RC4195

Fixed ±15V Dual Tracking Voltage Regulator

Features

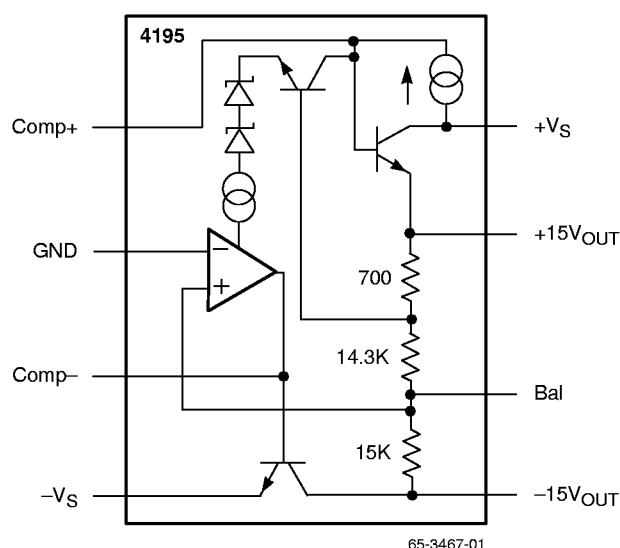* ±15V operational amplifier power at reduced cost and component density
* Thermal shutdown at T_J = +175°C in addition to short circuit protection

* Output currents to 100 mA
* May be used as single output regulator with up to +50V output
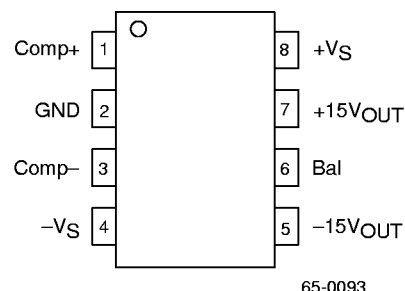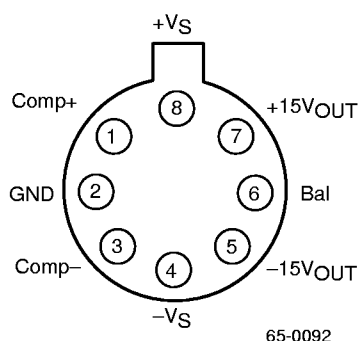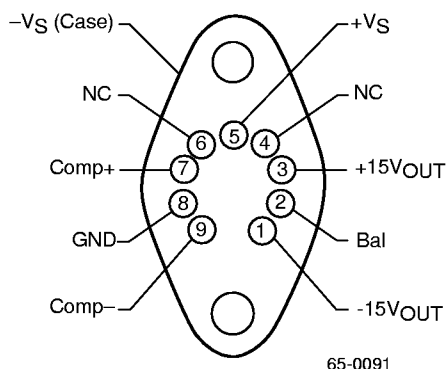* Available in TO-66, TO-99 and 8-lead mini-DIP

Description

The RM/RC4195 is a dual polarity tracking regulator designed to provide balanced positive and negative 15V output voltages at currents up to 100mA. This device is designed for local "on-card" regulation, eliminating distribution problems associated with single point regulation.
The regulator is intended for ease of application. Only two external components are required for operation (two 10 μF bypass capacitors).

The device is available in four package types to accommodate various applications requiring economy, high power, dissipation, and reduced component density.

Block Diagram

65-3467-01

Pin Assignments

65-0091

65-0092

65-0093

Absolute Maximum Ratings

(beyond which the device may be damaged)[1]

Parameter		Min	Typ	Max	Units
Supply Voltage ($\pm V_S$) to Ground				± 30	V
Load Current	PDIP/TO-99			150	mA
	TO-66			100	mA
$P_D T_A < 50°C$	PDIP			468	mW
	TO-99			658	mW
	TO-66			2381	mW
Junction Temperature	PDIP			125	°C
	TO-99			175	°C
	TO-66			150	°C
Storage Temperature		-65		150	°C
Operating Temperature (T_j)	RC4195	0		70	°C
	RM4195	-55		125	°C
Lead Soldering Temperature (60 sec)				300	°C
For $T_A > 50°C$ Derate at	PDIP		6.25		mW/°C
	TO-99		5.26		mW/°C
	TO-66		23.81		mW/°C

Note:

1. Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if Operating Conditions are not exceeded.

Operating Conditions

Parameter			Min	Typ	Max	Units
θ_{JC}	Thermal resistance	TO-99		50		°C/W
		TO-66		7		°C/W
θ_{JA}	Thermal resistance	PDIP		160		°C/W
		TO-99		190		°C/W
		TO-66		42		°C/W

Electrical Characteristics

(I_L = ±1mA; V_S = ±20V, C_L = 10μF; RM4195: -55°C ≤ T_j ≤ +125°C; RC4195: 0°C ≤ T_j ≤ +70°C unless otherwise specified)[1]

Parameters	Test Conditions	Min	Typ	Max	Units
Line Regulation	V_S = ±18V to ±30V		2	20	mV
Load Regulation	I_L = 1mA to 100mA		5	30	mV
Output Voltage Drift With Temperature			0.005	0.015	%/°C
Supply Current	V_S = ±30V, I_L = 0 mA		±1.5	±4.0	mA
Supply Voltage		±18		±30	V
Output Voltage	T_j = +25°C	14.5	15.0	15.5	V
Output Voltage Tracking			±50	±300	mV
Ripple Rejection	F = 120 Hz, T_A = +25°C		75		dB
Input-Output Voltage Differential	I_L = 50 mA	3.0			V
Short Circuit Current	T_j = +25°C		220		mA
Output Noise Voltage	T_j = +25°C, F = 100Hz to 120 kHz		60		μV$_{RMS}$
Internal Thermal Shutdown			175		°C

Note:

1. The specifications above apply for the given junction temperatures since pulse test conditions are used.
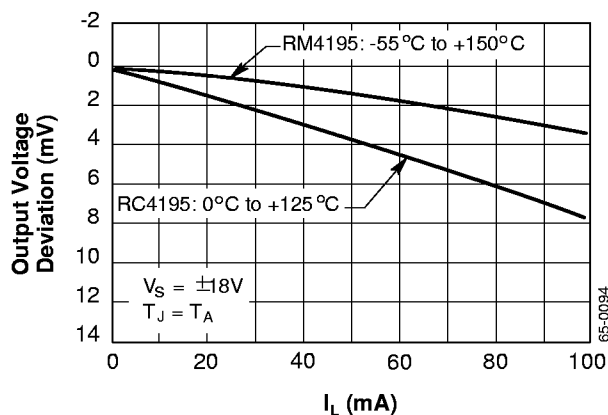
Typical Performance Characteristics
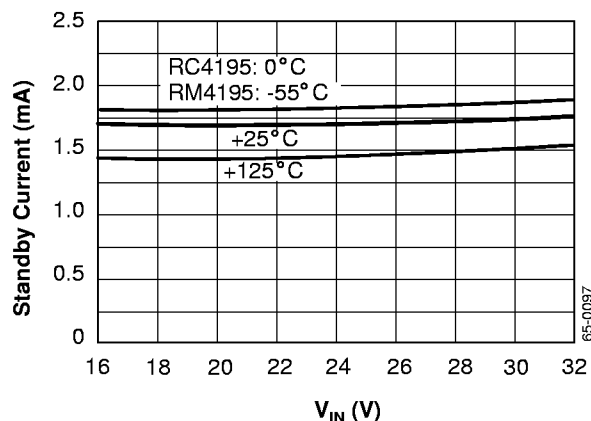

Figure 1. Output Load Regulation

Figure 2. Standby Current Drain

Figure 3. Regulator Dropout Voltage
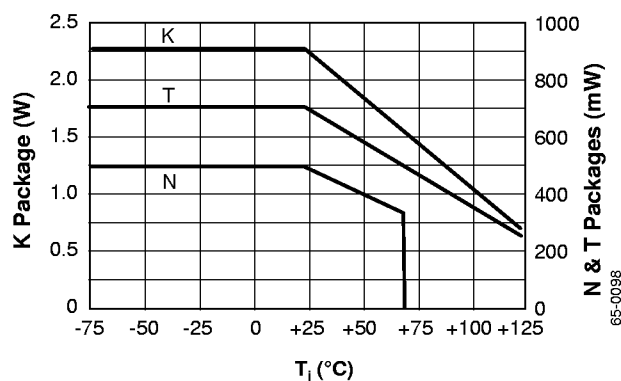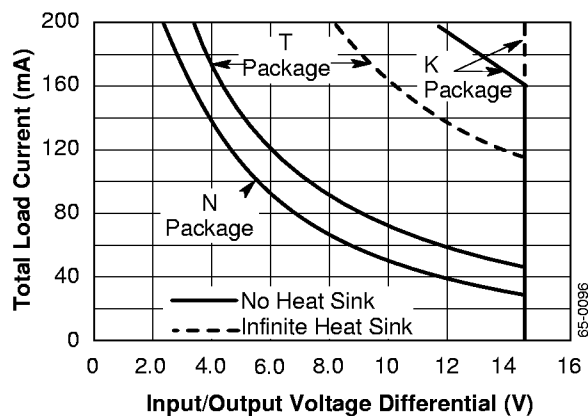

Figure 4. Power Dissipation

Figure 5. Maximum Current Capability

Figure 6. Ripple Rejection

Typical Applications

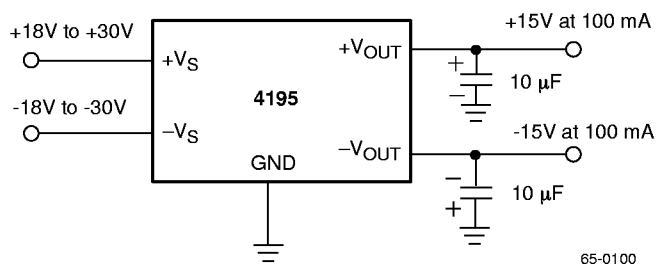**Figure 7. Balanced Output (V_{OUT} = ±15V)**

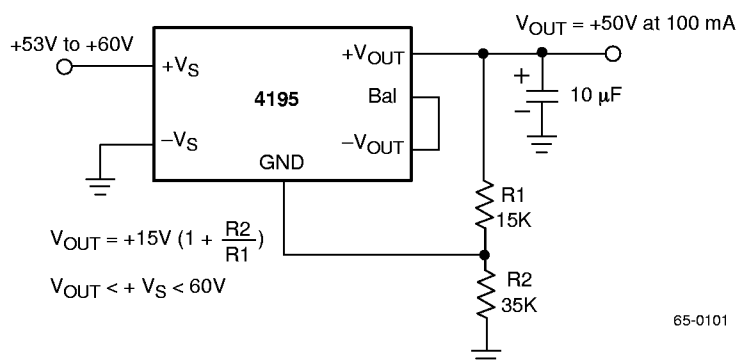$$V_{OUT} = +15V \left(1 + \frac{R2}{R1}\right)$$

$$V_{OUT} < + V_S < 60V$$

Figure 8. Positive Single Supply (+15V < V_{OUT} < +50V)

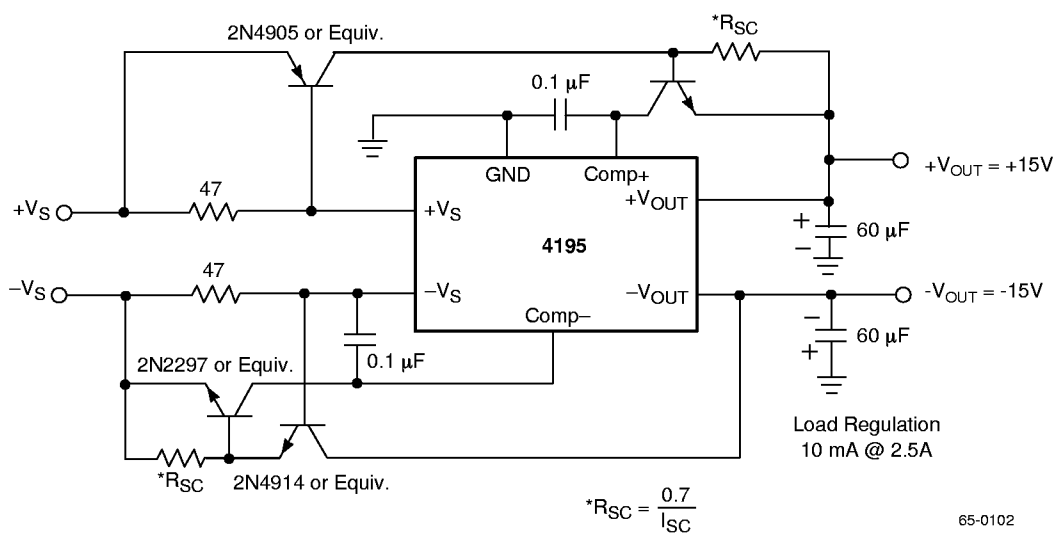$$*R_{SC} = \frac{0.7}{I_{SC}}$$

Figure 9. High Output Current

Brownout Protection

The RC4195 is one of the most easily applied and trouble-free monolithic ICs available. When used within the data sheet ratings (package power dissipation, maximum output current, minimum and maximum input voltages) it provides the most cost-effective source of regulated ±15V for powering linear ICs.

Sometimes occasions arise in which the RC4195 ratings must be exceeded. One example is the "brownout". During a brownout, line voltages may be reduced to as low as 75 V_{RMS}, causing the input voltage to the RC4195 to drop below the minimum dropout voltage. When this happens, the negative output voltage can go to positive. The maximum amount of current available is approximately 5 mA.

In general this is not enough current to damage most ICs which the RC4195 might be supplying, but it is a potentially destructive condition. Fortunately, it is easy to protect against. As shown in the typical application circuit, a diode, D, can be connected to the negative output.

If a small signal silicon diode is used, it will clamp the negative output voltage at about +0.55V. A Schottky barrier or germanium device would clamp the voltage at about +0.3V. Another cure which will keep the negative output negative all times is the 1 mΩ resistor connected between the +15V output and the Comp– terminal. this resistor will then supply drive to the negative output transistor, causing it to saturate to -1V during the brownout.

Heatsinking

When operating these devices near their extremes of load current, ambient temperature and input-output differential, consideration of package dissipation becomes important to avoid thermal shutdown at 175°C. The RC4195 has this feature to prevent damage to the device. It typically starts affecting load regulation approximately 2°C below 175°C. To avoid shutdown, some form of heatsinking should be used or one of the above operating conditions would need to be derated.*

The following is the basic equation for junction temperature:

$$T_J = T_A + P_D \theta_{J-A}$$

Equation 1

where

T_J = junction temperature (°C)

T_A = ambient air temperature (°C)

P_D = power dissipated by device (W)

θ_{J-A} = thermal resistance from junction to ambient air (°C/W)

The power dissipated by the voltage regulator can be detailed as follows:

$$P_D = (V_{IN} - V_{OUT}) \times I_O + V_{IN} \times I_Q$$

Equation 2

where

V_{IN} = input voltage

V_{OUT} = regulated output voltage

I_O = load current

I_Q = quiescent current drain

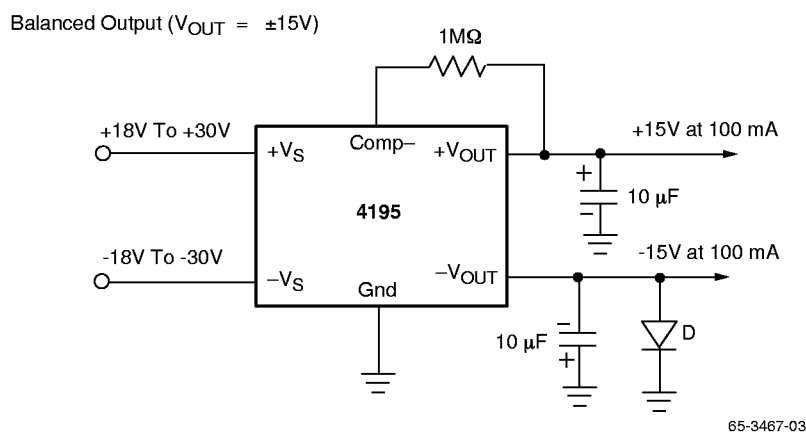Balanced Output (V_{OUT} = ±15V)

65-3467-03

Figure 10. Typical Application Circuit

*In allowing for process deviations, the user should work with a maximum allowable function temperature of 150°C.
**The current drain will increase by 50μA/V_{OUT} on positive side and 100μA/V_{OUT} on negative side

Let's look at an application where a user is trying to determine whether the RC4195 in a high temperature environment will need a heatsink.

Given:

T_J at thermal shutdown = 150°C

T_A = 125°C

$\theta_{J\text{-}A}$ = 41.6°C/W, K (TO-66) pkg.

V_{IN} = 40V

V_{OUT} = 30V

I_Q = 1 mA + 75 μA/V_{OUT} x 30V
    = 3.25 mA**

$$\theta_{J-A} = \frac{T_J - T_A}{P_D}$$

$$P_D = \frac{T_J - T_A}{\theta_{J-A}}$$

$$= (V_{IN} - V_{OUT}) \times I_O + V_{IN} \times I_Q$$

Solve for I_O,

$$I_O = \frac{T_J - T_A}{\theta_{J-A}(V_{IN} - V_{OUT})} - \frac{V_{IN} \times I_Q}{(V_{IN} - V_{OUT})}$$

$$I_O = \frac{150°C - 125°C}{41.6°C/W \times 10V} - \frac{40 \times 3.25 \times 10^{-3}}{10}$$

$$= 60 \text{ mA} - 13 \text{ mA} \sim 47 \text{ mA}$$

If this supply current does not provide at least a 10% margin under worst case load conditions, heatsinking should be employed. If reliability is of prime importance, the multiple regulator approach should be considered.

In Equation 1, $\theta_{J\text{-}A}$ can be broken into the following components:

$$\theta_{J\text{-}A} = \theta_{J\text{-}C} + \theta_{C\text{-}S} + \theta_{S\text{-}A}$$

where

$\theta_{J\text{-}C}$ = junction-to-case thermal resistance

$\theta_{C\text{-}S}$ = case-to-heatsink thermal resistance

$\theta_{S\text{-}A}$ = heatsink-to-ambient thermal resistance

In the above example, let's say that the user's load current is 200 mA and he wants to calculate the combined $\theta_{C\text{-}S}$ and $\theta_{S\text{-}A}$ he needs:

Given: I_O = 200 mA,

$$\theta_{J-A} = \frac{T_J - T_A}{(V_{IN} - V_{OUT}) \times I_O + V_{IN} \times I_Q}$$

$$= \frac{50°C - 125°C}{10V \times 200mA + 40 \times 3.25 \times 10^{-3}}$$

$$= 11.75°C/W$$

Given $\theta_{J\text{-}C}$ = 7.15°C/W for the 4194 in the K package,

$\theta_{C\text{-}S} + \theta_{S\text{-}A}$ = 11.75°C/W – 7.15°C/W

        = 4.6°C/W

When using heatsink compound with a metal-to-metal interface, a typical $\theta_{C\text{-}S}$ = 0.5°C/W for the K package. The remaining $\theta_{S\text{-}A}$ of approximately 4°C/W is a large enough thermal resistance to be easily provided by a number of heatsinks currently available. Table 1 is a brief selection guide to heatsink manufacturers.

Table 1. Commercial Heatsink Selection Guide

No attempt has been made to provide a complete list of all heatsink manufacturers. This list is only representative.

θ_{S-A}* (°C/W)	Manufacturer/Series or Part Number
	TO-66 Package
0.31 – 1.0	Thermalloy — 6441, 6443, 6450, 6470, 6560, 6590, 6660, 6690
1.0 – 3.0	Wakefield — 641
	Thermalloy — 6123, 6135, 6169, 6306, 6401, 6403, 6421, 6423, 6427, 6442, 6463, 6500
3.0 – 5.0	Wakefield — 621, 623
	Thermalloy — 6606, 6129, 6141, 6303
	IERC — HP
	Staver — V3-3-2
5.0 – 7.0	Wakefield — 690
	Thermalloy — 6002, 6003, 6004, 6005, 6052, 6053, 6054, 6176, 6301
	IERC — LB
	Staver— V3-5-2
7.0 – 10.0	Wakefield — 672
	Thermalloy — 6001, 6016, 6051, 6105, 6601
	IERC — LA, uP
	Staver — V1-3, V1-5, V3-3, V3-5, V3-7
10.0 – 25.0	Thermalloy — 6-13, 6014, 6015, 6103, 6104, 6105, 6117
	TO-99 Package
12.0 – 20.0	Wakefield — 260
	Thermalloy — 1101, 1103
	Staver — V3A-5
20.0 – 30.0	Wakefield — 209
	Thermalloy — 1116, 1121, 1123, 1130, 1131, 1132, 2227, 3005
	IERC — LP
	Staver — F5-5
3.0 – 50.0	Wakefield — 207
	Thermalloy — 2212, 2215, 225, 2228, 2259, 2263, 2264
	Dual In-line Package
20	Thermalloy — 6007
30	Thermalloy — 6010
32	Thermalloy — 6011
34	Thermalloy — 6012
45	IERC — LI
60	Wakefield — 650, 651

Staver Co., Inc.: 41-51 N Saxon Ave., Bay Shore, NY 11706

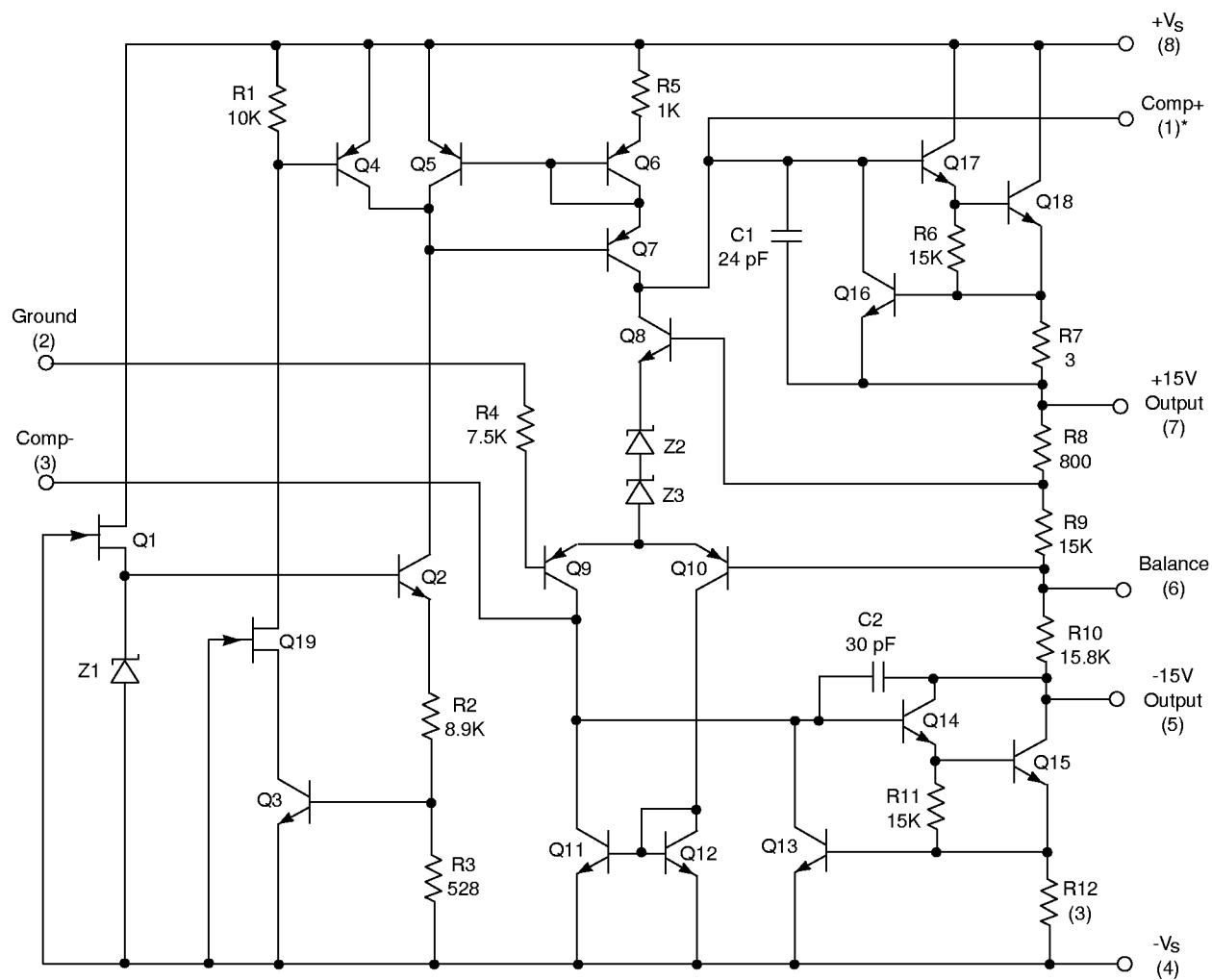IERC: 135 W Magnolia Blvd., Burbank, CA 91502

Thermalloy: P.O. Box 34829, 2021 W Valley View Ln., Dallas, TX

Wakefield Engin Ind: Wakefield, MA 01880

* All values are typical as given by manufacturer or as determined from characteristic curves supplied by manufacturer.

Simplified Schematic Diagram

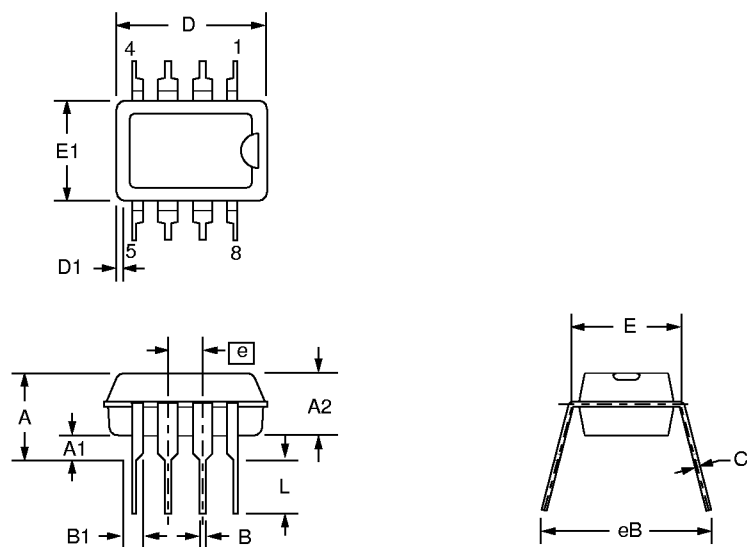

*Pin numbers are for 8-pin packages.   65-0090

Mechanical Dimensions

8-Lead Plastic DIP Package

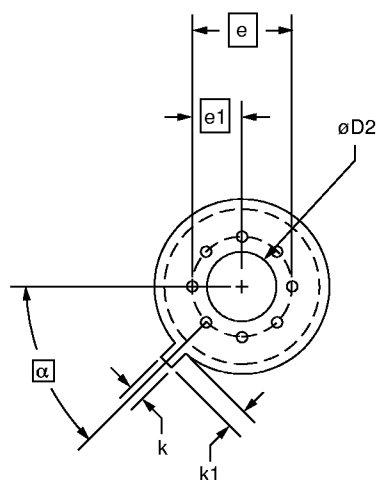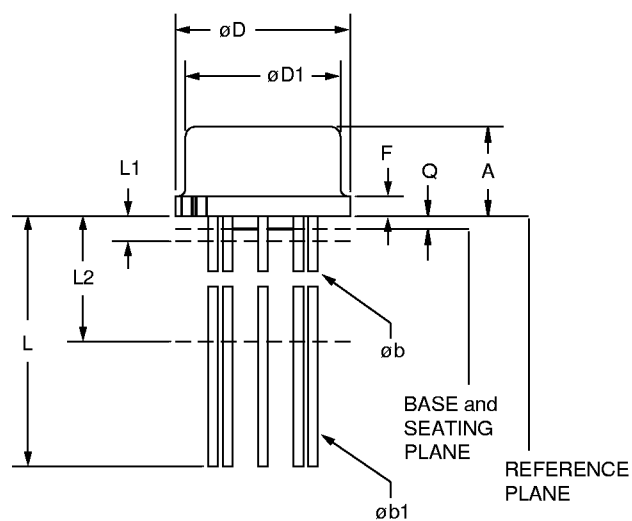| Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	—	.210	—	5.33	
A1	.015	—	.38	—	
A2	.115	.195	2.93	4.95	
B	.014	.022	.36	.56	
B1	.045	.070	1.14	1.78	
C	.008	.015	.20	.38	4
D	.348	.430	8.84	10.92	2
D1	.005	—	.13	—	
E	.300	.325	7.62	8.26	
E1	.240	.280	6.10	7.11	2
e	.100 BSC		2.54 BSC		
eB	—	.430	—	10.92	
L	.115	.160	2.92	4.06	
N	8°		8°		5

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. "D" and "E1" do not include mold flashing. Mold flash or protrusions shall not exceed .010 inch (0.25mm).
3. Terminal numbers are for reference only.
4. "C" dimension does not include solder finish thickness.
5. Symbol "N" is the maximum number of terminals.

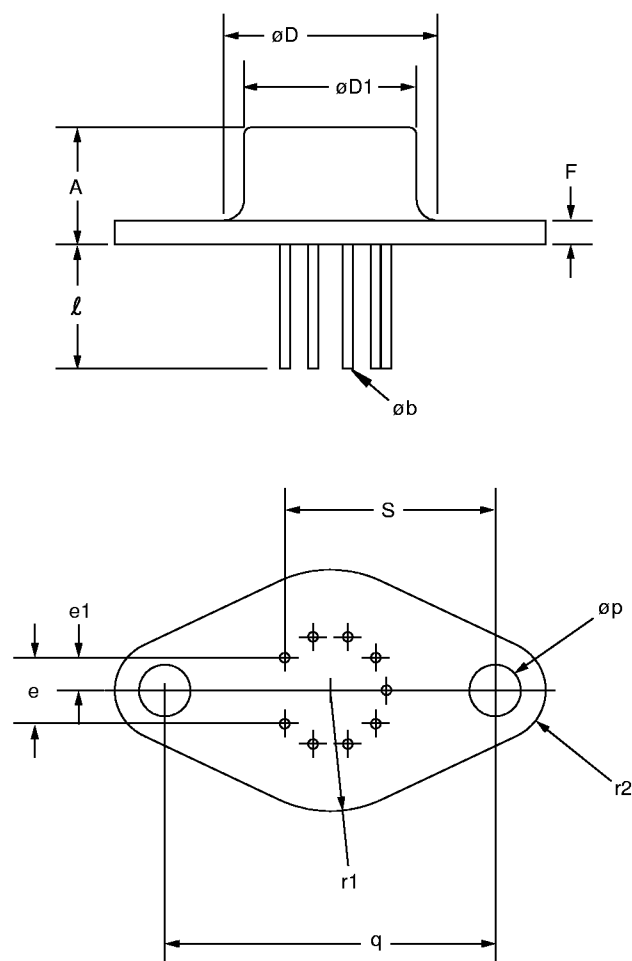# Mechanical Dimensions (continued)

8-Lead Metal Can IC Header Package

Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.165	.185	4.19	4.70	
øb	.016	.019	.41	.48	1, 5
øb1	.016	.021	.41	.53	1, 5
øD	.335	.375	8.51	9.52	
øD1	.305	.335	7.75	8.51	
øD2	.110	.160	2.79	4.06	
e	.200 BSC		5.08 BSC		
e1	.100 BSC		2.54 BSC		
F	—	.040	—	1.02	
k	.027	.034	.69	.86	
k1	.027	.045	.69	1.14	2
L	.500	.750	12.70	19.05	1
L1	—	.050	—	1.27	1
L2	.250	—	6.35	—	1
Q	.010	.045	.25	1.14	
α	45° BSC		45° BSC		

Notes:

1. (All leads) øb applies between L1 & L2. øb1 applies between L2 & .500 (12.70mm) from the reference plane. Diameter is uncontrolled in L1 & beyond .500 (12.70mm) from the reference plane.

2. Measured from the maximum diameter of the product.

3. Leads having a maximum diameter .019 (.48mm) measured in gauging plane, .054 (1.37mm) +.001 (.03mm) −.000 (.00mm) below the reference plane of the product shall be within .007 (.18mm) of their true position relative to a maximum width tab.

4. The product may be measured by direct methods or by gauge.

5. All leads – increase maximum limit by .003 (.08mm) when lead finish is applied.

Mechanical Dimensions (continued)

9-Lead Metal Can IC Header Package

Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.250	.340	6.35	8.64	
øb	.028	.034	.71	.86	1
øD	—	.620	—	15.75	
øD1	.470	.500	11.94	12.70	
e	.190	.210	4.83	5.33	
e1	.093	.107	2.36	2.72	
F	.050	.075	1.27	1.91	
ℓ	.360	—	9.14	—	
øp	.142	.152	3.61	3.86	
q	.958	.962	24.33	24.43	
r1	—	.350	—	8.89	
r2	—	.145	—	3.68	
S	.570	.590	14.48	14.99	

Notes:

1. All leads—increase maximum limit by .003 (.08mm) when lead finish is applied.

Ordering Information

Product Number	Temperature Range	Screening	Package
RC4195N	0° to +70°C	Commercial	8 Pin Plastic DIP
RC4195T	0° to +70°C	Commercial	8 Pin TO-99 Metal Can
RC4195K	0° to +70°C	Commercial	9 Pin TO-66 Metal Can
RM4195T	-55°C to +125°C	Commercial	8 Pin TO-99 Metal Can
RM4195T/883B	-55°C to +125°C	Military	8 Pin TO-99 Metal Can
RM4195K	-55°C to +125°C	Commercial	9 Pin TO-66 Metal Can

Note:

1. /883B suffix denotes MIL-STD-883, Par. 1.2.1 compliant device.