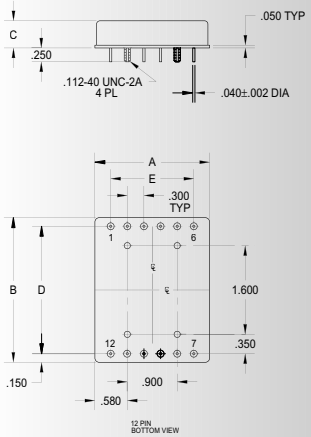
CASE STYLE 7



CASE STYLE 9



CASE STYLE 11



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

4–10 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Synchronous rectification for high efficiency
- Parallelable for higher current
- Non-isolated for intermediate bus applications
- Adjustable output voltage trim
- Thick Film Hybrid DC-DC Converter
- "Inhibit-not" function
- 100 kHz operation
- Sync input 1:1, 95-105 kHz
- Full hermetic package, solder seal and seam welded; PC and Chassis mount options

Specifications

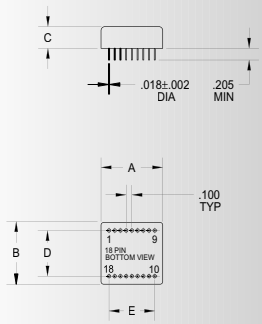
INPUT: 12 VDC nominal
Range: 11 to 16 VDC continuous
ISOLATION:
Input-Output: Non-Isolated
Input and Output to case: 100 VDC
OUTPUT:
External capacitance recommended for specified performance
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 20 grams typical

POSITIVE OUTPUT DEVICES		5080-P01 (4W)			5080-P01.2 (6W)			5080-P01.5 (6W)			5080-P01.8 (7.2W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	(Trim Range)	+0.9	+1.0	+1.1	+1.0	+1.2	+1.4	+1.3	+1.5	+1.7	+1.6	+1.8	+2.0
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	—	70%	—	—	75%	—	—	80%	—	—	80%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	20	—	—	20	—	—	20	—	—	20	—
External Output Cap	(µF)	1000	—	4000	1000	—	4000	1000	—	4000	1000	—	4000

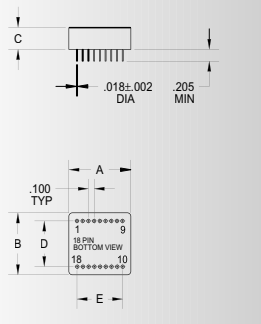
POSITIVE OUTPUT DEVICES		5080-P02.0 (8W)			5080-P02.5 (10W)			5080-P03.3 (10W)			5080-P05.0 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	(Trim Range)	+1.8	+2.0	+2.3	+2.2	+2.5	+3.0	+3.0	+3.3	+4.0	+4.0	+5.0	+6.0
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	3A	—	—	2A
Efficiency	P_{out} = max rated load	—	80%	—	—	80%	—	—	82%	—	—	85%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	20	—	—	25	—	—	30	—	—	50	—
External Output Cap	(µF)	1000	—	4000	1000	—	4000	1000	—	4000	500	—	2000

Model No.	Case Style	Pin Count	Mounting
5080	1	18	Solder Sealed Flangeless PCB Mount
5080 D	14	18	Seam Weld Flangeless PCB Mount
5080 TF	15	18	Seam Weld Chassis Mount with Flange

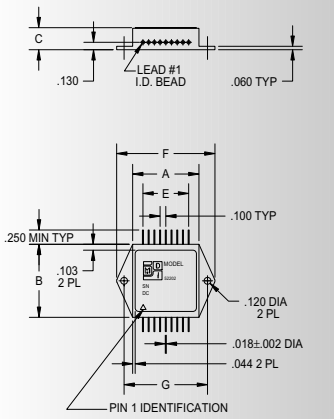
CASE STYLE 1



CASE STYLE 14



CASE STYLE 15



Case Dimensions

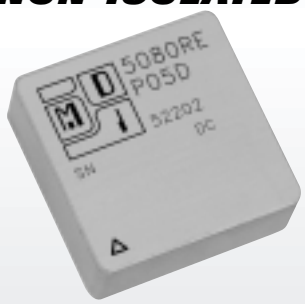
Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
1		1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
14	D	1.090 | 27.686	1.090 | 27.686	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
15	TF	1.160 | 29.464	1.283 | 32.588	0.380 | 9.652	— | —	0.800 | 20.320	1.754 | 44.552	1.460 | 37.084

9006

NON-ISOLATED



12 VDC

POSITIVE OUTPUT DEVICES		5080-P07.5 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX
Output voltage	(Trim Range)	+6.5	+7.5	+8.5
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.33A
Efficiency	P_{out} = max rated load	—	85%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	65mV	300mV
Load regulation	P_{out} = 10% to F.L.	—	65mV	300mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	50	—
External Output Cap	(µF)	500	—	2000

NEGATIVE OUTPUT DEVICES		5080-N02.0 (8W)			5080-N03.3 (10W)			5080-N05.0 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	(Trim Range)	-1.8	-2.0	-2.3	-3.0	-3.3	-4.0	-4.0	-5.0	-6.0
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	3A	—	—	2A
Efficiency	P_{out} = max rated load	—	70%	—	—	75%	—	—	85%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	20	—	—	30	—	—	50	—
External Output Cap	(µF)	1000	—	4000	1000	—	4000	500	—	2000

9006

5080

Pin 1	pos in	Pin 10	case
Pin 2	pos in	Pin 11	N/C
Pin 3	pos in	Pin 12	N/C
Pin 4	common	Pin 13	Vref
Pin 5	common	Pin 14	adjust
Pin 6	common	Pin 15	Iout
Pin 7	output	Pin 16	sync
Pin 8	output	Pin 17	bit
Pin 9	output	Pin 18	inhibit not

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

3.25–5 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- For MIL-STD-704 applications
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Short circuit protection
- Fully isolated, input to output
- Single, double or triple outputs
- 200 kHz operation for low ripple and fast response time
- No external filter caps required
- Full hermetic package

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives MIL-STD-704E transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
Grade R available as 53080, consult factory
WEIGHT: 20 grams typical

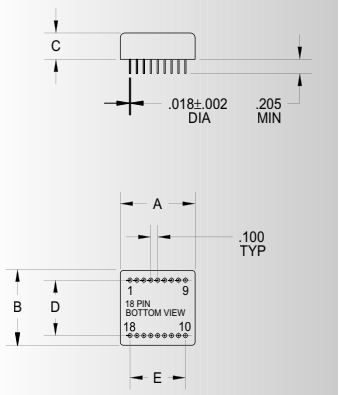
SINGLE OUTPUT DEVICES		3080-S02 (2W)			3080-S02.5 (2.5W)			3080-S03.3 (3.3W)			3080-S05 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1A	—	—	1A	—	—	1A	—	—	1A
Efficiency	P_{out} = max rated load	54%	57%	—	59%	62%	—	64%	67%	—	69%	72%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		3080-S05.2 (5W)			3080-S12 (5W)			3080-S15 (5W)			3080-S28 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	961mA	—	—	416mA	—	—	333mA	—	—	178mA
Efficiency	P_{out} = max rated load	69%	72%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	1250mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3080	1	18	Solder Sealed Flangeless PCB Mount

9000

CASE STYLE 1



Case Dimensions

Units: inches | millimeters

Case Style	A	B	C	D	E	F	G
1	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

DUAL OUTPUT DEVICES		3080-D05 (5W)			3080-D12 (5W)			3080-D15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±500mA	±15mA	—	±208mA	±12mA	—	±166mA
Efficiency	P_{out} = max rated load	71%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

28 VDC

TRIPLE OUTPUT DEVICES		3080-T05 (3.25W)			3080-T12 (3.7W)			3080-T15 (3.7W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.5 -11.5	+5.0 +12.0 -12.0	+5.1 +12.5 -12.5	+4.9 +14.5 -14.5	+5.0 +15.0 -15.0	+5.1 +15.5 -15.5
Output current	$V_{in\ min}$ — $V_{in\ max}$	100mA ±10mA	— —	500mA ±75mA	100mA ±5mA	— —	500mA ±50mA	100mA ±5mA	— —	500mA ±40mA
Efficiency	P_{out} = max rated load	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

3080-SXX output <24 VDC				3080-SXX output ≥24 VDC				3080-DXX				3080-TXX			
Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C
Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C
Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C
Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C
Pin 5	N/C	Pin 14	N/C	Pin 5	main out ret	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C
Pin 6	main out ret	Pin 15	inhibit not	Pin 6	N/C	Pin 15	inhibit not	Pin 6	output com	Pin 15	inhibit not	Pin 6	dual output ret	Pin 15	inhibit not
Pin 7	main out ret	Pin 16	N/C	Pin 7	N/C	Pin 16	N/C	Pin 7	output com	Pin 16	N/C	Pin 7	dual output ret	Pin 16	N/C
Pin 8	N/C	Pin 17	input ret	Pin 8	main output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret
Pin 9	N/C	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

7.5–20 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- For MIL-STD-704/1275 applications
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Short circuit protection
- Fully isolated, input to output
- Single, dual or triple outputs
- 200 kHz operation for low ripple and fast response time
- No external filter caps required
- Full hermetic package

Specifications

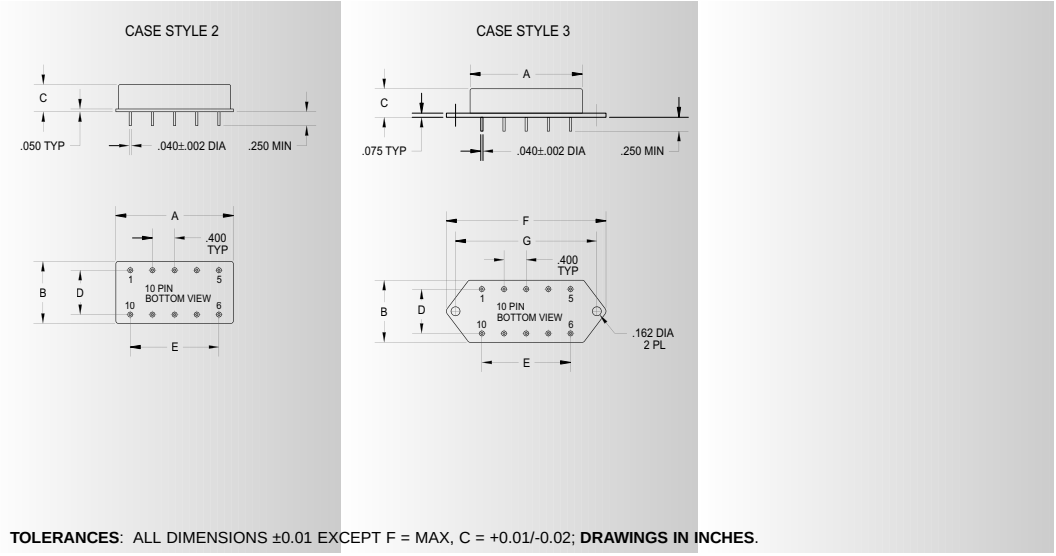
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 55 grams typical

SINGLE OUTPUT DEVICES		3011-S02 (8W)			3011-S02.5 (10W)			3011-S03.3 (13.2W)			3011-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	56%	61%	—	61%	66%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	60	—	40	85

SINGLE OUTPUT DEVICES		3011-S05.2 (20W)			3011-S12 (20W)			3011-S15 (20W)			3011-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3011	2	10	Solder Sealed Flangeless PCB Mount
3011 F	3	10	Solder Sealed PCB Mount with Flange

9000



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style	A	B	C	D	E	F	G
2	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3 F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

DUAL OUTPUT DEVICES		3011-D05 (20W)			3011-D12 (20W)			3011-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3011-T05 (12.5W)			3011-T12 (15W)			3011-T15 (15W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	60mA ±15mA	— —	2A ±250mA	30mA ±15mA	— —	2A ±208mA	30mA ±15mA	— —	2A ±167mA
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

28 VDC

9006

3011-SXX output <24 VDC				3011-SXX output ≥24 VDC				3011-DXX				3011-TXX			
Pin 1	+ input	Pin 7	N/C	Pin 1	+ input	Pin 7	N/C	Pin 1	+ input	Pin 7	N/C	Pin 1	+ input	Pin 7	main output
Pin 2	inhibit not	Pin 8	case	Pin 2	inhibit not	Pin 8	case	Pin 2	inhibit not	Pin 8	case	Pin 2	inhibit not	Pin 8	case
Pin 3	output adjust	Pin 9	N/C	Pin 3	main output	Pin 9	N/C	Pin 3	+ dual output	Pin 9	N/C	Pin 3	+ dual output	Pin 9	N/C
Pin 4	main out ret	Pin 10	input return	Pin 4	N/C	Pin 10	input return	Pin 4	dual out ret	Pin 10	input return	Pin 4	dual out ret	Pin 10	input return
Pin 5	main output			Pin 5	main out ret			Pin 5	- dual output			Pin 5	- dual output		
Pin 6	N/C			Pin 6	N/C			Pin 6	N/C			Pin 6	main out ret		

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

12.5–30 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- For MIL-STD-704/1275 applications
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Short circuit protection
- Fully isolated, input to output
- Single, dual or triple outputs
- 200 kHz operation for low ripple and fast response time
- No external filter caps required
- Full hermetic package

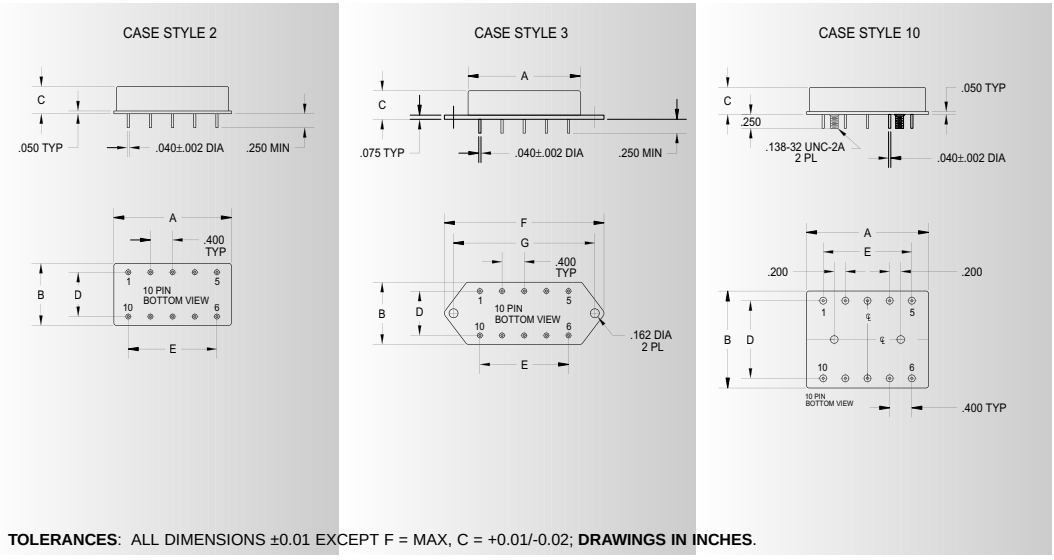
Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 65 grams typical

SINGLE OUTPUT DEVICES		3001-S02 (12W)			3001-S02.5 (15W)			3001-S03.3 (20W)			3001-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	57%	62%	—	62%	67%	—	67%	70%	—	72%	75%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		3001-S05.2 (30W)			3001-S12 (30W)			3001-S15 (30W)			3001-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	72%	75%	—	79%	83%	—	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3001	2	10	Solder Sealed Flangeless PCB Mount
3001 F	3	10	Solder Sealed PCB Mount with Flange
3001 PA	10	10	Solder Sealed Flangeless PCB Stud Mount
3001 MF	13	10	Seam Weld PCB Mount with Flange



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
2		1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
10	PA	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
13	MF	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944

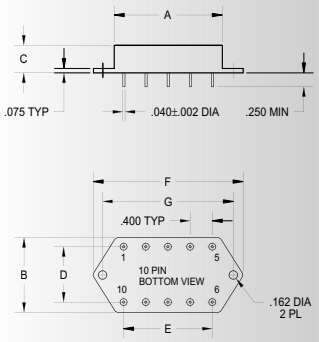
28 VDC

DUAL OUTPUT DEVICES		3001-D05 (30W)			3001-D12 (30W)			3001-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3001-T05 (12.5W)			3001-T12 (17.5W)			3001-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 13



3001-SXX output <24 VDC				3001-SXX output ≥24 VDC				3001-DXX				3001-TXX			
Pin 1	+ inhibit	Pin 7	case	Pin 1	+ inhibit	Pin 7	case	Pin 1	+ input	Pin 7	case	Pin 1	+ inhibit	Pin 7	case
Pin 2	inhibit not	Pin 8	N/C	Pin 2	N/C	Pin 8	inhibit not	Pin 2	N/C	Pin 8	inhibit not	Pin 2	main output	Pin 8	inhibit not
Pin 3	- remote sense	Pin 9	N/C	Pin 3	main output	Pin 9	N/C	Pin 3	+ dual output	Pin 9	N/C	Pin 3	output return	Pin 9	N/C
Pin 4	main out ret	Pin 10	input return	Pin 4	N/C	Pin 10	input return	Pin 4	dual out ret	Pin 10	input return	Pin 4	- dual output	Pin 10	input return
Pin 5	main output			Pin 5	main out ret			Pin 5	- dual output			Pin 5	+ dual output		
Pin 6	+ remote sense			Pin 6	N/C			Pin 6	N/C			Pin 6	N/C		

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

30 Watt Hybrid

Features

- Completely self contained Thick Film Hybrid DC-DC Converter
- For MIL-STD-704/1275 applications
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Short circuit protection
- Fully isolated, input to output
- Triple outputs
- 200 kHz operation for low ripple and fast response time
- No external filter caps required
- Full hermetic package

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 65 grams typical

NOTE: The main regulated output is the 5.0 VDC at 3 Amperes. The other outputs are regulated by virtue of being wound on the same transformer, therefore are termed "cross-regulated." Since the cross-regulated outputs do not have a linear (dissipative) regulator, the converter is more efficient and can deliver higher overall power than a corresponding linear post-regulated converter.

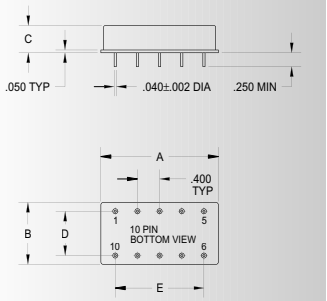
SINGLE OUTPUT DEVICES					
PARAMETER	CONDITION				
Output voltage	—				
Output current	$V_{in\ min}$ — $V_{in\ max}$				
Efficiency	P_{out} = max rated load				
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$				
Load regulation	P_{out} = 10% to F.L.				
Output ripple	F.L. BW 2 MHz mV_{pp}				

SINGLE OUTPUT DEVICES					
PARAMETER	CONDITION				
Output voltage	—				
Output current	$V_{in\ min}$ — $V_{in\ max}$				
Efficiency	P_{out} = max rated load				
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$				
Load regulation	P_{out} = 10% to F.L.				
Output ripple	F.L. BW 2 MHz mV_{pp}				

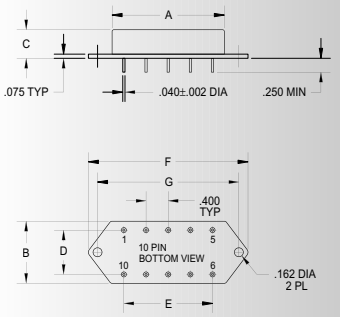
9006

Model No.		Case Style	Pin Count	Mounting
3138		2	10	Solder Sealed Flangeless PCB Mount
3138	F	3	10	Solder Sealed PCB Mount with Flange
3138	PA	10	10	Solder Sealed Flangeless PCB Stud Mount
3138	MF	13	10	Seam Weld PCB Mount with Flange

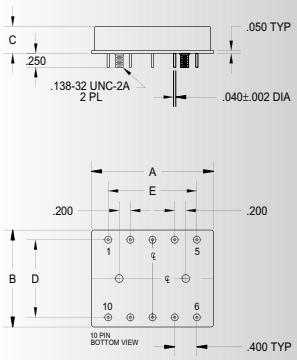
CASE STYLE 2



CASE STYLE 3



CASE STYLE 10



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
2		1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
10	PA	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
13	MF	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944

28 VDC

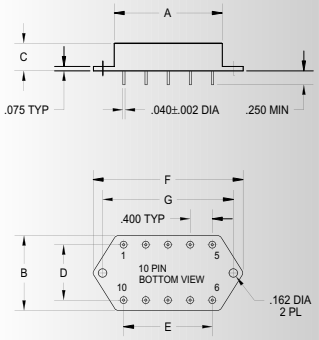
9006

DUAL OUTPUT DEVICES										
PARAMETER	CONDITION									
Output voltage	$+I_{out} = -I_{out}$									
Output current*	$V_{in\ min} — V_{in\ max}$									
Efficiency	P_{out} = max rated load									
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$									
Load regulation†	P_{out} = 10% to F.L.									
Output ripple	F.L. BW 2 MHz mV_{pp}									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3138-T05 (30W)			3138-T12 (30W)			3138-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.75	+5.0	+5.25	+11.5	+12.0	+12.5	+14.5	+15.0	+15.5
		-4.75	-5.0	-5.25	-11.5	-12.0	-12.5	-14.5	-15.0	-15.5
Output current	$V_{in\ min} — V_{in\ max}$	300mA	—	3A	300mA	—	3A	300mA	—	3A
		±150mA	—	±1.5A	±60mA	—	±625mA	±50mA	—	±500mA
Efficiency	P_{out} = max rated load	65%	70%	—	70%	75%	—	70%	75%	—
Line regulation	P_{out} = max rated load	—	10mV	25mV	—	10mV	25mV	—	10mV	25mV
	$V_{in\ min} — V_{in\ max}$	—	±120mV	±220mV	—	±250mV	±500mV	—	±250mV	±500mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
		—	±120mV	±220mV	—	±250mV	±500mV	—	±250mV	±500mV
Output ripple	F.L. BW 2 MHz	—	—	80	—	—	80	—	—	80
	mV_{pp}	—	—	50	—	—	50	—	—	50

CASE STYLE 13



3138-TXX

Pin 1	+ input	Pin 7	case
Pin 2	main output	Pin 8	inhibit not
Pin 3	output return	Pin 9	N/C
Pin 4	- dual output	Pin 10	input return
Pin 5	+ dual output		
Pin 6	N/C		

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

3.75–6.5 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

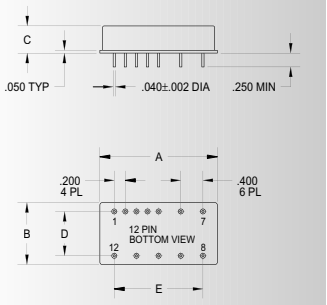
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		2690-S03.3 (6.5W)			2690-S05 (6.5W)			2690-S05.2 (6.5W)			2690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

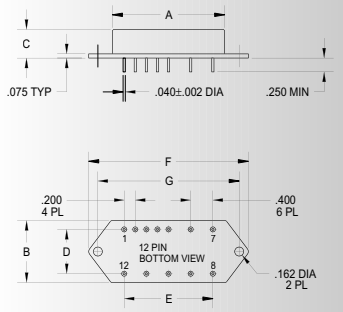
SINGLE OUTPUT DEVICES		2690-S15 (6.5W)			2690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
2690	2	12	Solder Sealed Flangeless PCB Mount
2690 F	3	12	Solder Sealed PCB Mount with Flange
2690 G	5	12	Seam Weld Flangeless PCB Mount
2690 GF	6	12	Seam Weld PCB Mount with Flange
2690 UF	8	12	Seam Weld Chassis Mount with Flange

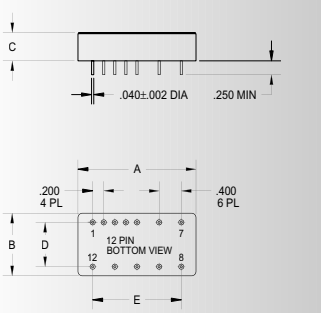
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

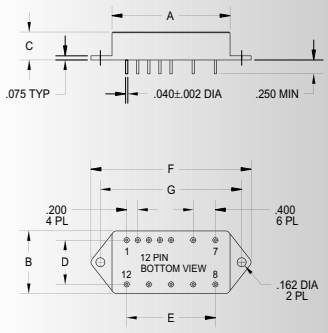
28 VDC

DUAL OUTPUT DEVICES		2690-D05 (6.5W)			2690-D12 (6.5W)			2690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	50	180

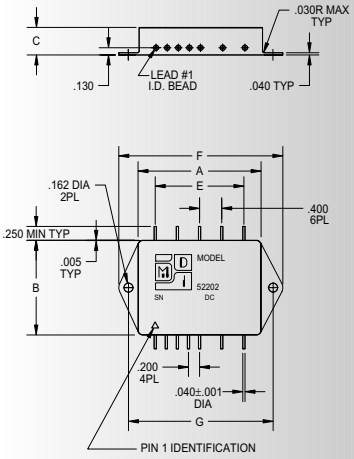
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		2690-T3.3/5 (3.75W)			2690-T3.3/12 (5W)			2690-T3.3/15 (5W)			2690-T05 (3.75W)			2690-T12 (5.6W)			2690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



2690-SXX output <24 VDC				2690-SXX output ≥24 VDC				2690-DXX				2690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

7.5–20 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

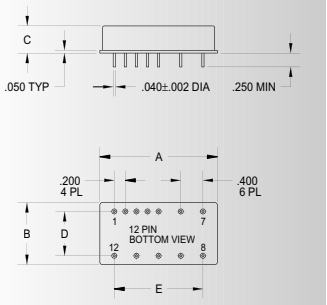
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		3107-S03.3 (13.2W)			3107-S05 (20W)			3107-S05.2 (20W)			3107-S12 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	3.85A	—	—	1.67A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

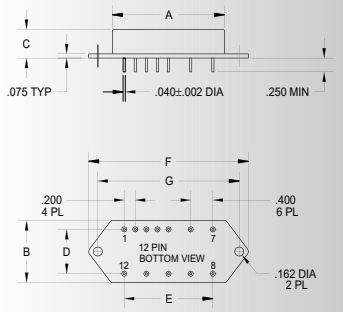
SINGLE OUTPUT DEVICES		3107-S15 (20W)			3107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3107	2	12	Solder Sealed Flangeless PCB Mount
3107 F	3	12	Solder Sealed PCB Mount with Flange
3107 H	5	12	Seam Weld Flangeless PCB Mount
3107 HF	6	12	Seam Weld PCB Mount with Flange
3107 VF	8	12	Seam Weld Chassis Mount with Flange

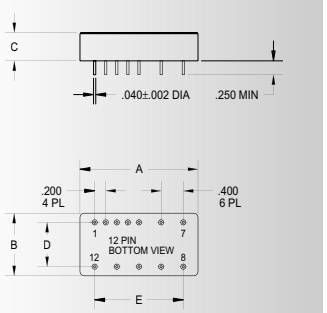
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

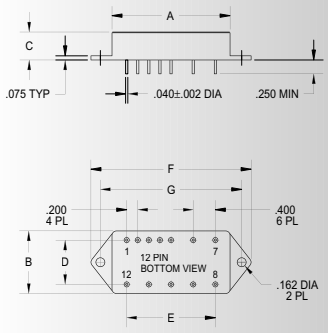
DUAL OUTPUT DEVICES		3107-D05 (20W)			3107-D12 (20W)			3107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

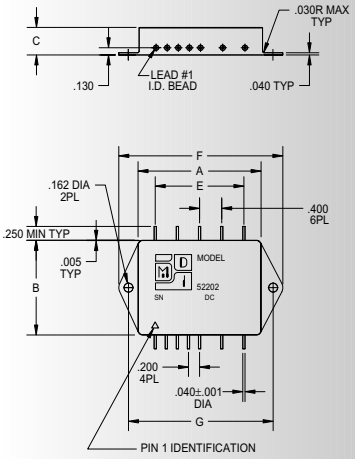
28 VDC

TRIPLE OUTPUT DEVICES		3107-T3.3/5 (7.5W)			3107-T3.3/12 (10W)			3107-T3.3/15 (10W)			3107-T05 (7.5W)			3107-T12 (10W)			3107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA ±15mA	— —	1.5A ±250mA	150mA ±15mA	— —	1.5A ±208mA	150mA ±15mA	— —	1.5A ±167mA	60mA ±15mA	— —	1A ±250mA	30mA ±15mA	— —	1A ±208mA	30mA ±15mA	— —	1A ±167mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



3107-SXX output <24 VDC				3107-SXX output ≥24 VDC				3107-DXX				3107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

12.5-30 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

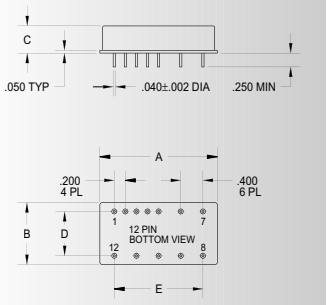
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		2680-S03.3 (20W)			2680-S05 (30W)			2680-S05.2 (30W)			2680-S12 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6A	—	—	5.76A	—	—	2.5A
Efficiency	P_{out} = max rated load	67%	70%	—	72%	75%	—	72%	75%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

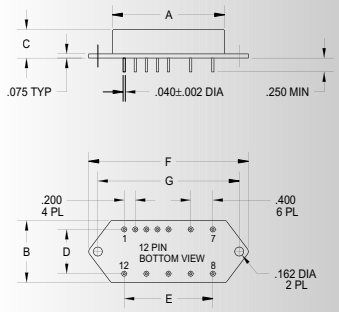
SINGLE OUTPUT DEVICES		2680-S15 (30W)			2680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
2680	2	12	Solder Sealed Flangeless PCB Mount
2680 F	3	12	Solder Sealed PCB Mount with Flange
2680 I	5	12	Seam Weld Flangeless PCB Mount
2680 IF	6	12	Seam Weld PCB Mount with Flange
2680 WF	8	12	Seam Weld Chassis Mount with Flange
2680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
2680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

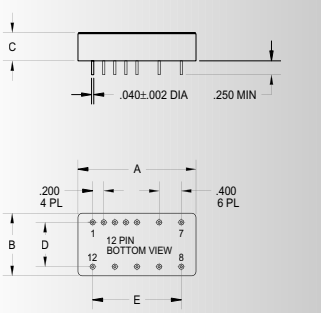
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

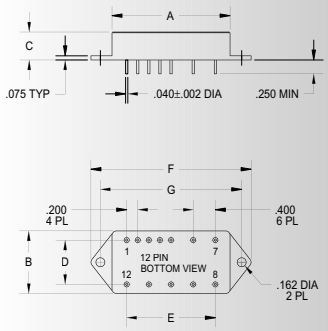
DUAL OUTPUT DEVICES		2680-D05 (30W)			2680-D12 (30W)			2680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

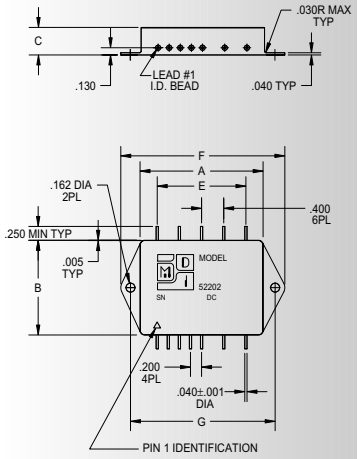
28 VDC

TRIPLE OUTPUT DEVICES		2680-T3.3/5 (12.5W)			2680-T3.3/12 (17.5W)			2680-T3.3/15 (17.5W)			2680-T05 (12.5W)			2680-T12 (17.5W)			2680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

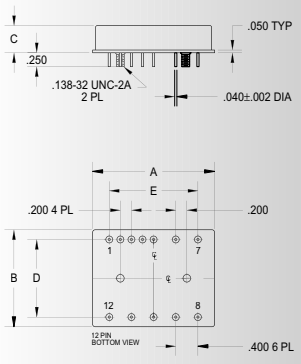
CASE STYLE 6



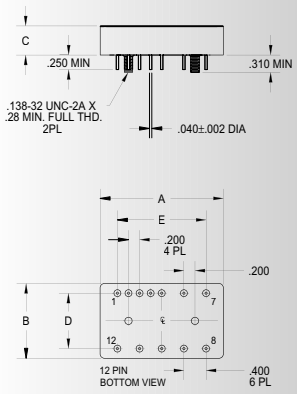
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



2680-SXX output <24 VDC				2680-SXX output ≥24 VDC				2680-DXX				2680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

19.5-40 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

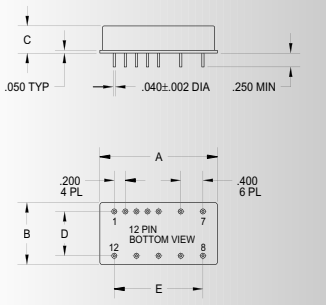
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		3193-S03.3 (26.4W)			3193-S05 (40W)			3193-S05.2 (40W)			3193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	67%	70%	—	72%	75%	—	72%	75%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

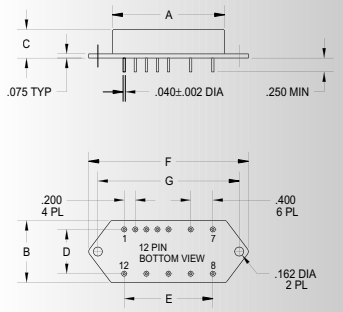
SINGLE OUTPUT DEVICES		3193-S15 (40W)			3193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3193	2	12	Solder Sealed Flangeless PCB Mount
3193 F	3	12	Solder Sealed PCB Mount with Flange
3193 J	5	12	Seam Weld Flangeless PCB Mount
3193 JF	6	12	Seam Weld PCB Mount with Flange
3193 XF	8	12	Seam Weld Chassis Mount with Flange
3193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

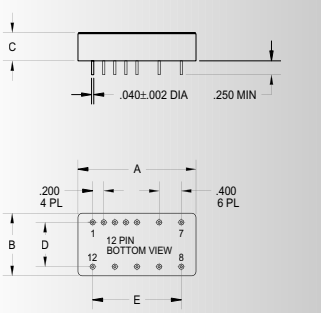
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.225 | 56.515	2.100 | 53.340	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

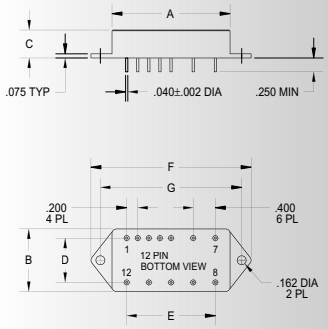
DUAL OUTPUT DEVICES		3193-D05 (40W)			3193-D12 (40W)			3193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

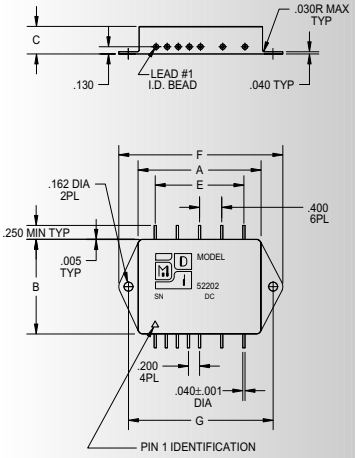
28 VDC

TRIPLE OUTPUT DEVICES		3193-T3.3/5 (17.7W)			3193-T3.3/12 (24W)			3193-T3.3/15 (25.2W)			3193-T05 (19.5W)			3193-T12 (25.8W)			3193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

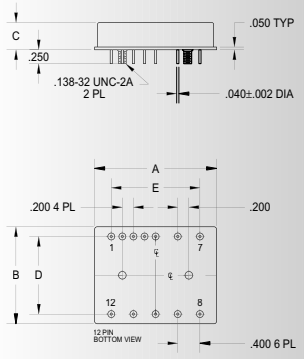
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



3193-SXX output <24 VDC				3193-SXX output ≥24 VDC				3193-DXX				3193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	-remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	-dual output	Pin 6	input ret	Pin 12	-dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

32.5–80 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		3031-S03.3 (49.5W)			3031-S05 (75W)			3031-S05.2 (78W)			3031-S12 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	6.25A
Efficiency	P_{out} = max rated load	67%	70%	—	72%	75%	—	72%	75%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

SINGLE OUTPUT DEVICES		3031-S15 (75W)			3031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3031	4	12	Solder Sealed PCB Mount with Flange
3031 LF	7	12	Seam Weld PCB Mount with Flange
3031 ZF	9	12	Seam Weld Chassis Mount with Flange
3031 PD	11	12	Solder Sealed Flangeless PCB Stud Mount

3031-SXX output <24 VDC				3031-SXX output ≥24 VDC				3031-DXX				3031-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

3031-SXX ZF output <24 VDC				3031-SXX ZF output ≥24 VDC				3031-DXX ZF				3031-TXX ZF			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit	Pin 8	main output	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	N/C	Pin 2	inhibit	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

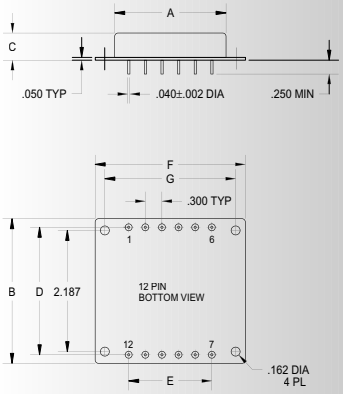
DUAL OUTPUT DEVICES		3031-D05 (75W)			3031-D12 (74.4W)			3031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
Efficiency	P_{out} = max rated load	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

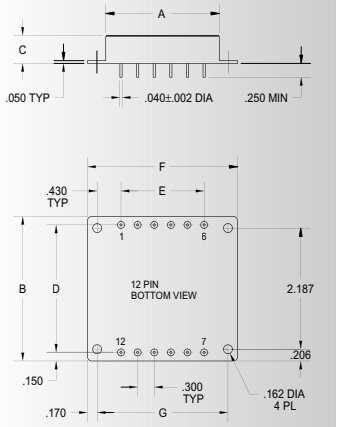
28 VDC

TRIPLE OUTPUT DEVICES		3031-T3.3/5 (32.25W)			3031-T3.3/12 (42.75W)			3031-T3.3/15 (47.25W)			3031-T05 (32.5W)			3031-T12 (43W)			3031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA ±40mA	— —	7.5A ±750mA	750mA ±40mA	— —	7.5A ±750mA	750mA ±32mA	— —	7.5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±32mA	— —	5A ±750mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

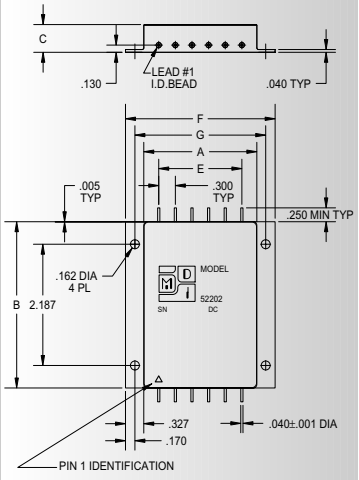
CASE STYLE 4



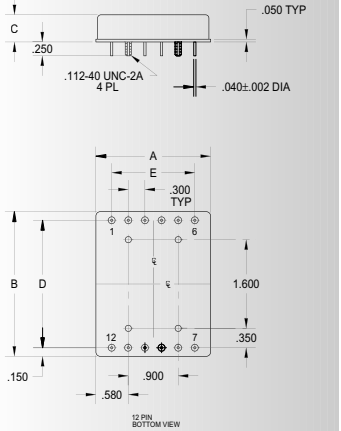
CASE STYLE 7



CASE STYLE 9



CASE STYLE 11



Case Dimensions
Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

3.25-6.5 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 300 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

Note

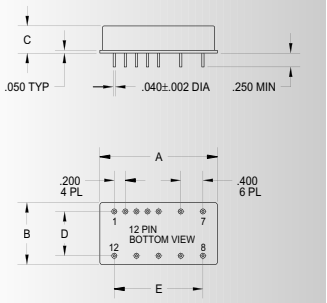
Series 6690 is recommended over 2690 for new designs ("Inhibit not" function yields a higher level of noise immunity).

SINGLE OUTPUT DEVICES		6690-S03.3 (6.5W)			6690-S03.3 (6.5W)			6690-S05.2 (6.5W)			6690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.97A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	30	65	—	40	85	—	60	150

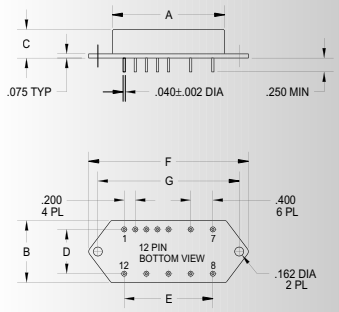
SINGLE OUTPUT DEVICES		6690-S15 (6.5W)			6690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
6690	2	12	Solder Sealed Flangeless PCB Mount
6690 F	3	12	Solder Sealed PCB Mount with Flange
6690 G	5	12	Seam Weld Flangeless PCB Mount
6690 GF	6	12	Seam Weld PCB Mount with Flange
6690 UF	8	12	Seam Weld Chassis Mount with Flange

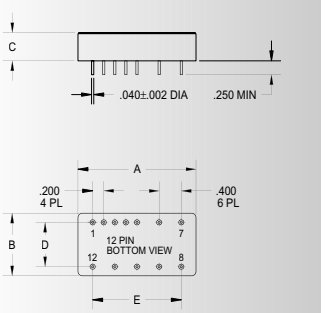
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

9006

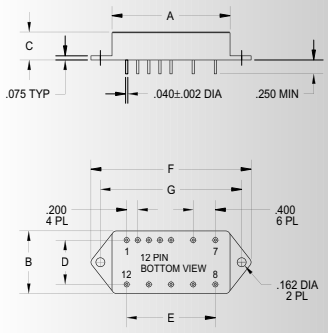
28 VDC

DUAL OUTPUT DEVICES		6690-D05 (6.5W)			6690-D12 (6.5W)			6690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

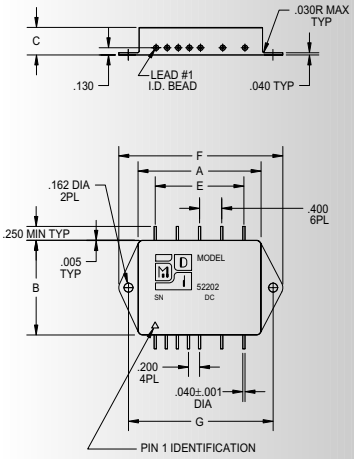
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		6690-T3.3/5 (3.75W)			6690-T3.3/12 (5W)			6690-T3.3/15 (5W)			6690-T05 (3.75W)			6690-T12 (5W)			6690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750A ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



6690-SXX output <24 VDC				6690-SXX output ≥24 VDC				6690-DXX				6690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

9006

7.5–20 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 300 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

Note

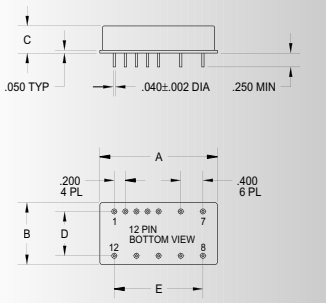
Series 6107 is recommended over 3107 for new designs ("Inhibit not" function yields a higher level of noise immunity).

SINGLE OUTPUT DEVICES		6107-S02 (8W)			6107-S02.5 (10W)			6107-S03.3 (13.2W)			6107-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	30	65	—	30	65	—	40	85

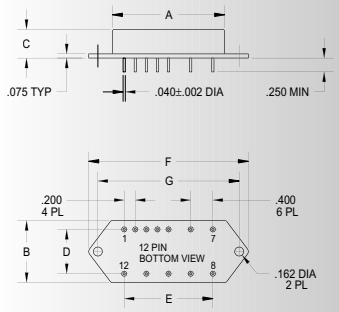
SINGLE OUTPUT DEVICES		6107-S05.2 (20W)			6107-S12 (20W)			6107-S15 (20W)			6107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	70%	73%	—	77%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
6107	2	12	Solder Sealed Flangeless PCB Mount
6107 F	3	12	Solder Sealed PCB Mount with Flange
6107 H	5	12	Seam Weld Flangeless PCB Mount
6107 HF	6	12	Seam Weld PCB Mount with Flange
6107 VF	8	12	Seam Weld Chassis Mount with Flange

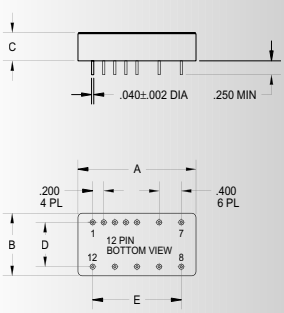
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

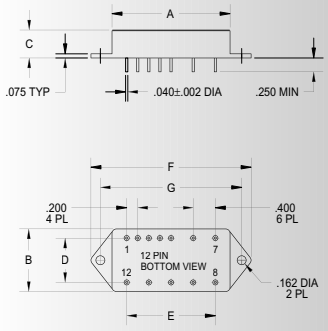
DUAL OUTPUT DEVICES		6107-D3.3/5 (11.6W)			6107-D05 (20W)			6107-D12 (20W)			6107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min} — V_{in\ max}$	200mA	—	2A	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
		100mA	—	1A									
Efficiency	P_{out} = max rated load	62%	65%	—	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load	—	±10mV	±30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min} — V_{in\ max}$	—	±10mV	±50mV									
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	±10mV	±50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

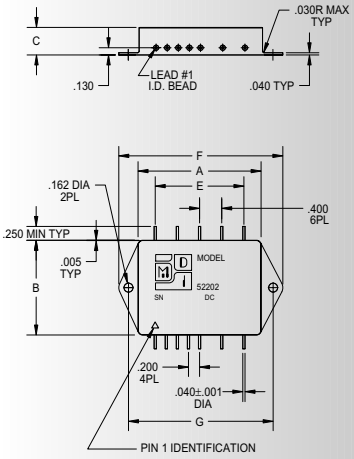
28 VDC

TRIPLE OUTPUT DEVICES		6107-T3.3/5 (7.5W)			6107-T3.3/12 (10W)			6107-T3.3/15 (10W)			6107-T05 (7.5W)			6107-T12 (10W)			6107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min} — V_{in\ max}$	150mA	—	1.5A	150mA	—	1.5A	150mA	—	1.5A	60mA	—	1A	30mA	—	1A	30mA	—	1A
		±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA	±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min} — V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 6



CASE STYLE 8



6107-SXX output <24 VDC				6107-SXX output ≥24 VDC				6107-DXX				6107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

12.5–30 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 300 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

Note

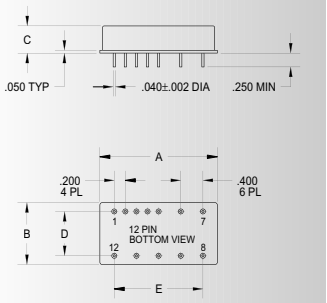
Series 6680 is recommended over 2680 for new designs ("Inhibit not" function yields a higher level of noise immunity).

SINGLE OUTPUT DEVICES		6680-S02 (12W)			6680-S02.5 (15W)			6680-S03.3 (20W)			6680-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

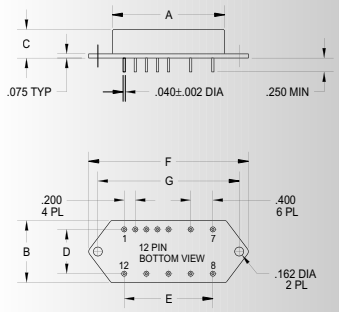
SINGLE OUTPUT DEVICES		6680-S05.2 (30W)			6680-S12 (30W)			6680-S15 (30W)			6680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
6680	2	12	Solder Sealed Flangeless PCB Mount
6680 F	3	12	Solder Sealed PCB Mount with Flange
6680 I	5	12	Seam Weld Flangeless PCB Mount
6680 IF	6	12	Seam Weld PCB Mount with Flange
6680 WF	8	12	Seam Weld Chassis Mount with Flange
6680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
6680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

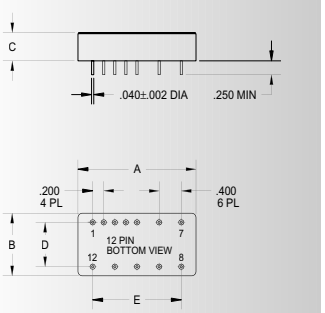
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

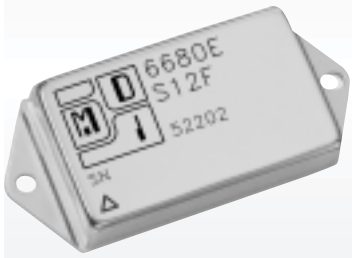
Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		6680-D3.3/5 (14.9W)			6680-D05 (30W)			6680-D12 (30W)			6680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
		100mA	—	1A									
Efficiency	P_{out} = max rated load	63%	66%	—	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load	—	±10mV	±30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV									
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	±10mV	±50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

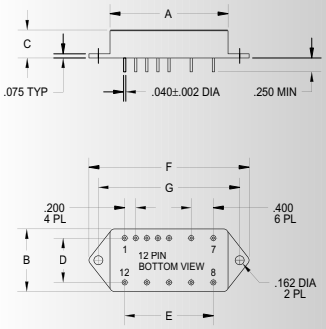
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*



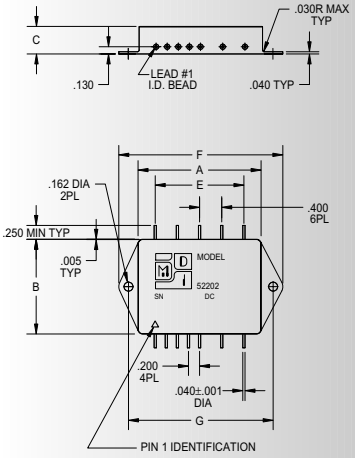
28 VDC

TRIPLE OUTPUT DEVICES		6680-T3.3/5 (12.5W)			6680-T3.3/12 (17.5W)			6680-T3.3/15 (17.5W)			6680-T05 (12.5W)			6680-T12 (17.5W)			6680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	300mA	—	3A	300mA	—	3A	90mA	—	2A	90mA	—	2A	90mA	—	2A
		±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA	±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

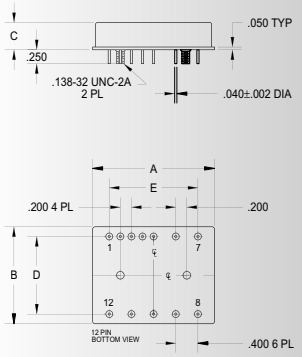
CASE STYLE 6



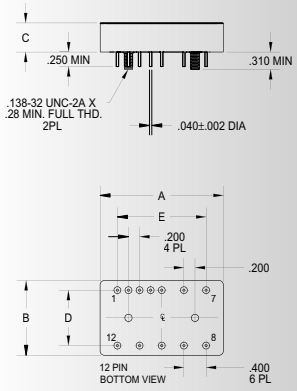
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



6680-SXX output <24 VDC				6680-SXX output ≥24 VDC				6680-DXX				6680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

19.5–40 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 300 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

Note

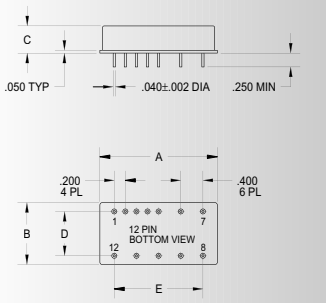
Series 6193 is recommended over 3193 for new designs ("Inhibit not" function yields a higher level of noise immunity).

SINGLE OUTPUT DEVICES		6193-S03.3 (26.4W)			6193-S05 (40W)			6193-S05.2 (40W)			6193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	65%	68%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

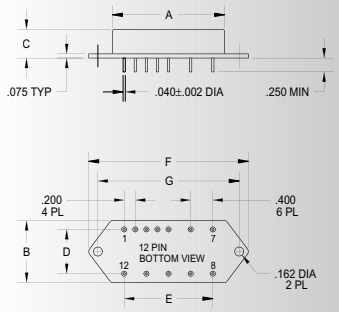
SINGLE OUTPUT DEVICES		6193-S15 (40W)			6193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
6193	2	12	Solder Sealed Flangeless PCB Mount
6193 F	3	12	Solder Sealed PCB Mount with Flange
6193 J	5	12	Seam Weld Flangeless PCB Mount
6193 JF	6	12	Seam Weld PCB Mount with Flange
6193 XF	8	12	Seam Weld Chassis Mount with Flange
6193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

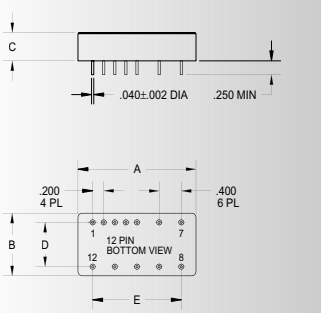
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.225 | 56.515	2.100 | 53.340	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

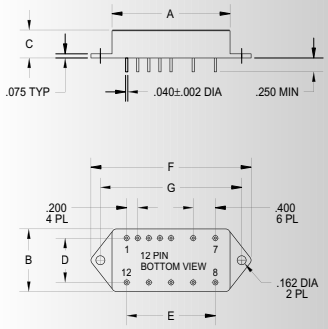
28 VDC

DUAL OUTPUT DEVICES		6193-D05 (40W)			6193-D12 (40W)			6193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	77%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

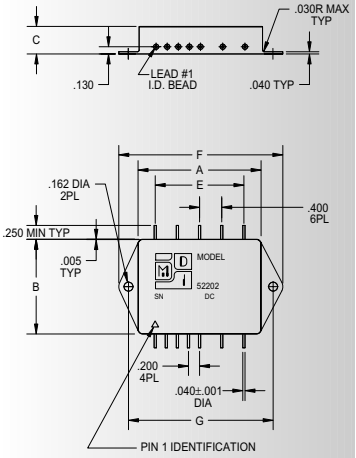
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		6193-T3.3/5 (17.5W)			6193-T3.3/12 (24W)			6193-T3.3/15 (25.2W)			6193-T05 (19.5W)			6193-T12 (25.8W)			6193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

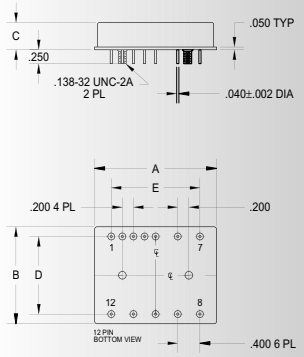
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



6193-SXX output <24 VDC				6193-SXX output ≥24 VDC				6193-DXX				6193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

32.5–80 Watt Hybrid

Features

- Specifically designed for redundant or individual military or aerospace applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 300 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

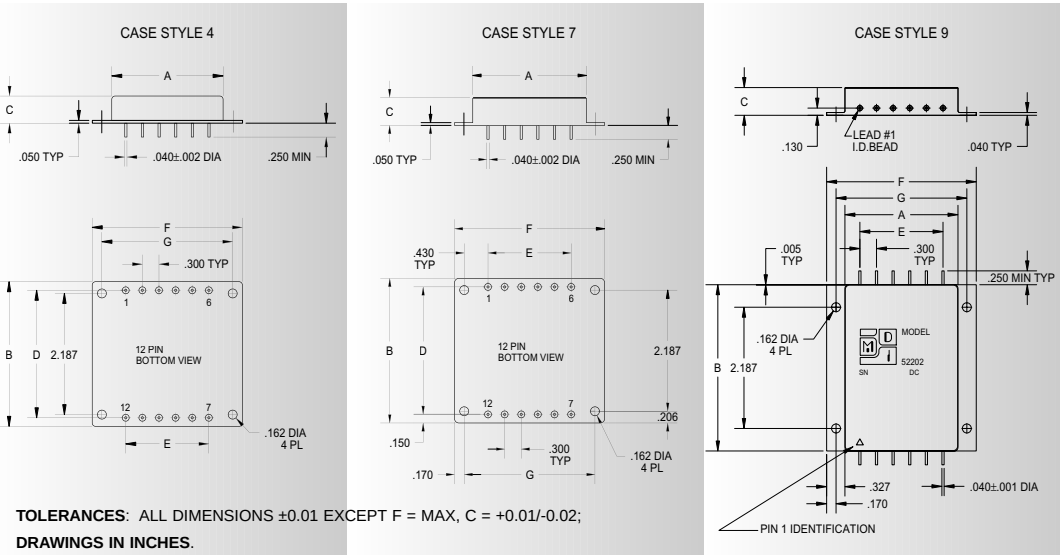
Note

Series 6031 is recommended over 3031 for new designs ("Inhibit not" function yields a higher level of noise immunity).

SINGLE OUTPUT DEVICES		6031-S02 (30W)			6031-S02.5 (37.5W)			6031-S03.3 (50W)			6031-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		6031-S05.2 (78W)			6031-S12 (75W)			6031-S15 (75W)			6031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	70%	73%	—	78%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
6031	4	12	Solder Sealed PCB Mount with Flange
6031 LF	7	12	Seam Weld PCB Mount with Flange
6031 ZF	9	12	Seam Weld PCB Stud Mount with Flange
6031 PD	11	12	Solder Sealed Flangeless PCB Stud Mount



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02;
DRAWINGS IN INCHES.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

9006

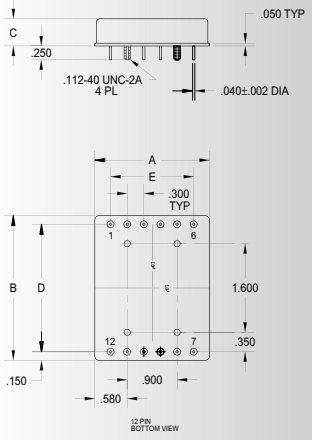
DUAL OUTPUT DEVICES		6031-D3.3/5 (31.78W)			6031-D05 (75W)			6031-D12 (74.4W)			6031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	660mA	—	6.6A	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
		200mA	—	2A									
Efficiency	P_{out} = max rated load	64%	67%	—	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

28 VDC

TRIPLE OUTPUT DEVICES		6031-T3.3/5 (32.25W)			6031-T3.3/12 (42.75W)			6031-T3.3/15 (47.25W)			6031-T05 (32.5W)			6031-T12 (43W)			6031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA	—	7.5A	750mA	—	7.5A	750mA	—	7.5A	90mA	—	5A	90mA	—	5A	90mA	—	5A
		±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA	±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	71%	74%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 11



6031-SXX output <24 VDC				6031-SXX output ≥24 VDC				6031-DXX				6031-TXX			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

2.5 Watt Hybrid

Features

- Efficiency optimized for low power applications
- Proton resistant 100K rad hard
- SEU resistant
- Typical no load quiescent current 8mA at 28 VDC
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 100 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

Note

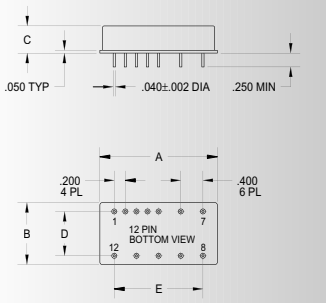
All units operate to no load. Minimum load is the measurement point for load regulation.

SINGLE OUTPUT DEVICES		4690-S02 (2.5W)			4690-S02.5 (2.5W)			4690-S03.3 (2.5W)			4690-S05 (2.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	125mA	—	1.25A	0.1A	—	1A	75mA	—	0.75A	0.50mA	—	0.50A
Efficiency	P_{out} = max rated load	70%	74%	—	72%	77%	—	74%	79%	—	77%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	50mV	100mV	—	62mV	125mV	—	75mV	150mV	—	0.1V	0.2V
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	30	65	—	30	65	—	40	85

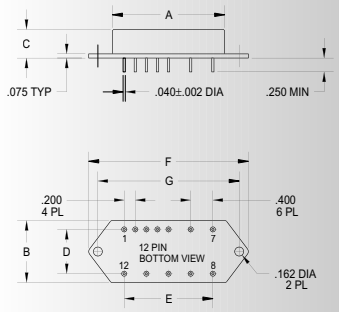
SINGLE OUTPUT DEVICES		4690-S05.2 (2.5W)			4690-S12 (2.5W)			4690-S15 (2.5W)			4690-S28 (2.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	48mA	—	480mA	20.8mA	—	0.208A	16.7mA	—	0.167A	9mA	—	90mA
Efficiency	P_{out} = max rated load	77%	82%	—	81%	85%	—	81%	86%	—	81%	86%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	0.1V	0.2V	—	0.25V	0.5V	—	0.3V	0.6V	—	600mV	1.2V
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
4690	2	12	Solder Sealed Flangeless PCB Mount
4690 F	3	12	Solder Sealed PCB Mount with Flange
4690 G	5	12	Seam Weld Flangeless PCB Mount
4690 GF	6	12	Seam Weld PCB Mount with Flange
4690 UF	8	12	Seam Weld Chassis Mount with Flange

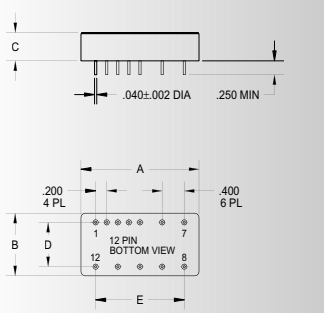
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



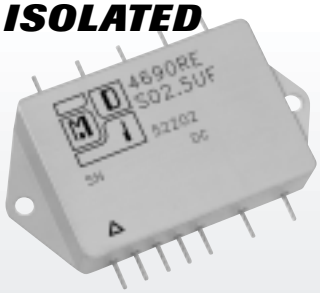
Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED



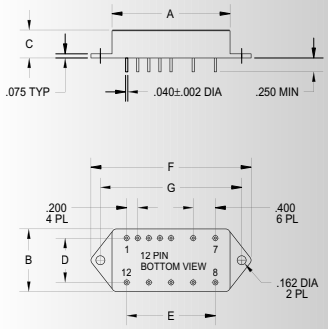
28 VDC

DUAL OUTPUT DEVICES		4690-D05 (2.5W)			4690-D12 (2.5W)			4690-D15 (2.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±25mA	—	±250mA	±10.4mA	—	±104mA	±8.3mA	—	±83mA
Efficiency	P_{out} = max rated load	77%	82%	—	81%	85%	—	81%	86%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±50mV	±100mV	—	±250mV	±0.5V	—	±0.3V	±0.6V
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

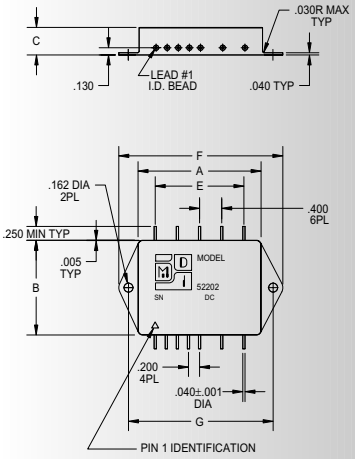
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		4690-T05 (2.5W)			4690-T12 (2.5W)			4690-T15 (2.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	30mA ±20mA	— —	250mA ±125mA	30mA ±20mA	— —	250mA ±52mA	30mA ±20mA	— —	250mA ±42mA
Efficiency	P_{out} = max rated load	65%	70%	—	72%	77%	—	73%	78%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 100mV	50mV 200mV	— —	10mV 100mV	50mV 200mV	— —	10mV 100mV	50mV 200mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 100mV	50mV 200mV	— —	10mV 100mV	50mV 200mV	— —	10mV 100mV	50mV 200mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



4690-SXX output <24 VDC				4690-SXX output ≥24 VDC				4690-DXX				4690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 KRAD, +85°C military/aerospace
RE 100 KRAD, +125°C military/aerospace
S 100 KRAD, +85°C space
SE 100 KRAD, +125°C space

3.75–6.5 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A

ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC

ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C

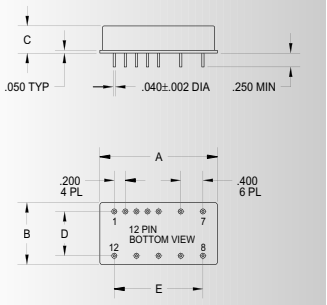
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		5690-S03.3 (6.5W)			5690-S05 (6.5W)			5690-S05.2 (6.5W)			5690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

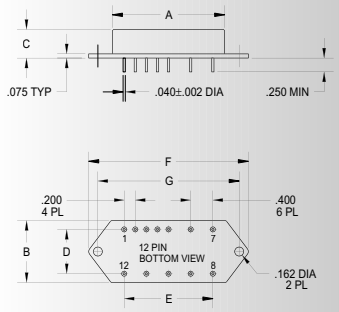
SINGLE OUTPUT DEVICES		5690-S15 (6.5W)			5690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
5690	2	12	Solder Sealed Flangeless PCB Mount
5690 F	3	12	Solder Sealed PCB Mount with Flange
5690 G	5	12	Seam Weld Flangeless PCB Mount
5690 GF	6	12	Seam Weld PCB Mount with Flange
5690 UF	8	12	Seam Weld Chassis Mount with Flange

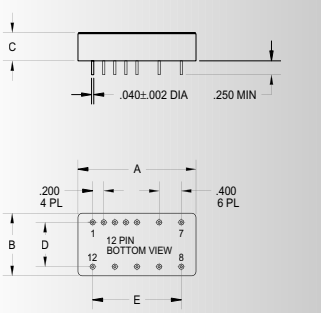
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



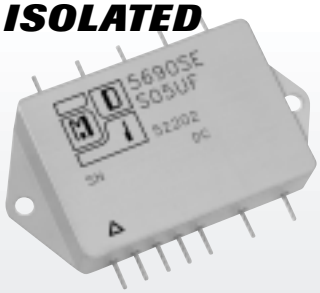
Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED



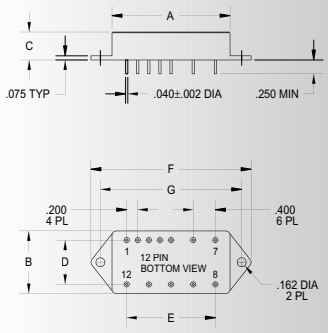
28 VDC

DUAL OUTPUT DEVICES		5690-D05 (6.5W)			5690-D12 (6.5W)			5690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

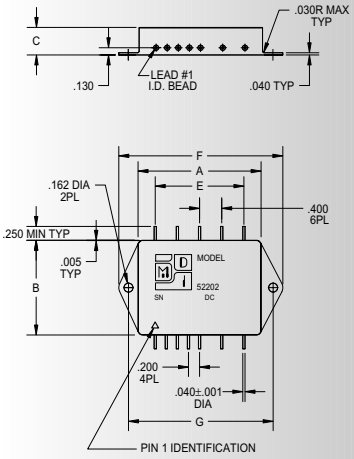
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		5690-T3.3/5 (3.75W)			5690-T3.3/12 (5W)			5690-T3.3/15 (5W)			5690-T05 (3.75W)			5690-T12 (5W)			5690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	66%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



5690-SXX output <24 VDC				5690-SXX output ≥24 VDC				5690-DXX				5690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

7.5–20 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A

ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC

ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C

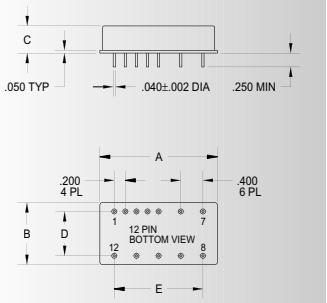
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		5107-S02 (8W)			5107-S02.5 (10W)			5107-S03.3 (13.2W)			5107-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

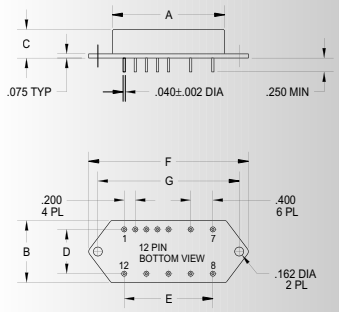
SINGLE OUTPUT DEVICES		5107-S05.2 (20W)			5107-S12 (20W)			5107-S15 (20W)			5107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	70%	73%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
5107	2	12	Solder Sealed Flangeless PCB Mount
5107 F	3	12	Solder Sealed PCB Mount with Flange
5107 H	5	12	Seam Weld Flangeless PCB Mount
5107 HF	6	12	Seam Weld PCB Mount with Flange
5107 VF	8	12	Seam Weld Chassis Mount with Flange

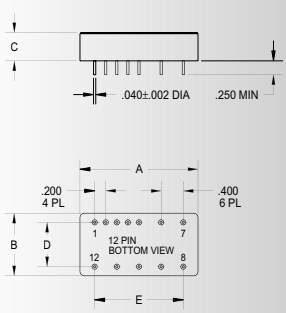
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

9006

MAGNETICALLY ISOLATED

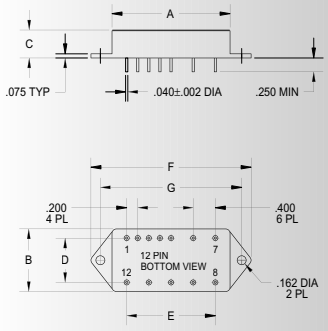
28 VDC

DUAL OUTPUT DEVICES		5107-D3.3/5 (11.6W)			5107-D05 (20W)			5107-D12 (20W)			5107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	200mA	—	2A	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
		100mA	—	1A									
Efficiency	P_{out} = max rated load	62%	65%	—	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

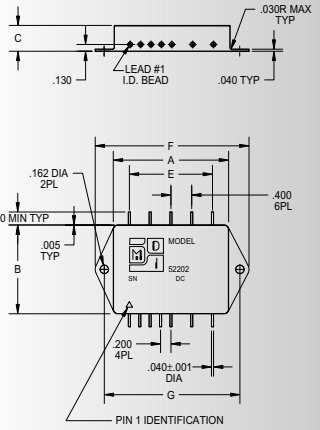
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		5107-T3.3/5 (7.5W)			5107-T3.3/12 (10W)			5107-T3.3/15 (10W)			5107-T05 (7.5W)			5107-T12 (10W)			5107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA	—	1.5A	150mA	—	1.5A	150mA	—	1.5A	60mA	—	1A	30mA	—	1A	30mA	—	1A
		±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA	±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 6



CASE STYLE 8



5107-SXX output <24 VDC				5107-SXX output ≥24 VDC				5107-DXX				5107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

12.5–30 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A

ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC

ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C

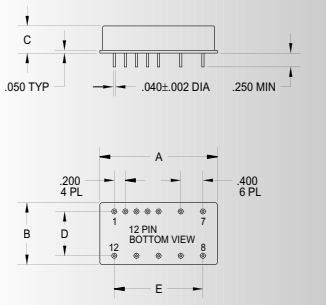
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		5680-S02 (12W)			5680-S02.5 (15W)			5680-S03.3 (20W)			5680-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

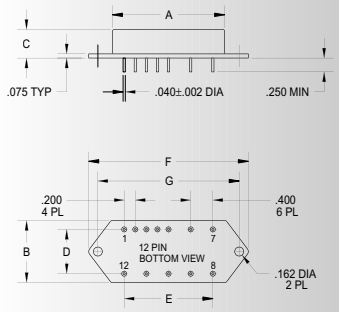
SINGLE OUTPUT DEVICES		5680-S05.2 (30W)			5680-S12 (30W)			5680-S15 (30W)			5680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
5680	2	12	Solder Sealed Flangeless PCB Mount
5680 F	3	12	Solder Sealed PCB Mount with Flange
5680 I	5	12	Seam Weld Flangeless PCB Mount
5680 IF	6	12	Seam Weld PCB Mount with Flange
5680 WF	8	12	Seam Weld Chassis Mount with Flange
5680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
5680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

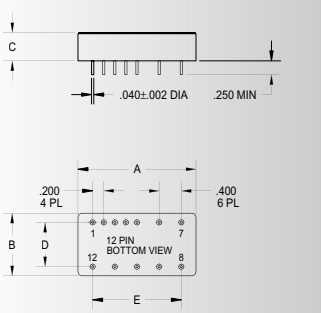
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		5680-D3.3/5 (14.9W)			5680-D05 (30W)			5680-D12 (30W)			5680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 -4.9	+3.3 -5.0	+3.4 -5.1	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min} — V_{in\ max}$	300mA 100mA	— —	3A 1A	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	63%	66%	—	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	— —	10mV 10mV	30mV 50mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	— —	10mV 10mV	30mV 50mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 25	65 50	—	40	85	—	60	150	—	75	180

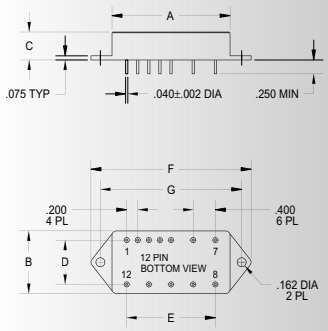
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

MAGNETICALLY ISOLATED

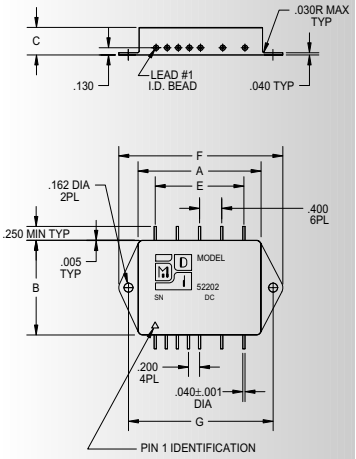
28 VDC

TRIPLE OUTPUT DEVICES		5680-T3.3/5 (12.5W)			5680-T3.3/12 (17.5W)			5680-T3.3/15 (17.5W)			5680-T05 (12.5W)			5680-T12 (17.5W)			5680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min} — V_{in\ max}$	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

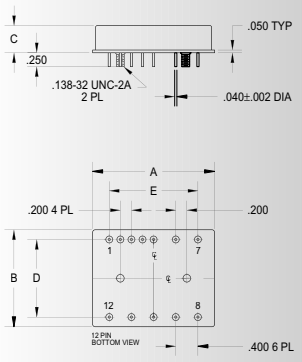
CASE STYLE 6



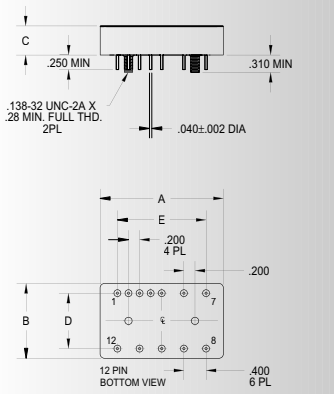
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



5680-SXX output <24 VDC				5680-SXX output ≥24 VDC				5680-DXX				5680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

19.5–40 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

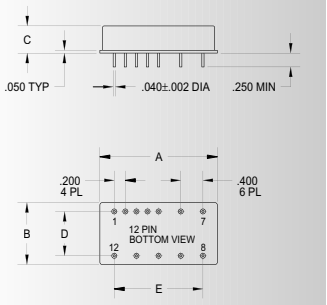
INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		5193-S03.3 (26.4W)			5193-S05 (40W)			5193-S05.2 (40W)			5193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

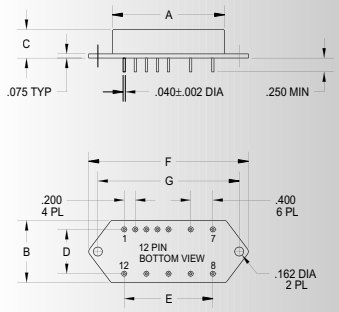
SINGLE OUTPUT DEVICES		5193-S15 (40W)			5193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
5193	2	12	Solder Sealed Flangeless PCB Mount
5193 F	3	12	Solder Sealed PCB Mount with Flange
5193 J	5	12	Seam Weld Flangeless PCB Mount
5193 JF	6	12	Seam Weld PCB Mount with Flange
5193 XF	8	12	Seam Weld Chassis Mount with Flange
5193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

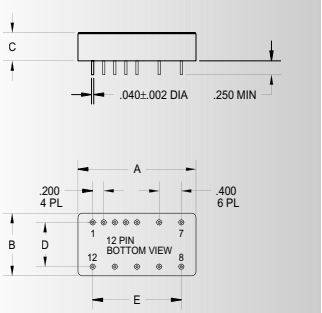
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		5193-D05 (40W)			5193-D12 (40W)			5193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	73%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

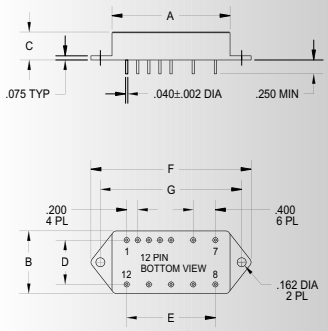
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

MAGNETICALLY ISOLATED

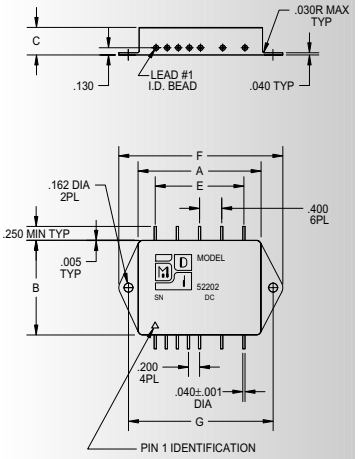
28 VDC

TRIPLE OUTPUT DEVICES		5193-T3.3/5 (17.7W)			5193-T3.3/12 (24W)			5193-T3.3/15 (25.2W)			5193-T05 (19.5W)			5193-T12 (25.8W)			5193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

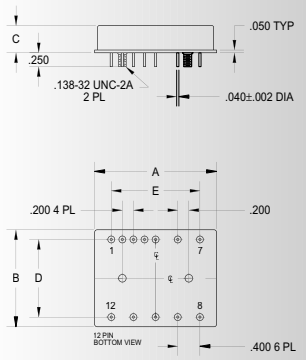
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



5193-SXX output <24 VDC				5193-SXX output ≥24 VDC				5193-DXX				5193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

32.5–80 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 28 VDC nominal
Range: 16 to 50 VDC continuous
18 to 50 VDC full power
Survives 80 V transients/MIL-STD-704A

ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC

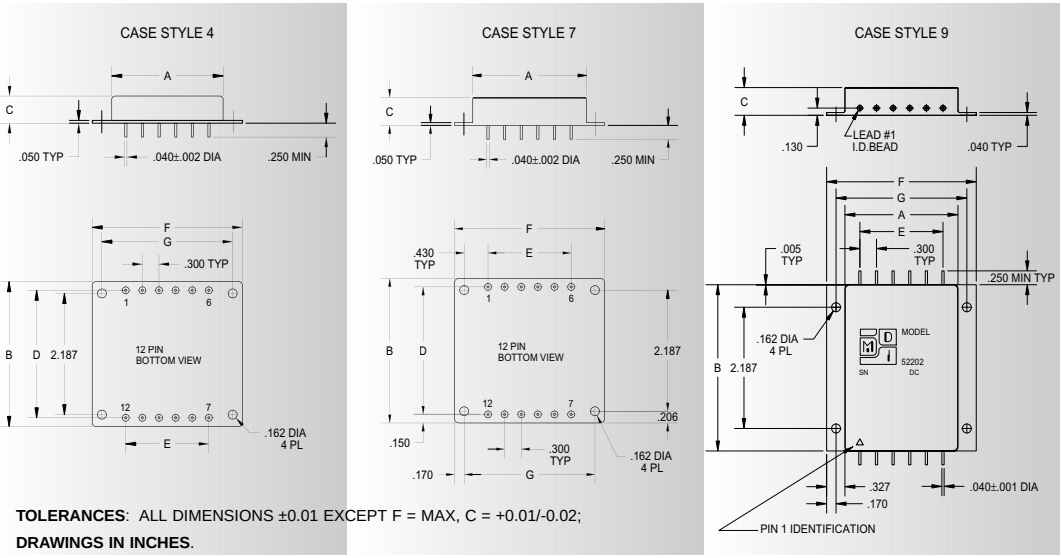
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C

WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		5031-S02 (30W)			5031-S02.5 (37.5W)			5031-S03.3 (50W)			5031-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		5031-S05.2 (78W)			5031-S12 (75W)			5031-S15 (75W)			5031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	70%	73%	—	77%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
5031	4	12	Solder Sealed PCB Mount with Flange
5031 LF	7	12	Seam Weld PCB Mount with Flange
5031 ZF	9	12	Seam Weld Chassis Mount with Flange
5031 PD	11	12	Solder Sealed Flangeless PCB Stud Mount



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02;
DRAWINGS IN INCHES.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

9000

MAGNETICALLY ISOLATED

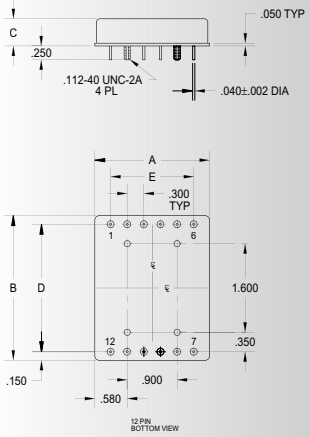
28 VDC

DUAL OUTPUT DEVICES		5031-D3.3/5 (31.78W)			5031-D05 (75W)			5031-D12 (74.4W)			5031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	+4.9	+5.0	+5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	660mA	—	6.6A	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
		200mA	—	2A									
Efficiency	P_{out} = max rated load	64%	67%	—	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		5031-T3.3/5 (32.25W)			5031-T3.3/12 (42.75W)			5031-T3.3/15 (47.25W)			5031-T05 (32.5W)			5031-T12 (43W)			5031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA	—	7.5A	750mA	—	7.5A	750mA	—	7.5A	90mA	—	5A	90mA	—	5A	90mA	—	5A
		±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA	±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 11



5031-SXX output <24 VDC				5031-SXX output ≥24 VDC				5031-DXX				5031-TXX			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

3.75–6.5 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 50 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

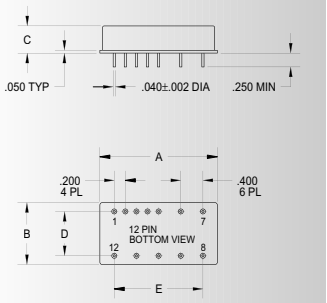
INPUT: 50 VDC nominal
Range: 30 to 75 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		7690-S03.3 (6.5W)			7690-S05 (6.5W)			7690-S05.2 (6.5W)			7690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

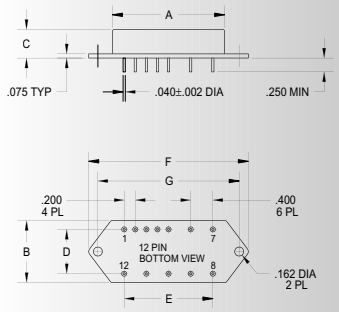
SINGLE OUTPUT DEVICES		7690-S15 (6.5W)			7690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
7690	2	12	Solder Sealed Flangeless PCB Mount
7690 F	3	12	Solder Sealed PCB Mount with Flange
7690 G	5	12	Seam Weld Flangeless PCB Mount
7690 GF	6	12	Seam Weld PCB Mount with Flange
7690 UF	8	12	Seam Weld Chassis Mount with Flange

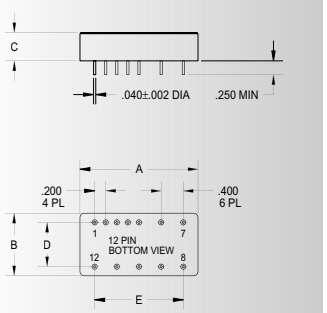
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

DUAL OUTPUT DEVICES		7690-D05 (6.5W)			7690-D12 (6.5W)			7690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

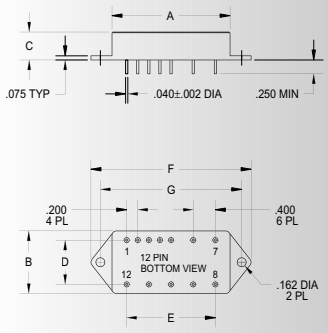
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

MAGNETICALLY ISOLATED

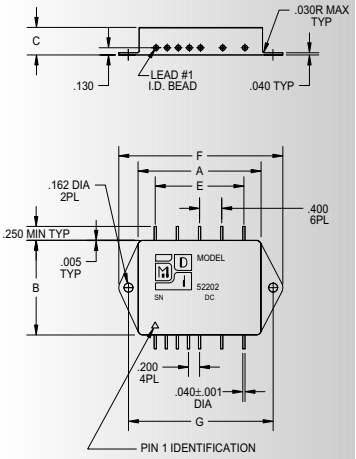
50 VDC

TRIPLE OUTPUT DEVICES		7690-T3.3/5 (3.75W)			7690-T3.3/12 (5W)			7690-T3.3/15 (5W)			7690-T05 (3.75W)			7690-T12 (5W)			7690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



7690-SXX output <24 VDC				7690-SXX output ≥24 VDC				7690-DXX				7690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

7.5–20 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 50 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

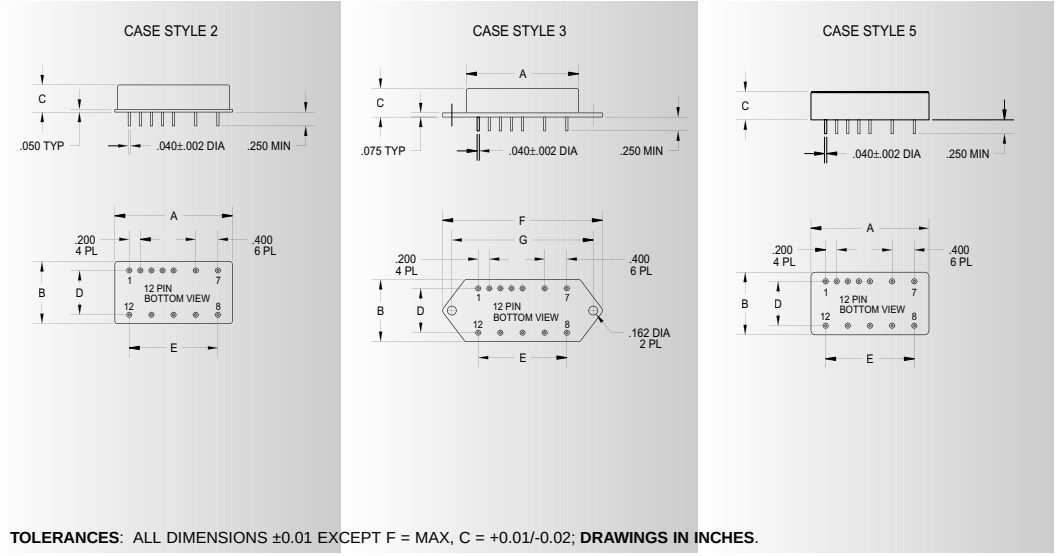
Specifications

INPUT: 50 VDC nominal
Range: 30 to 75 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		7107-S02 (8W)			7107-S02.5 (10W)			7107-S03.3 (13.2W)			7107-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		7107-S05.2 (20W)			7107-S12 (20W)			7107-S15 (20W)			7107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	70%	73%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
7107	2	12	Solder Sealed Flangeless PCB Mount
7107 F	3	12	Solder Sealed PCB Mount with Flange
7107 H	5	12	Seam Weld Flangeless PCB Mount
7107 HF	6	12	Seam Weld PCB Mount with Flange
7107 VF	8	12	Seam Weld Chassis Mount with Flange



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED

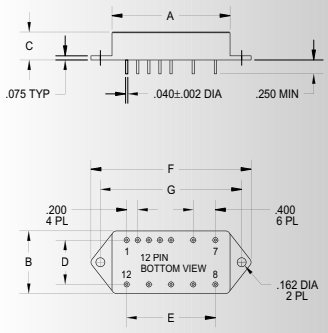
50 VDC

DUAL OUTPUT DEVICES		7107-D05 (20W)			7107-D12 (20W)			7107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

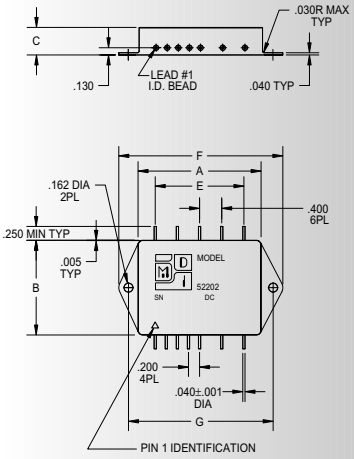
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		7107-T3.3/5 (7.5W)			7107-T3.3/12 (10W)			7107-T3.3/15 (10W)			7107-T05 (7.5W)			7107-T12 (10W)			7107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA ±15mA	— —	1.5A ±250mA	150mA ±15mA	— —	1.5A ±208mA	150mA ±15mA	— —	1.5A ±167mA	60mA ±15mA	— —	1A ±250mA	30mA ±15mA	— —	1A ±208mA	30mA ±15mA	— —	1A ±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



7107-SXX output <24 VDC				7107-SXX output ≥24 VDC				7107-DXX				7107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

12.5–30 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 50 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

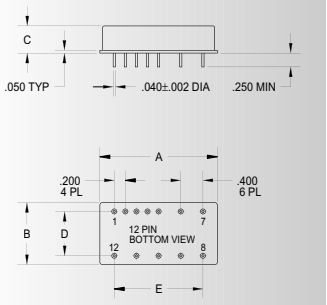
INPUT: 50 VDC nominal
Range: 30 to 75 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		7680-S02 (12W)			7680-S02.5 (15W)			7680-S03.3 (20W)			7680-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

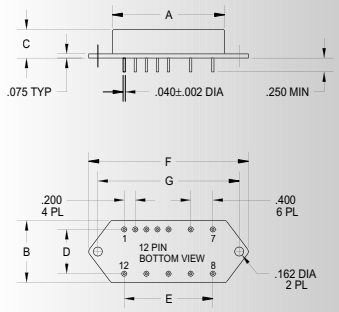
SINGLE OUTPUT DEVICES		7680-S05.2 (30W)			7680-S12 (30W)			7680-S15 (30W)			7680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
7680	2	12	Solder Sealed Flangeless PCB Mount
7680 F	3	12	Solder Sealed PCB Mount with Flange
7680 I	5	12	Seam Weld Flangeless PCB Mount
7680 IF	6	12	Seam Weld PCB Mount with Flange
7680 WF	8	12	Seam Weld Chassis Mount with Flange
7680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
7680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

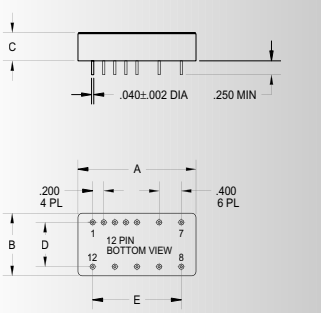
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

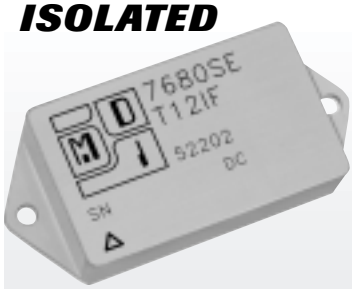
TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		7680-D05 (30W)			7680-D12 (30W)			7680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

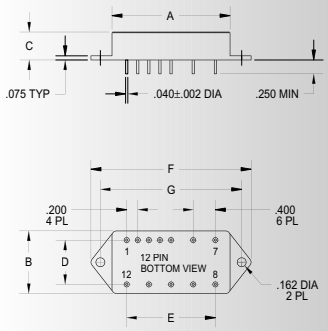
MAGNETICALLY ISOLATED



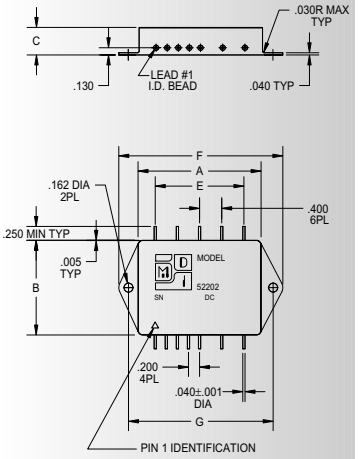
50 VDC

TRIPLE OUTPUT DEVICES		7680-T3.3/5 (12.5W)			7680-T3.3/12 (17.5W)			7680-T3.3/15 (17.5W)			7680-T05 (12.5W)			7680-T12 (17.5W)			7680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

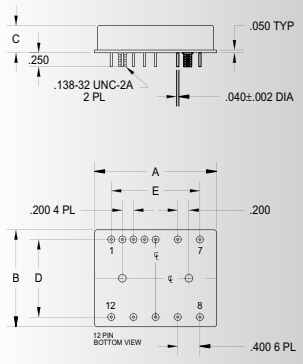
CASE STYLE 6



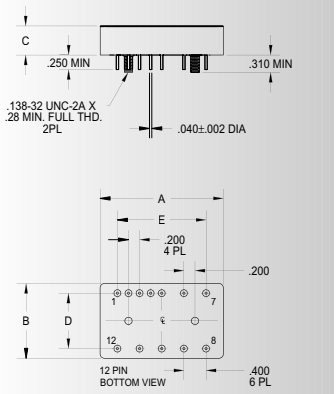
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



7680-SXX output <24 VDC				7680-SXX output ≥24 VDC				7680-DXX				7680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

19.5–40 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 50 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

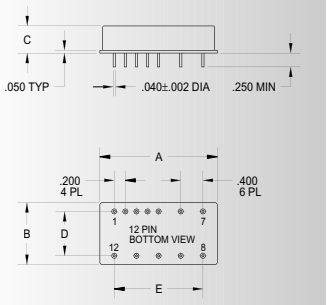
INPUT: 50 VDC nominal
Range: 30 to 75 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		7193-S03.3 (26.4W)			7193-S05 (40W)			7193-S05.2 (40W)			7193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

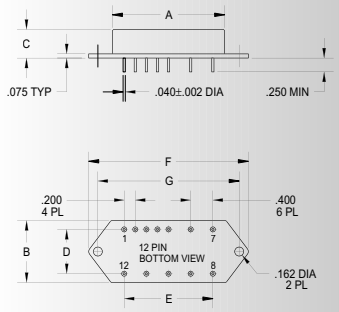
SINGLE OUTPUT DEVICES		7193-S15 (40W)			7193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
7193	2	12	Solder Sealed Flangeless PCB Mount
7193 F	3	12	Solder Sealed PCB Mount with Flange
7193 J	5	12	Seam Weld Flangeless PCB Mount
7193 JF	6	12	Seam Weld PCB Mount with Flange
7193 XF	8	12	Seam Weld Chassis Mount with Flange
7193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

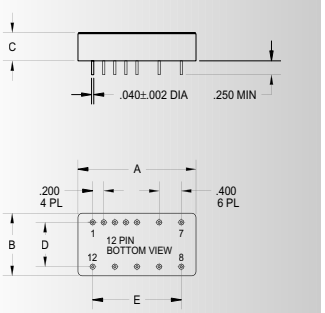
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

MAGNETICALLY ISOLATED

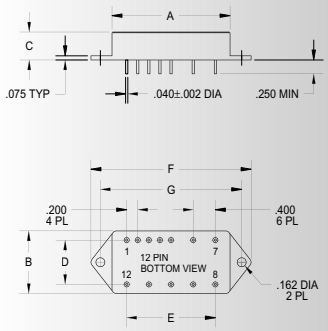
50 VDC

DUAL OUTPUT DEVICES		7193-D05 (40W)			7193-D12 (40W)			7193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	73%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

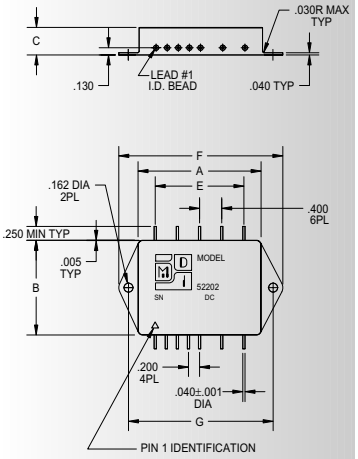
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		7193-T3.3/5 (17.5W)			7193-T3.3/12 (24W)			7193-T3.3/15 (25.2W)			7193-T05 (19.5W)			7193-T12 (25.8W)			7193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

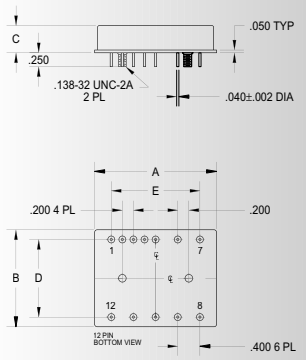
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



7193-SXX output <24 VDC				7193-SXX output ≥24 VDC				7193-DXX				7193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

32.5–80 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 50 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

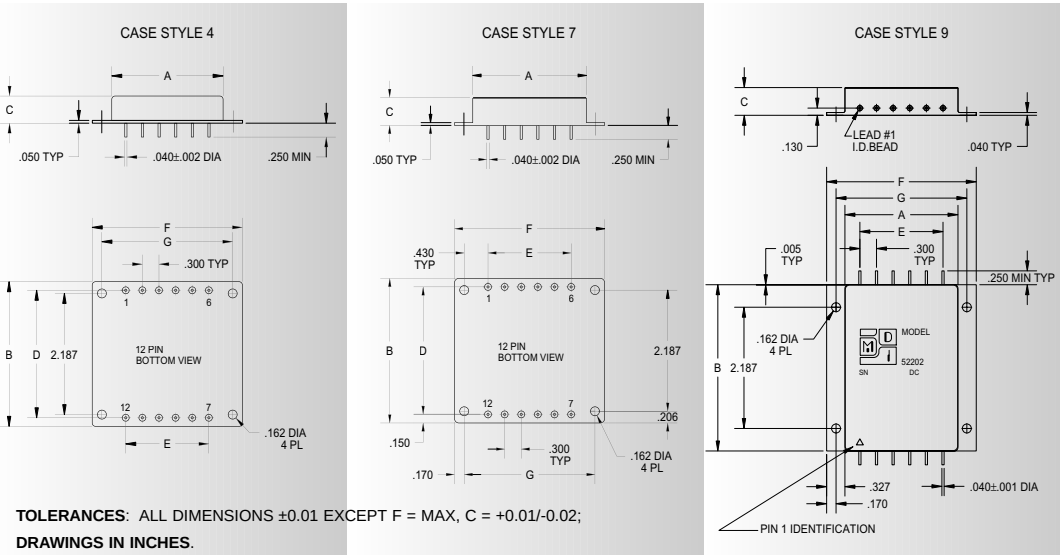
Specifications

INPUT: 50 VDC nominal
Range: 30 to 75 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		7031-S02 (30W)			7031-S02.5 (37.5W)			7031-S03.3 (50W)			7031-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		7031-S05.2 (78W)			7031-S12 (75W)			7031-S15 (75W)			7031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	70%	73%	—	77%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
7031	4	12	Solder Sealed PCB Mount with Flange
7031 LF	7	12	Seam Weld PCB Mount with Flange
7031 ZF	9	12	Seam Weld Chassis Mount with Flange
7031 PD	11	12	Solder Sealed Flangeless PCB Stud Mount



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02;
DRAWINGS IN INCHES.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

MAGNETICALLY ISOLATED

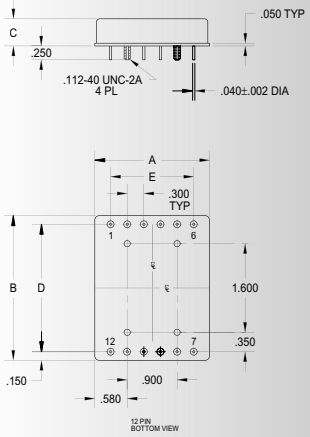
50 VDC

DUAL OUTPUT DEVICES		7031-D05 (75W)			7031-D12 (74.4W)			7031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		7031-T3.3/5 (32.25W)			7031-T3.3/12 (42.75W)			7031-T3.3/15 (47.25W)			7031-T05 (32.5W)			7031-T12 (43W)			7031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA ±40mA	— —	7.5A ±750mA	750mA ±40mA	— —	7.5A ±750mA	750mA ±32mA	— —	7.5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±32mA	— —	5A ±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 11



7031-SXX output <24 VDC				7031-SXX output ≥24 VDC				7031-DXX				7031-TXX			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

3.75–6.5 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 70 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

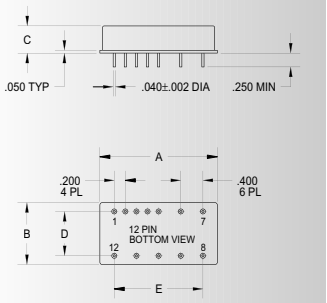
INPUT: 70 VDC nominal
Range: 55 to 90 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		8690-S03.3 (6.5W)			8690-S05 (6.5W)			8690-S05.2 (6.5W)			8690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

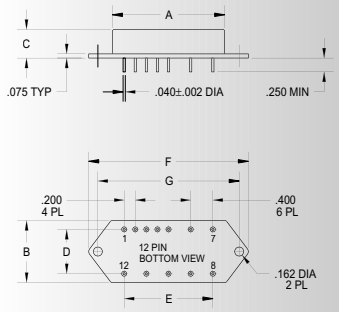
SINGLE OUTPUT DEVICES		8690-S15 (6.5W)			8690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
8690	2	12	Solder Sealed Flangeless PCB Mount
8690 F	3	12	Solder Sealed PCB Mount with Flange
8690 G	5	12	Seam Weld Flangeless PCB Mount
8690 GF	6	12	Seam Weld PCB Mount with Flange
8690 UF	8	12	Seam Weld Chassis Mount with Flange

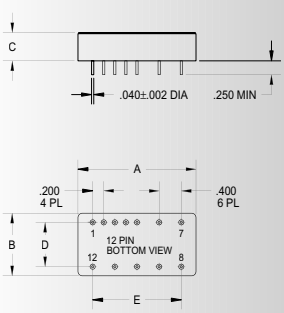
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



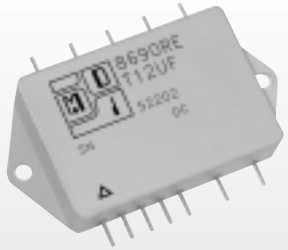
Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED



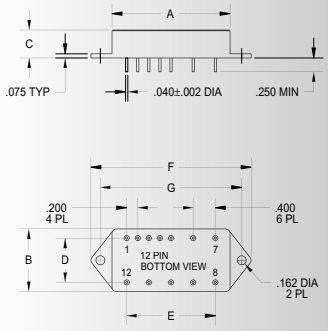
70 VDC

DUAL OUTPUT DEVICES		8690-D05 (6.5W)			8690-D12 (6.5W)			8690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

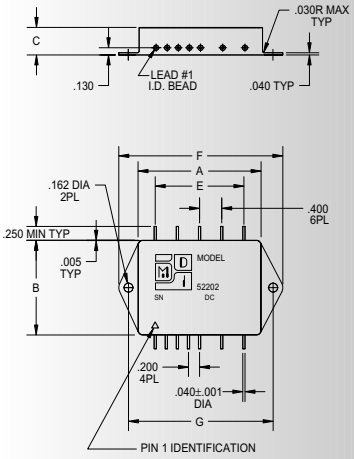
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		8690-T3.3/5 (3.75W)			8690-T3.3/12 (5W)			8690-T3.3/15 (5W)			8690-T05 (3.75W)			8690-T12 (5W)			8690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



8690-SXX output <24 VDC				8690-SXX output ≥24 VDC				8690-DXX				8690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

7.5–20 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 70 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

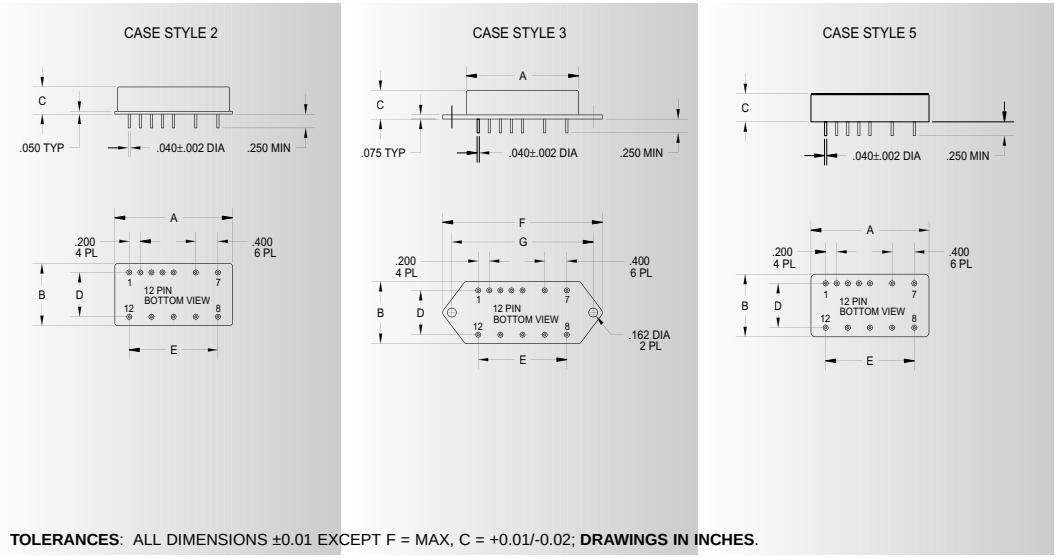
Specifications

INPUT: 70 VDC nominal
Range: 55 to 90 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		8107-S02 (8W)			8107-S02.5 (10W)			8107-S03.3 (13.2W)			8107-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		8107-S05.2 (20W)			8107-S12 (20W)			8107-S15 (20W)			8107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	70%	73%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
8107	2	12	Solder Sealed Flangeless PCB Mount
8107 F	3	12	Solder Sealed PCB Mount with Flange
8107 H	5	12	Seam Weld Flangeless PCB Mount
8107 HF	6	12	Seam Weld PCB Mount with Flange
8107 VF	8	12	Seam Weld Chassis Mount with Flange



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED

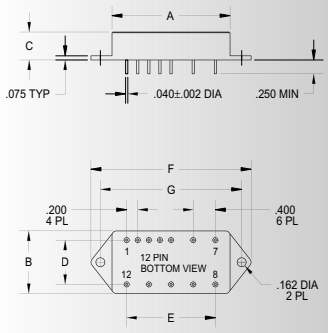
70 VDC

DUAL OUTPUT DEVICES		8107-D05 (20W)			8107-D12 (20W)			8107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

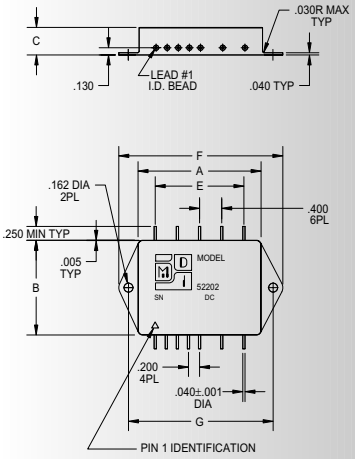
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		8107-T3.3/5 (7.5W)			8107-T3.3/12 (10W)			8107-T3.3/15 (10W)			8107-T05 (7.5W)			8107-T12 (10W)			8107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA ±15mA	— —	1.5A ±250mA	150mA ±15mA	— —	1.5A ±208mA	150mA ±15mA	— —	1.5A ±167mA	60mA ±15mA	— —	1A ±250mA	30mA ±15mA	— —	1A ±208mA	30mA ±15mA	— —	1A ±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



8107-SXX output <24 VDC				8107-SXX output ≥24 VDC				8107-DXX				8107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

12.5–30 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 70 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

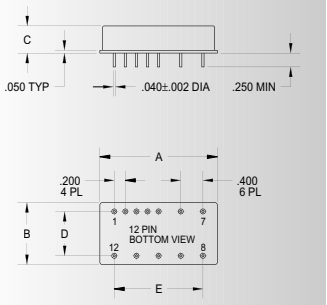
INPUT: 70 VDC nominal
Range: 55 to 90 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		8680-S02 (12W)			8680-S02.5 (15W)			8680-S03.3 (20W)			8680-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

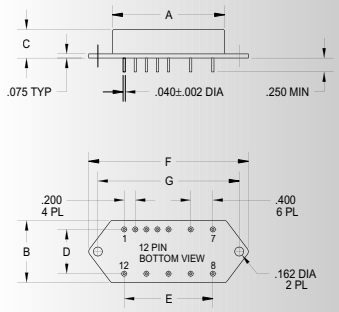
SINGLE OUTPUT DEVICES		8680-S05.2 (30W)			8680-S12 (30W)			8680-S15 (30W)			8680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
8680	2	12	Solder Sealed Flangeless PCB Mount
8680 F	3	12	Solder Sealed PCB Mount with Flange
8680 I	5	12	Seam Weld Flangeless PCB Mount
8680 IF	6	12	Seam Weld PCB Mount with Flange
8680 WF	8	12	Seam Weld Chassis Mount with Flange
8680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
8680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

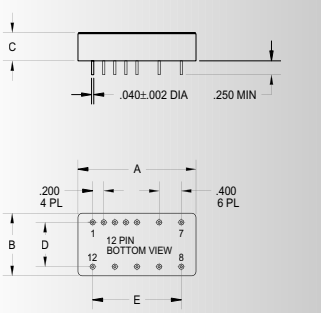
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		8680-D05 (30W)			8680-D12 (30W)			8680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

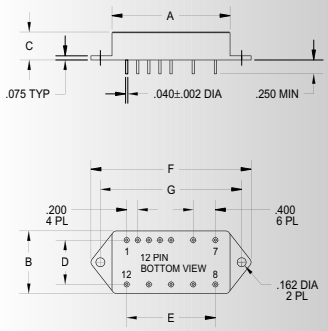
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

MAGNETICALLY ISOLATED

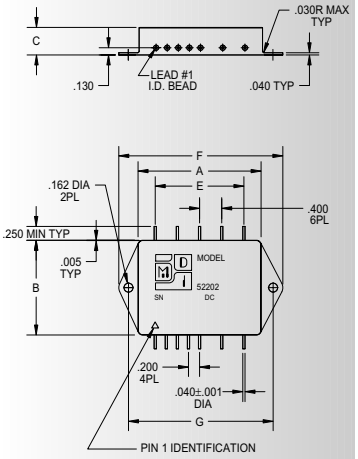
70 VDC

TRIPLE OUTPUT DEVICES		8680-T3.3/5 (12.5W)			8680-T3.3/12 (17.5W)			8680-T3.3/15 (17.5W)			8680-T05 (12.5W)			8680-T12 (17.5W)			8680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

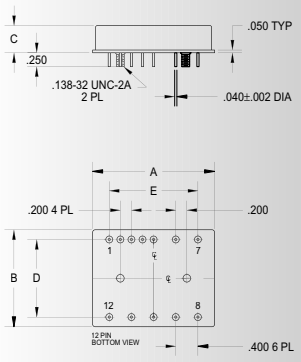
CASE STYLE 6



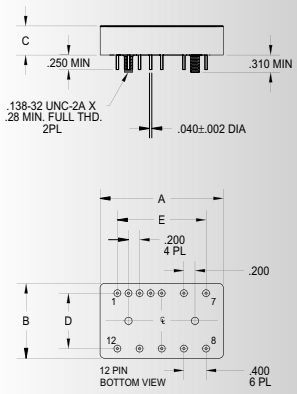
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



8680-SXX output <24 VDC				8680-SXX output ≥24 VDC				8680-DXX				8680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

19.5–40 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 70 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

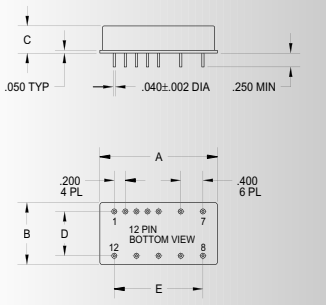
INPUT: 70 VDC nominal
Range: 55 to 90 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		8193-S03.3 (26.4W)			8193-S05 (40W)			8193-S05.2 (40W)			8193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

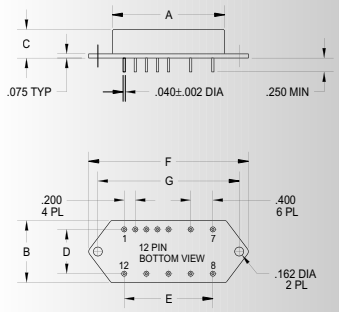
SINGLE OUTPUT DEVICES		8193-S15 (40W)			8193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
8193	2	12	Solder Sealed Flangeless PCB Mount
8193 F	3	12	Solder Sealed PCB Mount with Flange
8193 J	5	12	Seam Weld Flangeless PCB Mount
8193 JF	6	12	Seam Weld PCB Mount with Flange
8193 XF	8	12	Seam Weld Chassis Mount with Flange
8193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

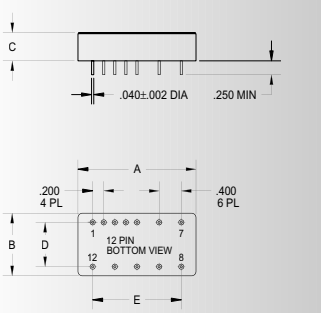
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

MAGNETICALLY ISOLATED

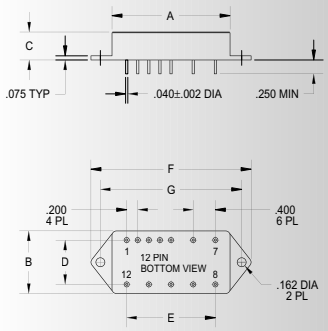
70 VDC

DUAL OUTPUT DEVICES		8193-D05 (40W)			8193-D12 (40W)			8193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	73%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

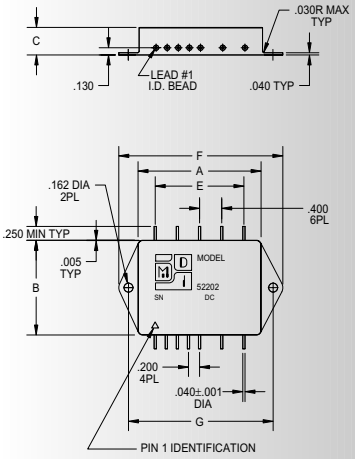
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		8193-T3.3/5 (17.5W)			8193-T3.3/12 (24W)			8193-T3.3/15 (25.2W)			8193-T05 (19.5W)			8193-T12 (25.8W)			8193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

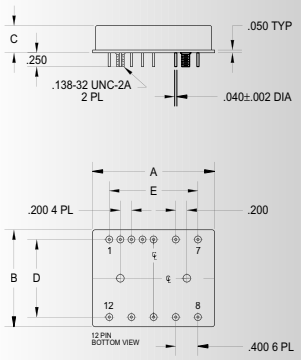
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



8193-SXX output <24 VDC				8193-SXX output ≥24 VDC				8193-DXX				8193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

32.5–80 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically engineered for 70 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

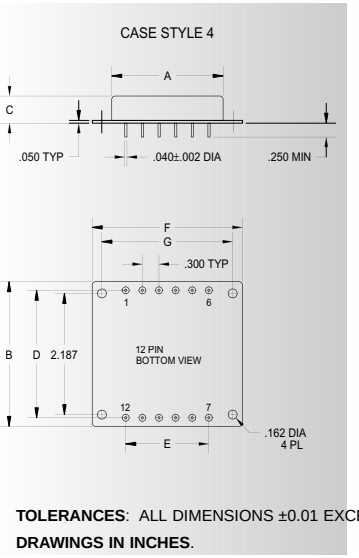
Specifications

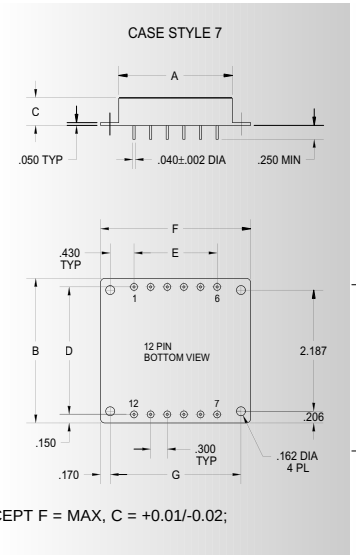
INPUT: 70 VDC nominal
Range: 55 to 90 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

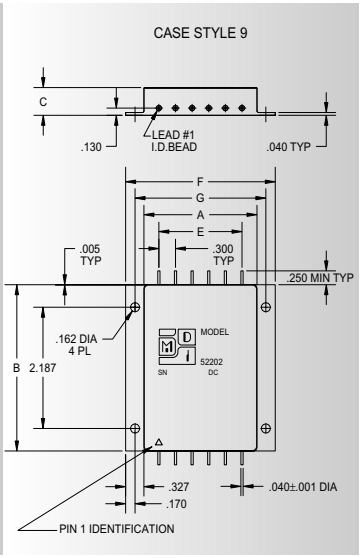
SINGLE OUTPUT DEVICES		8031-S02 (30W)			8031-S02.5 (37.5W)			8031-S03.3 (50W)			8031-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		8031-S05.2 (78W)			8031-S12 (75W)			8031-S15 (75W)			8031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	70%	73%	—	77%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.		Case Style	Pin Count	Mounting
8031		4	12	Solder Sealed PCB Mount with Flange
8031	LF	7	12	Seam Weld PCB Mount with Flange
8031	ZF	9	12	Seam Weld Chassis Mount with Flange
8031	PD	11	12	Solder Sealed Flangeless PCB Stud Mount







TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02;
DRAWINGS IN INCHES.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

MAGNETICALLY ISOLATED

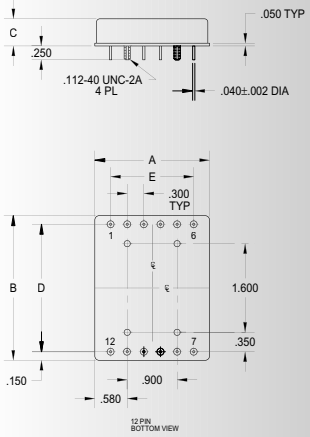
70 VDC

DUAL OUTPUT DEVICES		8031-D05 (75W)			8031-D12 (74.4W)			8031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		8031-T3.3/5 (32.25W)			8031-T3.3/12 (42.75W)			8031-T3.3/15 (47.25W)			8031-T05 (32.5W)			8031-T12 (43W)			8031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA ±40mA	— —	7.5A ±750mA	750mA ±40mA	— —	7.5A ±750mA	750mA ±32mA	— —	7.5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±32mA	— —	5A ±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 11



8031-SXX output <24 VDC				8031-SXX output ≥24 VDC				8031-DXX				8031-TXX			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

3.75–6.5 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for 100 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

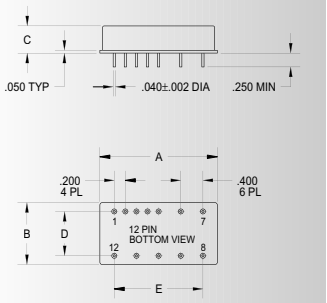
INPUT: 100 VDC nominal
Range: 80 to 120 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		9690-S03.3 (6.5W)			9690-S05 (6.5W)			9690-S05.2 (6.5W)			9690-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

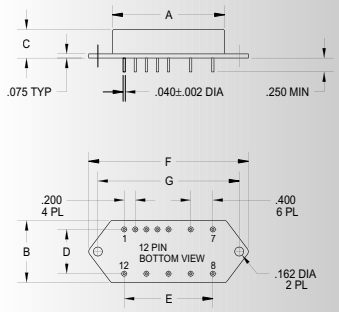
SINGLE OUTPUT DEVICES		9690-S15 (6.5W)			9690-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
9690	2	12	Solder Sealed Flangeless PCB Mount
9690 F	3	12	Solder Sealed PCB Mount with Flange
9690 G	5	12	Seam Weld Flangeless PCB Mount
9690 GF	6	12	Seam Weld PCB Mount with Flange
9690 UF	8	12	Seam Weld Chassis Mount with Flange

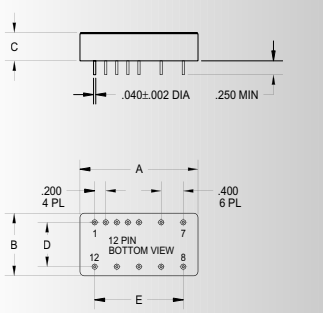
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	G	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	GF	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	UF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED

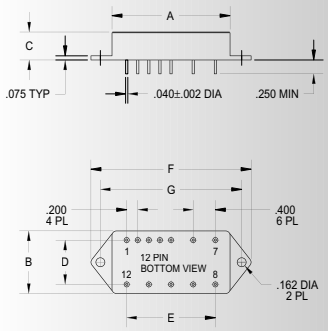
100 VDC

DUAL OUTPUT DEVICES		9690-D05 (6.5W)			9690-D12 (6.5W)			9690-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

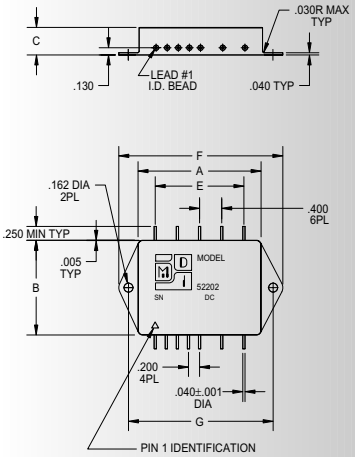
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		9690-T3.3/5 (3.75W)			9690-T3.3/12 (5W)			9690-T3.3/15 (5W)			9690-T05 (3.75W)			9690-T12 (5W)			9690-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



9690-SXX output <24 VDC				9690-SXX output ≥24 VDC				9690-DXX				9690-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

7.5–20 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for 100 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

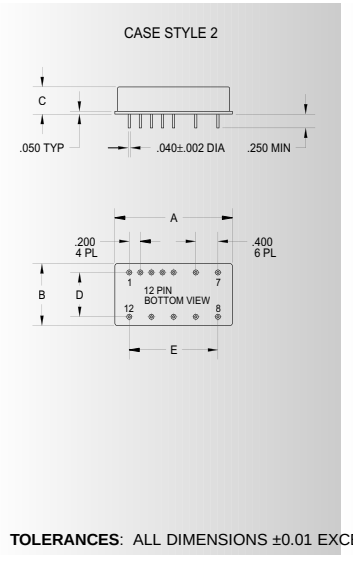
Specifications

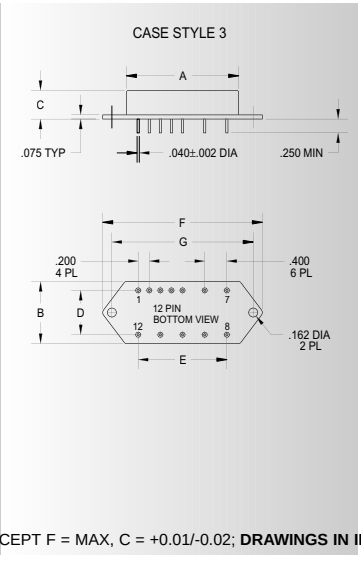
INPUT: 100 VDC nominal
Range: 80 to 120 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

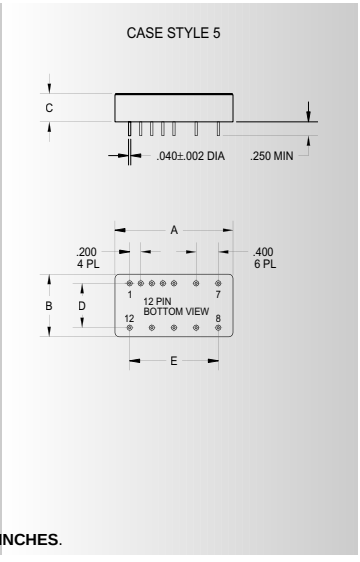
SINGLE OUTPUT DEVICES		9107-S02 (8W)			9107-S02.5 (10W)			9107-S03.3 (13.2W)			9107-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		9107-S05.2 (20W)			9107-S12 (20W)			9107-S15 (20W)			9107-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	70%	73%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
9107	2	12	Solder Sealed Flangeless PCB Mount
9107 F	3	12	Solder Sealed PCB Mount with Flange
9107 H	5	12	Seam Weld Flangeless PCB Mount
9107 HF	6	12	Seam Weld PCB Mount with Flange
9107 VF	8	12	Seam Weld Chassis Mount with Flange







Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

MAGNETICALLY ISOLATED

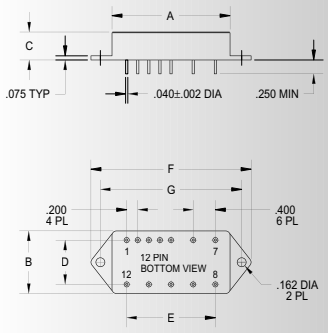
100 VDC

DUAL OUTPUT DEVICES		9107-D05 (20W)			9107-D12 (20W)			9107-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
Efficiency	P_{out} = max rated load	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

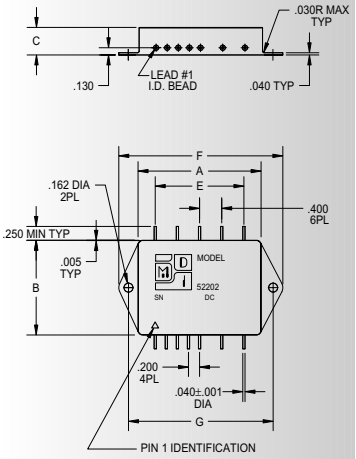
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		9107-T3.3/5 (7.5W)			9107-T3.3/12 (10W)			9107-T3.3/15 (10W)			9107-T05 (7.5W)			9107-T12 (10W)			9107-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA ±15mA	— —	1.5A ±250mA	150mA ±15mA	— —	1.5A ±208mA	150mA ±15mA	— —	1.5A ±167mA	60mA ±15mA	— —	1A ±250mA	30mA ±15mA	— —	1A ±208mA	30mA ±15mA	— —	1A ±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



9107-SXX output <24 VDC				9107-SXX output ≥24 VDC				9107-DXX				9107-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

12.5–30 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for 100 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

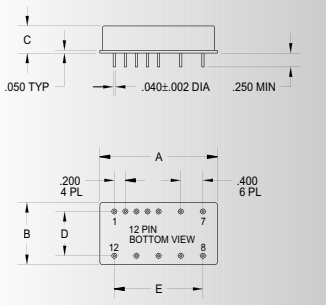
INPUT: 100 VDC nominal
Range: 80 to 120 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		9680-S02 (12W)			9680-S02.5 (15W)			9680-S03.3 (20W)			9680-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

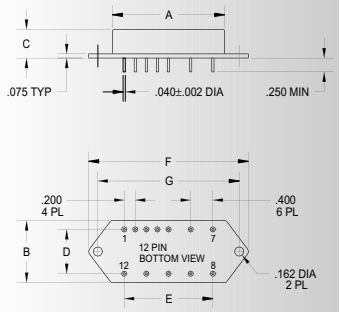
SINGLE OUTPUT DEVICES		9680-S05.2 (30W)			9680-S12 (30W)			9680-S15 (30W)			9680-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
9680	2	12	Solder Sealed Flangeless PCB Mount
9680 F	3	12	Solder Sealed PCB Mount with Flange
9680 I	5	12	Seam Weld Flangeless PCB Mount
9680 IF	6	12	Seam Weld PCB Mount with Flange
9680 WF	8	12	Seam Weld Chassis Mount with Flange
9680 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
9680 PE	12	12	Seam Weld Flangeless PCB Stud Mount

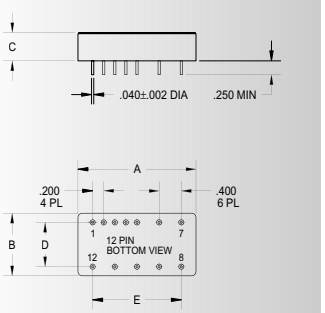
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

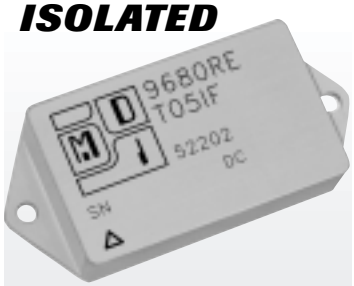
TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		9680-D05 (30W)			9680-D12 (30W)			9680-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

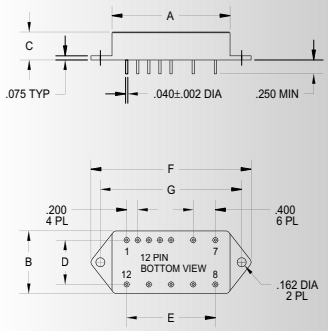
MAGNETICALLY ISOLATED



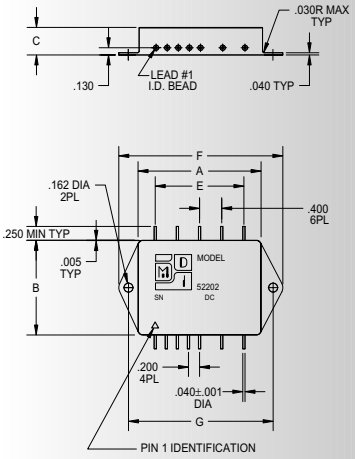
100 VDC

TRIPLE OUTPUT DEVICES		9680-T3.3/5 (12.5W)			9680-T3.3/12 (17.5W)			9680-T3.3/15 (17.5W)			9680-T05 (12.5W)			9680-T12 (17.5W)			9680-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA ±40mA	— —	3A ±250mA	300mA ±40mA	— —	3A ±312mA	300mA ±32mA	— —	3A ±250mA	90mA ±40mA	— —	2A ±250mA	90mA ±40mA	— —	2A ±312mA	90mA ±32mA	— —	2A ±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

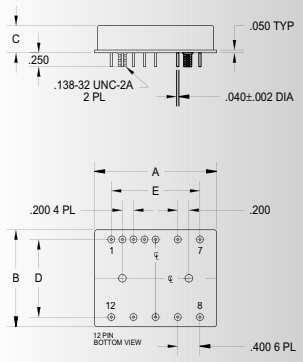
CASE STYLE 6



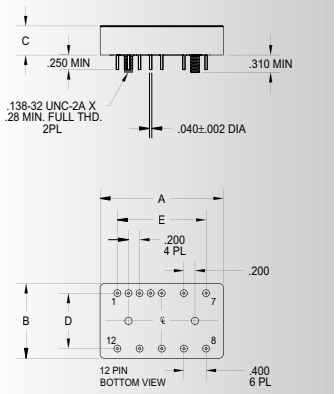
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



9680-SXX output <24 VDC				9680-SXX output ≥24 VDC				9680-DXX				9680-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

19.5–40 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for 100 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

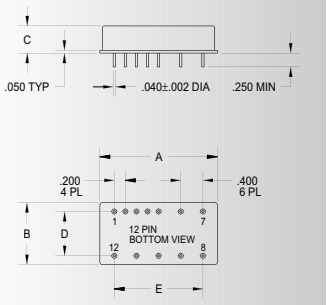
INPUT: 100 VDC nominal
Range: 80 to 120 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		9193-S03.3 (26.4W)			9193-S05 (40W)			9193-S05.2 (40W)			9193-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

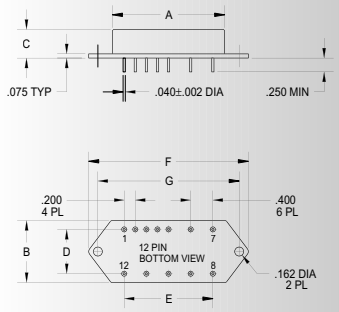
SINGLE OUTPUT DEVICES		9193-S15 (40W)			9193-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
9193	2	12	Solder Sealed Flangeless PCB Mount
9193 F	3	12	Solder Sealed PCB Mount with Flange
9193 J	5	12	Seam Weld Flangeless PCB Mount
9193 JF	6	12	Seam Weld PCB Mount with Flange
9193 XF	8	12	Seam Weld Chassis Mount with Flange
9193 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

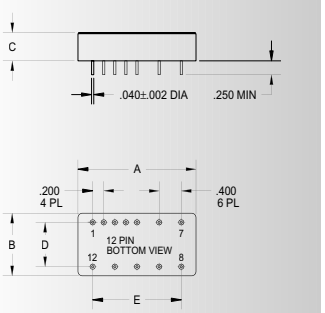
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

MAGNETICALLY ISOLATED

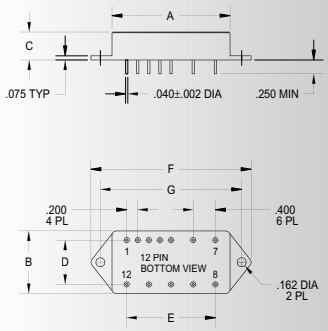
100 VDC

DUAL OUTPUT DEVICES		9193-D05 (40W)			9193-D12 (40W)			9193-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

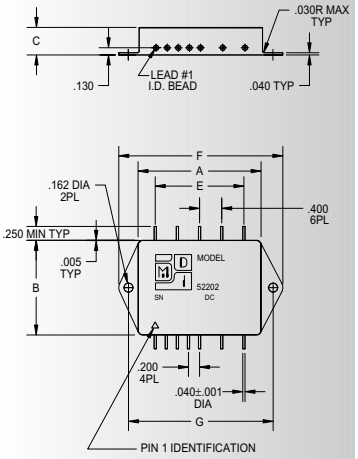
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		9193-T3.3/5 (17.5W)			9193-T3.3/12 (24W)			9193-T3.3/15 (25.2W)			9193-T05 (19.5W)			9193-T12 (25.8W)			9193-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

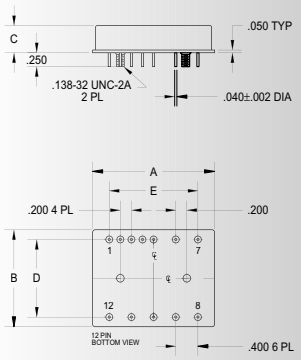
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



9193-SXX output <24 VDC				9193-SXX output ≥24 VDC				9193-DXX				9193-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	adjust	Pin 11	N/C	Pin 5	adjust	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

32.5–80 Watt Hybrid

Features

- Rad Hard: TID > 100kRad(Si)
- 2:1 margin: Operates beyond 200kRad TID
- No SEE: LET > 82MeV*cm^2/mg
- Proton Resistant: No optocouplers used
- Specifically designed for 100 VDC satellite bus
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

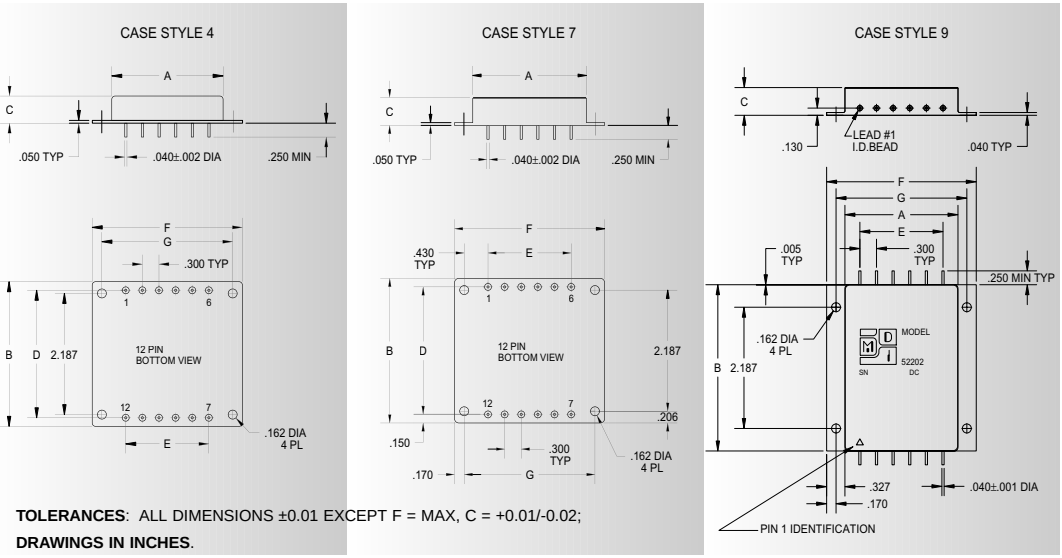
Specifications

INPUT: 100 VDC nominal
Range: 80 to 120 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades EU, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		9031-S02 (30W)			9031-S02.5 (37.5W)			9031-S03.3 (50W)			9031-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	55%	58%	—	60%	63%	—	65%	68%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		9031-S05.2 (78W)			9031-S12 (75W)			9031-S15 (75W)			9031-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	70%	73%	—	77%	81%	—	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
9031	4	12	Solder Sealed PCB Mount with Flange
9031 LF	7	12	Seam Weld PCB Mount with Flange
9031 ZF	9	12	Seam Weld Chassis Mount with Flange
9031 PD	11	12	Solder Sealed Flangeless PCB Stud Mount



TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02;
DRAWINGS IN INCHES.

Case Dimensions

Units: inches | millimeters

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

MAGNETICALLY ISOLATED

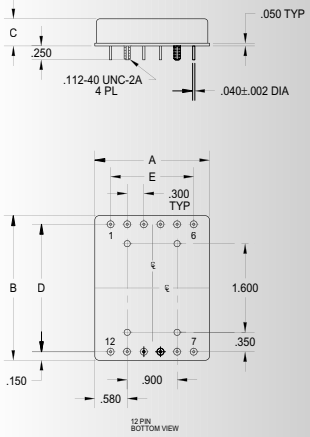
100 VDC

DUAL OUTPUT DEVICES		9031-D05 (75W)			9031-D12 (74.4W)			9031-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		9031-T3.3/5 (32.25W)			9031-T3.3/12 (42.75W)			9031-T3.3/15 (47.25W)			9031-T05 (32.5W)			9031-T12 (43W)			9031-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	750mA ±40mA	— —	7.5A ±750mA	750mA ±40mA	— —	7.5A ±750mA	750mA ±32mA	— —	7.5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±32mA	— —	5A ±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 11



9031-SXX output <24 VDC				9031-SXX output ≥24 VDC				9031-DXX				9031-TXX			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	adjust	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	+ remote sense	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	- remote sense	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. EU grade units will be shipped if no option is specified.

EU Engineering Units
R 100 K+™, +85°C military/aerospace
RE 100 K+™, +125°C military/aerospace
S 100 K+™, +85°C space
SE 100 K+™, +125°C space

3.25–5 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- "Inhibit-not" function
- Fully isolated, input to output
- Single, double or triple outputs
- Short circuit protection
- 200 kHz operation for low ripple and fast response time
- No external filter caps required
- Hermetically sealed package

Specifications

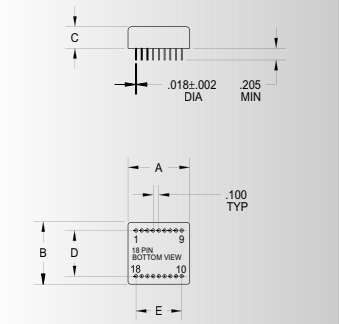
INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 20 grams typical

SINGLE OUTPUT DEVICES		3325-S02 (2W)			3325-S02.5 (2.5W)			3325-S03.3 (3.3W)			3325-S05 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1A	—	—	1A	—	—	1A	—	—	1A
Efficiency	P_{out} = max rated load	53%	56%	—	58%	61%	—	63%	66%	—	69%	72%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

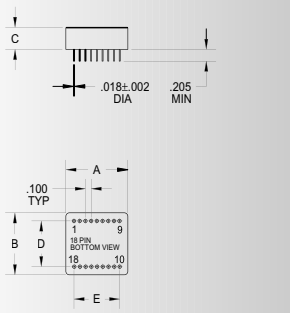
SINGLE OUTPUT DEVICES		3325-S05.2 (5W)			3325-S12 (5W)			3325-S15 (5W)			3325-S28 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	961mA	—	—	416mA	—	—	333mA	—	—	178mA
Efficiency	P_{out} = max rated load	69%	72%	—	76%	80%	—	77%	81%	—	76%	80%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	1250mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3325	1	18	Solder Sealed Flangeless PCB Mount
3325 D	14	18	Seam Weld Flangeless PCB Mount
3325 TF	15	18	Seam Weld Chassis Mount with Flange

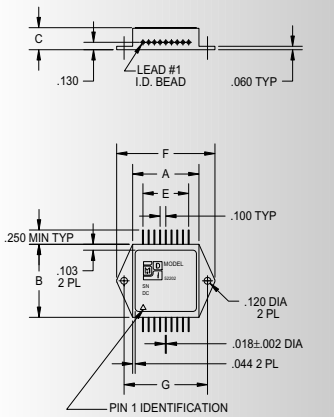
CASE STYLE 1



CASE STYLE 14



CASE STYLE 15



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
1		1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
14	D	1.090 | 27.686	1.090 | 27.686	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
15	TF	1.160 | 29.464	1.283 | 32.588	0.380 | 9.652	— | —	0.800 | 20.320	1.754 | 44.552	1.460 | 37.084

DUAL OUTPUT DEVICES		3325-D05 (5W)			3325-D12 (5W)			3325-D15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±500mA	±15mA	—	±208mA	±12mA	—	±166mA
Efficiency	P_{out} = max rated load	70%	74%	—	76%	80%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

120 VDC

TRIPLE OUTPUT DEVICES		3325-T05 (3.25W)			3325-T12 (3.7W)			3325-T15 (3.7W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.5 -11.5	+5.0 +12.0 -12.0	+5.1 +12.5 -12.5	+4.9 +14.5 -14.5	+5.0 +15.0 -15.0	+5.1 +15.5 -15.5
Output current	$V_{in\ min}$ — $V_{in\ max}$	100mA ±10mA	— —	500mA ±75mA	100mA ±5mA	— —	500mA ±50mA	100mA ±5mA	— —	500mA ±40mA
Efficiency	P_{out} = max rated load	64%	67%	—	69%	72%	—	69%	72%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

3325-SXX output <24 VDC				3325-SXX output ≥24 VDC				3325-DXX				3325-TXX			
Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C	Pin 1	+ input	Pin 10	N/C
Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C	Pin 2	+ input	Pin 11	N/C
Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C	Pin 3	N/C	Pin 12	N/C
Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C	Pin 4	case	Pin 13	N/C
Pin 5	N/C	Pin 14	N/C	Pin 5	main out ret	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C	Pin 5	- dual output	Pin 14	N/C
Pin 6	main out ret	Pin 15	inhibit not	Pin 6	N/C	Pin 15	inhibit not	Pin 6	output com	Pin 15	inhibit not	Pin 6	dual output ret	Pin 15	inhibit not
Pin 7	main out ret	Pin 16	N/C	Pin 7	N/C	Pin 16	N/C	Pin 7	output com	Pin 16	N/C	Pin 7	dual output ret	Pin 16	N/C
Pin 8	N/C	Pin 17	input ret	Pin 8	main output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret	Pin 8	+ dual output	Pin 17	input ret
Pin 9	main output	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	N/C	Pin 18	input ret	Pin 9	main output	Pin 18	input ret

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

3.25-6.5 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

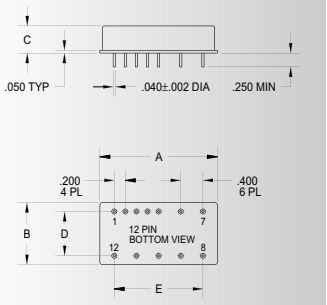
INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		3070-S03.3 (6.5W)			3070-S05 (6.5W)			3070-S05.2 (6.5W)			3070-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

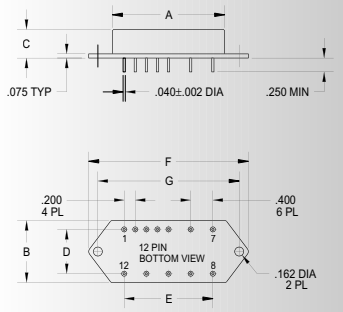
SINGLE OUTPUT DEVICES		3070-S15 (6.5W)			3070-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3070	2	12	Solder Sealed Flangeless PCB Mount
3070 F	3	12	Solder Sealed PCB Mount with Flange
3070 H	5	12	Seam Weld Flangeless PCB Mount
3070 HF	6	12	Seam Weld PCB Mount with Flange
3070 VF	8	12	Seam Weld Chassis Mount with Flange

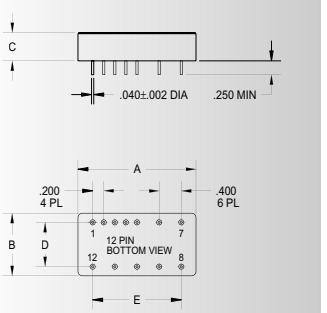
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

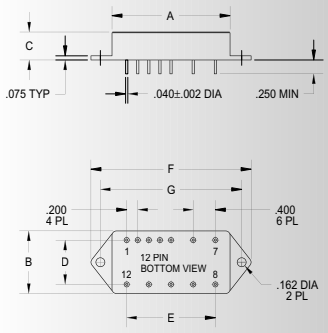
120 VDC

DUAL OUTPUT DEVICES		3070-D05 (6.5W)			3070-D12 (6.5W)			3070-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

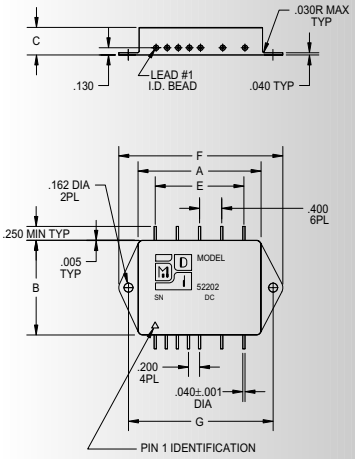
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3070-T3.3/5 (3.75W)			3070-T3.3/12 (5W)			3070-T3.3/15 (5W)			3070-T05 (3.75W)			3070-T12 (5W)			3070-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	60mA ±20mA	— —	500mA ±150mA	60mA ±20mA	— —	500mA ±105mA	60mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



3070-SXX output <24 VDC				3070-SXX output ≥24 VDC				3070-DXX				3070-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

7.5–20 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

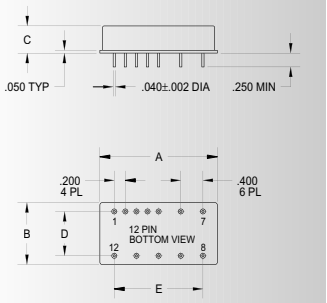
INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		3108-S02 (8W)			3108-S02.5 (10W)			3108-S03.3 (13.2W)			3108-S05 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	4A	—	—	4A
Efficiency	P_{out} = max rated load	56%	59%	—	61%	64%	—	66%	69%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

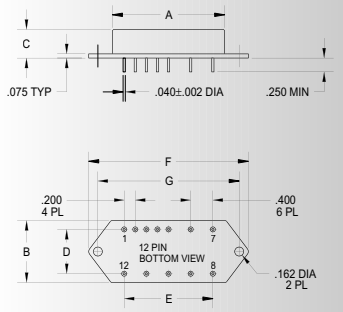
SINGLE OUTPUT DEVICES		3108-S05.2 (20W)			3108-S12 (20W)			3108-S15 (20W)			3108-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	3.85A	—	—	1.67A	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	71%	74%	—	78%	82%	—	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3108	2	12	Solder Sealed Flangeless PCB Mount
3108 F	3	12	Solder Sealed PCB Mount with Flange
3108 H	5	12	Seam Weld Flangeless PCB Mount
3108 HF	6	12	Seam Weld PCB Mount with Flange
3108 VF	8	12	Seam Weld Chassis Mount with Flange

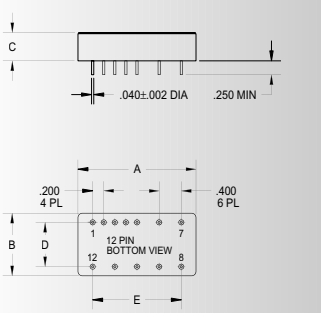
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

9006

DUAL OUTPUT DEVICES		3108-D3.3/5 (11.6W)			3108-D05 (20W)			3108-D12 (20W)			3108-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		+4.9	+5.0	+5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	200mA	—	2A	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
		100mA	—	1A									
Efficiency	P_{out} = max rated load	62%	65%	—	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

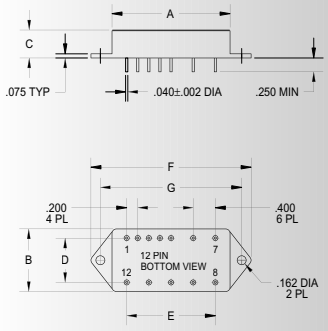
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

120 VDC

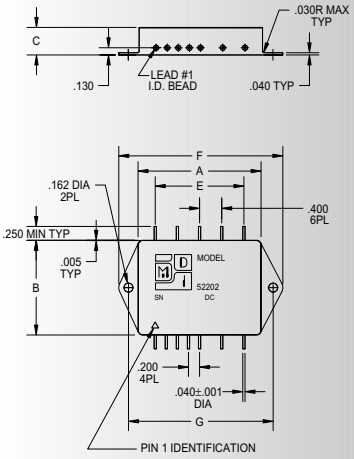
9006

TRIPLE OUTPUT DEVICES		3108-T3.3/5 (7.5W)			3108-T3.3/12 (10W)			3108-T3.3/15 (10W)			3108-T05 (7.5W)			3108-T12 (10W)			3108-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA	—	1.5A	150mA	—	1.5A	150mA	—	1.5A	60mA	—	1A	30mA	—	1A	30mA	—	1A
		±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA	±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 6



CASE STYLE 8



3108-SXX output <24 VDC				3108-SXX output ≥24 VDC				3108-DXX				3108-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

12.5–30 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

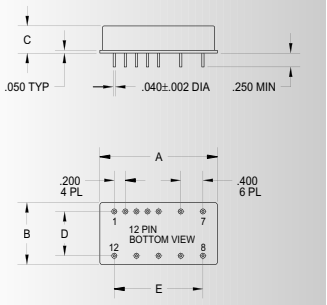
INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		3060-S02 (12W)			3060-S02.5 (15W)			3060-S03.3 (20W)			3060-S05 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6.06A	—	—	6.06A	—	—	6A
Efficiency	P_{out} = max rated load	57%	60%	—	62%	65%	—	67%	70%	—	72%	75%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

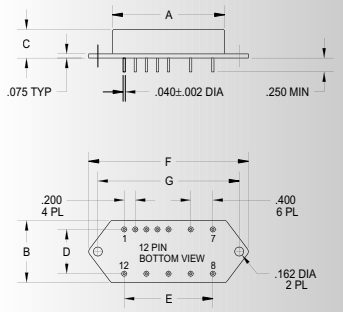
SINGLE OUTPUT DEVICES		3060-S05.2 (30W)			3060-S12 (30W)			3060-S15 (30W)			3060-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5.76A	—	—	2.5A	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	72%	75%	—	79%	83%	—	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3060	2	12	Solder Sealed Flangeless PCB Mount
3060 F	3	12	Solder Sealed PCB Mount with Flange
3060 I	5	12	Seam Weld Flangeless PCB Mount
3060 IF	6	12	Seam Weld PCB Mount with Flange
3060 WF	8	12	Seam Weld Chassis Mount with Flange
3060 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
3060 PE	12	12	Seam Weld Flangeless PCB Stud Mount

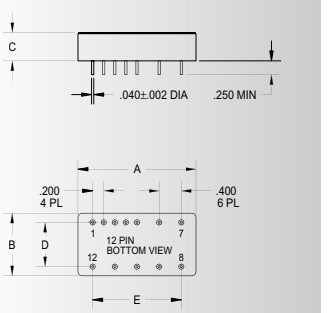
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

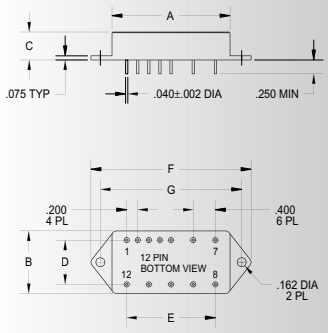
DUAL OUTPUT DEVICES		3060-D3.3/5 (14.9W)			3060-D05 (30W)			3060-D12 (30W)			3060-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		+4.9	+5.0	+5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
		100mA	—	1A									
Efficiency	P_{out} = max rated load	63%	66%	—	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

120 VDC

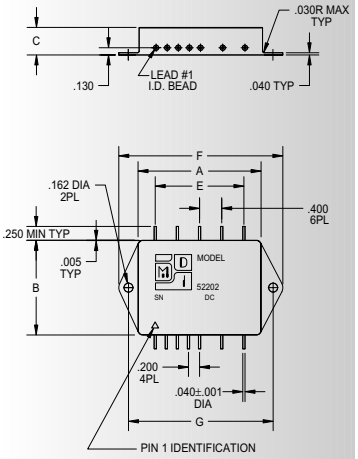
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3060-T3.3/5 (12.5W)			3060-T3.3/12 (17.5W)			3060-T3.3/15 (17.5W)			3060-T05 (12.5W)			3060-T12 (17.5W)			3060-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	300mA	—	3A	300mA	—	3A	90mA	—	2A	90mA	—	2A	90mA	—	2A
		±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA	±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

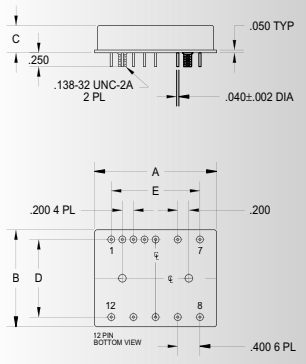
CASE STYLE 6



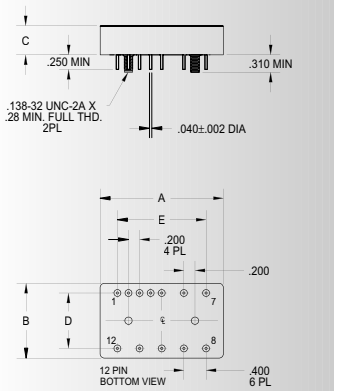
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



3060-SXX output <24 VDC				3060-SXX output ≥24 VDC				3060-DXX				3060-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

19.5–40 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

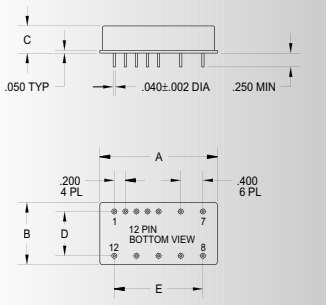
INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		3326-S03.3 (26.4W)			3326-S05 (40W)			3326-S05.2 (40W)			3326-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	65%	68%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

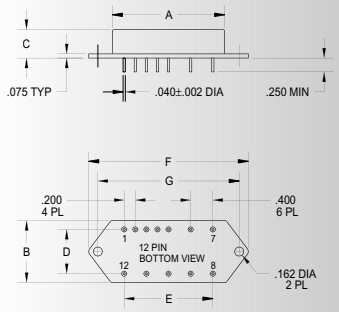
SINGLE OUTPUT DEVICES		3326-S15 (40W)			3326-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3326		2	12	Solder Sealed Flangeless PCB Mount
3326	F	3	12	Solder Sealed PCB Mount with Flange
3326	J	5	12	Seam Weld Flangeless PCB Mount
3326	JF	6	12	Seam Weld PCB Mount with Flange
3326	XF	8	12	Seam Weld Chassis Mount with Flange
3326	PC	10	12	Solder Sealed Flangeless PCB Stud Mount

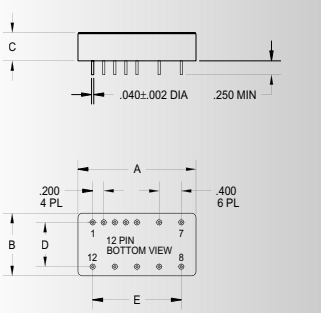
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



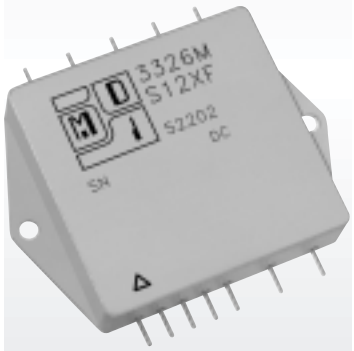
Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.190 | 55.626	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		3326-D05 (40W)			3326-D12 (40W)			3326-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min} — V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

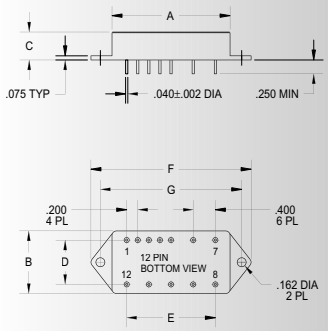


120 VDC

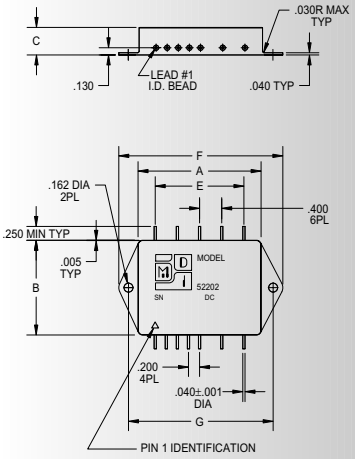
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3326-T3.3/5 (17.5W)			3326-T3.3/12 (24W)			3326-T3.3/15 (25.2W)			3326-T05 (19.5W)			3326-T12 (25.8W)			3326-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min} — V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

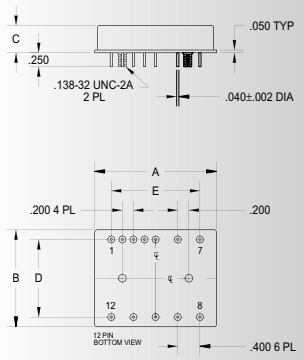
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



3326-SXX output <24 VDC				3326-SXX output ≥24 VDC				3326-DXX				3326-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

32.5–80 Watt Hybrid

Features

- Rad Hard: TID > 25kRad(Si)
- No SEE: LET > 37MeV*cm^2/mg
- Specifically designed for redundant or individual space applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 120 VDC nominal
Range: 86 to 158 VDC continuous
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grades M, R & S:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grades E, RE & SE:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		3051-S02 (30W)			3051-S02.5 (37.5W)			3051-S03.3 (49.5W)			3051-S05 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+1.9	+2.0	+2.1	+2.4	+2.5	+2.6	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	15A
Efficiency	P_{out} = max rated load	57%	60%	—	62%	65%	—	67%	70%	—	72%	75%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	30mV	—	10mV	30mV	—	10mV	50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	25	50	—	30	60	—	30	65	—	40	85

SINGLE OUTPUT DEVICES		3051-S05.2 (75W)			3051-S12 (75W)			3051-S15 (75W)			3051-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	6.25A	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	72%	75%	—	79%	83%	—	80%	84%	—	79%	83%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	20mV	100mV	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3051	4	12	Solder Sealed PCB Mount with Flange
3051 LF	7	12	Seam Weld PCB Mount with Flange
3051 ZF	9	12	Seam Weld Chassis Mount with Flange
3051 PD	11	12	Solder Sealed Flangeless PCB Stud Mount

3051-SXX output <24 VDC				3051-SXX output ≥24 VDC				3051-DXX				3051-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

3051-SXX ZF output <24 VDC				3051-SXX ZF output ≥24 VDC				3051-DXX ZF				3051-TXX ZF			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military
R 25 KRAD, +85°C military/aerospace
RE 25 KRAD, +125°C military/aerospace
S 25 KRAD, +85°C space
SE 25 KRAD, +125°C space

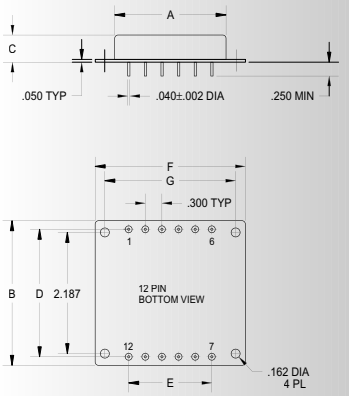
DUAL OUTPUT DEVICES		3051-D3.3/5 (31.78W)			3051-D05 (75W)			3051-D12 (74.4W)			3051-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		+4.9	+5.0	+5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min} — V_{in\ max}$	660mA	—	6.6A	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
		200mA	—	2A									
Efficiency	P_{out} = max rated load	64%	67%	—	73%	77%	—	79%	83%	—	80%	84%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min} — V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

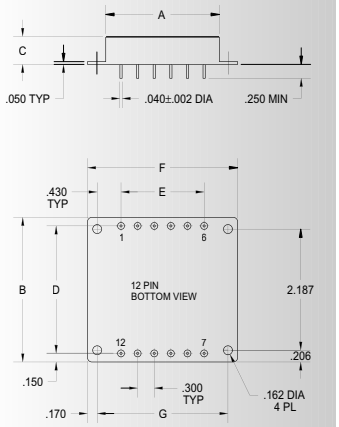
120 VDC

TRIPLE OUTPUT DEVICES		3051-T3.3/5 (32.25W)			3051-T3.3/12 (42.75W)			3051-T3.3/15 (47.25W)			3051-T05 (32.5W)			3051-T12 (43W)			3051-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min} — V_{in\ max}$	750mA	—	7.5A	750mA	—	7.5A	750mA	—	7.5A	90mA	—	5A	90mA	—	5A	90mA	—	5A
		±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA	±40mA	—	±750mA	±40mA	—	±750mA	±32mA	—	±750mA
Efficiency	P_{out} = max rated load	67%	70%	—	67%	70%	—	67%	70%	—	67%	70%	—	72%	75%	—	72%	75%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min} — V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

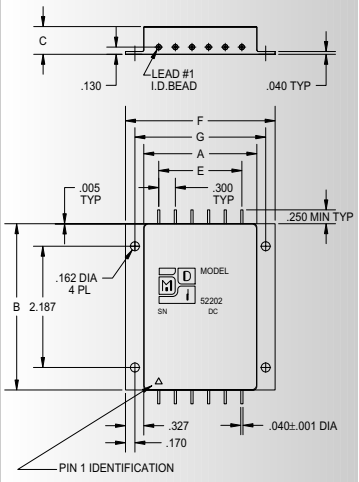
CASE STYLE 4



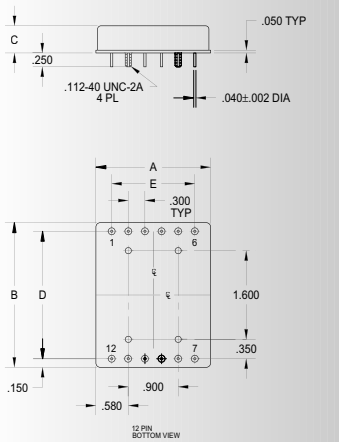
CASE STYLE 7



CASE STYLE 9



CASE STYLE 11



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

3.75–6.5 Watt Hybrid

Features

- Specifically designed for aircraft applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

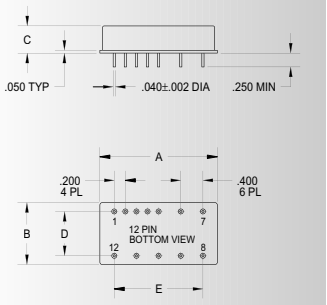
INPUT: 270 VDC nominal
Range: 185 to 335 VDC continuous
Survives 440 V transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 50 grams typical

SINGLE OUTPUT DEVICES		3020-S03.3 (6.5W)			3020-S05 (6.5W)			3020-S05.2 (6.5W)			3020-S12 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.97A	—	—	1.3A	—	—	1.25A	—	—	541mA
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

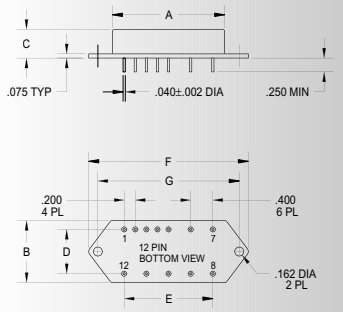
SINGLE OUTPUT DEVICES		3020-S15 (6.5W)			3020-S28 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	433mA	—	—	232mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3020	2	12	Solder Sealed Flangeless PCB Mount
3020 F	3	12	Solder Sealed PCB Mount with Flange
3020 H	5	12	Seam Weld Flangeless PCB Mount
3020 HF	6	12	Seam Weld PCB Mount with Flange
3020 VF	8	12	Seam Weld Chassis Mount with Flange

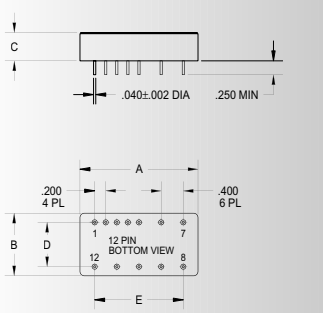
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

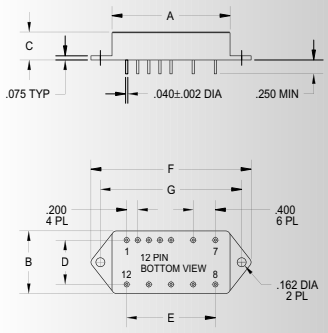
DUAL OUTPUT DEVICES		3020-D05 (6.5W)			3020-D12 (6.5W)			3020-D15 (6.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±35mA	—	±625mA	±35mA	—	±270mA	±32mA	—	±217mA
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

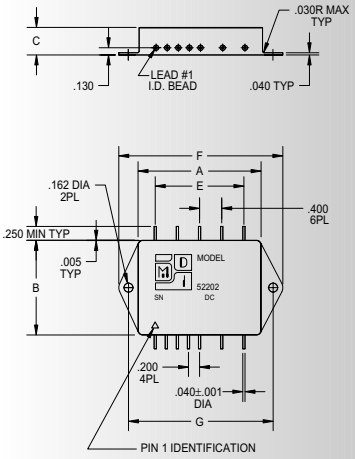
270 VDC

TRIPLE OUTPUT DEVICES		3020-T3.3/5 (3.75W)			3020-T3.3/12 (5W)			3020-T3.3/15 (5W)			3020-T05 (3.75W)			3020-T12 (5W)			3020-T15 (5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	75mA ±20mA	— —	750mA ±150mA	75mA ±20mA	— —	750mA ±105mA	75mA ±20mA	— —	750mA ±83mA	65mA ±20mA	— —	500mA ±150mA	62mA ±20mA	— —	500mA ±105mA	62mA ±20mA	— —	500mA ±83mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	71%	74%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

CASE STYLE 6



CASE STYLE 8



3020-SXX output <24 VDC				3020-SXX output ≥24 VDC				3020-DXX				3020-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

7.5–20 Watt Hybrid

Features

- Specifically designed for aircraft applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

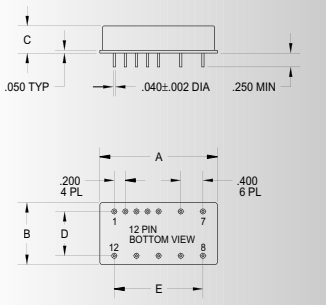
INPUT: 270 VDC nominal
Range: 185 to 335 VDC continuous
Survives 440 V transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 60 grams typical

SINGLE OUTPUT DEVICES		3109-S03.3 (13.2W)			3109-S05 (20W)			3108-S05.2 (20W)			3109-S12 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	4A	—	—	4A	—	—	3.85A	—	—	1.67A
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

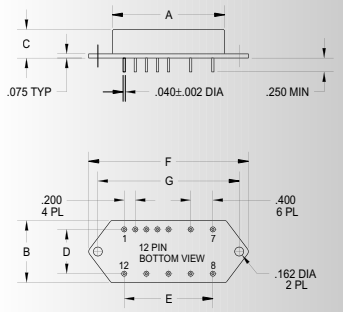
SINGLE OUTPUT DEVICES		3109-S15 (20W)			3109-S28 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	1.33A	—	—	714mA
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3109	2	12	Solder Sealed Flangeless PCB Mount
3109 F	3	12	Solder Sealed PCB Mount with Flange
3109 H	5	12	Seam Weld Flangeless PCB Mount
3109 HF	6	12	Seam Weld PCB Mount with Flange
3109 VF	8	12	Seam Weld Chassis Mount with Flange

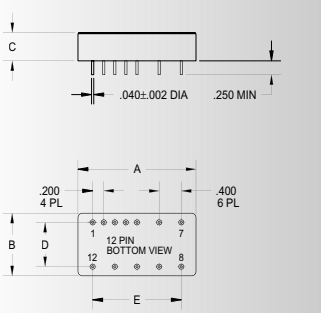
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
3	F	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5	H	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
6	HF	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8	VF	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

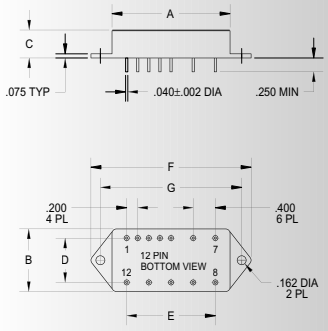
DUAL OUTPUT DEVICES		3109-D3.3/5 (11.6W)			3109-D05 (20W)			3109-D12 (20W)			3109-D15 (20W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		+4.9	+5.0	+5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	200mA	—	2A	±150mA	—	±2A	±125mA	—	±833mA	±100mA	—	±667mA
		100mA	—	1A									
Efficiency	P_{out} = max rated load	62%	65%	—	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

270 VDC

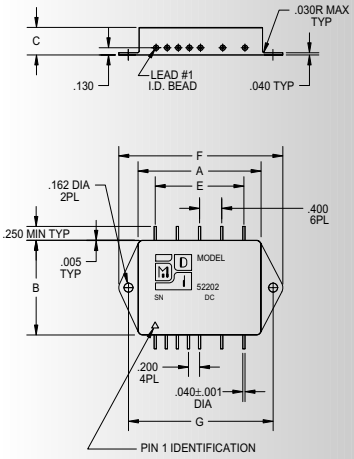
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3109-T3.3/5 (7.5W)			3109-T3.3/12 (10W)			3109-T3.3/15 (10W)			3109-T05 (7.5W)			3109-T12 (10W)			3109-T15 (10W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	150mA	—	1.5A	150mA	—	1.5A	150mA	—	1.5A	60mA	—	1A	30mA	—	1A	30mA	—	1A
		±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA	±15mA	—	±250mA	±15mA	—	±208mA	±15mA	—	±167mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	68%	—	70%	73%	—	70%	73%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

CASE STYLE 6



CASE STYLE 8



3109-SXX output <24 VDC				3109-SXX output ≥24 VDC				3109-DXX				3109-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	N/C	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	N/C	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

12.5–30 Watt Hybrid

Features

- Specifically designed for aircraft applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

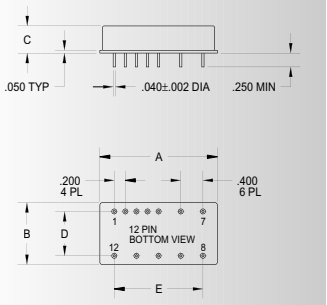
INPUT: 270 VDC nominal
Range: 185 to 335 VDC continuous
Survives 440 V transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 75 grams typical

SINGLE OUTPUT DEVICES		3000-S03.3 (20W)			3000-S05 (30W)			3000-S05.2 (30W)			3000-S12 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	6.06A	—	—	6A	—	—	5.76A	—	—	2.5A
Efficiency	P_{out} = max rated load	66%	69%	—	71%	74%	—	71%	74%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

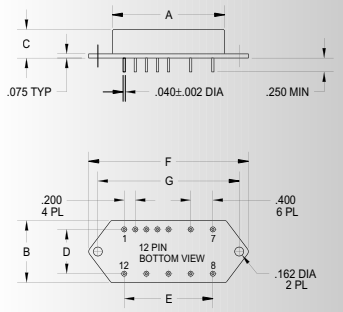
SINGLE OUTPUT DEVICES		3000-S15 (30W)			3000-S28 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2A	—	—	1.07A
Efficiency	P_{out} = max rated load	79%	83%	—	78%	82%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3000	2	12	Solder Sealed Flangeless PCB Mount
3000 F	3	12	Solder Sealed PCB Mount with Flange
3000 I	5	12	Seam Weld Flangeless PCB Mount
3000 IF	6	12	Seam Weld PCB Mount with Flange
3000 WF	8	12	Seam Weld Chassis Mount with Flange
3000 PB	10	12	Solder Sealed Flangeless PCB Stud Mount
3000 PE	12	12	Seam Weld Flangeless PCB Stud Mount

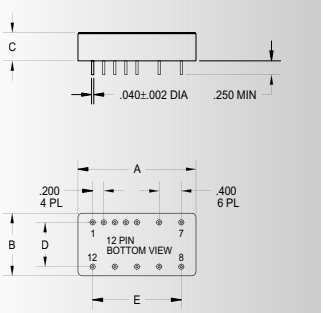
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3	F	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	I	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6	IF	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	WF	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PB	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
12	PE	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —

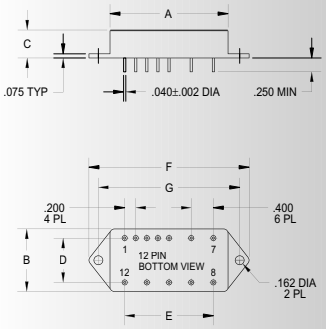
DUAL OUTPUT DEVICES		3000-D3.3/5 (14.9W)			3000-D05 (30W)			3000-D12 (30W)			3000-D15 (30W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		+4.9	+5.0	+5.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	±150mA	—	±3A	±95mA	—	±1.25A	±76mA	—	±1A
		100mA	—	1A									
Efficiency	P_{out} = max rated load	63%	66%	—	72%	76%	—	78%	82%	—	79%	83%	—
Line regulation	P_{out} = max rated load	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
	$V_{in\ min}$ — $V_{in\ max}$	—	10mV	50mV									
Load regulation†	P_{out} = 10% to F.L.	—	10mV	30mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
		—	10mV	50mV									
Output ripple	F.L. BW 2 MHz	—	30	65	—	40	85	—	60	150	—	75	180
	mV_{pp}	—	25	50									

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

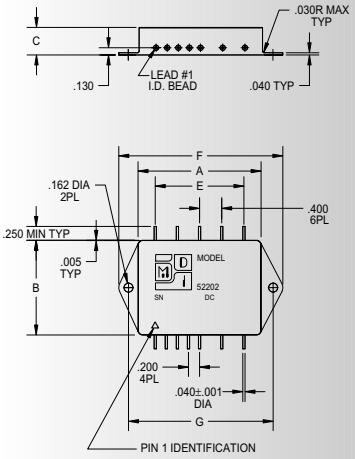
270 VDC

TRIPLE OUTPUT DEVICES		3000-T3.3/5 (12.5W)			3000-T3.3/12 (17.5W)			3000-T3.3/15 (17.5W)			3000-T05 (12.5W)			3000-T12 (17.5W)			3000-T15 (17.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1	+4.9	+5.0	+5.1
		+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1	+4.9	+5.0	+5.1	+11.9	+12.0	+12.1	+14.9	+15.0	+15.1
		-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1	-4.9	-5.0	-5.1	-11.9	-12.0	-12.1	-14.9	-15.0	-15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	300mA	—	3A	300mA	—	3A	300mA	—	3A	90mA	—	2A	90mA	—	2A	90mA	—	2A
		±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA	±40mA	—	±250mA	±40mA	—	±312mA	±32mA	—	±250mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	66%	69%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
	$V_{in\ min}$ — $V_{in\ max}$	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV	—	10mV	50mV
		—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV	—	25mV	50mV
Output ripple	F.L. BW 2 MHz	—	30	65	—	30	65	—	30	65	—	40	85	—	40	85	—	40	85
	mV_{pp}	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50	—	—	50

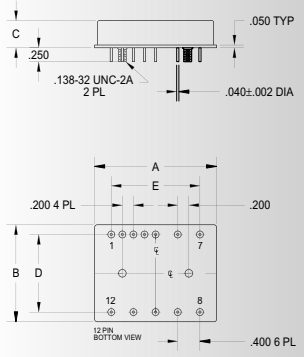
CASE STYLE 6



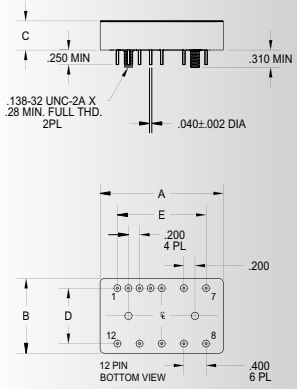
CASE STYLE 8



CASE STYLE 10



CASE STYLE 12



3000-SXX output <24 VDC				3000-SXX output ≥24 VDC				3000-DXX				3000-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

19.5–40 Watt Hybrid

Features

- Specifically designed for aircraft applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

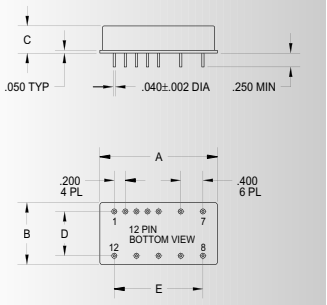
INPUT: 270 VDC nominal
Range: 185 to 335 VDC continuous
Survives 440 V transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 90 grams typical

SINGLE OUTPUT DEVICES		3327-S03.3 (26.4W)			3327-S05 (40W)			3327-S05.2 (40W)			3327-S12 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	8A	—	—	8A	—	—	7.69A	—	—	3.33A
Efficiency	P_{out} = max rated load	64%	67%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

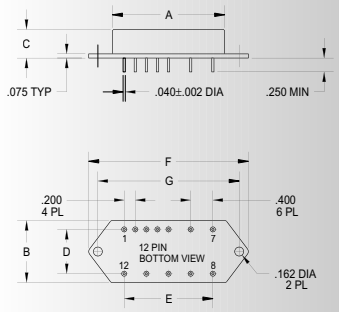
SINGLE OUTPUT DEVICES		3327-S15 (40W)			3327-S28 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	2.67A	—	—	1.43A
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load, $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz, mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3327	2	12	Solder Sealed Flangeless PCB Mount
3327 F	3	12	Solder Sealed PCB Mount with Flange
3327 J	5	12	Seam Weld Flangeless PCB Mount
3327 JF	6	12	Seam Weld PCB Mount with Flange
3327 XF	8	12	Seam Weld Chassis Mount with Flange
3327 PC	10	12	Solder Sealed Flangeless PCB Stud Mount

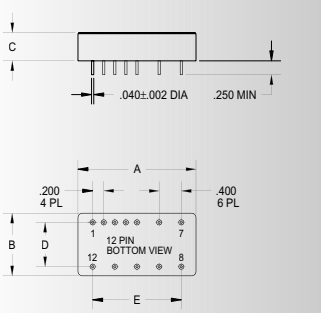
CASE STYLE 2



CASE STYLE 3



CASE STYLE 5



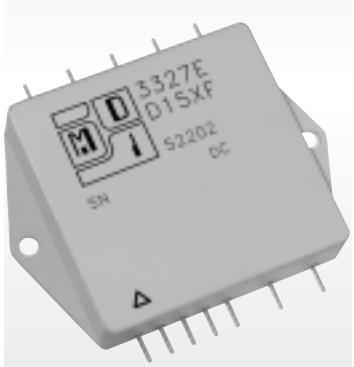
Case Dimensions

Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
2		2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3	F	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
5	J	2.190 | 55.626	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6	JF	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
8	XF	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
10	PC	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

DUAL OUTPUT DEVICES		3327-D05 (40W)			3327-D12 (40W)			3327-D15 (40W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min}$ — $V_{in\ max}$	±150mA	—	±4A	±95mA	—	±1.67A	±76mA	—	±1.33A
Efficiency	P_{out} = max rated load	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	40	85	—	60	150	—	75	180

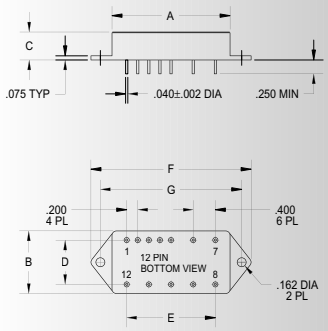


270 VDC

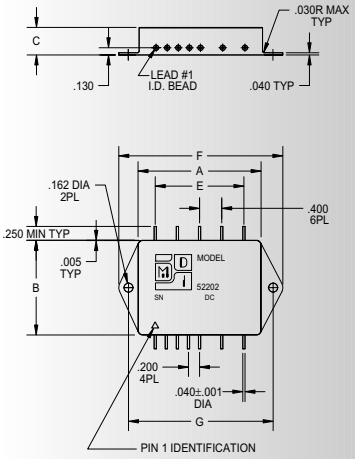
*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

TRIPLE OUTPUT DEVICES		3327-T3.3/5 (17.7W)			3327-T3.3/12 (24W)			3327-T3.3/15 (25.2W)			3327-T05 (19.5W)			3327-T12 (25.8W)			3327-T15 (27W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	400mA ±40mA	— —	4A ±450mA	400mA ±40mA	— —	4A ±450mA	400mA ±32mA	— —	4A ±400mA	90mA ±40mA	— —	3A ±450mA	90mA ±40mA	— —	3A ±450mA	90mA ±32mA	— —	3A ±400mA
Efficiency	P_{out} = max rated load	66%	69%	—	66%	69%	—	66%	69%	—	64%	68%	—	71%	74%	—	71%	74%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

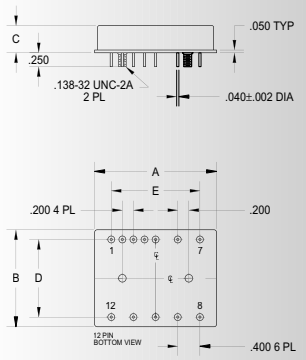
CASE STYLE 6



CASE STYLE 8



CASE STYLE 10



3327-SXX output <24 VDC				3327-SXX output ≥24 VDC				3327-DXX				3327-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

32.5–80 Watt Hybrid

Features

- Specifically designed for aircraft applications
- Completely self contained Thick Film Hybrid DC-DC Converter
- No external filter caps required
- Fully isolated design
- "Inhibit-not" function
- Power on soft start
- 200 kHz operation for low ripple and fast response time
- Built-in EMI input filter meets MIL-STD-461C requirements CE01, CE03, CS01, CS02 and CS06
- Short circuit and overvoltage protection
- Capability of external sync for switching frequencies
- Built-in test capability

Specifications

INPUT: 270 VDC nominal
Range: 185 to 335 VDC continuous
Survives 440 V transients
ISOLATION:
Input to case: 500 VDC
Input to output: 500 VDC
Output to case: 100 VDC
ENVIRONMENT:
Storage temperature: -55°C to +150°C
Shock: 50 G's
Acceleration: 500 G's
Vibration: 30 G's
Grade M:
Full Power Output at T_{case} = +85°C
Linearly derates to zero at T_{case} = +115°C
Grade E:
Full Power Output at T_{case} = +125°C
Linearly derates to zero at T_{case} = +135°C
WEIGHT: 160 grams typical

SINGLE OUTPUT DEVICES		3041-S03.3 (49.5W)			3041-S05 (75W)			3041-S05.2 (75W)			3041-S12 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+3.2	+3.3	+3.4	+4.9	+5.0	+5.1	+5.1	+5.2	+5.3	+11.9	+12.0	+12.1
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	15A	—	—	15A	—	—	15A	—	—	6.25A
Efficiency	P_{out} = max rated load	65%	68%	—	70%	73%	—	70%	73%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Load regulation	P_{out} = 10% to F.L.	—	10mV	30mV	—	10mV	50mV	—	10mV	50mV	—	20mV	100mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	30	65	—	40	85	—	40	85	—	60	150

SINGLE OUTPUT DEVICES		3041-S15 (75W)			3041-S28 (70W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	—	+14.9	+15.0	+15.1	+27.8	+28.0	+28.2
Output current	$V_{in\ min}$ — $V_{in\ max}$	—	—	5A	—	—	2.5A
Efficiency	P_{out} = max rated load	78%	82%	—	77%	81%	—
Line regulation	P_{out} = max rated load $V_{in\ min}$ — $V_{in\ max}$	—	25mV	125mV	—	50mV	250mV
Load regulation	P_{out} = 10% to F.L.	—	25mV	125mV	—	50mV	250mV
Output ripple	F.L. BW 2 MHz mV_{pp}	—	75	180	—	150	350

Model No.	Case Style	Pin Count	Mounting
3041	4	12	Solder Sealed PCB Mount with Flange
3041 LF	7	12	Seam Weld PCB Mount with Flange
3041 ZF	9	12	Seam Weld Chassis Mount with Flange
3041 PD	11	12	Solder Sealed Flangeless PCB Stud Mount

3041-SXX output <24 VDC				3041-SXX output ≥24 VDC				3041-DXX				3041-TXX			
Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input	Pin 1	bit	Pin 7	+ input
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	N/C	Pin 11	adjust	Pin 5	N/C	Pin 11	N/C	Pin 5	N/C	Pin 11	dual output ret	Pin 5	N/C	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

3041-SXX ZF output <24 VDC				3041-SXX ZF output ≥24 VDC				3041-DXX ZF				3041-TXX ZF			
Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C	Pin 1	bit	Pin 7	N/C
Pin 2	inhibit not	Pin 8	main output	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	N/C	Pin 2	inhibit not	Pin 8	main output
Pin 3	soft start	Pin 9	main output ret	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	N/C	Pin 3	soft start	Pin 9	main output ret
Pin 4	sync	Pin 10	+ remote sense	Pin 4	sync	Pin 10	main output	Pin 4	sync	Pin 10	+ dual output	Pin 4	sync	Pin 10	+ dual output
Pin 5	+ input	Pin 11	adjust	Pin 5	+ input	Pin 11	N/C	Pin 5	+ input	Pin 11	dual output ret	Pin 5	+ input	Pin 11	dual output ret
Pin 6	input ret	Pin 12	- remote sense	Pin 6	input ret	Pin 12	main output ret	Pin 6	input ret	Pin 12	- dual output	Pin 6	input ret	Pin 12	- dual output

Please specify **GRADE LEVEL** for your application. Industrial grade units will be shipped if no option is specified.

M +85°C military
E +125°C military

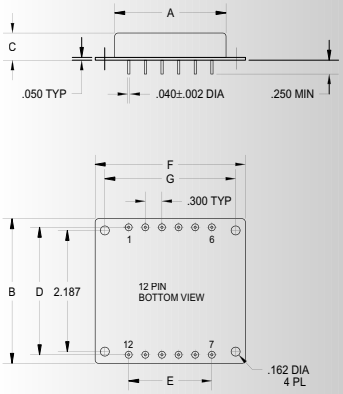
DUAL OUTPUT DEVICES		3041-D3.3/5 (31.78W)			3041-D05 (75W)			3041-D12 (74.4W)			3041-D15 (75W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9	+3.3 +5.0	+3.4 +5.1	+4.9 -4.9	+5.0 -5.0	+5.1 -5.1	+11.9 -11.9	+12.0 -12.0	+12.1 -12.1	+14.9 -14.9	+15.0 -15.0	+15.1 -15.1
Output current*	$V_{in\ min} — V_{in\ max}$	660mA 200mA	— —	6.6A 2A	±266mA	—	±7.5A	±158mA	—	±3.1A	±127mA	—	±2.5A
Efficiency	P_{out} = max rated load	64%	67%	—	72%	75%	—	77%	81%	—	78%	82%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	— —	10mV 10mV	30mV 50mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Load regulation†	P_{out} = 10% to F.L.	— —	10mV 10mV	30mV 50mV	—	±10mV	±50mV	—	±20mV	±100mV	—	±25mV	±125mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 25	65 50	—	40	85	—	60	150	—	75	180

*Notes: *Up to 90% full power available from either output if rated output power is not exceeded; †balanced load conditions.*

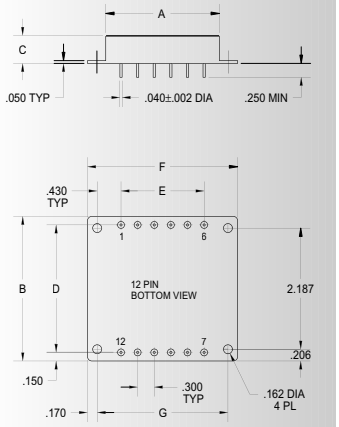
270 VDC

TRIPLE OUTPUT DEVICES		3041-T3.3/5 (32.25W)			3041-T3.3/12 (42.75W)			3041-T3.3/15 (47.25W)			3041-T05 (32.5W)			3041-T12 (43W)			3041-T15 (47.5W)		
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX
Output voltage	$+I_{out} = -I_{out}$	+3.2 +4.9 -4.9	+3.3 +5.0 -5.0	+3.4 +5.1 -5.1	+3.2 +11.9 -11.9	+3.3 +12.0 -12.0	+3.4 +12.1 -12.1	+3.2 +14.9 -14.9	+3.3 +15.0 -15.0	+3.4 +15.1 -15.1	+4.9 +4.9 -4.9	+5.0 +5.0 -5.0	+5.1 +5.1 -5.1	+4.9 +11.9 -11.9	+5.0 +12.0 -12.0	+5.1 +12.1 -12.1	+4.9 +14.9 -14.9	+5.0 +15.0 -15.0	+5.1 +15.1 -15.1
Output current	$V_{in\ min} — V_{in\ max}$	750mA ±40mA	— —	7.5A ±750mA	750mA ±40mA	— —	7.5A ±750mA	750mA ±32mA	— —	7.5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±40mA	— —	5A ±750mA	90mA ±32mA	— —	5A ±750mA
Efficiency	P_{out} = max rated load	65%	68%	—	65%	68%	—	65%	68%	—	65%	78%	—	71%	74%	—	70%	73%	—
Line regulation	P_{out} = max rated load $V_{in\ min} — V_{in\ max}$	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Load regulation	P_{out} = 10% to F.L.	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV	— —	10mV 25mV	50mV 50mV
Output ripple	F.L. BW 2 MHz mV_{pp}	— —	30 —	65 50	— —	30 —	65 50	— —	30 —	65 50	— —	40 —	85 50	— —	40 —	85 50	— —	40 —	85 50

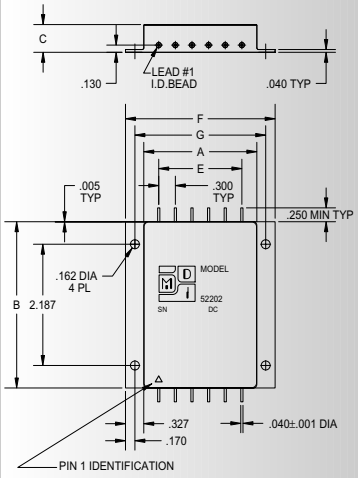
CASE STYLE 4



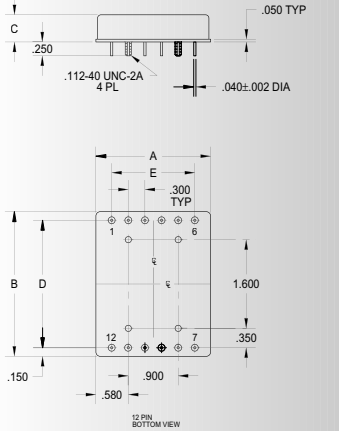
CASE STYLE 7



CASE STYLE 9



CASE STYLE 11



Case Dimensions
Units: inches | millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02; **DRAWINGS IN INCHES**.

Case Style		A	B	C	D	E	F	G
4		2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
7	LF	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
9	ZF	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
11	PD	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —

Pin Out Chart

Model Number / **Pin Number**	1	2	3	4	5	6	7
2680-SXX output <24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
2680-SXX output ≥24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
2680-DXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
2680-TXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
2690-SXX output <24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
2690-SXX output ≥24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
2690-DXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
2690-TXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3000-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3000-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3000-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3000-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3001-SXX output <24 VDC	+ input	inhibit not	– remote sense	main output ret	main output	+ remote sense	case
3001 SXX ≥24 VDC	+ input	N/C	main output	N/C	main output ret	N/C	case
3001 DXX	+ input	N/C	+ dual output	dual output ret	– dual output	N/C	case
3001 TXX	+ input	main output	output ret	– dual output	+ dual output	N/C	case
3011-SXX output <24 VDC	+ input	inhibit not	output adjust	main output ret	main output	N/C	N/C
3011-SXX output ≥24 VDC	+ input	inhibit not	main output	N/C	main output ret	N/C	N/C
3011-DXX	+ input	inhibit not	+ dual output	dual output ret	- dual output	N/C	N/C
3011-TXX	+ input	inhibit not	+ dual output	dual output ret	- dual output	main output ret	main output
3020-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3020-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3020-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3020-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3031-SXX output <24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3031-SXX output ≥24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3031-DXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3031-TXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3031-SXX ZF output <24 VDC	bit	inhibit	soft start	sync	+ input	input ret	N/C
3031-SXX ZF output ≥24 VDC	bit	inhibit	soft start	sync	+ input	input ret	N/C
3031-DXX ZF	bit	inhibit	soft start	sync	+ input	input ret	N/C
3031-TXX ZF	bit	inhibit	soft start	sync	+ input	input ret	N/C
3041-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3041-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3041-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3041-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3041-SXX ZF output <24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3041-SXX ZF output ≥24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3041-DXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3041-TXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3051-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3051-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3051-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3051-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3051-SXX ZF output <24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3051-SXX ZF output ≥24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3051-DXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3051-TXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3060-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3060 SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3060 DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3060 TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3061-SXX output <24 VDC	+ input	+ input	N/C	case	N/C	main output ret	main output ret
3061-SXX output ≥24 VDC	+ input	+ input	N/C	case	main output ret	N/C	N/C
3061-DXX	+ input	+ input	N/C	case	- dual output	output com	output com
3061-TXX	+ input	+ input	N/C	case	- dual output	dual output ret	dual output ret
3062-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3062-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3062-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3062-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input

9000

8	9	10	11	12	13	14	15	16	17	18
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	N/C main output + dual output + dual output	adjust N/C dual output ret dual output ret	N/C main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
N/C inhibit not inhibit not inhibit not	N/C N/C N/C N/C	input ret input ret input ret input ret								
case case case case	N/C N/C N/C N/C	input ret input ret input ret input ret								
main output N/C N/C main output	main output ret N/C N/C main output ret	N/C main output + dual output + dual output	adjust N/C dual output ret dual output ret	N/C main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
main output N/C N/C main output	main output ret N/C N/C main output ret	+ remote sense main output + dual output + dual output	adjust N/C dual output ret dual output ret	– remote sense main output ret – dual output – dual output						
N/C main output + dual output + dual output	main output N/C N/C main output	N/C N/C N/C N/C	N/C N/C N/C N/C	N/C N/C N/C N/C	N/C N/C N/C N/C	N/C N/C N/C N/C	inhibit not inhibit not inhibit not inhibit not	N/C N/C N/C N/C	input ret input ret input ret input ret	input ret input ret input ret input ret
main output N/C N/C main output	main output ret N/C N/C main output ret	N/C main output + dual output + dual output	adjust N/C dual output ret dual output ret	N/C main output ret – dual output – dual output						

Pin Out Chart

Model Number / **Pin Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3070-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3070-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3070-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3070-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3080-SXX output <24 VDC	+ input	+ input	N/C	case	N/C	main output ret	main output ret
3080-SXX output ≥24 VDC	+ input	+ input	N/C	case	main output ret	N/C	N/C
3080-DXX	+ input	+ input	N/C	case	- dual output	output com	output com
3080-TXX	+ input	+ input	N/C	case	- dual output	dual output ret	dual output ret
3107-SXX output <24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3107-SXX output ≥24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3107-DXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3107-TXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3108-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3108-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3108-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3108-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3109-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3109-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3109-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3109-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3113-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3113-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3113-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3113-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3114-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3114-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3114-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3114-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3114-SXX ZF output <24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3114-SXX ZF output ≥24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3114-DXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3114-TXX ZF	bit	inhibit not	soft start	sync	+ input	input ret	N/C
3138-TXX	+ input	main output	output ret	- dual output	+ dual output	N/C	case
3193-SXX output <24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3193-SXX output ≥24 VDC	bit	inhibit	soft start	sync	N/C	input ret	+ input
3193-DXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3193-TXX	bit	inhibit	soft start	sync	N/C	input ret	+ input
3325-SXX output <24 VDC	+ input	+ input	N/C	case	N/C	main output ret	main output ret
3325-SXX output ≥24 VDC	+ input	+ input	N/C	case	main output ret	N/C	N/C
3325-DXX	+ input	+ input	N/C	case	- dual output	output com	output com
3325-TXX	+ input	+ input	N/C	case	- dual output	dual output ret	dual output ret
3326-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3326-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3326-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3326-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3327-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3327-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3327-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3327-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3378-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3378-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3378-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
3378-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
4690-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
4690-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
4690-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
4690-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5031-SXX output <24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
5031-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	adjust
5031-DXX	bit	inhibit not	soft start	sync	+ input	input ret	adjust
5031-TXX	bit	inhibit not	soft start	sync	+ input	input ret	N/C

8	9	10	11	12	13	14	15	16	17	18
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
N/C	main output	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
main output	N/C	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
+ dual output	N/C	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
+ dual output	main output	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	N/C	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
inhibit not	N/C	input ret								
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
N/C	main output	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
main output	N/C	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
+ dual output	N/C	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
+ dual output	main output	N/C	N/C	N/C	N/C	N/C	inhibit not	N/C	input ret	input ret
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	N/C	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
+ remote sense	- remote sense	main output	N/C	main output ret						
+ remote sense	- remote sense	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						

Pin Out Chart

Model Number / **Pin Number**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5080	pos in	pos in	pos in	common	common	common	output
5107-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5107-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5107-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5107-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5193-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5193-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	adjust	input ret	+ input
5193-DXX	bit	inhibit not	soft start	sync	adjust	input ret	+ input
5193-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5680-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5680-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	adjust	input ret	+ input
5680-DXX	bit	inhibit not	soft start	sync	adjust	input ret	+ input
5680-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5690-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5690-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5690-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
5690-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6031-SXX output <24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
6031-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	+ input	input ret	N/C
6031-DXX	bit	inhibit not	soft start	sync	+ input	input ret	N/C
6031-TXX	bit	inhibit not	soft start	sync	+ input	input ret	N/C
6107-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6107-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6107-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6107-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6193-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6193-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6193-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6193-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6680-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6680-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6680-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6680-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6690-SXX output <24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6690-SXX output ≥24 VDC	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6690-DXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input
6690-TXX	bit	inhibit not	soft start	sync	N/C	input ret	+ input

Note for 7000, 8000, 9000 Series: Pinouts, packages, and dimensions are identical to the associated model from the MDI 5000 Series.

8	9	10	11	12	13	14	15	16	17	18
output	output	case	N/C	N/C	Vref	adjust	Iout	sync	bit	inhibit not
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
+ remote sense	- remote sense	main output	N/C	main output ret						
+ remote sense	- remote sense	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
+ remote sense	- remote sense	main output	N/C	main output ret						
+ remote sense	- remote sense	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	+ remote sense	adjust	– remote sense						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						
main output	main output ret	N/C	adjust	N/C						
N/C	N/C	main output	N/C	main output ret						
N/C	N/C	+ dual output	dual output ret	– dual output						
main output	main output ret	+ dual output	dual output ret	– dual output						

Case Dimensions

Model No.	Case Style	Pin Count	A	B	C	D	E	F	G
2680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
2690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3000	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3001	2	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
	PA 10	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	MF 13	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
3011	2	10	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	10	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3020	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
3041	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
3051	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
3060	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
3061	1	18	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
3062	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

Case Dimension Units: Inches | Millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02

Model No.	Case Style	Pin Count	A	B	C	D	E	F	G
3070	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3080	1	18	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
3107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3108	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3109	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3113	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
3114	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
3138	2	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
	PA 10	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	MF 13	10	1.950 | 49.530	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.710 | 68.834	2.360 | 59.944
3193	2	12	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 8	12	2.225 | 56.515	2.100 | 53.340	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3325	1	18	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
	D 14	18	1.090 | 27.686	1.090 | 27.686	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
	TF 15	18	1.160 | 29.464	1.283 | 32.588	0.380 | 9.652	— | —	0.800 | 20.320	1.754 | 44.552	1.460 | 37.084
3326	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.190 | 55.626	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 5	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
3327	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.190 | 55.626	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 8	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.190 | 55.626	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —

Case Dimensions

Model No.	Case Style	Pin Count	A	B	C	D	E	F	G
3378	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
4690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
5080	1	18	1.080 | 27.432	1.080 | 27.432	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
	D 14	18	1.090 | 27.686	1.090 | 27.686	0.380 | 9.652	0.800 | 20.320	0.800 | 20.320	— | —	— | —
	TF 15	18	1.160 | 29.464	1.283 | 32.588	0.380 | 9.652	— | —	0.800 | 20.320	1.754 | 44.552	1.460 | 37.084
5107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
5193	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 8	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
5680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
5690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
6031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
6107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

Case Dimension Units: Inches | Millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02

Model No.	Case Style	Pin Count	A	B	C	D	E	F	G
6193	2	12	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 8	12	2.225 | 56.515	2.100 | 53.340	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.225 | 56.515	1.750 | 44.450	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
6680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
6690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
7031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
7107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
7193	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F 3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J 5	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF 6	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF 8	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC 10	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
7680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F 3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I 5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF 6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF 8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB 10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE 12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
7690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G 5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF 6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
8031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF 7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF 9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD 11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
8107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F 3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H 5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF 6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF 8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

Case Dimensions

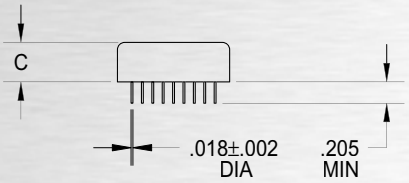
Model No.	Case Style	Pin Count	A	B	C	D	E	F	G
8193	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F	3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J	5	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF	6	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF	8	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC	10	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
8680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F	3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I	5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF	6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF	8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB	10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE	12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
8690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F	3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G	5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF	6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF	8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
9031	4	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	LF	7	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	ZF	9	12	2.040 | 51.816	3.010 | 76.454	0.495 | 12.573	— | —	1.500 | 38.100	2.710 | 68.834	2.360 | 59.944
	PD	11	12	2.040 | 51.816	2.610 | 66.294	0.495 | 12.573	2.300 | 58.420	1.500 | 38.100	— | —	— | —
9107	2	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F	3	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	H	5	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	HF	6	12	2.130 | 54.102	1.120 | 28.448	0.495 | 12.573	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	VF	8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
9193	2	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	F	3	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	J	5	12	2.205 | 56.007	1.755 | 44.577	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
	JF	6	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	XF	8	12	2.220 | 56.388	2.110 | 53.594	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PC	10	12	2.220 | 56.388	1.760 | 44.704	0.495 | 12.573	1.400 | 35.560	1.600 | 40.640	— | —	— | —
9680	2	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	F	3	12	2.200 | 55.880	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	I	5	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	IF	6	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	WF	8	12	2.225 | 56.515	1.710 | 43.434	0.495 | 12.573	— | —	1.600 | 40.640	2.960 | 75.184	2.610 | 66.294
	PB	10	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
	PE	12	12	2.225 | 56.515	1.350 | 34.290	0.495 | 12.573	1.000 | 25.400	1.600 | 40.640	— | —	— | —
9690	2	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	F	3	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	G	5	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	— | —	— | —
	GF	6	12	2.130 | 54.102	1.120 | 28.448	0.375 | 9.525	0.800 | 20.320	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770
	UF	8	12	2.160 | 54.864	1.510 | 38.354	0.495 | 12.573	— | —	1.600 | 40.640	2.890 | 73.406	2.550 | 64.770

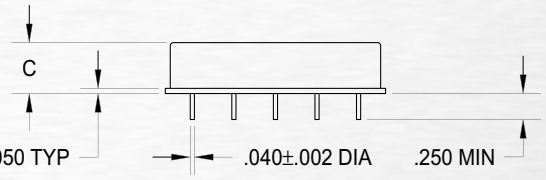
Case Dimension Units: Inches | Millimeters

TOLERANCES: ALL DIMENSIONS ±0.01 EXCEPT F = MAX, C = +0.01/-0.02

Case Styles

SOLDER SEALED PACKAGES





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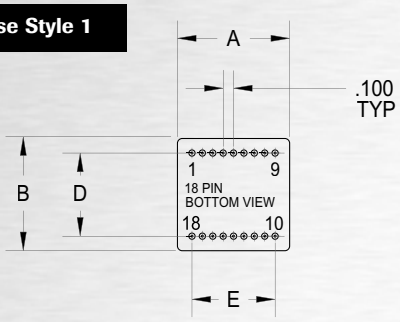

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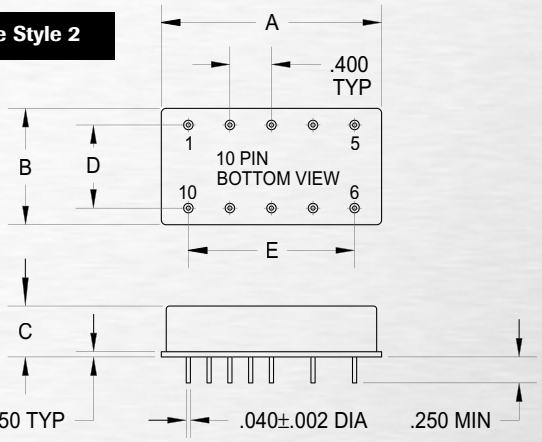

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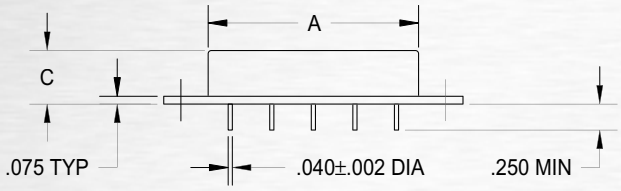

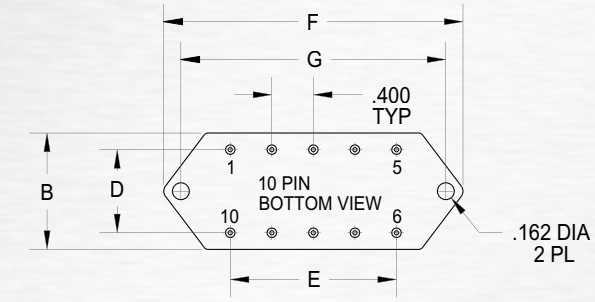

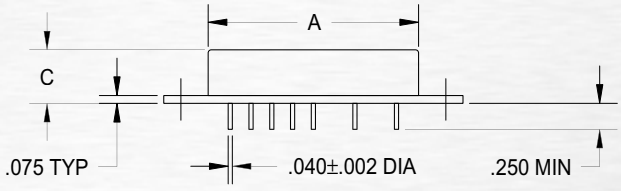

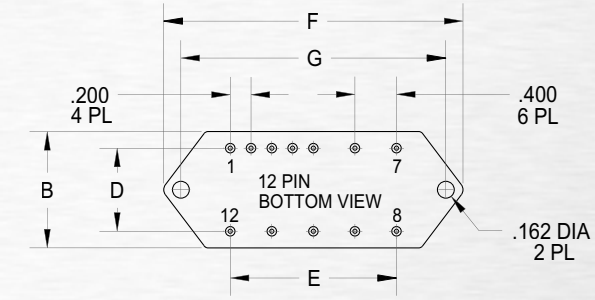

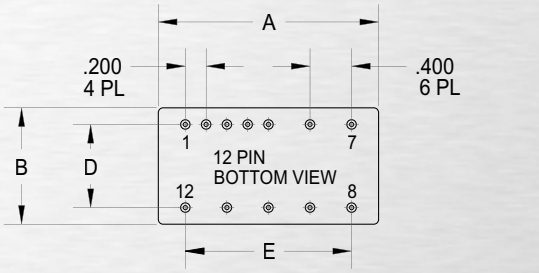

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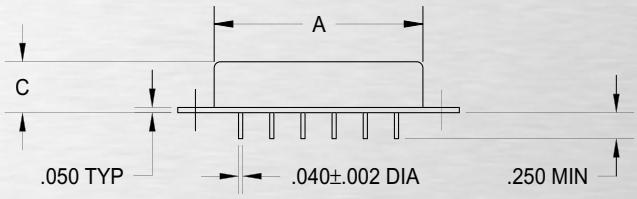
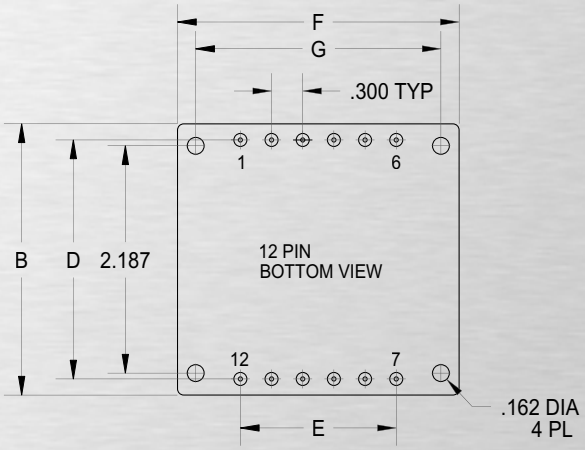
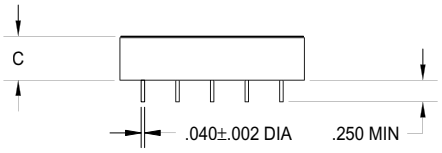


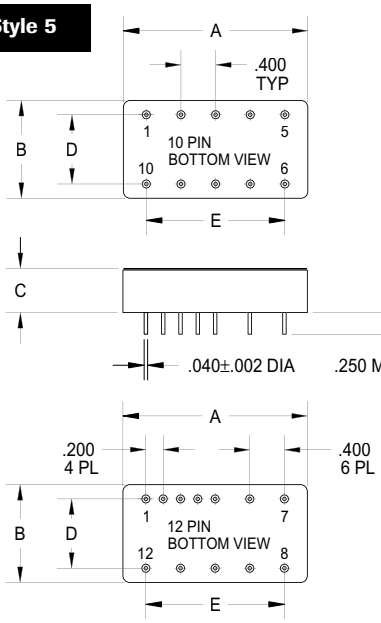


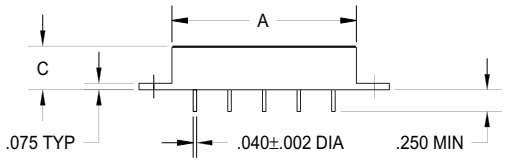
Case Styles

SEAM WELD PC BOARD MOUNT



Case Style 5





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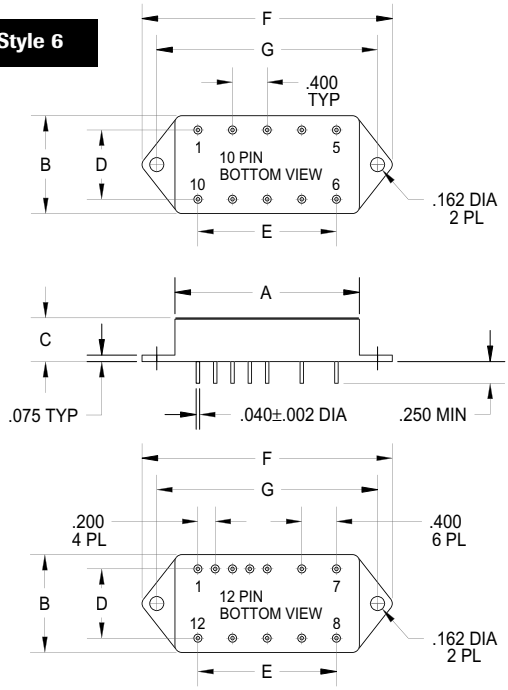
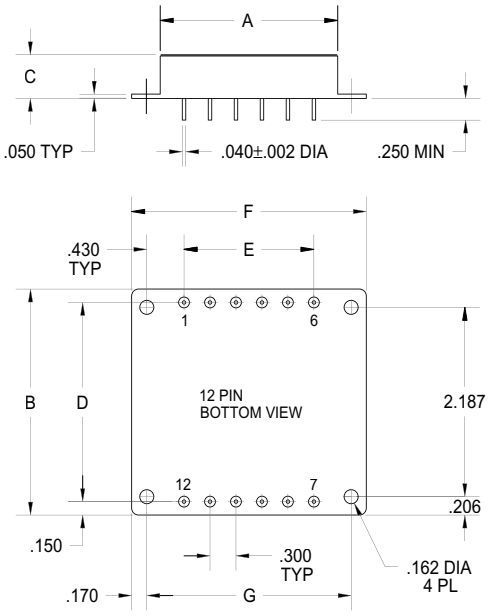
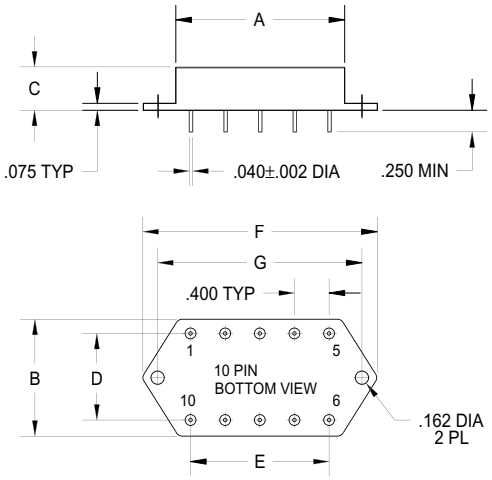


9000

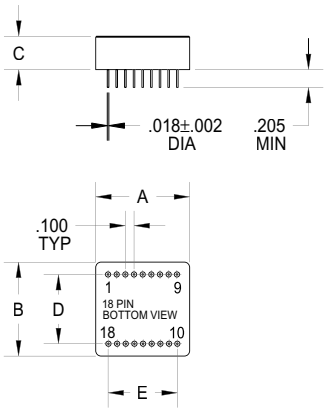
Case Style 7



Case Style 13



Case Style 14



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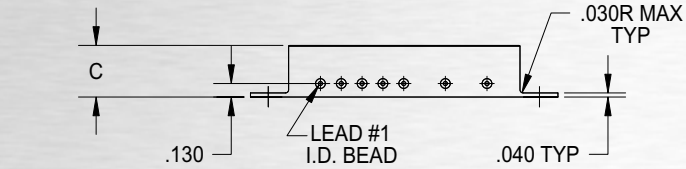

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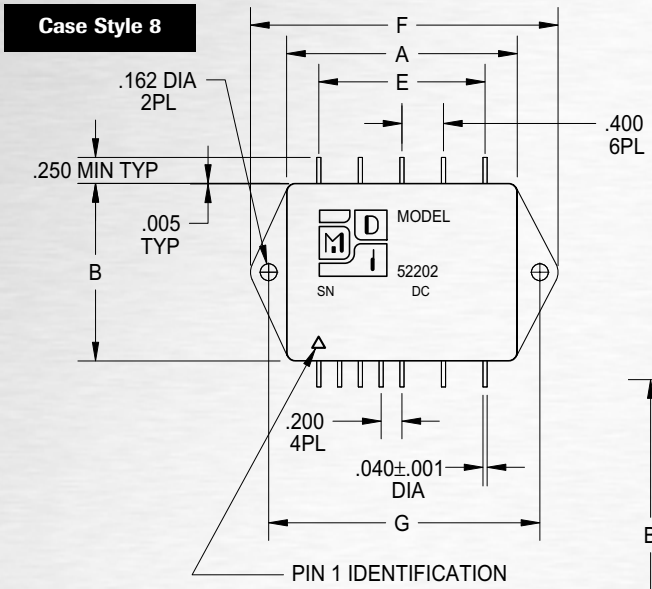
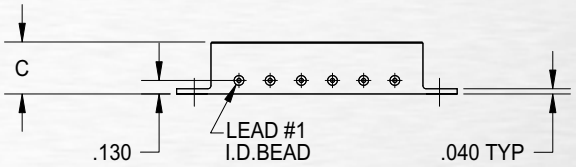
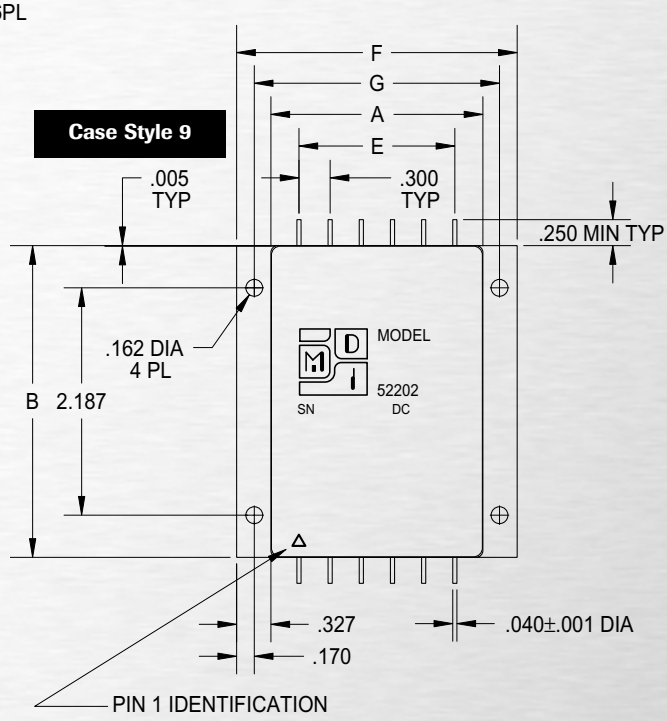
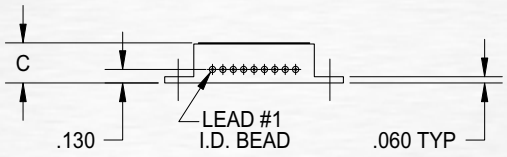


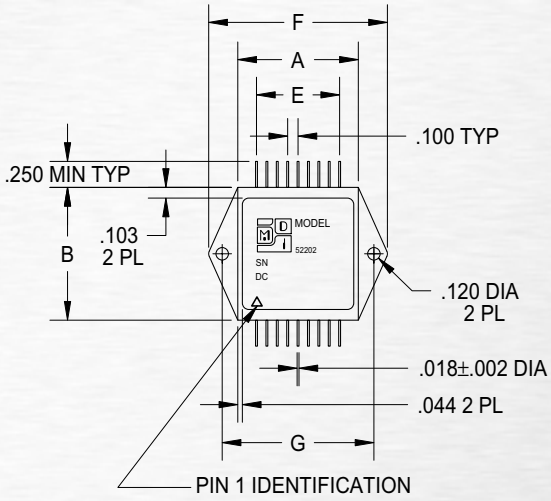


Case Style 9



Case Style 15

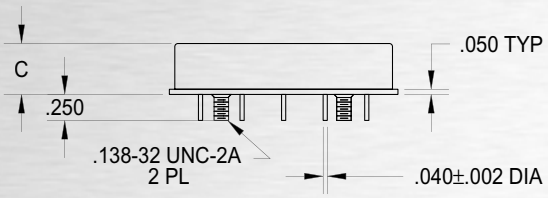


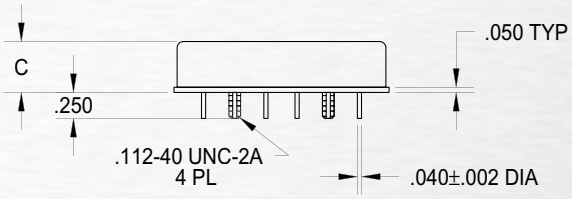


Modular Devices Inc
can design a custom power hybrid package to meet your specific requirements

Case Styles

SOLDER SEALED STUD MOUNT





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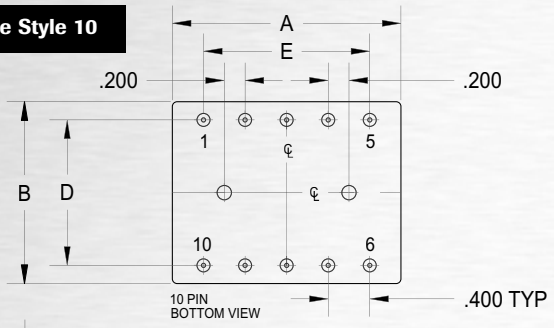

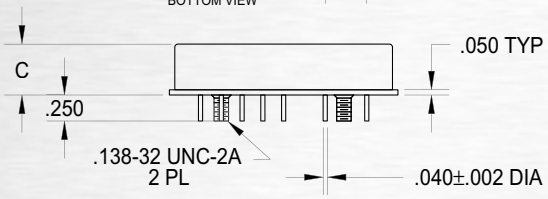

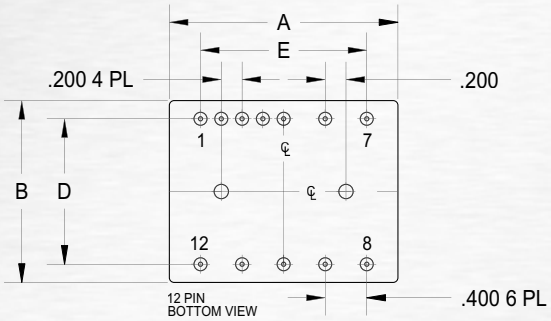

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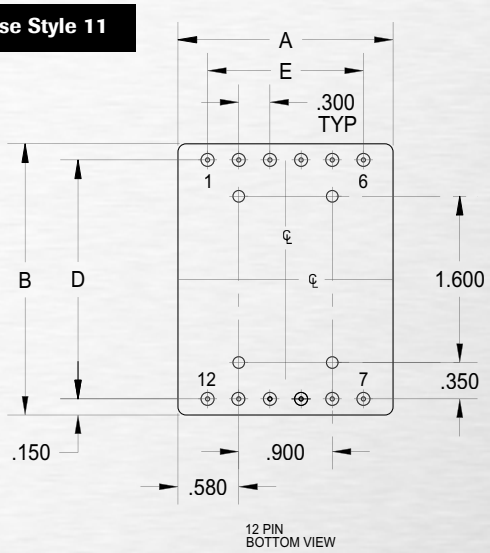
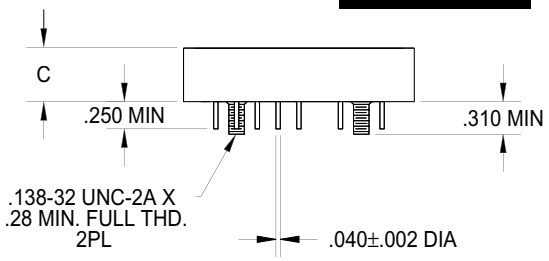
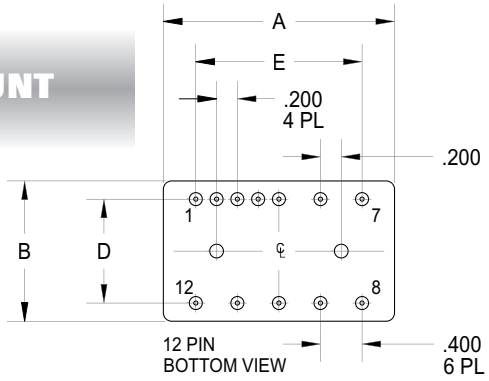


Case Style 12



SEAM WELD PCB STUD MOUNT



Hybrid DC/DC Converter Application Notes

Application Guide to MDI Full-Featured Converters

This application guide offers application information and technical insight on the MDI family of full featured hybrid DC/DC Converters. Hybrid DC/DC Converters offer the advantages of size, weight and performance when compared to discrete or surface mount units. This application note discusses the operation and use of full featured hybrid DC/DC Converters. These parts are currently available in four input voltage ranges. For nominal 28 VDC systems, in order of increasing power levels, the parts are designated Models 2690, 3107, 2680, 3193 and 3031. These parts are also available with "Inhibit Not" as Models 6690, 6107, 6680, 6193 and 6031. For nominal 120 VDC systems, in order of increasing power levels, the parts are designated Models 3070, 3108, 3060, 3326 and 3051. For nominal 270 VDC systems, in order of increasing power levels, the parts are designated Models 3020, 3109, 3000, 3327 and 3041. For nominal low voltage 8 to 40 VDC systems, in order of increasing power levels, the full featured parts are designated Models 3062, 3113, 3063 and 3114.

For space applications requiring radiation hardness, MDI offers the proton rad hard series. For 28 V nominal systems, the parts are designated 5690, 5107, 5680, 5193 and 5031. For 50 V nominal systems, the parts are designated 7690, 7107, 7680, 7193 and 7031. For 70 V nominal systems, the parts are designated 8690, 8107, 8680, 8193 and 8031. For 100 V nominal systems, the parts are designated 9690, 9107, 9680, 9193 and 9031.

The inherent advantages of hybrid switched-mode converters make them a logical solution for use in many applications including spacecraft, aircraft, missiles and undersea systems. Some of these advantages include small size and weight, hermetic sealing for environmental resistance, excellent DC and high frequency isolation, ease in heatsinking the single converter as compared to multiple power components, better control of EMI and output ripple and higher reliability.

The full featured connotation by MDI implies the inclusion of many useful functions that were previously not available in hybrid converters. The most important feature is the addition of a complete self contained EMI filter, allowing these units to meet MIL-STD-461 levels. Additional features include output common mode filtering, programmable soft start, open loop OVP protection, external synchronization inputs and an inhibit input.

Construction

MDI hybrid DC/DC Converters are completely self contained, hermetically sealed power supplies reconstructed on ceramic thick film substrates. They require no external components for standard operation from power buses. All necessary magnetic components, capacitors and filtering is contained within the hybrid package. The hybrid construction allows the converters to withstand severe environmental requirements. All magnetic components within the hybrid are constructed in toroidal form. Since the windings are on the outside, the toroidal construction results in better heatsinking of the magnetic components than possible with ferrite cored magnetics. The resistors are primarily printed directly on the thick film substrate, with certain key resistors as separate chips.

The active components are principally bipolar, excepting the switching FET. This allows the same circuit topology and layout to be used for both non-Rad Hard and Rad Hard uses, depending on actual part types used.

A wide variety of cases is offered in both PC mount and chassis mount configurations. Choices of solder sealed and seam welded packaging are also offered.

Features and Specifications

MDI full featured hybrid DC/DC Converters use a flyback topology operating at approximately 200 kHz or 300kHz. The flyback topology is especially well suited for a wide input voltage range and for multiple output voltages. The converters operate over an input voltage range from 5:1 (for the low voltage series) to a range of 1.67:1 (for the 270 V series). The range for the standard 28 VDC parts encompasses the limits of MIL-STD-704A. The "V" series parts of the 28 VDC range can survive the 100 VDC surges of MIL-STD-1275. Standard input to case isolation is 500 VDC for all ranges. Standard output to case isolation is 100 VDC. Standard input to output isolation is 500 VDC. All full featured units combine not only input MIL-STD-461 EMI filters, but also output common mode filters for spike suppression.

The hybrids have circuit features such as current limiting on each output, a programmable power on soft start, open loop OVP protection, an input inhibit, built-in test status pin and a synchronization input. All input functions except output adjust and remote sense are referenced to the input return.

DC Power Input Considerations

Turn on Voltage/Load Regulation Effects

At no load conditions at an ambient of 25°C, 28 VDC converters will start to turn on at approximately 11 VDC. The corresponding value for 120 VDC converters is 30-40 VDC. For 270 VDC, the turn on voltage is approximately 80 VDC. For the low voltage 8 to 40 VDC parts, turn on occurs at approximately 9.5 VDC. For 5000 series parts, turn on threshold are the same as other 28 VDC types. For 7000 series parts, turn on occurs at 25 VDC max. For 8000 series parts, turn on occurs at 40 VDC max. For 9000 series parts, turn on occurs at 55 VDC max. There are no constraints on how quickly or how slowly the input voltage is applied. Full regulation at no load can occur at approximately 10 to 20% above the initial start voltage. Between the initial start and reaching the regulation point, the output voltage increases monotonically as the input voltage is increased. External undervoltage lockout circuits are neither necessary nor desirable to control turn-on.

Steady State Input Range

The 28 VDC input converters were nominally designed to operate from the normal steady state range of MIL-STD-704A through E, but operate over the extended range of 16 to 50 VDC. A surge resistance of 80 VDC is standard for the 28 VDC parts. "V" rated units can withstand the 100 VDC surge of MIL-STD-1275.

The 120 VDC input converters were nominally designed to operate from the normal steady state range of Space Station power, and operate over the extended range of 86 to 158 VDC.

The 270 VDC input converters were nominally designed to operate from the normal steady state range of MIL-STD-704D and E, but operate over the extended steady state range of 200 to 335 VDC. A surge resistance of 440 VDC is standard for the 270 VDC parts.

The 8 to 40 VDC input converters are designed for special low voltage applications, such as low voltage satellite buses. They are not designed to operate from MIL-STD-704 without external limiting circuitry. Surge resistance over 40 VDC is not specified.

For 28 VDC input, the minimum full load output voltage requires an 18 VDC input (due to optimum transformer turns ratios), but operate down to 16 VDC at slightly lighter loads. For converters with an adjustable output voltage or remote sense, a higher output voltage or remote sense voltage recovery will also increase the minimum DC input voltage at full load. Units that operate at lower voltage are available on special order.

Hot and cold temperature extremes can also increase the minimum full load regulation point by several percent due to higher saturation drops or higher voltage.

Reverse Input Polarity

The DC/DC Converters are not internally protected against application of reverse polarity. However, if reverse polarity is applied to the input pins, the shunt body diode of the switching FET will conduct. The current rating of the FET shunt body is approximately 1 Ampere for the smaller converters ranging upward to 10 Amperes for the 80 watt parts. The input control circuits are protected against reverse polarity by a series rectifier. The input capacitors are non-polarized. If an external rectifier is used in series with the DC input lines, care must be taken to avoid peak detection of the input capacitors when external spikes such as CS06 waveforms are applied. This can happen with low power units operating with a light load. In this case, the voltage on the input filter capacitors can stairstep up to destructive levels.

Input Spikes and Surges

Virtually every use of a DC/DC Converter that operates from vehicle power (including spacecraft, aircraft, missiles, ground vehicles and marine applications) is subjected to surges in input voltage and voltage spikes of one sort or another. Surges are voltage increases that are of relatively long duration from sources with relatively low source impedance. Spikes are of much shorter duration, have higher amplitude than surges, may be of either polarity and are usually limited in energy.

Older style hybrid DC/DC Converters have neglected the spike and surge issue entirely, limiting the input voltage to an absolute maximum value. This leaves the entire job of protecting the unit from failing due to spikes and surges to the customer, who is usually not happy about having this assignment. Separate surge suppressing modules using linear pass stages are available, but are generally not reliable, cost effective or electrically efficient. EMI filter modules containing spike suppressing shunt zener diodes are also available from several vendors. These parts address the spike issue, but generally ignore the concomitant surge requirement.

The ideal solution to the spike and surge problem is found in the MDI full featured DC/DC Converters,

which have built in spike and surge resistance that allows them to operate directly from the vehicle power. This systems approach offers the customer a single solution to the system compatibility problem.

Spikes and surges are governed by several sometimes conflicting specifications. One group of specifications limits the magnitude of the disturbance that a power using device may cause on the power bus. A second group of specifications mandates the size of disturbances that a power using device must ignore while still performing its requirement. There is normally a guardband between the effects (or emissions) that a power using device generates and the amount of effect that will not upset it (or resistance to susceptibility).

In some instances, such as MIL-STD-461, both groups of requirements are contained within the same document.

In aircraft applications, the most common power requirement is MIL-STD-704, which has revisions A through E. Revisions A and C are most severe, with 28 VDC nominal systems experiencing 80 VDC surges for up to 50 milliseconds. The applicable revision depends on the vintage of the aircraft's electrical system. The corresponding requirement for commercial aircraft is RTCA D0160. Other specifications exist for unique requirements.

For ground vehicle requirements, the most commonly used specification is MIL-STD-1275. This 28 VDC nominal specification imposes 100 VDC surges for up to 100 milliseconds.

Spacecraft and missile applications tend to have small electrical systems, so the spike and surge requirements are generally unique for each application. However, missiles that are launched from an aircraft or ground vehicle may have a combination of requirements.

Spike amplitudes and durations are governed by numerous specifications. MIL-STD-461C has a CS06 spike test. MIL-STD-461D has an equivalent spike test via cable bundling. Other specifications with input spike requirements are MIL-STD-704, DO160, MIL-STD-1275, MIL-STD-1399 and MIL-E-6051.

The differing nature of surges versus spikes leads to different approaches to living with them. For example, the time duration of the typical surge requirement is quite long compared to the energy storage capability in an input filter. This implies that the basic DC/DC Converter circuitry, not only the input filter, must be able to withstand the applied voltage. The full featured parts are designed to operate through the surge conditions, which is a conservative design approach that offers the highest reliability in system applications.

The price paid for such wide operating ranges is a slight fall off in efficiency due to the use of higher voltage semiconductors.

Spike suppression is generally easier than surge suppression since the time durations are much shorter. Input spike suppression within the full featured parts relies on the EMI filter components to spread the energy without loss within the spike to a waveform of lower amplitude and longer time duration.

Conducted Susceptibility and Spike Effects

Conducted susceptibility is a test method that applies an AC modulation superimposed on the DC/DC Converter's power input leads. It corresponds to method CS01 and CS02 of MIL-STD-461C and CS101 of MIL-STD-461D. CS01 extends from 30 Hz to 50 kHz, so is called audio frequency susceptibility.

All testing for conducted susceptibility is normally done at nominal full load conditions. For the CS01 test, an audio signal of 2.8 volts RMS (8.2 volts peak to peak) is superimposed on the input 28 VDC. From 1.5 kHz to 50 kHz, the amplitude decreases linearly. In addition, the power of the susceptibility source is limited to 50 watts.

For the 120 VDC series of converters, the conducted susceptibility level is 5 volts RMS superimposed on a nominal 120 VDC level, in accordance with SSP30237. For the 270 VDC converters, the test voltage is 10 V RMS. The 8 to 40 VDC units are tested with a conducted susceptibility voltage of 1 volt RMS superimposed on a 14 VDC level.

For 5000 series parts, the CS01 voltage is 1Vp-p and the parts are tested at 28 VDC For 7000 series parts, the CS01 voltage is 1Vp-p and the parts are tested at 50 VDC For 8000 series parts, the CS01 voltage is 2Vp-p and the parts are tested at 70 VDC For 9000 series parts, the CS01 voltage is 2V p-p and the parts are tested at 100 VDC

Applying the audio susceptibility signal causes the DC/DC Converter's output to be modulated at the audio frequency. Thus, the output of the DC/DC Converter has the normal high frequency ripple with the audio superimposed. Standard MDI pass/fail criteria for CS01 testing is that the envelope of the peak to peak output modulation not exceed the specified peak to peak ripple specification. Therefore, the maximum allowable output deviation with a conducted susceptibility input is twice the allowable peak to peak ripple.

The MDI full featured DC/DC Converters have excellent rejection of conducted susceptibility due to their

current mode inner loop. The basic converter has a loop gain of greater than 50 dB. The typical EMI resonance is in the 5 kHz to 10 kHz area, where a peaking of approximately 10-12 dB can occur. This peaking amplifies the conducted susceptibility, so it subtracts from the basic audio rejection of the converter. Beyond this point, the filter adds attenuation.

In MDI's standard triple output converters, one output (usually 5 VDC) is the main regulated output. Only the main regulated output will exhibit conducted susceptibility effects. The other two outputs are linear regulated. In this event, there is virtually no discernible effect on the linear regulated outputs arising from the conducted susceptibility. The reason for this is the additional voltage rejection of the linear regulator itself.

CS02 testing extends the conducted susceptibility range from 50 kHz up through the low UHF region. The injection methods of CS02 are different from CS01 injection because of the frequency range. The coupling method allows the use of standard 50 ohm impedance RF generators and amplifiers.

Due to highly effective input filter response in this frequency range, it is unusual to detect any change in DC/DC Converter performance when this test is performed. Because the power return leg is at RF ground, the CS02 test should be performed on the positive power lead only.

Spikes impressed on the power input leads of the full featured DC/DC Converters are principally attenuated by the input EMI filter. The filter losslessly transforms the shape of narrow spike waveforms into a lower amplitude damped sinusoid at the input EMI filter's resonant frequency. A ± 5% output voltage deviation is allowed for the converters full featured DC/DC Converters when the CS06 or equivalent spike waveform is applied.

EMI Filter Characteristics

The MDI full featured DC/DC Converters incorporate an integral input EMI filter that reduces the conducted emissions below the level of CE03 of MIL-STD-461C. The EMI filter also attenuates the effects of input CS06 spikes and CS01/CS02 conducted susceptibility. It is a very challenging task to construct an EMI filter of very small dimensions and it is also difficult when the filter is located very close to the noise source. MDI has overcome these challenges in the design of the full featured DC/DC Converters.

The filter consists of elements that block the conducted emissions from the power leads. In addition, the filter has elements that provide low impedance shunt paths for unwanted current. The general filter schematic is shown in Figure 1. The output common mode filter is a most important adjunct to the input filter. Without the output common mode filter, uncontrolled conducted emissions will exit from the output leads of the converter. Some portion will flow back through chassis grounds and appear on the input leads.

Within the DC/DC Converter, conducted emissions can be differential mode or common mode. Differential mode emissions appear primarily on one input power lead, whereas common mode emissions appear on both because of the nature of the sources that generate the emissions, differential noise is more common below 1-2 MHz, where common mode noise is more prevalent at higher frequencies.

The input EMI filter in MDI's full featured converters is constructed with three inductive and three capacitive elements. A common mode inductor, or balun is connected to the input pins. This two winding inductor has a low differential inductance, but a high inductance for common mode currents. Following the common mode inductor are two LC "L" section differential filters. At the output of the final "L" section, there is a shunt capacitor to the hybrid case.

The common mode filter thus consists of the input common mode inductor and the shunt capacitor to the case. The differential mode filter consists of the two "L" sections.

Because of close proximity to switching noise sources, each of the differential filters have two windings, not one. Half the winding is placed in the positive power leg, half in the negative leg. By splitting the winding into two sections, radiated noise that would otherwise couple into the inductor is cancelled out.

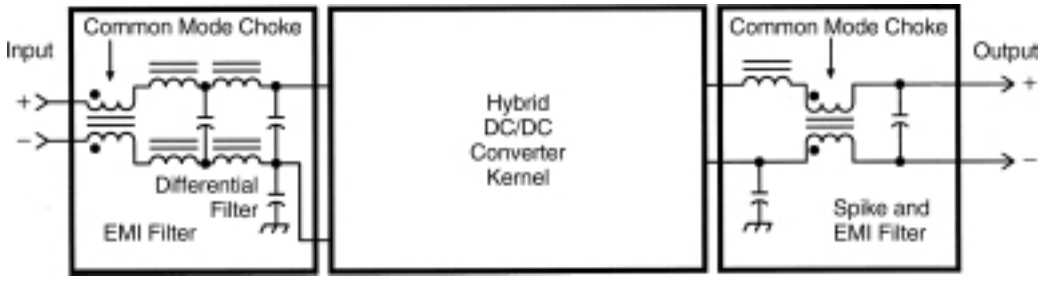


Figure 1: General Filter Schematic

The consequence of the split winding of the differential EMI filters is that the negative power return is not at the same AC potential as the return of all the input side connections. This mandates the need for care in using the input side pins so as to not upset the converter during dynamic transient events that cause a voltage drop across the negative leg of the input filter. Circuit techniques that are recommended for overcoming this fact are discussed when the control pins are reviewed.

The input EMI filter has a resonant rise of approximately 10-15 dB at a typical resonant frequency between 5 kHz and 10 kHz. 40 watt and 80 watt DC/DC Converters incorporate a damping network to reduce the magnitude of the resonant rise.

Input Rise Time and Inrush Current

There are no practical constraints on how fast or how slow the input voltage can be safely applied to the full featured DC/DC Converters. The typical input current as a function of time is shown in Figure 2.

There are two peaks in the current waveform. The first peak is due to input EMI filter capacitor charging. The capacitor charging peak current is dependent on the rate of rise of input voltage. Although the inductance and resistance of the input EMI filter limit the initial inrush current to some extent, the small cores in the filter tend to saturate during initial turn-on.

The second peak is due to the converter coming on and supplying the load as well as the internal and external load capacitance.

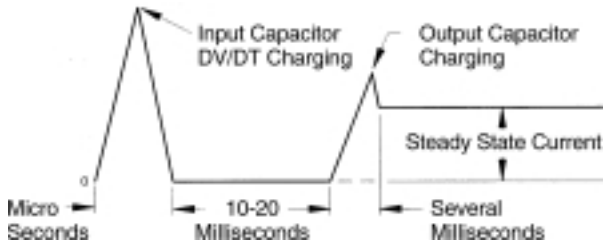


Figure 2: Typical Input Current vs Time

It can be seen that the initial inrush current due to capacitor charging will be highly dependent on the rate of rise of input voltage. Therefore, to limit inrush current, limit the rise time of the input voltage.

The approximate input capacitance of each converter is given in Table 1.

Converter Model Number	Input Capacitance *u*F	Converter Model Number	Input Capacitance *u*F
2680	13.5	5031	24.0
2690	4.5	5107	9.0
3000	1.98	5193	18.0
3001	13.5	5680	13.5
3011	9.0	5690	4.5
3020	0.66	6031	24.0
3031	24.0	6107	9.0
3041	2.64	6193	18.0
3051	18.4	6680	13.5
3060	10.8	6690	4.5
3061	6.6	7031	24.0
3062	6.0	7107	9.0
3070	3.6	7193	18.0
3080	3.0	7680	13.5
3107	9.0	7690	4.5
3108	7.2	8031	19.2
3109	1.32	8107	7.2
3113	9.0	8193	10.8
3114	18.0	8680	10.8
3138	18.0	8690	3.6
3193	18.0	9031	19.2
3325	1.0	9107	7.2
3326	14.4	9193	10.8
3327	1.98	9680	10.8
3378	13.5	9690	3.6

Table 1: Conversion Chart for Model Number and Capacitance Value

Efficiency Curves

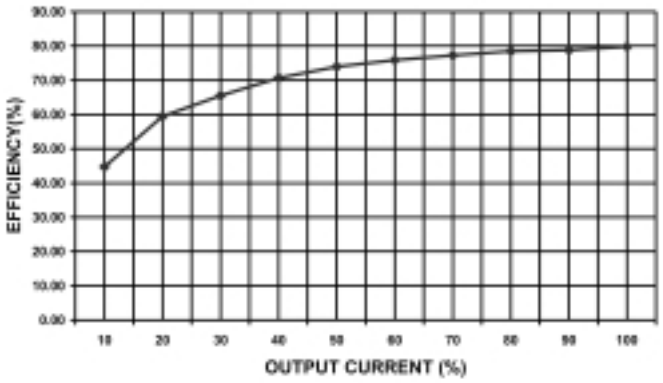
The efficiency of a DC/DC Converter depends on how the losses compare to the power delivered. In general, of the majority of losses, there are fixed losses that vary directly with power output and losses that vary with the square of output power (I squared R losses).

At Zero output power, the efficiency is always zero, due to the fixed losses. At some point in the output curve, the efficiency may be seen to peak. This is usually at the point where the sum of fixed and direct losses are equal to the square losses. As power is increased past this point, efficiency drops.

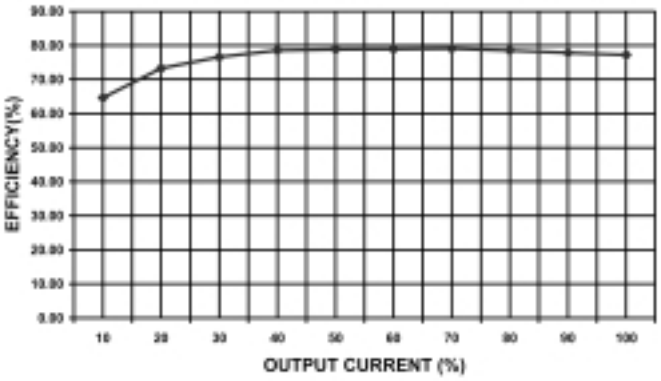
Some efficiency curves do not exhibit a peak, but constantly increase up to 100% load. In these cases, the peak efficiency point is greater than 100% output rating.

Representative efficiency curves are presented for 28 VDC nominal parts, 6.5 watt nominal, 30 watt nominal and 80 watt nominal. Curves for other inputs voltages and output powers are similar:

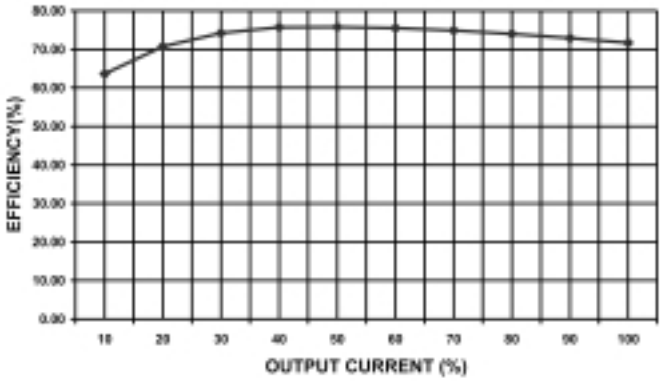
3080-D15 Typical Efficiency Characterization



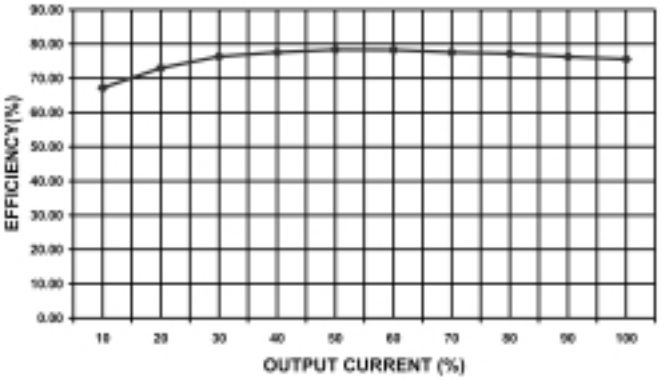
3108-S05 Typical Efficiency Characterization



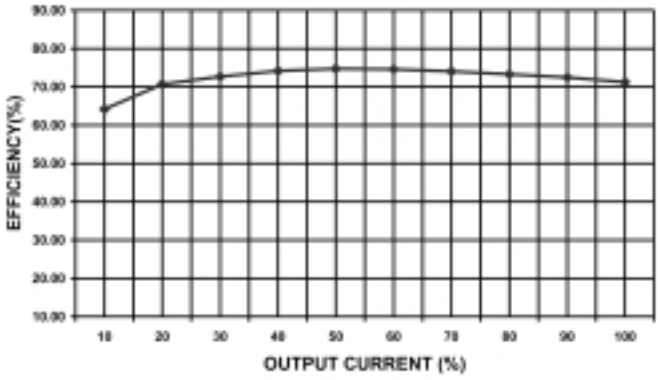
5193RE-S05XF Typical Efficiency Characterization



5680-S05 Typical Efficiency Characterization



6031-S05 Typical Efficiency Characterization



6690-S05 Typical Efficiency Characterization

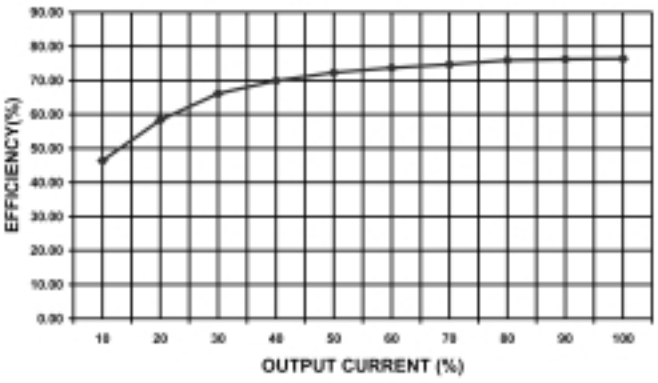


Figure 3: Typical Efficiency Curves

Output Considerations

Voltage Temperature Coefficients

Voltage limits for full featured parts shown in the MDI catalog are the nominal 25°C values. At temperatures outside 25°C, the output voltages may vary with case temperature in the following way:

Main regulated output : ± 100 PPM/°C maximum
Linear regulated output : ± 250 PPM/°C maximum
Cross regulated output : ± 1000 PPM/°C maximum

The main regulated output for single and dual output converters is the output. For a triple output converter, the main regulated output is usually the high current +5 VDC. Different temperature coefficients may be obtained on special order.

Ripple vs Temperature

The fundamental output ripple of the full featured converters is dependent on the absolute capacitance value of the output capacitors (when the output capacitors are multi-layer ceramic types), or the ESR of the output capacitors (when the output capacitors are solid tantalum types). The selection of output capacitor depends on the output voltage and type of converter. However, the following effects occur at temperature. For units using ceramic output capacitors, the capacitance falls off sharply at high and low temperature extremes. Although the low ESR of ceramic capacitors results in very low ripple voltages, it is not unusual for ripple voltage to double at the high and low temperature extremes. For units using solid tantalum output capacitors, the ESR rises sharply at low temperature extremes.

Therefore, users should assume a ripple temperature coefficient of 1% per °C increase over the 25°C base numbers.

Output Pin Voltage Drops

Full featured converters may be regulated at the inside of the output pins, or may be regulated by remote sense in the case of 30, 40 and 80 watt single output low voltage converters.

The output pins are .040" in diameter and have an approximate total length, internal and external, of 0.35". For converters under 80 watts, the pins are made of alloy 52, and have a typical resistance of 1.5 milliohms each. The 80 watt converters use copper cored alloy 52 pins and have a resistance of approximately 0.5 milliohms each.

It can be seen that the drops in the output pins will not be significant except in the case of low voltage/high current outputs.

Cross Regulation of Dual Outputs

Positive Load	Negative Load	+15 VDC Output	-15 VDC Output	Total Output
1.0A	1.0A	14.942	-14.953	29.957
1.0A	0.75A	14.907	-14.996	29.903
1.0A	0.5A	14.865	-15.054	29.919
1.0A	0.25A	14.813	-15.125	29.983
1.0A	0.0A	13.499	-16.458	29.957
0.5A	1.0A	15.036	-14.871	29.907
0.5A	0.75A	15.003	-14.915	29.918
0.5A	0.5A	14.96	-14.968	29.928
0.5A	0.25A	14.915	-15.035	29.95
0.5A	0.0A	14.188	-15.783	29.971

Table 2: Dual Output Values vs Positive and Negative Load Values

MDI's full featured dual output DC/DC Converters are normally regulated from the positive output to the negative output rail. Therefore, a dual 12 V output unit is actually a 24 V converter with a center tap. A dual 5 VDC unit is actually a 10 VDC unit with a center tap.

Since the voltage from end to end is tightly regulated, the voltage at the tap can and must move if the load is unbalanced. The reason for this is the impedances of the power conversion train and the output filters.

This data for a dual 15 VDC output part shows that the balanced half to full load regulation is 0.14%. Assuming 30 ohms as the per unit load resistance, the DC/DC Converter's per unit output impedance is .0029. The impedance of the center tap is approximately .0114 per unit for small deviations about a fully loaded condition. However, when the load unbalance is severe, the output voltages deviate by a much greater amount. The reason for this is that at heavier loads, more averaging of the power waveform takes place. At light loads, from under 10%, ranging to no load, more peak detecting takes place.

This is why a dual output voltage converter is not recommended for use at lighter than a 90%/10% load unbalance unless a relatively large load unbalance can be tolerated.

In many applications, there is a severe load unbalance, or two outputs of differing voltage are required. In

these applications, a conventional dual output part cannot be used.

There are two ways to overcome this situation (that occurs under extreme unbalanced load conditions) by constructing a full featured DC/DC Converter to special order. The first technique is to construct a dual output part made from a triple output design. The high current output is then the sole main regulated output. The lighter current output is derived from one of the linear regulated outputs. The second linear regulated output is not used.

The second technique is to construct a converter that balances output impedances closely to the load unbalance. This includes matching transformer and inductor resistances as well as diode drops, etc., so that the desired voltages are produced regardless of the load unbalance.

MDI full featured hybrid DC/DC Converters with dual output can be produced with the same polarity. For example, a dual output part can be constructed to produce +5 VDC and +3.3 VDC. Another example is a converter that produces +12 VDC and +5 VDC.

Outputs

The main 5 V output can be loaded with considerable additional capacitance without affecting the stability of the converter. The allowable external capacitance is a function of output power. Safe values are 100 mf for a 6.5 watt unit, 500 mf for a 30 watt unit and 1,000 mf for a 50 or 80 watt unit. For higher external output capacitances consult MDI Applications Engineering Department. For higher voltage or lower voltage outputs, the capacitance is adjusted as the inverse square of the voltage (with 5 VDC as a reference). For triple output units having a main 5 VDC output and linear regulated dual outputs, there are no restrictions on the capacitance that may be used externally on the dual outputs.

Bandwidth Specification of Output Ripple

Hybrid DC/DC Converters typically produce a complex output ripple spectrum that extends to 50 MHz or even to 500 MHz. The ripple voltage has two basic aspects. The first is differential voltage, and is the primary component of the lower frequency ripple. The second component is the common mode voltages generated from common mode currents. This component predominates above 2 MHz and is seen on the oscilloscope in the form of spikes.

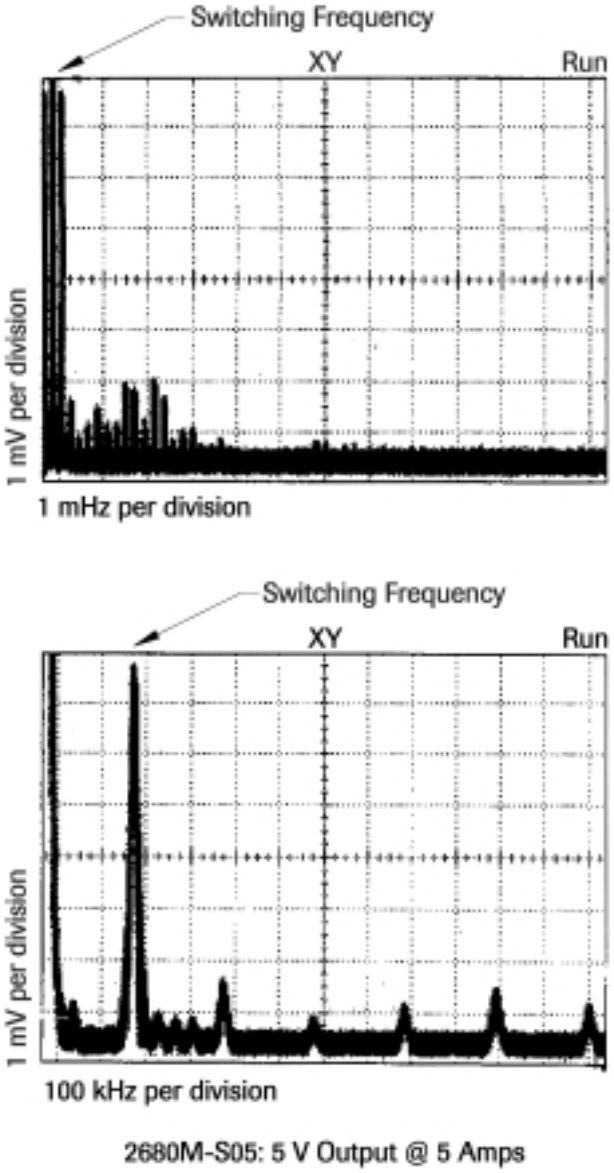


Figure 4: Typical Spectral Ripple Components to 10 MHz

Noise on converter output leads can also be specified and controlled by EMI specifications and techniques. However, in practice this proves cumbersome because the time domain characteristics are usually more pertinent and easier to visualize than the frequency domain characteristics.

This is why output ripple, noise and spikes are usually specified in terms of peak to peak voltage over a specified bandwidth. In actual practice, reliance on this type of specification can be misleading in several ways. One way is to limit the measurement bandwidth to 1 MHz or 2 MHz while the predominant spike content exceeds this. Virtually all manufacturers of hybrid DC/DC Converters specify output ripple with a 2 MHz bandwidth.

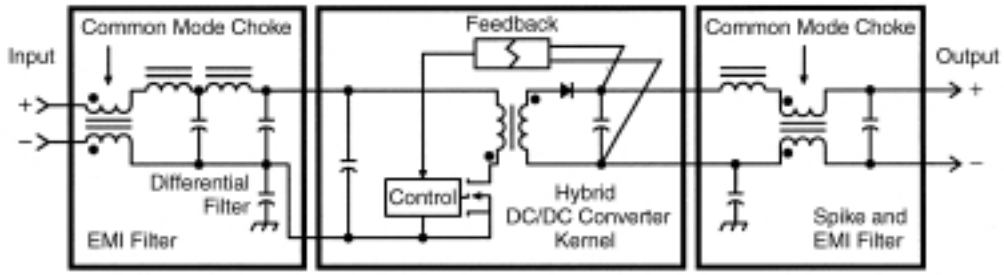


Figure 5: Hybrid DC/DC Converter Architecture

This encompasses the fundamental ripple frequency and several of its harmonics for most units sold today. This excludes the higher frequency, and often higher amplitude, noise content.

A second measurement technique is to make the measurements differentially. Since many hybrid DC/DC Converters are designed with a low ESR output chip capacitor straddling the output pins, differential measurements can produce good test results. When the units are used in a system, the noise output is inexplicably higher, but the difference is due to common mode noise.

The most useful method is to retain the voltage measurement over a meaningful bandwidth but measure it so as to include the output common mode noise since most higher frequency output ripple, noise and spikes are originated as common mode signals.

What is the significance of the distinction between the differential and common mode outputs? The differential ripple and noise can be relatively easy to filter either internally or externally. Common mode noise is relatively more difficult to filter and thus tends to proliferate throughout a system.

Common mode noise is caused by internal EMI currents that flow out through output lines seeking a return path back to the noise source. The best way of suppressing common mode noise is by using common mode filtering at the point closest to the noise source. The ideal location for this common mode filtering is within the hybrid converter itself.

Older generation hybrid DC/DC Converters have very simple filtering systems, often consisting of no more than output capacitors. These types of converters are usually very noisy at frequencies above 2 MHz, particularly in terms of common mode noise.

The latest generation of hybrid DC/DC Converter parts incorporate two advances that dramatically lower output ripple and spikes when compared to earlier generation DC/DC Converters. The first advance is the incorporation of output common mode filter chokes directly within the DC/DC Converter package. The second advance is the incorporation of high capacitance, low ESR ceramic multilayer capacitors in the output stage. These capacitors, which replace solid tantalum types common to older generation DC/DC Converters, provide 1 to 2 decades of improved filtering at high frequency when compared to solid tantalum filters.

Although these noise reduction techniques are not in themselves novel, they represent a radical improvement in performance when they are contained within the shielded enclosure of the hybrid DC/DC Converter.

The result of these two significant technology advances is dramatically reduced output ripple and noise.

Figure 5 shows the functional block diagram of a typical DC/DC Converter hybrid, with integral input and output noise filtering. As this diagram shows, it requires a substantial number of LC elements to control hybrid DC/DC Converter noise. However, by tailoring the elements precisely to the noise spectrum, the small sizes needed to fit within the hybrid converter package may be realized.

On the power input side, the common mode currents are interrupted by a high inductance common mode choke or balun. A shunt capacitor connected to the hybrid case allows the common mode input currents to be localized, instead of flowing out to the input leads. Two stages of LC differential filtering are used to reduce ripple current levels. By using two cascaded higher frequency stages, each stage is physically smaller than a larger, lower frequency single stage.

On the output side, it can be seen again that there is no substitute for filter elements. A common mode choke and shunt capacitor to case completely tame the common mode spikes. A small differential filter adds the final bit of filtering to the output leads. At above approximately 10 MHz, the output filters within the hybrid can become capacitive. To have these high frequency spikes, external ferrite beads and small capacitors may be used to tame the residual spikes.

In some applications (such as cameras, low noise amplifiers, etc.) it is desirable to attain additional differential filtering. Surface mount ceramic capacitors make the best filters when wired as shown in the figure (as a four terminal capacitor).

While other filter circuit topologies are possible, this type of filter arrangement has proved to be highly useful in production applications requiring good suppression of converter noise.

It is important to note that although the outputs of the hybrid DC/DC Converter are highly filtered, the outputs will normally exceed MIL-STD-461 levels. Also, connecting the case to the output leads bypasses the internal common mode filter and may result in the input exceeding EMI levels or the output spikes increasing. If the case must be connected to output ground for any reason, it is helpful to use a high value resistor (a value of 10K to 100K should be considered).

However, the case may be connected to RF or chassis ground to enhance EMI filtering.

Additional Filtering

Additional filtering may be added to the DC/DC Converter outputs to reduce load transients, fundamental ripple or spike waveforms.

If adding external components in order to reduce load application or load removal transients, low ESR solid tantalum capacitors should be used. An external series inductor should not be used since this will add impedance and negate the benefit of the external capacitance. Relatively large amounts of external capacitance may be added, but do not exceed the following guidelines without consulting MDI.

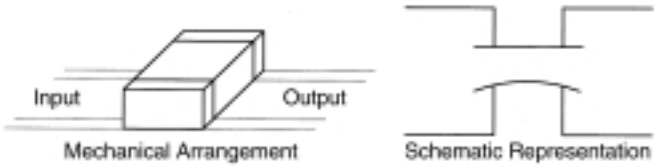


Figure 6: Four Terminal Capacitor Method for Improving Filtering

The maximum recommended external output capacitance on the main regulated output is a function of the converter's output voltage and power. For a 5 VDC output, 100 microfarads may be added to a 6.5 watt unit, 330 microfarads for a 20 watt unit, 500 microfarads for a 30 watt unit, 680 microfarads for a 40 watt unit and 1000 microfarads for an 80 watt unit.

For a higher voltage unit, the capacitance should be reduced by the inverse square of 5 VDC and the actual voltage. Conversely, for a lower voltage unit, the output capacitance may be increased by the square ratio. For outputs that are linear regulated, there is no restriction on the external output capacitance.

If adding external components in order to reduce high frequency spikes, multi-layer ceramic capacitors in surface mount chip form should be used. For best results, the capacitor should be connected as a four terminal device (see Figure 6). An external series common mode inductor or ferrite beads should be used between the converter and the capacitor.

Back Voltage

A back voltage may be applied to the outputs of the DC/DC Converter, whether it be energized or de-energized. Up to 20% above the output's rating may be applied. If the back voltage is applied to the main regulating output, linear regulated outputs (if any) will shut down.

Paralleling and Series Converter Connections

The outputs of like converters may be connected in parallel without damage. However, they will not share the output load to any guaranteed extent without some ballasting resistance or external circuitry. A proven circuit for forcing current sharing of three low voltage 80 watt converters is shown. This circuit may be extended to four or more converters.

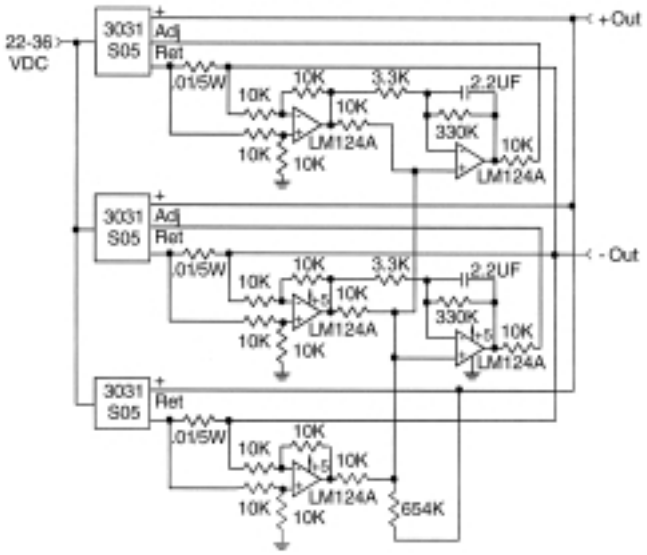


Figure 7: Active Parallel Circuit

When sharing power at a higher output voltage, converter outputs may be connected in series. For example, two 80 watt converters each delivering 14 VDC on their output may be connected in series to provide 160 watts at 28 VDC. Series converters always share output current. Power is shared to the extent of the (excellent) voltage regulation.

Use of "OR"-ing Diodes

Although it is perfectly safe to connect the outputs of two like converters together, many applications require the use of separate external diodes when connecting two or more redundant diodes to the same point.

When OR-ing diodes are used, there is an additional voltage drop. On single output units with an adjust pin, the output can usually be adjusted upwards to compensate for the drop in the external diode. On dual or triple output units, the outputs can be adjusted upwards on special order. For example, a triple output converter may be ordered as a 5.4 VDC main output and ± 12.4 VDC auxiliary outputs.

Output Overload and Short Circuit Protection

MDI's hybrid DC/DC converters are protected against the damage caused by output overloads and short circuits.

The peak current of the input switching stage is sampled and used to implement an inner current regulation loop, or current mode system. This current mode system improves the dynamic response of the converter.

On a cycle by cycle basis, the peak current in the switching FET is measured and compared to the set value. This then controls the switch off point of the switching FET.

In addition, this set point is limited. Therefore, on a high frequency, cycle basis, the peak current in the switching FET is also limited. This is the fast current limit.

In addition to the fast current limit, the converters have a slow current limit that operates at a lower trip current. This cycle circuit is called the "burp circuit". The burp circuit has a delay before actuation, typically 5 milliseconds. After actuation, the DC/DC converter is switched off for approximately 15 to 20 milliseconds. Then, the converter automatically restarts. This duty cycle feature produces a foldback characteristic of power dissipation. However, the fold back does not affect the converter's ability to charge output capacitors due to the delay built in.

The combination of the fast current limit provided through the current mode circuitry, and the slow current limit provided through the burp circuit provides good protection for the converter.

Since the over load and short circuit protection circuitry samples peak current in the switching FET, the circuit is more sensitive at the lower ranges of input voltages (where the input current is higher for a given load).

Therefore, the trip points are set at the lower steady state voltage.

The current protection circuitry is relatively insensitive to temperature effects. Nevertheless, the current protection circuitry is not intended to be a precision circuit. That is why it is normally set to activate between 120% and 130% of full load rated current, at the low line condition.

For Triple output converters, the auxiliary outputs are derived from three terminal linear regulators. These regulators provide additional current limiting protection, as well as thermal shutdown.

Overvoltage Protection

MDI DC/DC Converters have protection against any control loop malfunction that results in an output overvoltage.

All converters have an internal housekeeping voltage that operates the input side circuitry after the converter starts up. This housekeeping voltage is proportional to the output voltage. The exact proportion varies slightly from model type to model type.

If a control loop malfunction causes an excessive overvoltage, the "burp" circuit described in the previous section is activated. The converter shuts off and automatically restarts.

The trip point of the overvoltage protection is typically 33% above nominal. This trip point, which is not a precise value, is sufficiently high to prevent nuisance tripping.

It is important to note that the overvoltage protection circuit cannot monitor the output voltage, only the output voltage as reflected to the auxiliary transformer winding. Therefore, if an externally applied voltage causes the output overvoltage to exceed acceptable limits, the converter can neither sense this overvoltage nor limit it.

Secondly, the overvoltage set point is not precise. Therefore, if tighter tolerances are needed, other more precise circuits outside the converter must be used.

Control Pin Operation

Effect of Input EMI Filter

The input EMI filter is connected to the negative leg of the full featured hybrid DC/DC Converters as well as the positive leg. This is known as a split filter. While the equivalent filter components could theoretically be placed entirely in the positive leg, prevention of noise bypassing the filter requires that the filter be present in both input power circuits.

Therefore, the internal PWM circuit ground is isolated from the input power return by the lower leg of the input EMI filter. Care must be taken in the design of the externally connected circuitry such that a) the voltage drop across the negative leg of the input EMI filter does not get conductively coupled to the input circuitry, causing unwanted operation and b) that the negative EMI filter leg is not bypassed.

Normally, the static voltage drop across the input filter is very low, on the order of several hundred millivolts. However, under dynamic conditions, the voltage drop across the negative leg of the input filter can be much larger. Such dynamic conditions can include line voltage changes, (CS06) input spikes and (CS01) audio modulation.

Inhibit/Inhibit Not

Inhibit input for remote turn-on and turn-off, and is referenced to the input return through the negative EMI filter leg as discussed previously. Standard 28 VDC full featured DC/DC Converters have an “inhibit” function. Standard 120, 270 and 8 to 40VDC full featured DC/DC Converters have an “inhibit not” function. On special order, 28 VDC parts can be supplied with an “inhibit not” function.

Inhibit		Inhibit Not	
INPUT	OUTPUT	INPUT	OUTPUT
OPEN	ON	GROUND	OFF
+5 VDC	OFF	OPEN	ON

Table 3: Inhibit/Inhibit Not

An “inhibit” function means that the converter will turn off when a current input is applied to the inhibit pin. The input impedance is 15K ohms in series with a base-emitter junction. A minimum current of 100 microamperes emitter junction. A minimum current of 100 microamperes is recommended to inhibit the converter. To isolate the inhibit pin from effects due to the lower leg of the EMI filter, a minimum compliance voltage of 10 VDC should be used. Do not connect the inhibit pin to ground when not using, just leave this pin open. Connecting the inhibit pin to ground will cause unwanted operation under dynamic input voltage conditions. An optimum external circuit configuration for the inhibit pin is to use a PNP transistor referenced to a positive voltage source, such as the 28 VDC input. An external series resistor may be used on the inhibit pin provided at least 100 microamperes of drive current is achieved.

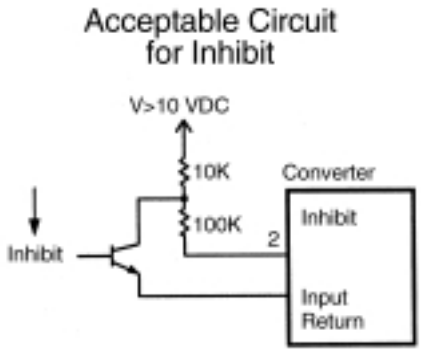


Figure 8: Inhibit Circuit

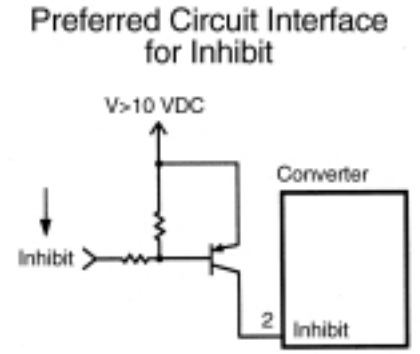


Figure 9: Inhibit Circuit

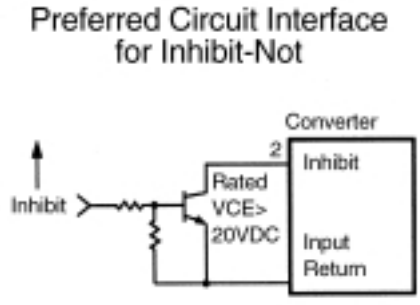


Figure 10: Inhibit Circuit

An “inhibit not” function means that the converter will turn off when the inhibit pin is grounded. Up to 3 milliamperes can flow to ground when the inhibit not pin is brought to zero. The open circuit voltage at the

inhibit pin for the inhibit not configuration is approximately 11 VDC. This pin is best driven by an open collector. The transition voltage is approximately 5 VDC. If the inhibit-not function is not used, the pin should be left floating. Suggested circuits for the inhibit pin interface are shown in Figures 8, 9 and 10 on the preceding page.

Sync Input

Pin 4 is the Sync Input. The power hybrid operates at approximately 180 kHz and may be synchronized to frequencies from 190 to 210 kHz. The sync input pulse must meet the following levels as shown in the diagram. The sync input should sit at nominal 5 VDC and transition to ground level at a 10% ±1% duty cycle. It should be noted that the internal oscillator runs at twice the switching frequency, so a 400 kHz sync is needed for 200 kHz operation. On special order, a sync input at 200 kHz may be obtained. Other frequencies are also available on special order. Contact MDI's Sales and Marketing Department for other sync frequencies.

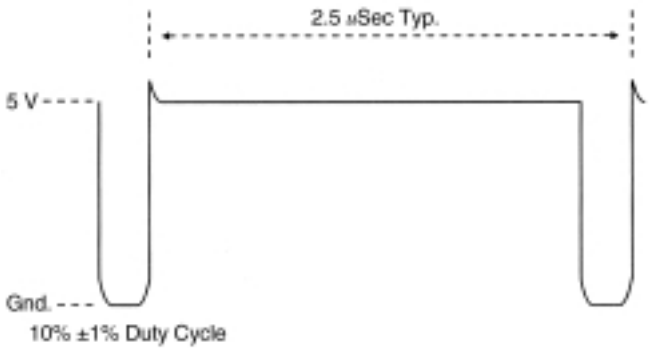


Figure 11: Typical Sync Waveform

Synchronizing the power conversion units within an extremely sensitive system ensures that any noise generation is coincident with the system clock.

The "sync pin" must be left open if unused.

BIT Signal

The bit signal is connected to pin 1. This signal is referenced to the input return (through the negative leg of the EMI filter). The BIT signal gives an opportunity to sense from the input side what the output is doing. The normal voltage on the BIT line is 5.5 VDC ± 1 VDC. When the output is inhibited, or cycling in overcurrent, or cycling in overvoltage, the BIT line goes low. In this state, the output is between 0 and 2 VDC.

It is important to note that the BIT signal is referenced to the input return through the bottom leg of the input filter. The BIT line should not be allowed to sink more than 1 mA from an external source when in the low state. When in the high state, the voltage is clamped by a zener diode. No more then 1 mA should be sourced into the BIT line when in the high state.

Soft Start

Pin 3 is the Soft Start input pin. The Soft Start pin may be used to externally program how slowly the converter turns on. There is an approximate 50 microampere current source on this pin, which charges an internal 1 microfarad capacitor. The voltage on this capacitor clamps the PWM stage error amplifier, causing the output voltage to ramp up. The connection to pin 3 allows external capacitors to be placed in parallel with the internal 1 microfarad capacitor.

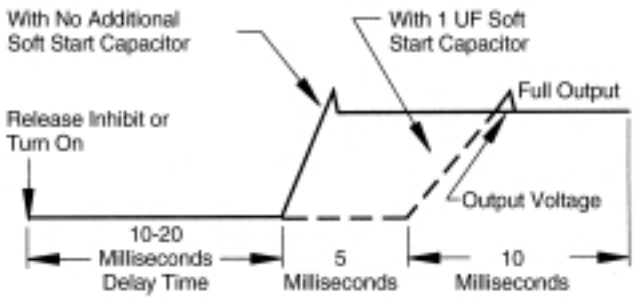


Figure 12: Typical Soft Start Waveform

At turn on, the capacitor is completely discharged. There is a charge interval during which the converter is completely off. This is known as the turn on delay interval. Then, the capacitor voltage traverses the active region. The capacitor voltage level in the active region depends on the load condition of the DC/DC Converter. If the converter is lightly loaded, the error amplifier voltage required to produce full regulated output is relatively low. Therefore, the transition through the active region is relatively fast. If the converter is fully loaded, the error amplifier voltage required to produce full regulated output is relatively high. Therefore, the transition through the active region is relatively slower. Following transition through the active region, the soft start capacitor voltage enters the saturation region, reaching approximately 5 VDC. Therefore, if an external Soft Start capacitor is used, it should be rated for at least 10 VDC.

The soft start pin must be left open if unused.

Operation at Light Load

MDI specifies the converter performance when the rated minimum values of load current as defined for each part number in MDI's catalog is applied.

In addition, the following information applies:

All Converters

MDI DC/DC Converters can not be damaged by light load or no load conditions. Most, but not all, converters continue to regulate at no load or light load. Output regulation is normally tested at 10% and 100% of rated load.

Single Output Converters

MDI single output DC/DC Converters do not require a minimum load to produce the nominal output voltage. (An exception is the magnetic feedback series 5000, 7000, 8000 and 9000 with single output below 5 VDC.) A minimum load of 10% is recommended, or consult factory for lower minimum loads. However, at load currents below 10% of the full load, the load response, line regulation, load regulation or output ripple may not perform as well as when the minimum load is exceeded. However, the operation below 10% of full load is generally satisfactory for most applications. MDI's single output converters whose output voltage is equal to or greater than 24 VDC are actually dual output converters. The output is connected from end to end and the center tap is not used.

Dual Output Converters

MDI dual output DC/DC Converters do not require a minimum load to produce the nominal output voltage. MDI dual output converters are regulated from the positive output to the negative output. The best regulation is obtained when the positive and negative loads are balanced. As discussed in more detail in the MDI application notes, unbalances up to 10%/90% do not produce unsatisfactory results. However, if one output on a dual output converter is essentially unloaded while the other output is heavily loaded, the output voltage unbalance can exceed 10%.

If both outputs are lightly loaded, or unloaded, the balance will remain reasonably balanced.

Triple Output Converters

For MDI's standard triple output DC/DC Converters, the main output is always the +5 VDC output. On all Semi-custom and Custom DC/DC Converters the main output is almost always the highest power output. This is because MDI usually PWM regulates around the high power output which yields the highest efficiency. The remaining two outputs, with the exception of Cross-regulated triples such as MDI model 3138- TXX, are regulated by two built-in linear regulator IC's.

The voltage produced by the linear regulators, called the auxiliary outputs, is the specified output voltage, and may typically be ±15 VDC, ±12 VDC or ±5 VDC. The unregulated internal voltage preceding the linear regulators is called the header voltage. To achieve reasonable efficiency, the drop across the linear regulators is minimized. Therefore, the header voltage is minimized, since the desired output voltage is fixed.

The header voltage changes in proportion to the load on the main regulated output. When the output load current on the main regulated output is low, the header voltage feeding the linear regulators is also low. When the output current on the main regulated output is below the specified minimum current, down to no load, the header voltage on the linear regulators may drop even lower.

A triple output converter whose main output is loaded at less than the minimum load can produce regulated voltage on the auxiliary outputs provided the load current on the auxiliary outputs is also low. A triple output converter whose main output is lightly loaded cannot produce full regulated voltage on the auxiliary outputs if the load current on the auxiliary outputs is high or at full rated output. The reason for this is that the header voltage produced is too low for full regulation.

The loads on the auxiliary outputs of a triple output converter can regulate down to zero current.

In Case of Doubt

To specify a particular MDI DC/DC Converter to be used with unbalanced loads or loads below minimum rated currents, submit a filled out copy of the Custom Specifier (found on page 176) and forward to MDI. As our first choice, we may be able to suggest a MDI standard part to fulfill the requirement. If a standard part cannot do the job, MDI can fabricate semi-custom units that have suitable performance for conditions

other than specified in the catalog. This may just involve a simple modification such as adding a turn or two on the transformer or changing a diode part number.

Implementing the Remote Sense and Adjust Functions

Certain models of single and dual output hybrid power converters have *Remote Sense* pins and/or *Voltage Adjust* pins available to use when voltage drop or output adjustment is required. Table 5 defines the models with these features.

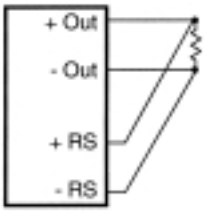


Figure 13: Typical Remote Sense Connection

The Remote Sense feature (see Figure 13) allows the user to compensate for line drops that are inherent in power distribution. This feature is not as useful for lower power or higher output voltage converters because the line drops tend to be small in these applications, therefore remote sense compensation is only available in certain units. The converters are generally designed to allow up to 0.25 V total line drop and still meet performance. It should be noted that as the line drop compensation increases, the low line voltage operating point increases slightly. In other words, the unit may only regulate down to 17 VDC (for 28 V units) rather than 16 VDC. The higher input voltage units have additional margin to give full performance with the .25 V line drop. Also, if the output voltage increases due to line drop compensation, the output current drawn should be proportionally reduced to maintain rated power output.

If the Remote Sense feature is not needed, the +RS terminal should be connected to the positive output terminal at the converter and the -RS terminal should be connected to the negative output terminal at the converter. If the remote sense terminals are left open, the unit will regulate at approximately 50 mV to 100 mV higher than the nominal set point and the load regulation may be degraded. However, no damage to the hybrid will be experienced.

When the Remote Sense feature is used, there is a chance of instability depending on the length of the output cable. The pole introduced by the cable inductance and the load resistance can cause the voltage loop to go unstable. The length of the allowable cabling (both positive and negative added together) has been calculated for various output voltages at several output currents. A minimum frequency of 50 kHz was used for these calculations. This allows minimal phase shift at the crossover frequency of the hybrid power converter. Table 4 lists the maximum load resistance/cable length for the various voltages and currents.

V_{out} / I_{out}	3.3V RL/FT*	5V RL/FT*	12V RL/FT*	15V RL/FT*	23V RL/FT*
1A	3.3/52'	5/79'	12/191'	15/239'	23/366'
2A	1.6/26'	2.5/40'	6/95'	7.5/119'	11.5/183'
4A	0.83/13'	1.3/20'	3/48'	3.8/59'	N/A
6A	0.55/8.7'	0.83/13'	2/32'	N/A	N/A
10A	0.33/5.3'	0.5/8'	N/A	N/A	N/A
15A	0.22/3.5'	.33/5.3'	N/A	N/A	N/A

Table 4: Maximum Load Resistance vs Cable Length

The Adjust Pin allows the user to externally adjust the output voltage to approximately 10% above or below the nominal value. When the adjust pin is connected to the *output return* through an external series resistor, the *output* will regulate at a level higher than the nominal output. Conversely, when the adjust pin is connected to the output through an external series resistor, the output will regulate at a level higher than the nominal output.

The adjust pin allows the converter's feedback voltage divider to be modified by the external resistor. Also, the adjust pin is connected to an internal series resistor whose purpose is to prevent damage to the internal circuit and to reduce noise pickup.

The Adjust Pin should be connected at the hybrid as connecting the pin at the load will cause a degeneration of the load regulation performance. *If the Adjust feature is not used, the adjust pin should be left unconnected.* It should be noted that for 28 VDC input units, as the output rises, the low line operating point increases slightly. In other words, the unit may only regulate down to 17 VDC (for 28 volt inputs) rather than the normal 16 VDC at full load. The higher input voltage units have suffcient margin so as not to be affected by any adjusted output voltage.

The following equations describe how to determine the external resistance value needed to program the converter voltage up or down:

V_{adj} is the desired output voltage.

V_o is the converter's nominal output voltage, prior to adjust.

V_{ref} is the converter's internal reference voltage, according to Table 5.

R1 is the internal resistor between the output and the feedback node, according to Table 5.

R2 is the internal resistor between the feedback node and the output return, according to Table 5.

R3 is the internal resistor between the feedback node and the adjust pin, according to Table 5.

R4 is the sum of R3 and the external adjust resistor.

To determine the external trim resistor, first compute the value of R1 from the Table 5 values and the converterís nominal output voltage, using equation #1. If an upward adjustment is desired, use equation #2 to solve for R4. For an upward adjustment, R4 is connected to the output return. If an downward adjustment is desired, use equation #2 to solve for R4. For an downward adjustment, R4 is connected to the output terminal.

Finally, since R4 is the sum of the internal resistor R3 and the external adjust resistor, use the value of R3 from Table 5 to find the value of the external adjust resistor.

Equation 1
$$R_1 = \frac{R_2(V_0 - V_{Ref})}{V_{Ref}}$$

Equation 2
$$V_{Adj} = V_{Ref}\left[1 + \frac{(R_1R_2 + (R_1R_4)}{R_2R_2}\right] \text{Upward}$$

Equation 3
$$V_{Adj} = V_{Ref}\left[1 + \frac{R_1R_4}{R_2(R_1 + R_4)}\right] \text{Downward}$$

Equation 4
$$R_4 = R_3 + R_{Adj}$$

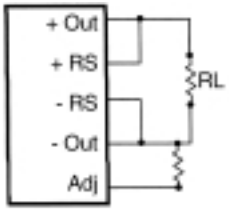


Figure 14(a): Typical Adust Pin Connection for increased Output voltage with local sense

MDI Model Number		Nominal Input VDC	Output Power	Remote Sense	V_{ref}	R 2	R 3
2680 *	SXX †	28	30W	Y	2.5	998	10K
2690 *	SXX †	28	6.5W	N	2.5	998	10K
3000 *	SXX †	270	30W	Y	2.5	998	10K
3001 *	SXX †	28	30W	Y	2.5	998	10K
3011 *	SXX †	28	20W	N	2.5	998	10K
3020 *	SXX †	270	6.5W	N	2.5	998	10K
3031 *	SXX †	28	80W	Y	2.5	998	10K
3041 *	SXX †	270	80W	Y	2.5	998	10K
3051 *	SXX †	120	80W	Y	2.5	998	10K
3060 *	SXX †	120	30W	Y	2.5	998	10K
3061 *	SXX †	8-40	5W	N	2.5	998	10K
3062 *	SXX †	8-40	6.5W	N	2.5	998	10K
3070 *	SXX †	120	6.5W	N	2.5	998	10K
3080 *	SXX †	28	5W	N	2.5	998	10K
3107 *	SXX †	28	20W	N	2.5	998	10K
3108 *	SXX †	120	20W	N	2.5	998	10K
3109 *	SXX †	270	20W	N	2.5	998	10K
3113 *	SXX †	8-40	20W	N	2.5	998	10K
3114 *	SXX †	8-40	40W	Y	2.5	998	10K
3193 *	SXX †	28	40W	Y	2.5	998	10K
3326 *	SXX †	120	40W	Y	2.5	998	10K
3327 *	SXX †	270	40W	Y	2.5	998	10K
3378 *	SXX †	8-40	30W	Y	2.5	998	10K
5031 *	S02-05.2 †	28	80W	Y	1.5	9.53K	15K
5031 *	S12-15 †	28	80W	Y	1.5	4.02K	15K
5031 *	D02-05.2 †	28	80W	Y	1.5	9.53K	15K
5031 *	D12-15 †	28	80W	Y	1.5	4.02K	15K
5107 *	SXX †	28	20W	N	1.5	9.53K/4.02K ‡	15K
5107 *	SXX †	28	20W	N	1.5	9.53K/4.02K ‡	15K
5193 *	SXX †	28	40W	Y	1.5	9.53K/4.02K ‡	1K
5193 *	SXX †	28	40W	Y	1.5	9.53K/4.02K ‡	1K
5193 *	DXX †	28	40W	Y	1.5	9.53K/4.02K ‡	15K
5193 *	DXX †	28	40W	Y	1.5	9.53K/4.02K ‡	15K
5680 *	SXX †	28	30W	Y	1.5	9.53K/4.02K ‡	15K
5680 *	SXX †	28	30W	Y	1.5	9.53K/4.02K ‡	15K
5680 *	DXX †	28	30W	Y	1.5	9.53K/4.02K ‡	15K
5680 *	DXX †	28	6.5W	N	1.5	9.53K/4.02K ‡	15K
6031 *	SXX †	28	80W	Y	2.5	998	10K
6107 *	SXX †	28	20W	N	2.5	998	10K
6193 *	SXX †	28	40W	Y	2.5	998	10K
6680 *	SXX †	28	30W	Y	2.5	998	10K
6690 *	SXX †	28	6.5W	N	2.5	998	10K
7031 *	SXX †	50	80W	Y	1.5	9.53K/4.02K ‡	15K
7031 *	DXX †	50	80W	Y	1.5	9.53K/4.02K ‡	15K
7107 *	SXX †	50	20W	N	1.5	9.53K/4.02K ‡	15K
7193 *	SXX †	50	40W	Y	1.5	9.53K/4.02K ‡	1K
7193 *	DXX †	50	40W	Y	1.5	9.53K/4.02K ‡	15K
7680 *	SXX †	50	30W	Y	1.5	9.53K/4.02K ‡	15K
7680 *	DXX †	50	30W	Y	1.5	9.53K/4.02K ‡	15K
7690 *	SXX †	50	6.5W	N	1.5	9.53K/4.02K ‡	15K
8031 *	SXX †	70	80W	Y	1.5	9.53K/4.02K ‡	15K
8031 *	SXX †	70	80W	Y	1.5	9.53K/4.02K ‡	15K
8107 *	SXX †	70	20W	N	1.5	9.53K/4.02K ‡	15K
8193 *	SXX †	70	40W	Y	1.5	9.53K/4.02K ‡	1K
8193 *	DXX †	70	40W	Y	1.5	9.53K/4.02K ‡	15K
8680 *	SXX †	70	30W	Y	1.5	9.53K/4.02K ‡	15K
8680 *	DXX †	70	30W	Y	1.5	9.53K/4.02K ‡	15K
8690 *	SXX †	70	6.5W	N	1.5	9.53K/4.02K ‡	15K
9031 *	SXX †	100	80W	Y	1.5	9.53K/4.02K ‡	15K
9031 *	DXX †	100	80W	Y	1.5	9.53K/4.02K ‡	15K
9107 *	SXX †	100	20W	N	1.5	9.53K/4.02K ‡	15K
9193 *	SXX †	100	40W	Y	1.5	9.53K/4.02K ‡	1K
9193 *	DXX †	100	40W	Y	1.5	9.53K/4.02K ‡	15K
9680 *	SXX †	100	30W	Y	1.5	9.53K/4.02K ‡	15K
9680 *	DXX †	100	30W	Y	1.5	9.53K/4.02K ‡	15K
9690 *	SXX †	100	6.5W	N	1.5	9.53K/4.02K ‡	15K

Notes to Table 5:

* indicates grade level

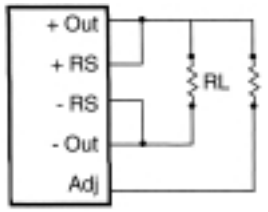
XX indicates an output voltage in the range of 3.3 to 23 VDC

† indicates case style

‡ 9.53K for units less than 12 VDC / 4.02K for units 12 VDC and above.

For the 5000, 7000,8000 and 9000 series converters, the value of R2 depends on the nominal output voltage, according to table 5.

Table 5: Hybrid Converter Models with Remote Sense and Adjust Functions



(If Required)

Figure 14(b):Typical Adjust Pin Connection for decreased Output voltage with local sense

The preceding examples have shown either the singular Remote Sense or the Adjust features being used singularly. However, both features can be used in tandem.

Within 10% external adjustment causes no problems internal to the hybrid power converter. Be aware that an adjustment of more than 10% may can cause internal damage to the hybrid converter. Please consult MDI applications engineering if an adjustment range greater than 10% is required.

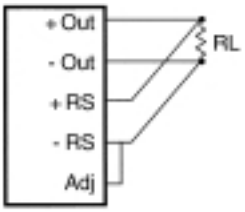


Figure 15: Adjust and Remote Sense Functions Used in Combination

The Remote Sense and Adjust functions integral to MDI's full featured power converters enable them to excel in a variety of situations under a range of circumstances. The reader is encouraged to contact Hybrid Engineering at MDI to discuss these features as well as any aspects of these devices.

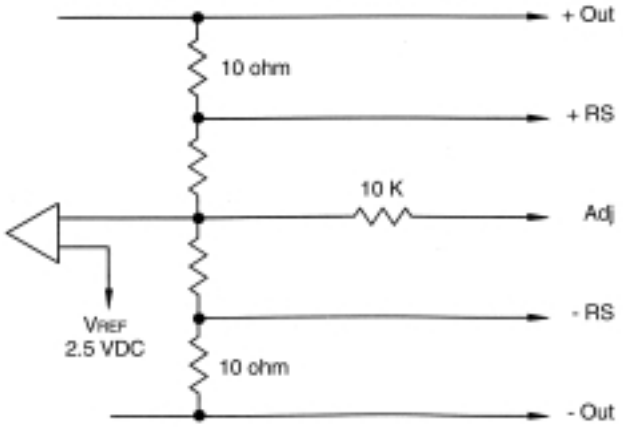


Figure 16: Internal Interconnections of Remote Sense and Adjust Pins

Recommended Mounting of Hybrids

Hybrid DC/DC Converters are power supplies that are fabricated with bare die as compared to using packaged parts. Elimination of the intermediate packages allows the size of the DC/DC Converter to be dramatically reduced. All parts are mounted on ceramic substrates which are well attached to the baseplate of the package.

Heat can be transferred by conduction (heat flow through solid material), convection (heat flow through air movement) and radiation to a cooler surrounding. Unlike some larger power supplies, hybrid DC/DC Converters are designed to be cooled by conduction cooling. Specifically, heat generated by the operation of the DC/DC Converter is designed to be removed from the baseplate of the package by conduction cooling, which is commonly known as heat sinking.

How much heat is dissipated by the DC/DC Converter? This is readily calculated by dividing the delivered power by the efficiency and then subtracting the delivered power. Dissipation may increase when the part is short circuited or overloaded. The efficiency may drop when the part is lightly loaded compared to full load ratings.

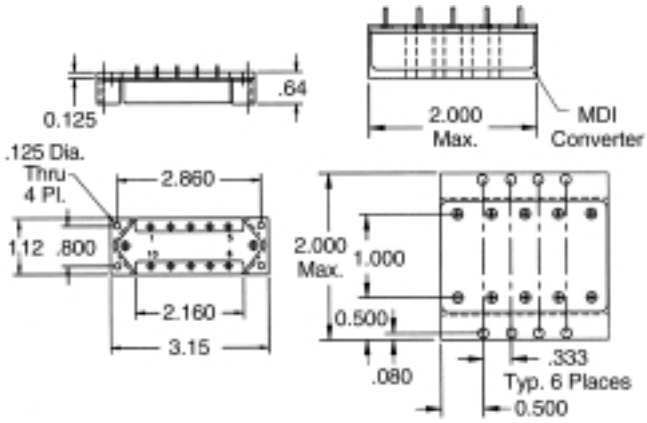


Figure 17: In special applications where "dead bug" mounting is desired, MDI had developed several types of mounting brackets

The DC/DC Converters are rated at various baseplate temperatures. It is the responsibility of the user to assure that the baseplate temperature of the converter does not exceed the rated value. The power dissipation of the elements is concentrated in a number of small areas. However, the thickness of the substrate and hybrid package do a good job of spreading the heat over the hybrid base plate area. In order to get the maximum benefit out of the hybrid, or maximum re-

liability, the surface on which the hybrid is mounted must be maintained at or below the hybrid's rated temperature. If the heat sink below the hybrid is very thin, the area under the DC/DC Converter's baseplate will be hotter than necessary. Also, a thin heat sink may not conduct heat away from the hybrid very well, in areas not below the DC/DC Converter. Sometimes the heat sink is very thick and connections to the DC/DC Converter's pins are difficult to wire. In this event, the heat sink should be locally counter bored in the vicinity of the pins.

Some Common Mistakes:

Running the hybrid DC/DC Converter without a heatsink:

This is commonly done during incoming inspection. The hybrid DC/DC Converter's small thermal mass allows the temperature to rise rapidly to high temperatures that may exceed the DC/DC Converter's rating.

Trying to use a printed wiring board as a heat sink:

A printed wiring board or copper traces on the printed wiring board will conduct heat. However, the thermal resistance may be very high. Special types of boards that have higher thermal conductivity are available. The mistake made in this instance is in using a printed wiring board as a conductive heat path, but not computing the thermal resistance of this path to the heat sink.

Connecting a heat sink to the top of the case:

The top of the case is typically quite thin and only attached to the baseplate at the periphery of the baseplate. Therefore, heat is conducted from the baseplate to the case, however, the thermal resistance is less than optimum. This results in an unsatisfactory part utilization, except in the case of a very low output power.

Using a heatsink that is too small or too thin:

The temperature drop from the baseplate to the ultimate heat sink is too high because the thermal resistance is too high for the power flux and the desired temperature rise through the heatsink. Therefore, the converter operates at an unsatisfactorily high baseplate temperature.

Trying to cool by convection or radiation in thin air or vacuum:

The following true anecdote illustrates this point. A customer mounted a DC/DC Converter for a space application on a printed wiring board. The board was mounted inside a unit and extensively tested. The converter operated perfectly until the customer performed a thermal vacuum test. The converter then failed. The unit was disassembled and examined. It was apparent that the DC/DC Converter had been exposed to extremely high temperatures. While operating at normal atmospheric pressure, the converter was cooled by free convection to some extent. When the atmosphere was removed for the thermal vacuum test, the heat removal provided by free convection was not available, and the converter overheated.

In high altitude aircraft applications, the air available for free convection is also practically nil, therefore to be conservative, all conduction should be designed to be satisfied by conduction cooling.

Controlling the temperature of the mounting, not the base plate of the DC/DC Converter:

The heat of the baseplate of the DC/DC Converter is the controlling variable for controlling the temperature of the internal components. Controlling the heat of the mount ing surface alone is not sufficient. Moreover, as heat flows from the DC/DC Converter through to the underlying heat sink, the temperature of the underlying heat tends to be increased by the heat flux. This must be accounted by the analysis.

Mounting a high power converter on a non-flat surface:

Both the hybrid DC/DC Converters and the underlying mounting surfaces tend to have irregularities. Therefore, the tendency would be that contact between the DC/DC Converter and the mounting surface is only made at a few points. This results in a higher than desirable thermal resistance. The way to improve this situation is to use a thermal gap filler. This can be a high thermal conductivity grease or a high thermal conductivity silicone rubber pad. Since the case of the DC/DC Converter is usually electrically isolated from the internal circuitry, the gap filler does not need to be electrically isolating. In fact, the gap filler should be as thin as possible but still fill in the irregularities. Excess gap filler will raise the temperature.

When bolting the hybrid to the cooling surface, use adequate pressure to minimize the thermal resistance from the hybrid DC/DC Converter to the mounting surface.

It is always the responsibility of the user to insure that the bottom of the hybrid's mounting surface is maintained at a safe temperature.

Cascaded Converters vs Single Stage Conversion

Cascaded power converters have occasionally been used in 270 VDC and 120 VDC applications because of a scarcity of converters made to operate on these input voltages, while many types are available which operate at 28 VDC. This situation has been remedied by MDI by producing a range of 270 VDC and 120 VDC DC/DC Converters that operate directly from the high voltage bus and produce the desired output voltages directly.

Other manufacturers who have a limited product range often suggest a cascade of converters from 270 VDC to 28 VDC (or from 120 VDC to 28 VDC) and then from 28 to the final user voltages. This approach has many drawbacks compared to a single stage of conversion.

- Cascaded converters often have feedback loop stability problems due to the regulating (negative resistance) load that the output converter reflects back to the input converter. These problems are more prevalent when the power levels of both converters are similar. This may result in oscillations.
- Overall conversion efficiency will be at least 15% lower, resulting in increased heat loads.
- MTBF will be reduced to up to 50% because of increased parts count.
- Weight will be increased by an integral factor.
- Unless synchronized, beat frequencies can occur between converters
- Price for a given output will be at least doubled.

MDI's wide range of available 270 VDC and 120 VDC input converters allows the user to generate board level voltages the right way.

Interface of 120 and 270 VDC Converters

The Split Input EMI Filter

All MDI hybrid DC/DC Converters have an input EMI filter. The filter includes a common mode inductor (balun) as well as one or more differential inductors. The common mode inductor has two identical windings. One winding is placed in the positive power input leg and one winding is placed in the negative power input leg. The differential inductors have "split" windings. The term split refers to the fact that each half of the winding is placed around the core in two winding sections. One section is placed in the positive power leg and the second section is placed in the negative power leg. The reason for splitting the winding into two sections is that any electromagnetic or electrostatic coupling from nearby noise sources impinges on the inductor in approximately equal amounts. This helps in canceling the net effect. Within the hybrid microcircuit, physical proximity of components is tight and there is no room for shields or EMI plenums. Therefore, splitting the inductor windings is necessary.

Voltage Across the Input Filter

The input EMI filter is bilateral. It not only prevents noise from emanating from the DC/DC Converter, it also prevents external noise from perturbing the converter. This means that essentially any AC voltage appearing on the input to the converter appears across the input filter, since the output of the filter is a large capacitor.

AC voltage can include audio modulation on the DC input, spikes, surges and turn on transients. On an AC basis, approximately half the voltage appears across the negative leg of the input EMI filter. While this voltage can be relatively small with a 28 VDC Converter, it is proportionally larger in a 120 or 270 VDC Converter.

Pin Functions Referenced to the Input Return

A typical hybrid DC/DC Converter has several control and monitoring functions that are referenced to the input return of the DC/DC Converter. These include the inhibit pin, the sync pin, the soft start pin and the BIT

pin. However, these functions are not actually referenced to the input return, they are referenced to the internal Converter circuitry, which is separated from the input return by the negative leg of the input EMI filter.

And from the preceding paragraph, approximately half of the AC component on the input power line appears across the negative leg of the filter. Because of the split input filter, extra consideration is required to a) provide proper control and monitoring function, b) prevent damage to the internal and external components and c) prevent conducted emissions from leaking around the negative leg of the input filter.

Connection Guidelines

Inhibit pin: The inhibit function on the 120 VDC and 270 VDC Converters is an "inhibit not". This means that the converter operates when the pin is open and is inhibited when the pin is connected to the return. The inhibit pin has a twelve volt zener diode and 0.1 microfarad capacitor connected from the inhibit pin to the converter common circuitry.

The inhibit pin does not pose a danger to leakage around the EMI filter, since it is in a high impedance mode when the Converter is operating. When the Converter is inhibited, no emissions are produced.

When turning on with a zero risetime, or when high voltage spikes are imposed, a 270 VDC converter can produce open circuit voltage in excess of 150 VDC on the collector of an external inhibit transistor. With negative going input voltage spikes applied, the base collector junction of an external transistor will be reverse biased.

The following recommendations should be followed when using the inhibit function on a 120 or 270 VDC hybrid DC/DC Converter. Use an external limiting resistor of 1,000 ohms, 1/4 watt, in series with the inhibit line. This will limit current flow into and out of the inhibit pin during spikes, surges and transients. Use an inhibit transistor with an adequately rated collector-emitter breakdown voltage. If driving the inhibit pin through an optocoupler, buffer the optocoupler's output with a transistor of suitable voltage rating.

BIT pin: The BIT pin is a low impedance source, however it should be connected to external circuitry through a relatively high impedance (above 47 K ohms is suggested) to prevent upset from external circuitry.

Soft start pin: The soft start pin is internally buffered and filtered. No special precautions are required for using the soft start pin.

Sync pin: The sync pin is connected internal through a 1000 pF. capacitor and limiting resistor. No special precautions are required for using the sync pin.

Piezoelectric Response of Input Capacitors

When 120 or 270 VDC hybrid DC/DC Converters are turned on from a fast rising waveform, or subjected to spike tests or audio modulation, ticks or sounds are sometimes heard emanating from the units. It is normal for the hybrid DC/DC Converter to produce sound when this type of voltage is applied.

The source of these sounds is the ceramic input capacitors which filter the high input voltage. The input capacitors are multilayer ceramic types with a Barium Titanate ceramic dielectric. When voltage is applied to the ceramic dielectric, the dielectric physically moves by a miniscule amount. While this effect is present at all voltages, it becomes much more pronounced at 120 or 270 VDC.

The piezoelectric effects can cause cumulative damage to the capacitor if the mounting terminations are too rigid. Therefore, MDI has developed special mounting techniques for high voltage ceramic input capacitors so that they can "sing" without damage.

The Effects of DV/DT on 120 and 270 VDC DC/DC Converters

120 VDC input hybrid DC/DC Converters have input capacitances ranging from 8 microfarads to 14.4 microfarads. 270 VDC input hybrid DC/DC Converters have input capacitances ranging from 2.3 microfarads to 5.6 microfarads. Although inrush current is limited by the input inductors, these inductors are only sized to accommodate a limited volt/second product. Therefore, on turn on, the input inductors will saturate to some extent. The saturation effect is greater for 120 and 270 VDC units than for 28 VDC parts.

As a conservative estimate of initial turn on inrush current, one may use the equation i=C(DV/DT). Typical input capacitances for hybrid DC/DC Converters is listed earlier in the application notes.

The turn on inrush current is usually more a problem during test and evaluation than in actual system applications. For example, because of contact arcing, relay contact switching is impractical at 120 VDC or 270 VDC. Most actual 120 VDC and 270 VDC systems use solid state power switching to apply bus voltage to the loads. 270 VDC buses derived from AC rectification of three phase power also have finite rise times.

Rise times of 125 microseconds or greater are preferable for 270 VDC systems; rise times of 75 microseconds or greater are preferable for 120 VDC systems. Most actual system applications have been found to meet or be lower than rise times.

Rather, it is during test and evaluation that high input voltage converters are energized from a low impedance power source by using an (over-rated) mechanical switch or a clip lead. When this happens, inrush currents can be very high and high voltages can be produced across the negative leg of the input filter. Either condition may cause damage to the Converter.

How to Lower DV/DT and Inrush Current

To lower inrush current that flows at the application of power, lower the input voltage DV/DT. If the system power source has a zero or unknown rate of rise, additional inrush limit protection should be provided.

For many high input voltage Converters, all that is required to limit inrush current is a limiting resistor in series with the input line. For example, a fully loaded 6.5 watt Converter operating from a 270 VDC source has a typical impedance of 7.8K ohms. If a 50 ohm resistor is put in series with the input line, the efficiency will drop only 0.6%. The dissipation in the resistor at this point is approximately 60 mW. However, the peak inrush current, even with a zero rise time input, will be less than 5.4 amperes.

For higher power applications, use a series resistor to charge the input capacitors, as above. However, use an FET to bypass the charging resistor when the input capacitors are charged. A simple inrush limiting circuit using an N channel FET in the negative power leg is shown in Figure 18. For 120 VDC applications, it is possible to use a P channel FET in the positive power leg.

For burn in and test applications, an inrush limiting thermistor is a good, simple solution to reduce turn on inrush currents. This solution does not work satisfactorily over a wide temperature range.

Standard Product MIL-STD461 Conducted Susceptibility Test Criteria

Conducted susceptibility is the response of the converter to unwanted signals applied to the power leads. Requirement CS01 tests the converter's ability to perform properly with audio frequency signals superimposed on the DC input. This is also called "audio frequency rejection." CS02 extends this into the RF range. Requirement CS06 applies positive and negative spikes to the converter's inputs.

CS01 Testing

The objective of the CS01 (Audio Susceptibility Test) is to assure that the DC/DC Converter produces a usable output when subjected to a simulated worst case AC modulation of the DC power supply input.

In the CS01 test, an audio signal ranging from 30 Hz to 50 kHz is connected between the DC/DC Converter and the power source. Both the positive and negative legs are tested if the input is isolated from the case. For a 28 VDC nominal unit, a 2.8 volt RMS (8.2 volts peak to peak) is applied. At 1.5 kHz to 50 kHz, the signal is linearly decreased. In addition, the power of the susceptibility source is limited to 50 watts. For higher voltage units, the voltage is usually scaled proportionally.

For meeting the audio susceptibility (CS01) requirements, it is not commonly realized that the audio frequencies involved are, for the most part, much lower in frequency than either an internal or external filter

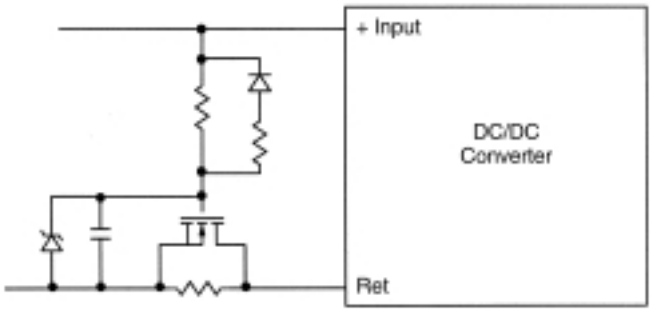


Figure 18: Inrush Limiting Circuit

can attenuate. Therefore, the design of the converter itself must be capable of audio frequency rejection. This requires high loop gain at the high audio frequency range. CS01 rejection is typically achieved by using current mode or dual loop feedback.

Applying the audio susceptibility signal causes the DC/DC Converter's output to be modulated at the audio frequency. The output of the converter has the normal high frequency ripple with the audio superimposed.

Standard pass fail criteria for the CS01 test is that the peak to peak modulation envelope not exceed the specified peak to peak ripple specification. For example, if the peak to peak ripple specification is 50 mV, an additional 50 mV is allowed when the audio susceptibility signal is applied.

CS02 Testing

CS02 testing is an extension of CS01 testing that starts at the same frequency and amplitude as CS01 testing and extends into the RF range. The coupling method is different from the CS01 method to allow use of 50 OHM RF generators. The power is also limited to 50 watts.

Due to highly effective input filter response in this frequency range, it is unusual to detect any change in DC/DC Converter performance when this test is performed.

CS06 Testing

Spike amplitudes and durations are governed by numerous specifications. The MIL-STD-461 CS06 spike test is typical. In this test, repetitive narrow (typically 10 microseconds width) spikes are applied to both power inputs (if not connected to case ground) in turn. For a 28 volt system, the peak amplitudes are 56 volts, both positive and negative. MIL-STD-704 and MIL-STD 1275 also have similar spike requirements. Another requirement imposing spikes is MIL-E-6051. Commercial aircraft also have a DO-160 spike test.

Spike suppression is generally easier than surge suppression since the time durations are much shorter. Spike suppression can be implemented completely within a hybrid package by relying on the EMI suppression components to spread the energy within the spike over a longer period of time. This essentially transforms the high voltage spike to a lower voltage waveform incurring no loss. In certain instances, zener diodes are also used to keep peak voltages below safe limits. Typical CS06 spike suppression pass/fail criteria allow a ±5% deviation when the spike is applied.

Standard Hybrid DC/DC Converter Derating Criteria

1.0 Scope

This criteria provides design ground rules for MDI standard hybrid DC/DC Converters. It is superseded by specific customer requirements. This document is based on the requirements of MIL-STD-454 requirement 18, MIL-STD-975 and MIL-PRF-38534.

2.0 Capacitors

2.1 Solid Tantalum (CWR or equivalent) shall be derated to 50% of steady state rated voltage as a goal, with an absolute maximum of 70% with design approval. Transient voltages shall not exceed the manufacturer's rated values. Worst case ripple current shall not exceed manufacturer's rating at maximum operating temperature. An impedance of 1 OHM per volt or the equivalent obtained by circuit impedance or rate of voltage rise control shall be provided to limit surge current.

2.2 Ceramic (CDR or equivalent) shall be derated to 60% of steady state rated voltage as a goal, with an absolute maximum of 80% with MDI design approval. Transient voltages shall not exceed the manufacturer's rated transient values. Worst case ripple current shall not exceed manufacturer's rating at maximum operating temperature.

3.0 Microcircuits

The derating of microcircuits shall conform to MIL-STD-975 Revision G, Paragraph 1.2.2.

4.0 Resistors

The derating of printed resistors shall be in accordance with the requirements of MIL-PRF-38534.

The derating of discrete and chip resistors within the hybrid shall conform to MIL-STD-975 Revision G, Paragraph 1.2.3.

5.0 Semiconductors

The derating of semiconductors shall be in accordance with MIL-STD-975 Revision G, Paragraph 1.2.4.

6.0 Magnetic Components

The derating of Magnetic Components shall be in accordance with MIL-STD-975 Revision G, Paragraph 1.2.5 and 1.2.6 except that an operating voltage of 90% of rated is permissible and a temperature relaxation of 20°C is permissible.

7.0 Bond Wires

Bond wire sizing shall be sized in accordance with MIL-H-38534, based on worst case peak currents.

8.0 Conductor Tracks

Printed Conductor tracks shall be sized in accordance with MIL-PRF-38534, based on worst case peak currents.

9.0 Voltage Breakdown between Insulated Points

The spacing between printed conductors, between bond wires and printed conductors, between package pins and the case, etc., shall be verified by design to permit a 50% derating of DC breakdown voltage at the worst case atmospheric conditions.

Effective 9/20/92

MTBF
Mean Time Between Failures

Meant Time Between Failures for a hybrid DC/DC converter may be estimated using the parts count method, or calculated using the stress method. In order to get a precise MTBF calculation, the following must be known:

- Component stress at the actual operating conditions.
- Component temperature at the actual operating conditions.
- Parts quality and screening.
- Actual application environment.
- The method and piece part failure rate data specified for performing the calculation.

This means that a lot of very specific analysis is required as a pre-requisite to getting an accurate MTBF value. Fortunately, MDI can offer generic MTBF values based on some common assumptions:

- Operating base temperature 50°C.
- Overall power derating 75%.
- Parts quality and screening suitable for applications
- MIL-HDBK-217F notice 2 used for calculations.

Based on these assumptions, the following are "generic" MTBF's for a typical 30 watt dual output converter:

A	Ground Benign	646.041.1 hours
B	Ground Mobile	394,802.9 hours
C	Naval Sheltered	394,802.9 hours
D	Airborne Inhabited Cargo	394,802.9 hours
E	Airborne Inhabited Fighter	355,322.6 hours
F	Airborne Uninhabited Fighter	273,325.1 hours
G	Rotary Wing Aircraft	273,325.1 hours
H	Missile Flight	355,322.6 hours
I	Space Applications	2,584,164.2 hours

MDI can provide specific MTBF calculations for a customer's actual operating conditions according to the customer's order.

Radiation Effects on DC/DC Converters

DC/DC Converters frequently must operate in the presence of various forms of radiation. The environment that the converter is exposed to may determine the design and performance of the part and how the part may perform during and following the radiation exposure. The following is a brief discussion of some of the radiation factors influencing DC/DC Converters.

Unmanned Space

The radiation environment mainly consists of a relatively steady accumulation of ionizing dose as well as sporadic high energy particles which cause Single Event Upsets (SEU).

Total ionizing dose accumulations for unmanned space applications range from several thousand Rads (Krads) to several hundred thousand rads. Many applications

have expected operating lives that exceed ten years, resulting in a correspondingly high accumulation of radiation dose. However, dose rates are relatively low. The ionizing radiation dose may consist of electrons, or of heavier particles such as protons or neutrons. The mix of radiation depends on the particular orbit as well as the degree of shielding between the converter and the environment. Shielding is more effective with electrons and less effective with energetic heavier particles.

Single Event Effects depend on the energy of the particles. Higher energy particles occur with a lower frequency than low energy particles. The measure of energy for single event particles is the MeV*cm^2/mg.

Manned Space

Since the lethal radiation dose for human beings is only several hundred Rads, manned space applications have much lower total dose requirements than unmanned space applications. Total dose accumulations normally do not exceed several Krads. However, more of the ionizing dose may consist of heavy particles, such as protons. Single event effects are also an important consideration.

Nuclear / Ground

The radiation considered in terrestrial applications arises from the detonation of nuclear weapons. The total accumulated dose can be relatively low compared to a space requirement, but the dose rate is much, much higher.

Moreover, there is a high rate of neutron fluence and X- ray effect associated with nuclear detonations.

Compared to radiation encountered in a space application, radiation effects from a nuclear detonation are much more transient in duration. The nuclear effect creates photocurrents in active devices which, for a very short duration, turn on the devices.

Total Ionizing Dose

Total ionizing radiation doses cause cumulative damage in electronic components. This damage can cause component parameters to change from their pre-radiation values. Some types of components are much less susceptible to radiation damage than others. Passive components, such as resistors, capacitors, inductors and transformers are relatively immune.

Active components such as rectifiers, junction FET's and zener diodes are not relatively affected.

Active components such as opto-couplers, integrated circuits, enhancement FET's and bipolar transistors may or may not be susceptible to parametric change due to total ionizing dose, depending on their construction.

Designing a DC/DC Converter that will perform properly after exposure to total ionizing dose requires a knowledge of which parts to select and how to overcome the limitations of existing parts to achieve the desired result. Very often, it is possible to use some components that have a level of change that is tenable due to the insensitivity of the surrounding circuit.

Total dose radiation falls into two basic categories. They are radiation from gamma rays (electrons) or from heavier particles (protons). Up until several years ago, it was not well known in the power electronics community that: a) the parametric degradation of certain components differed depending on whether the radiation consisted of electrons or protons and b) certain terrestrial orbits had significant proton radiation.

These conditions were first widely disseminated after analyzing failures in discrete (non-hybrid) optocouplers. The findings were that opto couplers were particularly sensitive to parametric degradation when exposed to proton radiation. Other types of active components were also found to be more affected by proton radiation than previously expected. However, most types of bipolar integrated circuits that are commonly used in DC/DC Converter designs are not affected significantly more with proton radiation than with gamma radiation.

In an unmanned space application, total ionizing dose occurs at a relatively low rate, but extends over many years. Since no one wants to wait many years for the performance of a radiation test, testing is done at a higher rate that takes a day or two at most. It has recently been discovered that low dose rates cause more parametric degradation than high dose rates. This is a counter-intuitive effect. However, it has been found that at the higher dose rates, the damage caused by the ionizing radiation is annealed, or healed. At the lower dose rates the damage is actually more cumulative. Therefore, the parametric change in components at low dose rates must also be considered when selecting components.

Total ionizing dose may be reduced by shielding. Most spacecraft applications use radiation shields outside the area of the DC/DC Converter. Shielding is more effective when the radiation dose consists of electrons and low energy particles. It is much less effective when the radiation dose consists of protons. Also, shielding

becomes ineffective beyond a certain point because of secondary emission. This means that radiation impinging on the shield causes a secondary emission, which emanates from the shield.

Single Event Effects

Single Event Effects are circuit upsets or damage caused by small numbers of energetic particles. The frequency of these events is inverse to the energy of the particles. That is, the more energetic particles occur less frequently.

The result of a Single Event Effect is usually the unwanted conduction of a semiconductor device for a nanosecond or sub-nanosecond interval. The device exposed to the single event particles can be latched into an unwanted state or can recover from the conduction after the event ends.If the device latches into an unwanted state, the cause may be activation of parasitic components that would normally be otherwise out of the picture.

Therefore, Single Event Effects can affect certain types of semiconductors, such as CMOS parts, more than other devices, such as bipolar junction isolated parts. The devices selected for MDI DC/DC Converters, which are designed to be radiation resistant, use bipolar IC's and avoid CMOS and BiCMOS IC's.

In addition, the circuit topology can very much influence Single Event tolerance. For example, a half bridge (or full bridge) power stage has one (or two) series connected switching transistors across the power line. Only one transistor is permitted on at a time in each leg. A single event can turn on the "off" transistor, causing a shoot through current. If the current is not limited by passive components in some way, the single event can cause destruction of the transistors. Other power stage topologies, such as flyback, single ended forward, etc., have the impedance of a transformer in series with the switching transistor. Therefore, the current that would flow in the event of an unwanted transient conduction is much more limited.

Control circuit topology can also cause problems when exposed to single event particles. As an example, the original MDI converters incorporated a cyclic current limit circuit using an LM139 comparator IC. The cyclic current limit circuit is designed to shut the converter off for a period of time when an overcurrent is detected, turning it back on automatically. However, if the LM139 is hit with a single event particle, it instantaneously changes state. Since the comparator reverts to the proper state after the event, this would not otherwise be a problem, except that the external latching circuitry recognizes the transient change of state as an overcurrent, and cycles the current limit. MDI resolved this unwanted operation by incorporating an RC time constant in the latch circuit. The purpose of the RC time constant is to discriminate against the very narrow pulses produced by a single event, and the wider pulses produced by a true overcurrent condition. By adding the RC circuit, MDI made the circuit function immune to Single Event Effects. The charge stored on the capacitor remembered the desired circuit state and allowed the circuit to recover after the event passed.

This demonstrates that with proper circuit topology, parts that may otherwise be sensitive to single event effects can be overcome by circuit elements.

Neutron Fluence

Neutron Fluence is significant mainly in applications where the DC/DC Converters must operate in the vicinity of a nuclear bomb blast. As would be expected, the effects caused by Neutron Fluence on the ground are similar to those caused by proton radiation in space.

As far as components normally used in DC/DC Converters, the optocoupler, if used, is found to be the susceptible component to damage from neutron fluence. In particular, the LED part of the optocoupler is found to be the item most usually degraded by neutron fluence. Different types of LED's are used within optocouplers. Some of these LED's are much more resistant to neutron fluence than the common GaAs LED's.

A better solution is to eliminate optocouplers altogether. Optocouplers transmit a signal from one ground to another. In a DC/DC Converter, the control loop error signal is the parameter that is passed through the optocoupler. This feedback function can also be achieved by coupling the error signal through a transformer. Elimination of the optocoupler and replacement by a magnetic coupling is the basis for MDI's 5000 series Proton Rad Hard DC/DC Converters.

MDI's 5000, 7000, 8000 and 9000 series parts, in the R, RE, S, SE grades have standard ratings of 100 Krads TID and 82 MeV*cm^2/mg for SEE. However, the ultimate capability of these parts is in excess of 200 Krads TID and 82 MeV*cm^2/mg

MDI's 120 VDC space station application parts in the R, RE, S, SE grades are rated for 25 Krads TID and 37 MeV*cm^2/mg, consistent with space station environments.

MDI's Low Voltage DC/DC Converter Series

In response to customer requests, MDI extended the line of 28 VDC full featured hybrid DC/DC Converters to a low input voltage range, 8 to 40 VDC. This represents a five to one operating range, a wider range than virtually all hybrid DC/DC Converters.

These DC/DC Converters were derived from MDI's line of 28 VDC nominal full featured parts. The modifications to the full featured family occurred in several areas. The nature of the modifications should be understood by the user so that full benefit can be derived from these parts.

5W	3061
6.5W	3062
20W	3113
30W	3378
50W	3114

Table 6: Available low voltage DC/DC Converters

1. In order to use established input EMI filter components, the current rating of the filter is rated at the current that flows at an input voltage of 16 VDC. As the input voltage is reduced below 16 VDC towards 8 VDC, the input current would proportionally increase if the output power remained constant. Therefore, to keep the input filter current from exceeding the 16 VDC values, the power delivered from these low input voltage DC/DC Converters is derated linearly below 16 VDC, to 50% of rated power at 8 VDC. The user may need to consider the derating at low voltage and use appropriately rated part.
2. To allow operation at low voltage, the primary to secondary turns ratio of the main transformer was reduced, in most cases, by 50%. Reducing the primary to secondary turns ratio by 50% doubles the peak currents drawn from the input capacitors at any given input voltage. The higher peak currents cause an approximate 6 dB in crease in low frequency conducted emissions, as compared standard 28 VDC range parts. How ever, the switching frequency of the parts is increased to 300 kHz as compared to the 180 kHz to 200 kHz of the standard 28 VDC parts. This mitigates the effect of the increased input pulse current.
3. To achieve a lower voltage drop in the input switching FET despite the increased current, a lower voltage rated FET is normally used. This FET prevents the part from being used in the presence of 80 or 100 VDC surges.
4. Housekeeping voltage to start the PWM function of the converter is provided by bipolar transistor start circuit. In normal operation, a regenerative winding derived from the main power transformer takes over, bypassing the bias supplied by the start circuit. In the low voltage line, the start circuit has been modified, eliminating all unnecessary voltage drops. In addition, a constant current diode is used in lieu of a resistor in the base of the start circuit. Over temperature extremes, it takes in excess of 9.5 VDC to start the DC/DC Converter. However, once running, the converter can operate down to 8 VDC, since the regenerative winding supplies housekeeping voltage to power the PWM stage.
5. In the low voltage family of converters, the inhibit function found in the standard 28 VDC units has been changed to the "inhibit-not" function. This means that the converters will inhibit when their inhibit pin (pin 2) is connected to the input return. An open collector transistor with a minimum 20 VDC rating is recommended for this function. The "inhibit-not" function has a higher transient noise immunity than the inhibit function, therefore it was established for these units.

MDI's Proton Rad Hard DC/DC Converters

MDI's Proton Rad Hard converters eliminate the use of optocouplers, which are the primary components that are affected by proton radiation.

Wattage	28 VDC	50 VDC	70 VDC	100 VDC
6.5W	5690	7690	8690	9690
20W	5107	7107	8107	9107
30W	5680	7680	8680	9680
40W	5193	7193	8193	9193
80W	5031	7031	8031	9031

Table 7: Available Proton Rad Hard Converters

In a typical DC/DC Converter application, there must be galvanic isolation between the power supply pins and the output pins. The reasons for this concern safety, noise reduction or circuit operation. In most applications, the various grounds within a system are

ultimately connected to a single point ground. In other applications, the outputs of the converter are referenced to a potential different from ground.

Previously, MDI offered radiation hardened DC/DC Converters which used an internal radiation hardened optocoupler for input/output isolation. Now, in order to provide an even higher level of radiation resistance, and one that is less susceptible to unit-to-unit variations in the optocoupler, the isolation function in all proton radiation hardned DC/DC Converters has been replaced by an amplitude modulated RF link. This RF link transmits the amplified error signal across the galvanic isolation barrier through a small transformer. On the other side of the galvanic barrier, the RF signal is demodulated and applies the error voltage to the PWM control circuit.

Comparing the Proton Rad Hard parts to units with an optocoupler: radiation resistance is improved since the aging and parametric degradation of the optocoupler is eliminated. The efficiency of the proton rad hard converters is slightly lower (1 to 2%), since the output magnetic modulator consumes slightly more power than the optocoupler and drive currents throughout the converter have been increased for additional radiation resistance. Operating life of the proton rad hard DC/DC Converters, even without radiation, is improved over the optocoupler units, since there is no LED output degradation over time as found in the optocoupler type.

Because the magnetic modulator in the proton rad hard DC/DC Converters contains an RF oscillator, the output noise of the proton rad hard DC/DC Converters is slightly higher than that of the optocoupler types. The higher noise is in the form of a very low level 2 MHz signal uncorrelated with the output ripple. The 2 MHz signal is normally at least 20 dB lower than the output ripple.

Comparing transient response of the proton rad hard DC/DC Converters with that of the optocoupler types, the load application, load removal and response to line transients is better in the proton rad hard version. The reason for this is that the optocouplers vary considerably in initial current transfer ratio, and also over life and radiation. This means that the optocoupler units have to be compensated for a much wider range of conditions than the magnetically isolated proton rad hard units. The compensation being more conservative, the closed loop bandwidth of the optocoupler types tends to be approximately half as much as the bandwidth of the proton rad hard units. Since the recovery times from transient events is inversely proportional to bandwidth, the proton rad hard converters have better transient response.

Similarly, the turn on overshoot of the proton rad hard DC/DC Converters is essentially non existent because the circuit topology and wider bandwidth.

Hybrid DC/DC Converters Excel in AC Applications

Hybrid DC/DC converters are rapidly dominating the next generation of high performance military and aerospace applications due to their small size.

However, physical volume reduction of miniature AC input converters have lagged behind their DC input counterparts. This is unfortunate, since many AC applications also demand the small size, light weight and high performance. By using a small rectifier and filter ahead of a suitable hybrid DC/DC converter, a very small AC/DC power supply may be implemented.

Primitive hybrid DC/DC converters were not regulated at all or had relatively narrow input voltage ranges. Second generation parts operate over a 2 1/2 :1 or 3:1 range. This is an impractically narrow range for running on highly pulsating full wave rectified AC.

For wide operating voltage range DC/DC converters, the choice of circuit topology is critical. It has been shown that the flyback topology is well suited for extreme operating voltage ranges. Reference #2 discusses a flyback construction operating over a 37:1 range.

The most common nominal voltage range for DC input units is 28 VDC followed by 270 VDC and 120 VDC. The 120 VDC range is used by the International Space Station Alpha program as well as some newer satellites. Modular Devices, Inc. is now manufacturing four families of hybrid 120 VDC input converters using flyback topology, ranging in power from 6.5 to 80 watts. The operating range of these parts encompasses 200 VDC on the high end to 80 VDC on the low end. In addition, these converters are current mode types and have a high degree of ripple rejection.

The wide operating voltage range feature makes this series of parts ideal for operating on pulsating DC derived from direct full wave rectification of nominal 115 VAC inputs.

A typical circuit configuration is shown in Figure 19. AC voltage is fed to a bridge rectifier, then to a capacitor in parallel with the DC/DC converter. For low power outputs the capacitor is not necessary since the internal capacitor of the DC/DC converter suffices.

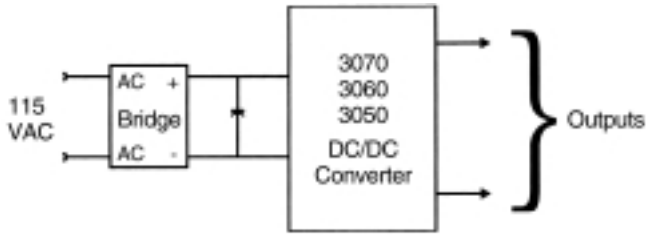


Figure 19: Typical Circuit Configuration Transforming 115 VAC Input Into DC Output

This configuration has excellent EMI characteristics. The high frequency emissions are controlled within the DC/DC converter itself. The low frequency conducted emissions are minimized by keeping the filter capacitance as small as possible. Since the DC/DC converter is designed to operate over a large input voltage range, it can cope with the high pulsating voltage resultant from a small capacitor.

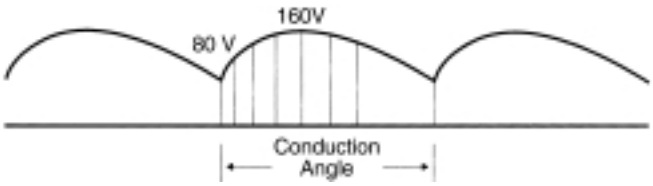


Figure 20: Converter Input Waveform

A typical input waveform is shown in Figure 20. The small capacitor results in a large conduction angle. The large conduction angle provides a high power factor and allows a relatively fast fall off of low frequency harmonics.

A substantial benefit of being able to operate with little or no external capacitance is the small physical dimensions of the resulting power supply.

Tables 8 through 11 show how much minimum capacitance is needed. In practice, an additional factor of safety in capacitance value may be desirable to counter the capacitance change over temperature, increase low line operating margins or reduce output ripple voltage.

The 3050/3060/3070 family of hybrid DC/DC converters typically has 60 dB of ripple rejection with 50-60 Hz inputs and 42 dB of ripple rejection with a 400 Hz input

With the capacitor values shown, typical full wave rectified ripple component is 0.5% p-p at 50/60 Hz., and 2.5% p-p at 400 Hz. This ripple is reduced directly as capacitance is increased. For 400 Hz applications it may be desirable to use a small inductor for filtering as this may be volumetrically better than capacitors and will improve power factor.

Battery Backup Power Supplies

The requirement to operate from an AC power line with a battery backup is often encountered in critical applications. A simple configuration for battery backed up power supplies using two hybrid DC/DC converters is shown in Figure 21. Highly compact uninterruptable or battery backed up power supplies can be implemented with hybrid converters.

AC power is full wave rectified and fed through a blocking diode to the principal DC/DC Converter, #1. This converter produces the desired regulated outputs.

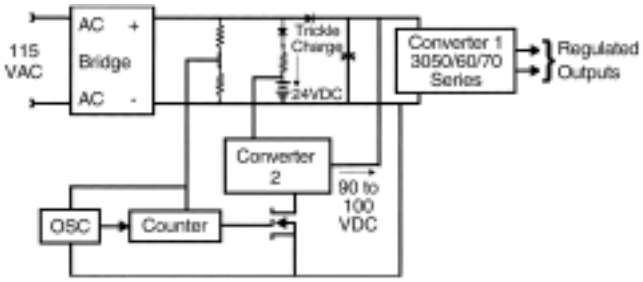


Figure 21: Typical Battery Backup System

A second diode connected to the pulsating full wave rectified voltage feeds a trickle charging resistor connected to a 20 cell Ni-Cad battery pack. The blocking diode is used to prevent unintentional back feed from the battery.

The trickle charge also supplies the no load current for DC/DC Converter # 2. Converter # 2 operates from the nominal 24 VDC battery output and delivers an output voltage in the 90 to 100 VDC range. This means that so long as AC power is present, DC/DC Converter # 2 is reverse biased and drawing only standby current. However, when the AC power source is low or not present, dropping below the output set point of DC/DC Converter #2, Converter #2 delivers the input voltage to Converter #1, drawing its power from the Ni-Cad battery.

The function of the oscillator/counter/FET switch is to disconnect DC/DC converter #2 from the battery after a preset time. This prevents the battery from discharging below an unusable potential.

Output with No External Capacitor	External Capacitance for Full Output
1.6 W at 50 Hz	8.7 μf/200 V
2.0 W at 60 Hz	6.5 μf/200 V
6.5 W at 400 Hz	—

Table 8: 3070 Family (to 6.5 Watts Output)

Output with No External Capacitor	External Capacitance for Full Output
2.2 W at 50 Hz	49 μf/200 V
2.6 W at 60 Hz	30 μf/200 V
17 W at 400 Hz	3.5 μf/200 V

Table 9: 3060 Family (to 20 Watts Output)

Output with No External Capacitor	External Capacitance for Full Output
5.4 W at 50 Hz	64 μf/200 V
6.5 W at 60 Hz	50 μf/200 V
44 W at 400 Hz	3.5 μf/200 V

Table 10: 3326 Family (to 40 Watts Output)

Output with No External Capacitor	External Capacitance for Full Output
5.4 W at 50 Hz	125 μf/200 V
6.5 W at 60 Hz	104 μf/200 V
44 W at 400 Hz	6.8 μf/200 V

Table 11: 3051 Family (to 80 Watts Output)

Capacitor Selection

Capacitors should have a minimum voltage rating of 200 to 250 VDC for this application or as derating criteria demands. The user can use a film, multilayer ceramic, tantalum foil or a high performance aluminum electrolytic capacitor. All of these part types are available in a height that is consistent with the height of the converters.

The dissipation factors of the capacitors should be reviewed since they are operating with a high ripple voltage. A high dissipation factor can cause power dissipation. At 400 Hz it may be desirable to use more capacitance than indicated to reduce the converter's output ripple voltage.

References

Hnatek, Eugene R. Design Of Solid State Power Supplies, Third Edition. Van Nostrand Reinhold, New York, 1989.

Summer, Steven E. and Zuckerman, Leonard. "Wide Input Range Multiple Output Power Supply." Proceedings of the Sixth International PCI Conference, April, 1983.

MDI's 6000 DC/DC Converter Series

MDI has introduced a new family of five types of DC/DC Converters. These "6000" series parts are derived from MDI models 2690, 3107, 2680, 3193 and 3031. The corresponding part numbers are 6690, 6107, 6680, 6193 and 6031.

The operating frequency of these parts is 270 kHz when unsynchronized, and 300 kHz when synchronized. The approximately 50% higher operating than the original parts results in a much lower fundamental output ripple for the 6000 series, typically half that of the baseline parts.

Because of the higher operating frequency, the typical efficiencies of the 6000 series parts is about 1% lower than the lower frequency counterparts.

In addition, the standard inhibit function found in the original lower frequency parts has been changed to an "inhibit-not" function, due to greater customer demand for this inverted connection. The inhibit-not features higher noise immunity than the standard inhibit function. When operating normally, the "inhibit-not" pin is open. To shut off the converter, the "inhibit-not" pin is connected to input return. This is typically performed with an open collector NPN transistor.

Custom DC/DC Converters

Overview

The availability of custom hybrid DC/DC Converter configurations can add value to many applications, even though a custom converter generally costs more than a standard part. The user should evaluate the costs and benefits of a custom approach when warranted by the application. Customers are often unaware that hybrid DC/DC Converters can be readily modified. The use of modified converters can cut cost, size, weight and improve efficiency.

A single converter can provide a high multiplicity of outputs, using just one part to provide what might have required two or three packages. Or, in assemblies of multiple converters, custom configurations can reduce the overall package count. This can cut cost, increase reliability, save size, weight and efficiency.

In low power applications, even the smallest DC/DC Converter may have several hundred milliwatts of quiescent losses. Therefore, reducing the number of converters required to implement a requirement can be vastly more efficient using one custom converter with many outputs. Special voltage trims can also reduce or eliminate the need for external circuits, post regulators or add voltage margin for external redundant diode OR schemes.

In high power applications, two or more hybrid DC/DC Converters may be needed to achieve a given output power level. When using multiple converters, it is always desirable that they share power loading. At a high enough output voltage, it is often more desirable to place multiple converters in series rather than in parallel. The series connection provides virtually perfect power sharing without any additional circuitry. When a series connection of converters is used, it is very often desirable to have a non-standard output voltage so that the sum of the output voltages adds up to the desired amount.

Some requirements, such as power converters for MESFET RF amplifiers, need outputs which are sequenced. MDI can provide the sequencing as part of the converter.

MDI can provide DC/DC Converters whose outputs can be adjusted over a wide range, or converters that provide a constant current output with a voltage limit. Adjustable voltage converters are frequently used to program RF amplifier power levels or as lighting controllers. Constant current output converters are frequently used to charge capacitor banks.

Other design possibilities for custom DC/DC Converters include unique input voltages, ultra low output ripple, telemetry functions and BIT functions.

The following modifications are classified in order of ascending cost and lead time:

A Minor voltage trim: An output voltage adjustment to an otherwise standard part that can be performed using a laser trim or chip resistor. The transformer windings stay unchanged.

B Major voltage change: An output voltage adjustment to an otherwise standard part that requires a transformer winding change, and may also include requirements for different output rectifiers, output capacitors and output filters. However, a standard substrate is used.

C Minor substrate change: A modification to an otherwise standard part that can be performed using wire bonding or internal wiring. The substrate wiring is changed via laser cut and wire or wire bond jumper techniques. The magnetic components usually stay unchanged.

D Major substrate change: The designer essentially starts with a clean sheet, but may drop in proven circuit and functional blocks from existing designs. A major substrate change often requires two iterations.

Unique Input Voltage

MDI's standard product range includes the following:

8-40 VDC	5:1 range	16 to 24 VDC nom.
16-50 VDC	3.125:1 range	28 VDC nom.
86 to 158 VDC	1.8372:1 range	120 VDC nom.
200 to 335 VDC	1.675:1 range	270 VDC nom.

Within these ranges are the absolute gaps of 50 to 86 VDC and 158 to 200 VDC.

In addition to the gaps mentioned above, it is less than ideal to unnecessarily operate a DC/DC Converter near its operating limits. Each of the converter types has been designed to be optimum for the nominal voltage indicated, and provide a specified level of performance at the voltage extremes. This implies that the performance of a part may be less than optimum near the extremes of a part's range. Performance fall off can

include efficiency, regulation, dynamic response, loop stability, ripple voltage and component derating.

Although a converter may operate near or at the edge of its rating, it is unwise to do so when the nominal conditions are close to the ratings. Instead, it is prudent to rewind the magnetic components and to otherwise change the design so that the converter is again optimized for the nominal input conditions.

Similarly, converters may be produced which operate over wide extremes of voltage, 10:1 ranges and greater. However, such wide operating ranges place great stresses on components. Consequently, severe derating must be used. This results in power levels for a given package size that are lower than obtainable with a standard input voltage range.

Unique Output Voltage

To obtain a unique output voltage that brackets an existing output rating, the output may either be trimmed or may require a transformer change. Most MDI hybrid DC/DC Converters have an output referenced sensing circuit. For most of the standard output voltages, the output sensing circuit is self powered directly from the output voltage. For units with a very low output voltage (less than 5 VDC) or a high output voltage (above 28 VDC), the output sensing circuit must be powered by a separate winding. This configuration exists in most MDI converter designs. However, for outputs beyond the range of self powering, a unique transformer design is normally required to derive the correct voltage for the output sensing circuit in reference to the output voltage.

Unique output voltages can include unique dual output converters and unique triple output converters. Here are some examples:

A dual output converter that produces +12 VDC and +5 VDC.

A dual output converter that produces +5 VDC and –5.2 VDC.

A dual output converter that produces +5 VDC and +3.3 VDC.

Triple output converters can be advantageously used to provide a dual output where one output has relatively low current. For example:

A dual output converter that produces +5 VDC at high current and +24 VDC at low current (This is a standard T12 configuration where the 24 is the sum of ±12 VDC).

Triple output converters can be modified so that the main output can be a voltage other than 5 VDC. For example, a converter can produce +28 VDC at high power, ± 15 VDC at low power. The low power outputs are independently regulated and isolated from the high power winding.

Triple output converters can also be modified to produce two auxiliary outputs with a positive polarity. The auxiliary voltages can be dissimilar.

Low Output Ripple

All MDI DC/DC Converters have an output common mode inductor to reduce output spikes. The common mode inductor is designed to have low differential inductance because output voltage is sensed beyond this inductor, at the output pins. However, it is possible to trade some slightly increased load regulation for a lower fundamental output ripple by internally rewiring the converter's sense point and increasing the differential output inductance.

This technique works well provided the effects of AC modulation on the DC input line (ie., conducted susceptibility) do not predominate in the output ripple response.

MDI has also provided output filter hybrids, which are capable of reducing output ripple and noise to extremely low levels.

High Audio Rejection

Some applications require a very high degree of isolation from input effects to the output voltage. A conventional DC/DC Converter with current mode feedback will provide 50 dB to 60 dB of audio rejection from input to output. The EMI filter typically adds (ie., reduces the rejection) by 10-20 dB at certain frequencies.

If the rejection is desired at low or audio frequencies, the rejection provided by a single regulating loop might not be sufficient. In this event, a second regulating loop is required. While the primary regulating loop is always the pulse width modulation (PWM) loop, the second regulating loop can be either switching or linear. For example, in a system two converters may be cascaded. While this is usually a bad practice in most instances (see application note on cascaded converters), one

benefit that is provided by cascaded converters is the reduction of audio susceptibility.

In a standard triple output converter manufactured by MDI, the main output is PWM regulated and the auxiliary outputs are linear regulated from header voltages derived from the main output. This is an example of dual regulating loops. There will be an extremely high audio rejection on the auxiliary outputs because of the two regulating loops in series.

In constructing higher power solutions with high audio susceptibility rejection, a low drop out linear regulator stage is still useful. This may either be incorporated within the hybrid or be external. When the regulator is external, the output voltage of the hybrid DC/DC Converter may be increased to provide adequate head room for the regulator's operation.

Output Sequencing

DC/DC Converters frequently power GaAs FET RF solid state power amplifiers (SSPA's). MDI has designed and manufactured many different DC/DC Converters for driving GaAs FET SSPA's in space applications, using several different topologies for this purpose. These amplifiers require that on turn on, the negative gate bias voltage appears first before the positive drain voltage is applied. On turn off, the negative gate bias must remain on while the positive drain voltage is removed.

The basic power converter for higher power SSPA applications (up to 100 watts in hybrid form) is derived from a unique MDI model originally used to power the main X band SSPA in the JPL Mars Pathfinder project.

The key features of the higher power design are as follows:

1. The power stage topology is a 200 kHz. current mode flyback converter, which has good rejection of input variations.

2. A single flyback converter stage is used for all positive and negative outputs.

3. Output sequencing and inhibit is achieved with output FET switches.

The basic power converter topology for the lower power (up to 30 watts in hybrid form) SSPA applications is derived from an MDI model originally used to power a backup SSPA in a space application. The low power topology has fewer parts, so it is more suited for low power applications. However, there is slightly less control over the sequencing delays than the higher power topology. The basic low power sequenced topology is a 200 kHz. current mode flyback converter, combined with a low power forward output. This combination of flyback and forward modes allows a naturally simple sequencing with a minimum of parts.

The negative output voltage is derived from a forward connected winding, also using a linear regulator. The positive outputs are derived from flyback windings. The principal of this topology relies on obtaining tight coupling between the flyback transformer primary and the forward winding. The initially very narrow spikes of the FET are peak detected and allow the forward voltage to appear first at turn on. The flyback voltages rise more slowly. This creates the turn on delay.

When power is removed, hold up capacitance supplies the negative output while the other outputs decay.

Since sequenced hybrid DC/DC Converters are not listed in MDI's catalog, consult MDI's sales and marketing department for specific requirements. The sequenced converter needed for your application may have been previously developed.

Adjustable Output Converters

Many applications require a variable output voltage that is commanded by an external signal. The signal is usually a voltage referenced to the output return. Applications for variable output converters include adjustable RF amplifiers, lighting controls, capacitor charging power supplies, battery chargers and constant current sources. The topology of the standard MDI hybrid DC/DC converters is a current mode flyback. This topology is highly suited for achieving a wide operating range, so is a good choice for an adjustable output unit.

MDI's standard hybrid DC/DC Converters are designed primarily for a fixed output voltage. Adjustments of up to ten percent in the nominal output voltage are achievable without unduly compromising the operating points. The standard converter design relies on the relatively fixed output voltage. For maximum efficiency, the input PWM stage is started by a transistor connected to the input line, but powered by a housekeeping winding when the converter operates. Similarly, the output voltage sensing circuitry is normally self powered from the output. If the output voltage varies considerably, the housekeeping winding will not be available to power the input PWM circuitry and the output voltage will not be available to power the output sensing circuitry.

To obtain a variable voltage converter, the start up circuit must be modified so that it powers the input PWM circuitry at all times. This results in slightly lower efficiency. In addition, the output sensing circuitry must be powered by a separate winding, as it usually cannot be self powered if the output voltage varies significantly. If the input voltage variation is relatively low, the output sensing circuits can be powered from a forward phased winding. Alternatively, a flyback phased winding with a linear regulator may be used.

To extend the operating range, it is sometimes advantageous to program the operating frequency downward as the output voltage is programmed downward. This gives an enhanced dynamic range.

Current sources derived from hybrid DC/DC Converters are similar to adjustable output DC/DC Converters. In this case, the output current is sampled and compared to a reference. The amplified error voltage between the reference and the measured current is used to drive an adjustable output DC/DC Converter. It is also possible, by varying the reference voltage, to obtain an adjustable constant current source.

Because of the flyback topology and construction techniques used, MDI's product line lends itself to economically producing custom configurations. This can include special packages, up to ten regulated outputs, units with hold up, units with telemetry, low power with high efficiency and also DC to AC inverters.

To start a dialog on the feasibility of a custom hybrid DC/DC Converter with MDI's Engineering Department, fill in and fax back a copy of the "Custom Specifier" for Hybrid DC/DC Converters on page 176.

Assemblies of Hybrids

Board Mounted Converters vs. Assembly of Hybrids

Before the availability of miniature modules made distributed power architectures popular, multi-output power supplies were usually concentrated in centralized power supply boxes. The power supply contained one or more inverter stages. Regulated sub-outputs were either PWM derived, obtained from magnetic amplifiers or linear regulator post regulators.

Hybrid DC/DC Converters are often associated with distributed power concepts. Distributed power is a system where local converter/regulators are used instead of a centralized power supply. In the distributed system, bus voltage is fed to individual subassemblies. The hybrid DC/DC Converter modules are packaged within the subassemblies, and created the regulated and filtered voltages needed by the subassemblies locally. Many hybrid DC/DC Converters are used in applications such as this.

However, the centralized power supply assembly has not been eliminated by the availability of modules, but is instead often constructed out of assemblies of hybrids. Centralized power supplies are often contained on plug in assembles such as VME racks and SEM modules. The centralized box approach still offers advantages in many applications. In some cases, the power supply needs to be physically or electrically isolated from the load because the load is sensitive to electrical noise, the heat generated by the power supply or some other aspect. A centralized assembly also provides the user with an LRU (Line Replaceable Unit) format with heatsinking and connectors.

Now that a wide range of hybrid DC/DC Converters are readily available, many users are constructing their own centralized power supplies and assemblies using modules. can deliver, is needed, an assembly of hybrids offers fewer advantages.

When are Assemblies of Hybrids Better than a Custom Power Supply?

A number of considerations lead the choice to use an assembly of hybrids instead of a full custom power supply. First consider the total number of outputs and

the power level of each output. Assemblies of hybrids are more suited for higher number of outputs with each output at relatively low power. When only one output, or a small number of outputs, at a power level considerably higher than single hybrid DC/DC Converters can deliver, is needed, an assembly of hybrids offers fewer advantages.

Second, consider the quantity of units to be produced to weigh the development cost and availability of development talent versus the production cost. An assembly of hybrids tends to have a higher unit cost than a non-modular power supply. However, an assembly of hybrids will require far less design time than required to develop a non-modular power supply. With the building block approach of using multiple hybrids, the majority of the development work has been done, and is embodied within the hybrids. For lower quantity applications, an assembly of hybrids can be very cost effective.

In addition, assemblies of hybrids offer the benefit of previously developed documentation because of the building block approach. MDI can provide interface, source and specification control drawings for its hybrid DC/DC Converters. Many MDI hybrid DC/DC Converters have a full set of detailed analyses available.

Multiple output power supplies built with single inverters and post regulated outputs often suffer from cross regulation effects. These effects are exacerbated by dynamic conditions. Better isolation between outputs is provided by assemblies of hybrids, due to individual regulating loops.

In comparing between a power supply with a single inverter and an assembly of hybrids, the former has a lower parts count. However, the assembly of hybrids can still offer smaller size and weight due to elimination of intermediate packages and higher frequency operation. Also, assemblies of hybrids are generally more robust than multi-output power supplies built with a single inverter. This is because the physically smaller elements of the hybrid DC/DC Converter have a higher shock and vibration resistance than the larger, discrete elements.

Additional Functions

Assemblies of hybrids provide additional functions beyond just packaging hybrids in a housing. These functions include the following:

Bus Switching: Power supplies are often powered from redundant power buses. Relays of solid state switches are needed to select the desired power bus. If relays are used, the voltage rise time presented to the DC/DC Converters will be very high. In this event, some form of inrush current limiting will be needed to avoid loading down the power bus and to avoid damage to the relays.

Inrush Current Limiting: When powered by a voltage source having a fast rise time, large current spikes can flow to charge up the input capacitance within the hybrid DC/DC Converter. Active circuitry can efficiently slow the rise time of the input voltage, minimizing input inrush currents.

Fuses/Circuit Breakers: Fuses or circuit breakers (either mechanical or solid state) are often needed on the input power lines to prevent failures from propagating to the power bus.

Reverse Polarity Protection: This function is often desired to prevent damage to the assembly during evaluation and test. Protection against damage caused by reverse polarity is normally never needed for the actual application with the exception of vehicles.

Input Hold Up: The assembly can provide energy storage which allows power to be delivered for a certain time even if input power sags or is interrupted. This function often requires reverse polarity protection to prevent the stored energy from feeding the interrupted power line.

Additional Input Filtering: When using several converters in an assembly, the input EMI emissions can add algebraically if they are synchronized. Therefore, in an assembly of multiple hybrid DC/DC Converters, it is often desirable to add supplemental input filtering to ensure that the overall assembly meets its EMI specifications. Care must be taken not to add too much impedance, since added impedance preceding a switching regulator may cause “Middlebrook” criteria type oscillation.

Additional Output Filtering: When ultra low output ripple is desired, additional filtering between the converters and the load can be added in an assembly. The desired frequency spectrum of the output determines the type of filter used.

Space Power Supplies

Figure 22: Power Converter using a combination of a hybrid module and outboard discrete components for fast lead time and low development cost. Unit shown is a 14 to 28 VDC converter with 90% efficiency at 40 Watts.

Spacecraft and satellites have self contained electrical power systems derived from batteries, photovoltaic arrays, fuel cells or radio-isotope generators. This power may be unconditioned, or may be conditioned to a regulated bus level, from which several to several hundred converters must efficiently convert the power for end users.

The principal issue facing space power supply applications is that extremely high MTBF must be achieved with quantities that are relatively low, compared to other power supply applications. The low quantities hamper learning curve (experience) driven improvements. The methodology evolved for the design and construction of space power supplies has overcome the constraint of low quantities.

Several tried and true techniques have been established to resolve this issue.

One important method is the use of "heritage" designs. These are designs and processes that have successfully flown on other spacecraft. To the extent that the new application provides the same environment as the heritage environment, there is a lot of validity to this approach. The disadvantage of this approach is that it is much less useful as the time span between the new requirement and the heritage application widens. The idea of using heritage attains its greatest benefit within just a few years after the heritage application. If the use of heritage based on designs one or two decades old occurs, the benefit becomes a detriment.

Preferred parts lists solely based on heritage may lag the present day by twenty to thirty years. Many of the components may be commercially obsolete, leading to lower reliability. The equipment becomes heavier and larger, leading to other design compromises. The manufacturing processes to make the piece parts accumulate change over the years, invisible to the activities maintaining the preferred parts list.

Another important technique to improve reliability is the separate qualification of piece parts. This may be performed on discrete parts as well as hybrid and chip elements. The piece parts are qualified to environmental levels much higher than they will experience within the completed assembly, giving a factor of safety to the designer. Designs sometimes are less reliable than they might be because some aspect affecting reliability has been overlooked. This can be avoided by complete review and scrutiny. This oversight requirement can be satisfied by the submission of complete and comprehensive drawing packages. This is also necessary to assure control of the configuration.

To supplement or as an adjunct to any overall testing program, various analyses should be performed. These analyses verify that all piece parts are properly applied and that the customer's overall expectations for reliability will be achieved.

Also, as part of an overall quality system, all manufacturing and design processes should be documented. Where necessary, such as soldering, all operators should be trained and certified.

Space applications tend to have environments that are unique to each application, in contrast to aircraft, shipboard, vehicle and fixed uses. Radiation effects including total dose and SEU depend on the orbit as well as time on orbit. Deep space applications have unique radiation requirements. Temperature cycles and extremes depend on the spacecraft's thermal control system as well as the location of the power supply.

Shock, vibration and pyrotechnic shocks also tend to be unique to the application.

Since space power supplies need to operate in a vacuum environment, all dissipative elements need

predictable paths to the thermal sink. This is sometimes overlooked by neophytes.

Most spacecraft applications contain optical and other systems that are affected by out gassing of volatile materials. Therefore, all materials must be categorized and selected for low out gassing.

Packaging Design Choices

Space Power Supplies can be fabricated with all discrete piece parts, fully in hybrid microcircuit form or a mixture of both. The mixed construction can also consist of a number of self contained hybrid DC/DC Converter modules in a housing. In determining which approach is best, both technical requirements as well as cost and schedule must be considered. Normally, a full hybrid approach is more expensive and takes longer to develop than a part hybrid or full discrete design. However, this applies to units that are essentially custom. When requirements can be derived from standard or previously developed designs, the cost and schedule picture can dramatically change for the better.

Full hybrid power supplies using thick film substrates, chip and wire semiconductor die and surface mount components contained within hermetic enclosures allows the ultimate in packaging density. The elimination of individual piece part packages also improves overall reliability. Resistors are screened and fired directly on the ceramic substrates, and are tailored in size for their exact wattages.

Figure 23: Eight-output converter with BIT showing part hybrid/part discrete modular construction.

The hermetic enclosure simplifies many environmental concerns and provides an excellent dormant storage life. The low mass of the chip components allows the full hybrid converters to withstand shock, vibration and acceleration that is considerably higher than tolerated by discrete units.

One drawback for full hybrid construction is that full MIL-STD-981 magnetic component construction is not possible due to size constraints. This includes the aspects relating to terminal design and encapsulation. However, most of the MIL-STD-981 requirements can be retained.

Full hybrid construction is best suited for output powers up to 120 watts at the present. Above this level, thermal considerations of the major dissipators (semiconductor die and magnetic components) make it more practical to use separate packages at higher power levels.

Figure 24: Six-output level 120 VDC input converter.

Above the optimum power level for full hybrid construction, it is advantageous to mix hybrid construction with discrete parts. Discrete construction also encompasses surface mount piece parts and techniques.

In this mixed construction, the low power, complex circuits are contained within the hybrid. The higher power and bulkier components are packaged separately. This gives good volumetric efficiency and allows better thermal paths for the higher power dissipators.

Mixed hybrid and discrete construction is best suited for power levels from 50 watts to 1000 watts. This is the most compact construction that can offer full MIL-STD-981 magnetic components. In addition, the mixed construction allows mechanical provisions for EMI

filtering, such as EMI plenums, making EMI filtering easier to implement than in full hybrids.

An advantageous variation of the part hybrid/part discrete approach is to combine a number of complete hybrid DC/DC Converters in an assembly, which can also include some small amount of discrete circuitry. This building block technique allows rapid development of complex units at a minimal cost.

Full discrete construction is suited best for high power applications as well as full custom applications that must be implemented with out dated preferred parts lists. In a high power situation, the size and weight savings produced by the low level hybrid microcircuits are not significant. Full discrete construction is applicable from several hundred watts to the kilowatt range.

One of the most important aspects of selecting a construction method is not technical, but depends on factors that are intangible. Inherent in the conservative structure surrounding many space requirements is the strong resistance to change.

Many recent programs are mandated to be “better, faster, cheaper,” and attitudes toward using more modern packaging design are gravitating toward full hybrid and part hybrid designs as the power level permits.

Construction Techniques

In fabricating space power supplies, great reliance is placed on documenting detailed procedures for all manufacturing operations, as well as training and certification of all operators. Quality requirements such as NHB-5300 and ISO 9001:2000 mandate procedures for all manufacturing operations.

The purpose of the procedures is to allow review of the operation, consistency in its application and as a criteria for training.

For a typical hybrid manufacturer approximately 40 procedures may be required. For magnetic component manufacture, approximately 20 procedures may be required. For discrete assembly, approximately 30 procedures may be required. The hybrid procedures are written around MIL-PRF-38534, the magnetic procedures around MIL-STD-981 and the discrete assembly procedures are based on NHB-5300.

The operators performing these procedures are trained (in accordance with a training procedure), tested on their knowledge and ability to perform the procedure, then are certified for that procedure. Outside agencies have cognizance of the certification of procedures as well as instructors, which is renewed at periodic intervals.

The intent of generating all these procedures and methods is that nothing be left to chance or to interpretation. This overcomes part of the learning curve that would otherwise occur with a small unit quantity.

Piece Part Selection and Qualification

One of the distinguishing features of space power supplies is the care with which piece parts are selected.

Various preferred parts lists (PPL’s) exist, many derived from MIL-STD-975. The advantage of using parts from these lists is that they represent mature parts with considerable heritage. The disadvantage of these lists is that the piece part and packaging technology is from ten to twenty years old. This produces units that are larger, heavier and less competitive than more current practice.

A phenomenon that must be unique to the space industry is often observed in designs based on PPL’s. This is circuit design based on unique combinations of minimum types of so called standard parts. It’s analogous to logic designs built entirely with NAND gates, or to linear circuits built entirely with NPN transistors.

The motivation for these types of designs is not only using parts on the PPL’s, but also the monetary costs for minimum lot costs of the parts.

Figure 25: Single-output 120 to 28 VDC converter

Very often, large excess amounts of space qualified piece parts have been purchased on earlier contracts, and the designers are mandated to use these parts until stock on hand is depleted. The resulting designs are very often non-competitive.

Competitive space power supplies will inevitably use some quantity of what are termed "non-standard" parts. This may include parts that are military standard but not on the PPL, or parts that are custom, such as magnetics. For a full hybrid design, all chip components may be considered non-standard.

The typical procedure for using a non-standard part begins with the generation of a source or specification control drawing. This document not only specifies all the electrical and mechanical parameters of the part, but also defines the qualification and quality conformance requirements. When generated for chip components, these drawings may be called detailed device specifications. Qualification is the initial testing that qualifies the part to meet the requirements of the drawing, and usually includes environmental testing as well as electrical testing. Quality Conformance Inspection testing (also known as QCI) qualifies the particular lot of parts, and is usually done at periodic intervals. QCI normally has a smaller subset of tests than qualification testing, so is less expensive. QCI is also known as group A, B, C, D and E testing. Depending on the type of parts, the "group" testing may be just group A and B, or A through E. In the QCI process, one or more units are destroyed, adding additional expense. There are various strategies for reducing QCI cost, which require the informed direction and approval of the customer.

The qualification process for chip components is called element evaluation, and is performed in accordance with MIL-PRF-38534. This is also used for quality conformance inspection.

Magnetic components for space power supplies are almost invariably non-standard. The usual governing specification for magnetic components is MIL-STD-981, which builds on MIL-PRF-27 and related specifications. Like many other detailed parts specifications, MIL-STD-981 allows qualification (not QCI) by similarity, provided the "similar" part meets certain tests of "closeness" with the previously qualified parts. This permits cost savings in many instances.

After the piece parts have been documented, qualified and built, the parts may be subjected to a further screening known as Destructive Physical Analysis (DPA). DPA is a process wherein representative parts from a lot are dissected to verify construction meets detailed requirements. If the samples from the lot pass the DPA, the entire lot is accepted. If they fail, the entire lot is rejected or otherwise dispositioned. Many piece part specifications have specific DPA requirements. However, it is not unusual to impose other specifications, such as MIL-STD-1580, which have other DPA requirements. Sometimes, the specific requirements differ and a part that meets its detail requirement will not meet an overall DPA specification. Resolving these specification conflicts is a usual recurrence.

The economic and schedule result in requiring QCI and DPA's on discrete components often results in a full hybrid construction being less expensive and more readily available than discrete construction since element evaluation is a quicker process than QCI on many discrete items.

Documentation

Space Power Supplies require extensive documentation efforts for two general reasons. The first may be considered in the nature of design disclosure. This allows the customer to thoroughly review the design and construction prior to hardware fabrication, as well as to review results of testing prior to actual use. The second is to document all aspects of the unit to allow configuration control and to assure that the unit was built exactly as intended.

A comprehensive documentation program may be streamlined by drawing heavily on existing documentation. It is important to distinguish between customer review of existing documentation and customer review and approval of existing documentation. The former has modest cost impact as no drawings or procedures will be changed. The latter has greater possibility of cost impact since changes are usually inherent in the approval.

Drawing packages are generated to DoD-STD-1000 guidelines. There are three levels of drawing packages in this document, Level 1, 2 or 3. Level 1 is an engineering drawing package, and is intended for the purposes of design disclosure. This level of drawing may be inadequate for this purpose when depicting space power supplies.

Levels 2 and 3 are suitable for use to document configuration control, as differentiated from design disclosure packages. Level 3 is the most comprehensive, and theoretically gives sufficient information for re-procurement if necessary.

The types of drawings contained in a Level 2 or Level 3 package follow a hierarchy, starting with the outline/installation drawing, next the top assembly

drawing, then the lower level assemblies. This is followed by detailed fabrication drawings. When components are purchased, the drawing package includes source and spec. control drawings. These are supplemented by schematics, block diagrams, manufacturing procedures, etc. Very often, due to schedule requirements, there will be more than one configuration supplied. In that even, “as built” drawings are provided, depicting specific configurations.

Many of the parts will be covered by specification control drawings or source control drawings. The former type is used when the requirements are not highly critical and source qualification is not deemed mandatory. The latter restricts procurement of the part from approved sources. Source control drawings usually list requirements which must be satisfied to qualify a part.

In practice, source control drawings are frequently preferred over specification control drawings when the specifier is aware of undefinable parameters that are important or that only one acceptable source exists. Another reason for source control drawings may be that the specifier knows the recommended source has unique test equipment or capabilities not available elsewhere.

Schematics and block diagrams are used as tools for design reviews and later analysis. With space power supplies, if any repairs or modification is required, only the original source should be entrusted with this work, so schematics and block diagrams are not needed as submittals for customer maintenance.

Block diagrams and schematics are also useful in conjunction with theories of operation, which describe how a unit operates.

Plans, procedures and reports are another important area for documentation. These documents control the testing of space power supplies.

Test plans are an important part of any test program. It is not correct to assume that specifications covering environmental or EMI testing are in themselves sufficient for conducting tests. What is missing is the mechanical configurations, electrical connections, ambient conditions and pass/fail criteria. These elements must be reviewed by the test activity as well as the customer prior to conducting the tests. The test plan is the vehicle that describes the missing information prior to test execution.

When the test plan is approved by the customer, a test procedure is generated, covering the actual testing. This embodies the elements of the test plan. The test procedure describes the testing in greater detail, listing the equipment or facilities to be used as well as the sequence of testing.

Following the actual testing, a test report is generated. This describes the test results, and is often accompanied by photographs. If any anomalies have occurred during testing, this is noted in the report.

Analysis

Although many aspects of the space power supply’s design are best characterized by testing, some areas also demand substantiation by analysis, which establishes the design margins.

In the development of a space power supply, the most frequently required analyses are circuit (SPICE), electrical stress, thermal, derating, worse case, MTBF, FMECA, EMI, environmental and radiation effects.

There is a hierarchy to these analyses, and just like in college courses, many have prerequisites.

The fundamental analysis is the circuit analysis, which usually employs a form of SPICE Modeling. The SPICE Model establishes the operating points and provides a sound analytical framework for later work. For a power supply, the SPICE Model gives data on the stability of the closed loop.

Using the SPICE Model to confirm operating points over a range of conditions, the worse case electrical stress for each part can be computed. Many parts have several parameters which must be assessed. For example, for a capacitor, working voltage as well as ripple current must be determined. For a resistor, it is power rating as well as maximum current or voltage. For diodes, it may be reverse voltage, reverse current, forward current and AC effects. The electrical stress information for all of the parts feeds into the thermal, derating and worse case analyses.

For the thermal analysis, the power dissipation for each part is computed. The goal of the thermal analysis is to determine how hot each component gets and verify that the computed temperatures meet design requirements. Since space power supplies are required to operate in vacuum conditions, heat removal is limited to conductive cooling and radiation. Practically, radiation is not significant.

One of the most useful tools for thermal analysis is the finite element analysis technique. This is represented by programs such as ALGOR FEA. The method of analysis proceeds in the following sequence. All heat paths are characterized. The physical construction is broken up

into infinitesimal elements and the heat flow is computed by matrix manipulation. The resulting output of these programs is a node listing which can be portrayed as isothermic lines. This allows the hot spot temperatures to be readily seen.

If a component exceeds its required temperature, the thermal design can be iterated and the analysis re-run.

The thermal analysis and electrical stress analysis feed into the derating analysis. Overall specifications, such as MIL-STD-975 and related specifications, impose derating limits for piece part application, many being temperature dependent. The derating analysis is usually in tabular form, comparing each piece part's rating with its stress level. Often a customer will only explicitly need the derating analysis, however, the SPICE Model, electrical stress and thermal analysis are all required for a meaningful input.

A worse case analysis may take the SPICE Model and vary the tolerances of the various components in a random way. This is also called Monte Carlo analysis. Or, the drift of component tolerances may be assessed for an End of Life analysis. This type of analysis predicts how the power supply will operate at the end of a long duration, for example a 30 year Space Station application.

MTBF (Mean Time Before Failure) analyses predict the failure rate of the space power supply. Using mostly experiential information and methods derived from MIL-HDB-217, and drawing on the temperature and electrical stress levels derived from earlier analyses, the failure rate may be computed. Computer programs to perform the computation are available. Simplified assessments using only the parts count are possible. However, they are not as precise as the actual stress method. Clearly, the electrical stress and thermal stress of the piece parts must be determined to accurately predict MTBF.

FMECA (Failure Modes Effects Criticality Analysis) is often required to be performed for a space power supply, as this allows more reliable units to be achieved. A knowledge of the functional operation as well as the failure rate of each piece part is needed to prepare a FMECA. Therefore, the MTBF and all subsidiary analyses are required for a FMECA.

EMI analyses are often required as an adjunct to testing. The benefit of an EMI analysis is that it may be performed before hardware is constructed, or may assess areas that may be difficult or costly to test. EMI analyses are often based on SPICE Models. Filter configurations may be readily modeled, as well as parasitic effects. This gives the designer a look ahead so that the design can anticipate and solve EMI problems before the (possible) long lead hardware is assembled.

Environmental analyses primarily consider the effects of mechanical inputs to the power supply, including vibration, shock and acceleration. These are most useful before actual hardware is built, although analysis may also help to fix inadequate mechanical designs. Finite element analysis techniques are mostly used, with the worst case elements modeled.

Radiation effects analyses consider the known effects of radiation on piece parts, such as the Vgs shift in power MOSFET's and the leakage current increases in semiconductors due to radiation induced defects. These analyses are based on the SPICE Model and the worse case analysis.

Testing

The purpose of a test program is risk mitigation. Unlike terrestrial power supply applications, environmental testing is performed in conjunction with analysis, not as an either/or situation. Testing alone may not reveal design margins or weak spots. Analysis alone may be flawed. Therefore, a balanced combination of analysis and testing is generally favored. The most significant tests are usually shock, vibration, thermal vacuum, EMI and radiation.

Most applications for space power supplies have a relatively benign shock and vibration environment on orbit, but a severe requirement during transportation and launch. Pyrotechnic shocks are normally the most challenging requirement for low mass units.

Thermal vacuum testing is another important area that cannot be confirmed without testing. Every heat dissipating component must have a reliable path of conductive heat removal. Many power supplies designed for non-space use neglect this necessity, and so fail when exposed to the hard vacuum environment of space.

EMI is another important area that varies widely from application to application. Because of the small capacity of most space electrical bus systems, there has been little standardization of bus specifications. This translates to a wide diversity of EMI requirements. Test plans, always important, assume an even greater importance in light of this diversity.

Radiation effects are normally tested on piece parts because of the great expense involved in testing complete units. The piece parts tested are those that are known from experience to be most susceptible to

radiation. In addition, since relatively few facilities can perform tests such as SEU resistance, long lead times and high costs for testing are common.

Successful testing programs characterize the equipment with minimal cost and schedule impact. One of the best ways found to facilitate this is to precede a formal qualification test program with an informal pre-qual program.

A pre-qual program is designed to hit the hot spots, or technical high risk areas of the development task, at an early stage in the program and at a modest cost. An assessment is made of the highest technical risk areas, and only those areas are tested. Test plans, procedures and reports are kept informal, which holds down costs. Source inspection is not invoked, streamlining the schedule. A pre-qual program can be performed with a brassboard, prototype or pre-production unit, and does not require flight level hardware.

A pre-qual program has two benefits. If it precedes a formal qual program, it gives early assurance of a satisfactory design. If testing shows that changes are necessary, changes can be made on non flight hardware, avoiding the high costs and long lead times of flight hardware.

The second benefit exists when the next higher assembly beyond the power supply will be subjected to formal qualification tests. In that event, the pre-qual program will give reasonable justification for combining the formal qualification test of the power supply with the testing of the next higher assembly.

Conclusion

Space Power Supplies cannot be practically repaired after deployment. Over the years, a body of knowledge has developed that offers guidance for producing highly reliable supplies. In the transition to smaller, faster and less expensive power supplies, it is important to use good judgment to wisely achieve these goals without fatally compromising the mission reliability.

Series 5080 Application Notes

The 5080 series are radiation hardened, non-isolated, synchronous switching regulators.

Non-isolated DC-DC converters are three terminal devices, having an input terminal, an output terminal and a common terminal.

Non isolated DC-DC converters may be described as “buck” converters, or as “boost” converters. Buck converters generate an output voltage that is lower than the input voltage, while boost converters generate a voltage that is higher than the input voltage. Converters that produce a negative output voltage are boost converters, since the magnitude of the input voltage plus output voltage is always greater than the input voltage.

In simplest form, the buck or boost converter uses a FET, a diode and an inductor. The buck and boost converters are topologically similar, but differ in grounding arrangements.

In order to obtain a higher power efficiency, the rectifying diode in the non-isolated DC-DC converter is replaced with a second FET. The forward voltage drop of the diode is usually higher than the drop across the second FET, therefore power losses are lower. The FET must be switched in synchronism with the waveform that would appear across the diode. Therefore, DC-DC converters that use a second FET to perform the action of the diode are called synchronous rectification devices.

Simplified Block Diagram

The block diagram of the Model 5080 shows that input power is applied to a power switch (see Figure 26). The switch is driven at a 100 kHz. rate by the pulse width modulator (PWM) circuit.

The switched waveform is then applied to the Buck/Boost choke. For the positive output models, the choke is connected between the power switch and the output load. For the negative output models, the choke is connected between the power switch and ground.

A second switch serves as the output rectifier. For the positive output models, the second switch is connected between the switch #1 output and ground. For the negative output models, the second switch is

connected between the switch #1 output and the negative output.

The ripple filtered output passes through a common mode inductor to reduce output spike voltages. The external damping capacitor is supplied by the user to optimize load application and load removal transients, as well as to lower the output ripple.

The output voltage is passed through the output sense circuit, which permits voltage sensing directly at the 5080's output pins for best static load regulation.

Input pins are provided for external sync (this can also be used for phase staggering of multiple 5080's), an inhibit pin and a voltage adjust pin. Output pins include a 5 VDC voltage reference (for output voltage adjustment), a BIT analog output and a current telemetry output (useful in paralleling multiple converters).

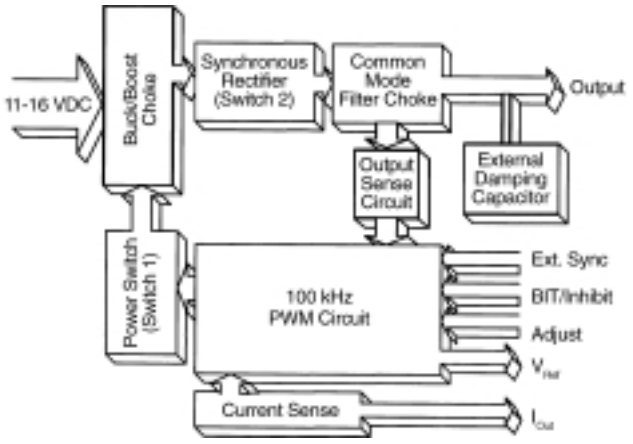


Figure 26: MDI 5080 Block Diagram

Input Voltage Source

The 5080 converters are intended to operate from an intermediate bus. This intermediate bus is a voltage of 11 to 16 VDC that is supplied by another, front end power converter. The front end power converter developing the intermediate bus is exposed to the bus variations and transients. Also, it is expected that the EMI filtering requirements of the system will be accommodated by the front end converter.

Therefore, the 5080 converters are rated strictly for the 11 to 16 VDC input range and also do not contain internal EMI filters.

Each fully loaded 5080 module can draw up to 1000 mA ripple current at its switching frequency of 100 kHz. Therefore, the front end DC-DC converter should provide appropriate decoupling capacitance to supply this maximum ripple current. A minimum decoupling capacitance of 30 microfarads (ceramic MLC or low ESR types) per 5080 module is recommended.

For most applications, an input voltage source that is nominally 12 VDC will provide the best electrical performance. A nominal 15 VDC source may also be used, however, the conversion efficiencies will be slightly lower.

Output Voltage

There are nine 5080 models that produce a positive output voltage and three models that produce a negative output voltage. Output voltage types and adjustment ranges are shown on the 5080 data sheet.

Output Current

Output current of the 5080 units is limited to 4 amperes or to the current produced at 10 watts output (considering the nominal output voltage), whichever is lower. The maximum output current is constant current limited.

External Output Capacitance

Due to the small size of the 5080, the internal output capacitance is limited in value to that necessary for high frequency filtering. For good load transient response, the 5080 data sheet shows a recommended minimum and maximum external capacitance that should be supplied by the user or present in the user's load. The use of low ESR types, such as multiple solid Tantalum chips in parallel is encouraged, as ripple voltage will also be reduced.

Use of Output "OR"ing Diodes

Although it is perfectly safe to connect the outputs of two like converters together, some applications require the use of separate external diodes when connecting two or more redundant diodes to the same point.

When ORing diodes are used, there is an additional voltage drop. On Model 5080 units, the output can usually be adjusted upwards to compensate for the drop in the external diode.

Output Voltage Temperature Coefficients

Voltage limits for Model 5080 parts shown in the MDI data sheets are the nominal 25°C values. At temperatures outside 25°C, the output voltage may vary ±100 PPM/°C maximum with base temperature.

Output Ripple

Due to its small size, the internal capacitance of the 5080 is limited. For good load removal and load application response, a minimum value of external capacitance is recommended.

When selecting external capacitors, low ESR solid tantalum capacitors are preferred. Capacitor leads with excessive series inductance should not be used, since this will add impedance and negate the benefit of the external capacitance. Relatively large amounts of external capacitance may be added, but do not exceed the data sheet guidelines without consulting MDI.

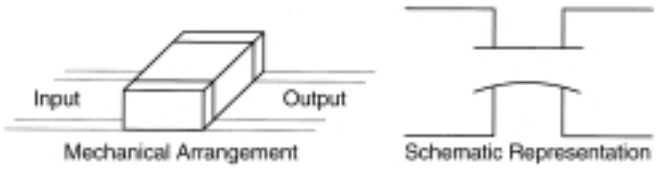


Figure 27: Four Terminal Capacitor Method for Improved Filtering

To reduce high frequency spikes, multilayer ceramic capacitors in surface mount chip form can be used. For best results, the capacitor should be connected as a four terminal device. An external series common mode inductor or ferrite beads can also be used between the converter and the capacitor.

Output Ripple vs Temperature

The fundamental output ripple of the 5080 converters is primarily dependent on the absolute capacitance value of the external output capacitors (when the output capacitors are multilayer ceramic types), or the ESR of the output capacitors (when the output capacitors are solid tantalum types). The selection of output capacitor depends on the output voltage and type of converter. However, the following effects occur at temperature. For units using ceramic output capacitors, the capacitance falls off sharply at high and low temperature extremes. Although the low ESR of ceramic capacitors results in very low ripple voltages, it is not unusual for ripple voltage to double at the high and low temperature extremes. For units using solid tantalum output capacitors, the ESR also rises sharply at low temperature extremes.

Therefore, users should conservatively assume a ripple temperature coefficient of 1% per °C increase over the 25°C base numbers.

Short Circuit and Overload Protection

Model 5080 DC/DC converters contain constant current limiting for protection against inadvertent output short circuits and overloads. The current limiting set point is approximately 125% of rated output current.

Output Over Voltage Protection

Model 5080 DC/DC converters do not contain any internal over voltage protection circuitry. If this function is required, it should be implemented externally by the user.

Output Load Transient Response

The output load removal and load application transient voltage is a function of the external capacitance and the magnitude of the current step. The following table lists the magnitude of the output voltage transient for a 25% to 75% rated load change, with the minimum recommended external capacitance.

Nom. V_{out}	Ext C (min.) μF	Z_{out} (ohms)	Delta V for 50% step	Ext C (max.) μF	Z_{out} (ohms)	Delta V 50% step
7.5	500	0.6146	0.4087	2000	0.3162	0.2103
5	500	0.302	0.302	2000	0.1577	0.1577
3.3	1000	0.2951	0.4426	4000	0.1119	0.1679
2.5	1000	0.1063	0.2127	4000	0.0557	0.1113
2	1000	0.1063	0.2127	4000	0.0557	0.1113
1.8	1000	0.1063	0.2127	4000	0.0557	0.1113
1.5	1000	0.1063	0.2127	4000	0.0557	0.1113
1.2	1000	0.1063	0.2127	4000	0.0557	0.1113
1	1000	0.1063	0.2127	4000	0.0557	0.1113
-3.3	1000	0.2951	0.4426	4000	0.1119	0.1679
-5	500	0.302	0.302	2000	0.1577	0.1577

Table 12: Magnitude of Output Voltage Transient Response

Back Voltage

A back voltage may be applied to the output of the DC/DC Converter, whether it be energized or de-energized. Up to 20% above the output voltage rating may be applied.

Pin Functions

Pin 1 Positive Input Power (internally paralleled with pins 2 and 3)
Pin 2 Positive Input Power (internally paralleled with pins 1 and 3)
Pin 3 Positive Input Power (internally paralleled with pins 1 and 2)
Pin 4 Input/Output Common (internally paralleled with pins 5 and 6)
Pin 5 Input/Output Common (internally paralleled with pins 4 and 6)
Pin 6 Input/Output Common (internally paralleled with pins 4 and 5)
Pin 7 Output (internally paralleled with pins 8 and 9)
Pin 8 Output (internally paralleled with pins 7 and 9)
Pin 9 Output (internally paralleled with pins 7 and 8)
Pin 10 Case Ground
Pin 11 No Connect
Pin 12 No Connect
Pin 13 V_{ref}: A nominal +5 VDC reference used for output voltage trimming
Pin 14 Adjust: Input pin used for voltage trimming and paralleling
Pin 15 I out: Signal proportional to output current, used for paralleling
Pin 16 Sync Input: Input pin used to accept external 100 kHz. sync signal
Pin 17 BIT: An analog output line indicating module status
Pin 18 Inhibit: Ground to inhibit converter

Voltage Reference (Pin 13)

The voltage reference pin is primarily used for downward voltage adjustment of the output. However, it may also be used for other applications. Up to 10 milliamperes may be drawn by the user. This current, if used, is ultimately drawn from the input voltage.

Output Voltage Adjustment (Pin 14)

The adjust pin function (pin 14) allows the user to set the 5080 output voltage slightly above or below it's initial set point. The recommended adjust range for each part type is listed in the data sheet.

When trimming for an increased output magnitude (of either polarity), the adjust resistor is connected to the common ground. When trimming for an decreased output magnitude (of either polarity), the adjust resistor is connected to the V ref pin (pin 13).

The adjust pin is connected to an internal 10K resistor, whose purpose is to prevent damage to the internal circuits and to reduce noise pickup.

The following table gives applicable resistor values for each 5080 type, as well as which equations to use to calculate the external adjust resistor value. For purposes of computing the external adjust resistor power dissipation, a maximum of 2.5 VDC appears across the external adjustment resistor.

If the external adjust feature is not used, both the adjust pin (14) and the V ref pin (13) should be left unconnected.

When the converter is adjusted upwards, the output power should be limited to 10 watts, or the output current should be limited to 4 amperes, whichever is lower.

V_{out}	R1	R2	R3	Equation for Upward Adjust	Equation for Downward Adjust
7.5	20K	10K	10K	Equations 1A and 3	Equations 2A and 3
5	10K	10K	10K	Equations 1A and 3	Equations 2A and 3
3.3	16K	50K	10K	Equations 1A and 3	Equations 2A and 3
2.5	10K	Infinity	10K	Equations 1A and 3	Equations 2A and 3
2	10K	50K	10K	Equations 1B and 3	Equations 2B and 3
1.8	10K	35.7K	10K	Equations 1B and 3	Equations 2B and 3
1.5	10K	25K	10K	Equations 1B and 3	Equations 2B and 3
1.2	10K	19.23K	10K	Equations 1B and 3	Equations 2B and 3
1	10K	16.67K	10K	Equations 1B and 3	Equations 2B and 3
-3.3	16K	50K	10K	Equations 1A and 3	Equations 2A and 3
-5	10K	10K	10K	Equations 1A and 3	Equations 2A and 3

Table 13: 5080 Resistor Values

Equation 1(a) $$\frac{V_{Adj} - 2.5}{R_1} = \frac{2.5}{R_1} + \frac{2.5}{R_4}$$

Equation 1(b) $$\frac{2.5 - V_{Adj}}{R_1} = \frac{2.5}{R_2} - \frac{2.5}{R_4}$$

Equation 2(a) $$\frac{V_{Adj} - 2.5}{R_1} = \frac{2.5}{R_2} + \frac{2.5}{R_4}$$

Equation 2(b) $$\frac{2.5 - V_{Adj}}{R_1} = \frac{2.5}{R_2} + \frac{2.5}{R_4}$$

Equation 3 $$R_3 = R_4 - 10k$$

Output Current (Pin 15)

An analog of the output current is provided in pin 15. This is useful in paralleling applications.

Nom. V_{out}	Vin = 12 VDC	Vin = 15 VDC
7.5	205	164
5	136	109
3.3	90	72
2.5	68	55
2	55	44
1.8	49	39
1.5	41	33
1.2	32	26
1	27	22
-3.3	90	72
-5	136	109

Table 14: Model 5080 Pin 15 millivolts per ampere scaling

Connecting 5080 Units in parallel for higher output current

The outputs of like converters may be connected in parallel without damage. However, they will not share the output load to any determinate extent without some external ballasting resistance or external circuitry. A suggested circuit for forcing current sharing of two or more 5080 DC/DC converters is shown. This circuit may be extended to multiple converters.

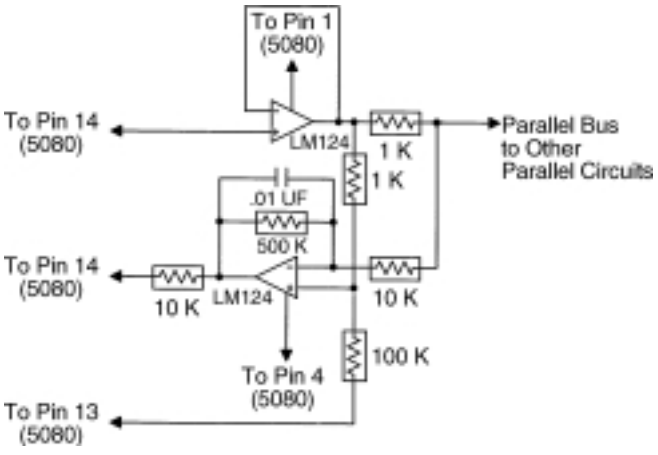


Figure 28: Active Parallel Circuit

Sync Input (Pin 16)

Pin 16 is the Sync Input. The 5080 hybrid operates at approximately 95 kHz and may be synchronized to frequencies from 95 to 105 kHz. The sync input pulse should meet the following levels as shown in the diagram. The sync input should sit at nominal 5 VDC and transition to ground level at a 10% ± 1% duty cycle. It should be noted that the internal oscillator runs at the switching frequency. Other frequencies are also available on special order. Contact MDI's Sales and Marketing Department for other sync frequencies.

Synchronizing the power conversion units within an extremely sensitive system ensures that any noise generation is coincident with the system clock.

If two or more 5080 units are used, a phase staggered sync signal may be applied in order to reduce the overall input and output ripple.

The "sync pin" should be left open if unused.

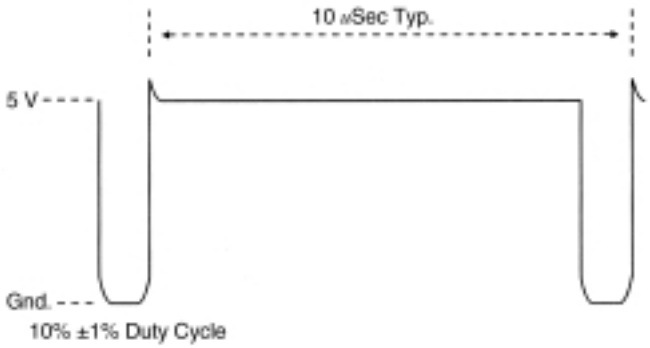


Figure 29: Typical Sync Waveform

BIT (Pin 17)

Pin17 is the BIT pin. The BIT signal is an analog signal which is the buffered output of the internal PWM error amplifier. The source impedance of the BIT line is approximately 50K ohms.

The normal voltage range of the BIT line is 0.9 VDC to 3.3 VDC. A voltage lower or higher than these values indicates that the internal regulating loop considers the output voltage to be too high or too low, respectively.

The BIT line may be connected to an external comparator window detector to produce a discrete BIT signal.

Inhibit (Pin 18)

Pin18 is the Inhibit pin. To inhibit the output voltage, the inhibit input should be returned to the common ground pins, within 0.5 VDC. When the inhibit pin is connected to the common ground, the inhibit current is approximately 1 milliampere.

An open collector transistor may be use to actuate the inhibit. However, the inhibit pins may be safely

connected to any positive voltage up to 16 VDC. Therefore, the inhibit pins may also be safely driven by standard 3.3 or 5 VDC logic devices.

When not inhibited, pin 18 should either be floating or returned to a voltage higher than 3.3 VDC.

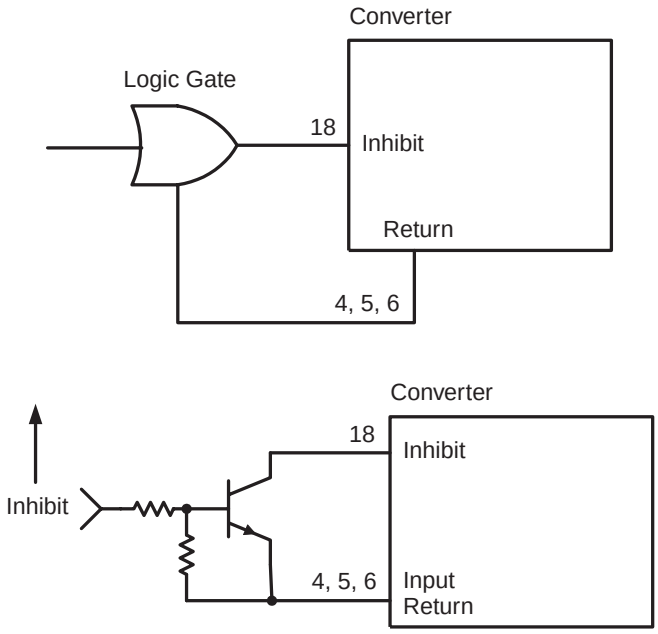


Figure 30: Inhibit Circuits / Preferred Circuit Interface for Inhibit

9006

5080 Heat Removal and Mounting Recommendations

The Model 5080 Hybrid DC/DC Converters are power supplies that are fabricated with bare die as compared to using packaged parts. Elimination of the intermediate packages allows the size of the 5080 DC/DC Converter to be dramatically reduced. All internal parts are mounted on ceramic substrates that are well attached to the baseplate of the package.

Heat can be transferred by conduction (heat flow through solid material), convection (heat flow through air movement) and radiation to a cooler surrounding. Model 5080 DC/DC Converters are designed to be cooled by conduction cooling from the baseplate, which is commonly known as heat sinking.

The maximum heat is dissipated by a 5080 DC/DC converter under full load normal operating conditions is 2.5 watts. Dissipation may increase when the part is short circuited or overloaded. The operating efficiency may drop when the part is lightly loaded compared to full load ratings.

The 5080 DC/DC Converters are rated for maximum baseplate temperature. It is the responsibility of the user to assure that the baseplate temperature of the converter does not exceed the rated value. The power dissipation of the elements is concentrated in a number of small areas. However, the thickness of the substrate and hybrid package do a good job of spreading the heat over the hybrid base plate area. In order to get the maximum benefit out of the hybrid, or maximum reliability, the surface on which the hybrid is mounted must be maintained at or below the hybrid's rated temperature. If the heat sink below the hybrid is very thin, the area under the DC/DC Converter's baseplate will be hotter than necessary. A thin heat sink may not conduct heat away from the hybrid very well. If the heat sink is very thick and connections to the DC/DC Converter's pins are difficult to wire, the heat sink may be locally counter bored in the vicinity of the pins.

Some Common Application Mistakes: See page 147

Custom Specifier

HYBRID DC–DC CONVERTERS

If our standard hybrid DC–DC converters don't meet your requirements, let Modular Devices design a custom part for you. Our large inventory of part designs and automated design techniques make this feasible and economical for many applications.

Consider these custom hybrid DC–DC converter possibilities:

- Different input voltage
- Different output voltage
- Multiple outputs
- Low power with high efficiency
- Unique packaging
- DC to AC inverters

9006

Condensed Specification Guide

Your application:

- ☐ Space
- ☐ Aerospace
- ☐ Military

Your requirements:

Output power _____ Watts

Case style _____

Operating temperature range _____°C to _____ °C

Input voltage range _____ volts to _____ volts

Output	No. 1	No. 2	No. 3	No. 4	No. 5
Voltage					
Maximum Current					
Minimum Current					
Line/Load/Temp Regulation					
Ripple mV_{pp}					

Desired Options:

- ☐ Radiation Hard, level: _____
- ☐ Proton Rad Hard, level: _____
- ☐ Military environment required
- ☐ MIL-STD-461 EMI
- ☐ Short circuit protection
- ☐ Overvoltage protection
- ☐ Inhibit function
- ☐ BIT
- ☐ Remote sensing
- ☐ Sync capability
- ☐ Reverse polarity protection
- ☐ Hold up
- ☐ Output voltage adjustability, specify output number and range:

  output number: _____

  from _____ VDC to _____ VDC

Name _____

Title _____ E-mail _____

Phone ( ) _____ Fax ( ) _____

Company _____

Address _____

City/State/Zip _____

Quantity Required _____ Date Needed: _____

Program Designation _____

For more information, contact us at:

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