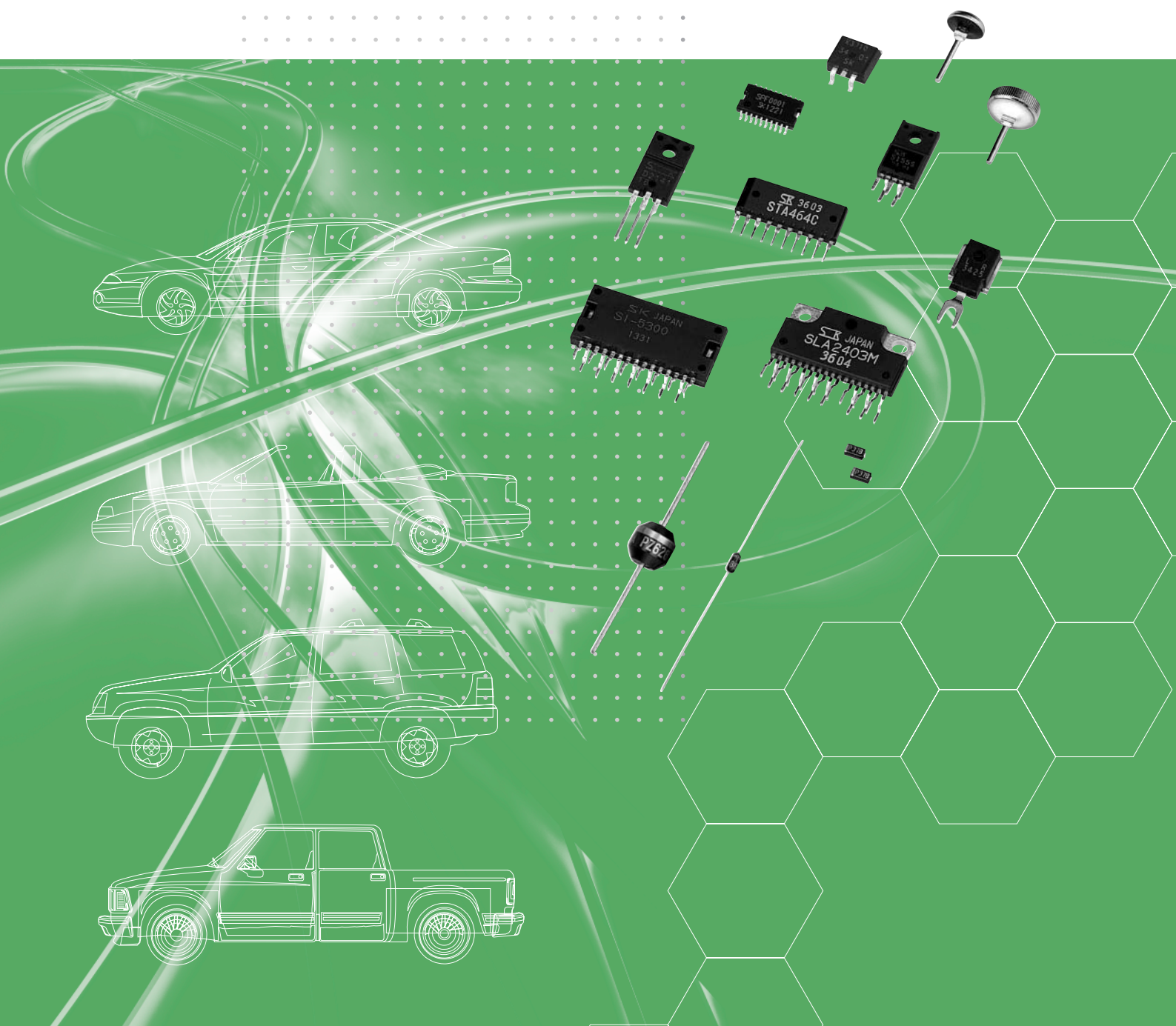


# DEVICES for AUTOMOTIVE



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# Examples of Use of Typical Products by Application

## Alternators

- **Diodes** (p.127)  
Solder and press fit type as well as Zener type is available.  
SG-9 / SG-10 / SG-14
- **Regulator ICs**  
Custom-made (contact our sales reps.)

## Throttle System

- **DC Motor Driver ICs** (p.60 and after)  
Control IC and full bridge power stage in a single package.  
Surface-mounting type series are also available.  
SI-5300 / SPF7301
- **Motor Driver Transistor Arrays** (p.99)  
H-bridge of NPN x 2 and PNP x 2 in a single package.  
With integrated back emf. clamp diode.  
SLA8004
- **Motor driver power transistors** (p.68 and after)  
With integrated back emf. clamp diode.  
2SA1568 / 2SC4065

## Fuel Injectors

- **Injector transistors** (p.84 and after)  
Transistors and MOS FETs are available in discretes and arrays in various packages.  
2SB1622 / 2SC4153 / 2SD2382 / MN611S / STA461C /  
STA463C / STA508A / SDC09 / SDK09 / SPF0001 / SSD103

## Headlamps

- **HID lamp driver ICs** (p.64 and after)  
High-voltage controller IC and 4-circuit power stage in a single package.  
Direct drive from CPU.  
SLA2402M / SLA2403M / SMA2409M
- **Thyristors for HID lamp ignition** (p.125 and after)  
Best suited to C-discharge SW element on high-voltage primary side of an igniter.  
Integrates a reverse direction diode.  
High di/dt resistance  
TFC561D / TFC562D
- **MOS FET arrays for driving HID lamps** (p.122)  
4 circuits of N-ch MOS FETs of 450V/7A in a single package.  
SMA5113
- **2-ph stepper-motor driver ICs for AFS** (p.58 and after)  
Low output saturation voltage, integrated recovery diode, surface-mount.  
SPF7211

## Ignition System

- **High-voltage diodes for ignition** (p.128)  
Withstand voltage range: 0.5 to 15kV  
SHV-01JN / SHV-05J / SHV-06JN
- **Ignition transistors** (p.89 and after)  
2SD2141 / MN638S
- **Ignition ICs**  
Custom-made (contact our sales reps.)

## Room Lamp

- Multi-chip LED modules (p.142)

## Car Navigation and Audio

- Various LEDs (p.133)

## Power Steering

- Motor driver MOS FETs (p.108 and after)  
Various packages integrating low ON resistors, bidirectional Zener diodes, etc.  
2SK3710 / 2SK3711 / 2SK3724 / 2SK3800 / 2SK3801 / 2SK3803 / 2SK3851

## Tail Lamps

- Power LED  
Custom-made  
(contact our sales reps.)

## O<sub>2</sub> sensor heater

- Heater driver MOS FETs (p.115)  
Low ON resistor and integral gate protection diode.  
FKV460S

## Transmission

- AT solenoid drivers (high-side power switch ICs) (p.26 and after)  
Integral diagnostic function, surface-mount, 2- and 3-circuit types and other diverse models.  
SI-5151S / SPF5003 / SPF5004 / SPF5007 / SLA2502M
- AT linear solenoid driver (high-side power switch ICs) (p.46 and after)  
Integral current detection resistor, current monitor output, surface-mount and 2-circuit types are also available.  
SPF5017 / SPF5018

## ABS and VDC

- Solenoid/motor driver MOS FETs (p.108 and after)  
Various packages from discretes to arrays.  
2SK3710 / FKV660S / SLA5027 / SDK08
- Solenoid/motor driver ICs (p.54)  
Surface-mount 4-circuit type with output voltage monitor.  
SPF5012



# 1 ICs

## 1-1. Regulator ICs

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## 1-5. Custom ICs .....



# Application Note for Regulator ICs

## ■ Temperature and Reliability

Reliability of an IC is generally heavily dependent on operating temperature. Heat radiation must be fully considered, and an ample margin should be given to the radiating area in designing heatsinks. When mounting ICs on heatsinks, always apply silicone grease and firmly tighten. Air convection should actively be used in actual heat dissipation. The reliability of capacitors and coils, the peripheral components, is also closely related to temperature. A high operating temperature may reduce the service life. Exceeding the allowable temperature may cause coils to be burned or capacitors to be damaged. Make sure that output smoothing coils and input/output capacitors do not exceed their allowable temperature limit in operation. We recommend, in particular, to provide an ample margin for the ratings of coils to minimize heat generation.

## ■ Power Dissipation ( $P_D$ )

### 1. Dropper Type

$$P_D = I_O \cdot [V_{IN}(\text{mean}) - V_O]$$

### 2. Switching Type

$$P_D = V_O \cdot I_O \left( \frac{100}{\eta_{\chi}} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

Efficiency  $\eta_{\chi}$  depends on input/output conditions.

Refer to the efficiency characteristics.

$V_O$ : Output voltage       $\eta_{\chi}$ : Efficiency

$V_{IN}$ : Input voltage       $V_F$ : Diode forward voltage

$I_O$ : Output current

## ■ Heatsink Design

The maximum junction temperature  $T_j(\text{max})$  and the maximum case temperature  $T_c(\text{max})$  given in the absolute maximum ratings are specific to each product type and must be strictly met. Thus, heatsink design must be performed in consideration of the condition of use which affects the maximum power dissipation  $P_D(\text{max})$  and the maximum ambient temperature  $T_a(\text{max})$ . To facilitate heatsink design, the relationship between these two parameters is presented in the  $T_a$ - $P_D$  characteristic graphs. Heatsink design must be performed in the following steps:

1. Obtain the maximum ambient temperature  $T_a(\text{max})$  (within the set).
2. Obtain the maximum power dissipation  $P_D(\text{max})$ .
3. Identify the intersection on the  $T_a$ - $P_D$  characteristic graph and obtain the size of the heatsink to be used.

The size of a heatsink has been obtained. In actual applications, a 10 to 20% derating factor is

generally used. Moreover, the heat dissipation capacity of a heatsink is heavily dependent on how it is mounted. It is therefore important and recommended to measure the heatsink and case temperature in actual operating environments.

## ■ Setting DC Input Voltage

Observe the following precautions when setting the DC input voltage:

- $V_{IN(\text{min})}$  must be at least the set output voltage plus dropout voltage for the dropper type. It must be at least the recommended lowest input voltage for the switching type.
- $V_{IN(\text{max})}$  must not exceed the DC input voltage of the electrical characteristics.

## ■ Screw Torque

Screw torque should be between 0.588 to 0.686 [N • m] (6.0 to 7.0 [kgf • cm]).

## ■ Recommended silicone grease

Volatile type silicone grease may produce cracks after elapse of long term, resulting in reducing heat radiation effect.

Silicone grease with low consistency (hard grease) may cause cracks in the mold resin when screwing the product to a heatsink.

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	GE Toshiba Silicones Co., Ltd.
SC102	Dow Corning Toray Silicone Co., Ltd.

## ■ Others

This product may not be connected in parallel. The switching type may not be used for current boosting and stepping up voltage.

## Dropper Type Regulator ICs [With Output ON/OFF Control] SI-3001S

## Features

- Output current of 1.0A
- 5-terminal type <output on/off control, variable output voltage (rise only)>
- Voltage accuracy of  $\pm 2\%$
- Low dropout voltage  $\leq 1V$  at  $I_O \leq 1.0A$ ,  $\leq 0.5V$  at  $I_O \leq 0.4A$
- Built-in overcurrent, overvoltage and thermal protection circuits
- Withstands external electromagnetic noises
- TO220 equivalent full-mold package

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
DC Input Voltage	$V_{IN}$	35	V	
Output Control Terminal Voltage	$V_C$	$V_{IN}$	V	
Output Current	$I_O$	1.0 *1	A	
Power Dissipation	$P_{D1}$	18	W	With infinite heatsink
	$P_{D2}$	1.5	W	Stand-alone without heatsink
Junction Temperature	$T_J$	- 40 to +125	°C	
Operating Temperature	$T_{OP}$	- 40 to +100	°C	
Storage Temperature	$T_{stg}$	- 40 to +125	°C	
Junction to Case Thermal Resistance	$\theta_{J-C}$	5.5	°C/W	
Junction to Ambient-Air Thermal Resistance	$\theta_{J-a}$	66.7	°C/W	Stand-alone without heatsink

## Electrical Characteristics

Electrical Characteristics

(T<sub>J</sub> = 25°C, V<sub>IN</sub> = 14V unless otherwise specified)

Parameter		Symbol	Ratings			Unit	Conditions
			min	typ	max		
Input Voltage		V <sub>IN</sub>	6 <sup>*2</sup>		30 <sup>*1</sup>	V	
Output Voltage		V <sub>O</sub>	4.90	5.00	5.10	V	V <sub>IN</sub> = 12 to 16V, I <sub>O</sub> = 0.4A
Dropout Voltage	V <sub>DIF</sub>				0.5	V	I <sub>O</sub> ≤ 0.4A
					1.0	V	I <sub>O</sub> ≤ 1.0A
Line Regulation		ΔV <sub>O LINE</sub>			30	mV	I <sub>O</sub> = 0.4A, V <sub>IN</sub> = 6 to 16V
Load Regulation		ΔV <sub>O LOAD</sub>			100	mV	I <sub>O</sub> = 0 to 0.4A
Output Voltage Temperature Coefficient		ΔV <sub>O</sub> /ΔT		±0.5		mV/°C	I <sub>O</sub> = 5mA, T <sub>a</sub> = -10 to +100°C
Ripple Rejection		R <sub>REJ</sub>		54		dB	f = 100 to 120Hz
Quiescent Circuit Current		I <sub>q</sub>		3	10	mA	I <sub>O</sub> = 0A
Overcurrent Protection Starting Current		I <sub>ST</sub>	1.2 <sup>*3</sup>			A	
V <sub>C</sub> Terminal	Control Voltage	Output ON	V <sub>C, IH</sub>	2.0 <sup>*4</sup>		V	
		Output OFF	V <sub>C, IL</sub>		0.8	V	
	Control Current	Output ON	I <sub>C, IH</sub>		20	μA	V <sub>C</sub> = 2.7V
		Output OFF	I <sub>C, IL</sub>		-0.3	mA	V <sub>C</sub> = 0.4V

Notes:

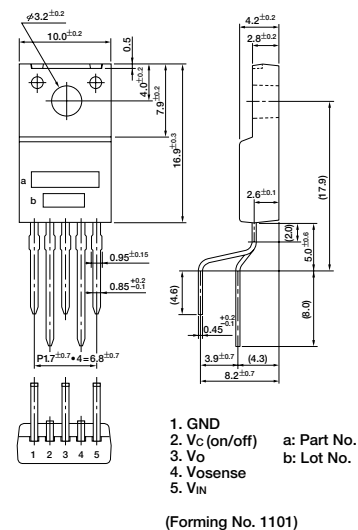
\*1. Since  $P_D(\max) = (V_{IN} - V_O) \cdot I_O = 18(W)$ ,  $V_{IN}(\max)$  and  $I_O(\max)$  may be limited depending on operating conditions. Refer to the Ta-P<sub>D</sub> curve to compute the corresponding values.

\*2. Refer to the dropout voltage.

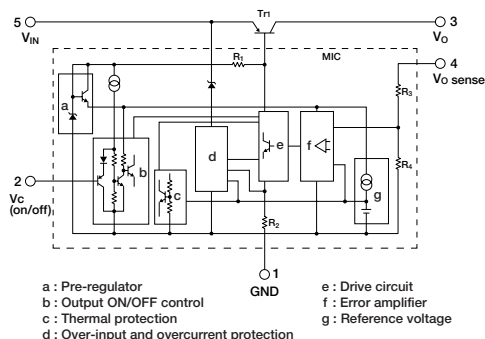
\*3.  $I_{S1}$  rating shall be the point at which the output voltage  $V_O$  ( $V_{IN} \equiv 14V$ ,  $I_O \equiv 0.4A$ ) drops to  $-5\%$ .

\*4. The output control terminal Vc is pulled up inside the IC. Each input level can be directly driven with LS-TTL ICs. Thus, LS-TTL direct driving is also possible.

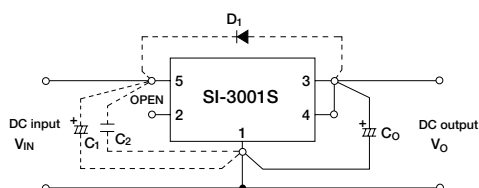
## External Dimensions (unit: mm)



## Equivalent Circuit Diagram



## Standard Circuit Diagram



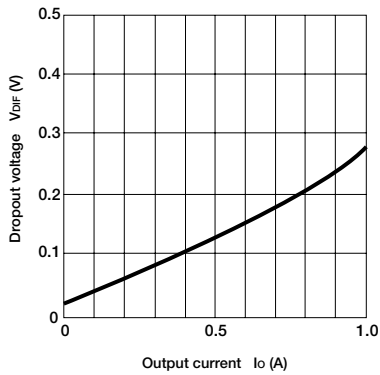
Co : Output capacitor (47 to 100 $\mu$ F, 50V)

**C<sub>1</sub>, C<sub>2</sub>:** Input capacitors (C<sub>1</sub>: approx. 47μF, C<sub>2</sub>: approx. 0.33μF).  
These are required for inductive input lines or long wiring.  
Tantalum capacitors are recommended for C<sub>1</sub> and C<sub>o</sub>,  
especially at low temperatures.

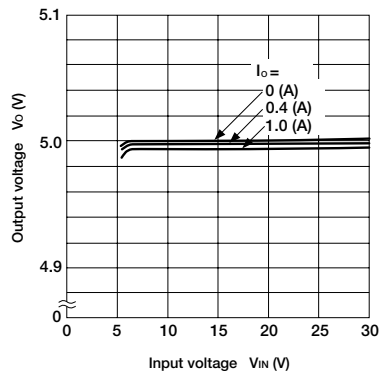
D1: Protection diode. Required as protection against reverse biasing between input and output.  
(Recommended diode: Sanken EU2Z.)

## Electrical Characteristics

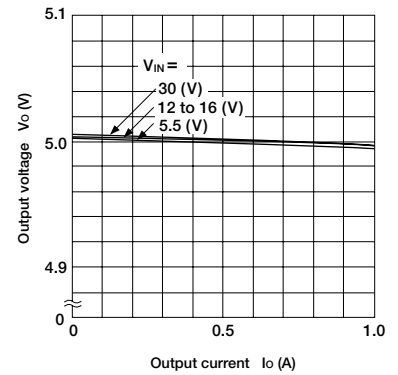
■  $I_O$  vs  $V_{DIF}$  Characteristics



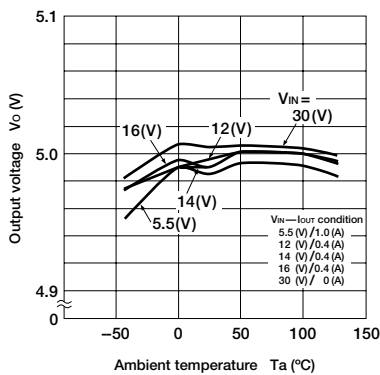
■ Line Regulation



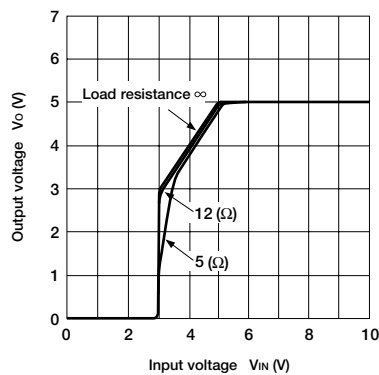
■ Load Regulation



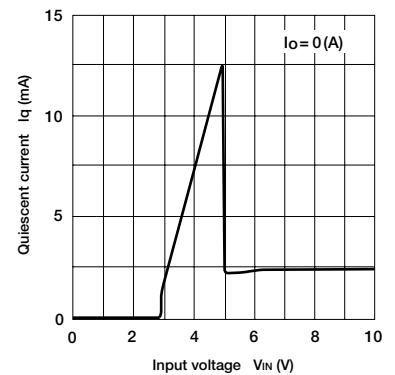
■ Output Voltage Temperature Characteristics



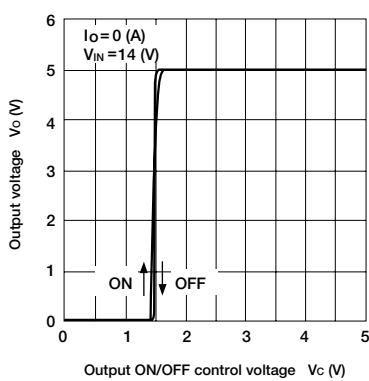
■ Rise Characteristics



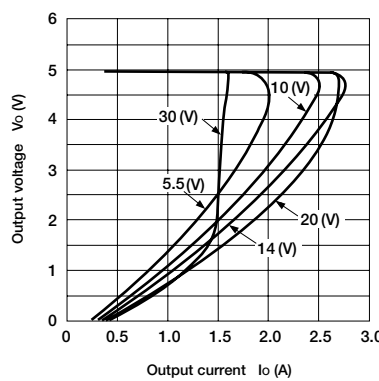
■ Quiescent Circuit Current



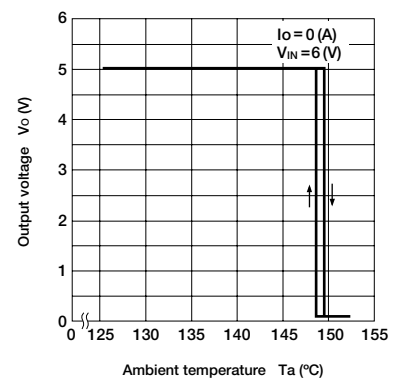
■ ON/OFF Control Characteristics



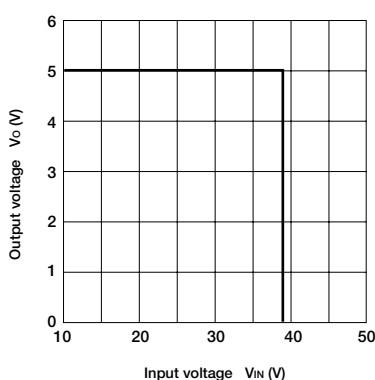
■ Overcurrent Protection Characteristics



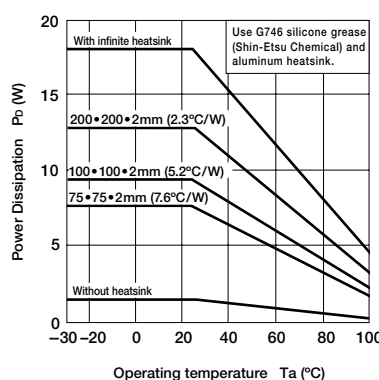
■ Thermal Protection Characteristics



■ Overvoltage Protection Characteristics



■  $T_a$ — $P_D$  Characteristics



**Note on Thermal Protection Characteristics:**  
The thermal protection circuit is intended for protection against heat during instantaneous short-circuiting. Its operation, including reliability, is not guaranteed for short-circuiting over an extended period of time.

# Dropper Type Regulator ICs [3-terminal] SI-3003S

## Features

- 3-terminal IC regulator with 0.8A output current
- Voltage accuracy of  $\pm 2\%$
- Low Dropout voltage  $\leq 0.5V$  at  $I_O \leq 0.5A$ ,  $\leq 1V$  at  $I_O \leq 0.8A$
- Built-in dropping type overcurrent, overvoltage and thermal protection circuits
- TO220 equivalent full-mold package

## Absolute Maximum Ratings

( $T_a = 25^\circ C$ )

Parameter	Symbol	Ratings	Unit	Conditions
DC input voltage	$V_{IN}$	35	V	
Output current	$I_O$	0.8 *2	A	
Power Dissipation	$P_{D1}$	22	W	With infinite heatsink
	$P_{D2}$	1.8	W	Stand-alone without heatsink
Junction temperature	$T_J$	-40 to +150	$^\circ C$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ C$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ C$	
Junction to case thermal resistance	$\theta_{j-c}$	5.5	$^\circ C/W$	
Junction to ambient-air thermal resistance	$\theta_{j-a}$	66.7	$^\circ C/W$	Stand-alone without heatsink

## Electrical Characteristics

( $T_J = 25^\circ C$ ,  $V_{IN} = 14V$ ,  $I_O = 0.5A$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Input voltage	$V_{IN}$	6 *2		30 *1	V	
Output voltage	$V_O$	4.90	5.00	5.10	V	
Dropout voltage	$V_{DIF}$			0.5	V	$I_O \leq 0.5A$
				1.0	V	$I_O \leq 0.8A$
Line regulation	$\Delta V_{O LINE}$			30	mV	$V_{IN} = 8$ to $16V$
Load regulation	$\Delta V_{O LOAD}$			100	mV	$I_O = 0$ to $0.5A$
Ripple rejection	$R_{REJ}$		54		dB	$f = 100$ to $120Hz$
Quiescent circuit current	$I_q$		3	10	mA	$I_O = 0A$
Overcurrent protection starting current	$I_{S1}$	0.9 *3			A	

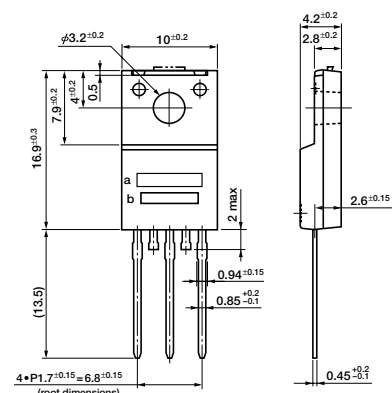
### Notes:

\*1. Since  $P_{D(max)} = (V_{IN} - V_O) \cdot I_O = 22(W)$ ,  $V_{IN(max)}$  and  $I_O(max)$  may be limited depending on operating conditions. Refer to the  $T_a - P_D$  curve to compute the corresponding values.

\*2. Refer to the dropout voltage.

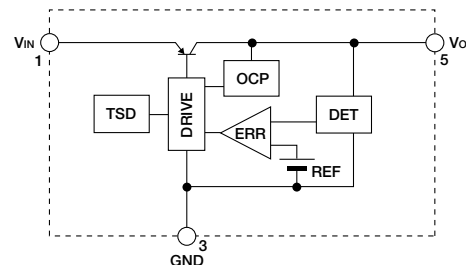
\*3.  $I_{S1}$  rating shall be the point at which the output voltage  $V_O$  ( $V_{IN} = 14V$ ,  $I_O = 0.5A$ ) drops to  $-5\%$ .

## External Dimensions (unit: mm)

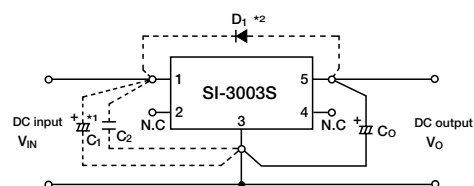


Terminal connections  
 1.  $V_{IN}$   
 2. (NC)  
 3. GND  
 4. (NC)  
 5.  $V_O$   
 a: Part No.  
 b: Lot No.  
 (Forming No. 1115)

## Equivalent Circuit Diagram



## Standard Circuit Diagram



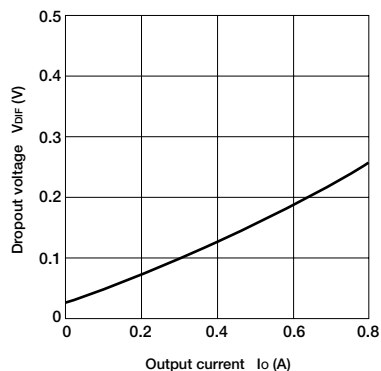
$C_O$ : Output capacitor (47 to  $100\mu F$ , 50V)

\*1  $C_1, C_2$ : Input capacitors ( $C_1$ : approx.  $47\mu F$ ,  $C_2$ : approx.  $0.33\mu F$ ). These are required for inductive input lines or long wiring. Tantalum capacitors are recommended for  $C_1$  and  $C_O$ , especially at low temperatures.

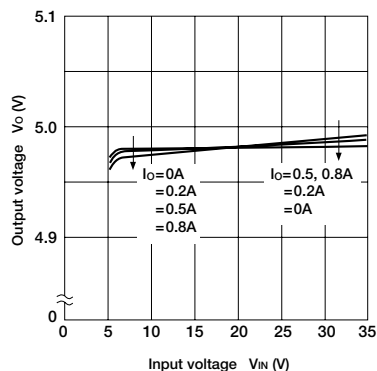
\*2  $D_1$ : Protection diode. Required as protection against reverse biasing between input and output.  
 (Recommended diode: Sanken EU2Z.)

## Electrical Characteristics

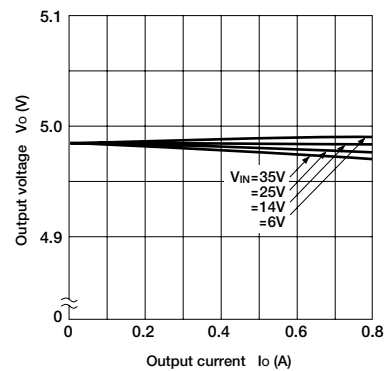
■  $I_O$  vs  $V_{DIF}$  Characteristics



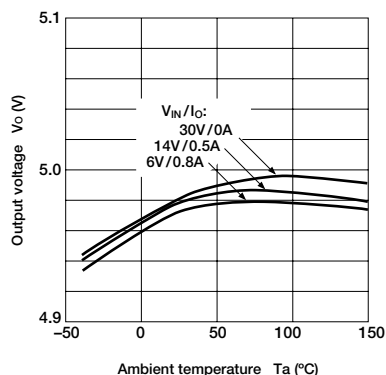
■ Line Regulation



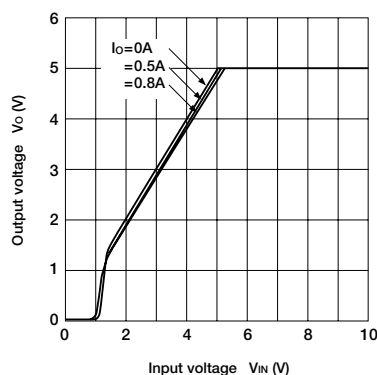
■ Load Regulation



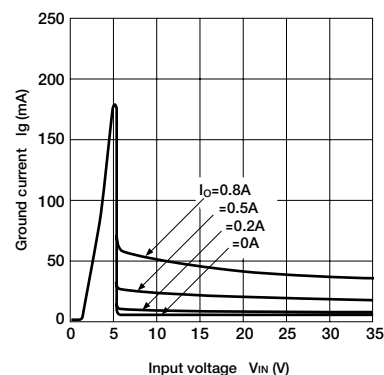
■ Output Voltage Temperature Characteristics



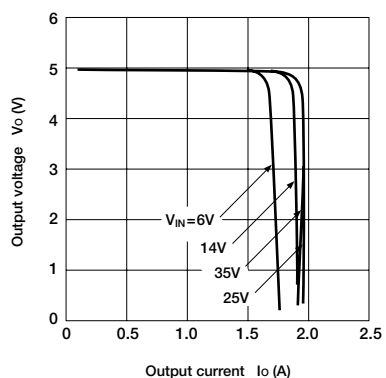
■ Rise Characteristics



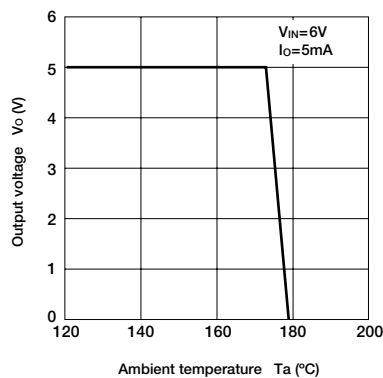
■ Circuit Current



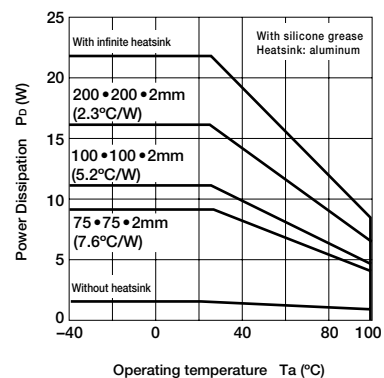
■ Overcurrent Protection Characteristics



■ Thermal Protection Characteristics



■  $T_a$ — $P_D$  Characteristics



**Note on Thermal Protection Characteristics:**  
The thermal protection circuit is intended for protection against heat during instantaneous short-circuiting. Its operation, including reliability, is not guaranteed for short-circuiting over an extended period of time.

# Dropper Type Regulator ICs [2-output] SI-3101S

## Features

- Single input dual output <sub output (5V/0.07A), main output (5V/0.4A)>
- Main output can be externally turned ON/OFF (with ignition switch, etc.)  
<most suitable as memory backup power supply>
- Low standby current ( $\leq 0.8\text{mA}$ )
- Low dropout voltage  $\leq 1\text{V}$
- Built-in dropping type overcurrent, overvoltage and thermal protection circuits
- TO220 equivalent 5-terminal full-mold package

## Absolute Maximum Ratings

( $T_a=25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
DC input voltage	$V_{IN}$	40	V	
Battery reverse connection	$V_{INB}$	-13 *6	V	One minute
Output control terminal voltage	$V_C$	$V_{IN}$	V	
Output current	CH1	$I_{O1}$	0.07 *1	A
	CH2	$I_{O2}$	0.4 *1	A
Power Dissipation	$P_{D1}$	18	W	With infinite heatsink
	$P_{D2}$	1.5	W	Stand-alone without heatsink
Junction Temperature	$T_J$	-40 to +125	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +115	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +125	$^\circ\text{C}$	
Junction to case thermal resistance	$\theta_{J-C}$	5.5	$^\circ\text{C/W}$	
Junction to ambient-air thermal resistance	$\theta_{J-a}$	66.7	$^\circ\text{C/W}$	Stand-alone without heatsink

## Electrical Characteristics

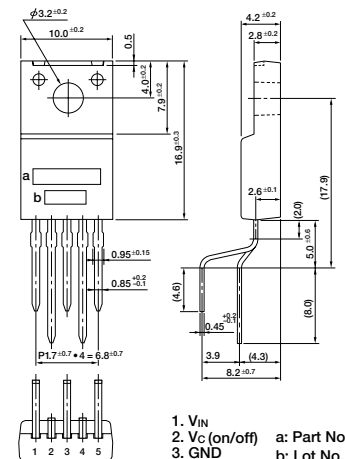
( $T_J=25^\circ\text{C}$ ,  $V_{IN}=14\text{V}$  unless otherwise specified)

Parameter		Symbol	Ratings			Unit	Conditions
			min	typ	max		
Input voltage		V <sub>IN</sub>	6 *2		35 *1	V	
Output voltage	CH1	V <sub>O1</sub>	4.80	5.00	5.20	V	I <sub>O</sub> =0.05A
	CH2	V <sub>O2</sub>	4.80	5.00	5.20	V	I <sub>O</sub> =0.3A
Channel-channel voltage difference (V <sub>O1</sub> —V <sub>O2</sub> )		ΔV <sub>O</sub>	−0.1		0.1	V	I <sub>O1</sub> = 0 to 0.05A I <sub>O2</sub> = 0 to 0.3A
Dropout voltage	CH1	V <sub>DIF1</sub>			1.0	V	I <sub>O1</sub> ≤ 0.05A
	CH2	V <sub>DIF2</sub>			1.0	V	I <sub>O2</sub> ≤ 0.4A
Line regulation	CH1	ΔV <sub>O LINE1</sub>		10	30	mV	V <sub>IN</sub> =6 to 18V, I <sub>O</sub> =0.05A
	CH2	ΔV <sub>O LINE2</sub>		10	30	mV	V <sub>IN</sub> =6 to 18V, I <sub>O</sub> =0.3A
Load regulation	CH1	ΔV <sub>O LOAD1</sub>		30	70	mV	I <sub>O1</sub> =0 to 0.05A
	CH2	ΔV <sub>O LOAD2</sub>		40	70	mV	I <sub>O2</sub> =0 to 0.3A
Ripple rejection	CH1	R <sub>REJ1</sub>		54		dB	f=100 to 120Hz
	CH2	R <sub>REJ2</sub>		54		dB	f=100 to 120Hz
Quiescent circuit current		I <sub>q</sub>			0.8	mA	I <sub>O1</sub> =0A, V <sub>C</sub> =0V
Overcurrent protection starting current	CH1	I <sub>(S1) 1</sub>	0.1 *3			A	
	CH2	I <sub>(S1) 2</sub>	0.5 *3			A	
Output control voltage	Output ON	V <sub>CH</sub>	4.2	4.5	4.8	V	
	Output OFF	V <sub>CL</sub>	3.2	3.5	3.8	V	
Output control current	Output ON	I <sub>CH</sub>			100	μA	V <sub>C</sub> =4.8V
	Output OFF	I <sub>CL</sub>	−100			μA	V <sub>C</sub> =3.2V
Overvoltage protection starting voltage		V <sub>OVP</sub>	35 *4			V	
Thermal protection starting temperature		T <sub>TSD</sub>	130 *5			°C	

Notes:

- \*1. Since  $P_{D(max)} = (V_{IN}-V_O) \cdot I_{O1} + (V_{IN}-V_{O2}) \cdot I_{O2} = 18\text{ (W)}$ ,  $V_{IN(max)}$ ,  $I_{O1(max)}$  and  $I_{O2(max)}$  may be limited depending on operating conditions. Refer to the  $T_a-P_D$  curve to compute the corresponding values.
- \*2. Refer to the dropout voltage.
- \*3.  $I_{S1}$  rating shall be the point at which the output voltage  $V_{O1}$  or  $V_{O2}$  ( $V_{IN}=14\text{V}$ ,  $I_{O1}=0.05\text{A}$  or  $I_{O2}=0.3\text{A}$ ) drops to -5%.
- \*4. Overvoltage protection circuit is built only in CH2 ( $V_{O2}$  side).
- \*5. The indicated temperatures are junction temperatures.
- \*6. All terminals, except  $V_{IN}$  and GND, are open.

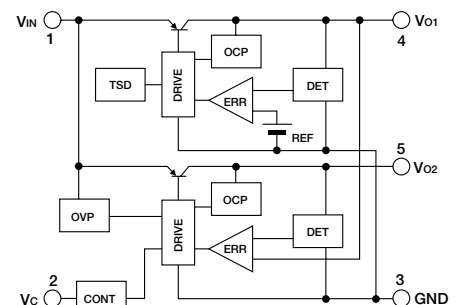
## External Dimensions (unit: mm)



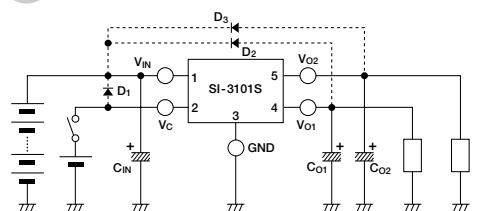
1.  $V_{IN}$
  2.  $V_C$  (on/off)
  3. GND
  4.  $V_{O1}$
  5.  $V_{O2}$
- a: Part No.  
b: Lot No.

(Forming No. 1101)

## Equivalent Circuit Diagram



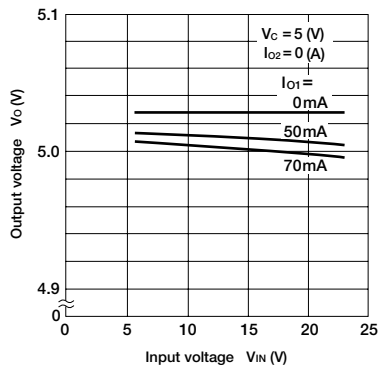
## Standard Circuit Diagram



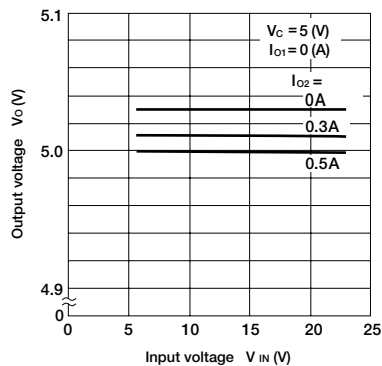
- $C_{O1}$ : Output capacitor (47 to 100 $\mu\text{F}$ , 50V)  
 $C_{O2}$ : Output capacitor (47 to 100 $\mu\text{F}$ , 50V)  
 \*1  $C_{IN}$ : Input capacitors (approx. 47 $\mu\text{F}$ ).  
 Tantalum capacitors are recommended for  $C_{O1}$ ,  $C_{O2}$  and  $C_{IN}$ , especially at low temperatures.
- \*2  $D_1$ ,  $D_2$ ,  $D_3$ : Protection diode.  
 Required as protection against reverse biasing between input and output.  
 (Recommended diode: Sanken EU2Z.)

## Electrical Characteristics

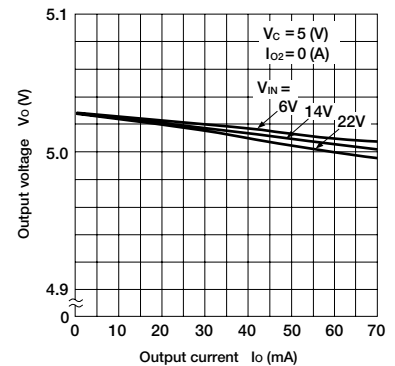
■ Line Regulation (1)



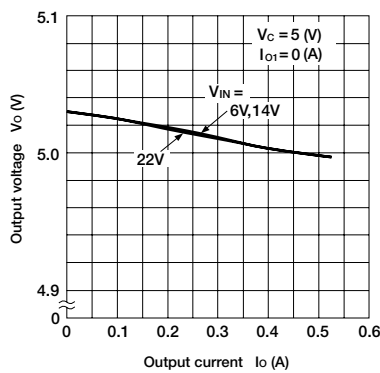
■ Line Regulation (2)



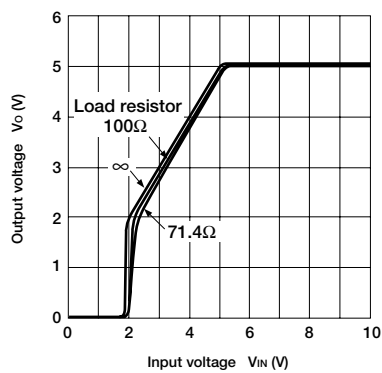
■ Load Regulation (1)



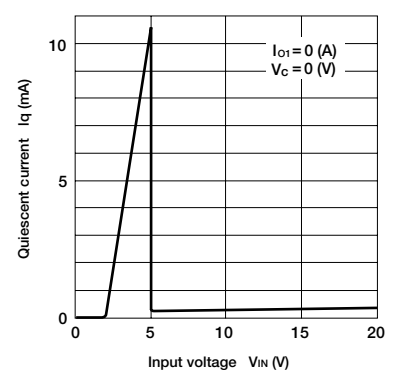
■ Load Regulation (2)



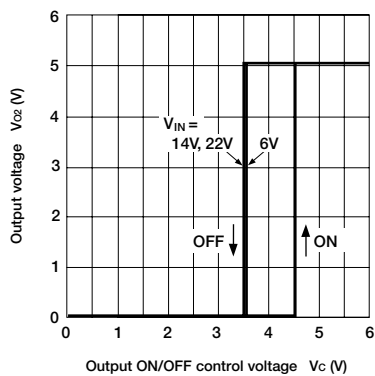
■ Rise Characteristics



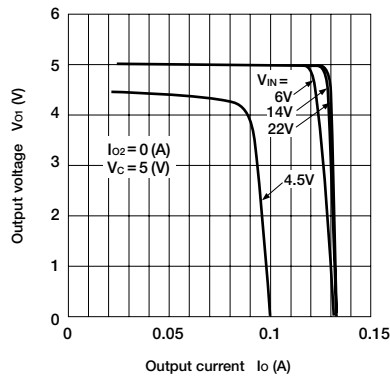
■ Quiescent Circuit Current



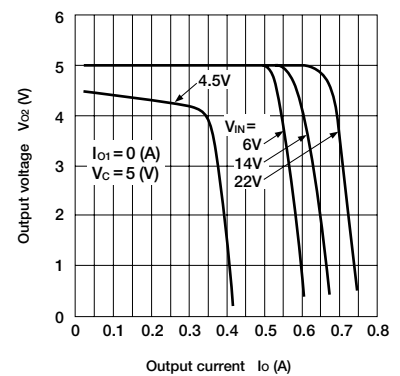
■ ON/OFF Control Characteristics



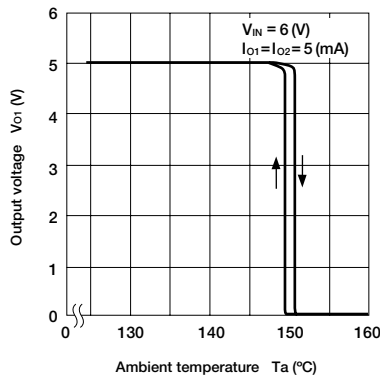
■ Overcurrent Protection Characteristics (1)



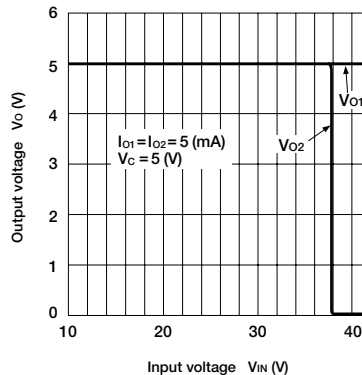
■ Overcurrent Protection Characteristics (2)



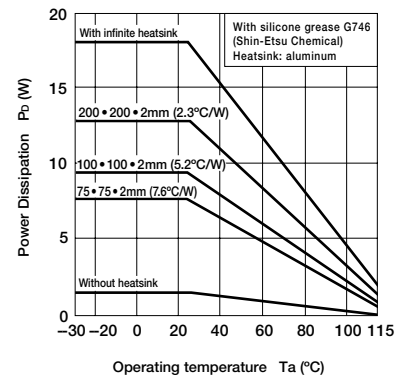
■ Thermal Protection Characteristics



■ Overvoltage Protection Characteristics



■ Ta—PD Characteristics



**Note on Thermal Protection Characteristics:**  
The thermal protection circuit is intended for protection against heat during instantaneous short-circuiting. Its operation, including reliability, is not guaranteed for short-circuiting over an extended period of time.

# Dropper Type Regulator ICs [2-output] SI-3102S

## Features

- Single input dual output <sub output (5V/0.04A), main output (5V/0.1A)>
- Main output can be externally turned ON/OFF (with ignition switch, etc.)  
<most suitable as memory backup power supply>
- Low standby current ( $\leq 0.8\text{mA}$ )
- Low dropout voltage  $\leq 1\text{V}$
- Built-in dropping type overcurrent, overvoltage and thermal protection circuits
- TO220 equivalent 5-terminal full-mold miniature package

## Absolute Maximum Ratings

( $T_a=25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
DC input voltage	$V_{IN}$	35	V	
Battery reverse connection	$V_{INB}$	-13 <sup>*6</sup>	V	One minute
Output control terminal voltage	$V_C$	$V_{IN}$	V	
Output current	CH1	$I_{O1}$	0.04 <sup>*1</sup>	A
	CH2	$I_{O2}$	0.1 <sup>*1</sup>	A
Power Dissipation	$P_{D1}$	22	W	With infinite heatsink
	$P_{D2}$	1.8	W	Stand-alone without heatsink
Junction temperature	$T_J$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +105	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ\text{C}$	
Junction to case thermal resistance	$\theta_{J-C}$	5.5	$^\circ\text{C/W}$	
Junction to ambient-air thermal resistance	$\theta_{J-A}$	66.7	$^\circ\text{C/W}$	Stand-alone without heatsink

## Electrical Characteristics

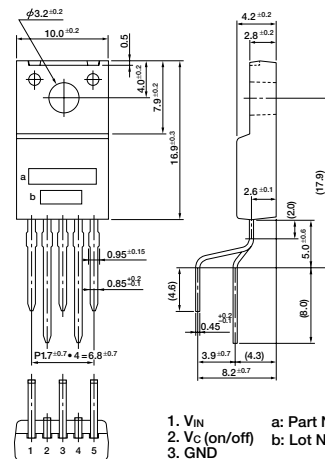
( $T_J=25^\circ\text{C}$ ,  $V_{IN}=14\text{V}$  unless otherwise specified)

Parameter		Symbol	Ratings			Unit	Conditions
			min	typ	max		
Input voltage		V <sub>IN</sub>	6 *2		30 *1	V	
Output voltage	CH1	V <sub>O1</sub>	4.80	5.00	5.20	V	I <sub>O1</sub> =0.04A
	CH2	V <sub>O2</sub>	4.80	5.00	5.20	V	I <sub>O2</sub> =0.1A
Channel-channel voltage difference (V <sub>O1</sub> —V <sub>O2</sub> )		ΔV <sub>O</sub>	−0.1		0.1	V	I <sub>O1</sub> =0 to 0.04A I <sub>O2</sub> =0 to 0.1A
Dropout voltage	CH1	V <sub>DIF1</sub>			1.0	V	I <sub>O1</sub> ≦0.04A
	CH2	V <sub>DIF2</sub>			1.0	V	I <sub>O2</sub> ≦0.1A
Line regulation	CH1	ΔV <sub>O LINE1</sub>		10	50	mV	V <sub>IN</sub> =6 to 30V, I <sub>O</sub> =0.04A
	CH2	ΔV <sub>O LINE2</sub>		10	50	mV	V <sub>IN</sub> =6 to 30V, I <sub>O</sub> =0.1A
Load regulation	CH1	ΔV <sub>O LOAD1</sub>		30	70	mV	I <sub>O1</sub> =0 to 0.04A
	CH2	ΔV <sub>O LOAD2</sub>		40	70	mV	I <sub>O2</sub> =0 to 0.1A
Ripple rejection	CH1	R <sub>REJ1</sub>		54		dB	f=100 to 120Hz
	CH2	R <sub>REJ2</sub>		54		dB	f=100 to 120Hz
Quiescent circuit current		I <sub>q</sub>			0.8	mA	I <sub>O1</sub> =0A, V <sub>C</sub> =0V
Overcurrent protection starting current	CH1	I <sub>(S1) 1</sub>	0.06 *3			A	
	CH2	I <sub>(S1) 2</sub>	0.15 *3			A	
Output control voltage	Output ON	V <sub>CH</sub>	4.2	4.5	4.8	V	
	Output OFF	V <sub>CL</sub>	3.2	3.5	3.8	V	
Output control current	Output ON	I <sub>CH</sub>			100	μA	V <sub>C</sub> =4.8V
	Output OFF	I <sub>CL</sub>	−100			μA	V <sub>C</sub> =3.2V
Overvoltage protection starting voltage		V <sub>OVP</sub>	30 *4			V	
Thermal protection starting temperature		T <sub>TSD</sub>	151 *5			°C	

### Notes:

- \*1. Since  $P_D(\text{max}) = (V_{IN}-V_O) \cdot I_{O1} + (V_{IN}-V_{O2}) \cdot I_{O2} = 22\text{ (W)}$ ,  $V_{IN}(\text{max})$ ,  $I_{O1}(\text{max})$  and  $I_{O2}(\text{max})$  may be limited depending on operating conditions. Refer to the  $T_a-P_D$  curve to compute the corresponding values.
- \*2. Refer to the dropout voltage.
- \*3.  $I_{S1}$  rating shall be the point at which the output voltage  $V_{O1}$  or  $V_{O2}$  ( $V_{IN}=14\text{V}$ ,  $I_{O1}=0.04\text{A}$  or  $I_{O2}=0.1\text{A}$ ) drops to -5%.
- \*4. Overvoltage protection circuit is built only in CH2 ( $V_{O2}$  side).
- \*5. The indicated temperatures are junction temperatures.
- \*6. All terminals, except  $V_{IN}$  and GND, are open.

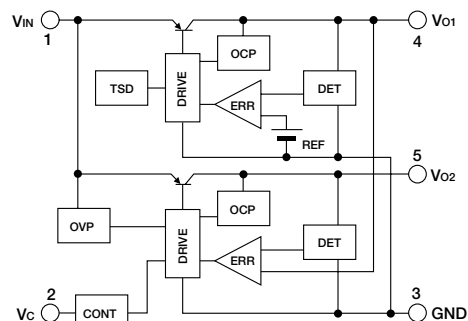
## External Dimensions (unit: mm)



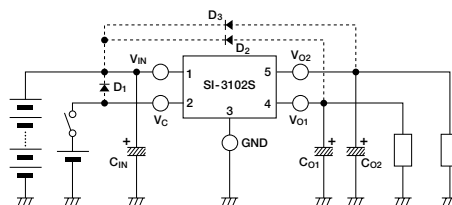
1.  $V_{IN}$
  2.  $V_C$  (on/off)
  3. GND
  4.  $V_{O1}$
  5.  $V_{O2}$
- a: Part No.  
b: Lot No.

(Forming No. 1101)

## Equivalent Circuit Diagram



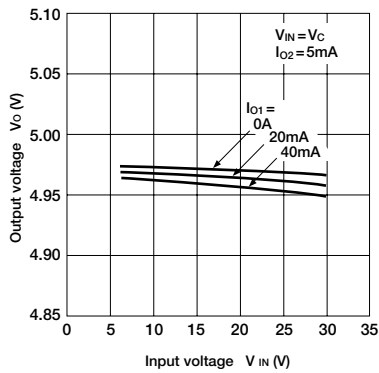
## Standard Circuit Diagram



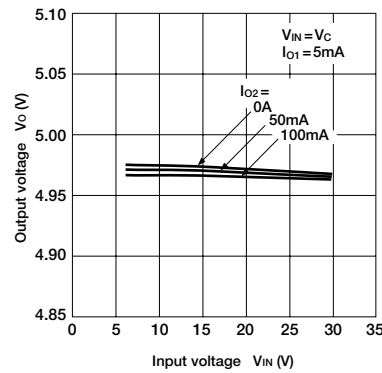
- $C_{O1}$ : Output capacitor (47 to 100 $\mu\text{F}$ , 50V)  
 $C_{O2}$ : Output capacitor (47 to 100 $\mu\text{F}$ , 50V)  
 $C_{IN}$ : Input capacitors (approx. 47 $\mu\text{F}$ ).  
 Tantalum capacitors are recommended, for  $C_{O1}$ ,  $C_{O2}$  and  $C_{IN}$ , especially at low temperatures.  
 $D1, D2, D3$ : Protection diode.  
 Required as protection against reverse biasing between input and output.  
 (Recommended diode: Sanken EU2Z.)

## Electrical Characteristics

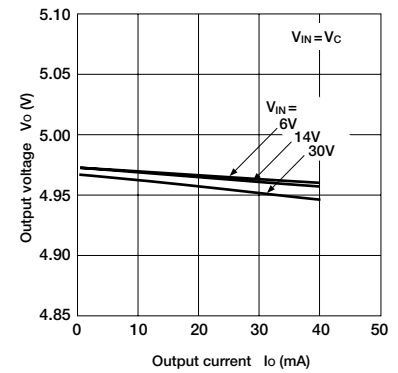
■ Line Regulation (1)



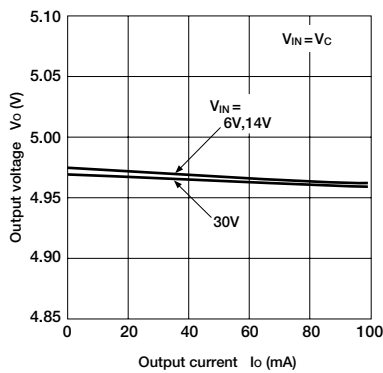
■ Line Regulation (2)



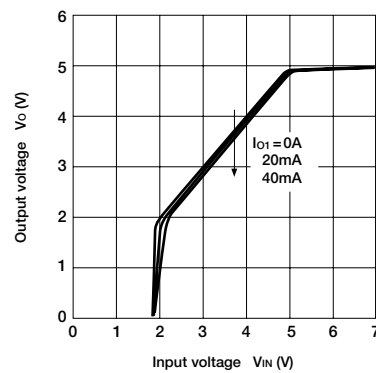
■ Load Regulation (1)



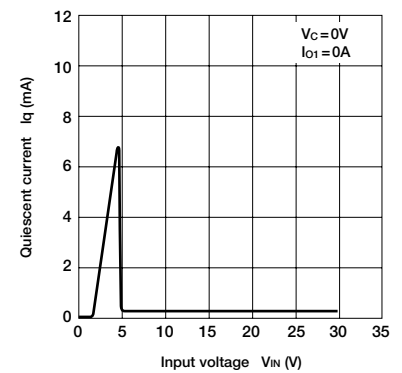
■ Load Regulation (2)



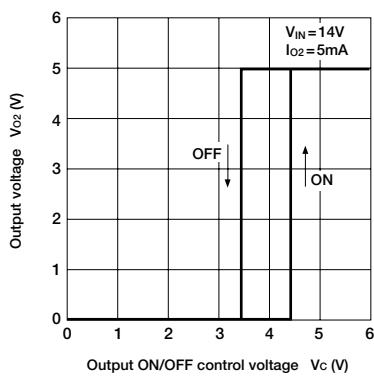
■ Rise Characteristics



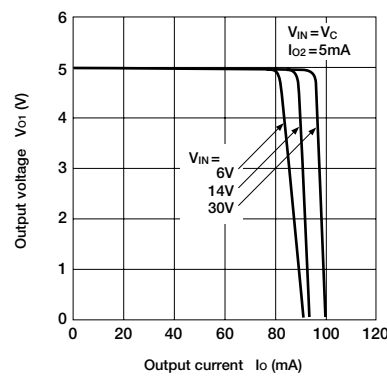
■ Quiescent Circuit Current



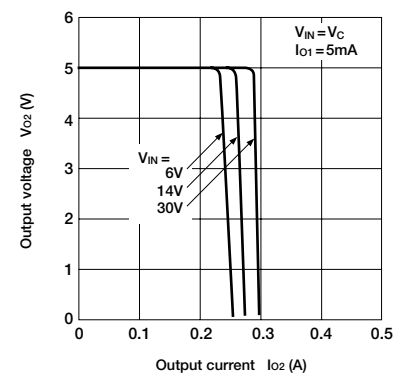
■ ON/OFF Control Characteristics



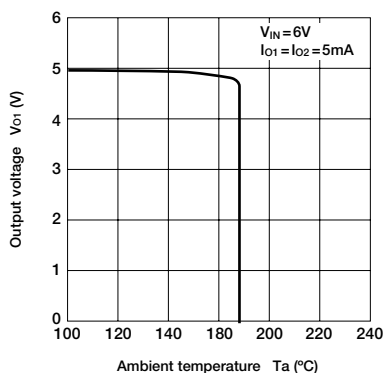
■ Overcurrent Protection Characteristics (1)



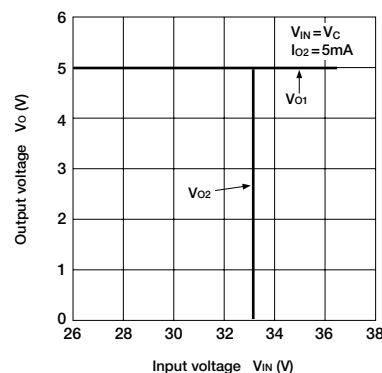
■ Overcurrent Protection Characteristics (2)



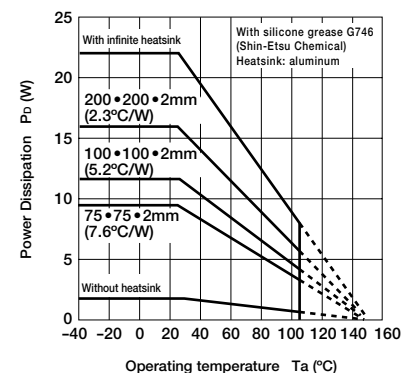
■ Thermal Protection Characteristics



■ Overvoltage Protection Characteristics



■ T<sub>a</sub>—P<sub>D</sub> Characteristics



**Note on Thermal Protection Characteristics:**  
The thermal protection circuit is intended for protection against heat during instantaneous short-circuiting. Its operation, including reliability, is not guaranteed for short-circuiting over an extended period of time.

## Dropper Type System Regulator ICs SI-3322S

## Features

- High accuracy output of  $5V \pm 30mV$
- Memory backup power supply  $4V \pm 0.2V$
- Power on reset function
- Supply voltage monitor function
- Watch dog timer
- CR not required for setting external time constant

## Absolute Maximum Ratings

Parameter	Symbol	Applicable terminals	Ratings	Unit	Conditions
Terminal voltage	V <sub>IN</sub> (1)	BA1, V <sub>CC</sub> , V <sub>NMIC</sub>	−0.3 to 32	V	
	V <sub>IN</sub> (2)	V <sub>S</sub> , NMIC, RSTTC, OUTE	−0.3 to 7	V	
		V <sub>SC</sub> , NMI, RESET, OUTE			
		W/D, STBY			
Storage temperature	T <sub>stg</sub>	—	−40 to +125	°C	
Operating temperature	T <sub>op</sub>	—	−40 to +105	°C	
Power dissipation	P <sub>D</sub>	—	1.4	W	T <sub>a</sub> = 25°C

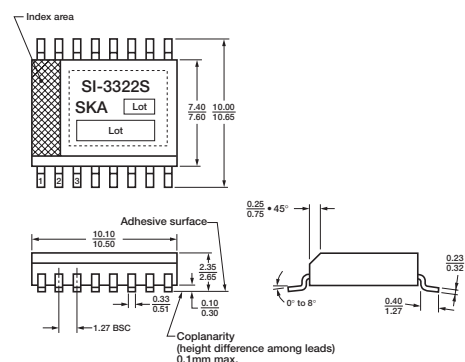
## Electrical Characteristics

(Ta = 25°C unless otherwise specified)

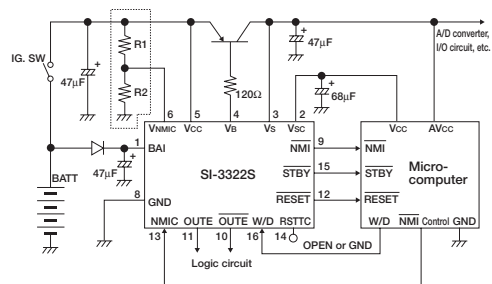
Parameter		Symbol	Ratings			Unit	Conditions
			min	typ	max		
V <sub>SC</sub> output voltage		V <sub>SC</sub>	3.8	4	4.2	V	BAI = 4.2 to 16V, I <sub>SC</sub> = -0.2mA
V <sub>S</sub> output voltage		V <sub>S</sub>	4.97	5	5.03	V	V <sub>CC</sub> = 5.2 to 16V, I <sub>O</sub> = -350mA
V <sub>S</sub> -V <sub>SC</sub> voltage difference		ΔV <sub>S</sub>			0.3	V	V <sub>CC</sub> = 5.2V, I <sub>SC</sub> = -50mA
BAI input current		I <sub>BAI</sub>			0.6	mA	BAI = 4.9 to 16V, I <sub>SC</sub> = -0.2mA
V <sub>CC</sub> input current		I <sub>CC</sub>			5	mA	V <sub>CC</sub> = 3 to 16V
V <sub>B</sub> input current		I <sub>B</sub>			25	mA	V <sub>CC</sub> = 3 to 16V
V <sub>S</sub> input current		I <sub>S</sub>			20	mA	V <sub>CC</sub> = BAI = 3 to 16V, I <sub>SC</sub> = 0mA
NMIC input current		I <sub>NMIC</sub>	-0.04	-0.1	-0.4	mA	V <sub>CC</sub> = BAI = 14V
W/D input current		I <sub>W/D</sub>	-0.04	-0.1	-0.4	mA	V <sub>CC</sub> = BAI = 14V
RSTTC input current		I <sub>RTC</sub>	-0.04	-0.1	-0.4	mA	V <sub>CC</sub> = BAI = 14V
NMI judge voltage	Lo	V <sub>NIL</sub>	4.9	5	5.1	V	NMIC = 0V
	Hysteresis	ΔV <sub>N</sub>	0.12		0.3	V	
NMI output voltage	Hi	V <sub>NOH</sub>	V <sub>S</sub> -0.5			V	I <sub>source</sub> = -1mA
	Lo	V <sub>NOL</sub>			0.6	V	I <sub>sink</sub> = 0.5mA
STBY output voltage	Hi	V <sub>SOH</sub>	V <sub>S</sub> -0.5			V	I <sub>source</sub> = -1mA
	Lo	V <sub>SOL</sub>			0.6	V	I <sub>sink</sub> = 0.5mA
RESET output voltage	Hi	V <sub>ROH</sub>	V <sub>S</sub> -0.5			V	I <sub>source</sub> = -1mA
	Lo	V <sub>ROL</sub>			0.6	V	I <sub>sink</sub> = 0.5mA
OUTE output voltage	Hi	V <sub>UOH</sub>	V <sub>S</sub> -0.5			V	I <sub>source</sub> = -1mA
	Lo	V <sub>UOL</sub>			0.6	V	I <sub>sink</sub> = 0.5mA
OUTE output voltage	Hi	V <sub>TOH</sub>	V <sub>S</sub> -0.5			V	I <sub>source</sub> = -1mA
	Lo	V <sub>TOL</sub>			0.6	V	I <sub>sink</sub> = 0.5mA
Standby release time		T <sub>ST</sub>	5	10	20	ms	
Reset release time		T <sub>RE</sub>	60	75	90	ms	
Reset cycle		T <sub>RC</sub>	40	50	60	ms	
Reset period		T <sub>RP</sub>	20	25	30	ms	
W/D signal stop detect period		T <sub>WS</sub>	10	12.5	15	ms	
Reset signal output time		T <sub>NR</sub>	80			μs	
Standby signal output time		T <sub>RS</sub>	10			μs	
W/D fail judge frequency		F <sub>FH</sub>	2		5	kHz	
Out enable release time		T <sub>WE</sub>	40	50	10	ms	

Notes: The direction of current flowing into the IC is positive (+).

### External Dimensions (unit: mm)



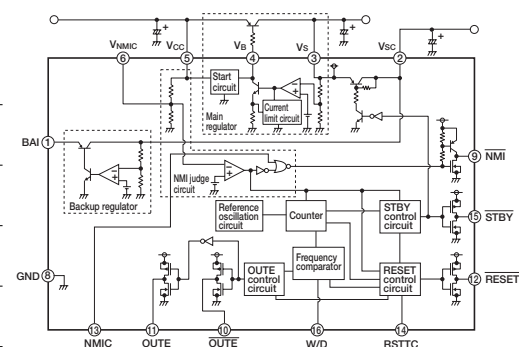
## Standard Connection Diagram



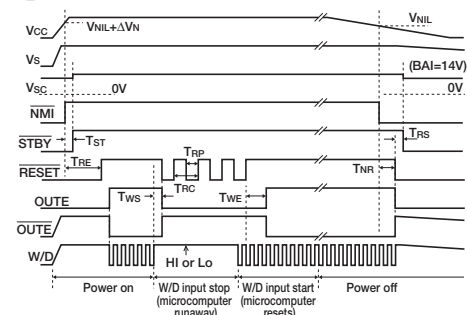
R1, R2:  $\overline{\text{NMI}}$  judge voltage (5V typ) variable resistor  
 $\overline{\text{NMI}}$  judge voltage  $\approx (R1 + R2) \cdot 2.5V/R2$   
 R1, R2  $\leq 2k$   
 Normally, VNMIC terminal is open.

RSTTC: Normally open.  
 GND connected when TRE is to be halved.

## Circuit Block Diagram

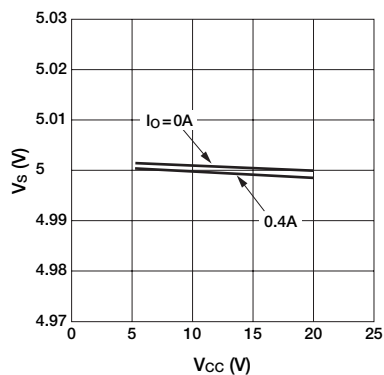


## Timing Chart

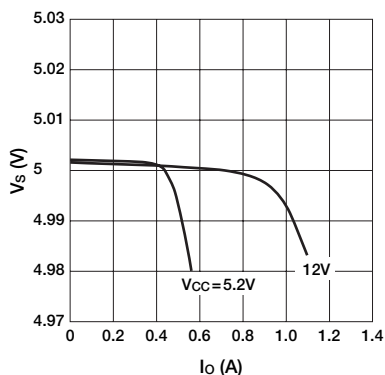


## Electrical Characteristics

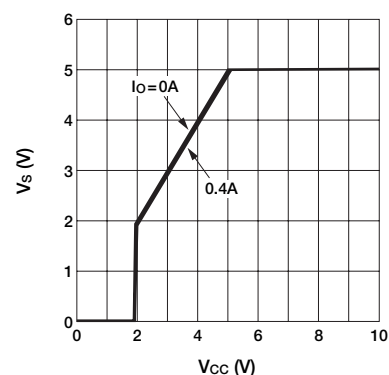
■  $V_S$  Line Regulation



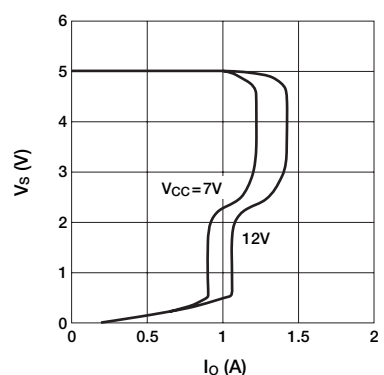
■  $V_S$  Load Regulation



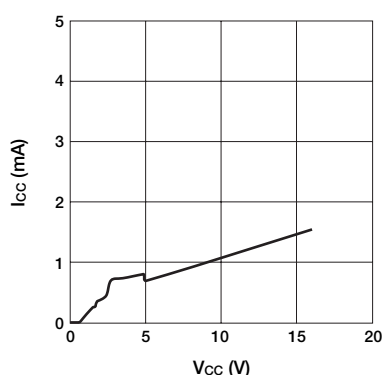
■  $V_S$  Rise Characteristics



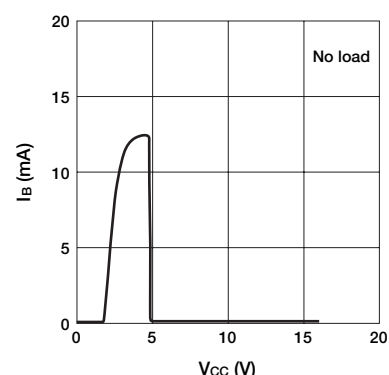
■  $V_S$  Overcurrent Protection Characteristics



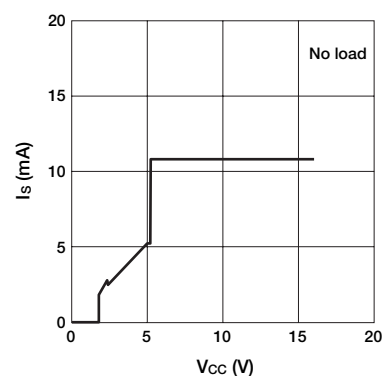
■  $V_{CC}$  Input Current



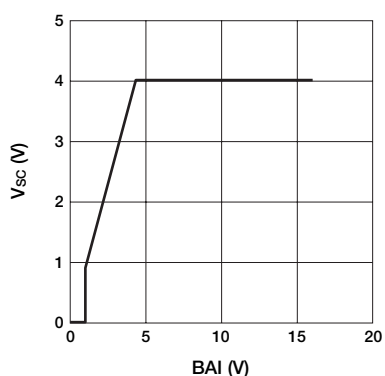
■  $V_S$  Input Current



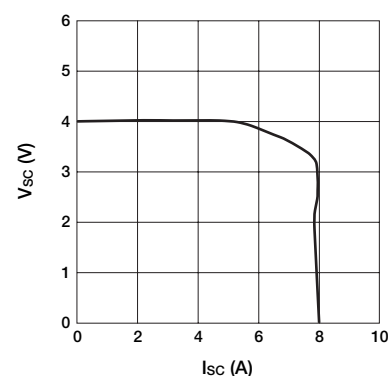
■  $V_S$  Input Current



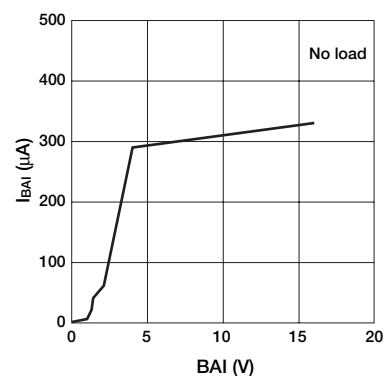
■  $V_{SC}$  Rise Characteristics



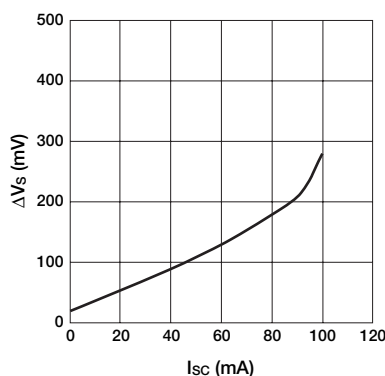
■  $V_{SC}$  Overcurrent Protection Characteristics



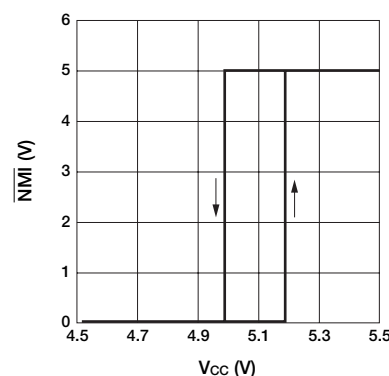
■  $B_{AI}$  Input Current



■  $V_S$ - $V_{SC}$  Voltage Difference



■  $\overline{NMI}$  Judge Voltage Characteristics



# Dropper Type System Regulator ICs [Surface-mount 2-output] **SPF3004**

## Features

- Single input dual output (ch1: 5V/0.4A, ch2: 3.3V/0.2A)
- Power on reset function
- Watchdog timer
- Built-in drooping type overcurrent and thermal protection circuits (ch1)

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Remarks
DC input voltage	$V_{IN}$	-13 to 35 40	V	Reverse connection 1 min max. <400mS
Output control terminal voltage	EN	-0.3 to 35 40	V	<400mS
Output current	CH1 CH2	$I_{O1}$ $I_{O2}$	A	
MODE terminal input voltage	MODE			
W/D/C terminal input voltage	W/D/C			
TC terminal input voltage	TC			
CK terminal input voltage	CK			
Vo1-fail terminal output voltage	Vo1-fail			
Reset terminal output voltage	RESET			
Junction temperature	$T_j$	-40 to 150	°C	
Storage temperature	$T_{stg}$	-40 to 150	°C	
Thermal resistance (junction to case)	$\theta_{j-c}$	4.1	°C/W	With infinite heatsink
Thermal resistance (junction to ambient air)	$\theta_{j-a}$	38	°C/W	With glass epoxy + copper foil board (size 5.0 x 7.4cm; t: glass epoxy = 1.6mm/copper foil = 18μm)

## Electrical Characteristics

Parameter		Symbol	Ratings			Unit	Conditions
			min	typ	max		
Input voltage		V <sub>IN</sub>	V <sub>01</sub> +V <sub>DIFF1</sub> *3		35 *4	V	
Output voltage	CH1	V <sub>O1</sub>	4.90	5.00	5.10	V	V <sub>IN</sub> =V <sub>01</sub> +V <sub>DIFF1</sub> to 18V, I <sub>01</sub> =0 to 0.4A, T <sub>J</sub> =-40 to 125°C
	CH1	V <sub>O1</sub>	4.85	5.00	5.15		V <sub>IN</sub> =V <sub>01</sub> +V <sub>DIFF1</sub> to 18V, I <sub>01</sub> =0 to 0.4A, T <sub>J</sub> =-40 to 150°C
	CH2	V <sub>O2</sub>	3.15	3.30	3.45		V <sub>IN</sub> =V <sub>O2</sub> +V <sub>DIFF1</sub> +V <sub>DIFF2</sub> to 18V, I <sub>01</sub> =0 to 0.2A
Dropout voltage	CH1	V <sub>DIFF1</sub>			0.5	V	I <sub>01</sub> =0.4A
	CH1	V <sub>DIFF2</sub>			0.25		I <sub>01</sub> =0.2A, T <sub>J</sub> =25°C
	CH2	V <sub>DIFF2</sub>			0.5		I <sub>02</sub> =0.2A
Ripple rejection	CH1	R <sub>REJ1</sub>		54		dB	f=100 to 200Hz
	CH2	R <sub>REJ2</sub>		54			
Quiescent circuit current		I <sub>Q</sub>		10	50	μA	V <sub>IN</sub> =16V, EN=0V
				50	250		V <sub>IN</sub> =35V, EN=0V
				5	10	mA	
GND current		I <sub>GND</sub>		70	100	mA	I <sub>01</sub> =I <sub>02</sub> =0.2A
Overcurrent protection starting current	CH1	I <sub>S11</sub>	0.402		1.80	A	V <sub>01</sub> =4.5V
	CH2	I <sub>S21</sub>	0.201		0.80		V <sub>02</sub> =2.8V
Residual current at a short	CH1	I <sub>S21</sub>	0.402		1.80	A	V <sub>01</sub> =0V
	CH2	I <sub>S22</sub>	0.201		0.80		V <sub>02</sub> =0V
EN output control voltage		V <sub>ENth</sub>	1.0		3.5	V	T <sub>J</sub> =-40 to 125°C
			0.9		3.5		*8
EN output control current	ON	I <sub>ENH1</sub>			50	μA	EN=6.4V, T <sub>J</sub> =-40 to 125°C
		I <sub>ENH2</sub>			30		EN=3.51V, T <sub>J</sub> =-40 to 125°C
	OFF	I <sub>ENL</sub>	-1.0		1.0		EN=0V, T <sub>J</sub> =-40 to 125°C
Vo1-fail terminal LOW voltage		V <sub>failL</sub>			0.5	V	I <sub>sink</sub> =250μA, (Pull-up resistance 20kΩ typ)
Vo1-fail terminal HI voltage		V <sub>failH</sub>	V <sub>01</sub> -0.8V *5			V	I <sub>source</sub> =15μA
Reset terminal LOW voltage		V <sub>RSL</sub>			0.5	V	I <sub>sink</sub> =250μA, (Pull-up resistance 20kΩ typ)
Reset terminal HI voltage		V <sub>RSH</sub>	V <sub>01</sub> -0.8V *5			V	I <sub>source</sub> =15μA
Reset detect voltage	CH1	V <sub>01thH</sub>			V <sub>01</sub> •0.97	V	V <sub>RS</sub> , V <sub>fail</sub> > 4.5V
		V <sub>01thL</sub>	4.05			V	V <sub>RS</sub> , V <sub>fail</sub> < 0.8V
	CH2	V <sub>02thH</sub>			V <sub>02</sub> •0.985	V	V <sub>RS</sub> > 3.0V
		V <sub>02thL</sub>	3.00			V	V <sub>RS</sub> < 0.8V
Reset detect voltage hysteresis width	CH1	ΔV <sub>01th</sub>			0.255	V	ΔV <sub>01th</sub> =V <sub>01thH</sub> -V <sub>01thL</sub>
	CH2	ΔV <sub>02th</sub>			0.105	V	ΔV <sub>02th</sub> =V <sub>02thH</sub> -V <sub>02thL</sub>
Power on reset delay time		t <sub>tdly</sub>	0.70•R <sub>tc</sub> •C <sub>tc</sub>	0.72•R <sub>tc</sub> •C <sub>tc</sub>	0.74•R <sub>tc</sub> •C <sub>tc</sub>	S	Min. set time: 6mS
W/D time		t <sub>wd</sub>	0.52•R <sub>tc</sub> •C <sub>tc</sub>	0.54•R <sub>tc</sub> •C <sub>tc</sub>	0.56•R <sub>tc</sub> •C <sub>tc</sub>	S	Min. set time: 4mS
W/D pulse time		t <sub>wdp</sub>	0.04•R <sub>tc</sub> •C <sub>tc</sub>	0.06•R <sub>tc</sub> •C <sub>tc</sub>	0.08•R <sub>tc</sub> •C <sub>tc</sub>	S	Min. set time: 400μS
MODE terminal control voltage		V <sub>modeth</sub>	1.0		3.0	V	
MODE terminal control current	ON	I <sub>modeH</sub>			200	μA	MODE=5V
	OFF	I <sub>modeL</sub>	-1.0		1.0		MODE=0V, T <sub>J</sub> =-40 to 125°C
W/D/C terminal control voltage		V <sub>w/d/cth</sub>	1.0		3.0	V	*7
W/D/C terminal control current	ON	I <sub>w/d/cH</sub>			200	μA	W/D/C=5V
	OFF	I <sub>w/d/cL</sub>	-1.0		1.0		W/D/C=0V, T <sub>J</sub> =-40 to 125°C
CK terminal control voltage		V <sub>ckth</sub>	1.0		3.0	V	Min. clock pulse time=5μS (Duty 50%)
CK terminal control current	ON	I <sub>ckH</sub>			200	μA	CK=5V
	OFF	I <sub>ckL</sub>	-1.0		1.0		CK=0V, T <sub>J</sub> =-40 to 125°C

**Notes:**

\*3: Refer to dropout voltage.

\*4: Since  $P_{D(\max)} = \{(V_{IN} - V_{O1}) \cdot (I_{O1} + I_{O2})\} + (V_{IN} \cdot I_Q) + \{(V_{O1} - V_{O2}) \cdot I_{O2}\} = 30W$ ,  $V_{IN}(\max)$ ,  $I_{O1}(\max)$  and  $I_{O2}(\max)$  may be limited depending on operating conditions.

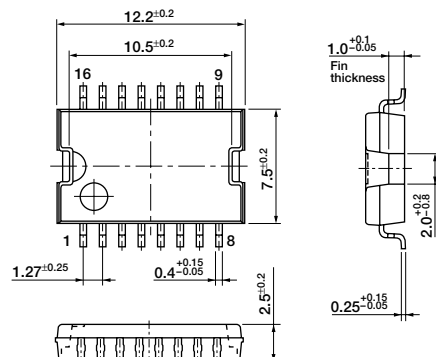
\*5: The Vo1-fail and RESET terminals are pulled up in the IC; may be directly connected to logic circuits.

\*6: The thermal protection function is built in VO1 (CH1 side) only. The design thermal protection starting temperature is 155°C (min.) and 165°C (typ). These values represent the design warranty.

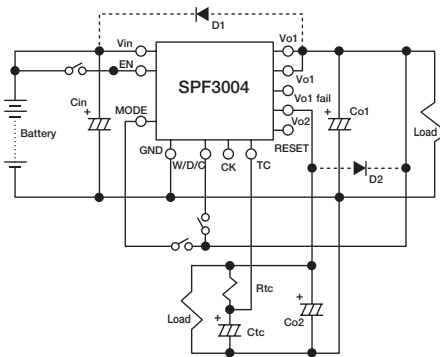
\*7: The threshold voltage of the W/D/C terminals is determined by the presence/absence of WD operation (occurrence of RESET signal pulses). The W/D/C function is assumed to be OFF during the period when RESET pulses occur.

\*8: The TOFF-EN operation ( $V_{EN}: 5V \Rightarrow 0V$ ) for  $T_j=150^{\circ}C$  is 16mS (0.32V/mS) max.

### External Dimensions (unit: mm)



## Standard Connection Diagram



Cin: Capacitor (39 $\mu$ F) for oscillation prevention

C<sub>O1</sub>: Output capacitor (39 $\mu$ F)

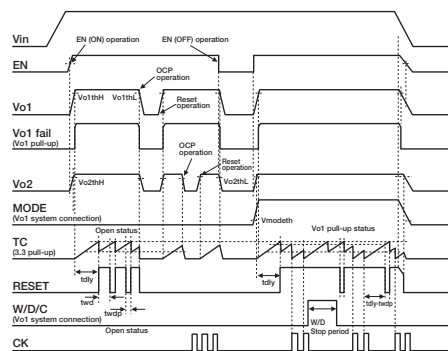
**C<sub>O2</sub>:** Output capacitor (39 $\mu$ F)

Tantalum capacitors are recommended especially for low

temperatures.

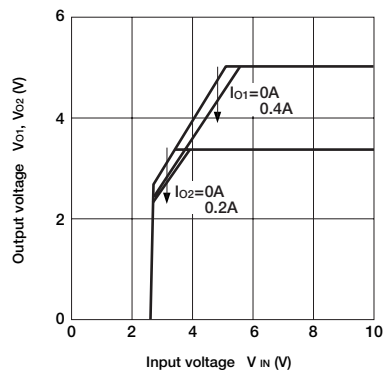
D1, D2: Protection diodes.  
Required as protection against reverse biasing between input and output (Recommended diode: SANKEN EU2Z).

## Timing Chart

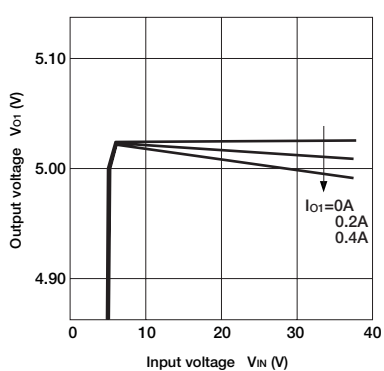


## Electrical Characteristics

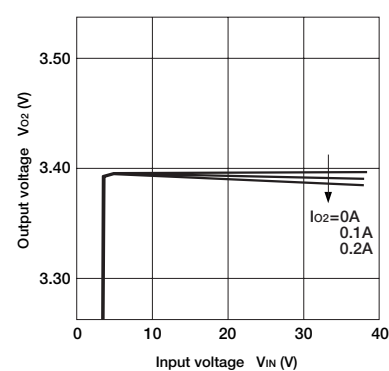
■ Rise Characteristics of Output Voltage



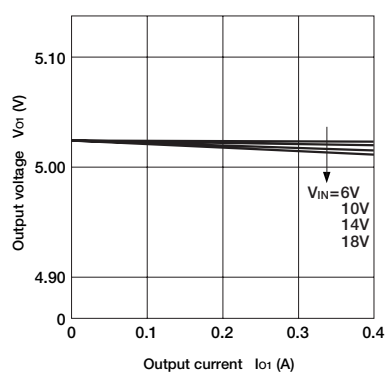
■ Line Regulation ( $V_{O1}$ )



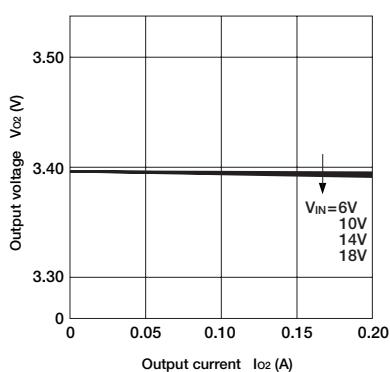
■ Line Regulation ( $V_{O2}$ )



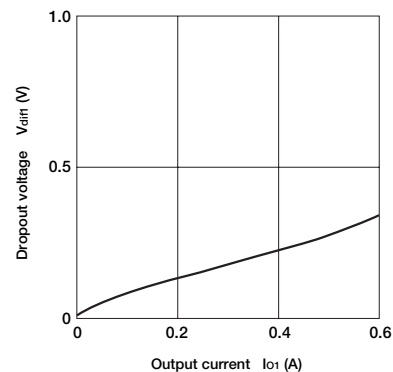
■ Load Regulation ( $V_{O1}$ )



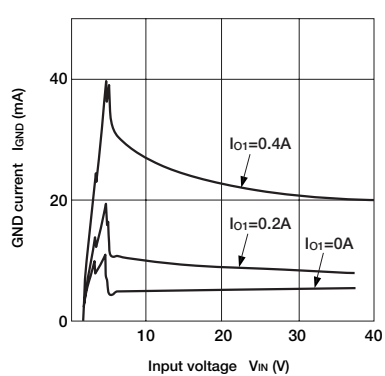
■ Load Regulation ( $V_{O2}$ )



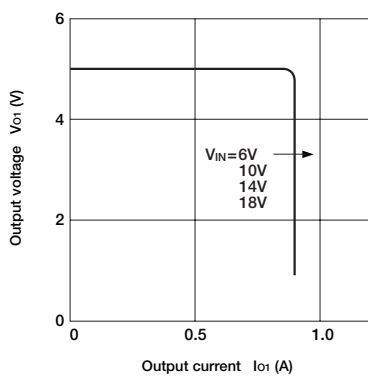
■ Dropout Voltage ( $V_{O1}$ )



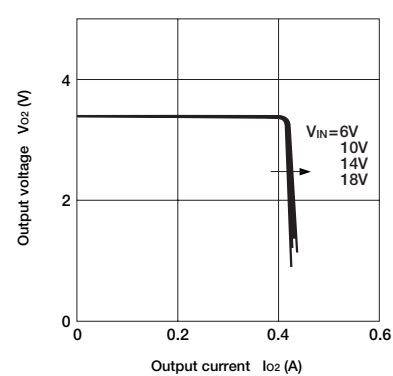
■ GND Current



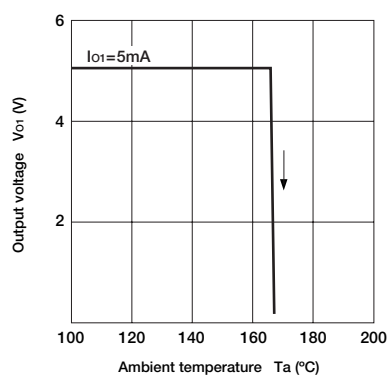
■ Overcurrent Protection Characteristics ( $V_{O1}$ )



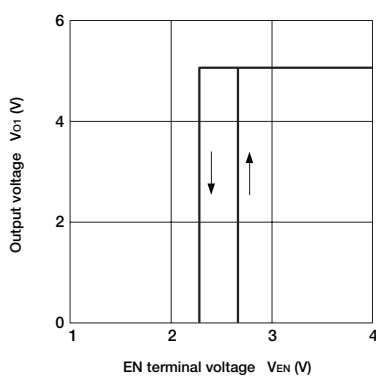
■ Overcurrent Protection Characteristics ( $V_{O2}$ )



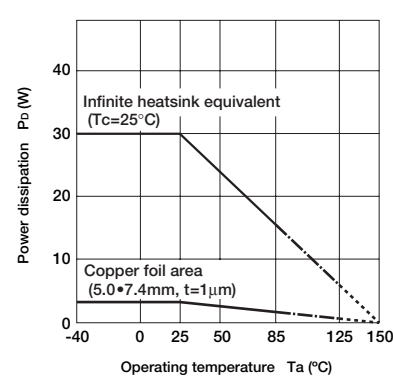
■ Thermal Protection Characteristics



■ EN Terminal Output Voltage



■  $T_a$ — $P_D$  Characteristics



# Dropper Type System Regulator ICs [Surface-mount 2-output] **SPF3006**

## Features

- Dual input and dual output (ch1: 5V/0.4A, ch2: 5V/0.2A)
- Power on reset function
- Watchdog timer
- Built-in drooping type overcurrent and thermal protection circuits (ch1)

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Remarks
DC input voltage	V <sub>IN1</sub>	-13 to 35	V	Reverse connection 1 min max.
	V <sub>IN2</sub>			
Vo1, Vo2 output control terminal voltage	EN	-0.3 to 35	V	
Vo2 output control terminal voltage	VC	-0.3 to 35	V	
Output current	CH1	I <sub>o1</sub>	A	
	CH2	I <sub>o2</sub>		
TC terminal input voltage	TC	-0.3 to 7	V	
CK terminal input voltage	CK			
W/D/C terminal input voltage	W/D/C			
Reset terminal output voltage	RESET			
Power dissipation	P <sub>o1</sub>	18.6	W	With an infinite heatsink mounted. *1
	P <sub>o2</sub>	2.97		
Junction temperature	T <sub>J</sub>	-40 to 150	°C	
Operating temperature	T <sub>op</sub>	-40 to 105	°C	
Storage temperature	T <sub>stg</sub>	-40 to 150	°C	
Thermal resistance (junction to case)	θ <sub>j-c</sub>	6.7	°C/W	With an infinite heatsink mounted.
Thermal resistance (junction to ambient air)	θ <sub>j-a</sub>	42	°C/W	

Notes: \*1: With glass epoxy + copper foil board (size 5.0 • 7.4cm; t: glass epoxy = 1.6mm / copper foil = 18μm)

## Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Input voltage	V <sub>IN1, 2</sub>	Vo1+V <sub>DIF1</sub>		35	V	*2, 3
Output voltage	CH1	Vo1	4.85	5.00	5.15	V
	CH2	Vo2	4.85	5.00	5.15	V
Dropout voltage	CH1	V <sub>DIF1</sub>		0.5		V
	CH2	V <sub>DIF2</sub>		0.5		V
Ripple rejection	CH1	R <sub>REJ1</sub>	54			db
	CH2	R <sub>REJ2</sub>	54			f = 100 to 120Hz
Quiescent circuit current	I <sub>q</sub>		10	50	μA	V <sub>IN1</sub> = 16V, V <sub>EN</sub> = 0V
			50	250	μA	V <sub>IN1</sub> = 35V, V <sub>EN</sub> = 0V
			5	10	mA	
GND current	I <sub>GND</sub>		70	100	mA	I <sub>o1</sub> = I <sub>o2</sub> = 0.2A
Overcurrent protection starting current	CH1	I <sub>s11</sub>	0.402	1.8	A	Vo1 = 4.5V
	CH2	I <sub>s21</sub>	0.201	0.8	A	Vo2 = 4.5V
Residual current at a short	CH1	I <sub>s21</sub>	0.402	1.8	A	Vo1 = 0V
	CH2	I <sub>s22</sub>	0.201	0.8	A	Vo2 = 0V
EN output control voltage	V <sub>ENth</sub>	0.9		3.5	V	
EN output control current	ON	I <sub>ENH</sub>		50	μA	EN = 5V
	OFF	I <sub>ENL</sub>	-1.0	1.0	μA	EN = 0V
Reset terminal LOW voltage	V <sub>RsL</sub>			0.5	V	I <sub>sink</sub> = 250μA (Pull-up resistance 20kΩ typ)
Reset terminal HI voltage	V <sub>RsH</sub>	Vo1 - 0.8V			V	I <sub>source</sub> = 15μA *4
Reset detect voltage	CH	Vo1thH		Vo1 + 0.9V	V	V <sub>Rs</sub> > 4.5V
		Vo1thL	4.05		V	V <sub>Rs</sub> < 0.8V
Power on reset delay time	t <sub>dly</sub>	1.18 • R <sub>tc</sub> • C <sub>tc</sub>	1.26 • R <sub>tc</sub> • C <sub>tc</sub>	1.35 • R <sub>tc</sub> • C <sub>tc</sub>	S	Min. set time: 6mS
W/D time	t <sub>wd</sub>	0.93 • R <sub>tc</sub> • C <sub>tc</sub>	1.03 • R <sub>tc</sub> • C <sub>tc</sub>	1.13 • R <sub>tc</sub> • C <sub>tc</sub>	S	Min. set time: 4mS
W/D pulse time	t <sub>wdp</sub>	0.07 • R <sub>tc</sub> • C <sub>tc</sub>	0.13 • R <sub>tc</sub> • C <sub>tc</sub>	0.19 • R <sub>tc</sub> • C <sub>tc</sub>	S	Min. set time: 400μS
CK terminal control voltage	V <sub>ckth</sub>	1.0		3.0	V	Min. clock pulse time: 5μs (Duty 50%)
CK terminal control current	ON	I <sub>ckH</sub>		200	μA	V <sub>CK</sub> = 5V
	OFF	I <sub>ckL</sub>	-1.0	1.0	μA	V <sub>CK</sub> = 0V
Vc output control voltage	V <sub>cth</sub>	1.0		3.5	V	
Vc output control current	I <sub>ch</sub>			300	μA	V <sub>C</sub> = 5V
	I <sub>cl</sub>	-1.0		1.0	μA	V <sub>C</sub> = 0V
W/D/C terminal control voltage	V <sub>w/d/cth</sub>	1.0		3.0	V	
W/D/C terminal control current	ON	I <sub>w/d/ch</sub>		200	μA	V <sub>W/D/C</sub> = 5V
	OFF	I <sub>w/d/cl</sub>	-1.0	1.0	μA	V <sub>W/D/C</sub> = 0V

Notes:

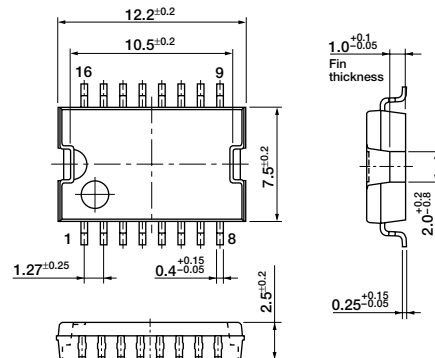
\*2: Refer to Dropout Voltage.

\*3: Since P<sub>D(max)</sub> = (V<sub>IN</sub> - V<sub>O1</sub>) • I<sub>o1</sub> + (V<sub>IN2</sub> - V<sub>O2</sub>) • I<sub>o2</sub> + (V<sub>IN</sub> • I<sub>q</sub>) = 22W, V<sub>IN(max)</sub>, I<sub>o1(max)</sub> and I<sub>o2(max)</sub> may be limited depending on operating conditions.

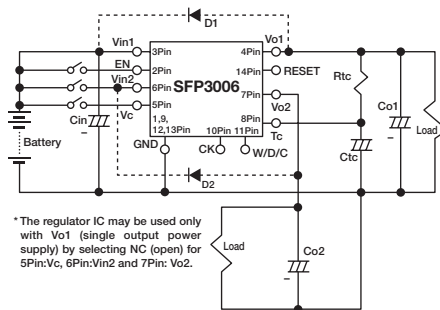
\*4: The RESET terminal is pulled up in the IC; may be directly connected to logic circuits.

\*6: The thermal protection function is built in V<sub>O1</sub> (CH1 side) only. The design thermal protection starting temperature is 151 °C (min.) and 165 °C (typ). These values represent the design warranty.

## External Dimensions (unit: mm)



## Standard Connection Diagram



\* The regulator IC may be used only with Vo1 (single output power supply) by selecting NC (open) for 5Pin:Vc, 6Pin:Vin2 and 7Pin:Vo2.

Cin: Capacitor (39μF) for oscillation prevention

Co1: Output capacitor (39μF)

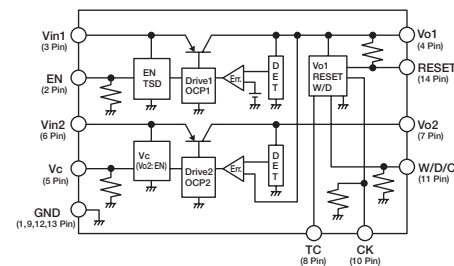
Co2: Output capacitor (39μF)

Tantalum capacitors are recommended particularly for low temperatures (tantalum capacitors of about 0.47μF in parallel).

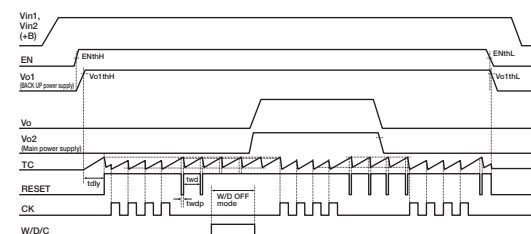
D1, D2: Protection diodes.

Required for protection against reverse biasing between input and output (Recommended diode: SANKEN EU2Z).

## Circuit Block Diagram

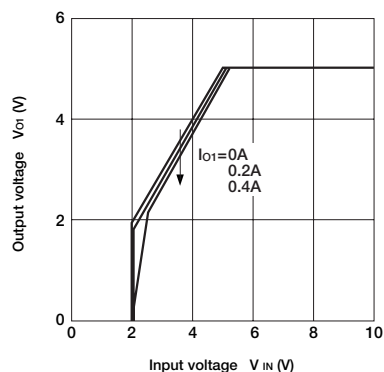


## Timing Chart

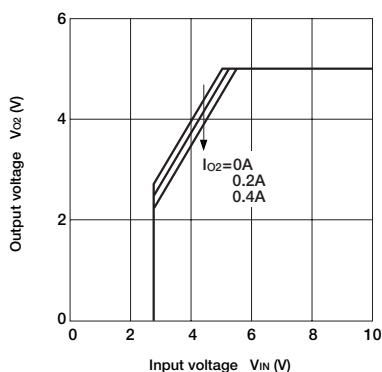


## Electrical Characteristics

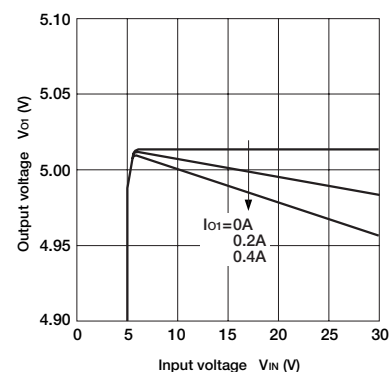
■ Rise Characteristics of Output Voltage ( $V_{O1}$ )



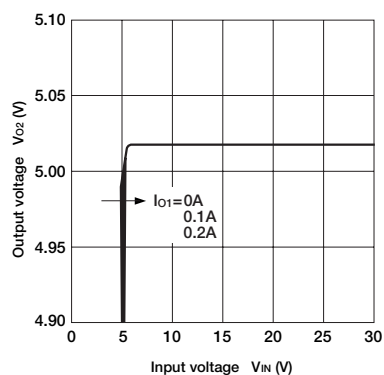
■ Rise Characteristics of Output Voltage ( $V_{O2}$ )



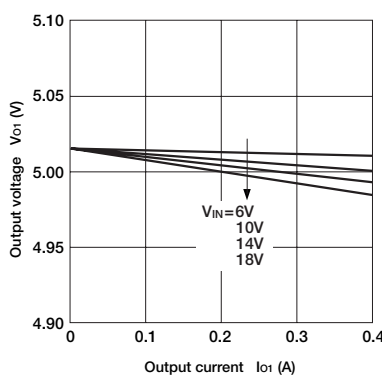
■ Line Regulation ( $V_{O1}$ )



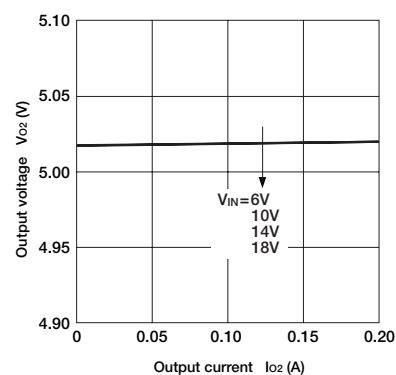
■ Line Regulation ( $V_{O2}$ )



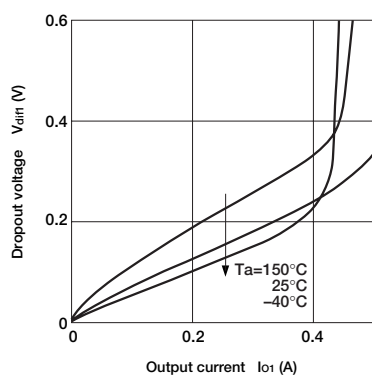
■ Load Regulation ( $V_{O1}$ )



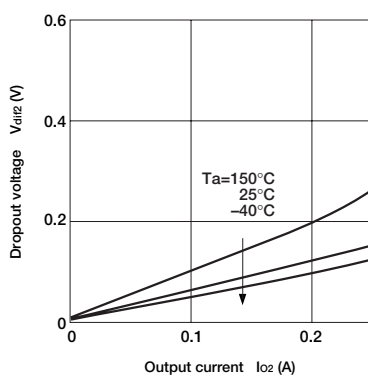
■ Load Regulation ( $V_{O2}$ )



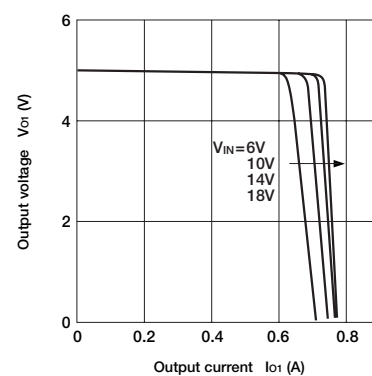
■ Dropout Voltage ( $V_{O1}$ )



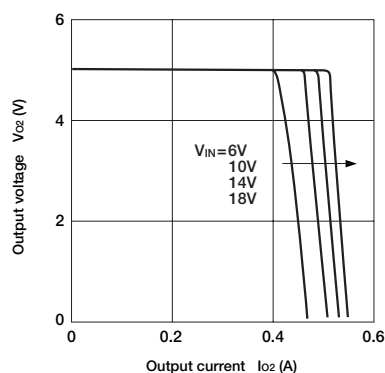
■ Dropout Voltage ( $V_{O2}$ )



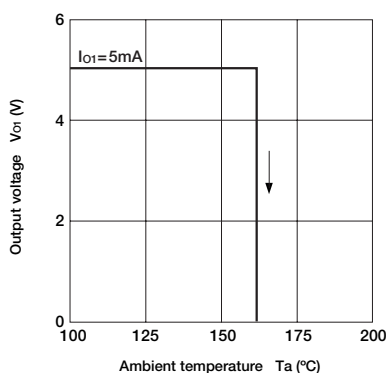
■ Overcurrent Protection Characteristics ( $V_{O1}$ )



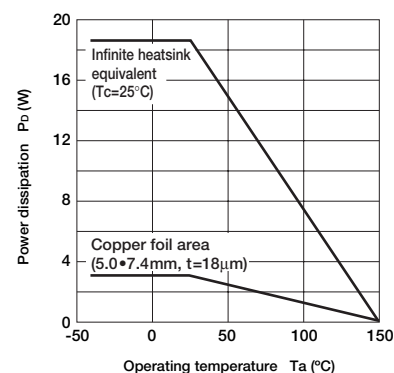
■ Overcurrent Protection Characteristics ( $V_{O2}$ )



■ Thermal Protection Characteristics



■  $T_a$ — $P_D$  Characteristics



# Switching Type Regulator ICs SI-3201S

## Features

- Output current of 3A ( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 8$  to  $18\text{V}$ )
- High efficiency of 82% ( $V_{IN} = 14\text{V}$ ,  $I_O = 2\text{A}$ )
- Requires 5 external components only
- Built-in reference oscillator (60kHz)
- Phase internally corrected
- Output voltage internally corrected
- Built-in overcurrent and thermal protection circuits
- Built-in soft start circuit

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Input voltage	$V_{IN}$	35	V	
Output voltage	$I_O$	3	A	
SW <sub>OUT</sub> terminal voltage	$V_{SWOUT}$	-1	V	
Power Dissipation	$P_{D1}$	22	W	With infinite heatsink
	$P_{D2}$	1.8	W	Stand-alone
Junction temperature	$T_J$	-40 to +150	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +125	$^\circ\text{C}$	
Junction to case thermal resistance	$\theta_{J-C}$	5.5	$^\circ\text{C/W}$	
Junction to ambient-air thermal resistance	$\theta_{J-a}$	66.7	$^\circ\text{C/W}$	

## Recommended Operating Conditions

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Input voltage	$V_{IN}$	8		18	V	
Output current	$I_O$	0.5		3	A	
Operating temperature	$T_{op}$	-40		+85	$^\circ\text{C}$	$T_a - P_D$ characteristics

## Electrical Characteristics

( $V_{IN} = 14\text{V}$ ,  $I_{OUT} = 2\text{A}$ ,  $T_J = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Output voltage	$V_O$	4.80	5.00	5.20	V	
Line regulation	$\Delta V_{O LINE}$			100	mV	$V_{IN} = 8$ to $18\text{V}$
Load regulation	$\Delta V_{O LOAD}$			50	mV	$I_O = 0.5$ to $3\text{A}$
Efficiency *1	$\eta$		82		%	
Oscillation frequency	$f_{OSC}$	50	60	70	kHz	
Quiescent circuit current	$I_Q$		5	10	mA	$I_O = 0\text{A}$
Overcurrent protection starting current	$I_S$	3.1			A	*2
Soft start *3	Low level voltage	$V_{SSL}$		0.2	V	
	Source current when low	$I_{SSL}$	15	25	$\mu\text{A}$	$V_{SSL} = 0.2\text{V}$
	Discharge resistance	$R_{DIS}$	200		k $\Omega$	$V_{IN} = 0\text{V}$

Notes:

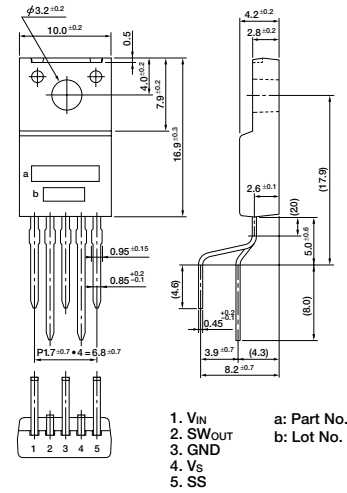
\*1. Efficiency is calculated by the following equation:

$$\eta = \frac{V_O \cdot I_O}{V_{IN} \cdot I_{IN}} \cdot 100 (\%)$$

\*2. A dropping-type overcurrent protection circuit is built in the IC.

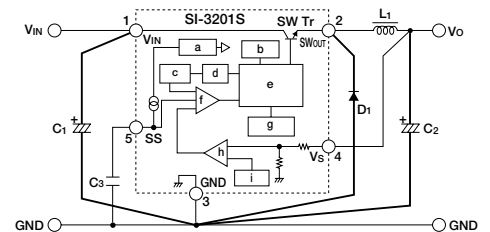
\*3. An external voltage may not be applied to the soft start terminal. As shown in the diagram to the right, use this IC in the soft start mode with a capacitor or in the open-collector drive mode with a transistor. Leave the soft start terminal open when not using it since it is already pulled up in the IC.

## External Dimensions (unit: mm)



(Forming No. 1101)

## Standard Circuit Diagram

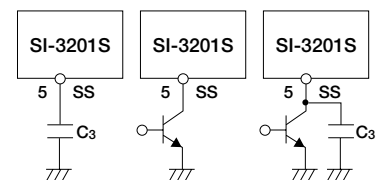


C1: 1000 $\mu\text{F}$   
C2: 1000 $\mu\text{F}$   
L1: 250 $\mu\text{H}$   
D1: RK46 (Sanken)

a: Internal power supply  
b: Thermal protection  
c: Reference oscillator  
d: Reset  
e: Latch & driver  
f: Comparator  
g: Overcurrent protection  
h: Error amplifier  
i: Reference voltage

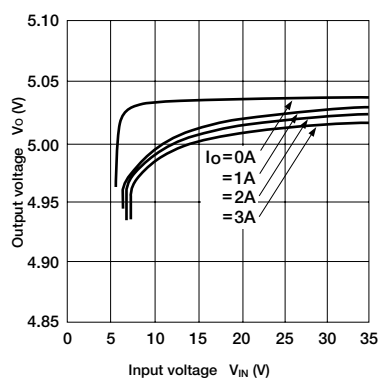
### Cautions:

- (1) A high-ripple current flows through  $C_1$  and  $C_2$ . Use high-ripple type 1000 $\mu\text{F}$  or higher capacitors with low internal resistance. Refer to the respective data books for more information on reliability and electrical characteristics of the capacitor.
- (2)  $C_3$  is a capacitor used for soft start.
- (3)  $L_1$  should be a choke coil with a low core loss for switching power supplies.
- (4) Use a Schottky barrier diode for  $D_1$  and make sure that the reverse voltage applied to the 2nd terminal (SW<sub>OUT</sub> terminal) is within the maximum ratings (-1V). If you use a fast-recovery diode, the recovery voltage and the ON forward voltage may cause a reversed-bias voltage exceeding the maximum ratings to be applied to the 2nd terminal (SW<sub>OUT</sub> terminal). Applying a reversed-bias voltage exceeding the maximum rating to the 2nd terminal (SW<sub>OUT</sub> terminal) may damage the IC.
- (5) The 4th terminal ( $V_S$ ) is an output voltage detection terminal. Since this terminal has a high impedance, connect it to the positive (+) terminal of  $C_2$  via the shortest possible route.
- (6) Leave the 5th terminal (soft start terminal) open when not using it. It is pulled up internally.
- (7) To ensure optimum operating environment, connect the high-frequency current line with minimum wiring length.

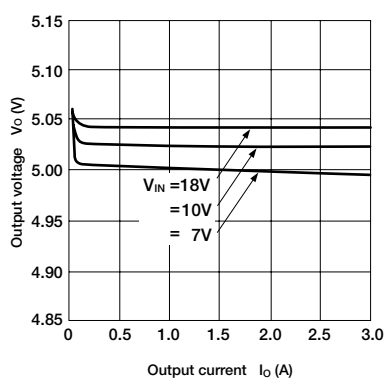


## Electrical Characteristics

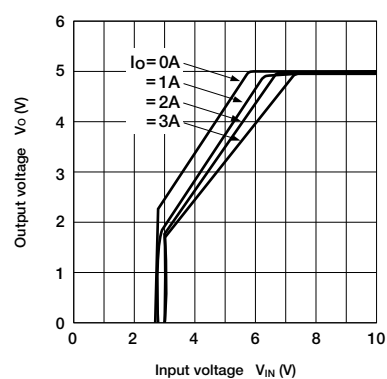
■ Line Regulation



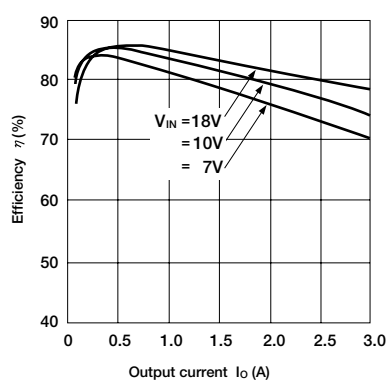
■ Load Regulation



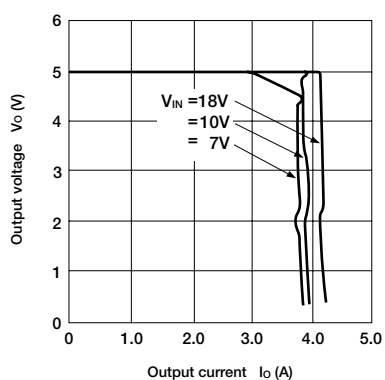
■ Rise Characteristics



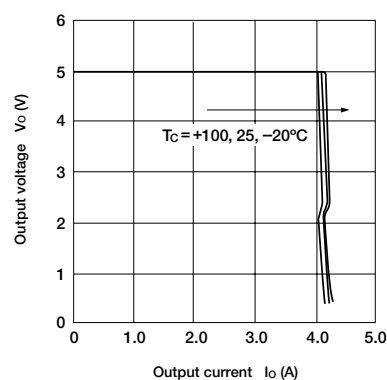
■ Efficiency Curve



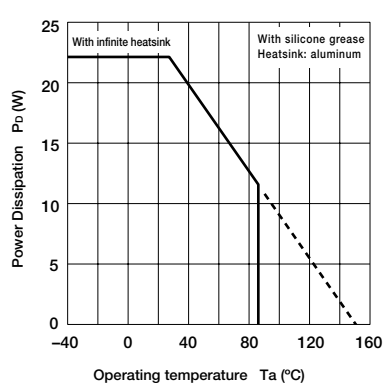
■ Overcurrent Protection Characteristics



■ Overcurrent Protection Temperature Characteristics



■  $T_a$ — $P_D$  Characteristics



# High-side Power Switch ICs [With Diagnostic Function, Surface-mount 2-circuits] SDH04

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent protection circuits
- Built-in protection against reverse connection of power supply
- $T_j = 150^\circ\text{C}$  guaranteed
- Surface-mount full-mold package

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Drive terminal applied voltage	$V_D$	-0.3 to $V_B$	V	
Input terminal voltage	$V_{IN}$	-0.3 to +7.0	V	
DIAG output applied voltage	$V_{DIAG}$	-0.3 to +7.0	V	
DIAG output source current	$I_{DIAG}$	3	mA	
Voltage across power supply and drive terminal	$V_{B-D}$	$V_B - 0.4$	V	
Output current	$I_O$	1.5	A	
Power dissipation	$P_D$	2.6	W	Without heatsink, all circuits operating
Junction temperature	$T_j$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ\text{C}$	

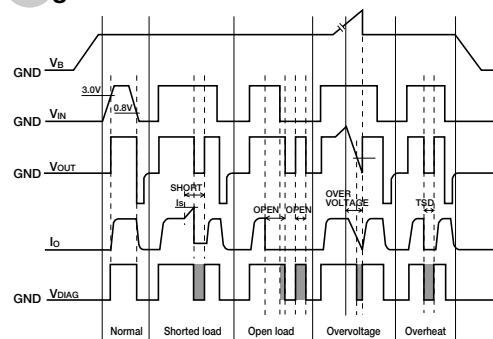
## Electrical Characteristics

( $V_{Bopr} = 14\text{V}$ ,  $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		16	V	
Quiescent circuit current	$I_q$		5	12	mA	Lo output
Threshold input voltage	$V_{INth}$	0.8		3.0	V	
Input current	Hi output	$I_{IN}$		1.0	mA	$V_{IN} = 5\text{V}$
	Lo output	$I_{IN}$	0	100	$\mu\text{A}$	$V_{IN} = 0\text{V}$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.5	V	$I_O \leq 1.0\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
Output terminal sink current	$I_{O(off)}$			2.0	mA	$V_O = 0\text{V}$ , $V_{IN} = 0\text{V}$
Saturation voltage of DIAG output	$V_{DL}$			0.3	V	$I_{DIAG} = 3\text{mA}$
Leak current of DIAG output	$I_{DGH}$			100	$\mu\text{A}$	$V_{DIAG} = 5\text{V}$
Open load detection resistor	$R_{open}$	1		30	k $\Omega$	
Overcurrent protection starting current	$I_s$	1.6			A	$V_O = V_{Bopr} - 1.9\text{V}$
Output transfer time	$T_{ON}$		8	30	$\mu\text{s}$	$I_O = 1\text{A}$
	$T_{OFF}$		15	30	$\mu\text{s}$	$I_O = 1\text{A}$
DIAG output transfer time	$T_{PLH}$		10	30	$\mu\text{s}$	$I_O = 1\text{A}$
	$T_{PHL}$		15	30	$\mu\text{s}$	$I_O = 1\text{A}$

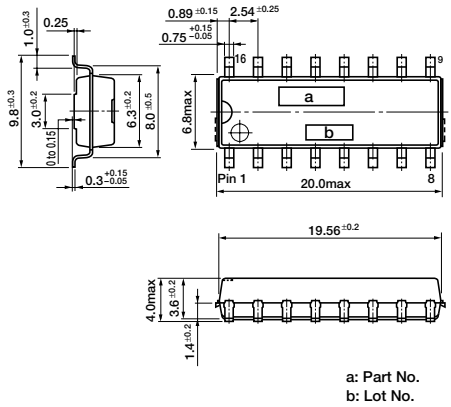
Note: \* The rule of protection against reverse connection of power supply is  $V_B = -13\text{V}$ , one minute (all terminals except,  $V_B$  and GND, are open).

## Diagnostic Function

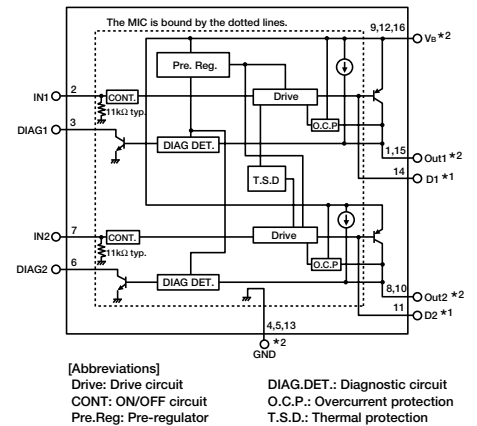


ERROR SIGNAL for CPU

## External Dimensions (unit: mm) SMD-16A

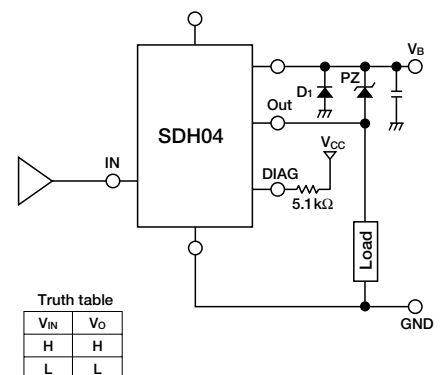


## Equivalent Circuit Diagram



- \*1. The base terminal (D terminal) is connected to the output transistor base. It is also connected to the control monolithic IC. Do not, therefore, apply an external voltage in operation.  
\*2. SDH04 have two or three terminals of the same function ( $V_B$ , Out1, Out2, GND). The terminals of the same function must be shorted at a pattern near the product.

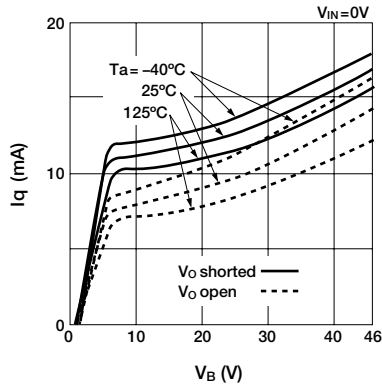
## Standard Circuit Diagram



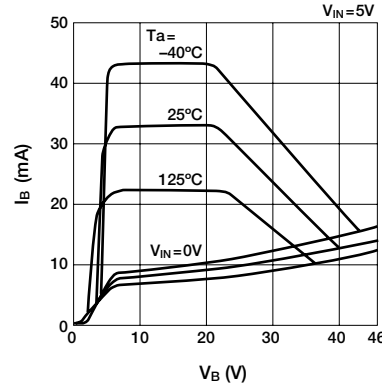
Note 1: A pull-down resistor (11 k $\Omega$  typ.) is connected to the IN terminal.  $V_{OUT}$  turns "L" when a high impedance is connected to the IN terminal in series.

## Electrical Characteristics

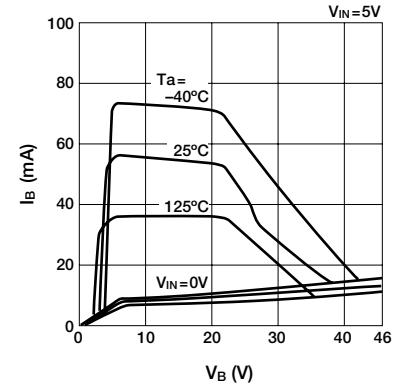
■ Quiescent Circuit Current (dual circuit)



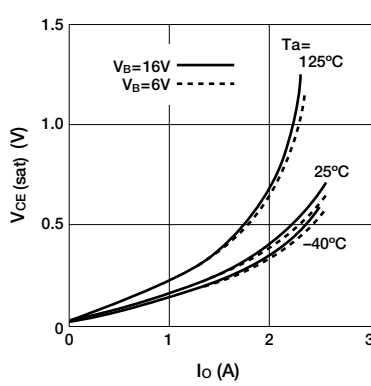
■ Circuit Current (single circuit)



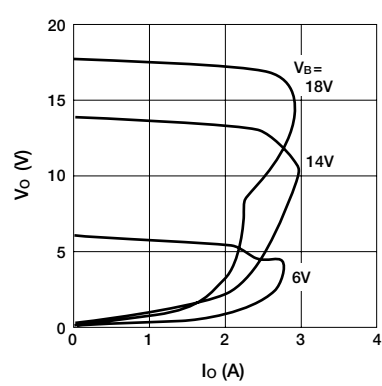
■ Circuit Current (dual circuit)



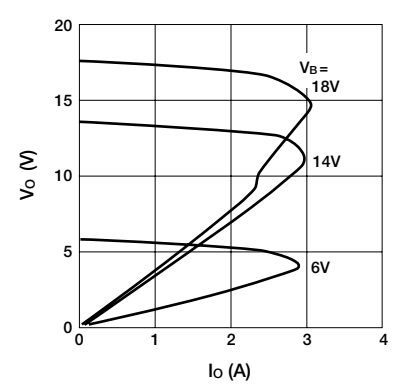
■ Saturation Voltage of Output Transistor



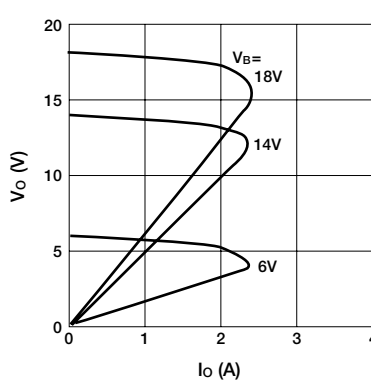
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



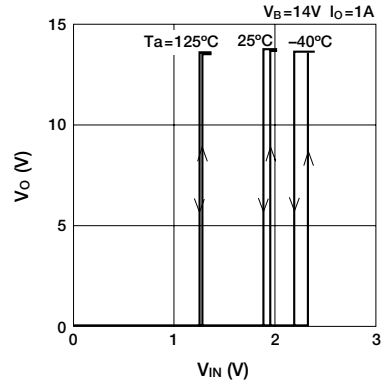
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



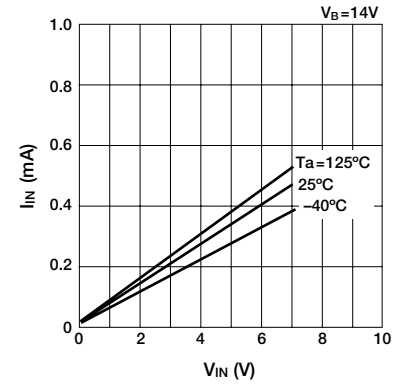
■ Overcurrent Protection Characteristics ( $T_a = 125^\circ\text{C}$ )



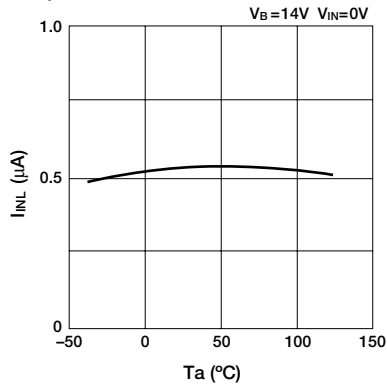
■ Threshold Characteristics of Input Voltage



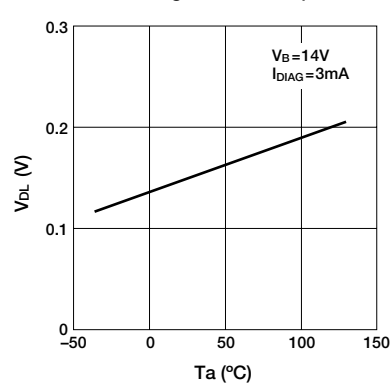
■ Input Terminal Source Current



■ Input Terminal Sink Current



■ Saturation Voltage of DIAG Output



# High-side Power Switch ICs [With Diagnostic Function] SI-5151S

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent and thermal protection circuits
- Built-in protection against reverse connection of power supply
- TO220 equivalent full-mold package not require insulation mica

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	V <sub>B</sub>	40	V	
Input terminal voltage	V <sub>IN</sub>	-0.3 to V <sub>B</sub>	V	
DIAG terminal voltage	V <sub>DIAG</sub>	6	V	
Collector-emitter voltage	V <sub>CE</sub>	40	V	
Output current	I <sub>O</sub>	1.8	A	
Power Dissipation	P <sub>D1</sub>	18	W	With infinite heatsink (T <sub>c</sub> =25°C)
	P <sub>D2</sub>	1.5	W	Stand-alone without heatsink (T <sub>c</sub> =25°C)
Junction temperature	T <sub>j</sub>	-40 to +125	°C	
Operating temperature	T <sub>OP</sub>	-40 to +100	°C	
Storage temperature	T <sub>stg</sub>	-40 to +125	°C	

## Electrical Characteristics

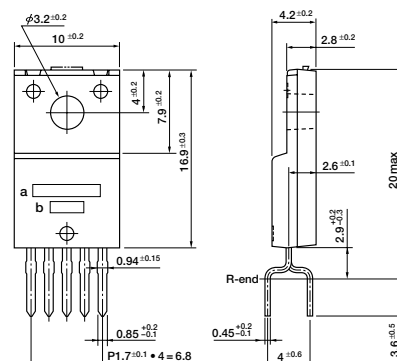
(Ta=25°C unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	V <sub>Bopr</sub>	6.0		30	V	
Quiescent circuit current	I <sub>q</sub>		5	12	mA	V <sub>Bopr</sub> =14V, V <sub>IN</sub> =0V
Saturation voltage of output transistor	V <sub>CE(sat)</sub>			0.5	V	I <sub>O</sub> ≤ 1.0A, V <sub>Bopr</sub> =6 to 16V
				1.0	V	I <sub>O</sub> ≤ 1.8A, V <sub>Bopr</sub> =6 to 16V
Output leak current	I <sub>O, leak</sub>			2	mA	V <sub>CE</sub> =16V
Input voltage	Output ON	V <sub>IH</sub>	2.0	V <sub>B</sub>	V	V <sub>Bopr</sub> =6 to 16V
	Output OFF	V <sub>IL</sub>	-0.3	0.8	V	V <sub>Bopr</sub> =6 to 16V
Input current	Output ON	I <sub>IH</sub>		1	mA	V <sub>IN</sub> =5V
	Output OFF	I <sub>IL</sub>	-0.1		mA	V <sub>IN</sub> =0V
Overcurrent protection starting current	I <sub>s</sub>	1.9			A	V <sub>Bopr</sub> =14V, V <sub>O</sub> =V <sub>Bopr</sub> -1.5V
Thermal protection starting temperature	T <sub>TSD</sub>	125	145		°C	
Open load detection resistor	R <sub>open</sub>			30	kΩ	V <sub>Bopr</sub> =6 to 16V
Output transfer time	T <sub>ON</sub>		8	30	μs	V <sub>Bopr</sub> =14V, I <sub>O</sub> =1A
	T <sub>OFF</sub>		15	30	μs	V <sub>Bopr</sub> =14V, I <sub>O</sub> =1A
DIAG output voltage	V <sub>DH</sub>	4.5		6	V	V <sub>CC</sub> =6V
	V <sub>DL</sub>			0.3	V	V <sub>CC</sub> =6V, I <sub>DD</sub> =2mA
DIAG output transfer time	T <sub>PLH</sub>			30	μs	V <sub>Bopr</sub> =14V, I <sub>O</sub> =1A
	T <sub>PHL</sub>			30	μs	V <sub>Bopr</sub> =14V, I <sub>O</sub> =1A
Minimum load inductance	L	1			mH	

Note:

\* The rule of protection against reverse connection of power supply is V<sub>B</sub> = -13V, one minute (all terminals except, V<sub>B</sub> and GND, are open).

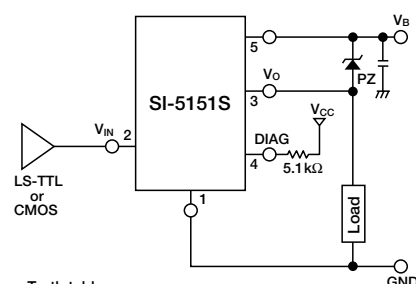
## External Dimensions (unit: mm)



1. GND
  2. V<sub>IN</sub>
  3. V<sub>O</sub>
  4. DIAG
  5. V<sub>B</sub>
- a: Part No.  
b: Lot No.

(Forming No. 1123)

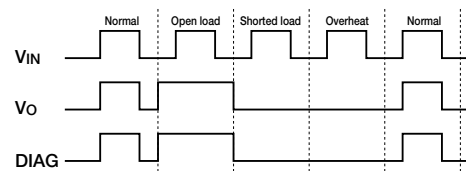
## Standard Circuit Diagram



Truth table

V <sub>IN</sub>	V <sub>O</sub>
H	H
L	L

## Diagnostic Function

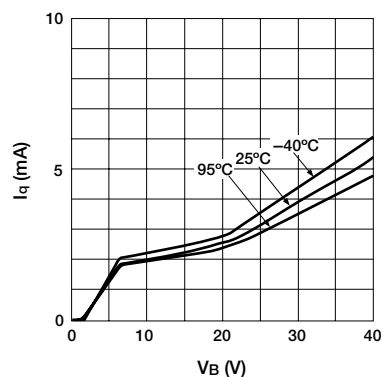


Mode	V <sub>IN</sub>	V <sub>O</sub>	DIAG
Normal	L	L	L
Open load	L	H	H
Shorted load	L	L	L
Overheat	L	L	L

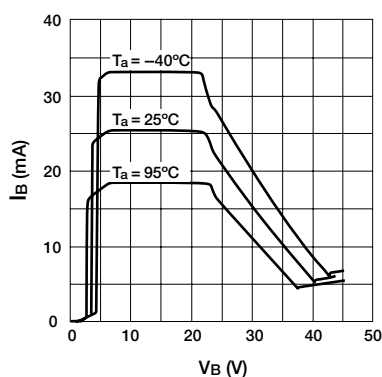
- DIAG output will be undetermined when a voltage exceeding 25V is applied to V<sub>B</sub> terminal.

## Electrical Characteristics

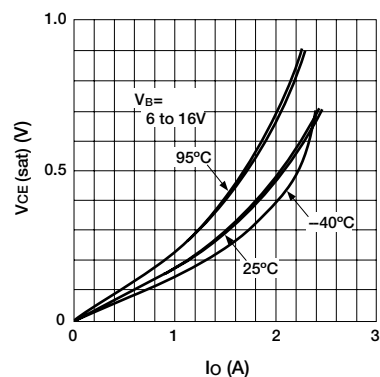
■ Quiescent Circuit Current



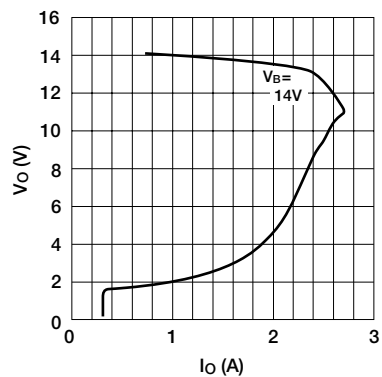
■ Circuit Current



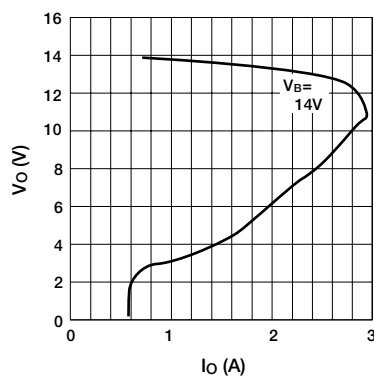
■ Saturation Voltage of Output Transistor



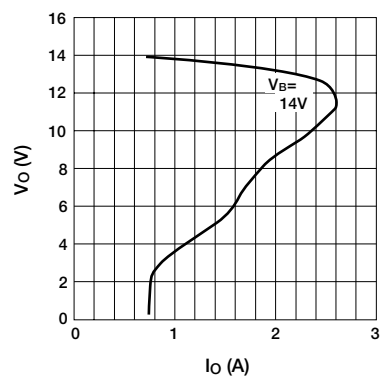
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



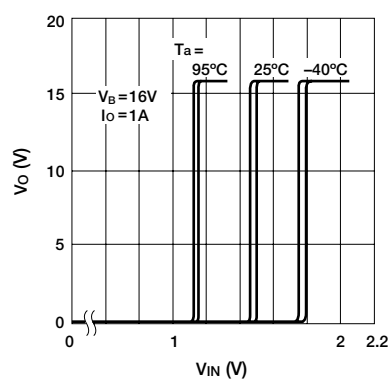
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



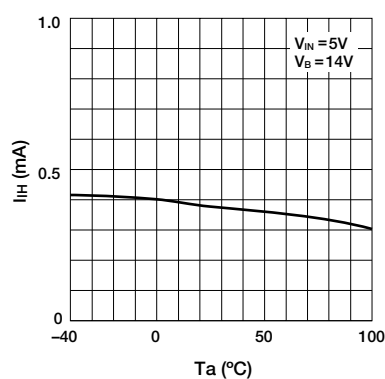
■ Overcurrent Protection Characteristics ( $T_a = 100^\circ\text{C}$ )



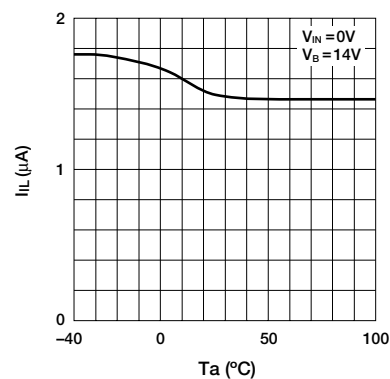
■ Threshold input voltage



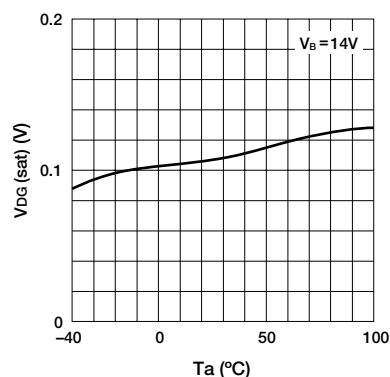
■ Input Current (Output ON)



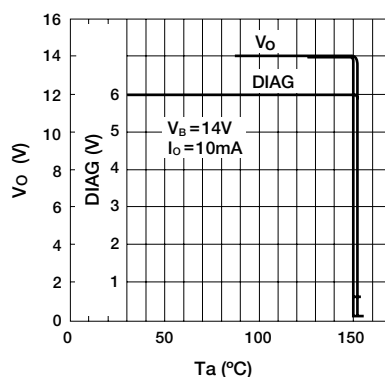
■ Input Current (Output OFF)



■ Saturation Voltage of DIAG Output



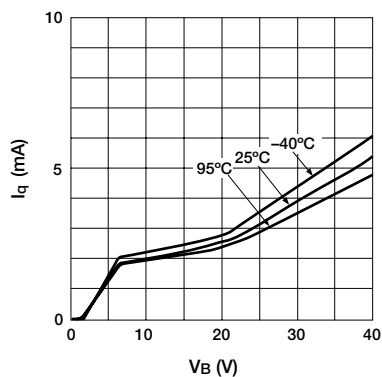
■ Thermal Protection Characteristics



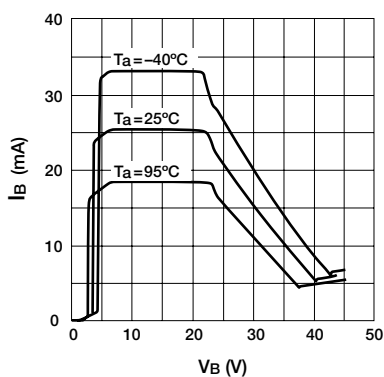


## Electrical Characteristics

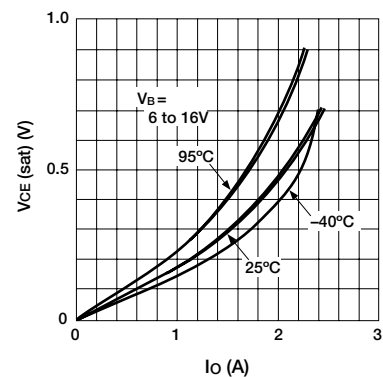
■ Quiescent Circuit Current



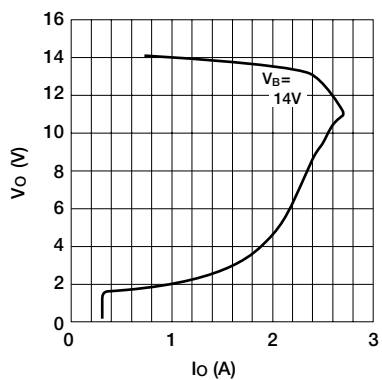
■ Circuit Current



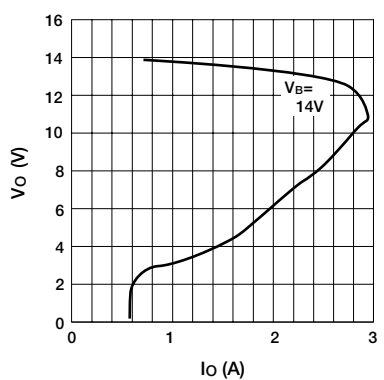
■ Saturation Voltage of Output Transistor



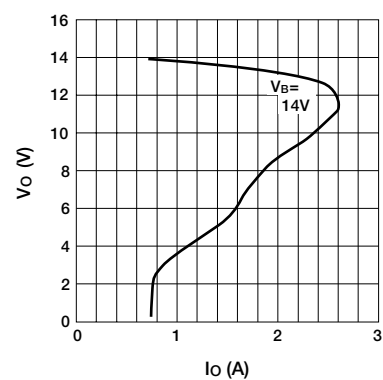
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



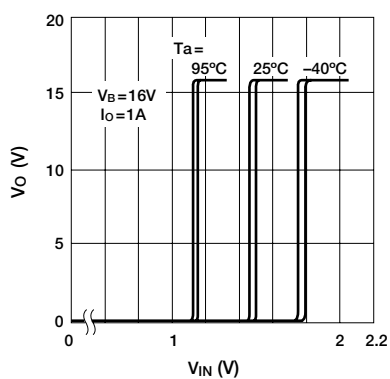
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



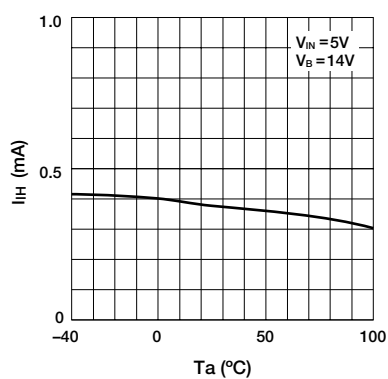
■ Overcurrent Protection Characteristics ( $T_a = 100^\circ\text{C}$ )



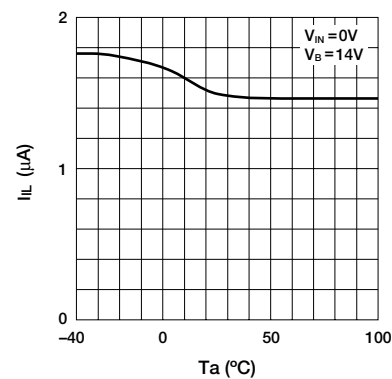
■ Threshold input voltage



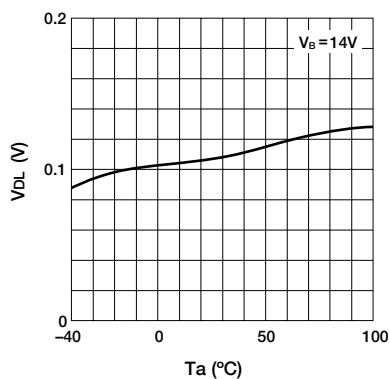
■ Input Current (Output ON)



■ Input Current (Output OFF)



■ Saturation Voltage of DIAG Output



## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent and thermal protection circuits
- Built-in protection against reverse connection of power supply
- $T_j = 150^\circ\text{C}$  guaranteed
- Built-in Zener diode
- TO220 equivalent full-mold package not require insulation mica

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Input terminal voltage	$V_{IN}$	-0.3 to $V_B$	V	
DIAG terminal voltage	$V_{DIAG}$	6	V	
Collector-emitter voltage	$V_{CE}$	$V_B - V_Z$	V	Refer to "Surge clamp voltage" in Electrical Characteristics
Output current	$I_O$	2.04	A	
Power Dissipation	$P_{D1}$	22	W	With infinite heatsink ( $T_c = 25^\circ\text{C}$ )
	$P_{D2}$	1.8	W	Stand-alone without heatsink
Junction temperature	$T_j$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ\text{C}$	

## Electrical Characteristics

( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		30	V	
Quiescent circuit current	$I_q$		5	12	mA	$V_{Bopr} = 14\text{V}$ , $V_{IN} = 0\text{V}$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.47	V	$I_O \leq 2.05\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
Output leak current	$I_{O, leak}$			2	mA	$V_{CE0} = 16\text{V}$ , $V_{IN} = 0\text{V}$
Input voltage	Output ON	$V_{IH}$	2.0		V	$V_{Bopr} = 6$ to $16\text{V}$
	Output OFF	$V_{IL}$	-0.3	0.8	V	$V_{Bopr} = 6$ to $16\text{V}$
Input current	Output ON	$I_{IH}$		1	mA	$V_{IN} = 5\text{V}$
	Output OFF	$I_{IL}$	-0.1		mA	$V_{IN} = 0\text{V}$
Overcurrent protection starting current	$I_S$	2.05			A	$V_{Bopr} = 14\text{V}$ , $V_O = V_{Bopr} - 1.5\text{V}$
Thermal protection starting temperature	$T_{SD}$	150			$^\circ\text{C}$	$V_{Bopr} \geq 6\text{V}$
Open load detection resistor	$R_{open}$			30	k $\Omega$	$V_{Bopr} = 6$ to $16\text{V}$
Output transfer time	$T_{ON}$		8	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{OFF}$		15	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
DIAG output voltage	$V_{DH}$	4.5		6	V	$V_{CC} = 6\text{V}$ , $V_{Bopr} = 6$ to $16\text{V}$
	$V_{DL}$			0.3	V	$V_{CC} = 6\text{V}$ , $V_{Bopr} = 6$ to $16\text{V}$ , $I_{O0} = 2\text{mA}$
DIAG output transfer time	$T_{PLH}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{PHL}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
Minimum load inductance	$L$	1			mH	
Surge clamp voltage	$V_Z$	28	34	40	V	$I_C = 5\text{mA}$

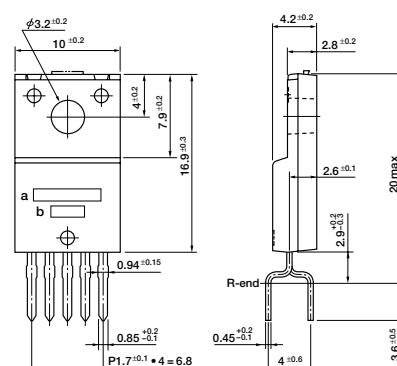
Note:

\*1. The Zener diode for surge clamping has an energy capability of 140 mJ (single pulse).

\* The rule of protection against reverse connection of power supply is  $V_B = -13\text{V}$ , one minute.

\* This driver is exclusively used for ON/OFF control.

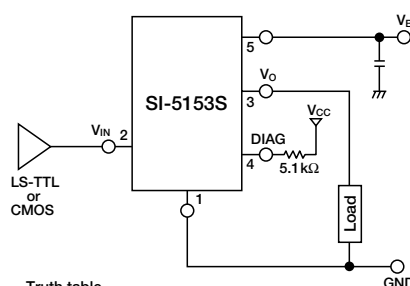
## External Dimensions (unit: mm)



1. GND
  2.  $V_{IN}$
  3.  $V_O$
  4. DIAG
  5.  $V_B$
- a: Part No.  
b: Lot No.

(Forming No. 1123)

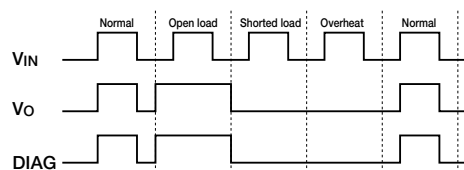
## Standard Circuit Diagram



Truth table

$V_{IN}$	$V_O$
H	H
L	L

## Diagnostic Function

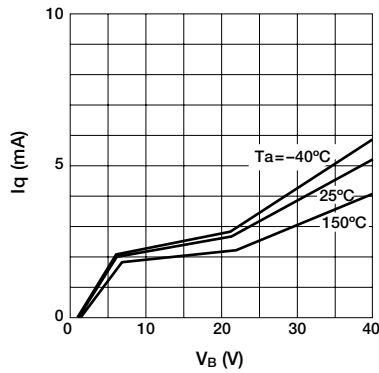


Mode	$V_{IN}$	$V_O$	DIAG
Normal	L	L	L
Open load	L	H	H
Shorted load	L	L	L
Overheat	L	L	L

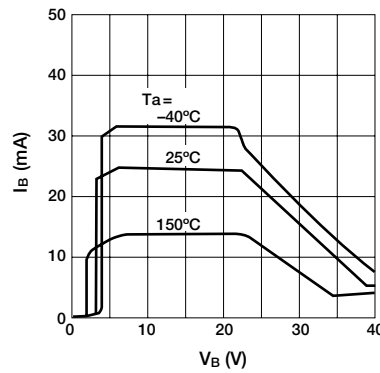
- DIAG output will be undetermined when a voltage exceeding 25V is applied to  $V_B$  terminal.

## Electrical Characteristics

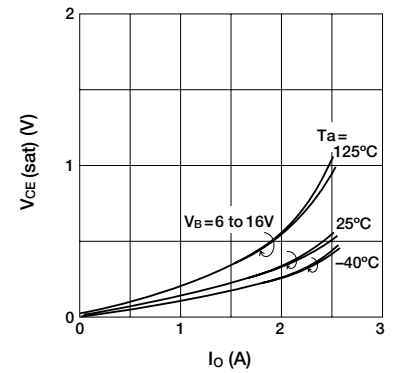
■ Quiescent Circuit Current



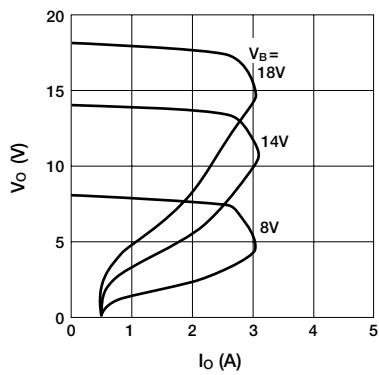
■ Circuit Current



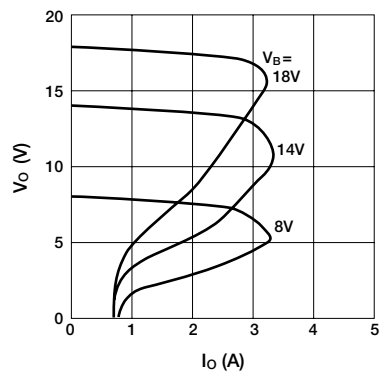
■ Saturation Voltage of Output Transistor



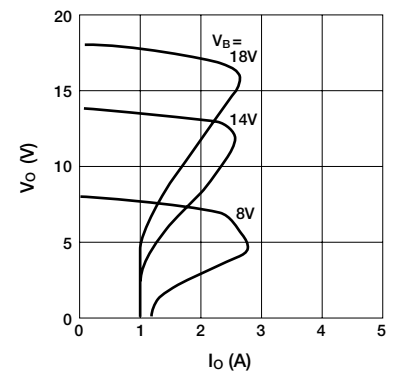
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



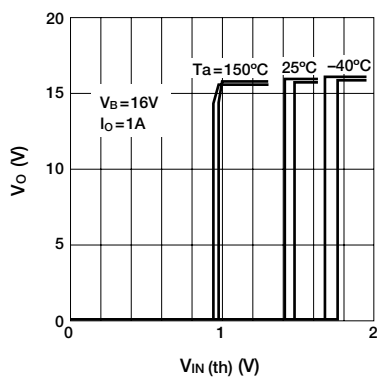
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



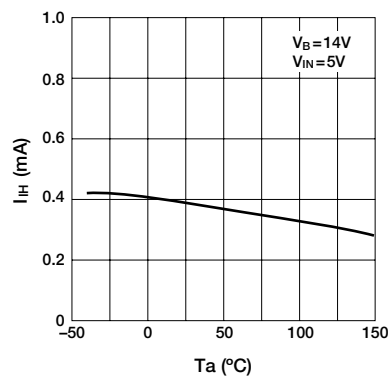
■ Overcurrent Protection Characteristics ( $T_a = 125^\circ\text{C}$ )



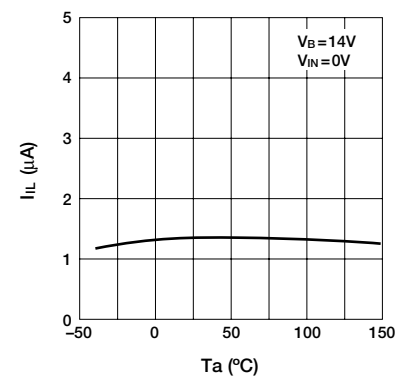
■ Threshold Characteristics of Input Voltage



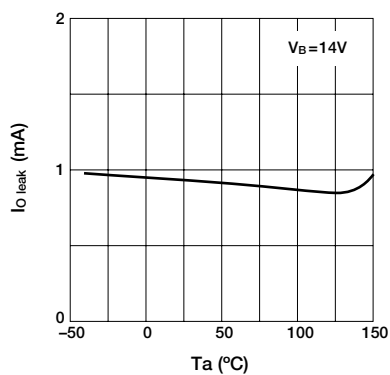
■ Input Current (Output ON)



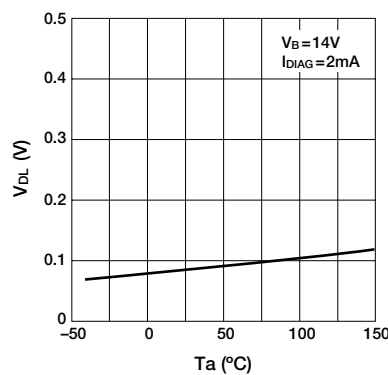
■ Input Current (Output OFF)



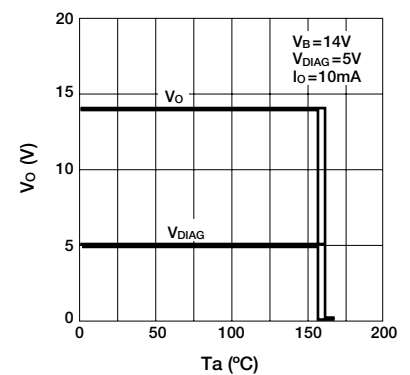
■ Output Terminal Leak Current



■ Saturation Voltage of DIAG Output



■ Thermal Protection Characteristics



## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent and thermal protection circuits
- Built-in protection against reverse connection of power supply
- $T_J = 150^\circ\text{C}$  guaranteed
- Built-in Zener diode
- TO220 equivalent full-mold package not require insulation mica

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Input terminal voltage	$V_{IN}$	-0.3 to $V_B$	V	
DIAG terminal voltage	$V_{DIAG}$	6	V	
Collector-emitter voltage	$V_{CE}$	$V_B - V_Z$	V	Refer to "Surge clamp voltage" in Electrical Characteristics
Output current	$I_O$	2.5	A	
Power Dissipation	$P_{D1}$	22	W	With infinite heatsink ( $T_c = 25^\circ\text{C}$ )
	$P_{D2}$	1.8	W	Stand-alone without heatsink
Junction temperature	$T_J$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ\text{C}$	

## Electrical Characteristics

( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		30	V	
Quiescent circuit current	$I_q$		5	12	mA	$V_{Bopr} = 14\text{V}$ , $V_{IN} = 0\text{V}$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.3	V	$I_O \leq 1.0\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
				0.72	V	$I_O \leq 2.5\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
Output leak current	$I_{O, leak}$			2	mA	$V_{CE} = 16\text{V}$ , $V_{IN} = 0\text{V}$
Input voltage	Output ON	$V_{IH}$	2.0	$V_B$	V	$V_{Bopr} = 6$ to $16\text{V}$
	Output OFF	$V_{IL}$	-0.3	0.8	V	$V_{Bopr} = 6$ to $16\text{V}$
Input current	Output ON	$I_{IH}$		1	mA	$V_{IN} = 5\text{V}$
	Output OFF	$I_{IL}$	-0.1		mA	$V_{IN} = 0\text{V}$
Overcurrent protection starting current	$I_S$	2.6			A	$V_{Bopr} = 14\text{V}$ , $V_O = V_{Bopr} - 1.5\text{V}$
Thermal protection starting temperature	$T_{TSD}$	150			$^\circ\text{C}$	$V_{Bopr} \geq 6\text{V}$
Open load detection resistor	$R_{open}$			30	k $\Omega$	$V_{Bopr} = 6$ to $16\text{V}$
Output transfer time	$T_{ON}$		8	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{OFF}$		15	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
DIAG output voltage	$V_{DH}$	4.5		6	V	$V_{CC} = 6\text{V}$ , $V_{Bopr} = 6$ to $16\text{V}$
	$V_{DL}$			0.3	V	$V_{CC} = 6\text{V}$ , $V_{Bopr} = 6$ to $16\text{V}$ , $I_{DO} = 2\text{mA}$
DIAG output transfer time	$T_{PLH}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{PHL}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
Minimum load inductance	$L$	1			mH	
Surge clamp voltage	$V_Z$	28	34	40	V	$I_C = 5\text{mA}$

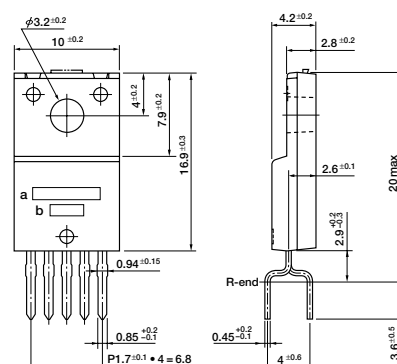
Note:

\*1. The Zener diode for surge clamping has an energy capability of 200 mJ (single pulse).

\* The rule of protection against reverse connection of power supply is  $V_B = -13\text{V}$ , one minute.

\* This driver is exclusively used for ON/OFF control.

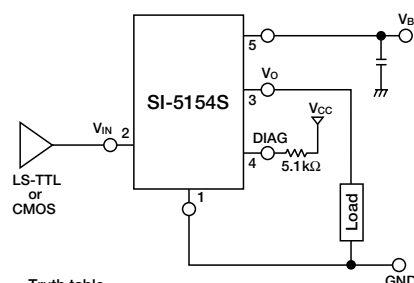
## External Dimensions (unit: mm)



1. GND
  2.  $V_{IN}$
  3.  $V_O$
  4. DIAG
  5.  $V_B$
- a: Part No.  
b: Lot No.

(Forming No. 1123)

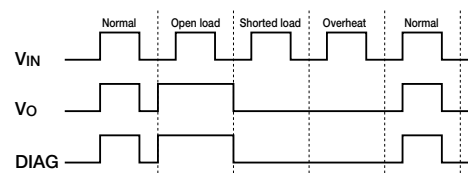
## Standard Circuit Diagram



Truth table

$V_{IN}$	$V_O$
H	H
L	L

## Diagnostic Function

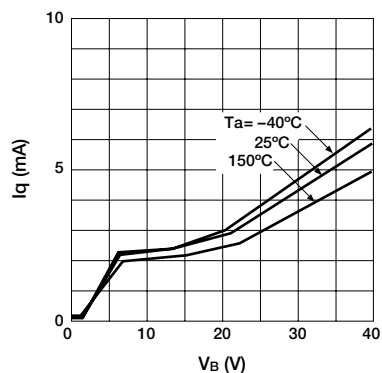


Mode	$V_{IN}$	$V_O$	DIAG
Normal	L	L	H
Open load	L	H	H
Shorted load	L	L	L
Overheat	L	L	L

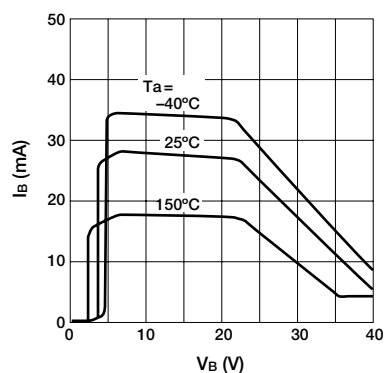
- DIAG output will be undetermined when a voltage exceeding 25V is applied to  $V_B$  terminal.

## Electrical Characteristics

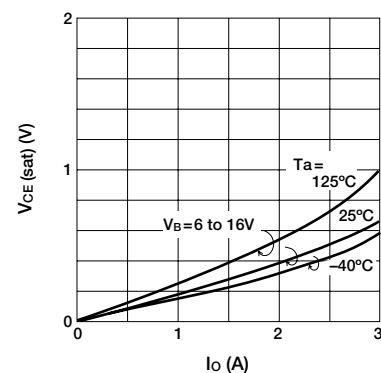
■ Quiescent Circuit Current



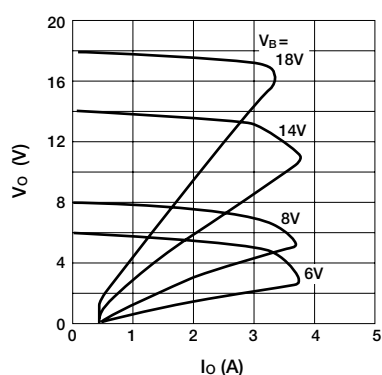
■ Circuit Current



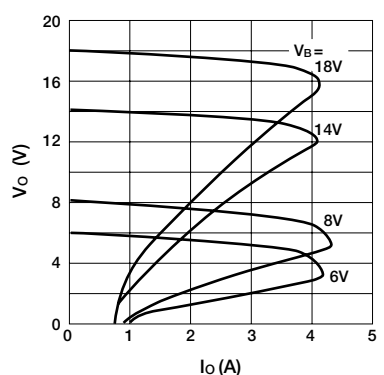
■ Saturation Voltage of Output Transistor



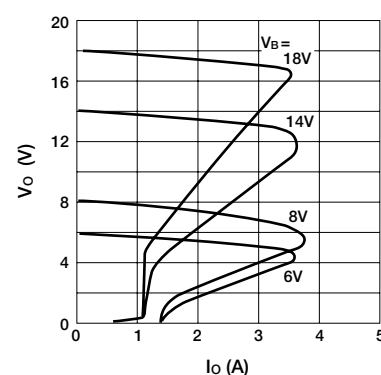
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



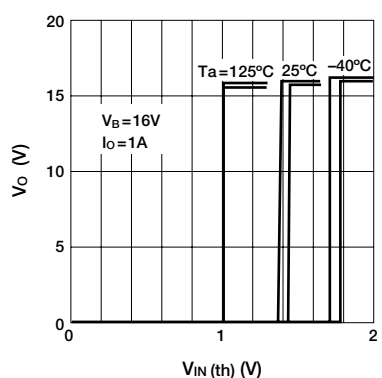
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



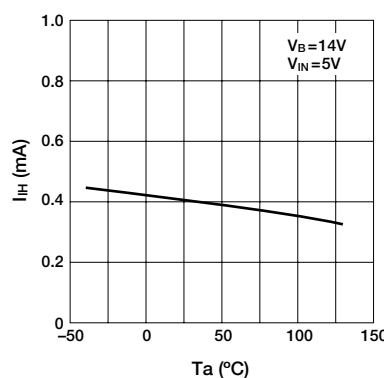
■ Overcurrent Protection Characteristics ( $T_a = 125^\circ\text{C}$ )



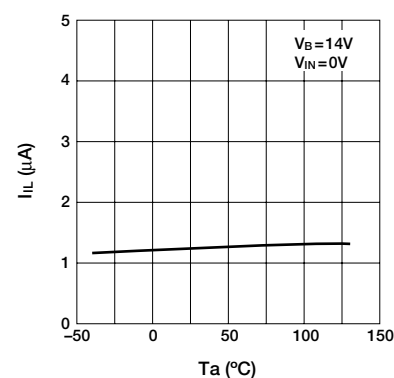
■ Threshold input voltage



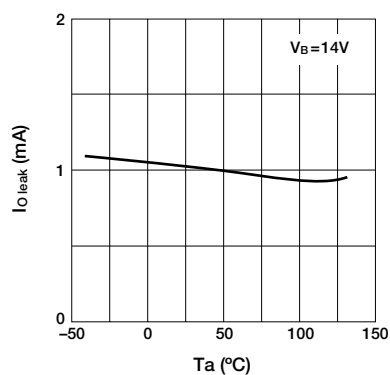
■ Input Current (Output ON)



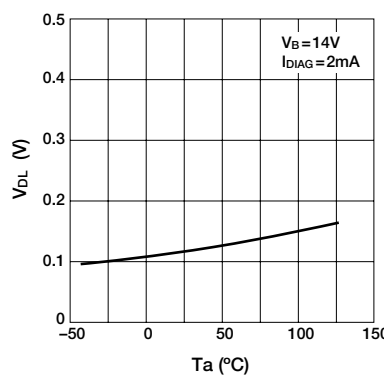
■ Input Current (Output OFF)



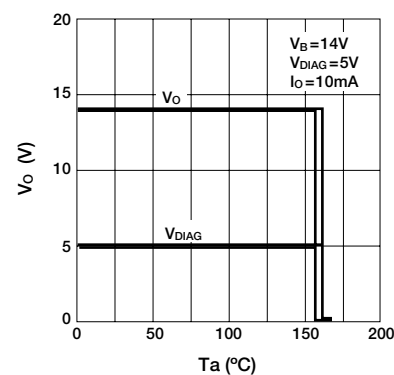
■ Output Terminal Leak Current



■ Saturation Voltage of DIAG Output



■ Thermal Protection Characteristics



# High-side Power Switch ICs [With Diagnostic Function] SI-5155S

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent and thermal protection circuits
- Built-in protection against reverse connection of power supply
- $T_J = 150^\circ\text{C}$  guaranteed
- TO220 equivalent full-mold package not require insulation mica

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Input terminal voltage	$V_{IN}$	-0.3 to $V_B$	V	
DIAG terminal voltage	$V_{DIAG}$	6	V	
Collector-emitter voltage	$V_{CE}$	40	V	
Output current	$I_O$	2.5	A	
Power dissipation	$P_{D1}$	22	W	With infinite heatsink ( $T_c = 25^\circ\text{C}$ )
	$P_{D2}$	1.8	W	Stand-alone without heatsink
Junction temperature	$T_J$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^\circ\text{C}$	

## Electrical Characteristics

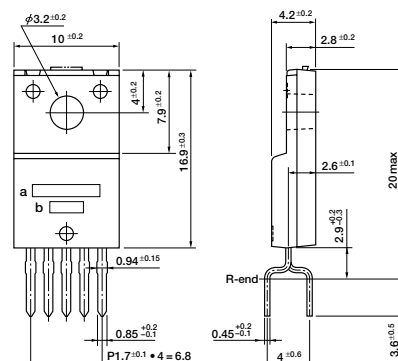
( $T_a = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		30	V	
Quiescent circuit current	$I_q$		5	12	mA	$V_{Bopr} = 14\text{V}$ , $V_{IN} = 0\text{V}$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.3	V	$I_O \leq 1.0\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
				0.72	V	$I_O \leq 2.5\text{A}$ , $V_{Bopr} = 6$ to $16\text{V}$
Output leak current	$I_{o, leak}$			2	mA	$V_{CE0} = 16\text{V}$ , $V_{IN} = 0\text{V}$
Input voltage	Output ON	$V_{IH}$	2.0	$V_B$	V	$V_{Bopr} = 6$ to $16\text{V}$
	Output OFF	$V_{IL}$	-0.3	0.8	V	$V_{Bopr} = 6$ to $16\text{V}$
Input current	Output ON	$I_{IH}$		1	mA	$V_{IN} = 5\text{V}$
	Output OFF	$I_{IL}$	-0.1		mA	$V_{IN} = 0\text{V}$
Overcurrent protection starting current	$I_S$	2.6			A	$V_{Bopr} = 14\text{V}$ , $V_O = V_{Bopr} - 1.5\text{V}$
Thermal protection starting temperature	$T_{TSD}$	150			$^\circ\text{C}$	$V_{Bopr} \geq 6\text{V}$
Open load detection resistor	$R_{open}$			30	$k\Omega$	$V_{Bopr} = 6$ to $16\text{V}$
Output transfer time	$T_{ON}$		8	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{OFF}$		15	30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
DIAG output voltage	$V_{DH}$	4.5		6	V	$V_{CC} = 6\text{V}$ , $V_{Bopr} = 6$ to $16\text{V}$ , $I_{DO} = 2\text{mA}$
	$V_{DL}$			0.3	V	
DIAG output transfer time	$T_{PLH}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
	$T_{PHL}$			30	$\mu\text{s}$	$V_{Bopr} = 14\text{V}$ , $I_O = 1\text{A}$
Minimum load inductance	$L$	1			mH	

Note:

\* The rule of protection against reverse connection of power supply is  $V_B = -13\text{V}$ , one minute (all terminals except,  $V_B$  and GND, are open).

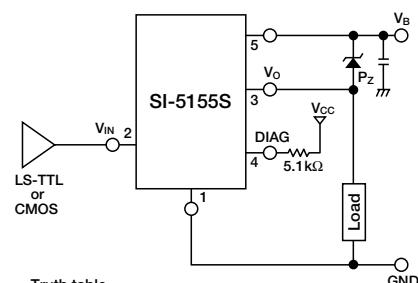
## External Dimensions (unit: mm)



1. GND
  2.  $V_{IN}$
  3.  $V_O$
  4. DIAG
  5.  $V_B$
- a: Part No.  
b: Lot No.

(Forming No. 1123)

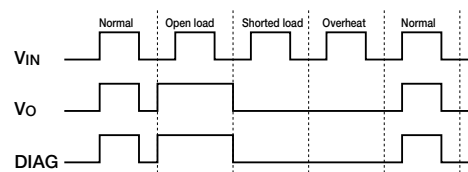
## Standard Circuit Diagram



Truth table

$V_{IN}$	$V_O$
H	H
L	L

## Diagnostic Function

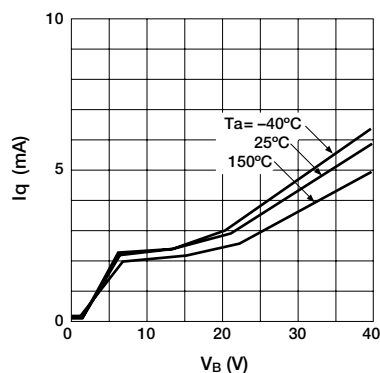


Mode	$V_{IN}$	$V_O$	DIAG
Normal	L	L	L
Open load	L	H	H
Shorted load	L	L	L
Overheat	L	L	L

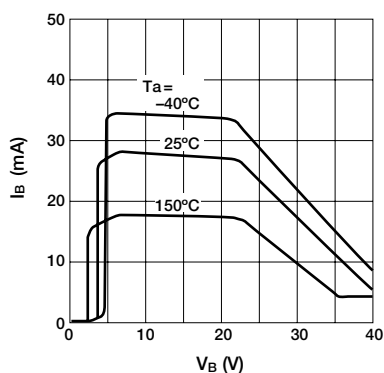
- DIAG output will be undetermined when a voltage exceeding 25V is applied to  $V_B$  terminal.

## Electrical Characteristics

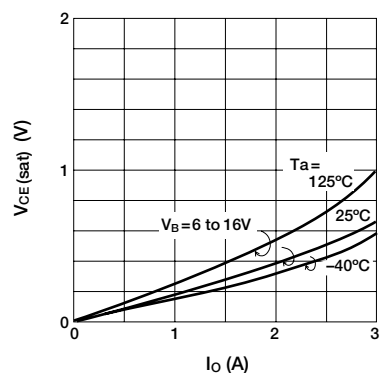
■ Quiescent Circuit Current



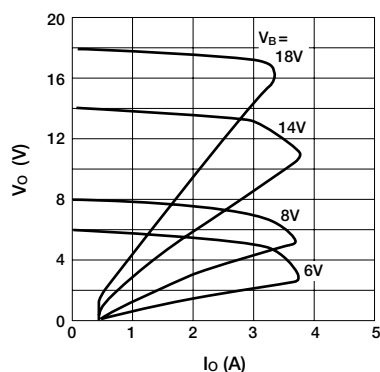
■ Circuit Current



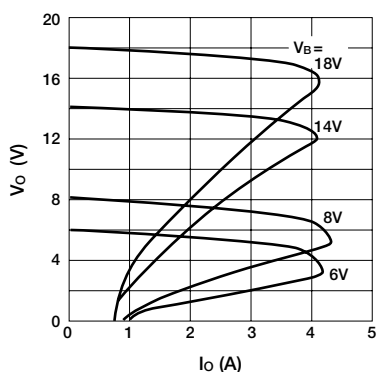
■ Saturation Voltage of Output Transistor



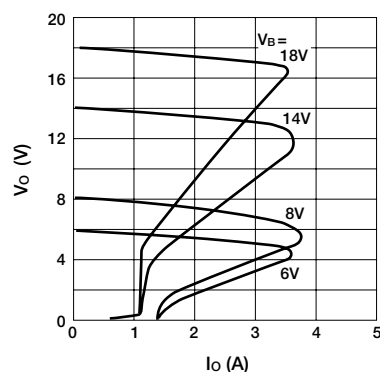
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



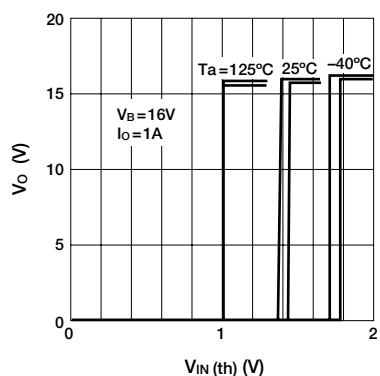
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ\text{C}$ )



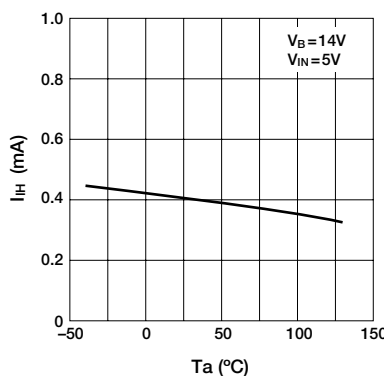
■ Overcurrent Protection Characteristics ( $T_a = 125^\circ\text{C}$ )



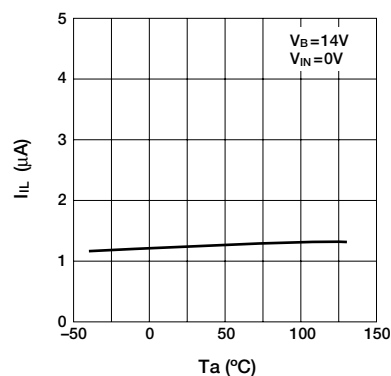
■ Threshold input voltage



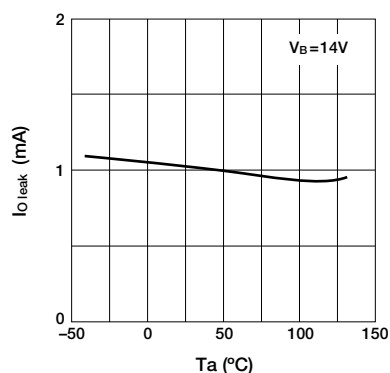
■ Input Current (Output ON)



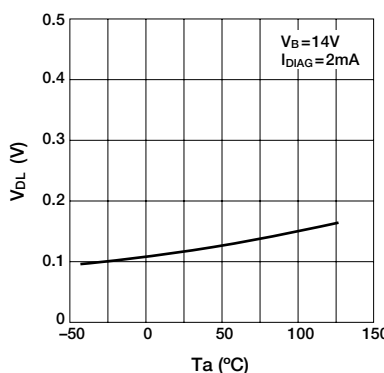
■ Input Current (Output OFF)



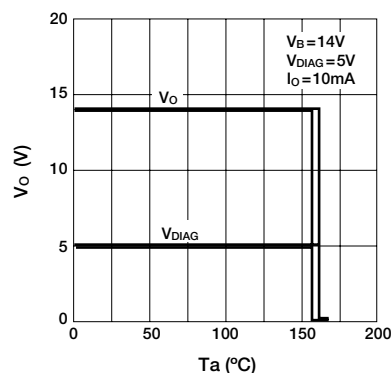
■ Output Terminal Leak Current



■ Saturation Voltage of DIAG Output



■ Thermal Protection Characteristics



# High-side Power Switch ICs [With Diagnostic Function, 3-circuits] SLA2501M

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use ( $V_{CE(sat)} \leq 0.2V$ )
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in Zener diode in transistor eliminates the need of (or simplifies) external surge absorption circuit
- Built-in independent overcurrent and thermal protection circuit in each circuit
- Built-in protection against reverse connection of power supply
- $T_j = 150^\circ\text{C}$  guaranteed

## Absolute Maximum Ratings

( $T_a = 25^\circ\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Drive terminal applied voltage	$V_D$	-0.3 to $V_B$	V	
Input terminal voltage	$V_{IN}$	-0.3 to +7.0	V	
DIAG output applied voltage	$V_{DIAG}$	-0.3 to +7.0	V	
DIAG output source current	$I_{DIAG}$	-3	mA	
Voltage across power supply and output terminal	$V_{B-O}$	$V_B - 34$	V	
Voltage across power supply and drive terminal	$V_{B-D}$	-0.4	V	
Output current	$I_O$	1.5	A	
Output reverse current	$I_O$	-1.8	A	
Electrostatic resistance	$E_S/A$	$\pm 250$	V	$C = 200\text{pF}$ , $R = 0\Omega$
Power Dissipation	$P_D$	4.8	W	Stand-alone without heatsink, all circuits operating
Junction temperature	$T_j$	-40 to +150	$^\circ\text{C}$	
Operating temperature	$T_{OP}$	-40 to +115	$^\circ\text{C}$	
Storage temperature	$T_{stg}$	-50 to +150	$^\circ\text{C}$	

## Electrical Characteristics

( $V_{Bopr} = 14V$ ,  $T_j = -40$  to  $+150^\circ\text{C}$  unless otherwise specified)

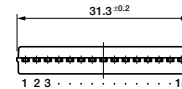
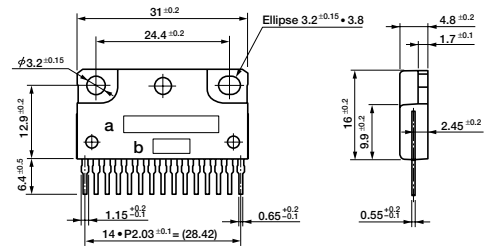
Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		16	V	
Quiescent circuit current (per circuit)	$I_q$		0.8	1.6	mA	$I_O$ output
Circuit current (per circuit)	$I_B$		19.3		mA	$T_j = 25^\circ\text{C}$
Threshold input voltage	$V_{INth}$	0.8		3.0	V	
Input voltage	Hi output	$V_{IN}$	3.7		V	
	Lo output	$V_{IN}$		1.5	V	
Input current	Hi output	$I_{IN}$		-1.0	mA	$V_{IN} = 5V$
	Lo output	$I_{IN}$	100		$\mu\text{A}$	$V_{IN} = 0V$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.2	V	$I_O \leq 1.2A$ , $V_{Bopr} = 6$ to $16V$
	$V_{CE(sat)}$		1.0		V	$I_O \leq 1.5A$ , $V_{Bopr} = 6$ to $16V$
Output terminal sink current	$I_{O(off)}$		2.5	5	mA	$T_j = 25^\circ\text{C}$ , $V_{CEO} = 14V$
	$V_{B-O}$	29	34	39	V	$T_j = 25^\circ\text{C}$ , $I_C = 10\text{mA}$
Surge clamp voltage	$V_{B-O}$	28	34	40	V	$I_C = 5\text{mA}$
Saturation voltage of DIAG output	$V_{DL}$			0.4	V	$I_{OGH} = -2\text{mA}$ , $V_{Bopr} = 6$ to $16V$
Leak current of DIAG output	$I_{DGH}$			-100	$\mu\text{A}$	$V_{CC} = 7V$
Open load detection resistor	$R_{open}$	5.5			$k\Omega$	
Overcurrent protection starting current	$I_S$	1.6			A	$V_O = V_{Bopr} - 1.5V$
Thermal protection starting temperature	$T_{TSD}$				$^\circ\text{C}$	$V_{Bopr} \geq 6V$
Output transfer time	$T_{ON}$			30	$\mu\text{s}$	$I_O = 1A$
	$T_{OFF}$			100	$\mu\text{s}$	$I_O = 1A$
DIAG output transfer time	$T_{PLH}$			30	$\mu\text{s}$	$I_O = 1A$
	$T_{PHL}$			100	$\mu\text{s}$	$I_O = 1A$
Minimum load inductance	$L_O$	1.0			mH	
Maximum ON duty	$D_{(ON)}$	0		60	%	

Note:

\* The Zener diode has an energy capability of 200 mJ (single pulse).

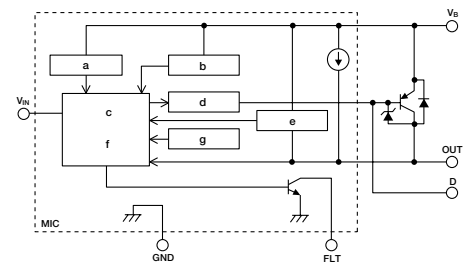
\* A start failure may occur if a short OFF signal of 10 ms or below is input in the  $V_{IN}$  terminal.

## External Dimensions (unit: mm)



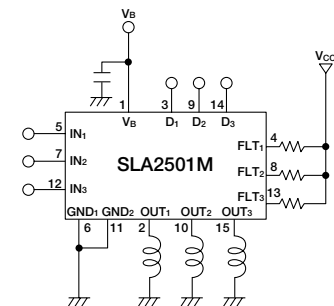
a: Part No.  
b: Lot No.

## Equivalent Circuit Diagram

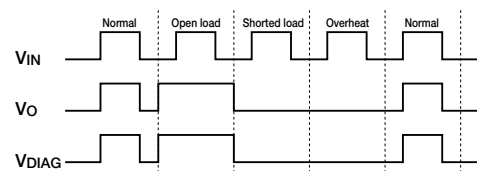


- a: Pre-regulator  
b: Overvoltage protection circuit  
c: Control circuit  
d: Driver circuit  
e: Overcurrent protection circuit  
f: Diagnostic circuit  
g: Thermal protection circuit

## Standard Circuit Diagram

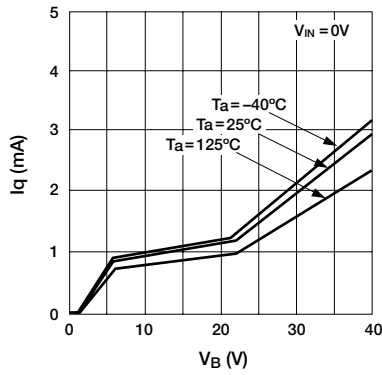


## Diagnostic Function

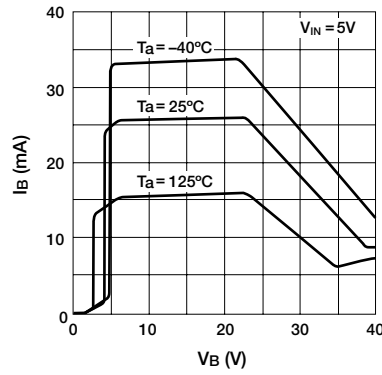


## Electrical Characteristics

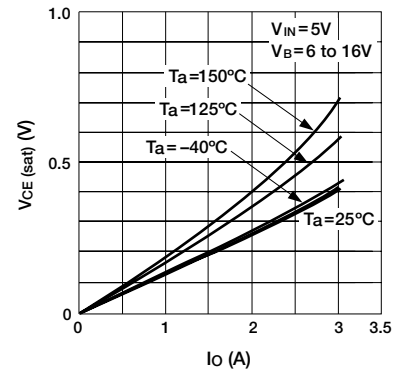
■ Quiescent Circuit Current (single circuit)



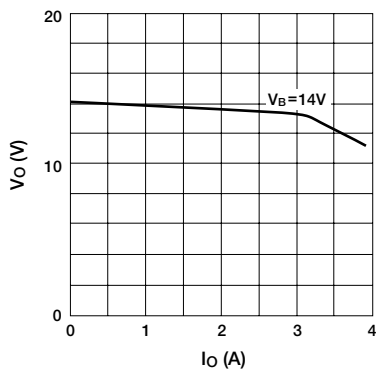
■ Circuit Current (single circuit)



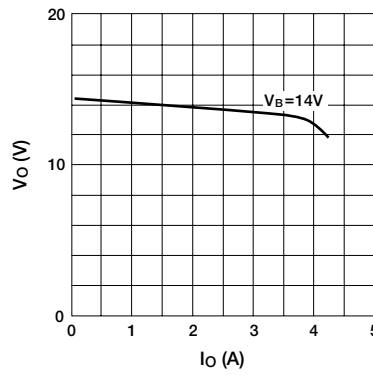
■ Saturation Voltage of Output Transistor



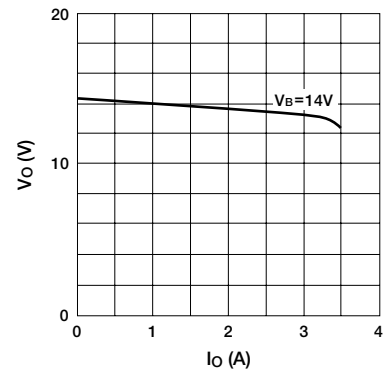
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ C$ )



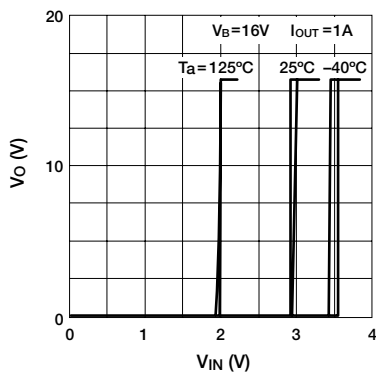
■ Overcurrent Protection Characteristics ( $T_a = 25^\circ C$ )



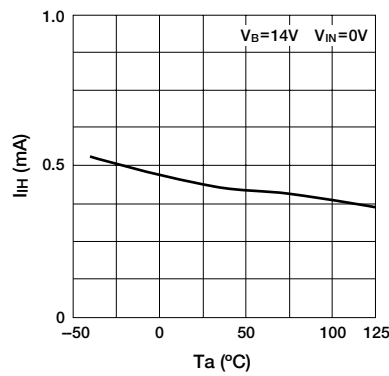
■ Overcurrent Protection Characteristics ( $T_a = 125^\circ C$ )



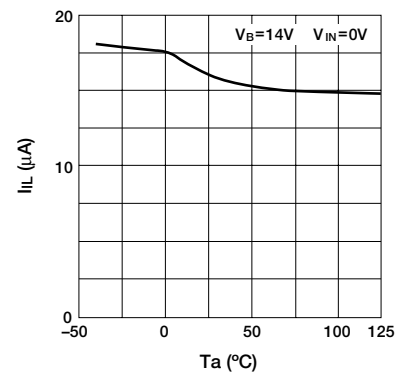
■ Threshold Input Voltage



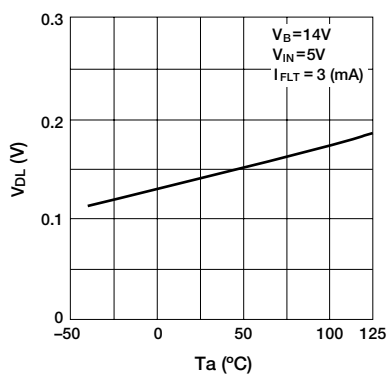
■ Input Current (Output ON)



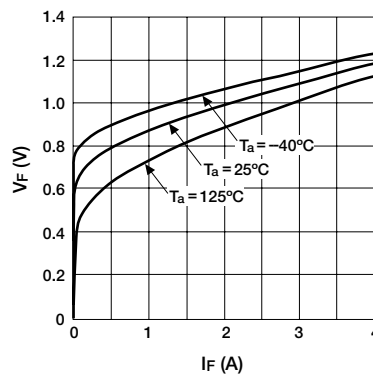
■ Input Current (Output OFF)



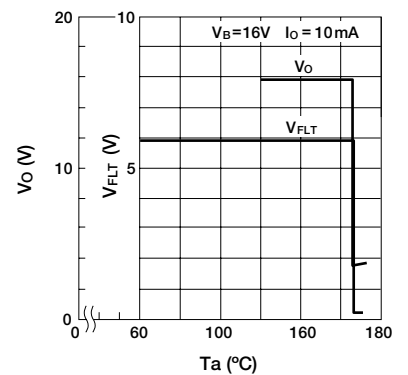
■ Saturation Voltage of DIAG Output



■ Output Reverse Current



■ Thermal Protection



# High-side Power Switch ICs [With Diagnostic Function, 4-circuits] SLA2502M

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- Low saturation PNP transistor use ( $V_{CE(sat)} \leq 0.5V$ )
- Allows direct driving using LS-TTL and C-MOS logic levels
- Built-in overcurrent protection circuits
- Built-in protection against reverse connection of power supply
- $T_J = 150^\circ C$  guaranteed

## Absolute Maximum Ratings

( $T_a = 25^\circ C$ )

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	-13 to +40	V	
Input terminal voltage	$V_{IN}$	-0.3 to +7.0	V	
DIAG output applied voltage	$V_{DIAG}$	-0.3 to +7.0	V	
DIAG output source current	$I_{DIAG}$	3	mA	
Output current	$I_O$	1.2	A	
Power Dissipation	$P_D$	4.8	W	Stand-alone operation without heatsink; all circuits operating
Junction temperature	$T_J$	-40 to +150	$^\circ C$	
Operating temperature	$T_{OP}$	-40 to +100	$^\circ C$	
Storage temperature	$T_{stg}$	-50 to +150	$^\circ C$	

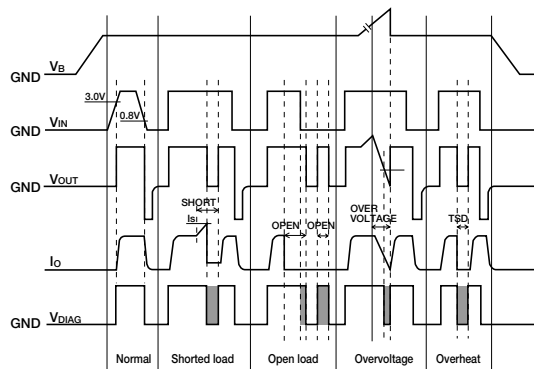
## Electrical Characteristics

( $V_{Bopr} = 14V$ ,  $T_a = 25^\circ C$  unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	$V_{Bopr}$	6.0		16	V	
Quiescent circuit current (per circuit)	$I_q$		5	12	mA	$V_{IN} = 0V$
Threshold input voltage	$V_{INth}$	0.8		3.0	V	
Input current	Hi output	$I_{IN}$		1.0	mA	$V_{IN} = 5V$
	Lo output	$I_{IN}$	0	100	$\mu A$	$V_{IN} = 0V$
Saturation voltage of output transistor	$V_{CE(sat)}$			0.5	V	$I_O \leq 1.0A$ , $V_{Bopr} = 6$ to $16V$
Output terminal sink current	$I_O(off)$			2.0	mA	$V_O = 0V$ , $V_{IN} = 0V$
Saturation voltage of DIAG output	$V_{DL}$			0.3	V	$I_{DIAG} = 3mA$
Leak current of DIAG output	$I_{DGH}$			100	$\mu A$	$V_{DIAG} = 5V$
Open load detection resistor	$R_{open}$			30	k $\Omega$	
Overcurrent protection starting current	$I_S$	1.6			A	$V_O = V_{Bopr} - 1.9V$
Output transfer time	$T_{ON}$		8	30	$\mu s$	$I_O = 1A$
	$T_{OFF}$		15	30	$\mu s$	$I_O = 1A$
DIAG output transfer time	$T_{PLH}$		10	30	$\mu s$	$I_O = 1A$
	$T_{PHL}$		15	30	$\mu s$	$I_O = 1A$

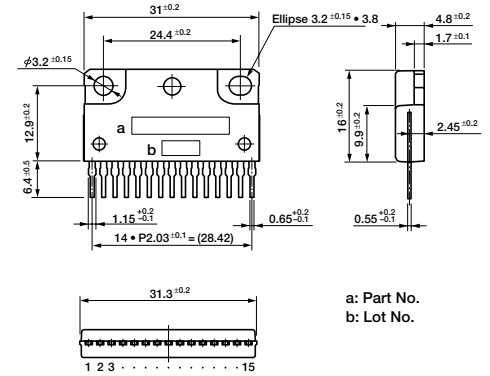
Note: \* The rule of protection against reverse connection of power supply is  $V_B = -13V$ , one minute (all terminals except  $V_B$  and GND should be open).

## Diagnostic Function

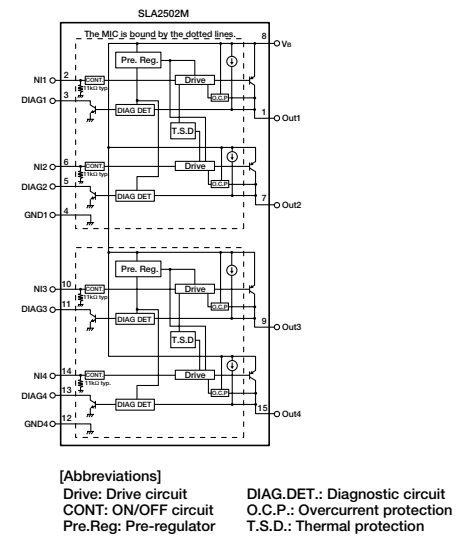


ERROR SIGNAL for CPU

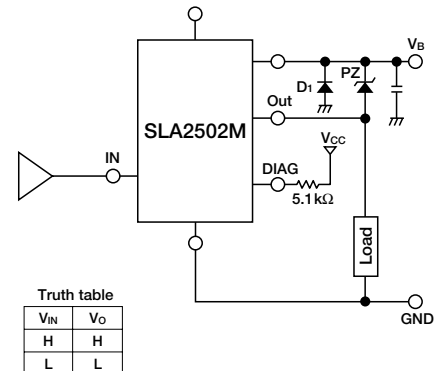
## External Dimensions (unit: mm)



## Equivalent Circuit Diagram



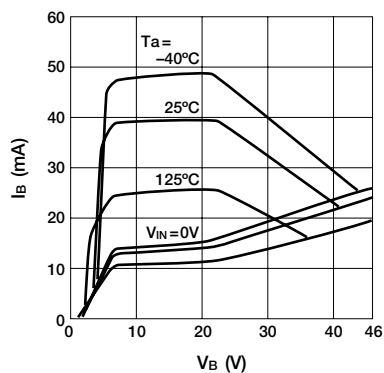
## Standard Circuit Diagram



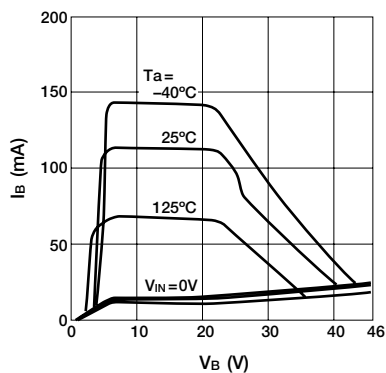
- Note 1: A pull-down resistor (11k $\Omega$  typ.) is connected to the IN terminal.  $V_{OUT}$  turns "L" when a high impedance is connected to the IN terminal in series.
- Note 2: Grounds GND1 and GND2 are not wired internally. They must be shorted at a pattern near the product.

## Electrical Characteristics

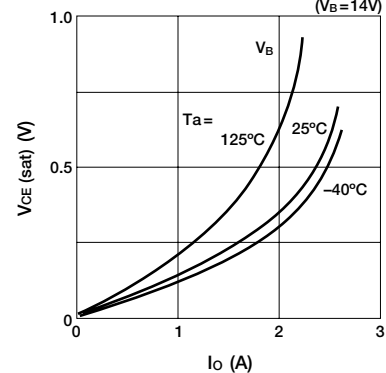
■ Circuit Current (single circuit)



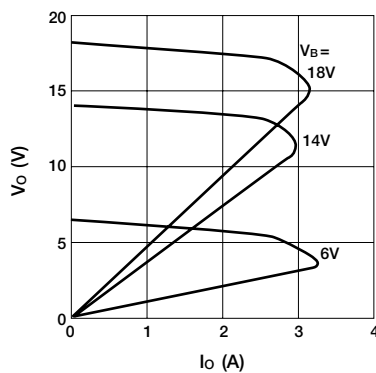
■ Circuit Current (4 circuits)



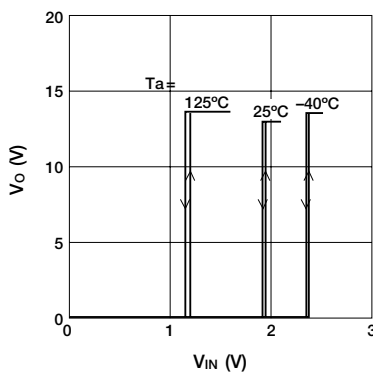
■ Saturation Voltage of Output Transistor ( $V_B = 14\text{V}$ )



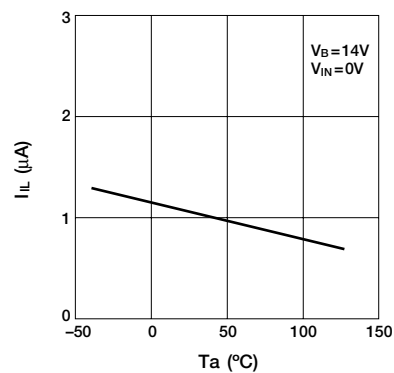
■ Overcurrent Protection Characteristics ( $T_a = -40^\circ\text{C}$ )



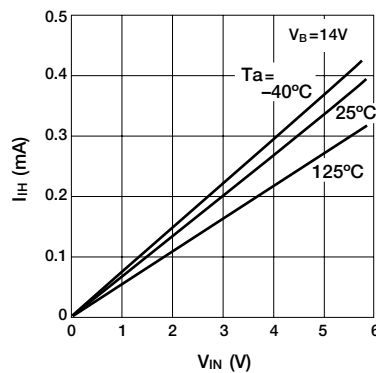
■ Threshold Input Voltage



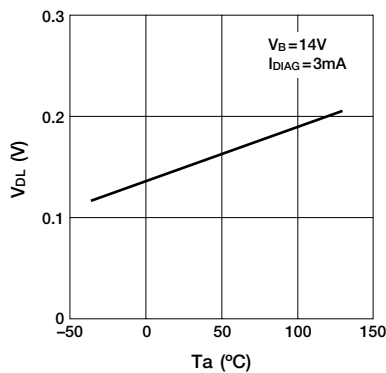
■ Input Current (Output OFF)



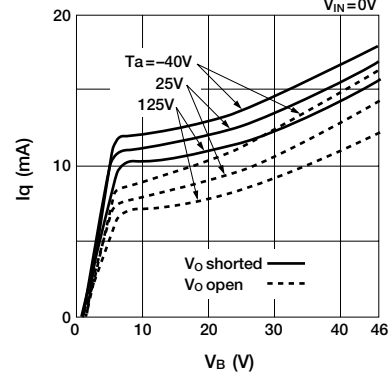
■ Input Current (Output Hi)



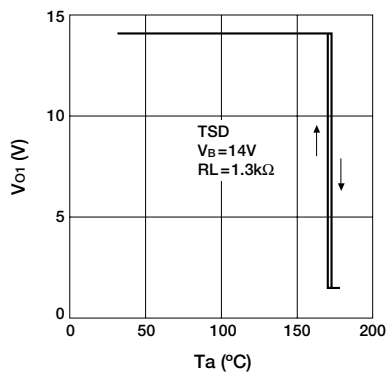
■ Saturation Voltage of DIAG Output



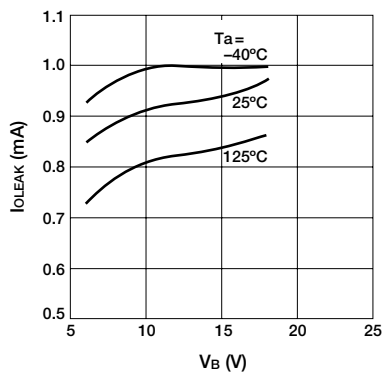
■ Quiescent Circuit Current (dual circuit) ( $V_{IN} = 0\text{V}$ )



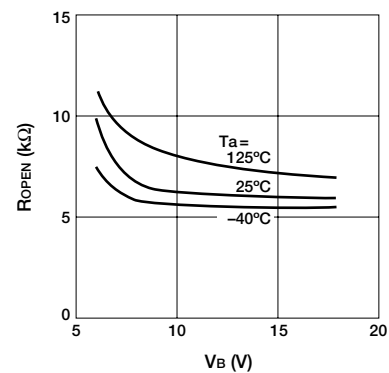
■ Thermal Protection Characteristics



■ Output Terminal Leak Current ( $V_O = 0\text{V}$ )



■ Open Load Detection Resistor



## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- DMOS 2ch output
- Allows ON/OFF using C-MOS logic level
- Built-in overcurrent and thermal protection circuits

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	35	V	
Input terminal voltage	$V_{IN}$	-0.3 to 7	V	
Input terminal current	$I_{IN}$	5	mA	
DG terminal voltage	$V_{DG}$	-0.3 to 7	V	
DG terminal current	$I_{DG}$	5	mA	
Drain to source voltage	$V_{DS}$	$V_B-45$	V	
Output current	$I_O$	1.8	A	
Power dissipation	$P_D$	2	W	$T_a=25^{\circ}\text{C}$
Source to drain $D_i$ forward current	$I_F$	0.8	A	
Channel temperature	$T_{ch}$	150	$^{\circ}\text{C}$	
Operating temperature	$T_{OP}$	-40 to +105	$^{\circ}\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^{\circ}\text{C}$	

## Electrical Characteristics

(V<sub>B</sub>=14V, T<sub>a</sub>=25°C unless otherwise specified)

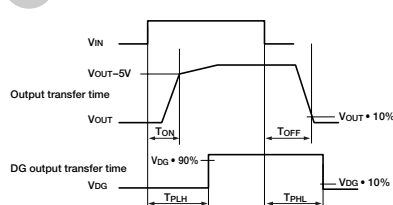
Parameter	Symbol	Ratings			Unit	Conditions	
		min	typ	max			
Operating power supply voltage	V <sub>B(OPP)</sub>	5.5		35	V		
Quiescent circuit current	I <sub>q</sub>			1	mA	V <sub>IN</sub> =0V, V <sub>OUT</sub> =0V	
Output ON resistance	R <sub>OS(ON)</sub>			200	mΩ	I <sub>O</sub> =1A	
				300	mΩ	I <sub>O</sub> =1A, T <sub>a</sub> =80°C	
Output leak current	I <sub>O, leak</sub>		50	100	μA	V <sub>OUT</sub> =0V	
Input threshold voltage	Output ON	V <sub>IHth</sub>	1.4	2.0	3.0	V	T <sub>a</sub> = -40 to +105°C
	Output OFF	V <sub>ILth</sub>	1.0	1.8		V	T <sub>a</sub> = -40 to +105°C
Inpup current	Output ON	I <sub>IH</sub>		70	200	μA	V <sub>IN</sub> =5V
	Output OFF	I <sub>IL</sub>			12	μA	V <sub>IN</sub> =0V
Overcurrent protection starting current	I <sub>S</sub>	1.9	3		A	V <sub>OUT</sub> =V <sub>O</sub> -1.5V	
Internal current limit	I <sub>Lim</sub>		5		A	V <sub>OUT</sub> =0V	
Thermal shutdown operating temperature	T <sub>TSD</sub>	155	165		°C		
Load open detection threshold voltage	V <sub>open</sub>	1.5	3	4.5	V		
Output transfer time *1	T <sub>ON</sub>		70	140	μs	R <sub>L</sub> =14Ω, V <sub>O</sub> =-5V	
	T <sub>OFF</sub>		35	90	μs	R <sub>L</sub> =14Ω, V <sub>O</sub> •10%	
DG leak current	I <sub>DG</sub>			20	μA	V <sub>DG</sub> =5.5V	
Low level DG output voltage	V <sub>DGL</sub>		0.15	0.5	V	I <sub>DG</sub> =1.6mA	
DG output transfer time *1	T <sub>PLH</sub>		70	140	μs		
	T <sub>PHL</sub>		45	120	μs		

Note: \*1. Transient time is showed Wave Form below.

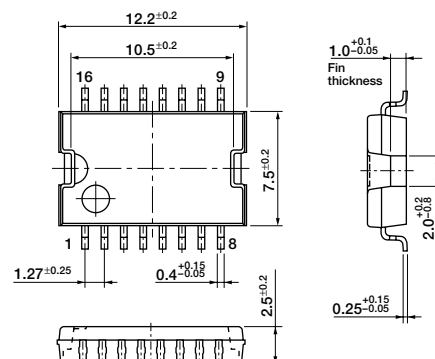
### Recommended Operating Conditions (for one channel)

Parameter	Ratings		Unit
	min	max	
Power supply voltage	5.5	16	V
V <sub>IH</sub>	4	5.5	V
V <sub>IL</sub>	−0.3	0.9	V
I <sub>O</sub>		1	A
R <sub>IN</sub>	10	20	kΩ
R <sub>DS</sub>	10	20	kΩ

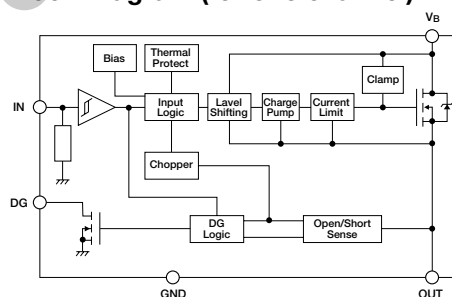
## Wave Form



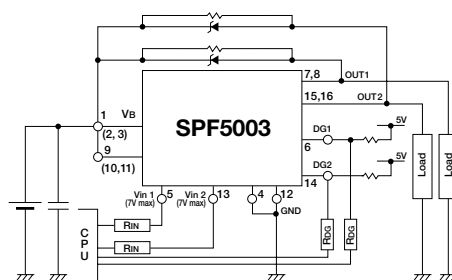
## External Dimensions (unit: mm)



### Block Diagram (for one channel)

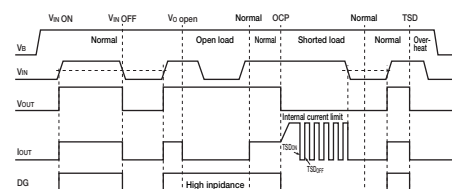


## Standard Connection Diagram



- \* RIN and RDG are needed to protect CPU and SPF5003 in case of reverse connection of V<sub>B</sub> terminal.
- \* Make V<sub>B</sub> of 1Pin and 9Pin short from the fin to be plated by solder.

## Timing Chart



Mode	V <sub>IN</sub>	DG	V <sub>O</sub>
Normal	H L	H L	H L
Open load	H L	H H	H H
Shorted load	H L	L L	L (Limiting) L
Overheat	H L	L L	L L



# High-side Power Switch ICs [With Diagnostic Function, Surface-mount 2-circuits] **SPF5004**

## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- DMOS 2ch output
- Allows ON/OFF using C-MOS logic level
- Built-in overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	V <sub>B</sub>	35	V	
Input terminal voltage	V <sub>IN</sub>	-0.3 to 7	V	
Input terminal current	I <sub>IN</sub>	5	mA	
DG terminal voltage	V <sub>DG</sub>	-0.3 to 7	V	
DG terminal current	I <sub>DG</sub>	5	mA	
Drain to source voltage	V <sub>DS</sub>	V <sub>B</sub> -45	V	
Output current	I <sub>O</sub>	2.5	A	
Power dissipation	P <sub>D</sub>	2.7	W	Ta=25°C
Source to drain Di forward current	I <sub>F</sub>	0.8	A	
Channel temperature	T <sub>ch</sub>	150	°C	
Operating temperature	T <sub>OP</sub>	-40 to +105	°C	
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	

## Electrical Characteristics

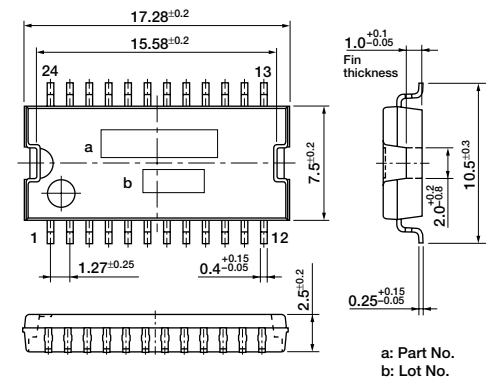
(V<sub>B</sub>=14V, Ta=25°C unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage	V <sub>B (opr)</sub>	5.5		35	V	
Quiescent circuit current	I <sub>q</sub>			1	mA	V <sub>IN</sub> =0V, V <sub>OUT</sub> =0V
Output ON resistance	R <sub>DS (ON)</sub>			150	mΩ	I <sub>O</sub> =2A
				250	mΩ	I <sub>O</sub> =1A, Ta=80°C
Output leak current	I <sub>O, leak</sub>		50		μA	V <sub>OUT</sub> =0V
Input voltage	Output ON	V <sub>IH</sub>	2.0	3.0	V	Ta= -40 to +105°C
	Output OFF	V <sub>IL</sub>	1.0	1.8	V	Ta= -40 to +105°C
Input current	Output ON	I <sub>IH</sub>	70		μA	V <sub>IN</sub> =5V
Overcurrent protection starting current	I <sub>s</sub>	2.6			A	V <sub>OUT</sub> =V <sub>O</sub> -1.5V
Internal current limit	I <sub>Lim</sub>		10		A	V <sub>OUT</sub> =0V
Thermal shutdown operating temperature	T <sub>TSD</sub>	155	165		°C	
Load open detection threshold voltage	V <sub>open</sub>		3		V	
Output transfer time	T <sub>ON</sub>		165		μs	
	T <sub>OFF</sub>		60		μs	
DG leak current	I <sub>DG</sub>			20	μA	V <sub>DG</sub> =5.5V
Low level DG output voltage	V <sub>DGL</sub>		0.15		V	I <sub>DG</sub> =1.6mA
DG output transfer time	T <sub>PLH</sub>		70		μs	
	T <sub>PHL</sub>		45		μs	

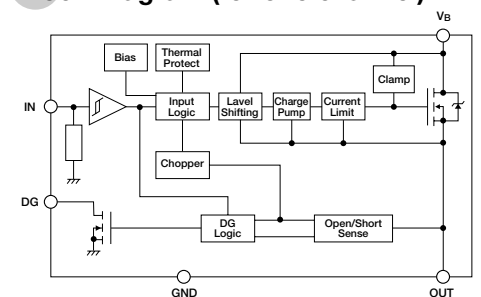
## Recommended Operating Conditions (for one channel)

Parameter	Ratings		Unit
	min	max	
Power supply voltage	5.5	16	V
V <sub>IH</sub>	4	5.5	V
V <sub>IL</sub>	-0.3	0.9	V
I <sub>O</sub>		1.15	A
R <sub>IN</sub>	10	20	kΩ
R <sub>DG</sub>	10	20	kΩ

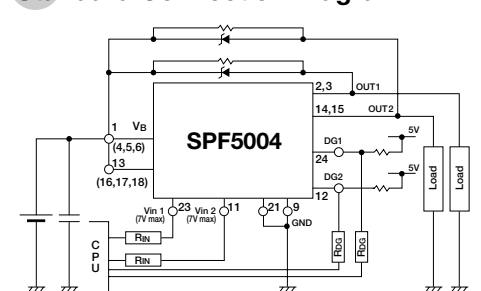
## External Dimensions (unit: mm)



## Block Diagram (for one channel)

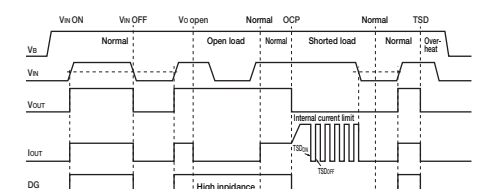


## Standard Connection Diagram



\* Make V<sub>B</sub> of 4Pin, 5Pin, 6Pin, 16Pin, 17Pin and 18Pin short from the fin to be plated by solder.

## Timing Chart



Mode	V <sub>IN</sub>	DG	V <sub>O</sub>
Normal	H	H	H
Open load	H	H	H
Shorted load	H	L	L (Limiting)
Overheat	H	L	L



## Features

- Built-in diagnostic function to detect short and open circuiting of loads and output status signals
- DMOS 3ch output
- Allows ON/OFF using C-MOS logic level
- Built-in overcurrent and thermal protection circuits

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	35	V	
Input terminal voltage	$V_{IN}$	-0.3 to 7	V	
Input terminal current	$I_{IN}$	5	mA	
DG terminal voltage	$V_{DG}$	-0.3 to 7	V	
DG terminal current	$I_{DG}$	5	mA	
Drain to source voltage	$V_{DS}$	$V_B-45$	V	
Output current	$I_O$	1.8	A	
Power dissipation	$P_D$	2.7	W	$T_a=25^{\circ}\text{C}$ , all circuit operating
Source to drain $D_i$ forward current	$I_F$	0.8	A	
Channel temperature	$T_{ch}$	150	$^{\circ}\text{C}$	
Operating temperature	$T_{OP}$	-40 to +105	$^{\circ}\text{C}$	
Storage temperature	$T_{stg}$	-40 to +150	$^{\circ}\text{C}$	

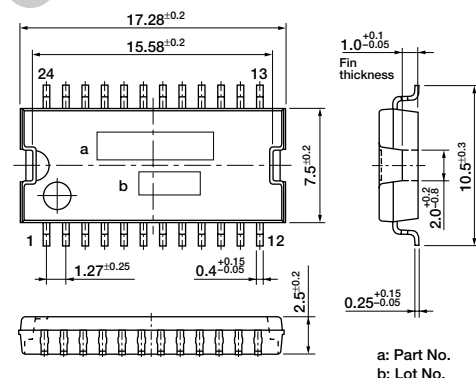
## Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions	
		min	typ	max			
Operating power supply voltage	V <sub>B (opr)</sub>	5.5		35	V		
Quiescent circuit current	I <sub>q</sub>			1	mA	V <sub>IN</sub> =0V, V <sub>OUT</sub> =0V	
Output ON resistance	R <sub>DS (ON)</sub>			200	mΩ	I <sub>O</sub> =1A	
				350	mΩ	I <sub>O</sub> =1A, T <sub>a</sub> =80°C	
Output leak current	I <sub>o, leak</sub>		50	100	μA	V <sub>OUT</sub> =0V	
Input threshold voltage	Output ON	V <sub>IHth</sub>	1.4	2.0	3.0	V	T <sub>a</sub> = -40 to +105°C
	Output OFF	V <sub>ILth</sub>	1.0	1.8		V	T <sub>a</sub> = -40 to +105°C
Inpup current	Output ON	I <sub>IH</sub>		70	200	μA	V <sub>IN</sub> =5V
	Output OFF	I <sub>IL</sub>			12	μA	V <sub>IN</sub> =0V
Overcurrent protection starting current	I <sub>S</sub>	1.9	3		A	V <sub>OUT</sub> =V <sub>O</sub> -1.5V	
Internal current limit	I <sub>Lim</sub>		5		A	V <sub>OUT</sub> =0V	
Thermal shutdown operating temperature	T <sub>TSD</sub>	155	165		°C		
Load open detection threshold voltage	V <sub>open</sub>	1.5	3	4.5	V		
Output transfer time	T <sub>ON</sub>		70	140	μs	R <sub>L</sub> =14Ω, V <sub>OUT</sub> =V <sub>B</sub> -5V	
	T <sub>OFF</sub>		35	90	μs	R <sub>L</sub> =14Ω, V <sub>B</sub> *10%	
DG leak current	I <sub>DG</sub>			20	μA	V <sub>DG</sub> =5.5V	
Low level DG output voltage	V <sub>DGL</sub>		0.15	0.5	V	I <sub>DG</sub> =1.6mA	
DG output transfer time	T <sub>PLH</sub>		70	140	μs		
	T <sub>PHL</sub>		45	120	μs		

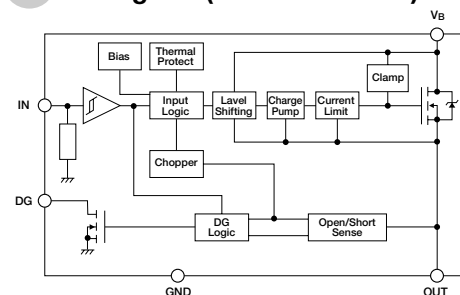
### Recommended Operating Conditions (for one channel)

Parameter	Ratings		Unit
	min	max	
Power supply voltage	5.5	16	V
$V_{IH}$	4	5.5	V
$V_{IL}$	-0.3	0.9	V
$I_O$		1	A
$R_{IN}$	10	20	k $\Omega$
$R_{DG}$	10	20	k $\Omega$

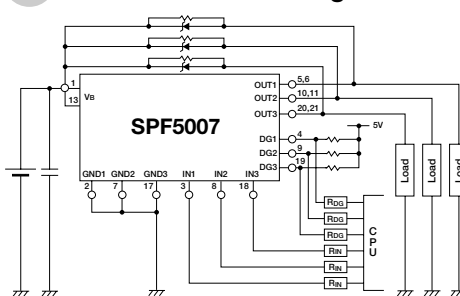
### External Dimensions (unit: mm)



### Block Diagram (for one channel)

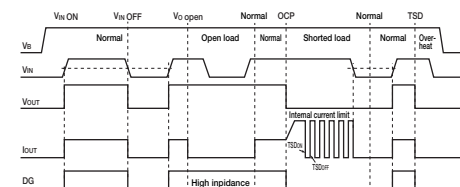


## Standard Connection Diagram



- \* RIN and RDG are needed to protect CPU and SPF5007 in case of reverse connection of V<sub>B</sub> terminal.
- \* Make V<sub>B</sub> of 1Pin and 13Pin short from the fin to be plated by solder.

## Timing Chart



Mode	V <sub>IN</sub>	DG	V <sub>O</sub>
Normal	H L	H L	H L
Open load	H L	H H	H H
Shorted load	H L	L L	L (Limiting) L
Overheat	H L	L L	L L



# High-side Power Switch ICs [Surface-mount 2-circuit, current monitor output function] **SPF5017**

## Features

- Internal current sense resistor
- High accuracy current monitor output (sample & hold function)
- Built-in overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage 1	V <sub>B</sub>	0 to 32	V	
Power supply voltage 2	V <sub>CC</sub>	-0.5 to 7.0	V	
Power supply voltage 3	V <sub>B</sub>	0 to 40	V	V <sub>B</sub> terminal, t = 1 min
Current sensing voltage	V <sub>sense</sub> <sup>+</sup>	-0.8 to 6	V	
	V <sub>sense</sub> <sup>-</sup>	V <sub>sense</sub> <sup>+</sup> ± I <sub>O</sub> • R <sub>sense</sub>		
Output terminal voltage	V <sub>OUT</sub>	-2 to 32	V	
Input terminal voltage	V <sub>PWM</sub>	-0.5 to 7.0	V	
	V <sub>Hold</sub>			
Output current	I <sub>OUT</sub>	2.0	A	
Power dissipation	P <sub>D</sub>	2.4 to 5.0	W	Depends on surface-mount board pattern
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	
Channel temperature	T <sub>ch</sub>	150	°C	

## Electrical Characteristics

(V<sub>B</sub>=14V, Ta=25°C unless otherwise specified) – One circuit equivalent

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Min. operating power supply voltage	V <sub>B</sub> min	6			V	Minimum operation of OUT terminal.
Operating power supply voltage 1	V <sub>B</sub>	10	14	16	V	*1
Operating power supply voltage 2	V <sub>CC</sub>		5.0		V	*2
Quiescent circuit current 1	I <sub>qvb</sub>			7.2	mA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =0V, One circuit equivalent
Quiescent circuit current 2	I <sub>qvcc</sub>			0.2	mA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =0V
PWM terminal input voltage	V <sub>PWMH</sub>	3.5			V	V <sub>CC</sub> =5V
	V <sub>PWML</sub>			1.5		
PWM terminal input current	I <sub>PWMH</sub>		70	110	μA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =5V, Active H *3
	I <sub>PWML</sub>					
Hold terminal input voltage	V <sub>HoldH</sub>	3.5			V	V <sub>CC</sub> =5V
	V <sub>HoldL</sub>			1.5		
Hold terminal input current	I <sub>HoldH</sub>		70	110	μA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =5V, Active H *3
	I <sub>HoldL</sub>					
Output ON resistance	R <sub>DSon</sub>			0.14	Ω	I <sub>OUT</sub> =1A
				0.21		I <sub>OUT</sub> =1A, Ta=125°C
Current sensing resistance	R <sub>sense</sub>			0.21	Ω	I <sub>OUT</sub> =1A
				0.25		I <sub>OUT</sub> =1A, Ta=125°C
Overcurrent protection starting current	I <sub>S</sub>	3.0			A	*4
Thermal shutdown operating temperature	T <sub>tsd</sub>	150			°C	
Operation circuit for current monitor output	I <sub>O</sub>	0.2		1.2	A	*1
Current monitor output voltage	V <sub>SH</sub>			0.2	V	I <sub>O</sub> =0A, V <sub>CC</sub> =5V
		0.488	0.500	0.512	V	I <sub>O</sub> =0.2A, V <sub>CC</sub> =5V
		1.219	1.250	1.281	V	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V, Ta=-40 to 140°C
		2.925	3.000	3.075	V	I <sub>O</sub> =1.2A, V <sub>CC</sub> =5V, Ta=-40 to 140°C
					V	I <sub>O</sub> =1.2A, V <sub>CC</sub> =5V, Ta=-40 to 140°C
Current monitor output current	I <sub>SH</sub>			5	mA	I <sub>O</sub> =1A, V <sub>CC</sub> =5V, V <sub>SH</sub> =0V
		-6			mA	I <sub>O</sub> =1A, V <sub>CC</sub> =5V, V <sub>SH</sub> =5V
Output transfer time	t <sub>on</sub>			15	μs	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V
	t <sub>off</sub>			15	μs	
Output rise time	t <sub>r</sub>			100	μs	
Output fall time	t <sub>f</sub>			50	μs	
Current monitor output hold time	t <sub>sh</sub>	500		650	μs	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V, C1=0.033μF
Current monitor output delay time	t <sub>shd</sub>			1	μs	
Hold time after inputting hold	t <sub>shh</sub>			2	μs	
S/H settling time	t <sub>stt</sub>			70	μs	
				80	μs	V <sub>B</sub> =11V, V <sub>CC</sub> =5V, I <sub>O</sub> =1.2A, C1=0.033μF, Ta=125°C

Note:

\*1: Accuracy warranty range for current monitor output

\*2: Equivalent errors are not included in current monitor output accuracy.

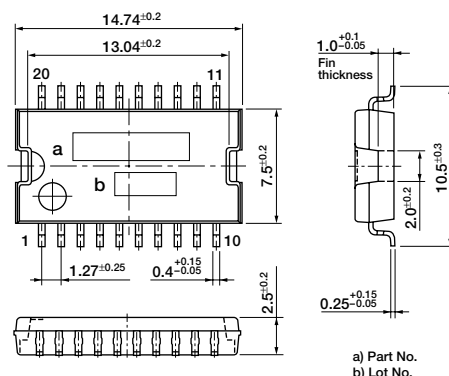
\*3: With built-in pull-down resistance (70kΩ typ)

\*4: Self-excitation and oscillation type

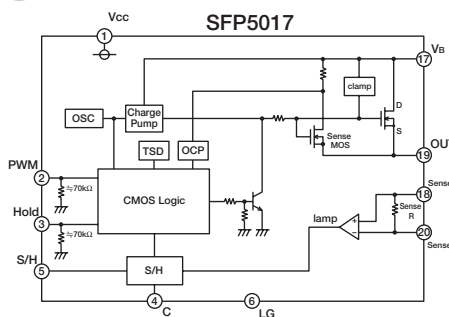
\*5: Accuracy of current monitor output is affected by the materials of the hold capacitor (C1).

The capacitor C1 must be of low dielectric absorption and have good bias and leak current characteristics.

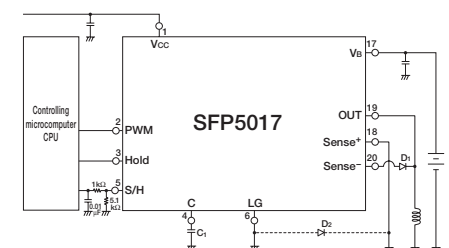
## External Dimensions (unit: mm)



## Block Diagram (for one channel)

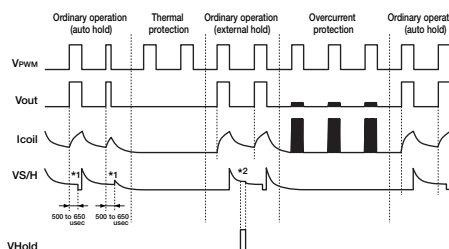


## Standard Connection Diagram



\* Use a Schottky Di for D2 when the Sense\* terminal is lower than the abs. max. rated voltage (-0.8V)

## Timing Chart



Truth table

V <sub>PWM</sub>	L	H
V <sub>OUT</sub>	L	H



# High-side Power Switch ICs [Surface-mount, current monitor output function] SPF5018

## Features

- Internal current sense resistor
- High accuracy current monitor output (sample & hold function)
- Built-in overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage 1	V <sub>B</sub>	0 to 32	V	
Power supply voltage 2	V <sub>CC</sub>	-0.5 to 7.0	V	
Power supply voltage 3	V <sub>B</sub>	0 to 40	V	V <sub>B</sub> terminal, t = 1 min
Current sensing voltage	V <sub>sense</sub> <sup>+</sup>	-0.8 to 6	V	
	V <sub>sense</sub> <sup>-</sup>	V <sub>sense</sub> <sup>+</sup> ± I <sub>O</sub> • R <sub>sense</sub>		
Output terminal voltage	V <sub>OUT</sub>	-2 to 32	V	
Input terminal voltage	V <sub>PWM</sub>	-0.5 to 7.0	V	
	V <sub>Hold</sub>			
Output current	I <sub>OUT</sub>	2.0	A	
Power dissipation	P <sub>D</sub>	2.0	W	Depends on surface-mount board pattern
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	
Channel temperature	T <sub>ch</sub>	150	°C	

## Electrical Characteristics

(V<sub>B</sub>=14V, Ta=25°C unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Min. operating power supply voltage	V <sub>B</sub> min	6			V	Minimum operation of OUT terminal.
Operating power supply voltage 1	V <sub>B</sub>	10	14	16	V	*1
Operating power supply voltage 2	V <sub>CC</sub>		5.0		V	*2
Quiescent circuit current 1	I <sub>qvb</sub>			7.2	mA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =0V
Quiescent circuit current 2	I <sub>qvcc</sub>			0.2	mA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =0V
PWM terminal input voltage	V <sub>PWMH</sub>	3.5			V	V <sub>CC</sub> =5V
	V <sub>PWML</sub>			1.5		
PWM terminal input current	I <sub>PWMH</sub>		70	110	μA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =5V, Active H *3
	I <sub>PWML</sub>					
Hold terminal input voltage	V <sub>HoldH</sub>	3.5			V	V <sub>CC</sub> =5V
	V <sub>HoldL</sub>			1.5		
Hold terminal input current	I <sub>HoldH</sub>		70	110	μA	V <sub>CC</sub> =5V, V <sub>PWM</sub> =5V, Active H *3
	I <sub>HoldL</sub>					
Output ON resistance	R <sub>DSon</sub>			0.14	Ω	I <sub>OUT</sub> =1A
				0.21		I <sub>OUT</sub> =1A, Ta=125°C
Current sensing resistance	R <sub>sense</sub>			0.21	Ω	I <sub>OUT</sub> =1A
				0.25		I <sub>OUT</sub> =1A, Ta=125°C
Overcurrent protection starting current	I <sub>S</sub>	3.0			A	*4
Thermal shutdown operating temperature	T <sub>tsd</sub>	150			°C	
Operation circuit for current monitor output	I <sub>O</sub>	0.2		1.2	A	*1
Current monitor output voltage	V <sub>SH</sub>			0.2	V	I <sub>O</sub> =0A, V <sub>CC</sub> =5V
		0.488	0.500	0.512	V	I <sub>O</sub> =0.2A, V <sub>CC</sub> =5V
		1.219	1.250	1.281	V	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V, Ta=-40 to 140°C
		2.925	3.000	3.075	V	I <sub>O</sub> =1.2A, V <sub>CC</sub> =5V, Ta=-40 to 140°C
					V	I <sub>O</sub> =1.2A, V <sub>CC</sub> =5V, V <sub>SH</sub> =0V
Current monitor output current	I <sub>SH</sub>			5	mA	I <sub>O</sub> =1A, V <sub>CC</sub> =5V, V <sub>SH</sub> =0V
		-6			mA	I <sub>O</sub> =1A, V <sub>CC</sub> =5V, V <sub>SH</sub> =5V
Output transfer time	t <sub>on</sub>			15	μs	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V
	t <sub>off</sub>			15	μs	
Output rise time	t <sub>r</sub>			100	μs	
Output fall time	t <sub>f</sub>			50	μs	
Current monitor output hold time	t <sub>sh</sub>	500		650	μs	I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V, C1=0.033μF
Current monitor output delay time	t <sub>shd</sub>			1	μs	
Hold time after inputting hold	t <sub>shh</sub>			2	μs	
S/H settling time	t <sub>stt</sub>			70	μs	V <sub>B</sub> =11V, V <sub>CC</sub> =5V, I <sub>O</sub> =1.2A, C1=0.033μF
				80	μs	V <sub>B</sub> =11V, V <sub>CC</sub> =5V, I <sub>O</sub> =1.2A, C1=0.033μF, Ta=125°C

Note:

\*1: Accuracy warranty range for current monitor output

\*2: Equivalent errors are not included in current monitor output accuracy.

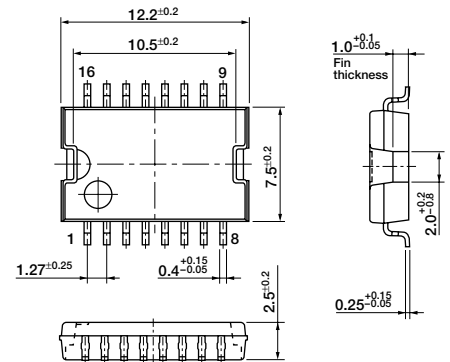
\*3: With built-in pull-down resistance (70kΩ typ)

\*4: Self-excitation and oscillation type

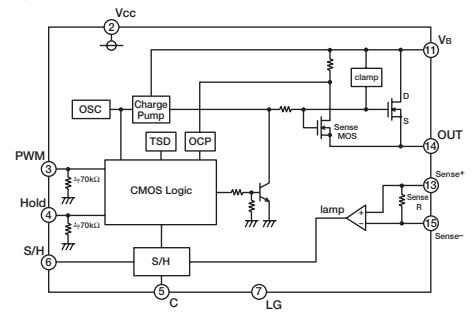
\*5: Accuracy of current monitor output is affected by the materials of the hold capacitor (C1).

The capacitor C1 must be of low dielectric absorption and have good bias and leak current characteristics.

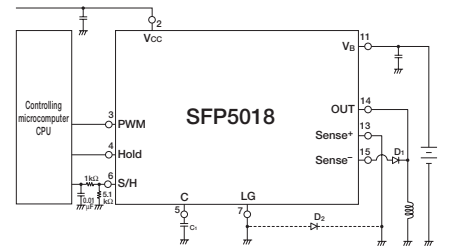
## External Dimensions (unit: mm)



## Block Diagram (for one channel)

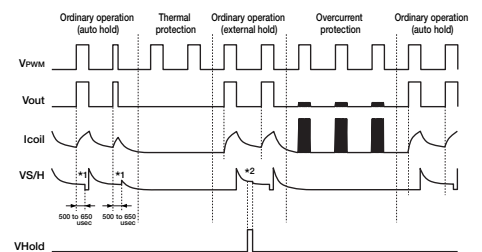


## Standard Connection Diagram



\* Use a Schottky Di for D2 when the Sense\* terminal is lower than the abs. max. rated voltage (-0.5V)

## Timing Chart



Truth table

V <sub>PWM</sub>	L	H
V <sub>OUT</sub>	L	H



## Low-side Switch ICs [Surface-mount 4-circuits] — **SPF5002A**

## Features

- DMOS 4ch output
- Allows ON/OFF using C-MOS logic level
- Built-in overcurrent, overvoltage and thermal protection circuits

## Absolute Maximum Ratings

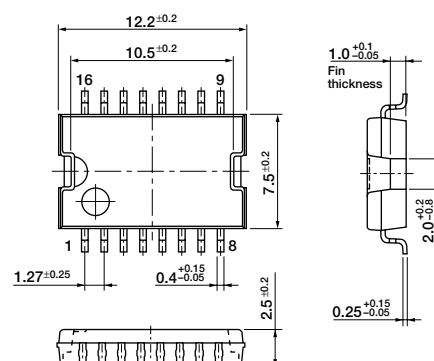
Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	$V_B$	40	V	
Output terminal voltage	$V_{OUT}$	37	V	*
Input terminal voltage	$V_{IN}$	-0.5 to +7.5	V	
Output current	$I_O$	1.8	A	
Power Dissipation	$P_D$	2	W	
Storage temperature	$T_{stg}$	-40 to +150	°C	
Channel temperature	$T_{ch}$	150	°C	
Output avalanche capability	$E_{AV}$	50	mJ	Single pulse

Note: \* At the clamping operation, refer to VOUT (clamp) in the section of electrical characteristics.

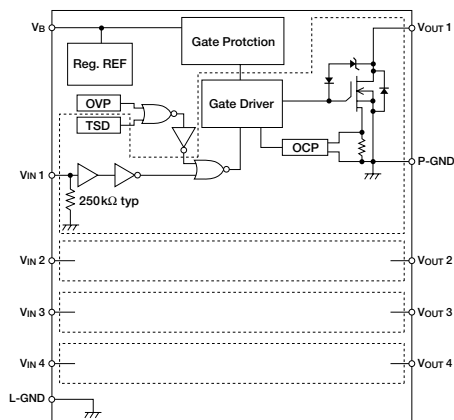
## Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Power supply voltage	$V_{Bopr}$	5.5		25	V	
Quiescent circuit current	$I_q$		5	7	mA	$V_{IN}=0V$ (all inputs)
Operating circuit current	$I_{CC}$		8	12	mA	$V_{IN}=5V$ (all inputs)
Input voltage	Hi output	$V_{IN}$	3.5	5.5	V	$I_O=1A$
	Lo output	$V_{IN}$	-0.5	1.5	V	
Input current	Hi output	$I_{IN}$		50	$\mu A$	$V_{IN}=5V$
	Lo output	$I_{IN}$		30	$\mu A$	$V_{IN}=0V$
Output ON resistance	$R_{DS(ON)}$		0.4	0.6	$\Omega$	
			0.5	0.7	$\Omega$	$V_B=5.5V$
Output clamp voltage	$V_{OUT(clamp)}$	41	50	55	V	$I_O=1A$
Output leak current	$I_{OH}$			10	$\mu A$	$V_O=37V$
Forward voltage of output stage diode	$V_F$			1.6	V	$I_F=0.5A$
Overvoltage protection starting voltage	$V_{B(ovp)}$	25		40	V	
Thermal protection starting temperature	$T_{TSD}$	151	165		$^{\circ}C$	
Overcurrent protection starting current	$I_S$	1.1			A	
Output transfer time	$T_{ON}$			12	$\mu s$	$R_L=14\Omega, I_O=1A$
	$T_{OFF}$			8	$\mu s$	$R_L=14\Omega, I_O=1A$
Output rise time	$T_r$			5	$\mu s$	$R_L=14\Omega, I_O=1A$
Output fall time	$T_f$			10	$\mu s$	$R_L=14\Omega, I_O=1A$

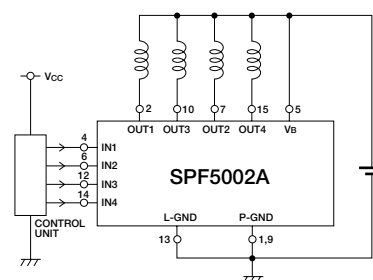
### External Dimensions (unit: mm)



## Equivalent Circuit Diagram



## Circuit Example

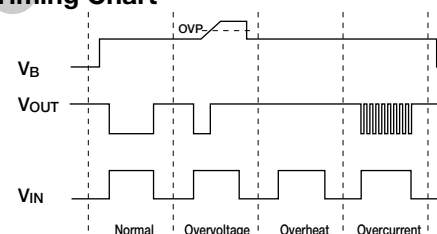


Use L-GND and P-GND being connected.

### Truth table

$V_{IN}$	$V_O$
H	L
L	H

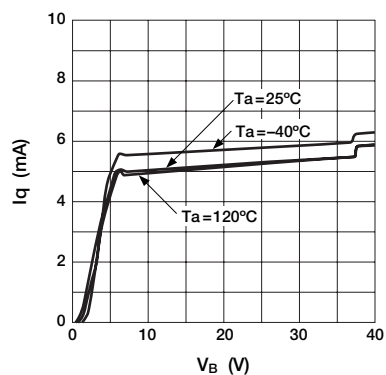
## Timing Chart



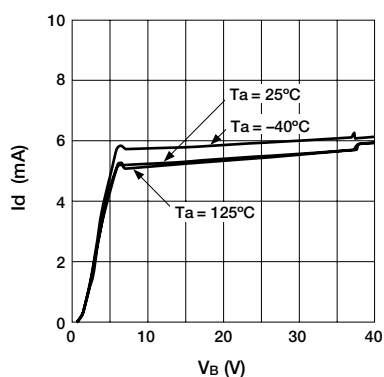
\* Self-excited frequency is used in the overcurrent protection.

## Electrical Characteristics

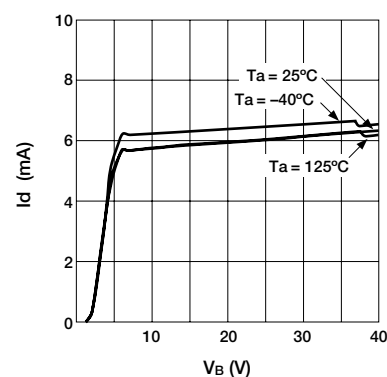
■ Quiescent Circuit Current



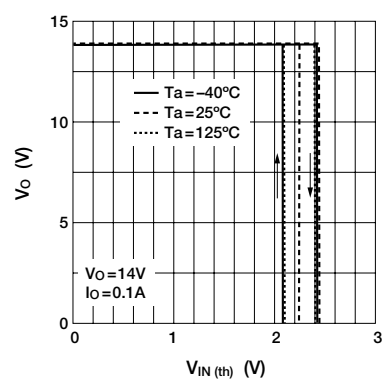
■ Circuit Current (single circuit)



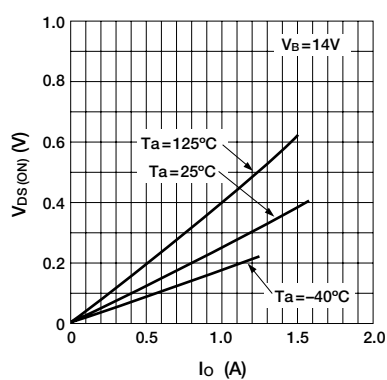
■ Circuit Current (4 circuits)



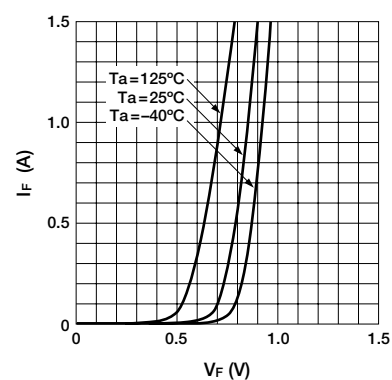
■ Threshold Input Voltage



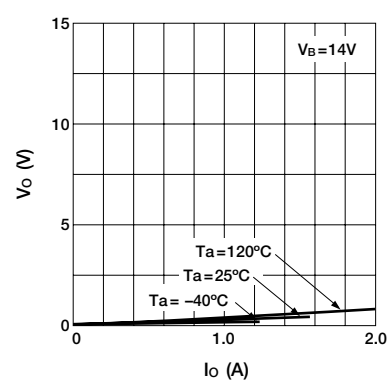
■ Output ON Voltage



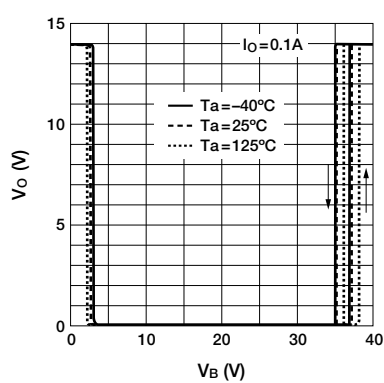
■ Forward Voltage of Output Stage Diode



■ Overcurrent Protection Characteristics



■ Overvoltage Protection Starting Voltage



Low-side Switch ICs [Surface-mount 4-circuits]

SPF5009 (under development)

Features

- DMOS 4ch output
- Allows ON/OFF using C-MOS logic level
- Built-in over current and thermal protection circuit and diagnostic function to detect open load
- Built-in output status signals (over current, over heat and open load)

Absolute Maximum Ratings

(Ta=25°C)

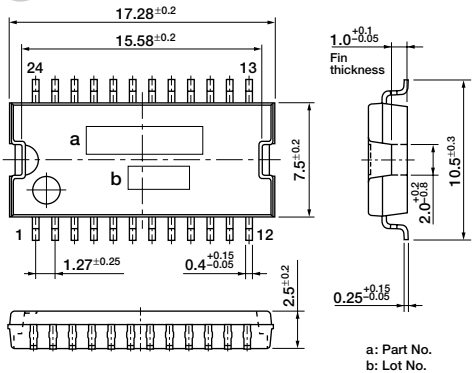
Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	V <sub>B</sub>	40	V	
Output terminal voltage (DC)	V <sub>OUT</sub>	50	V	
Output terminal voltage (pulse)	V <sub>OUT</sub>	Output clamping (max 70V)	V	
Output current (DC)	I <sub>OUT</sub>	±2.9	A	
Output current (pulse)	I <sub>OUT</sub>	Over current protection starting current	A	
Input terminal voltage	V <sub>(IN, SEL, B/U)</sub>	−0.5 to +6.5	V	
Diag output source current	V <sub>DIAG</sub>	6.5	V	
Diag output voltage	I <sub>DIAG</sub>	5	mA	
Power Dissipation	P <sub>D</sub>	2.8	W	
Storage temperature	T <sub>stg</sub>	−40 to +150	°C	
Channel temperature	T <sub>ch</sub>	150	°C	
Output avalanche capability	E <sub>AV</sub>	80	mJ	Single pulse

Electrical Characteristics

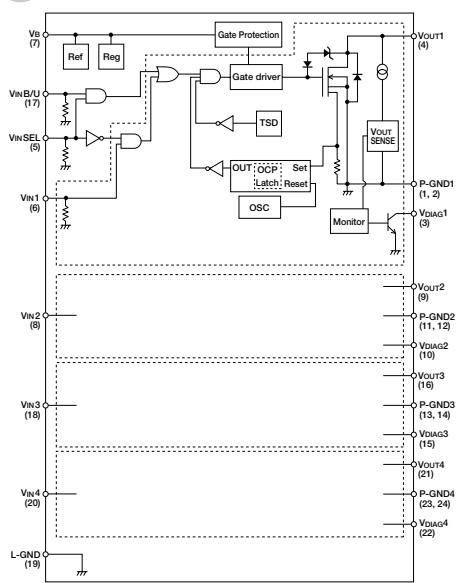
(V<sub>B</sub>=14V, Ta= 25°C unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Power supply voltage	V <sub>B (opr)</sub>	5.5		40	V	
Quiescent circuit current	I <sub>q</sub>		9	12	mA	V <sub>B</sub> =14V, V <sub>IN</sub> =0V
Operating circuit current	I <sub>d</sub>		12	15	mA	V <sub>B</sub> =14V, V <sub>IN</sub> =5V (all inputs)
Input voltage (1 to 4, SEL, B/U)	V <sub>IN (H)</sub>	3.5		6.5	V	V <sub>B</sub> =14V, V <sub>O</sub> =1A
	V <sub>IN (L)</sub>	−0.5		1.5	V	V <sub>B</sub> =14V
Input current (single circuit) (1 to 4, SEL, B/U)	I <sub>IN (H)</sub>			200	μA	V <sub>B</sub> =14V, V <sub>IN</sub> =5V
	I <sub>IN (L)</sub>			30	μA	V <sub>B</sub> =14V, V <sub>IN</sub> =0V
Output ON resistance	R <sub>DS (ON)</sub>			0.18	Ω	V <sub>B</sub> =14V, I <sub>O</sub> =1A
Output clamp voltage	V <sub>OUT (clamp)</sub>	60	65	70	V	V <sub>B</sub> =14V, I <sub>O</sub> =1A
Output leak current	I <sub>OH</sub>			50	μA	V <sub>B</sub> =14V, V <sub>O</sub> =50V
Forward voltage of output stage diode	V <sub>F</sub>			1.5	V	I <sub>F</sub> =1A
Output moniter threshold voltage	V <sub>thM</sub>			2	V	V <sub>B</sub> =14V
DIAG output voltage	V <sub>DIAG (H)</sub>	6.4		6.5	V	V <sub>B</sub> =14V, V <sub>DIAG</sub> =6.5V
	V <sub>DIAG (L)</sub>			0.5	V	V <sub>B</sub> =14V, I <sub>DIAG</sub> =5mA
DIAG output leak current	I <sub>OH</sub>			10	μA	V <sub>B</sub> =14V, V <sub>DIAG</sub> =6.5V
Thermal shutdown operating temperature	T <sub>TSD</sub>	151	165		°C	V <sub>B</sub> =14V
Overcurrent protection starting current	I <sub>S</sub>	3.0			A	V <sub>B</sub> =14V
Output transfer time	T <sub>ON</sub>			12	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
	T <sub>OFF</sub>			8	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
Output rise time	T <sub>r</sub>			5	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
Output fall time	T <sub>f</sub>			10	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
DIAG output transfer time	t <sub>DON</sub>			12	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
	t <sub>DOFF</sub>			8	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A

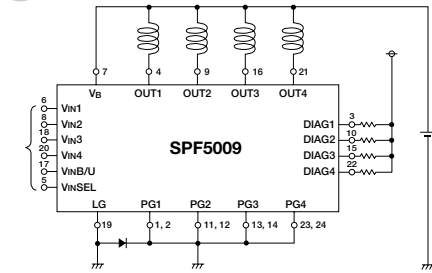
External Dimensions (unit: mm)



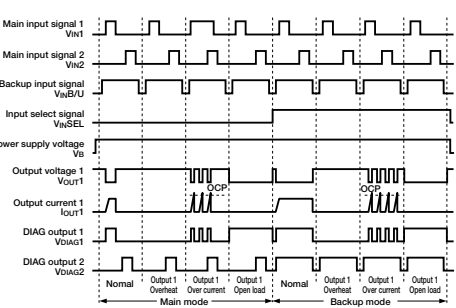
Equivalent Circuit Diagram



Circuit Example



Timing Chart





# Low-side Switch ICs [Surface-mount 4-circuits with Output Monitor] **SPF5012**

## Features

- Output monitor circuit (DIAG)
- DMOS 4ch output
- Allows ON/OFF using C-MOS logic level
- Built-in overcurrent, overvoltage and thermal protection circuits

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage 1	V <sub>B</sub>	40	V	
Power supply voltage 2	V <sub>CC</sub>	7.5	V	
Output voltage	V <sub>O</sub>	40 (DC)	V	*1
Logic input voltage	V <sub>IN</sub>	-0.5 to +7.5	V	
Output current	I <sub>O</sub>	Self Limited	A	
Diag output voltage	V <sub>DIAG</sub>	0 to V <sub>CC</sub>	V	
Power Dissipation	P <sub>D</sub>	2.8 to 5	W	*2
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	
Channel temperature	T <sub>ch</sub>	150	°C	
Output avalanche capability	E <sub>AV</sub>	100	mJ	Single pulse

\*1. At the clamping operation, refer to the section of V<sub>OUT (clamp)</sub> in electrical characteristics

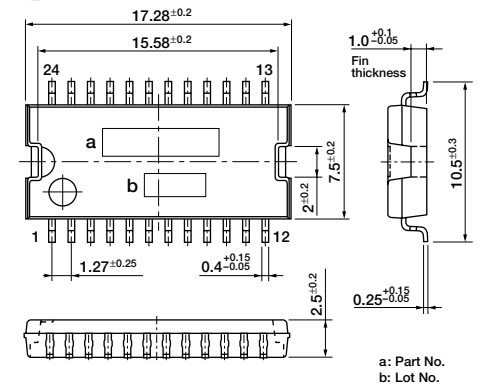
\*2. Changes by the pattern of mounted substrate

## Electrical Characteristics

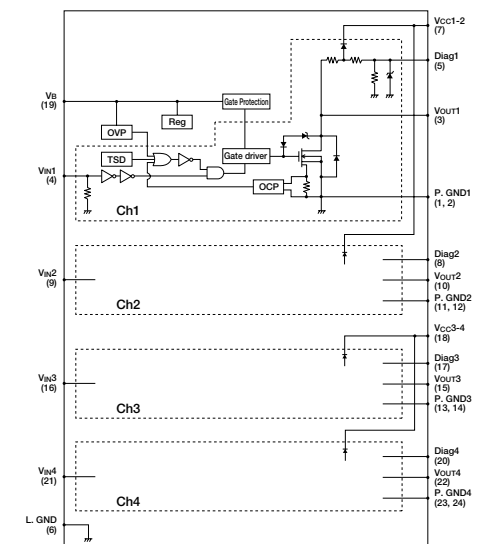
(V<sub>B</sub>=14V, Ta=25°C unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Operating power supply voltage 1	V <sub>B (opr)</sub>	5.5		40	V	
Operating power supply voltage 2	V <sub>CC (opr)</sub>	4.5		5.5	V	
Quiescent circuit current	I <sub>q</sub>		4	6	mA	V <sub>B</sub> =14V, V <sub>IN</sub> =0V
Operating circuit current	I <sub>d</sub>		8	12	mA	V <sub>B</sub> =14V, V <sub>IN</sub> =5V
Input voltage	Hi output	V <sub>IN</sub>	3.5	5.5	V	V <sub>B</sub> =14V, V <sub>O</sub> =1A
	Lo output	V <sub>IN</sub>	-0.5	1.5	V	V <sub>B</sub> =14V
Input current	Hi output	I <sub>IN</sub>		50	μA	V <sub>B</sub> =14V, V <sub>IN</sub> =5V
	Lo output	I <sub>IN</sub>		-30	μA	V <sub>B</sub> =14V, I <sub>O</sub> 1A
Output ON resistance	R <sub>DS (ON)</sub>			0.3	Ω	V <sub>B</sub> =14V, I <sub>O</sub> =1A, Ta=125°C
				0.2	Ω	V <sub>B</sub> =14V, I <sub>O</sub> =1A, Ta=25°C
Output clamp voltage	V <sub>OUT (clamp)</sub>	45	50	55	V	V <sub>B</sub> =14V, I <sub>O</sub> =1A
Output leak current	I <sub>OH</sub>			2.8	mA	V <sub>B</sub> =14V, V <sub>CC</sub> =5V, V <sub>IN</sub> =0V, V <sub>O</sub> =40V, Ta=25°C
				900	μA	V <sub>B</sub> =14V, V <sub>CC</sub> =5V, V <sub>IN</sub> =0V, V <sub>O</sub> =14V, Ta=25°C
Forward voltage of output stage diode	V <sub>F</sub>			1.6	V	I <sub>F</sub> =1A
Overvoltage protection starting voltage	V <sub>B (ovp)</sub>	25		40	V	
Overvoltage protection hysteresis voltage	V <sub>B (ovp+hyss)</sub>		8		V	
Thermal shutdown operating temperature	T <sub>TSD</sub>	151	165		°C	V <sub>B</sub> =14V
Overcurrent protection operating current	I <sub>S</sub>	6			A	V <sub>B</sub> =14V, Ta=-40°C
		6			A	V <sub>B</sub> =14V, Ta=25°C
		5			A	V <sub>B</sub> =14V, Ta=125°C
Output transfer time	T <sub>ON</sub>			12	μs	V <sub>B</sub> =14V, R <sub>L</sub> =14Ω, I <sub>O</sub> =1A
	T <sub>OFF</sub>			8	μs	
Output rise time	T <sub>r</sub>			5	μs	
Output fall time	T <sub>f</sub>			10	μs	
Output-diag voltage ratio	r <sub>a</sub> (DIAG)	0.195	0.2	0.205		V <sub>B</sub> =14V, V <sub>O</sub> =1 to 14V, R <sub>diag</sub> =500kΩ
Diag output clamping voltage	V <sub>DIAG (clamp)</sub>			4.85	V	V <sub>B</sub> =14V, V <sub>CC</sub> =5V, V <sub>O</sub> =40V

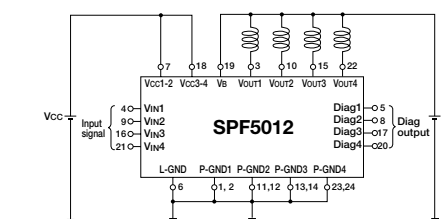
## External Dimensions (unit: mm)



## Equivalent Circuit Diagram



## Circuit Example

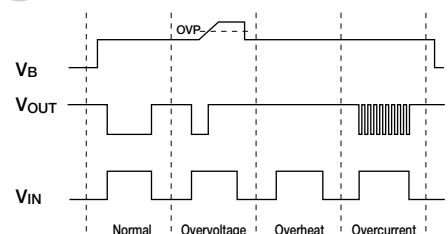


Truth table

V <sub>IN</sub>	V <sub>O</sub>
H	L
L	H

Short L-GND and P-GND in a pattern near the product.

## Timing Chart



\* Self-excited frequency is used in the overcurrent protection.



## Stepper-motor Driver ICs SLA4708M

## Features

- High output breakdown voltage of 50V
- Affluent output current of 1.5A
- Built-in overcurrent, overvoltage and thermal protection circuits
- Low standby current of 50μA

## Absolute Maximum Ratings

(Ta=25°C)

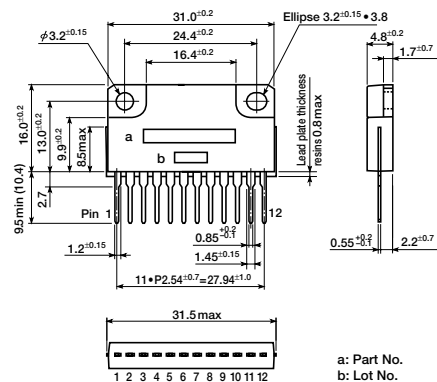
Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	V <sub>S</sub>	35	V	
Breakdown voltage	V <sub>O</sub>	50	V	
Input voltage	V <sub>IN</sub>	-0.3 to +7	V	
Output current	I <sub>O, AVE</sub>	1.5	A	
Diagnostic output sink current	I <sub>DIAG</sub>	10	mA	
Diagnostic output withstand voltage	I <sub>DIAG, H</sub>	7	V	
Operating temperature	T <sub>OP</sub>	-40 to +85	°C	
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	
Power Dissipation	P <sub>D</sub>	3.5 (T <sub>a</sub> =25°C)	W	Without heatsink

## Electrical Characteristics

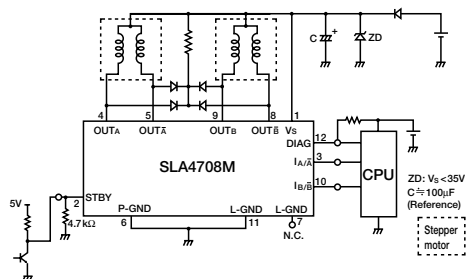
( $V_S=12V$ ,  $T_a=25^{\circ}C$ )

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Input voltage ( $I_A/\bar{A}$ , $I_B/\bar{B}$ standby)	$V_{IL}$			0.8	V	
	$V_{IH}$	2.4			V	
Input current	$I_{IL}$			-0.8	mA	$V_{IN}=0.4V$
	$I_{IH}$			50	$\mu A$	$V_{IN}=2.4V$
Output saturation voltage	$V_{O,STA}$			1.3	V	$I_O=1A$ , $T_a=25^\circ C$
	$V_{O,STA}$			1.5	V	$I_O=1.5A$ , $T_a=25^\circ C$
Output leak current	$I_{O,LEAK}$			100	$\mu A$	$V_O=16V$
Overcurrent detection	$I_{SD}$	1.8			A	
Overvoltage detection	$V_{SD}$	27.5			V	
Saturation voltage of diagnostic output	$V_{DIAG,L}$			0.3	V	$I_{DIAG}=5mA$
Standby current	$I_{STB}$		50		$\mu A$	$V_S=12V$

### External Dimensions (unit: mm)

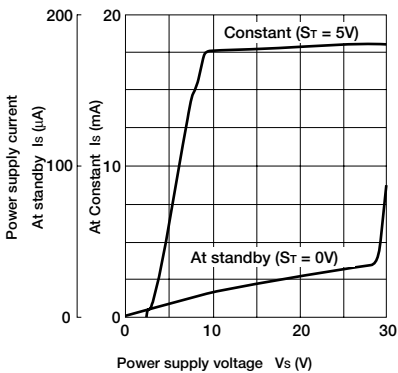


## Standard Circuit Diagram

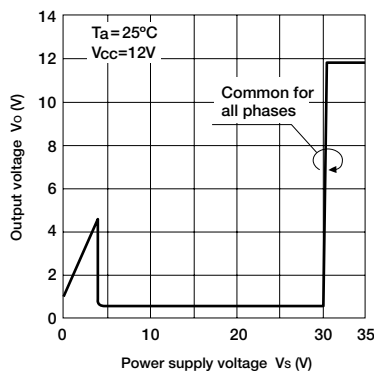


Electrical Characteristics

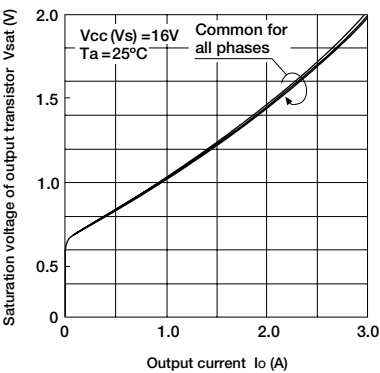
Power Supply Current Characteristics



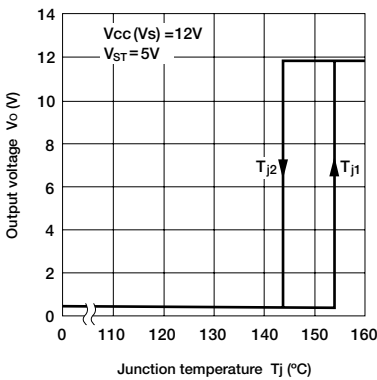
Overvoltage Protection Characteristics



Saturation Voltage of Output Transistor Characteristics



Thermal Protection Characteristics



# 2-ph Stepper-motor Driver ICs SPF7211

## Features

- Low output saturation voltage (high-side: 1.5V max.; low-side: 0.8V max.)
- Built-in recovery diode
- Built-in standby function
- Built-in overcurrent and thermal protection circuits and low voltage input shutoff function
- Built-in overload and disconnection detection function

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Remarks
Main power supply voltage	V <sub>BB</sub>	40	V	
Input voltage	V <sub>IN</sub>	-0.3 to 15	V	V <sub>IN</sub> ≤ V <sub>BB</sub>
Output current	I <sub>O</sub>	±0.8	A	
	I <sub>OPeak</sub>	±1.0	A	T <sub>w</sub> < 1mS
Flag terminal withstand voltage	V <sub>Flag</sub>	7	V	V <sub>Flag</sub> ≤ V <sub>BB</sub>
Flag terminal current	I <sub>Flag</sub>	3	mA	
Detect voltage	V <sub>Rs</sub>	-2 to 2	V	
Power dissipation	P <sub>D</sub>	4.1	W	For Ta = 25°C *1
		39	W	For Tc (T <sub>tab</sub> ) = 25°C
Junction temperature	T <sub>J</sub>	150	°C	
Operating temperature	Top	-40 to 110	°C	
Storage temperature	T <sub>stg</sub>	-40 to 150	°C	

Note: \*1: With glass epoxy + copper foil board (size 5.0•7.4cm; t: glass epoxy=1.6mm/copper foil=18μm)

## Recommended Operation Range

Parameter	Symbol	Ratings	Unit	Remarks
Main power supply voltage	V <sub>BB</sub>	6 to 18	V	
Input voltage	V <sub>IN</sub>	-0.3 to 7.0	V	V <sub>IN</sub> ≤ V <sub>BB</sub>
Output current	I <sub>O</sub>	±0.5	A	Continuous
Flag terminal withstand voltage	V <sub>Flag</sub>	0 to 7.0	V	V <sub>Flag</sub> ≤ V <sub>BB</sub>
Flag terminal current	I <sub>Flag</sub>	0 to 1.0	mA	
Detect voltage	V <sub>Rs</sub>	-1 to 1	V	
Operating temperature	Top	-40 to 110	°C	

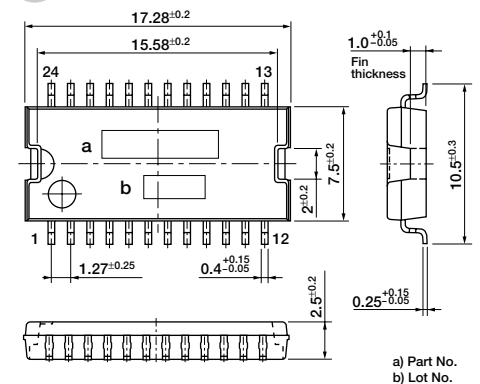
## Electrical Characteristics

Parameter	Symbol	Ratings		Unit	Conditions
		min	typ		
Main power supply current	I <sub>BB</sub>			50	In ordinary operation (no load)
	I <sub>BBs</sub>			50	At sleep
Low voltage protection operation voltage	V <sub>UVLO</sub>	3.5		4.5	V
UVLO hysteresis voltage	V <sub>UVLOHys</sub>		0.5		V
Output leak current	I <sub>leakL</sub>	-100		100	V <sub>BB</sub> = 40V, V <sub>O</sub> = 0V
	I <sub>leakH</sub>			0.5	V <sub>BB</sub> = V <sub>O</sub> = 40V
Output saturation voltage	V <sub>satL</sub>			0.8	I <sub>O</sub> = 0.5A
				1.2	I <sub>O</sub> = 0.8A
				1.5	I <sub>O</sub> = -0.5A
				1.2	I <sub>O</sub> = -0.8A
Recovery diode forward voltage	V <sub>F</sub> L			1.2	I <sub>O</sub> = 0.5A
	V <sub>F</sub> H			1.3	I <sub>O</sub> = -0.5A
	V <sub>F</sub> GO	1.2			I <sub>O</sub> = -0.5A
Input terminal	Input voltage			0.8	V
	Hysteresis voltage		0.5		V
Ph terminal	Input current			5	μA
				5	μA
Ixx, Set terminals	Input current			50	μA
				50	μA
Detect voltage	V <sub>Rs</sub>	660	700	740	mV
		420	450	480	mV
		40	70	90	mV
Oscillation frequency	F <sub>osc</sub>	28.8	48	72	kHz
PWM frequency	F <sub>PWM</sub>	14.4	24	36	kHz
Ct terminal threshold voltage	V <sub>ctL</sub>		0.5		V
	V <sub>ctH</sub>		1.5		V
Ct terminal current	I <sub>ctsink</sub>		720		μA
	I <sub>ctsource</sub>		-120		μA
Overcurrent detection voltage	V <sub>ocpL</sub>	1.5	3.0	4.2	V
	V <sub>ocpH</sub>	V <sub>BB</sub> -2.5	V <sub>BB</sub> -2.0	V <sub>BB</sub> -1.7	V
	V <sub>ocpL</sub>	1.0		1.85	V
	V <sub>ocpH</sub>	V <sub>BB</sub> -2.3		V <sub>BB</sub> -1.5	V
Open detection voltage	V <sub>open</sub>		-60		mV
Flag terminal leak current	I <sub>leakFlag</sub>			10	μA
Flag terminal saturation voltage	V <sub>FlagL</sub>			0.5	V
Flag terminal current	I <sub>Flag</sub>			3	mA
Set terminal	Response pulse width	T <sub>pw</sub>	10		μS
		T <sub>pws</sub>	100		μS
	Pulse rate	F <sub>clock</sub>	17	24	Hz
	Pulse number	Pulse		256	
Flag response time	OCP operation	t <sub>ocp1</sub>	2.5	5.0	10.0
		t <sub>ocp2</sub>	5.0	10.0	20.0
		t <sub>ocp3</sub>	5.0	10.0	20.0
	Open operation	t <sub>open1</sub>	2.5	5.0	10.0
		t <sub>open2</sub>	2.5	5.0	10.0
		t <sub>openH</sub>		1.5	
I/O propagation time		toffH1		1.5	
		toffH2		1.5	
		toffH1	100		
		toffH2	100		
		tonL1		2.0	
		toffL1		0.5	
		tonL2	100		
		toffL2	100		
		T <sub>J</sub>	150		
		ΔT <sub>J</sub>		20	
Thermal protection temperature	T <sub>J</sub>			150	
Thermal protection hysteresis	ΔT <sub>J</sub>		20		
Thermal alarm temperature	T <sub>alarm</sub>	120	130	140	
Thermal alarm hysteresis	ΔT <sub>alarm</sub>		20		

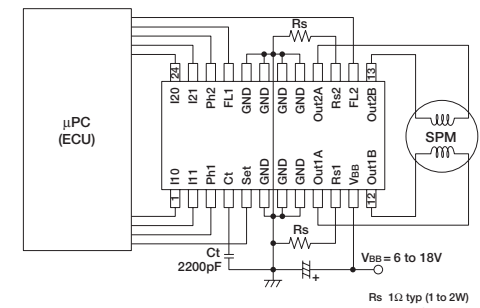
Note:

\*1: The Ct terminal threshold voltage and current are the design values. Warranty is based on the oscillation frequency.  
\*2: Thermal protection and alarm temperatures are design values.

## External Dimensions (unit: mm)

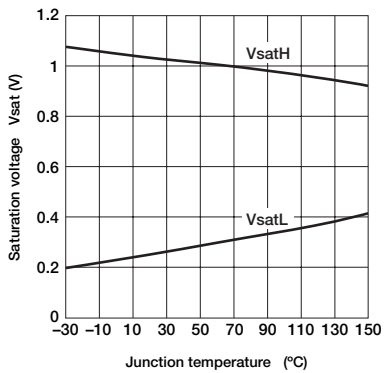


## Standard Circuit Diagram

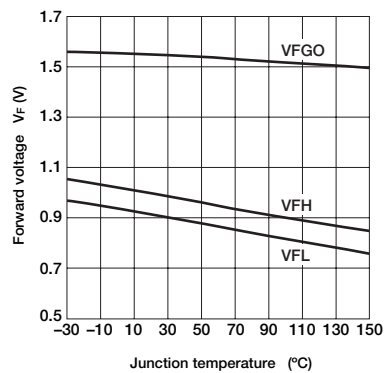


Electrical Characteristics

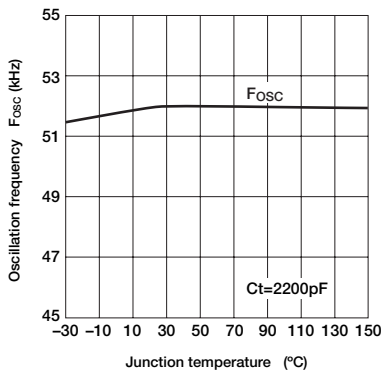
■ Vsat Temperature Characteristics (Io=0.5A)



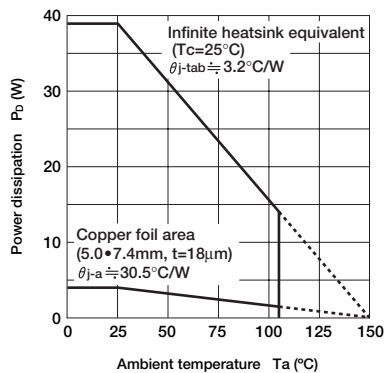
■ Diode Vf Characteristics (If=0.5A)



■ OSC Temperature Characteristics



■ Ta-PD Characteristics



# Full Bridge PWM Control DC Motor Driver ICs SI-5300

## Features

- P-ch MOS for high side and N-ch MOS for low side in one package
- Enable to drive DC±5V
- Possible to drive a motor at the LS-TTL, C-MOS Logic level
- Guarantee  $T_J=T_{CH}=150^{\circ}\text{C}$
- Built-in over current protection and thermal shut down circuits
- Built-in diagnosis function to monitor and signal the state of each protection circuits
- Built-in vertical current prevention circuits (Dead time is defined internally.)
- No insulator required for Sanken's original package (SPM package)

## Absolute Maximum Ratings

( $T_a=25^{\circ}\text{C}$ )

Parameter	Symbol	Ratings	Unit	Conditions
Motor supply voltage	$V_M$	40	V	
Input terminal voltage	IN1	-0.3 to 7	V	
	IN2	-0.3 to 7	V	
	PWM	-0.3 to 7	V	
Output current	$I_O$	±5	A	
	$I_O$ (p-p)	±17	A	$P_W \leq 1\text{ms}$ , Duty $\leq 50\%$
PWM control frequency	$f_{PWM}$	20	kHz	Duty=20% to 80%
Forward • reverse rotation switch frequency*	$f_{CW}$	500	Hz	
Operating temperature	$T_{OP}$	-40 to +85	$^{\circ}\text{C}$	
Junction and channel temperature	$T_J, T_{CH}$	-40 to +150	$^{\circ}\text{C}$	
Storage temperature	$T_{STG}$	-40 to +150	$^{\circ}\text{C}$	
Thermal resistance	$\theta_{J-C}$	3.7	$^{\circ}\text{C/W}$	
	$\theta_{J-A}$	35	$^{\circ}\text{C/W}$	
Power dissipation	$P_{D1}$	3.6	W	Without heatsink
	$P_{D2}$	33.7	W	With infinite heatsink

Note: \* The dead time for the length current prevention in positive and the reversing switch is set by internal control IC. The set point in internal IC at the dead time is 20μs (typical). Please take into account the dead time and consider the load conditions when you use the IC.

## Electrical Characteristics

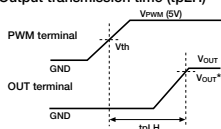
(Unless, otherwise specified,  $T_J=T_{CH}=25^{\circ}\text{C}$ ,  $V_M=14\text{V}$ ,  $I_O=3\text{A}$ )

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Motor supply voltage	$V_{IN}$	6		18	V	$V_M=24\text{V}$ (2 min.)
Output saturation voltage	$V_I, V_M-V_O$			0.8	V	$I_O=3\text{A}$
	$V_I, V_O-PG$			0.3	V	$I_O=3\text{A}$
Output leakage current	$I_{L, L}$			100	μA	$V_M=40\text{V}$
	$I_{L, H}$			100	μA	$V_M=40\text{V}$
Output transmission time	tpLH			10 *2	μs	$V_{PWM}: L \rightarrow H$ ( $V_{th}=2.5\text{V typ}$ )
	tpHL			15 *3	μs	$V_{PWM}: H \rightarrow L$ ( $V_{th}=2.5\text{V typ}$ )
	tpHL-tpLH			10	μs	
Forward voltage characteristic of diode between drain and source	$V_F \cdot L$		0.8		V	$I_O=3\text{A}$
			1.0		V	$I_O=10\text{A}$
	$V_F \cdot H$		0.8		V	$I_O=3\text{A}$
			1.0		V	$I_O=10\text{A}$
Static circuit current	IM1		22		mA	Stop mode
	IM2		22		mA	Forward and reverse mode
	IM3		16		mA	Brake mode
Input terminal voltage	$V_{IN, H}$	3.0			V	$V_{IN1}=V_{IN2}=V_{PWM}$
	$V_{IN, L}$			2.0	V	$V_{IN1}=V_{IN2}=V_{PWM}$
Input terminal current	$I_{IN, L}$	-100			μA	$V_{IN1}=V_{IN2}=V_{PWM}=0\text{V}$
	$I_{IN, H}$			200	μA	$V_{IN1}=V_{IN2}=V_{PWM}=5\text{V}$
OPC start current	$I_{OCP}$	16			A	*1
DIAG output pulse width	$t_{DIAG}$	20			ms	$C=1\mu\text{F}$ (typ)
DIAG terminal voltage	$V_{D \cdot L}$			0.3	V	$ID \cdot SINK=1\text{mA}$ *4

Note:

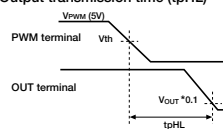
\*1: The standard value of  $I_{OCP}$  is assumed to be a value by which the output of each Power MOS FET cuts off. When the protection circuit of OCP and TSD operates, Power MOS FETs keeps cutoff. When a signal (5V: H → 0V: L) is input to the terminal PWM, the cutoff operation will be released. Moreover, three minutes ( $T_a=25^{\circ}\text{C}$ ,  $f_{PWM}=10\text{kHz}$ ,  $V_M=14\text{V}$ ) are assumed to be max at the overcurrent state continuance time in the  $V_M$  operation and the ground of output terminal (OUT1, OUT2). It is not the one to assure the operation including reliability in the state that the short-circuit continues for a long time.

\*2: Output transmission time (tpLH)



Output transmission time tpLH is time from  $V_{th}$  (2.5V typ) of the terminal of PWM to output ( $V_{OUT} \cdot 0.9$ ) of the output terminal.

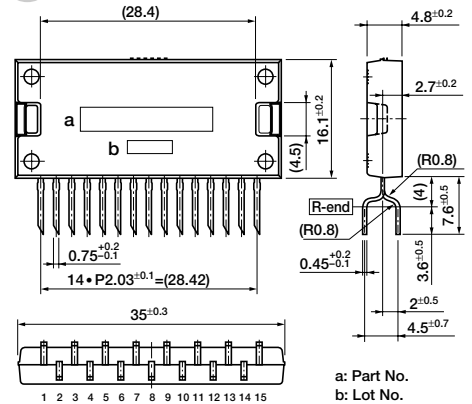
\*3: Output transmission time (tpHL)



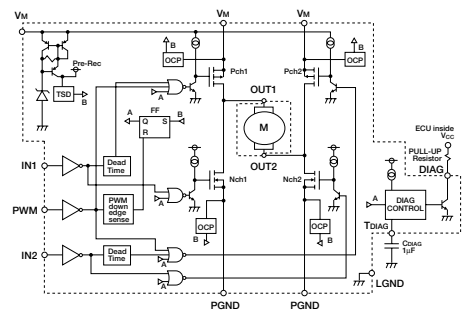
Output transmission time tpHL is time from  $V_{th}$  (2.5V typ) of the terminal of PWM to output ( $V_{OUT} \cdot 0.1$ ) of the output terminal.

\*4: DIAG signal output terminal is an open collector output. Use a pull-up resistor when connecting it to a logic circuit.

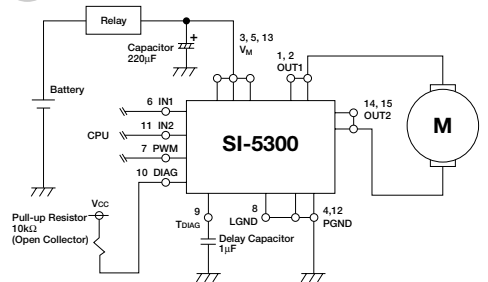
## External Dimensions (unit: mm)



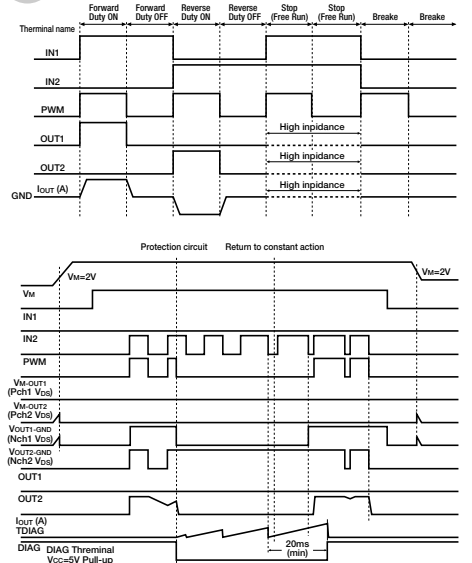
## Equivalent Circuit



## Standard Connection Diagram

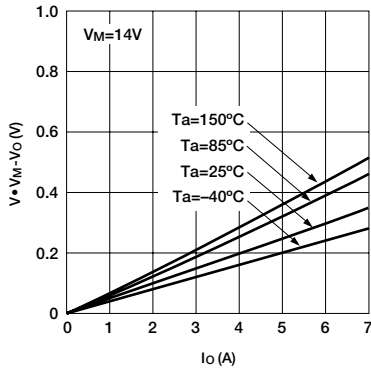


## Timing Chart

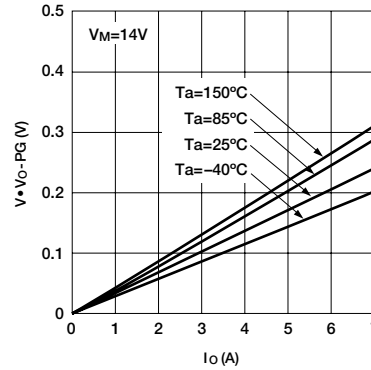


## Electrical Characteristics

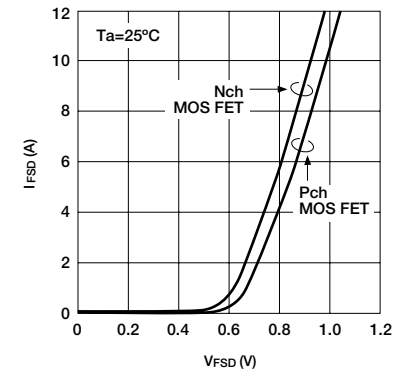
■ Output saturation voltage (Pch)



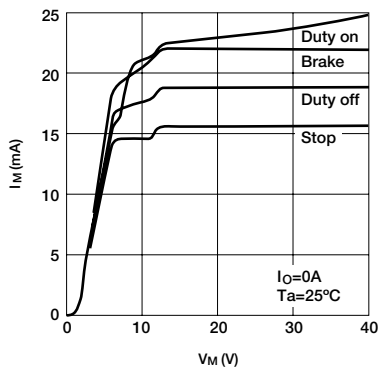
■ Output saturation voltage (Nch)



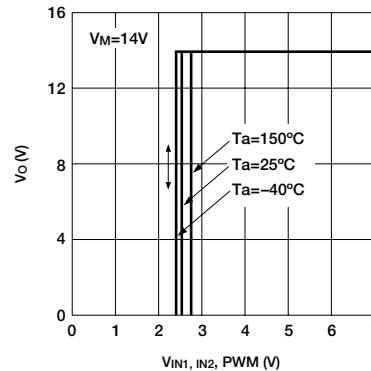
■ Forward voltage of Diode between drain and source



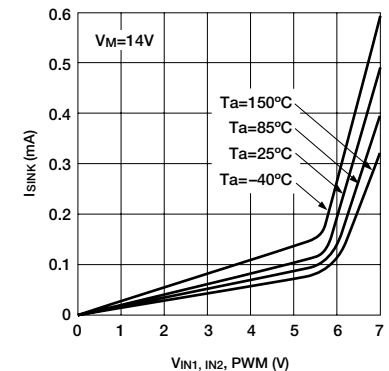
■ Quiescent circuit current



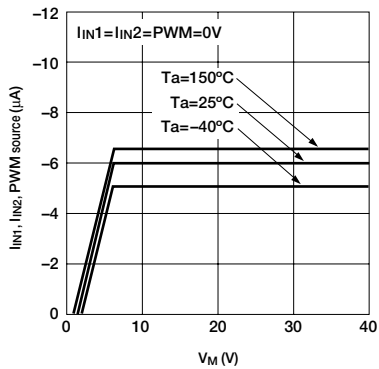
■ Voltage of input terminal (Threshold voltage)



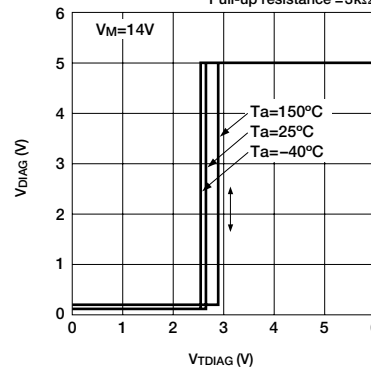
■ Current of input terminal (SINK current)



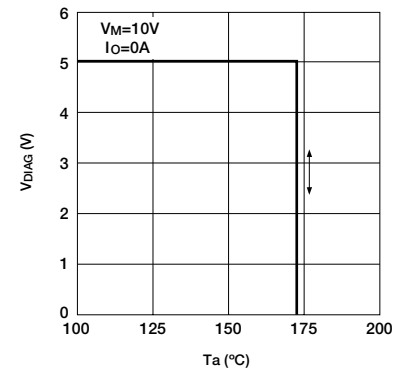
■ Current of input terminal (Source current)



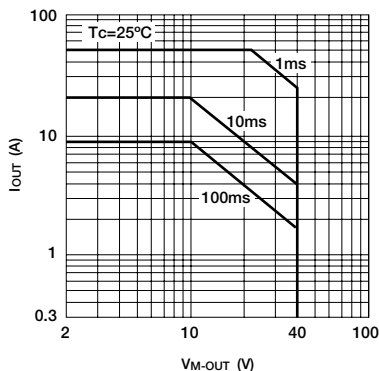
■ VTDIAG – VDIAG Characteristics



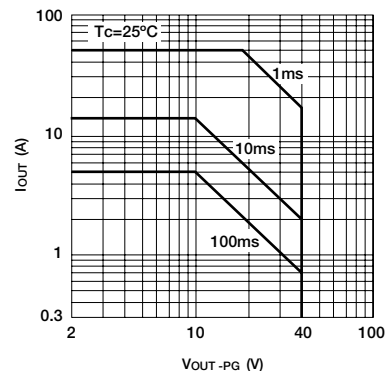
■ Thermal shut down protection



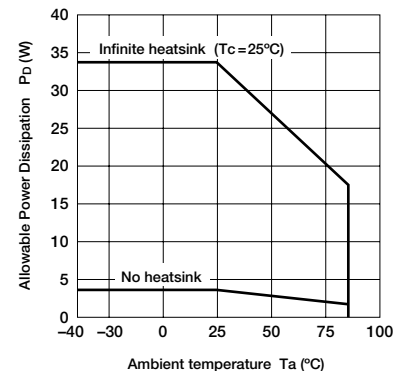
■ Pch MOS FET Safe Operating Area (SOA)



■ Nch MOS FET Safe Operating Area (SOA)



■ Pd—Ta Characteristics



# Full Bridge DC Motor Driver ICs    SPF7301(under development)

## Features

- A DMOS of low ON resistance ( $0.1\Omega$  typ) is mounted on the high and low side power elements
- Two input signals control the forward/reverse/brake of a DC motor
- Current limit and overcurrent protection circuits
- Low voltage and thermal protection, excess input detecting output and input terminal open protection

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Symbol	Ratings	Unit	Remarks
Main power supply voltage	V <sub>B</sub>	-0.3 to 36	V	
Input terminal input voltage	V <sub>IN1</sub> , V <sub>IN2</sub>	-0.3 to 6	V	
EN terminal voltage	V <sub>EN</sub>	-0.3 to 12	V	
Disable terminal input voltage	V <sub>DI</sub>	-0.3 to 6	V	
Output current	I <sub>o</sub>	±7	A	
	I <sub>oPeak</sub>	±15	A	1kHz, Duty<1%, Pulse<10μS
DIAG output current	V <sub>DIAG</sub>	-0.3 to 6	V	
DIAG inflow current	I <sub>DIAG</sub>	-3	mA	DIAG terminal sink current
Power dissipation	P <sub>D1</sub>	39	W	With an infinite heatsink mounted
	P <sub>D2</sub>	4	W	*1
Junction temperature	T <sub>J</sub>	-40 to 150	°C	
Operating temperature	T <sub>OP</sub>	-40 to 105	°C	
Storage temperature	T <sub>STG</sub>	-40 to 150	°C	
Thermal resistance (junction to case)	θ <sub>J-C</sub>	3.2	°C/W	
Thermal resistance (junction to ambient air)	θ <sub>J-A</sub>	31	°C/W	

Note: \*1: With glass epoxy + copper foil board (size 5.0•7.4cm; t: glass epoxy=1.6mm/copper foil=18μm)

## Recommended Operation Range

Parameter	Symbol	Ratings	Unit	Remarks
Main power supply voltage	V <sub>B</sub>	8 to 18	V	
DI terminal input voltage	V <sub>DI</sub>	-0.3 to 5.3	V	
Input terminal input voltage	V <sub>INx</sub>	-0.3 to 5.3	V	
Output current	I <sub>o</sub>	±1	A	
DIAG terminal voltage	V <sub>DIAG</sub>	-0.3 to 5.3	V	
Operating temperature	T <sub>OP</sub>	-40 to 105	°C	

## Electrical Characteristics

(T<sub>J</sub> = 30 to 125°C, V<sub>B</sub> = 14V, EN = DI = 5V, C<sub>CP</sub> = 33nF, R<sub>DIAG</sub> = 20kΩ unless otherwise specified) \*2

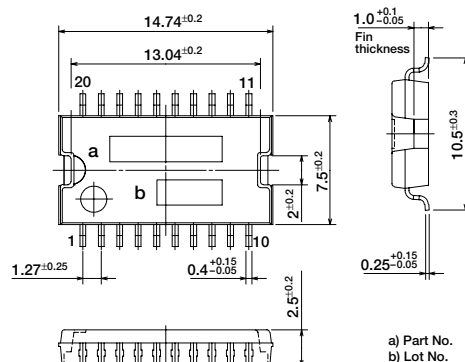
Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Main power supply current	I <sub>BB1</sub>		15		mA	
	I <sub>BB2</sub>			100	μA	For V <sub>EN</sub> =0V
Low voltage protection operation voltage	V <sub>UVLOH</sub>	5.0		7.0	V	
	V <sub>UVLOL</sub>	4.5		6.5	V	
UVLO hysteresis voltage	ΔV <sub>UVLO</sub>		0.5		V	
Output terminal leak current	I <sub>leakHS</sub>	-100			μA	
	I <sub>leakLS</sub>			100	μA	
Output DMOS RDS (ON)	R <sub>DS(ON)_1H</sub>		100	200	mΩ	
	R <sub>DS(ON)_2H</sub>		100	200	mΩ	
	R <sub>DS(ON)_1L</sub>		100	200	mΩ	
	R <sub>DS(ON)_2L</sub>		100	200	mΩ	
Forward voltage characteristics between output DMOS and DS	V <sub>F_H1</sub>		1.5		V	I <sub>o1</sub> = 1A
	V <sub>F_H2</sub>		1.5		V	I <sub>o2</sub> = 1A
	V <sub>F_L1</sub>		1.5		V	I <sub>o1</sub> = -1A
	V <sub>F_L2</sub>		1.5		V	I <sub>o2</sub> = -1A
Overcurrent limiting operation current	I <sub>ocp1_H1</sub>	4.5	7	10	A	
	I <sub>ocp1_H2</sub>	4.5	7	10	A	
	I <sub>ocp1_L1</sub>	4.5	7	10	A	
	I <sub>ocp1_L2</sub>	4.5	7	10	A	
OPC start current	I <sub>ocp2_H1</sub>		15		A	
	I <sub>ocp2_H2</sub>		15		A	
	I <sub>ocp2_L1</sub>		15		A	
	I <sub>ocp2_L2</sub>		15		A	
Input terminal voltage	V <sub>INxH</sub>	2			V	
	V <sub>INxL</sub>			0.8	V	
Input terminal current	I <sub>INxH</sub>	-100			μA	V <sub>DI</sub> = 5V
	I <sub>INxL</sub>	-100			μA	V <sub>DI</sub> = 0V
DI terminal voltage	V <sub>DHxH</sub>	2			V	
	V <sub>DHxL</sub>			0.8	V	
DI terminal current	I <sub>DHxH</sub>	-100			μA	V <sub>DI</sub> = 5V
	I <sub>DHxL</sub>	-100			μA	V <sub>DI</sub> = 0V
EN terminal input voltage	V <sub>ENth</sub>	0.8		4	V	
EN terminal input current	I <sub>ENH</sub>			100	μA	V <sub>EN</sub> = 5V
	I <sub>ENL</sub>	-10		10	μA	V <sub>EN</sub> = 0V
DIAG terminal output voltage	V <sub>DIAG</sub>			0.8	V	I <sub>DIAG</sub> = 0.5mA
DIAG terminal output current	I <sub>DIAG</sub>	1.5			mA	For V <sub>DIAG</sub> = 1.6V
DIAG terminal leak current	I <sub>DIAGL</sub>	-10		15	μA	
	T <sub>don</sub>			20	μS	Time from V <sub>INxH</sub> to V <sub>outx</sub> •0.2
	T <sub>doff</sub>			15	μS	Time from V <sub>INxL</sub> to V <sub>outx</sub> •0.8
	T <sub>r</sub>			6	μS	Time of V <sub>outx</sub> from 20% to 80%
	T <sub>f</sub>			6	μS	Time of V <sub>outx</sub> from 80% to 20%
	T <sub>ddis</sub>			4	μS	Time from D <sub>lthH</sub> to V <sub>outx</sub> •0.2
Overvoltage protection operation voltage	V <sub>ovp</sub>	35	40	45	V	
OVP hysteresis width	ΔV <sub>ovp</sub>		5		V	
Thermal protection starting temperature	T <sub>tsd_ON</sub>	151	165		°C	*3
Thermal protection hysteresis width	ΔT <sub>tsd</sub>		15		°C	*3

Note:

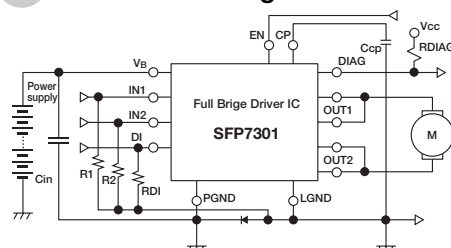
\*2: For the electrical characteristics for T<sub>J</sub> = -40 to 150°C, the design warranty applies to the above specification values.

\*3: Thermal protection starting temperature is 165°C (typ) by design. The above parameters are the design specifications.

## External Dimensions (unit: mm)



## Standard Circuit Diagram



\* Recommended connection parts  
Pressure rise capacitor for charge pump circuits (CP to GND) C<sub>p</sub> 33nF  
DIAG terminal pull-up resistance R<sub>DIAG</sub>: 20kΩ  
Input terminal pull-down resistance R1, R2, RDI, RDL: 10kΩ



# High Voltage Full Bridge Drive ICs SLA2402M

## Features

- One Package Full Bridge Driver Consisted of High Voltage IC and Power MOS FETs (4 pieces)
- High Voltage Driver which accepts direct connection to the input signal line
- External components such as high voltage diodes and capacitors are not required

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Power source voltage *	$V_M$	500	V	
Input voltage	$V_{IN}$	15	V	
Output voltage	$V_O$	500	V	
Output current	$I_O$	15	A	$P_W \leq 250\mu s$
Power dissipation	$P_D$	5 ( $T_a=25^\circ C$ )	W	Without heatsink
Storage temperature	$T_{stg}$	-40 to +125	$^\circ C$	
Operation temperature	$T_{opr}$	-40 to +105	$^\circ C$	

\* Power GND (D terminal) to -HV (-HV terminal) voltage.

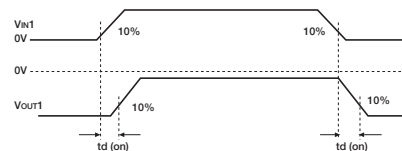
## Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Power MOS FET output breakdown voltage	$BV_{OUT}$	500			V	$I_O=100\mu A$
Power MOS FET output leakage voltage	$I_{OUT(off)}$			100	$\mu A$	$V_O=500V$
High-side Power MOS FET output on-state voltage	$V_{OUT(on)1}$	0.28	0.4	0.52	V	$I_O=0.4A, V_{IN}=10V$
	$V_{OUT(on)2}$	1.4	2.0	2.6	V	$I_O=2A, V_{IN}=10V$
Low-side Power MOS FET output on-state voltage	$V_{OUT(on)1}$	0.28	0.4	0.52	V	$I_O=0.4A, V_{GL}=10V$
	$V_{OUT(on)2}$	1.4	2.0	2.6	V	$I_O=2A, V_{GL}=10V$
Quiescent circuit current	$I_{CC1}$			3.0	mA	$V_{CC}=4.5$ to 15V
	$I_{CC2}$			4.0	mA	$V_{CC}=10V, V_M=400V$
Operating circuit current	$I_{CC3}$			4.0	mA	$V_{CC}=10V, V_M=400V$
Input voltage (High level)	$V_{IH}$	0.8V <sub>CC</sub>			V	$V_{CC}=4.5$ to 15V
Input voltage (Low level)	$V_{IL}$			0.2V <sub>CC</sub>	V	$V_{CC}=4.5$ to 15V
Delay time *	$t_d(on)$		1.4		$\mu s$	$V_{CC}=10A, V_{IN}=10V,$ $V_M=85A,$ $I_O=0.41A$
	$t_d(off)$		3.3		$\mu s$	
	$\Delta t$		2.5		$\mu s$	
Operating voltage	$V_{CC}$			15	V	-40 to +105 $^\circ C$

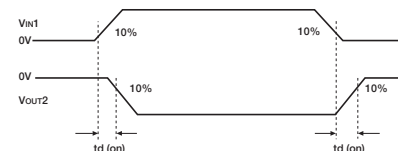
\* About delay time

Signal input waveform vs output waveform

① Highside switch turn-on, turn-off

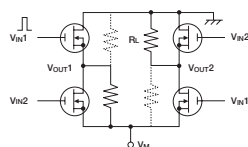


② Lowside switch turn-on, turn-off



\*  $\Delta t: \Delta t = t_d(on) - t_d(off)$

Measurement Circuit

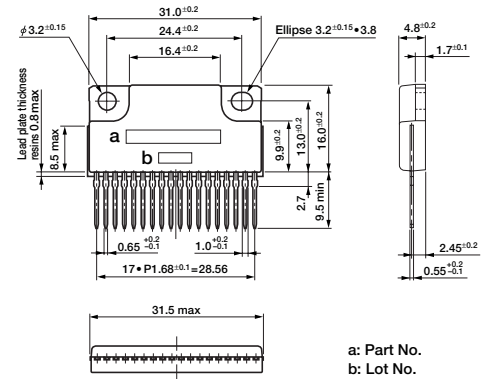


Conditions

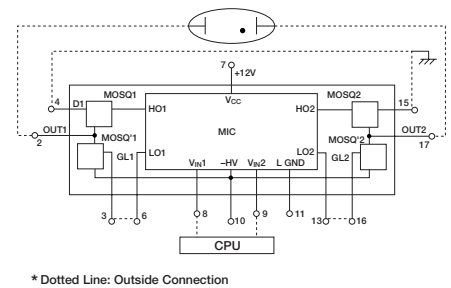
$V_{CC}=10V, V_{IN}=10V$  (pulse)  
 $V_M=85V$   
 $I_O=0.41A$  ( $R_L=207\Omega$ )

\* When pulse signal is inputted to  $V_{IN1}$ ,  $R_L$  on solid line is ON and dotted line  $R_L$  is off.  
On the contrary, when pulse signal is inputted to  $V_{IN2}$ ,  $R_L$  on dotted line is ON and dotted line  $R_L$  is off.

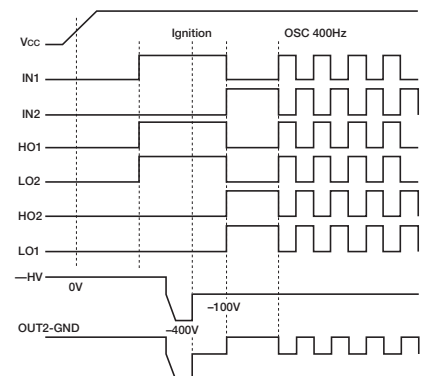
## External Dimensions (unit: mm)



## Block Diagram

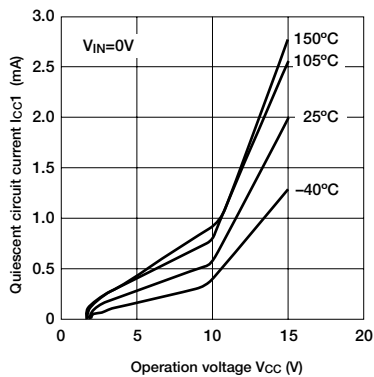


## Timing Chart

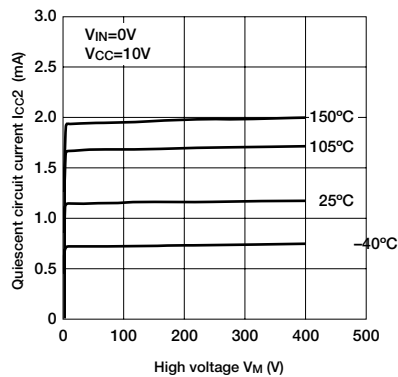


## Electrical Characteristics

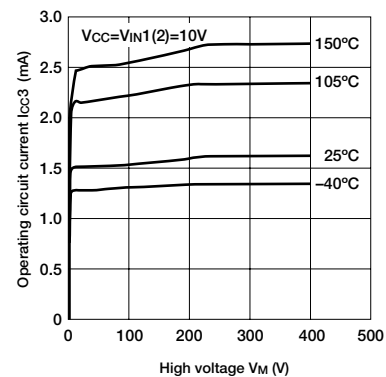
■ Quiescent circuit current



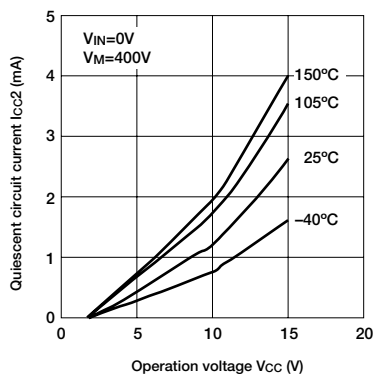
■ Quiescent circuit current supplied high voltage



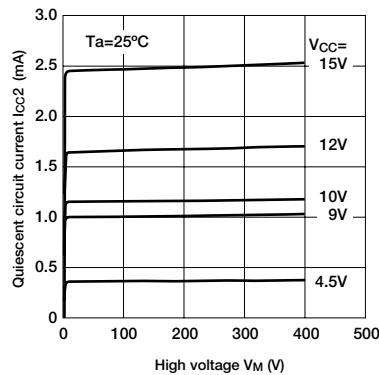
■ Operating circuit current



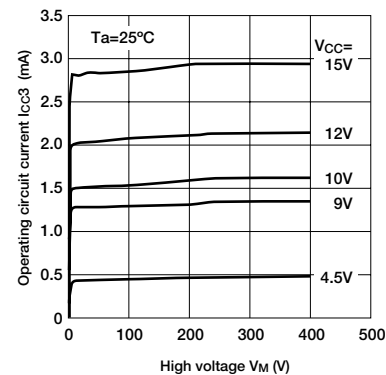
■ Quiescent circuit current supplied high voltage



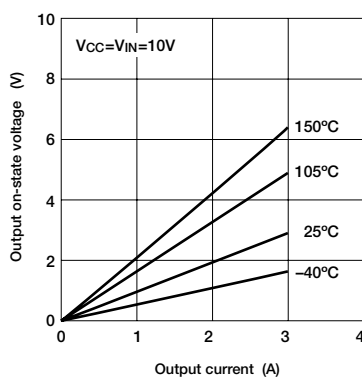
■ Quiescent circuit current



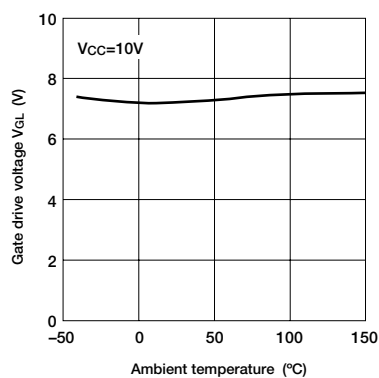
■ Operating circuit current



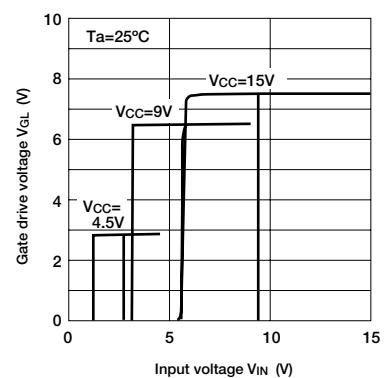
■ Output on-state voltage



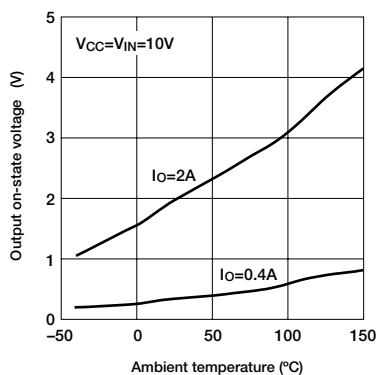
■ Gate drive voltage



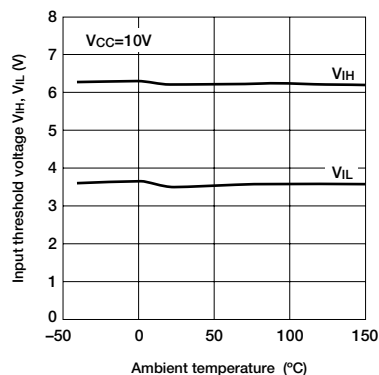
■ Gate drive voltage



■ Output on-state voltage

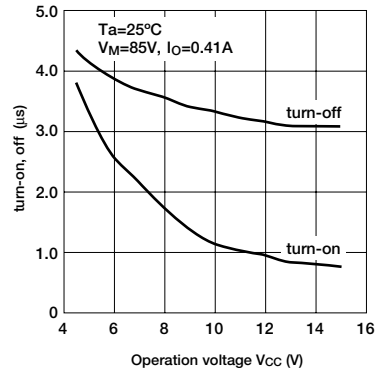


■ Input threshold voltage

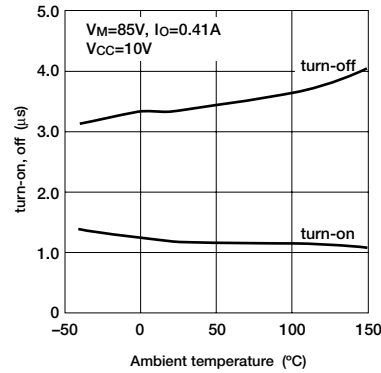


Electrical Characteristics

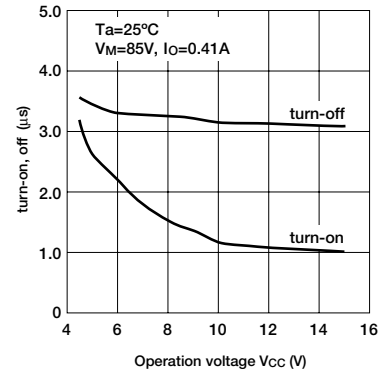
High side switch turn-on, off



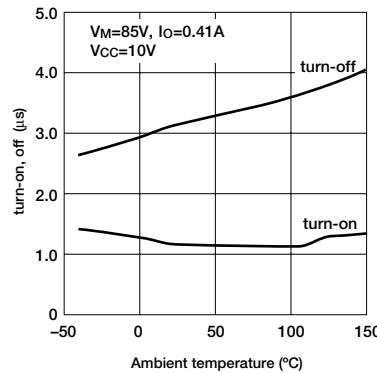
High side switch turn-on, off



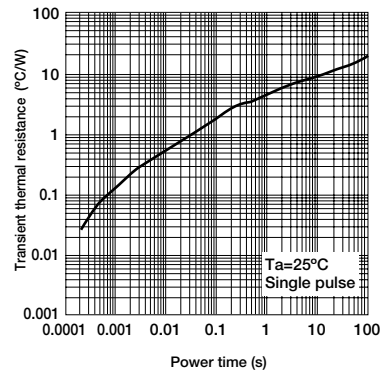
Low side switch turn-on, off



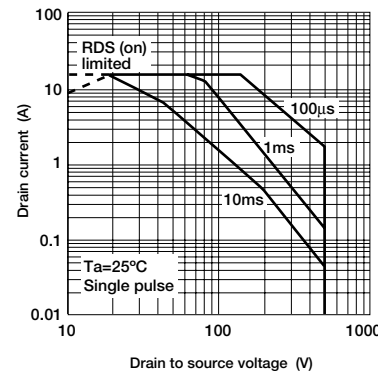
Low side switch turn-on, off



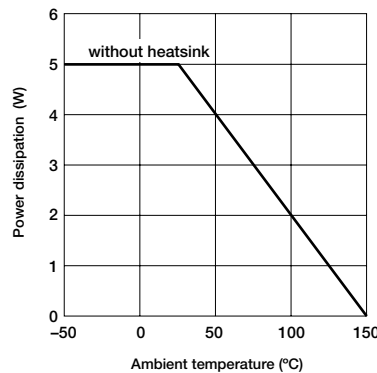
Transient thermal resistance characteristics



Safe operating area (Power MOS FET)



Power derating curve





# High Voltage Full Bridge Drive ICs SLA2403M

## Features

- One Package Full Bridge Driver Consisted of High Voltage IC and Power MOS FETs (4 pieces)
- High Voltage Driver which accepts direct connection to the input signal line
- External components such as high voltage diodes and capacitors are not required

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Power source voltage *	$V_M$	500	V	
Input voltage	$V_{IN}$	15	V	
Output voltage	$V_O$	500	V	
Output current	$I_O$	7	A	$T_C=25^\circ\text{C}$
	$I_O$ (peak)	15	A	$P_W \leq 250\mu\text{s}$
Power dissipation	$P_D$	5 ( $T_a=25^\circ\text{C}$ )	W	Without heatsink
		40 ( $T_C=25^\circ\text{C}$ )	W	With infinite heatsink
Storage temperature	$T_{stg}$	-40 to +125	$^\circ\text{C}$	
Operation temperature	$T_{opr}$	-40 to +125	$^\circ\text{C}$	
Junction temperature	$T_J$	150	$^\circ\text{C}$	

\* Power GND (D terminal) to -HV (-HV terminal) voltage.

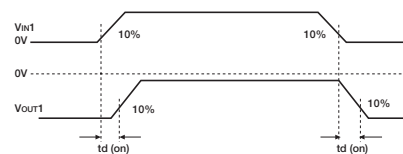
## Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Power MOS FET output breakdown voltage	$BV_{OUT}$	500			V	$I_O=100\mu\text{A}$
Power MOS FET output leakage voltage	$I_{OUT}(\text{off})$			100	$\mu\text{A}$	$V_O=500\text{V}$
High-side Power MOS FET output on-state voltage	$V_{OUT}(\text{on})$	0.18	0.26	0.34	V	$I_O=0.4\text{A}$ , $V_{IN}=10\text{V}$
Lowside Power MOS FET output on-state voltage	$V_{OUT}(\text{on})$	0.18	0.26	0.34	V	$I_O=0.4\text{A}$ , $V_{GL}=10\text{V}$
Quiescent circuit current	$I_{CC1}$			3.0	mA	$V_{CC}=6$ to $15\text{V}$
	$I_{CC2}$			4.0	mA	$V_{CC}=10\text{V}$ , $V_M=400\text{V}$
Operating circuit current	$I_{CC3}$			4.0	mA	$V_{CC}=10\text{V}$ , $V_M=400\text{V}$
Input voltage (High level)	$V_{IH}$	$0.8V_{CC}$			V	$V_{CC}=6$ to $15\text{V}$
Input voltage (Low level)	$V_{IL}$			$0.2V_{CC}$	V	$V_{CC}=6$ to $15\text{V}$
Delay time *	$t_d(\text{on})$		2.0		$\mu\text{s}$	$V_{CC}=10\text{A}$ , $V_{IN}=10\text{V}$ , $V_M=85\text{V}$ , $I_O=0.41\text{A}$
	$t_d(\text{off})$		3.0		$\mu\text{s}$	
Operating voltage	$V_{CC}$	6		15	V	-40 to +125 $^\circ\text{C}$

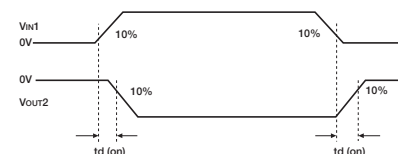
\* About delay time

Signal input waveform vs output waveform

① Highside switch turn-on, turn-off

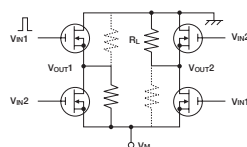


② Lowside switch turn-on, turn-off



\*  $\Delta t: \Delta t = t_d(\text{on}) - t_d(\text{off})$

Measurement Circuit



Conditions

$V_{CC}=10\text{V}$ ,  $V_{IN}=10\text{V}$  (pulse)

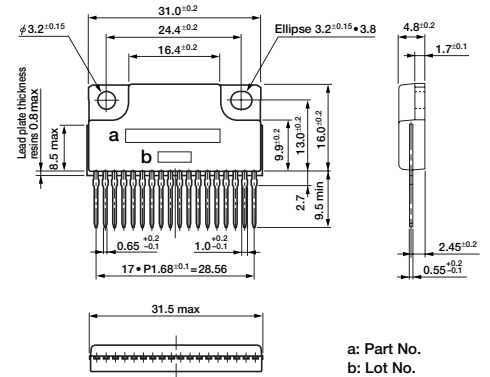
$V_M=85\text{V}$

$I_O=0.41\text{A}$  ( $R_L=207\Omega$ )

\* When pulse signal is inputted to  $V_{IN1}$ ,  $R_L$  on solid line is ON and dotted line  $R_L$  is off.

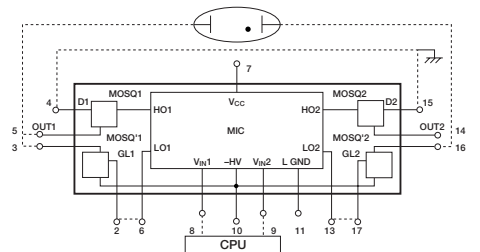
On the contrary, when pulse signal is inputted to  $V_{IN2}$ ,  $R_L$  on dotted line is ON and solid line  $R_L$  is off.

## External Dimensions (unit: mm)



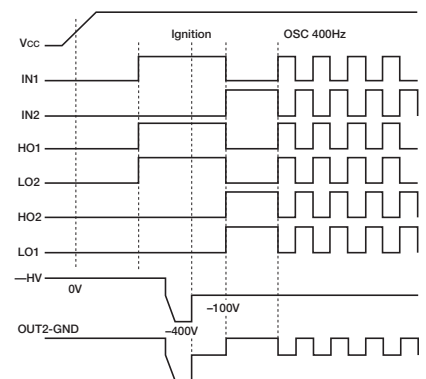
a: Part No.  
b: Lot No.

## Block Diagram



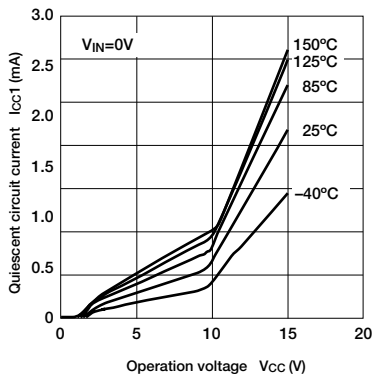
\* Dotted Line: Outside Connection

## Timing Chart

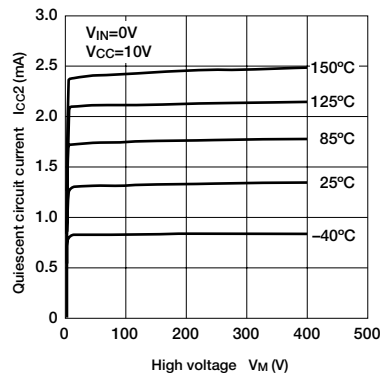


## Electrical Characteristics

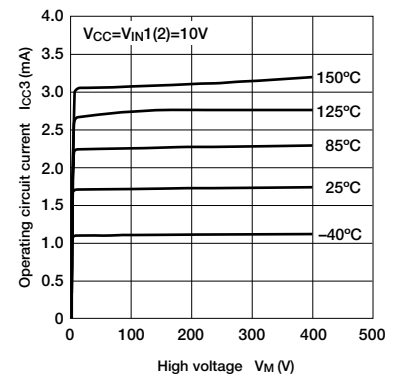
■ Quiescent circuit current



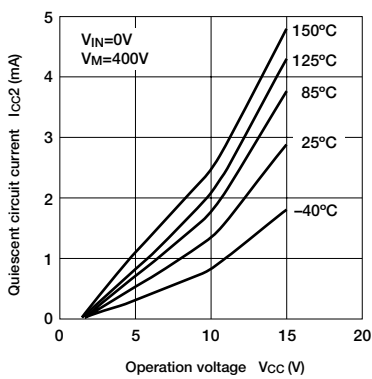
■ Quiescent circuit current supplied high voltage



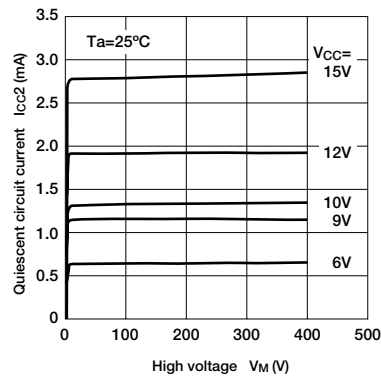
■ Operating circuit current



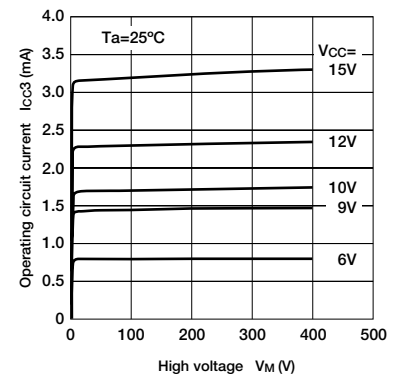
■ Quiescent circuit current supplied high voltage



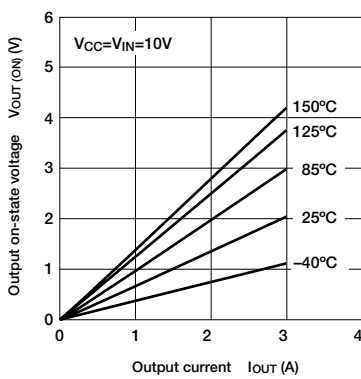
■ Quiescent circuit current supplied high voltage



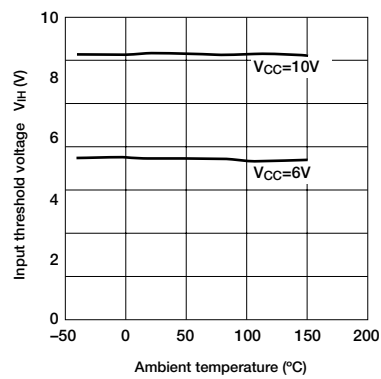
■ Operating circuit current



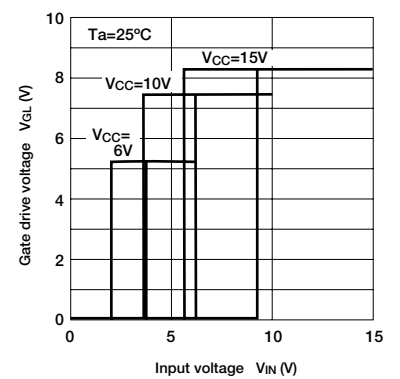
■ Output on-state voltage



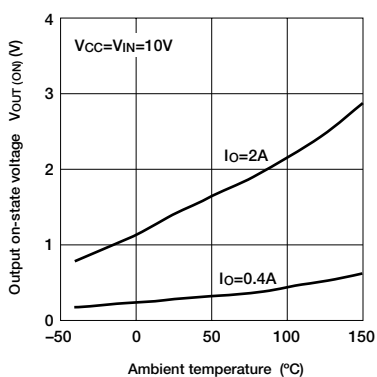
■ Input threshold voltage



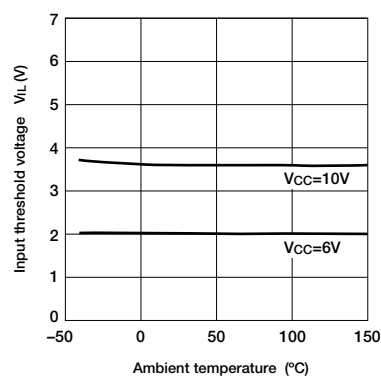
■ Gate drive voltage



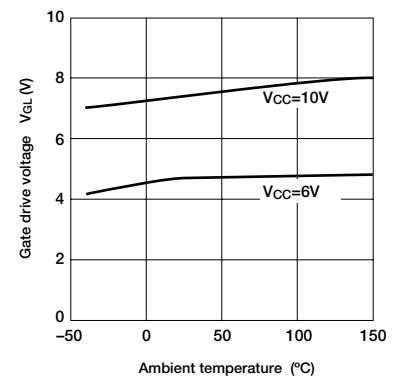
■ Output on-state voltage



■ Input threshold voltage

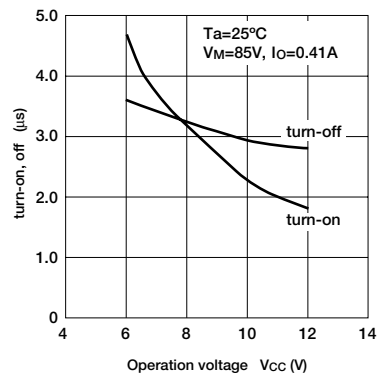


■ Gate drive voltage

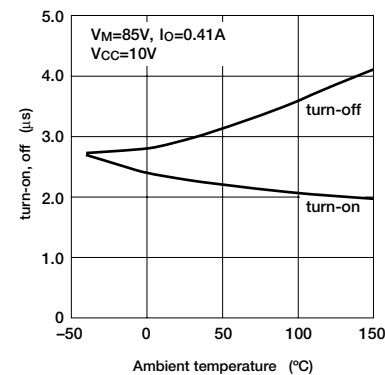


Electrical Characteristics

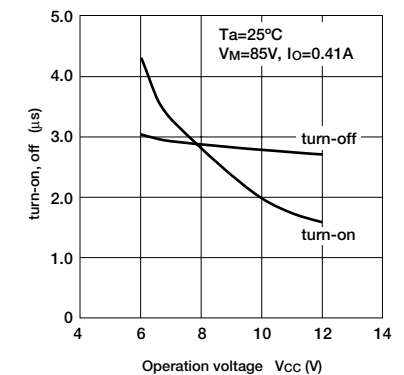
■ High side switch turn-on, off



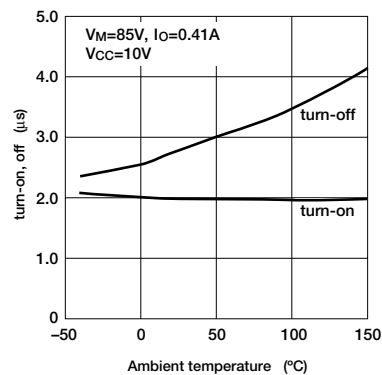
■ High side switch turn-on, off



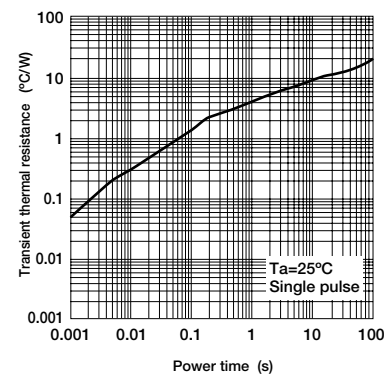
■ Low side switch turn-on, off



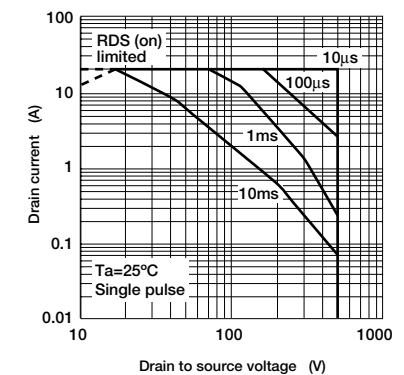
■ Low side switch turn-on, off



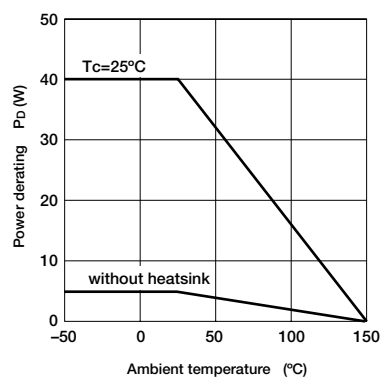
■ Transient thermal resistance characteristics



■ Safe operating area (Power MOS FET)



■ Power derating curve





# High Voltage Full Bridge Drive ICs SMA2409M

## Features

- One Package Full Bridge Driver Consisted of High Voltage IC and Power IGBT (4 pieces)
- High Voltage Driver which accepts direct connection to the input signal line

## Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Power supply voltage	V <sub>M</sub>	500	V	Power GNG to HV
Input voltage	V <sub>IN</sub>	15	V	
Operation voltage	V <sub>CC</sub>	15	V	
Output voltage	V <sub>O</sub>	500	V	
Output current (DC)	I <sub>O(DC)</sub>	7	A	
Output current (pulses)	I <sub>O(pulse)</sub>	15	A	Single pulse (PW = 50μs max.)
Power dissipation	P <sub>D</sub>	4	W	T <sub>C</sub> = 25°C
		20		
Thermal resistance	θ <sub>J-a</sub>	31.2	°C/W	T <sub>C</sub> = 25°C
		6.2		
Operating temperature	T <sub>opr</sub>	-40 to +105	°C	
Storage temperature	T <sub>stg</sub>	-40 to +150	°C	
Junction temperature	T <sub>J</sub>	150	°C	
IGBT single pulse avalanche resistance	E <sub>AS</sub>	5	mJ	V <sub>DD</sub> = 30V, L = 1mH, Unclamped, I <sub>C</sub> = 3.2A
ESD protection	E <sub>SD</sub>	±2	kV	Human body model (C = 100pF, R = 1.5kΩ)

## Electrical Characteristics

(Ta = 25°C)

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
IGBT output breakdown voltage	BV <sub>OUT</sub>	570			V	I <sub>O</sub> = 100μA, T <sub>J</sub> = 25°C
IGBT output leak current	I <sub>OUT (off)</sub>			100	μA	V <sub>O</sub> = 500V
IGBT output ON voltage	V <sub>OUT (on)</sub>		1.0	1.2	V	I <sub>O</sub> = 0.4A, V <sub>IN</sub> (or V <sub>GL</sub> ) = 10V
			1.3	1.8	V	I <sub>O</sub> = 2.0A, V <sub>IN</sub> (or V <sub>GL</sub> ) = 10V
Quiescent circuit current	I <sub>CC1</sub>			3.0	mA	V <sub>CC</sub> = 10V, V <sub>M</sub> = V <sub>IN</sub> = 0V
	I <sub>CC2</sub>			4.0	mA	V <sub>CC</sub> = 10V, V <sub>M</sub> = 400V, V <sub>IN</sub> = 0V
Operating circuit current	I <sub>CC3</sub>			4.0	mA	V <sub>CC</sub> = 10V, V <sub>M</sub> = 400V, V <sub>IN1</sub> (or V <sub>IN2</sub> ) = 10V
Input threshold voltage	V <sub>IH</sub>	0.8 • V <sub>CC</sub>			V	V <sub>CC</sub> = 9 to 15V
	V <sub>IL</sub>			0.2 • V <sub>CC</sub>	V	
Low-side IGBT gate drive voltage	V <sub>GL</sub>	0.8 • V <sub>CC</sub>		16	V	V <sub>CC</sub> = 9 to 15V
Delay time*	High side	t <sub>d (on)</sub>	0.6	0.7	0.8	μs
		t <sub>d (off)</sub>	1.8	2.2	2.6	μs
	Low side	t <sub>d (on)</sub>	0.8	0.9	1.0	μs
		t <sub>d (off)</sub>	1.3	1.6	1.9	μs
	Δt <sub>d</sub>				2.5	μs
Operating voltage	V <sub>CC</sub>	9		15	V	T <sub>a</sub> = -40 to +105°C

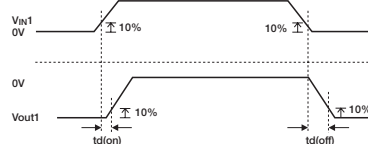
## Recommended Operation Range

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
Dead time	t <sub>d</sub>	5.0			μs	T <sub>a</sub> = -40 to +105°C

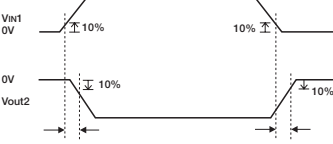
\* About delay time

Signal input waveform vs output waveform

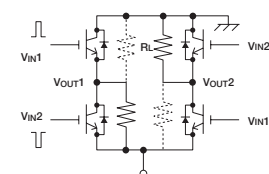
① Highside switch turn-on, turn-off



② Lowside switch turn-on, turn-off



### Measurement Circuit

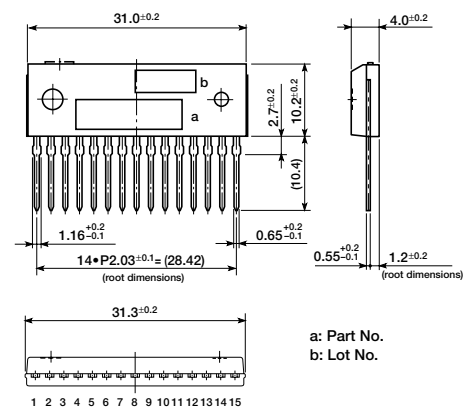


### Conditions

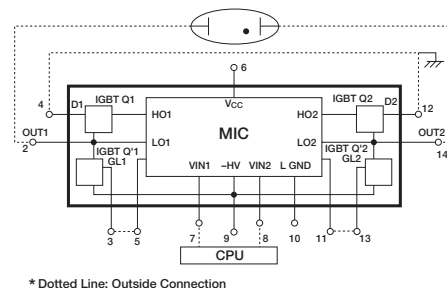
V<sub>CC</sub> = 10V, V<sub>IN</sub> = 10V (pulse)  
V<sub>M</sub> = 85V  
I<sub>O</sub> = 0.41A (R<sub>L</sub> = 206Ω)

\* When pulse signal is inputted to V<sub>IN1</sub>, R<sub>L</sub> on solid line is ON and dotted line is off.  
On the contrary, when pulse signal is inputted to V<sub>IN2</sub>, R<sub>L</sub> on dotted line is ON and solid line is off.

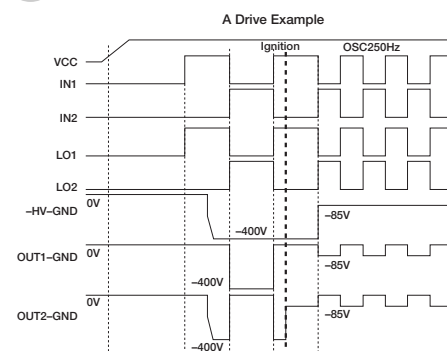
## External Dimensions (unit: mm)



## Block Diagram

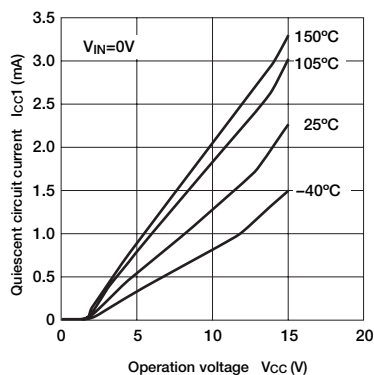


## Timing Chart

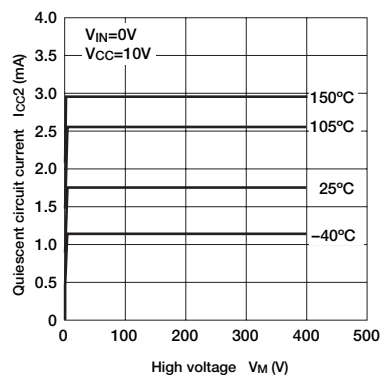


## Electrical Characteristics

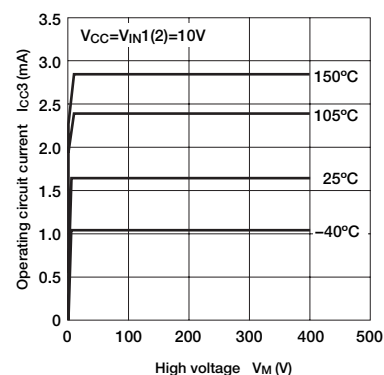
■ Quiescent circuit current



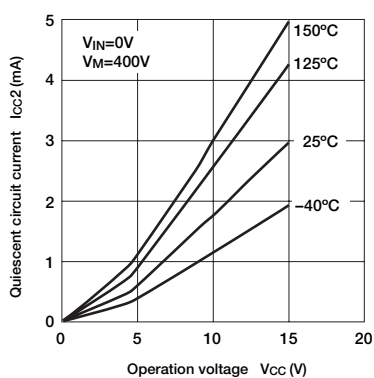
■ Quiescent circuit current supplied high voltage



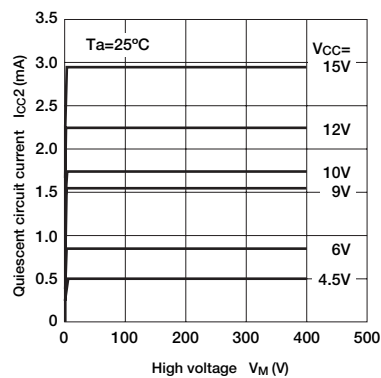
■ Operating circuit current



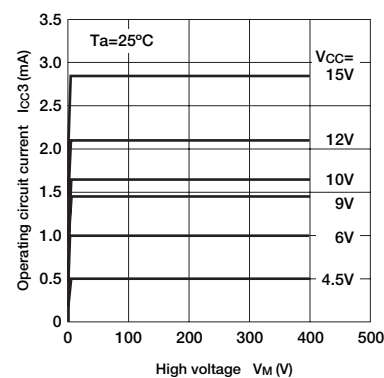
■ Quiescent circuit current supplied high voltage



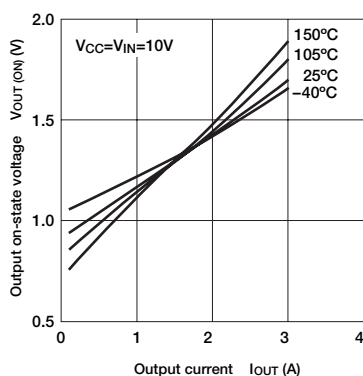
■ Quiescent circuit current supplied high voltage



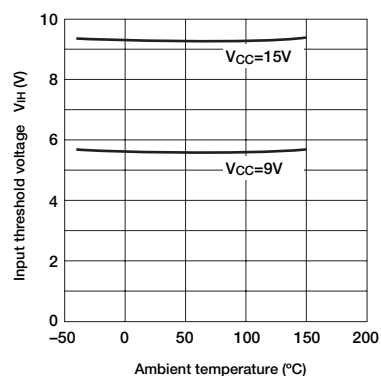
■ Operating circuit current



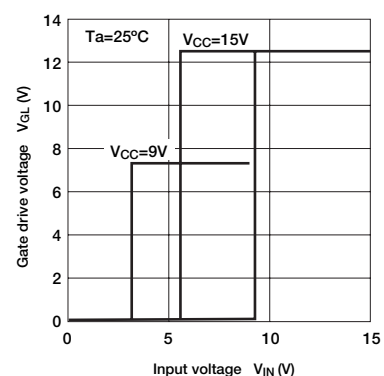
■ Output on-state voltage



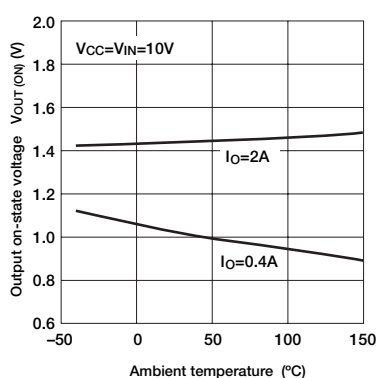
■ Input threshold voltage



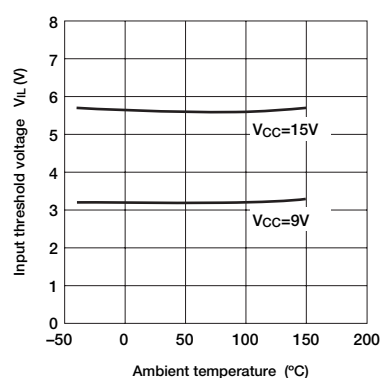
■ Gate drive voltage



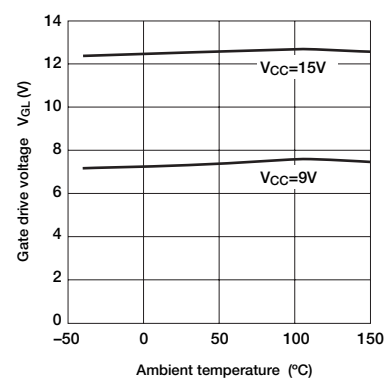
■ Output on-state voltage



■ Input threshold voltage

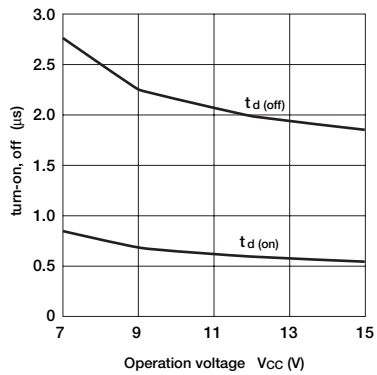


■ Gate drive voltage

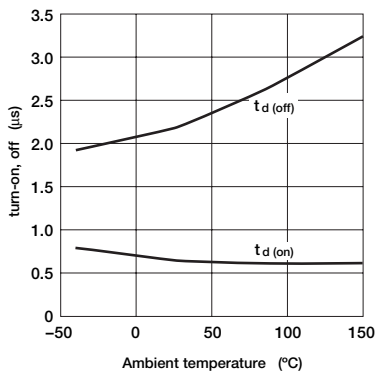


Electrical Characteristics

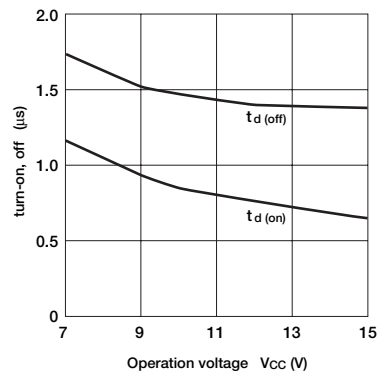
High side switch turn-on, off



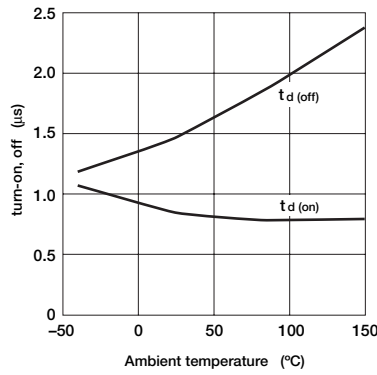
High side switch turn-on, off



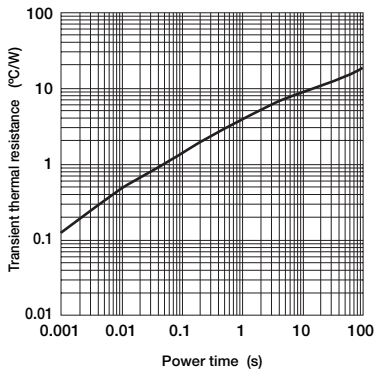
Low side switch turn-on, off



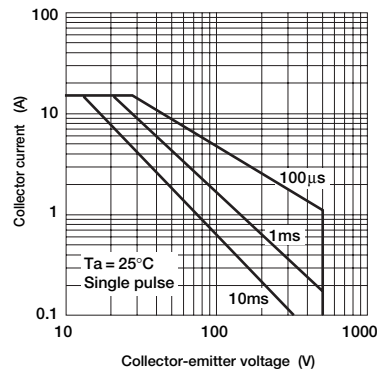
Low side switch turn-on, off



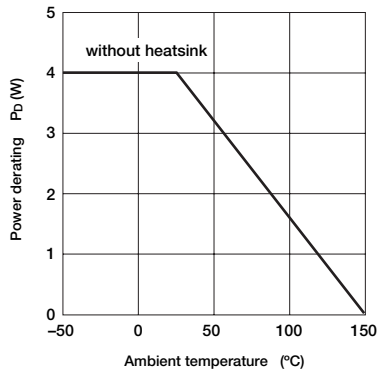
Transient thermal resistance characteristics



IGBT ASO characteristics



Power derating curve





# Custom ICs

- Various processing technologies of BIP, BiCMOS, CMOS and BCD can be used for the semiconductor chips.
- Meets detailed user needs, especially power ICs. A wide range of general-purpose ICs is also available.
- Employs a monolithic chip with flip-chip construction for increased reliability making it ideal for car electronic devices.
- Also available in hybrid ICs with transfer mold construction, multi-chip IC configuration and power monolithic IC configuration.

## Features

- All semiconductor chips used are manufactured by Sanken.
- Main product lineup consists of power ICs produced out of many years' experience of Sanken.
- Uses monolithic chips with flip-chip construction.
- Mainly available in miniature transfer-mold packages.

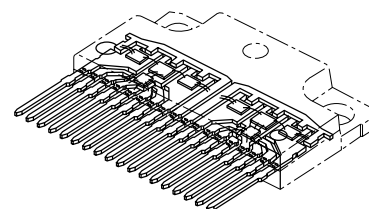
## Examples of Custom Hybrid IC Products

- Regulators for alternators
- Igniters
- Power supply for microcomputer system
- Power steering control IC
- Motor and actuator driver
- Others

## Examples of Sanken Automotive Hybrid ICs

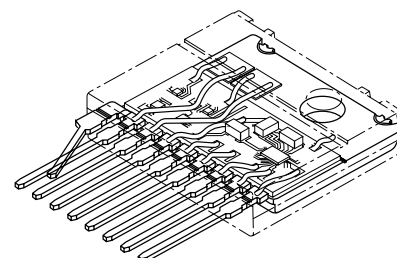
Lead frame type  
multi-chip power IC

- One-chip power IC

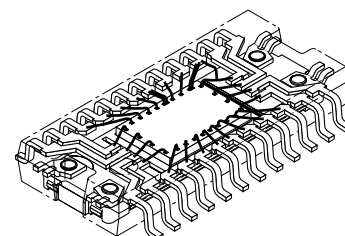


Lead frame type  
power hybrid IC with  
ceramic substrate

- High-output high-breakdown voltage IC
- Simplified integration of custom circuits
- Distribution of unit functions  
(Actuators may be built in the device)

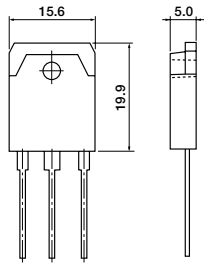


Surface-mount  
power IC

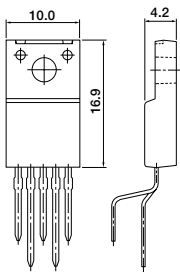


External Dimensions (unit: mm)

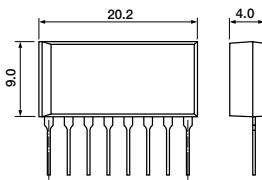
MT-100



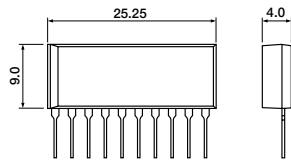
FM205



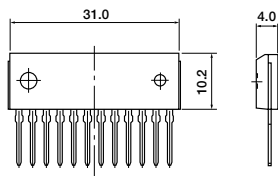
STA 8pin



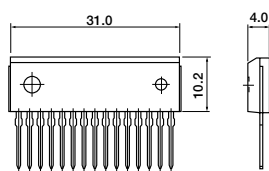
STA 10pin



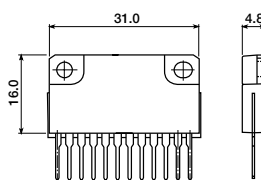
SMA12pin



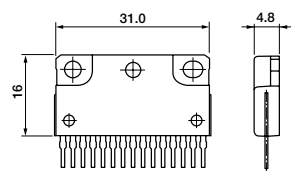
SMA15pin



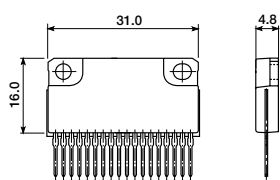
SLA12pin



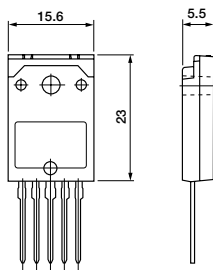
SLA15pin



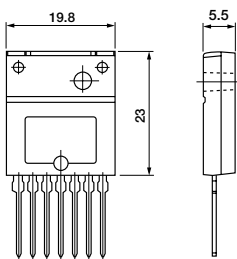
SLA18pin



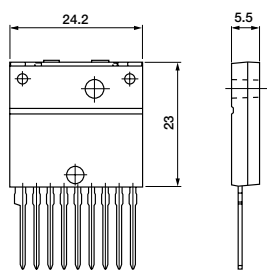
3GR-F



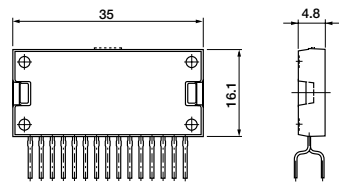
3GR-M



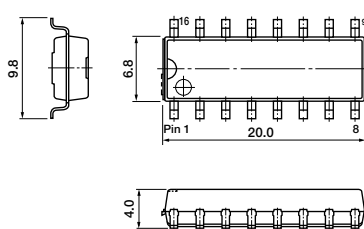
STR-S



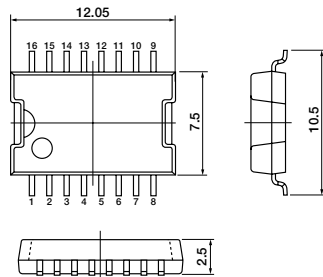
SPM



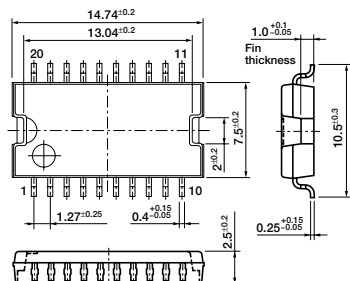
SMD16pin



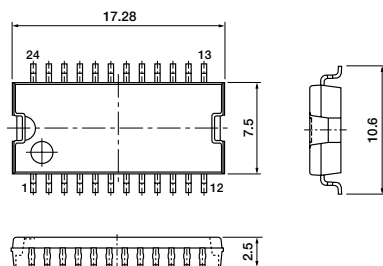
SPF16pin



SPF20pin



SPF24pin





# 2

## Discretes

### 2-1. Transistors

2-1-1. Transistors	80
2SA1488/1488A (–60V/–4A, –80V/–4A)	80
2SA1567 (–50V/–12A)	81
2SA1568 (–60V/±12A)	82
2SA1908 (–120V/–8A)	83
2SB1622 (–200V/–15A)	84
2SC3852 (60V/3A)	85
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# Power Transistor 2SA1488/1488A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings		Unit
	2SA1488	2SA1488A	
V <sub>CB0</sub>	-60	-80	V
V <sub>CE0</sub>	-60	-80	V
V <sub>EB0</sub>	-6		V
I <sub>C</sub>	-4		A
I <sub>B</sub>	-1		A
P <sub>C</sub>	25 (T <sub>C</sub> = 25°C)		W
T <sub>j</sub>	150		°C
T <sub>stg</sub>	-55 to +150		°C

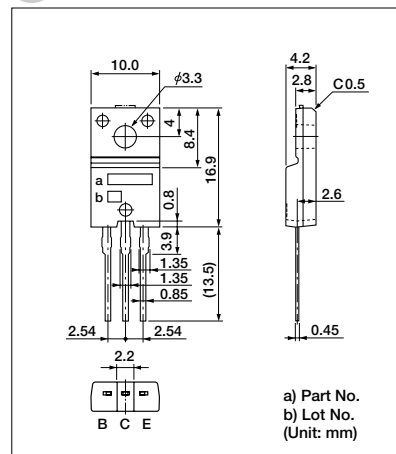
## Electrical Characteristics (Ta = 25°C)

Symbol	Test Conditions	Ratings		Unit
		2SA1488	2SA1488A	
I <sub>CB0</sub>	V <sub>CB</sub> =	-100max	-100max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = -6V	-100max	-100max	μA
V <sub>(BR) CE0</sub>	I <sub>C</sub> = -25mA	-60min	-80min	V
h <sub>FE</sub>	V <sub>CE</sub> = -4V, I <sub>C</sub> = -1A	40min		
V <sub>CE</sub> (sat)	I <sub>C</sub> = -2A, I <sub>B</sub> = -0.2A	-0.5max		V
f <sub>T</sub>	V <sub>CE</sub> = -12V, I <sub>E</sub> = -0.2A	15typ		MHz
C <sub>OB</sub>	V <sub>CB</sub> = -10V, f = 1MHz	90typ		pF

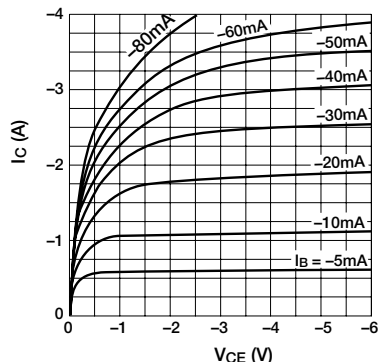
## Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
-12	6	-2	-10	5	-200	200	0.25typ	0.75typ	0.25typ

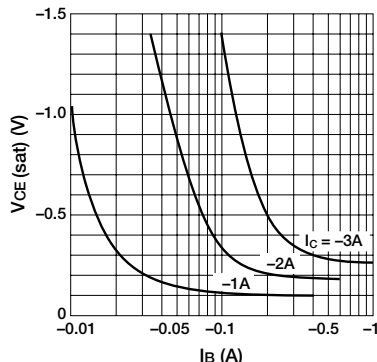
## External Dimensions TO220F (full-mold)



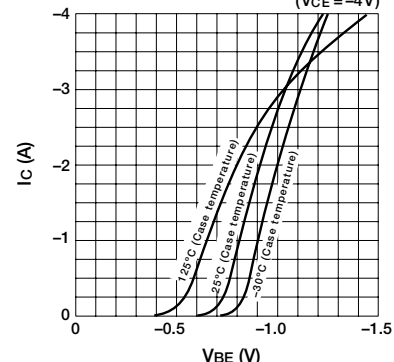
■ I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



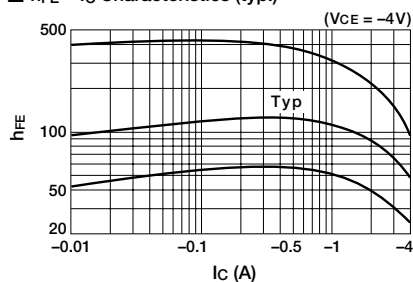
■ V<sub>CE</sub> (sat)—I<sub>B</sub> Characteristics (typ.)



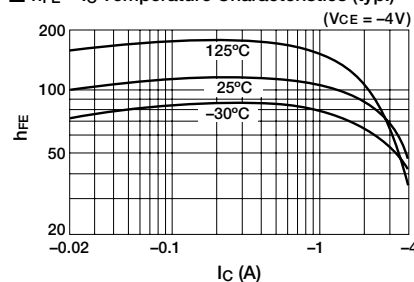
■ I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



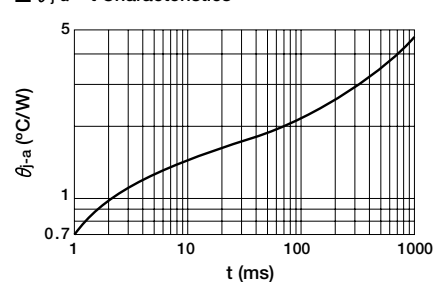
■ h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.)



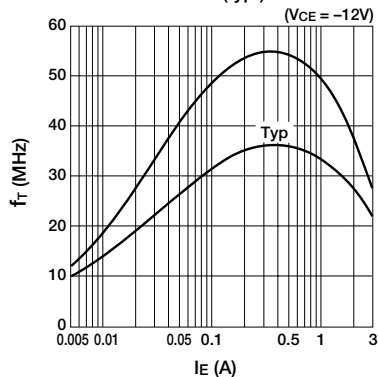
■ h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



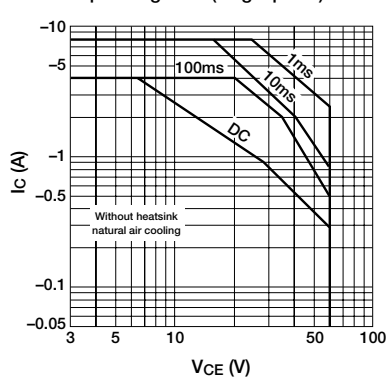
■ θ<sub>JA</sub>—t Characteristics



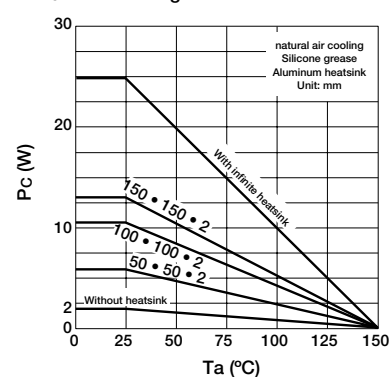
■ f<sub>T</sub>—I<sub>E</sub> Characteristics (typ.)



■ Safe Operating Area (single pulse)



■ P<sub>C</sub>—T<sub>a</sub> Derating



# Power Transistor 2SA1567

## Absolute Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

Symbol	Ratings	Unit
$V_{CB0}$	-50	V
$V_{CE0}$	-50	V
$V_{EB0}$	-6	V
$I_C$	-12	A
$I_B$	-3	A
$P_C$	35 ( $T_c = 25^\circ\text{C}$ )	W
$T_j$	150	$^\circ\text{C}$
$T_{stg}$	-55 to +150	$^\circ\text{C}$

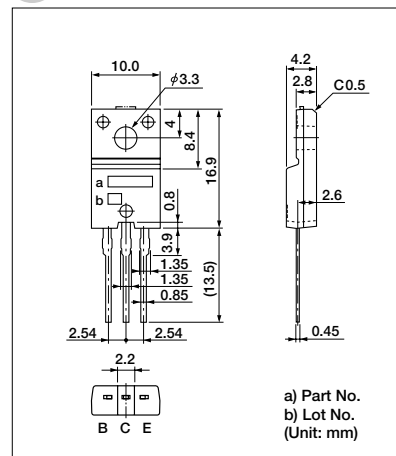
## Electrical Characteristics ( $T_a = 25^\circ\text{C}$ )

Symbol	Test Conditions	Ratings	Unit
$I_{CBO}$	$V_{CB} = -50\text{V}$	-100max	$\mu\text{A}$
$I_{EBO}$	$V_{EB} = -6\text{V}$	-100max	$\mu\text{A}$
$V_{(BR)CE0}$	$I_C = -25\text{mA}$	-50min	V
$h_{FE}$	$V_{CE} = -1\text{V}$ , $I_C = -6\text{A}$	50min	
$V_{CE(sat)}$	$I_C = -6\text{A}$ , $I_B = -0.3\text{A}$	-0.35max	V
$f_T$	$V_{CE} = -12\text{V}$ , $I_E = -0.5\text{A}$	40typ	MHz
$COB$	$V_{CB} = -10\text{V}$ , $f = 1\text{MHz}$	330typ	pF

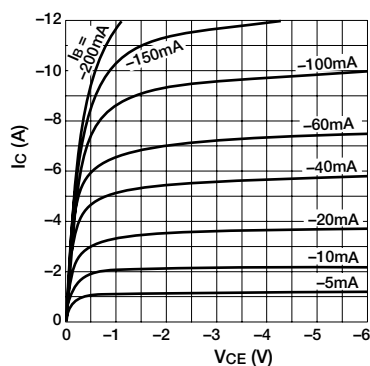
## Typical Switching Characteristics (common emitter)

$V_{CC}$ (V)	$R_L$ ( $\Omega$ )	$I_C$ (A)	$V_{BB1}$ (V)	$V_{BB2}$ (V)	$I_{B1}$ (mA)	$I_{B2}$ (mA)	$t_{on}$ ( $\mu\text{s}$ )	$t_{stg}$ ( $\mu\text{s}$ )	$t_f$ ( $\mu\text{s}$ )
-24	4	-6	-10	5	-120	120	0.4typ	0.4typ	0.2typ

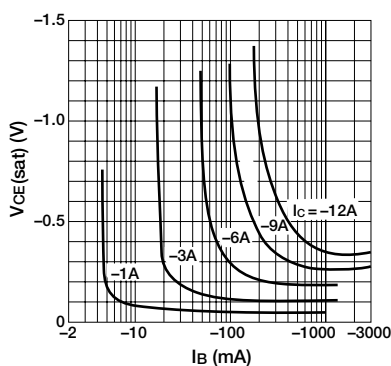
## External Dimensions TO220F (full-mold)



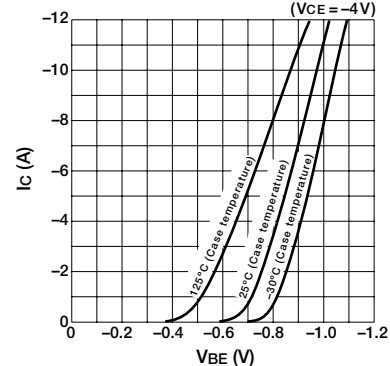
■  $I_C$ — $V_{CE}$  Characteristics (typ.)



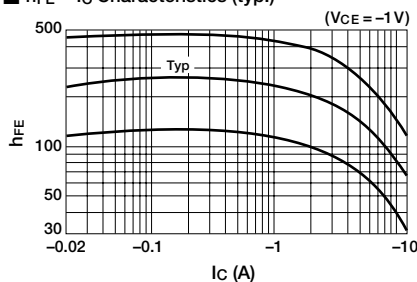
■  $V_{CE(sat)}$ — $I_B$  Characteristics (typ.)



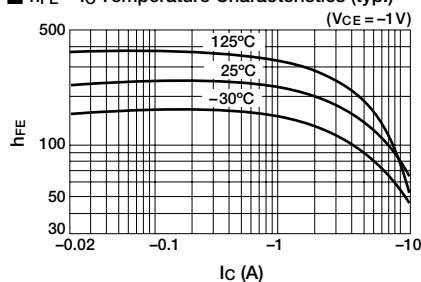
■  $I_C$ — $V_{BE}$  Temperature Characteristics (typ.)



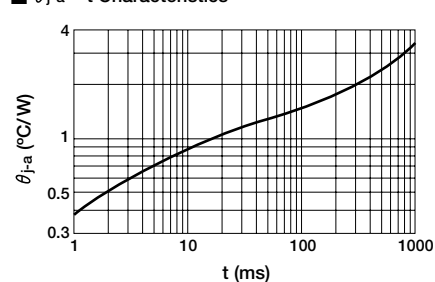
■  $h_{FE}$ — $I_C$  Characteristics (typ.)



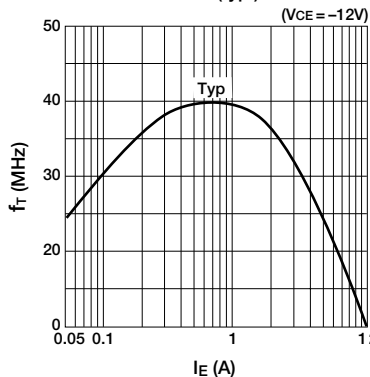
■  $h_{FE}$ — $I_C$  Temperature Characteristics (typ.)



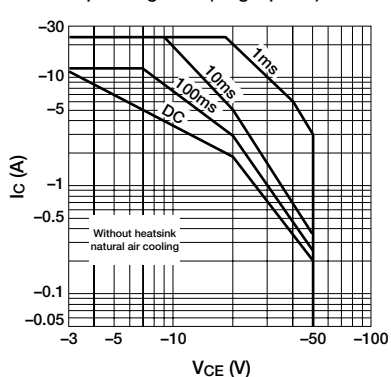
■  $\theta_{JA}$ — $t$  Characteristics



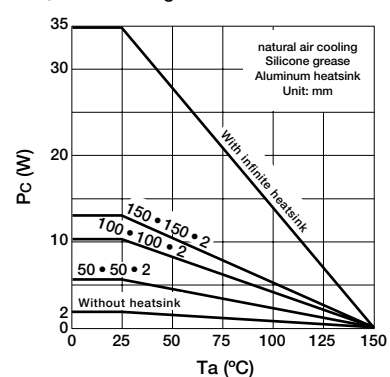
■  $f_T$ — $I_E$  Characteristics (typ.)



■ Safe Operating Area (single pulse)



■  $P_C$ — $T_a$  Derating



# Power Transistor 2SA1568

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
VCBO	-60	V
VCEO	-60	V
VEBO	-6	V
IC	±12	A
IB	-3	A
PC	35 (Tc=25°C)	W
TJ	150	°C
Tstg	-55 to +150	°C

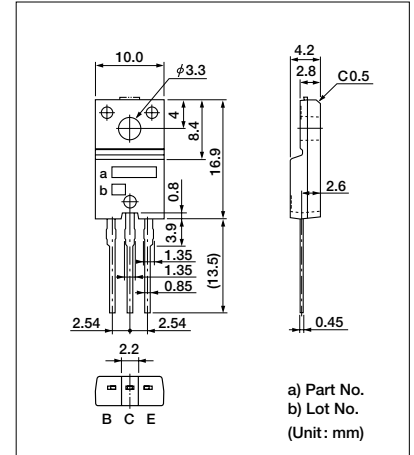
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
ICBO	VCB = -60V	-100max	μA
IEBO	VEB = -6V	-60max	mA
V(BR) CEO	IC = -25 mA	-60min	V
hFE	VCE = -1V, IC = -6A	50min	
VCE(sat)	IC = -6A, IB = -0.3A	-0.35max	V
VFEC	IECO = -10A	-2.5max	V
fT	VCE = -12V, IE = 0.5A	40typ	MHz
COB	VCB = -10V, f = 1MHz	330typ	pF

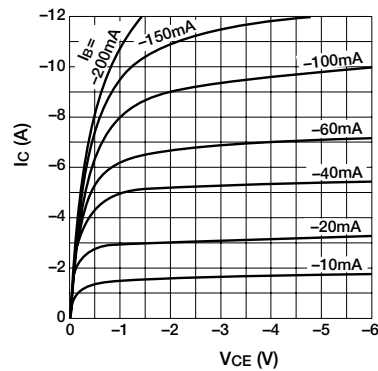
## Typical Switching Characteristics (common emitter)

VCC (V)	RL (Ω)	IC (A)	VBB1 (V)	VBB2 (V)	IB1 (mA)	IB2 (mA)	ton (μs)	tstg (μs)	tf (μs)
-24	4	-6	-10	5	-120	120	0.4typ	0.4typ	0.2typ

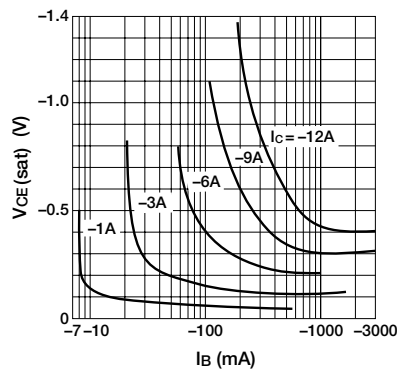
## External Dimensions TO220F (full-mold)



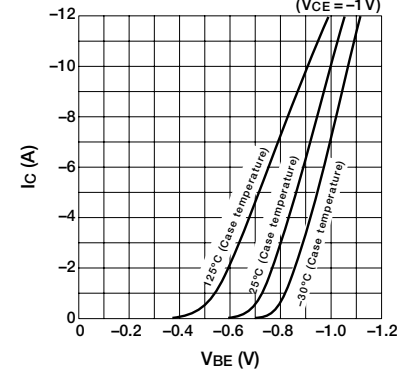
### IC—VCE Characteristics (typ.)



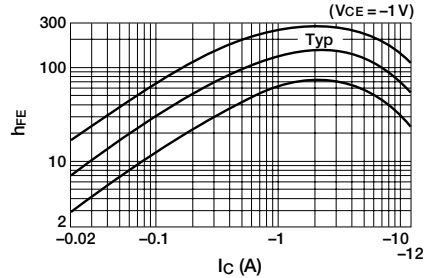
### VCE(sat)—IB Characteristics (typ.)



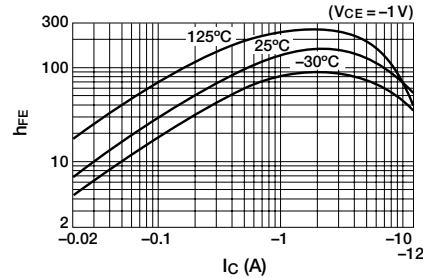
### IC—VBE Temperature Characteristics (typ.)



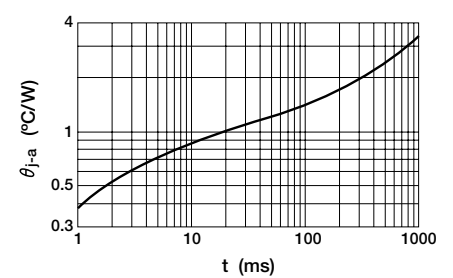
### hFE—IC Characteristics (typ.)



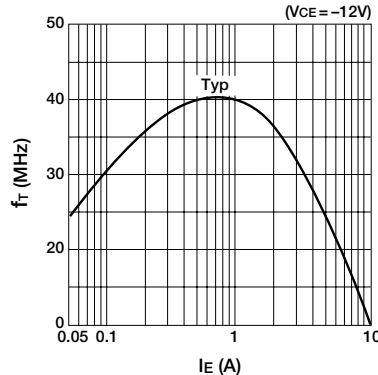
### hFE—IC Temperature Characteristics (typ.)



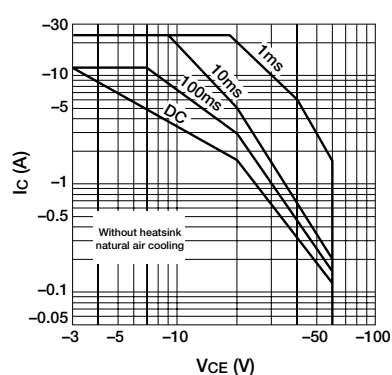
### θJA—t Characteristics



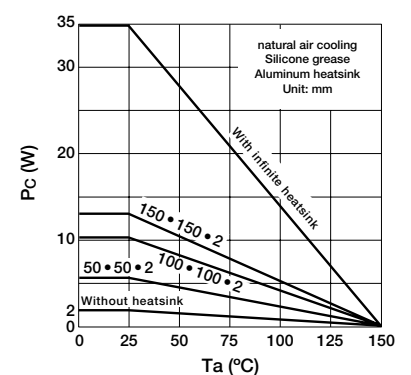
### fT—IE Characteristics (typ.)



### Safe Operating Area (single pulse)



### PC—Ta Derating



# Power Transistor 2SA1908

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	-120	V
V <sub>CE0</sub>	-120	V
V <sub>EB0</sub>	-6	V
I <sub>C</sub>	-8	A
I <sub>B</sub>	-3	A
P <sub>C</sub>	75 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

## Electrical Characteristics (Ta=25°C)

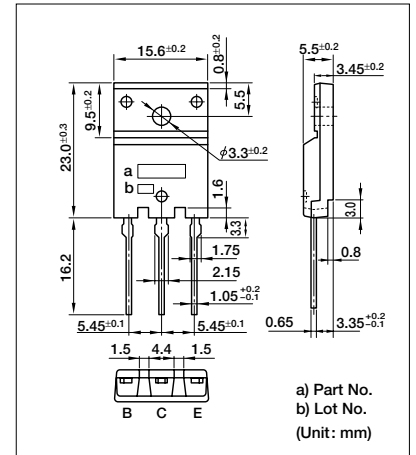
Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = -120V	-10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = -6V	-10max	μA
V <sub>(BR) CEO</sub>	I <sub>C</sub> = -50mA	-120min	V
h <sub>FE</sub> *	V <sub>CE</sub> = -4V, I <sub>C</sub> = -3A	50min	
V <sub>CE (sat)</sub>	I <sub>C</sub> = -3A, I <sub>B</sub> = -0.3A	-0.5max	V
f <sub>T</sub>	V <sub>CE</sub> = -12V, I <sub>E</sub> = 0.5A	20typ	MHz
C <sub>OB</sub>	V <sub>CB</sub> = -10V, f = 1MHz	300typ	pF

\* Rank: O (50 to 100), P (70 to 140), Y (90 to 180)

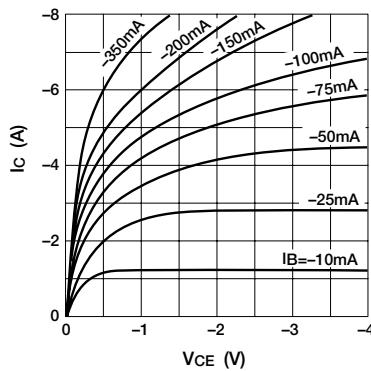
## Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
-40	10	-4	-10	5	-400	400	0.14typ	1.40typ	0.21typ

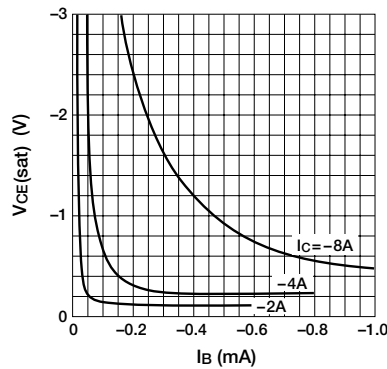
## External Dimensions FM100 (T03PF)



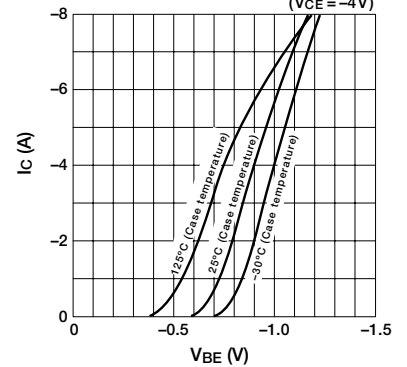
■ I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



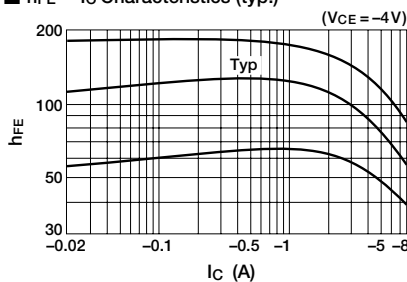
■ V<sub>CE (sat)</sub>—I<sub>B</sub> Characteristics (typ.)



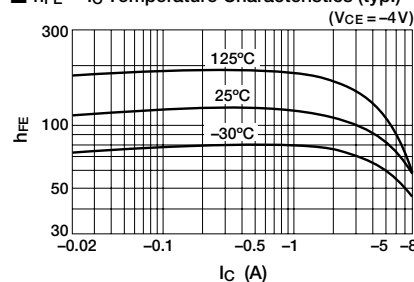
■ I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



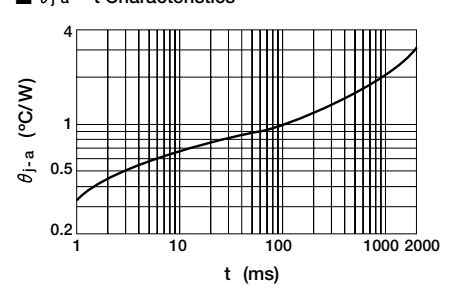
■ h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.)



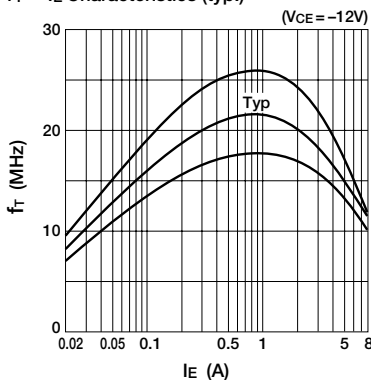
■ h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



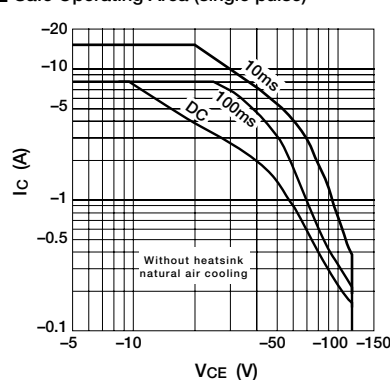
■ θ<sub>J-a</sub>—t Characteristics



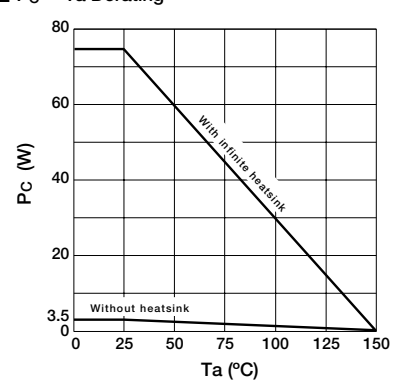
■ f<sub>T</sub>—I<sub>E</sub> Characteristics (typ.)



■ Safe Operating Area (single pulse)



■ P<sub>C</sub>—T<sub>a</sub> Derating



# Power Transistor 2SB1622

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	-200	V
V <sub>CEO</sub>	-200	V
V <sub>EB0</sub>	-5	V
I <sub>C</sub>	-15	A
I <sub>B</sub>	-1	A
P <sub>C</sub>	85 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

## Electrical Characteristics (Ta=25°C)

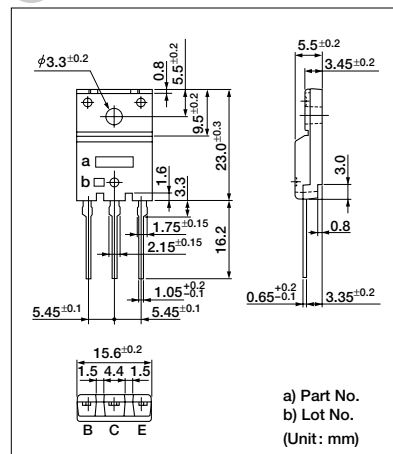
Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> = -200V			-100	μA
I <sub>EB0</sub>	V <sub>EB</sub> = -5V			-100	μA
V <sub>CEO</sub>	I <sub>C</sub> = -30mA	-200			V
h <sub>FE</sub> *	V <sub>CE</sub> = -4V, I <sub>C</sub> = -10A	5000		30000	
V <sub>CE(sat)</sub>	I <sub>C</sub> = -10A, I <sub>B</sub> = -10mA			-2.5	V
V <sub>BE(sat)</sub>	I <sub>C</sub> = -10A, I <sub>B</sub> = -10mA			-3.0	V
f <sub>T</sub>	V <sub>CE</sub> = -12V, I <sub>E</sub> = 2A		60		MHz
C <sub>OB</sub>	V <sub>CB</sub> = -10V, f = 1MHz		270		pF

\*Rank: O(5000 to 12000), P(6500 to 20000), Y(15000 to 30000)

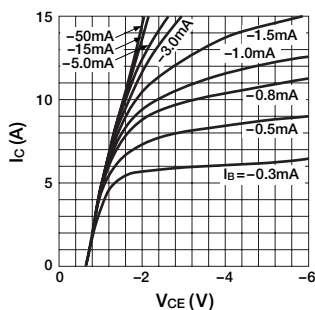
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
-40	4	-10	-10	5	-10	10	0.4typ	3.6typ	1.0typ

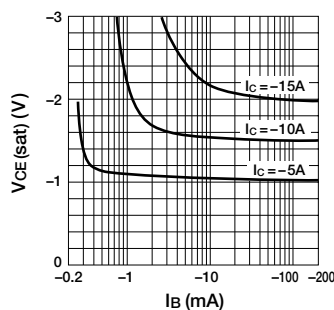
## External Dimensions



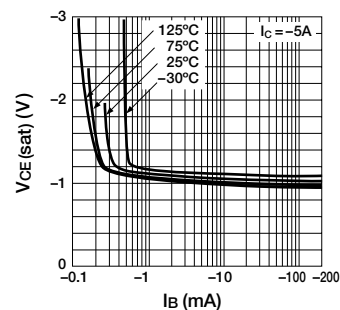
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



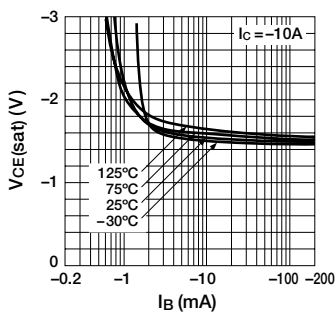
### V<sub>CE(sat)</sub> — I<sub>B</sub> Characteristics (typ.)



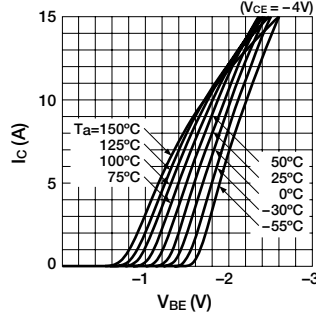
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics (typ.)



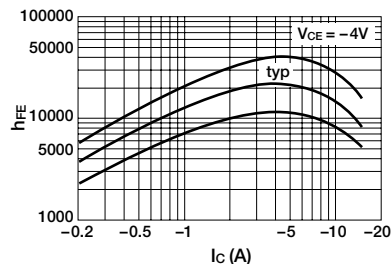
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics (typ.)



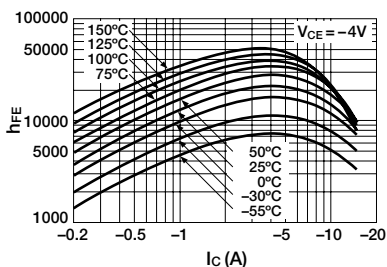
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



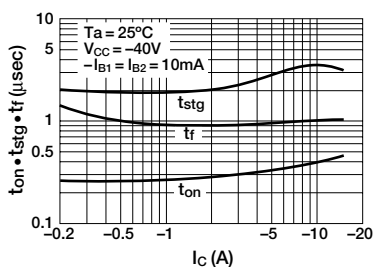
### h<sub>FE</sub> — I<sub>C</sub> Characteristics (typ.)



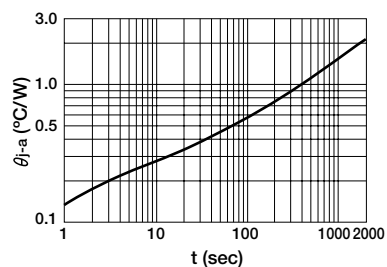
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



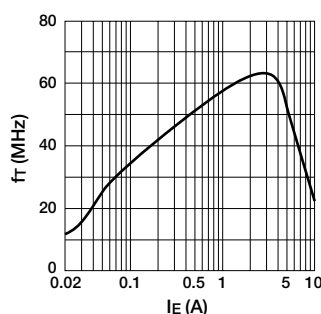
### t<sub>on</sub> • t<sub>stg</sub> • t<sub>f</sub> — I<sub>C</sub> Characteristics (typ.)



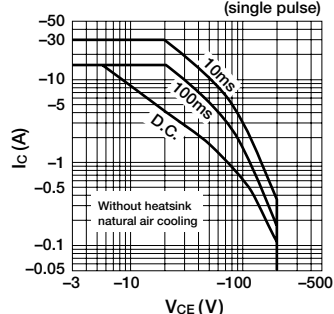
### θ<sub>JA</sub> — t Characteristics



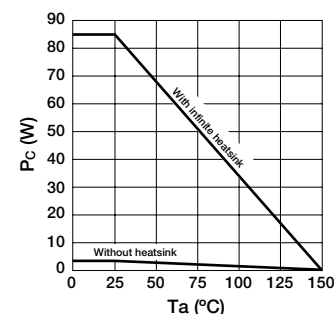
### f<sub>T</sub> — I<sub>E</sub> Characteristics (typ.)



### Safe Operating Area



### P<sub>C</sub> — T<sub>a</sub> Derating



# Power Transistor 2SC3852

### Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CBO</sub>	80	V
V <sub>CEO</sub>	60	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	3	A
I <sub>B</sub>	1	A
P <sub>C</sub>	25 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

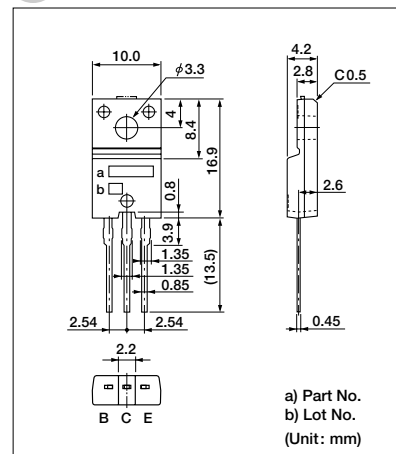
## Electrical Characteristics

Symbol	Test Conditions	Ratings	Unit
ICBO	V <sub>CB</sub> = 80V	10max	μA
IEBO	V <sub>EB</sub> = 6V	100max	μA
V <sub>(BR)</sub> CEO	I <sub>C</sub> = 25mA	60min	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 0.5A	500min	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 2A, I <sub>B</sub> = 50mA	0.5max	V
f <sub>T</sub>	V <sub>CE</sub> = 12V, I <sub>E</sub> = -0.2A	15typ	MHz
COB	V <sub>CB</sub> = 10V, f = 1MHz	50typ	pF

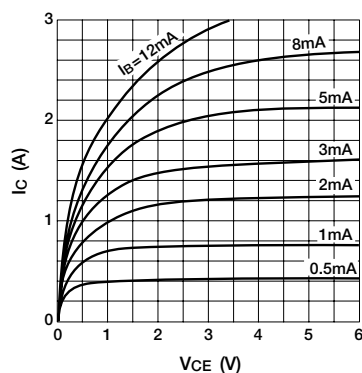
### Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
20	20	1.0	10	-5	15	-30	0.8 <sub>typ</sub>	3.0 <sub>typ</sub>	1.2 <sub>typ</sub>

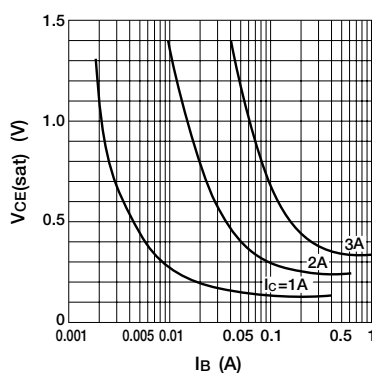
### External Dimensions TO220F (full-mold)



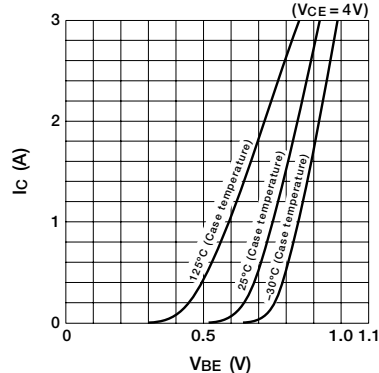
■  $I_C$ — $V_{CE}$  Characteristics (typ.)



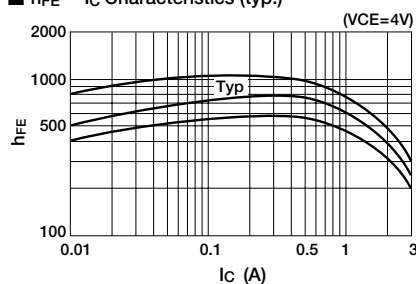
■  $V_{CE}(\text{sat})$  —  $I_B$  Characteristics (typ.)



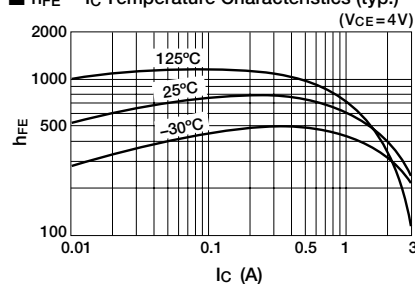
■  $I_C$ — $V_{BE}$  Temperature Characteristics (typ.)



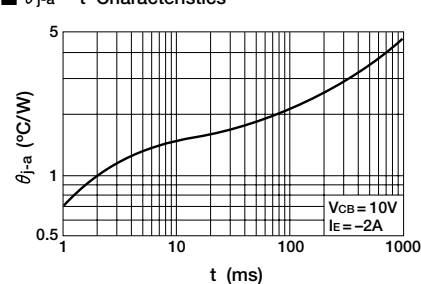
### ■ $h_{FE}$ — $I_C$ Characteristics (typ.)



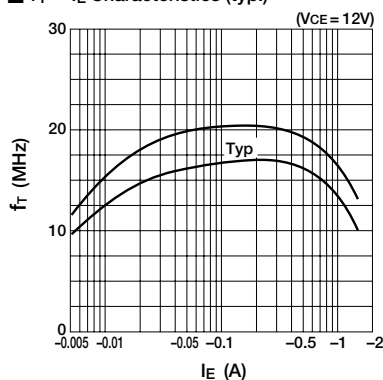
### ■ $h_{FE}$ — $I_C$ Temperature Characteristics (typ.)



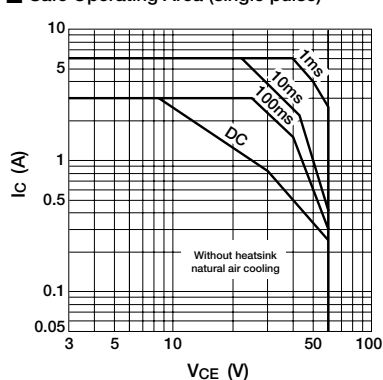
### ■ $\theta_{j-a-t}$ Characteristics



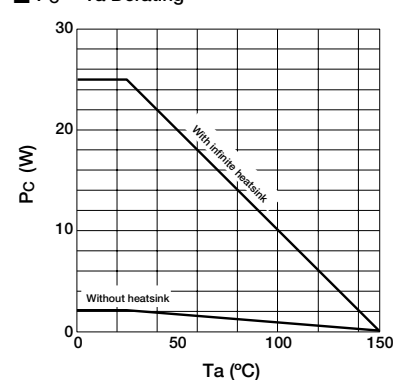
■  $f_T$ — $I_E$  Characteristics (typ.)



■ Safe Operating Area (single pulse)



### ■ $P_C$ —Ta Derating



# Power Transistor 2SC4024

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	100	V
V <sub>CE0</sub>	50	V
V <sub>EB0</sub>	15	V
I <sub>C</sub>	10	A
I <sub>B</sub>	3	A
P <sub>C</sub>	35 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

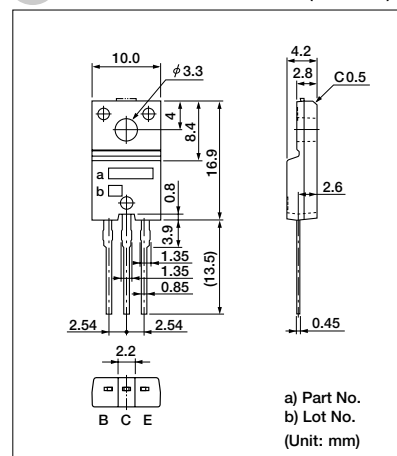
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 100V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 15V	10max	μA
V <sub>(BR) CEO</sub>	I <sub>C</sub> = 25 mA	50min	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 1A	300 to 1600	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 5A, I <sub>B</sub> = 0.1A	0.5max	V
f <sub>T</sub>	V <sub>CB</sub> = 12V, I <sub>E</sub> = -0.5A	24typ	MHz
COB	V <sub>CB</sub> = 10V, f = 1MHz	150typ	pF

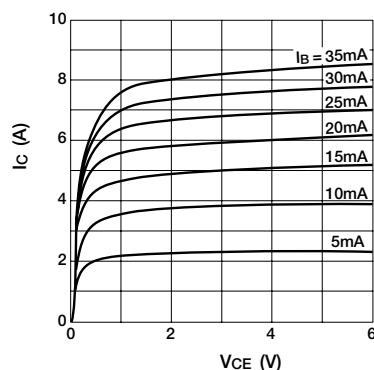
## Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	I <sub>B1</sub> (A)	I <sub>B2</sub> (A)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
20	4	5	0.1	-0.1	0.5typ	2.0typ	0.5typ

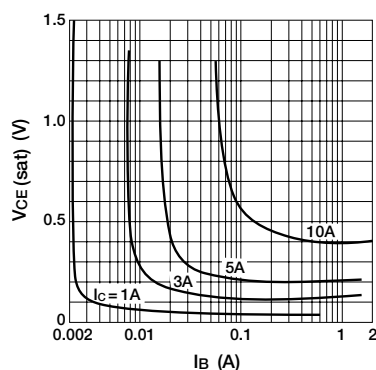
## External Dimensions TO220F (full-mold)



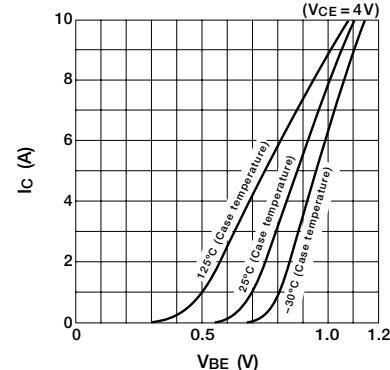
■ I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



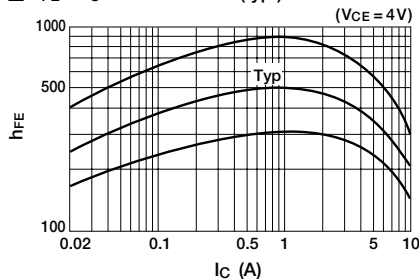
■ V<sub>CE(sat)</sub>—I<sub>B</sub> Characteristics (typ.)



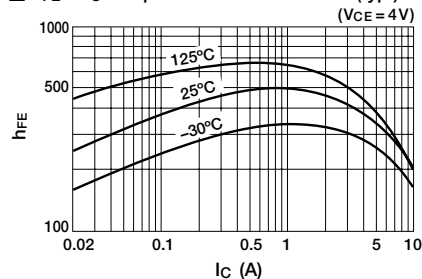
■ I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



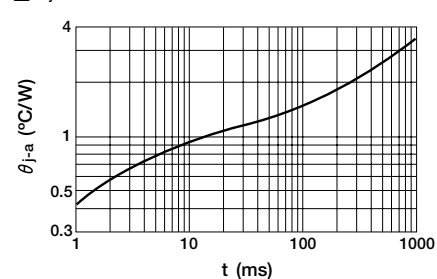
■ h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.)



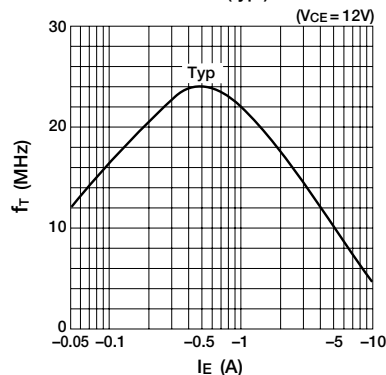
■ h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



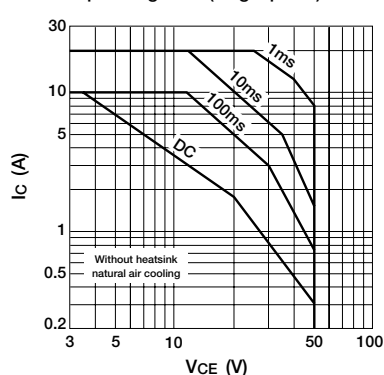
■ θ<sub>J-a</sub>—t Characteristics



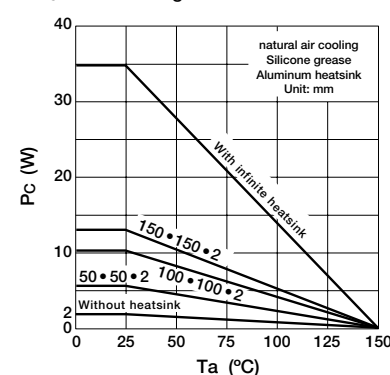
■ f<sub>T</sub>—I<sub>E</sub> Characteristics (typ.)



■ Safe Operating Area (single pulse)



■ P<sub>C</sub>—T<sub>a</sub> Derating



# Power Transistor 2SC4065

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
VCBO	60	V
VCEO	60	V
VEBO	6	V
IC	±12	A
IB	3	A
PC	35 (Tc=25°C)	W
TJ	150	°C
Tstg	-55 to +150	°C

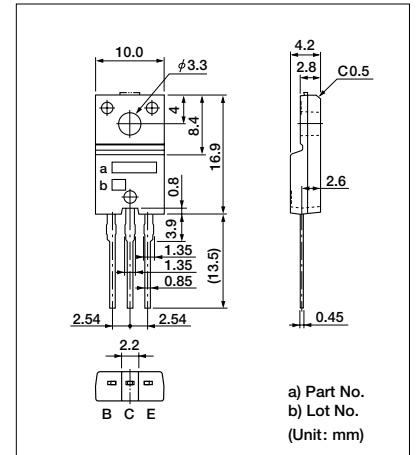
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
ICBO	V <sub>CB</sub> = 60V	100max	μA
IEBO	V <sub>EB</sub> = 6V	60max	mA
V(BR)CEO	I <sub>C</sub> = 25mA	60min	V
hFE	V <sub>CE</sub> = 1V, I <sub>C</sub> = 6A	50min	
VCE(sat)	I <sub>C</sub> = 6A, I <sub>B</sub> = 1.3A	0.35max	V
V <sub>FEC</sub>	V <sub>ECO</sub> = 10A	2.5max	V
f <sub>T</sub>	V <sub>CE</sub> = 12V, I <sub>E</sub> = -0.5A	24typ	MHz
COB	V <sub>CB</sub> = 10V, f = 1MHz	180typ	pF

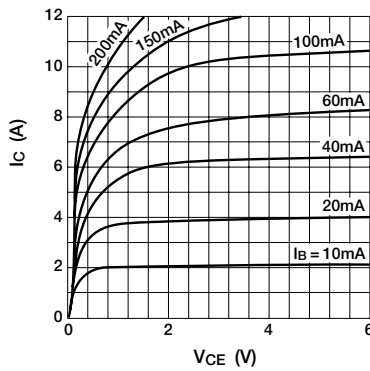
## Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (A)	I <sub>B2</sub> (A)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
24	4	6	10	-5	0.12	-0.12	0.6typ	1.4typ	0.4typ

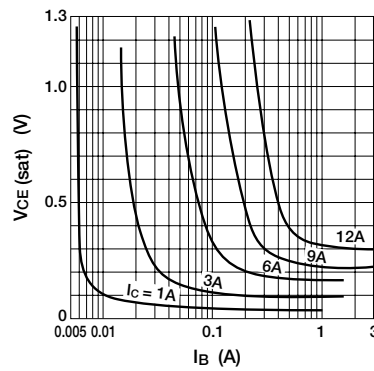
## External Dimensions TO220F (full-mold)



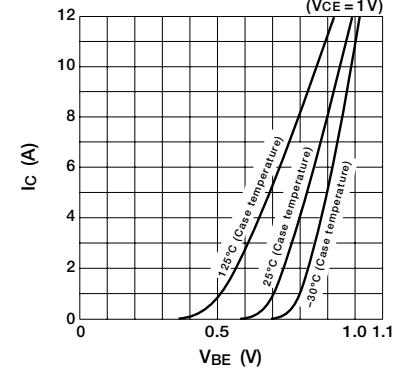
### IC—VCE Characteristics (typ.)



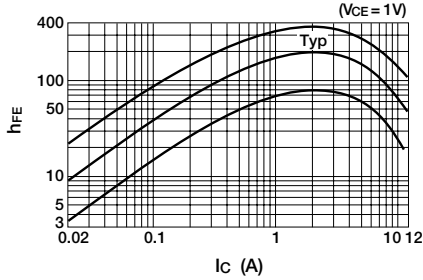
### VCE(sat)—IB Characteristics (typ.)



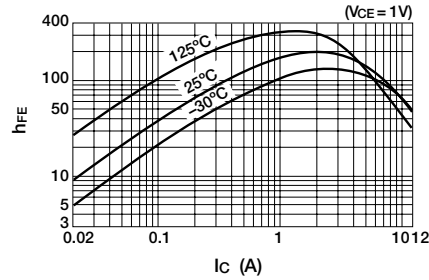
### IC—VBE Temperature Characteristics (typ.)



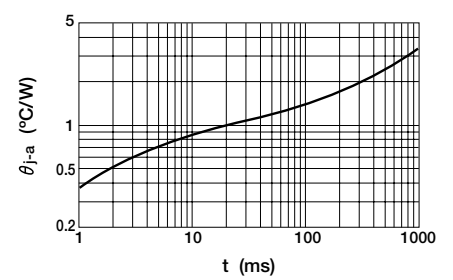
### hFE—IC Characteristics (typ.)



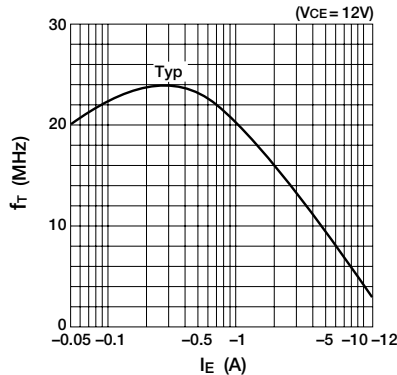
### hFE—IC Temperature Characteristics (typ.)



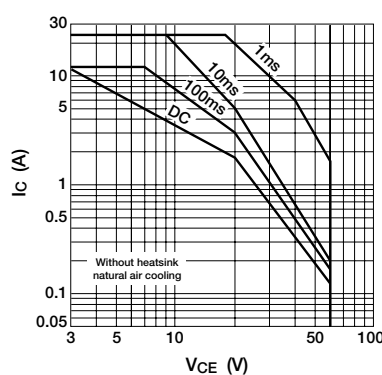
### θJA—t Characteristics



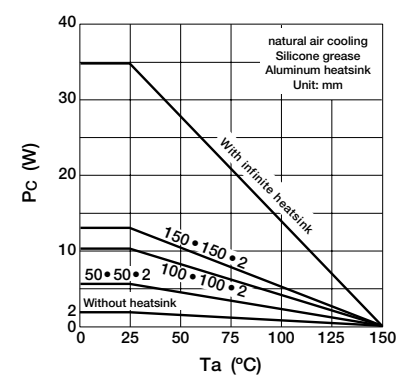
### f<sub>T</sub>—IE Characteristics (typ.)



### Safe Operating Area (single pulse)



### PC—Ta Derating



# Power Transistor 2SC4153

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	200	V
V <sub>CE0</sub>	120	V
V <sub>EB0</sub>	8	V
I <sub>C</sub>	7 (pulse 14)	A
I <sub>B</sub>	3	A
P <sub>C</sub>	30 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

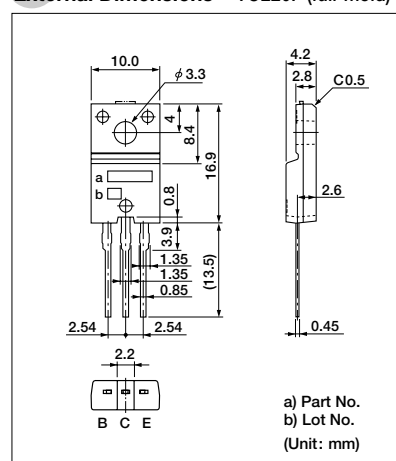
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 200V	100max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 8V	100max	μA
V <sub>(BR) CEO</sub>	I <sub>C</sub> = 50mA	120min	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 3A	70 to 220	
V <sub>CE (sat)</sub>	I <sub>C</sub> = 3A, I <sub>B</sub> = 0.3A	0.5max	V
V <sub>BE (sat)</sub>	I <sub>C</sub> = 3A, I <sub>B</sub> = 0.3A	1.2max	V
f <sub>T</sub>	V <sub>CE</sub> = 12V, I <sub>E</sub> = -0.5A	30typ	MHz
COB	V <sub>CB</sub> = 10V, f = 1MHz	110typ	pF

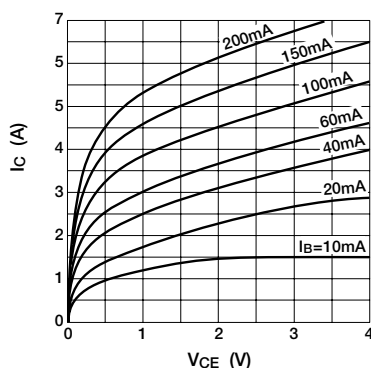
## Typical Switching Characteristics (common emitter)

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (A)	I <sub>B2</sub> (A)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
50	16.7	3	10	-5	0.3	-0.6	0.5max	3max	0.5max

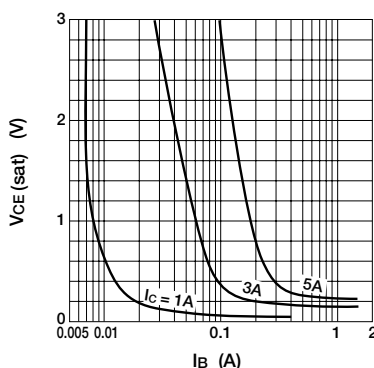
## External Dimensions TO220F (full-mold)



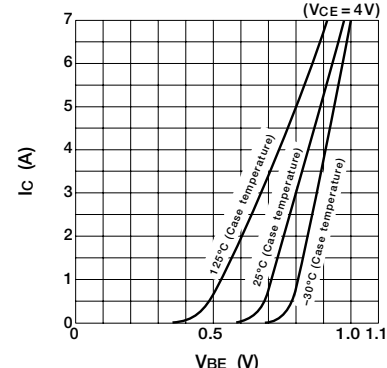
### I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



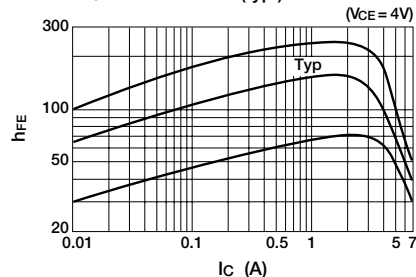
### V<sub>CE (sat)</sub>—I<sub>B</sub> Characteristics (typ.)



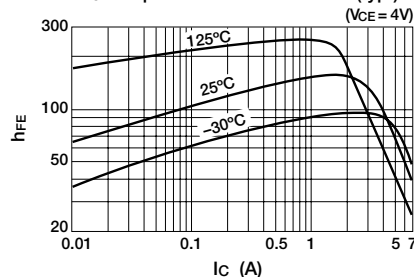
### I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



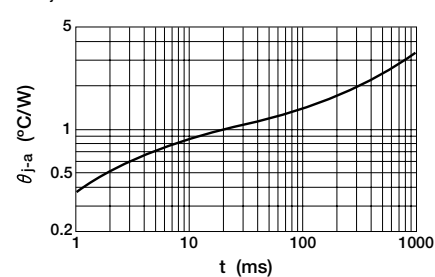
### h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.)



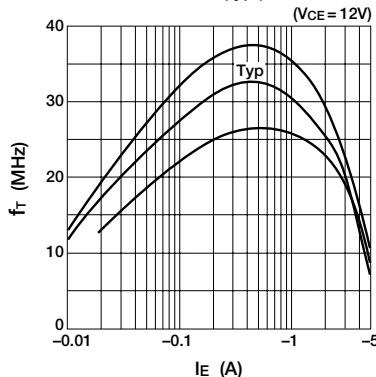
### h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



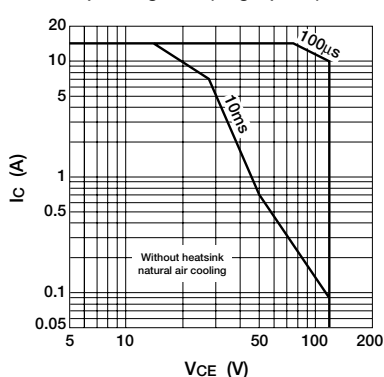
### θ<sub>J-a</sub>—t Characteristics



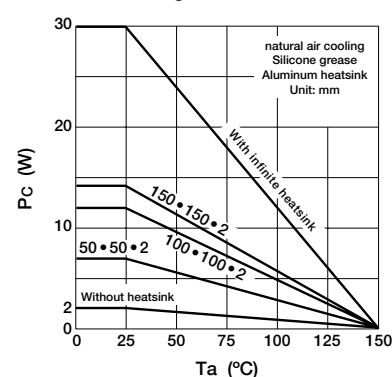
### f<sub>T</sub>—I<sub>E</sub> Characteristics (typ.)



### Safe Operating Area (single pulse)



### P<sub>C</sub>—T<sub>a</sub> Derating



# Power Transistor 2SD2141

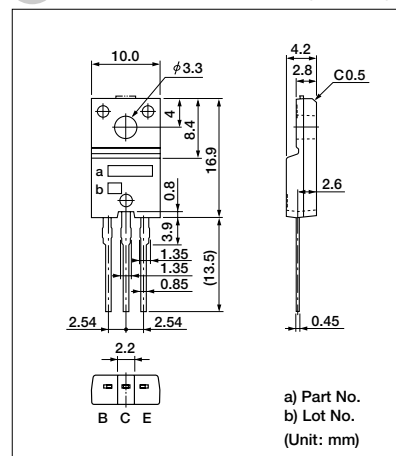
### Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CBO</sub>	380±50	V
V <sub>CEO</sub>	380±50	V
V <sub>EBO</sub>	6	V
I <sub>C</sub>	6 (pulse 10)	A
I <sub>B</sub>	1	A
P <sub>C</sub>	35 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

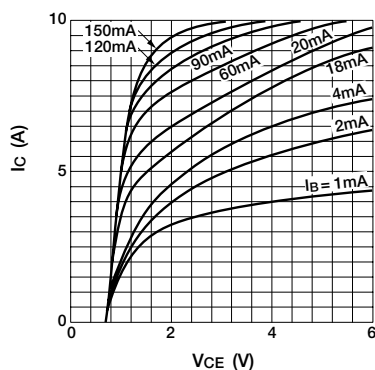
## Electrical Characteristics

Symbol	Test Conditions	Ratings	Unit
ICBO	$V_{CB} = 330V$	10max	$\mu A$
IEBO	$V_{EB} = 6V$	20max	$\mu A$
$V_{(BR) CEO}$	$I_C = 25mA$	330 to 430	V
hFE	$V_{CE} = 2V, I_C = 3A$	1500min	
$V_{CE(sat)}$	$I_C = 4A, I_B = 20mA$	1.5max	V

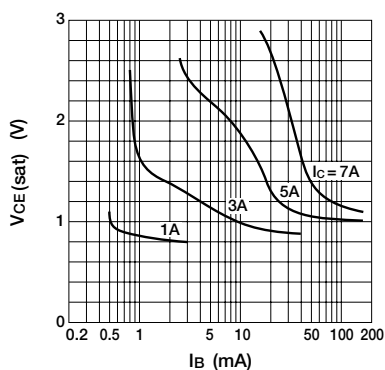
### External Dimensions TO220F (full-mold)



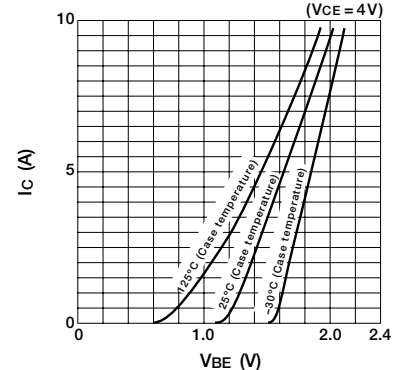
■  $I_C - V_{CE}$  Characteristics (typ.)



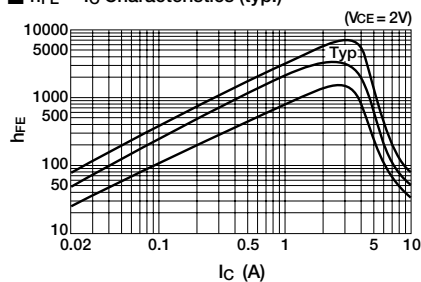
■  $V_{CE(sat)}$  —  $I_B$  Characteristics (typ.)



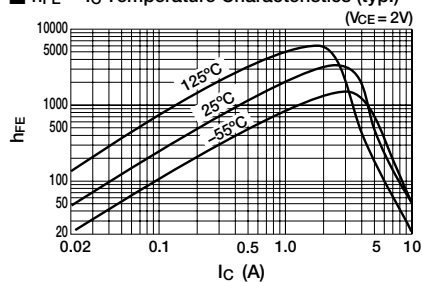
■  $I_C$ — $V_{BE}$  Temperature Characteristics (typ.)



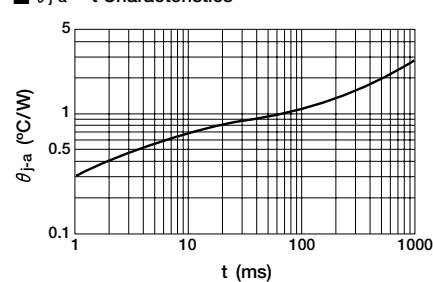
### ■ $h_{FE}$ — $I_C$ Characteristics (typ.)



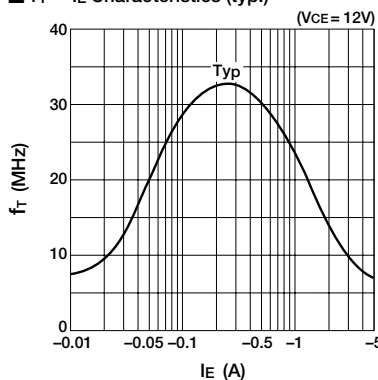
### ■ $h_{FE}$ — $I_C$ Temperature Characteristics (typ.)



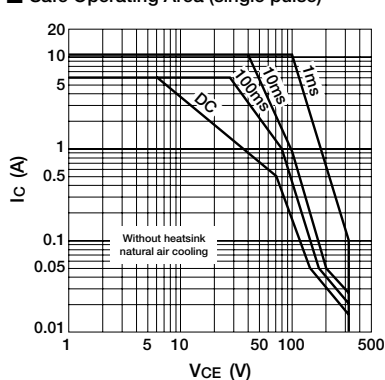
### ■ $\theta_{j-a-t}$ Characteristics



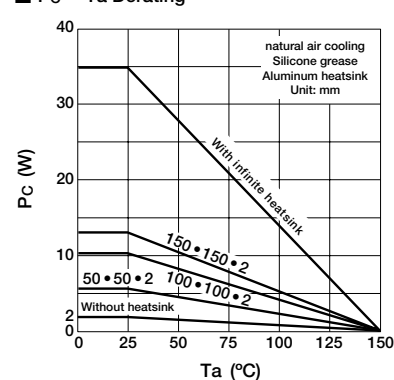
■  $f_T$ — $I_E$  Characteristics (typ.)



■ Safe Operating Area (single pulse)



### ■ Pc—Ta Derating



# Power Transistor 2SD2382

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	65±5	V
V <sub>CE0</sub>	65±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6 (pulse ±10)	A
I <sub>B</sub>	1	A
P <sub>C</sub>	30 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

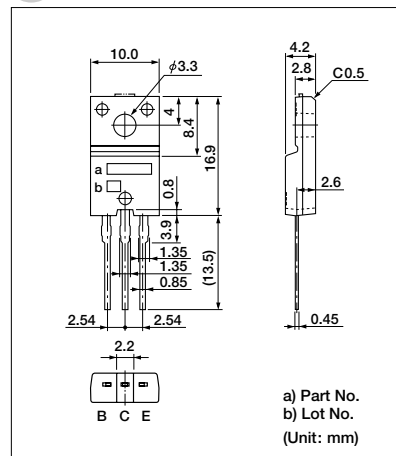
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 60V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	10max	μA
V <sub>CE0</sub>	I <sub>C</sub> = 50mA	60 to 70	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 1A	700 to 3000	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 1.5A, I <sub>B</sub> = 15mA	0.15max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 6A	1.5max	V
Es/b	L = 10mH, single pulse	200min	mJ

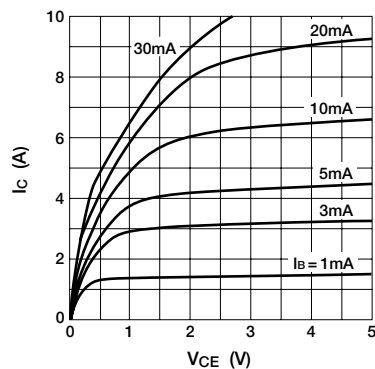
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	30	-30	0.25	0.8	0.35

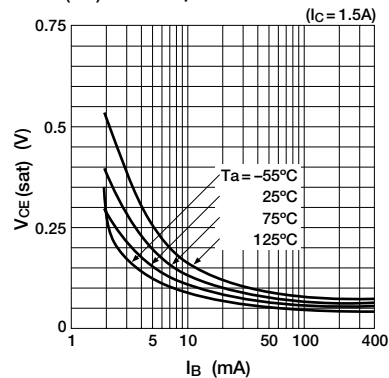
## External Dimensions TO220F (full-mold)



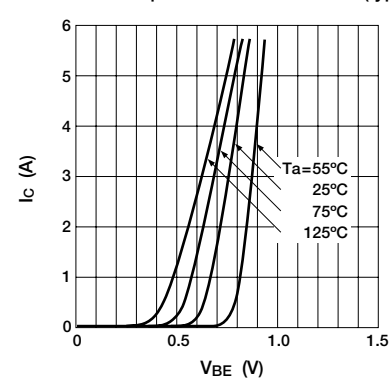
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



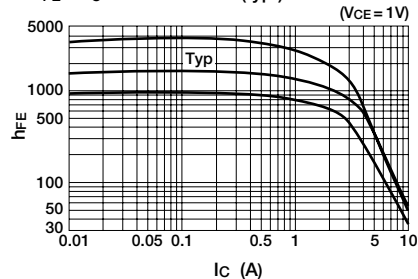
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics (typ.)



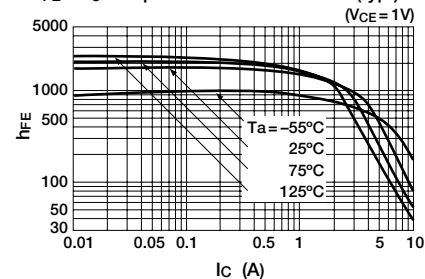
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



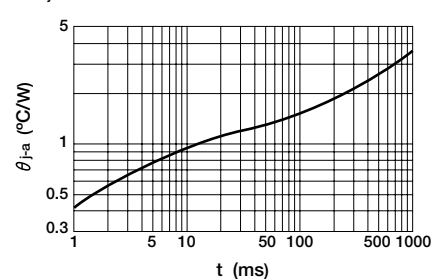
### h<sub>FE</sub> — I<sub>C</sub> Characteristics (typ.)



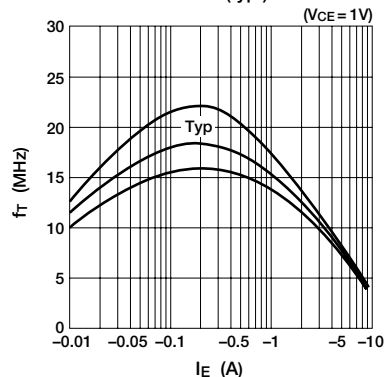
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



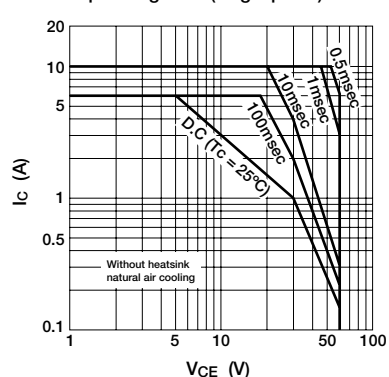
### θ<sub>J-a</sub> — t Characteristics



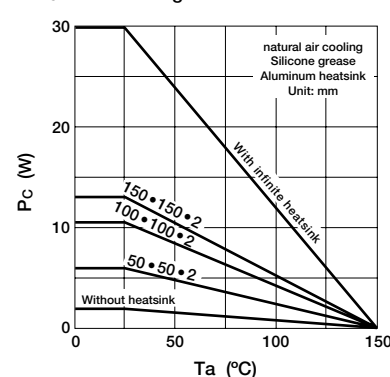
### f<sub>T</sub> — I<sub>E</sub> Characteristics (typ.)



### Safe Operating Area (single pulse)



### P<sub>C</sub> — Ta Derating



# Power Transistor 2SD2633

### Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CBO</sub>	200	V
V <sub>CEO</sub>	150	V
V <sub>EBO</sub>	6	V
I <sub>C</sub>	8	A
I <sub>B</sub>	1	A
P <sub>C</sub>	35 (T <sub>C</sub> =25°C)	W
	2 (T <sub>a</sub> =25°C, No Fin)	
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

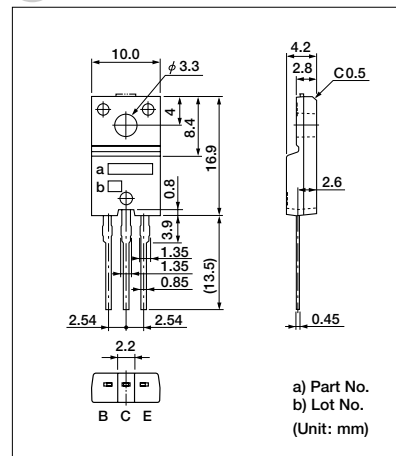
## Electrical Characteristics

( $T_a=25^{\circ}\text{C}$ )

Symbol	Test Conditions	Ratings	Unit
ICBO	V <sub>CB</sub> =200V	100max	μA
IEBO	V <sub>EB</sub> =6V	10max	mA
V <sub>CEO</sub>	I <sub>C</sub> =50mA	150min	V
h <sub>FE</sub>	V <sub>CE</sub> =2V, I <sub>C</sub> =6A	2000min	
V <sub>CE</sub> (sat)	I <sub>C</sub> =6A, I <sub>B</sub> =6mA	1.5max	V
V <sub>BE</sub> (sat)	I <sub>C</sub> =6A, I <sub>B</sub> =6mA	2.0max	V

### External Dimensions

TO220F (full-mold)



# Power Transistor FP812

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	-120	V
V <sub>CE0</sub>	-120	V
V <sub>EB0</sub>	-6	V
I <sub>C</sub>	-8 (pulse -12)	A
I <sub>B</sub>	-3	A
P <sub>C</sub>	35 (T <sub>C</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

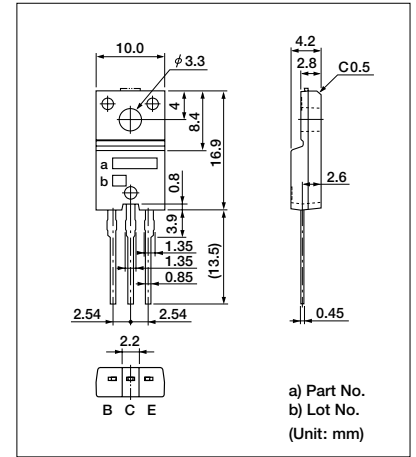
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = -120V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = -6V	10max	μA
V <sub>CE0</sub>	I <sub>C</sub> = -50mA	-120min	V
h <sub>FE</sub>	V <sub>CE</sub> = -4V, I <sub>C</sub> = -3A	70min	
V <sub>CE(sat)</sub>	I <sub>C</sub> = -3A, I <sub>B</sub> = -0.3A	-0.3max	V

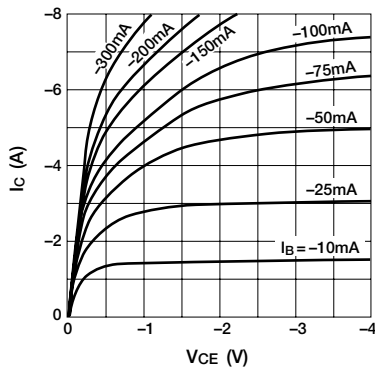
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
-12	4	-3	-10	5	-30	30	2.5	0.4	0.6

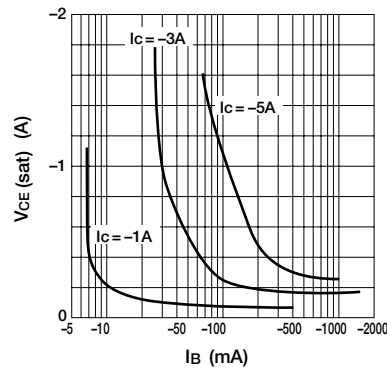
## External Dimensions TO220F (full-mold)



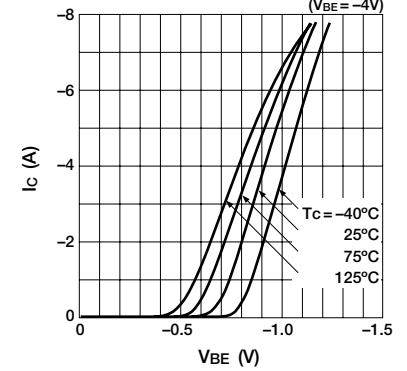
### I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



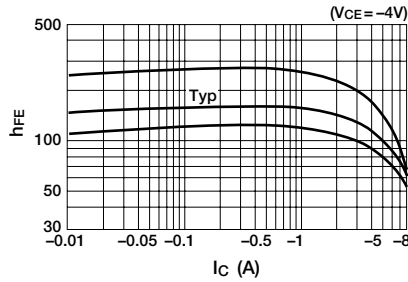
### V<sub>CE(sat)</sub>—I<sub>B</sub> Characteristics (typ.)



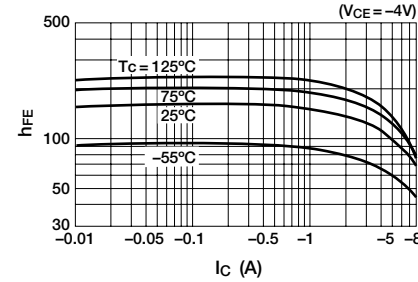
### I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



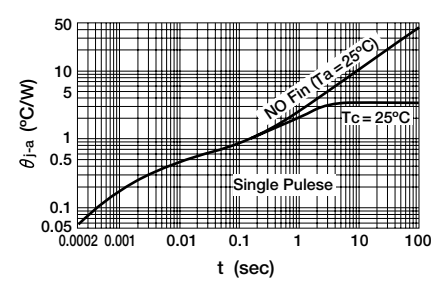
### h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.)



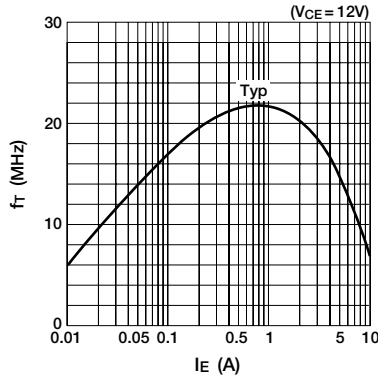
### h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



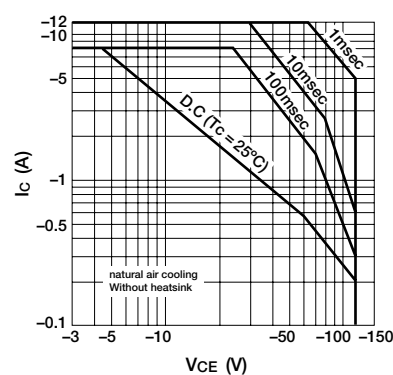
### θ<sub>J-a</sub>—t Characteristics



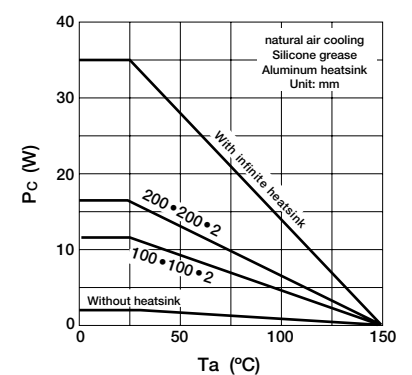
### f<sub>T</sub>—I<sub>E</sub> Characteristics (typ.)



### Safe Operating Area (single pulse)



### P<sub>C</sub>—T<sub>a</sub> Derating



# Power Transistor MN611S

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	115±10	V
V <sub>CE0</sub>	115±10	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6 (pulse ±10)	A
I <sub>B</sub>	1	A
P <sub>C</sub>	50 (Tc=25°C) 1.2 (Ta=25°C, No Fin)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

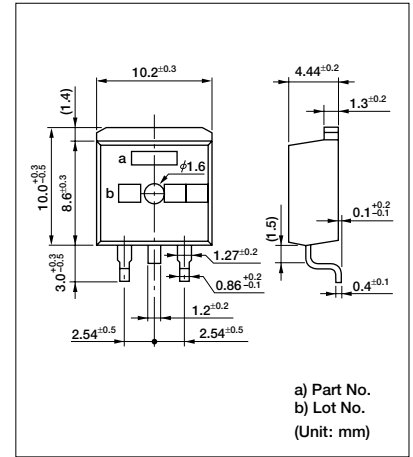
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> =105V			10	μA
I <sub>EB0</sub>	V <sub>EB</sub> =6V			10	μA
V <sub>CE0</sub>	I <sub>C</sub> =50mA	105	115	125	V
h <sub>FE</sub>	V <sub>CE</sub> =1V, I <sub>C</sub> =1A	400	800	1500	
V <sub>CE</sub> (sat)	I <sub>C</sub> =1.2A, I <sub>B</sub> =12mA		0.08	0.12	V
V <sub>FEC</sub>	I <sub>FEC</sub> =6A		1.25	1.5	V
E <sub>s</sub> /B	L=10mA	45			mJ

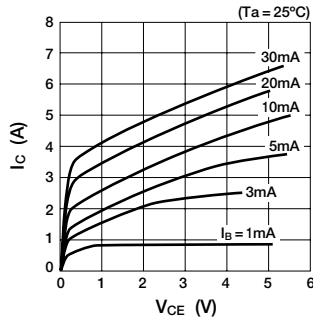
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>C</sub> (A)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	10	-5	1	30	-30	0.2typ	5.7typ	0.4typ

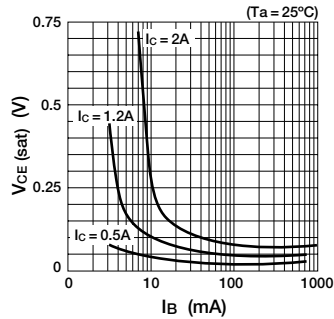
## External Dimensions T0220S



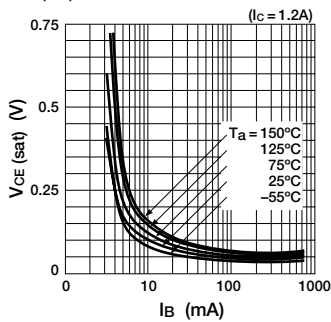
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



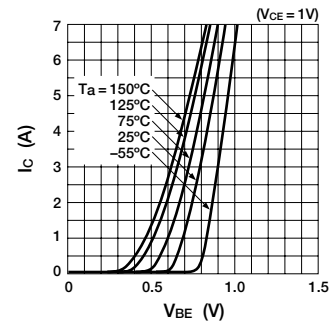
### V<sub>CE</sub>(sat) — I<sub>B</sub> Characteristics (typ.)



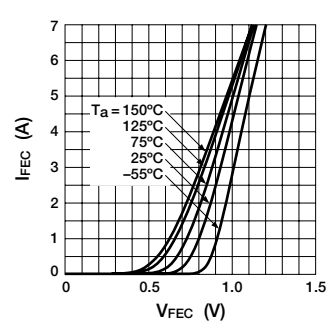
### V<sub>CE</sub>(sat) — I<sub>B</sub> Temperature Characteristics (typ.)



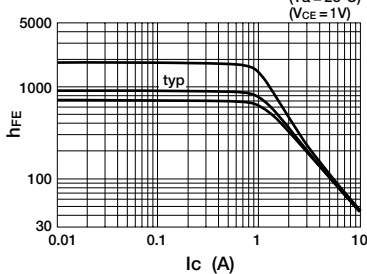
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



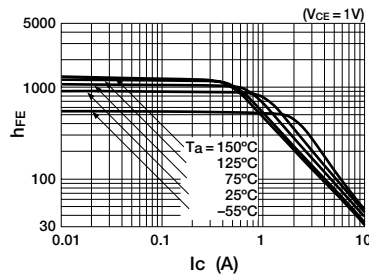
### I<sub>FEC</sub> — V<sub>FEC</sub> Temperature Characteristics (typ.)



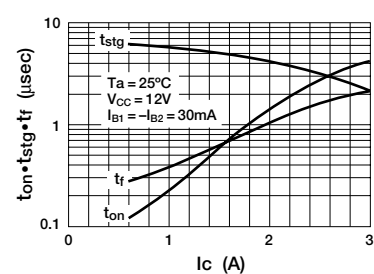
### h<sub>FE</sub> — I<sub>C</sub> Characteristics (typ.)



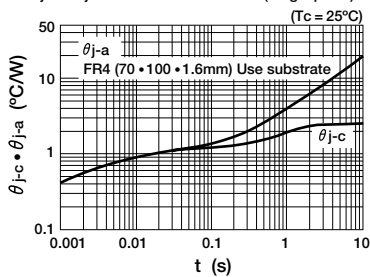
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



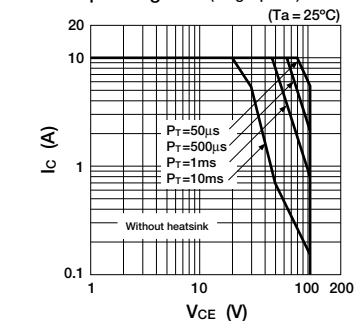
### t<sub>on</sub> • t<sub>stg</sub> • t<sub>f</sub> — I<sub>C</sub> Characteristics (typ.)



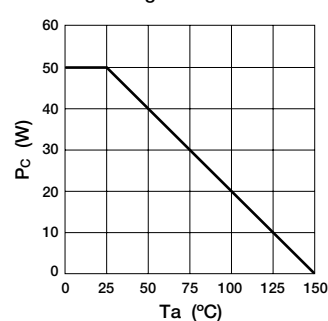
### θ<sub>J-C</sub> • θ<sub>J-a</sub> — t Characteristics (Single pulse)



### Safe Operating Area (Single pulse)



### P<sub>T</sub> — T<sub>a</sub> Derating



# Power Transistor MN638S

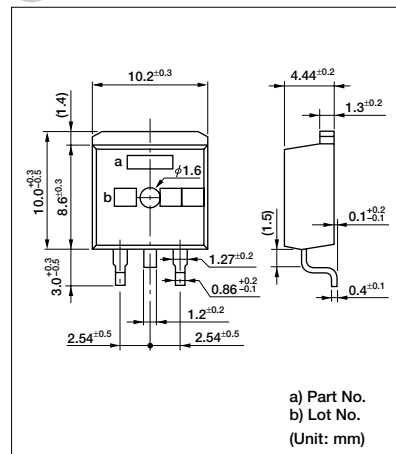
**Absolute Maximum Ratings** ( $T_a=25^\circ\text{C}$ )

Symbol	Ratings	Unit
$V_{CB0}$	$380\pm 50$	V
$V_{CE0}$	$380\pm 50$	V
$V_{EB0}$	6	V
$I_C$	6 (pulse 10)	A
$I_B$	1	A
$P_C$	60 ( $T_C=25^\circ\text{C}$ )	W
$T_j$	150	$^\circ\text{C}$
$T_{stg}$	-55 to +150	$^\circ\text{C}$

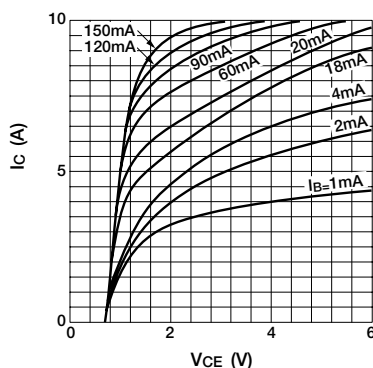
**Electrical Characteristics**

Symbol	Test Conditions	Ratings	Unit
$I_{CBO}$	$V_{CB}=330\text{V}$	10max	$\mu\text{A}$
$I_{EBO}$	$V_{EB}=6\text{V}$	20max	mA
$V_{(BR)CE0}$	$I_C=25\text{mA}$	330 to 430	V
$h_{FE}$	$V_{CE}=2\text{V}$ , $I_C=3\text{A}$	1500min	
$V_{CE(sat)}$	$I_C=4\text{A}$ , $I_B=20\text{mA}$	1.5max	V

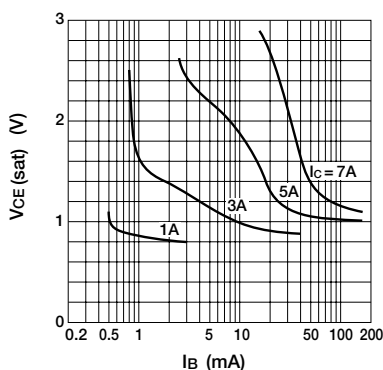
**External Dimensions** TO220S



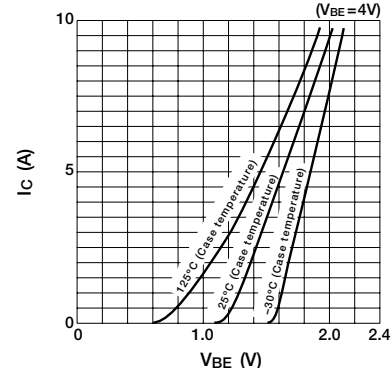
■  $I_C - V_{CE}$  Characteristics (typ.)



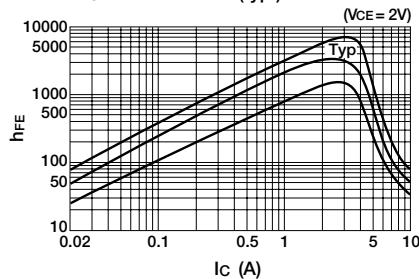
■  $V_{CE(sat)} - I_B$  Characteristics (typ.)



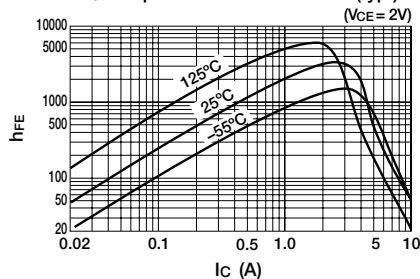
■  $I_C - V_{BE}$  Temperature Characteristics (typ.)



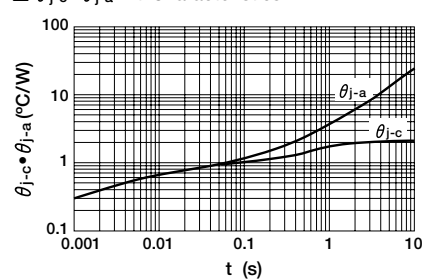
■  $h_{FE} - I_C$  Characteristics (typ.)



■  $h_{FE} - I_C$  Temperature Characteristics (typ.)



■  $\theta_{j-c} \cdot \theta_{j-a} - t$  Characteristics



# Surface-mount Power Transistor SSD103

## Absolute Maximum Ratings (Ta=25°C)

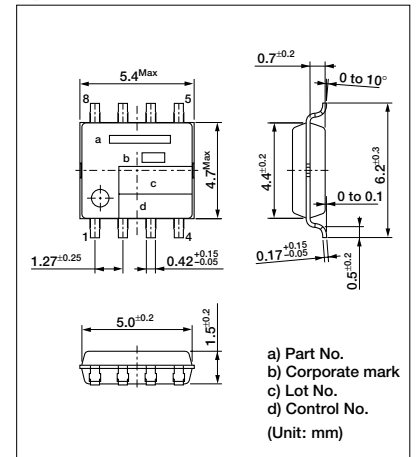
Symbol	Ratings	Unit
V <sub>CB0</sub>	65±5	V
V <sub>CE0</sub>	65±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	6	A
I <sub>C</sub> (pulse)	10 (Pw≤1mS, Duty≤25%)	A
I <sub>B</sub>	10	A
P <sub>C</sub>	1.5*1	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\*1: FR4 70mm×100mm×1.6mm  
(drain heatsink copper foil area 25×25mm)

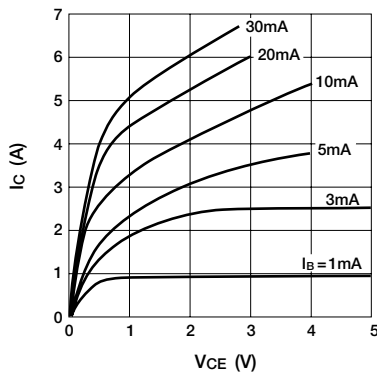
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> = 60V, I <sub>E</sub> = 0A			10	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V, I <sub>C</sub> = 0A			10	μA
V <sub>CE0</sub>	I <sub>C</sub> = 50mA	60	65	70	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 1A	400	800	1500	
V <sub>CE</sub> (sat)	I <sub>C</sub> = 1.5A, I <sub>B</sub> = 15mA	0.11	0.15		V
V <sub>FEC</sub>	I <sub>FEC</sub> = 6A		1.25	1.5	V
Es/b	L = 10mH	80			mJ

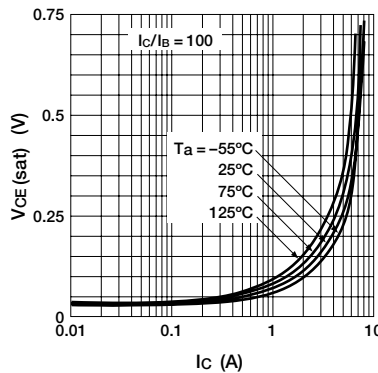
## External Dimensions SOP8



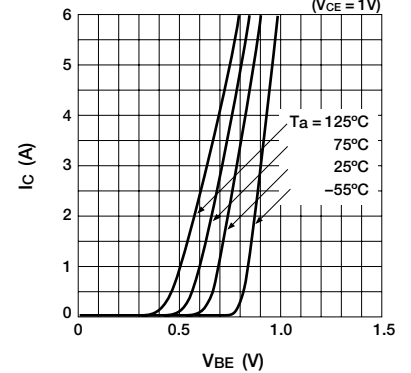
## I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



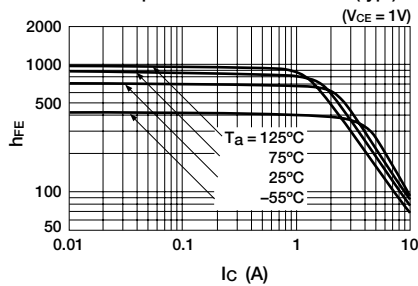
## V<sub>CE</sub> (sat)—I<sub>C</sub> Temperature Characteristics (typ.)



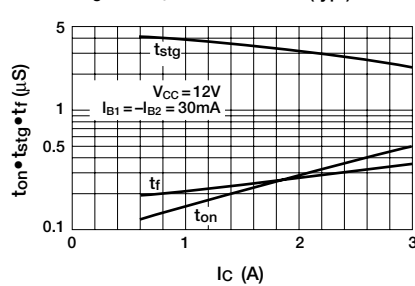
## I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



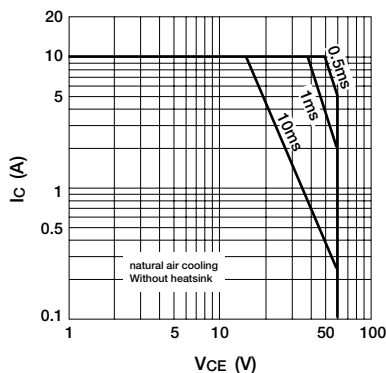
## h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



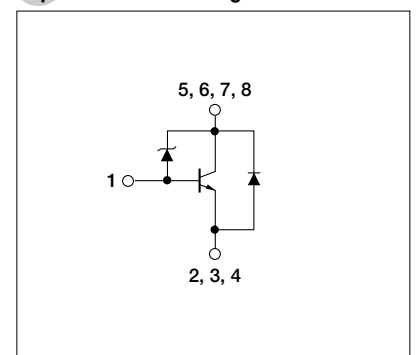
## t<sub>on</sub>•t<sub>stg</sub>•t<sub>r</sub>—I<sub>C</sub> Characteristics (typ.)



## Safe Operating Area (Single pulse)



## Equivalent Circuit Diagram





# Surface-mount Power Transistor Array SDA04

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
VCBO	-60	V
VCEO	-60	V
VEBO	-6	V
IC	-6 (pulse -12)	A
IB	-1	A
PT	2.5 (No Fin)	W
Tj	150	°C
Tstg	-55 to +150	°C

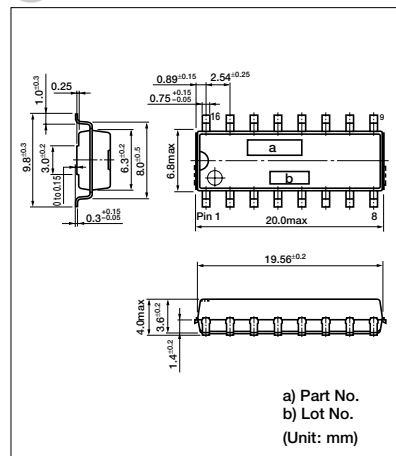
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
ICBO	VCB = -60V	-10max	μA
IEBO	VEB = -6V	-10max	μA
VCEO	IC = -25mA	-60min	V
hFE	VCE = -4V, IC = -2A	100min	
VCE(sat)	IC = -2A, IB = -0.1A	-0.4max	V

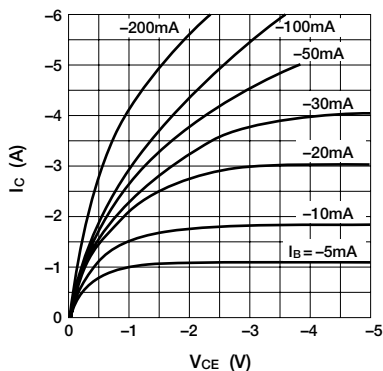
## Typical Switching Characteristics

VCC (V)	RL (Ω)	IC (A)	VBB1 (V)	VBB2 (V)	IB1 (mA)	IB2 (mA)	ton (μs)	tstg (μs)	tr (μs)
-12	12	-1	-10	5	-50	50	0.4	1.75	0.22

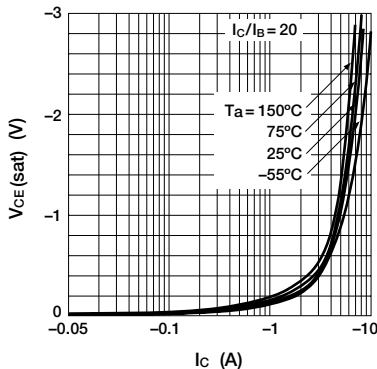
## External Dimensions SMD-16A



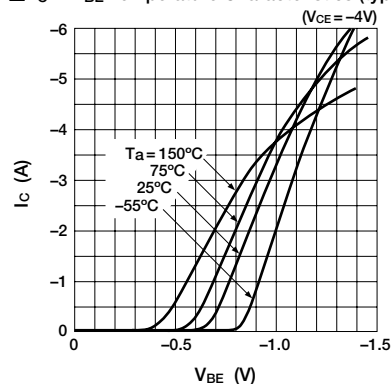
### IC — VCE Characteristics



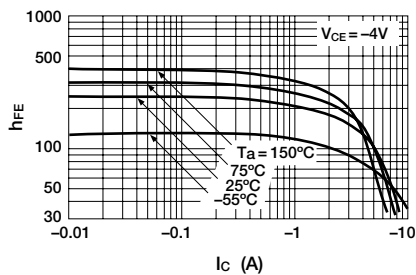
### VCE(sat) — IC Temperature Characteristics (typ.)



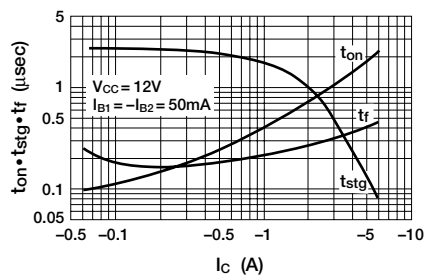
### IC — VBE Temperature Characteristics (typ.)



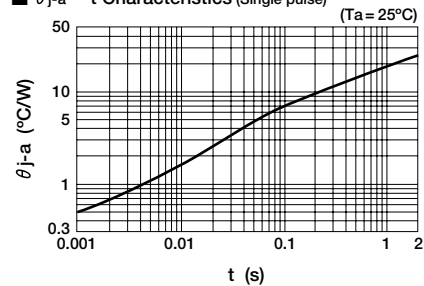
### hFE — IC Temperature Characteristics



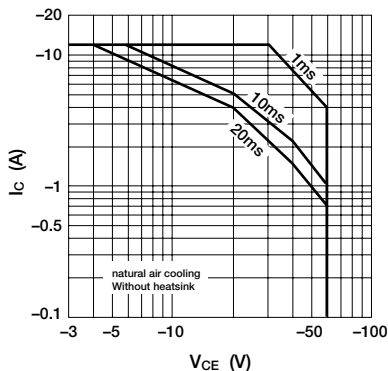
### ton • tstg • tr — IC Characteristics



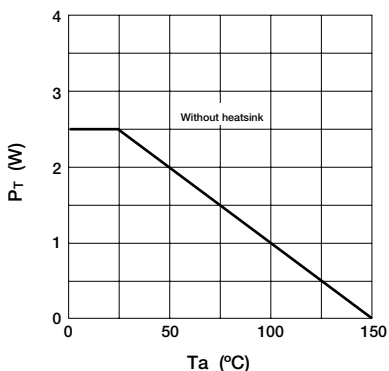
### θJA — t Characteristics (Single pulse) (Ta = 25°C)



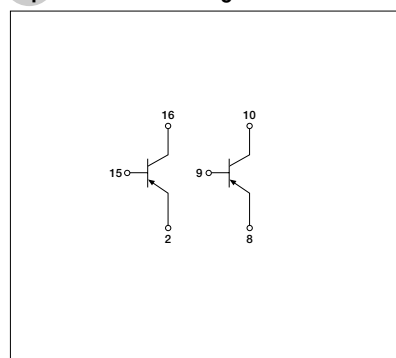
### Safe Operating Area (Single pulse)



### PT — Ta Derating



## Equivalent Circuit Diagram



# Surface-mount Power Transistor Array SDC09

## Absolute Maximum Ratings (Ta=25°C)

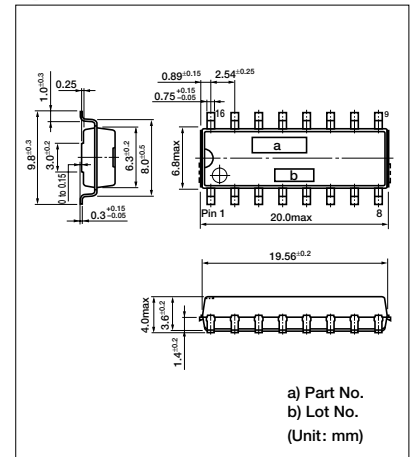
Symbol	Ratings	Unit
VCBO	65±5	V
VCEO	65±5	V
VEBO	6	V
IC	6 (pulse 10*)	A
IB	1	A
PT	2.8	W
Tj	150	°C
Tstg	-55 to +150	°C

\* Pw ≤ 100μs, Duty ≤ 1%

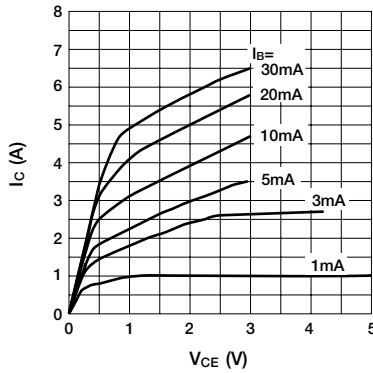
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
ICBO	VCB = 60V	10max	μA
IEBO	VEB = 6V	10max	μA
VCEO	IC = 50mA	60 to 70	V
hFE	VCE = 1V, IC = 1A	400 to 1500	
VCE(sat)	IC = 1.5A, IB = 15mA	0.15max	V
VFEC	IFEC = 6A	1.5max	V
Es/b	L = 10mH, single pulse	80min	mJ

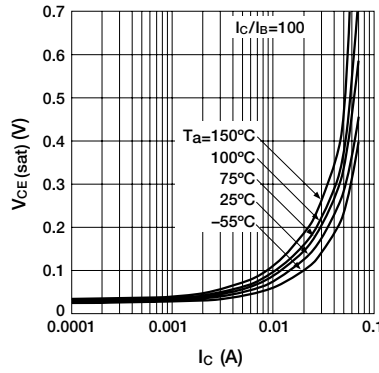
## External Dimensions SMD-16A



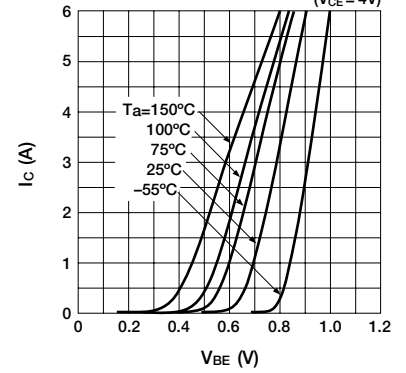
## IC — VCE Characteristics



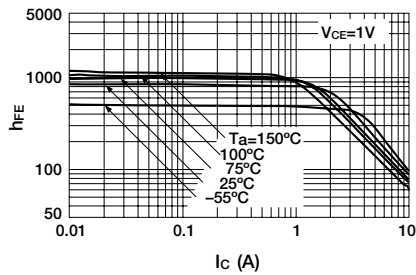
## VCE(sat) — IC Temperature Characteristics (typ.)



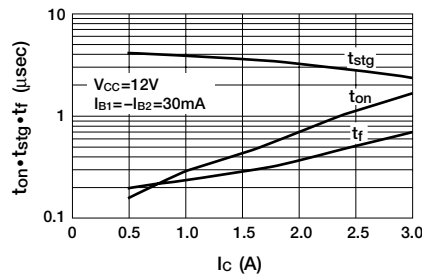
## IC — VBE Temperature Characteristics (typ.)



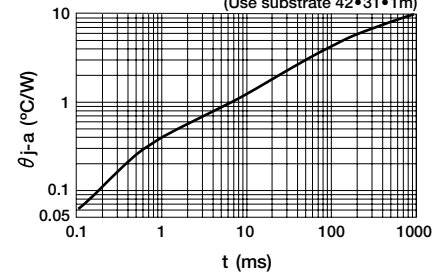
## hFE — IC Temperature Characteristics



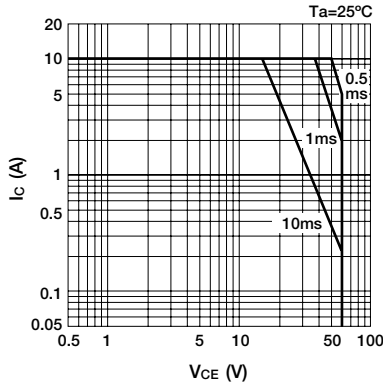
## ton•tstg•tr — IC Characteristics



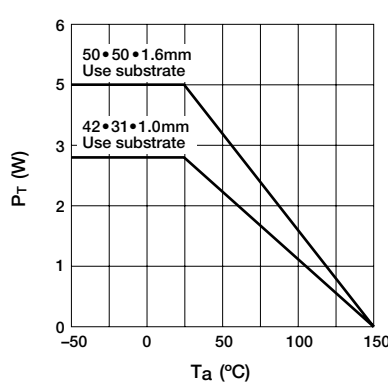
## θj-a — t Characteristics (Single pulse)



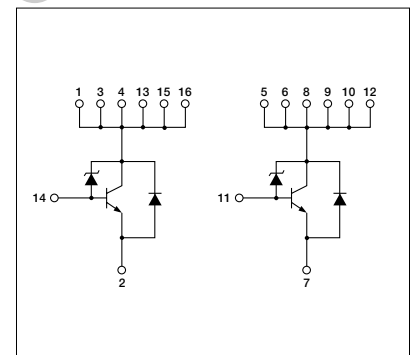
## Safe Operating Area (Single pulse)



## PT — Ta Derating



## Equivalent Circuit Diagram



# Power Transistor Array SLA8004

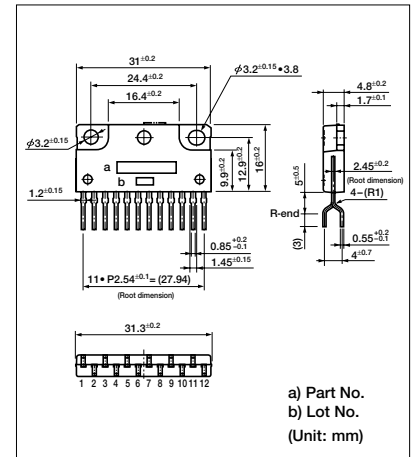
## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings		Unit
	NPN	PNP	
V <sub>CB0</sub>	60	-55	V
V <sub>CE0</sub>	60	-55	V
V <sub>EB0</sub>	6	-6	V
I <sub>C</sub>	12	-12	A
I <sub>B</sub>	3	-3	A
P <sub>T</sub>	5 (Tc=25°C, No Fin)		W
	40 (Tc=25°C)		W
T <sub>J</sub>	150		°C
T <sub>stg</sub>	-55 to +150		°C

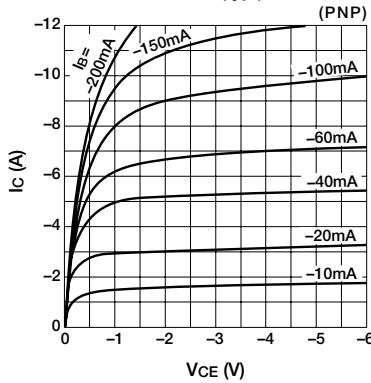
## Electrical Characteristics (Ta=25°C)

Symbol	NPN		PNP		Unit
	Test Conditions	Ratings	Test Conditions	Ratings	
I <sub>CB0</sub>	V <sub>CB</sub> = 60V	100max	V <sub>CB</sub> = -55V	-100max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	60max	V <sub>EB</sub> = -6V	-60max	mA
V <sub>CE0</sub>	I <sub>C</sub> = 25mA	60min	I <sub>C</sub> = -25mA	-55min	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 3A	150min	V <sub>CE</sub> = -1V, I <sub>C</sub> = -3A	80min	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 6A, I <sub>B</sub> = 0.3A	0.35max	I <sub>C</sub> = -6A, I <sub>B</sub> = -0.3A	-0.35max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 10A	2.5max	I <sub>FEC</sub> = 10A	2.5max	V

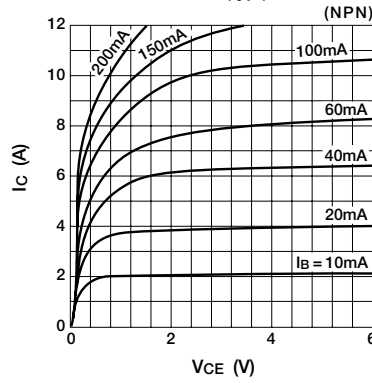
## External Dimensions SLA 12pin (LF817)



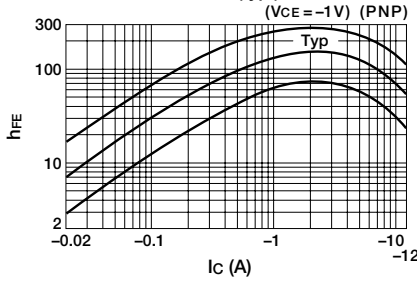
### I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.) (PNP)



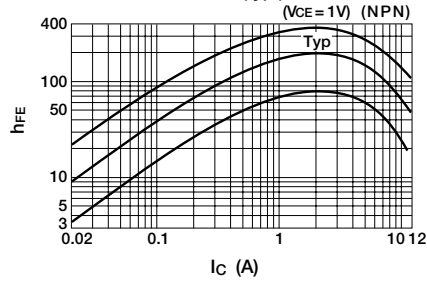
### I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.) (NPN)



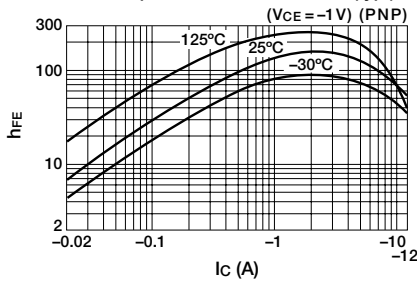
### h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.) (PNP)



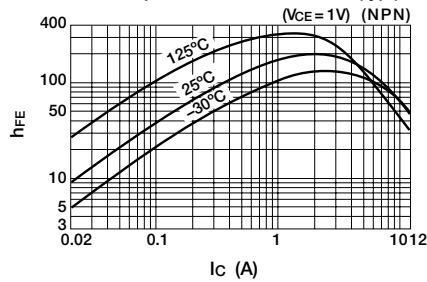
### h<sub>FE</sub>—I<sub>C</sub> Characteristics (typ.) (NPN)



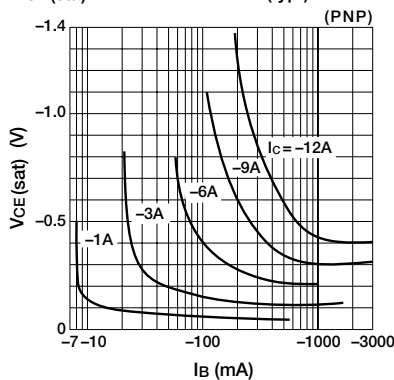
### h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.) (PNP)



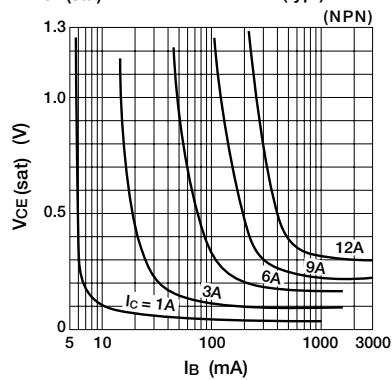
### h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.) (NPN)



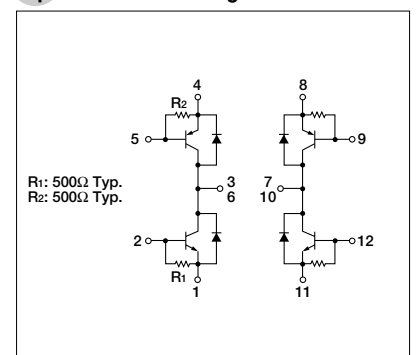
### V<sub>CE(sat)</sub>—I<sub>B</sub> Characteristics (typ.) (PNP)



### V<sub>CE(sat)</sub>—I<sub>B</sub> Characteristics (typ.) (NPN)



## Equivalent Circuit Diagram



# Surface-mount Power Transistor Array SPF0001

## Absolute Maximum Ratings (Ta=25°C)

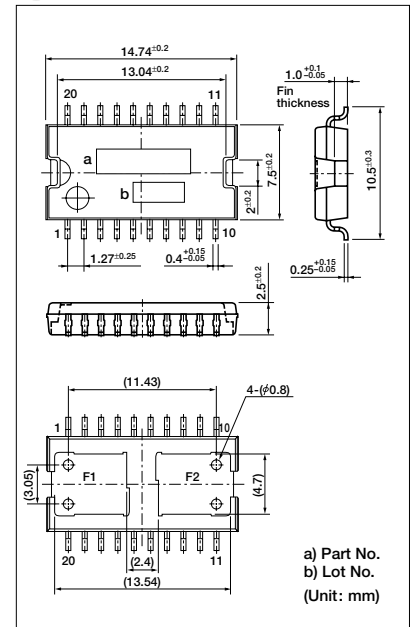
Symbol	Ratings	Unit
V <sub>CB0</sub>	115±10	V
V <sub>CE0</sub>	115±10	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6 (pulse ±10)	A
I <sub>B</sub>	1	A
P <sub>T</sub> *	2.5 (Ta=25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* Use glass epoxy substrate (FR4) 70mm•100mm•1.6mm

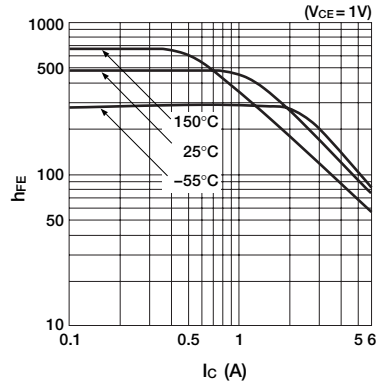
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> =105V			10	μA
I <sub>EB0</sub>	V <sub>EB</sub> =6V			10	μA
V <sub>CE0</sub>	I <sub>C</sub> =50mA	105	115	125	V
h <sub>FE</sub>	V <sub>CE</sub> =1V, I <sub>C</sub> =1A	400	800	1500	
V <sub>CE</sub> (sat)	I <sub>C</sub> =1.2A, I <sub>B</sub> =12mA		0.08	0.12	V
V <sub>FEC</sub>	I <sub>FEC</sub> =6A		1.25	1.5	V
Es/b	L=10mH	45			mJ

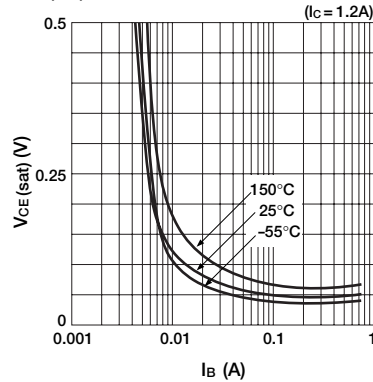
## External Dimensions SPF 20pin



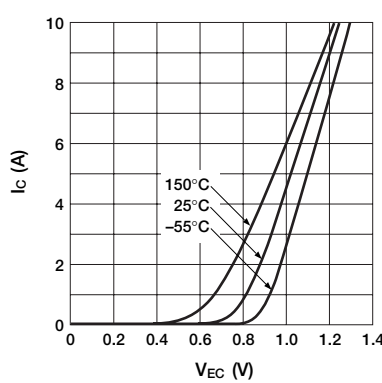
■ h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



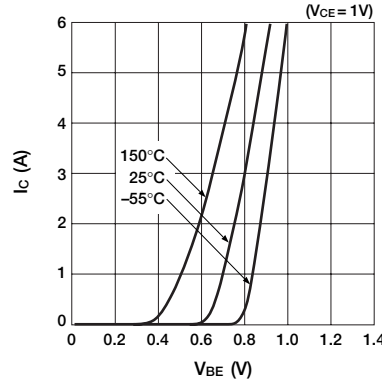
■ V<sub>CE</sub>(sat)—I<sub>B</sub> Temperature Characteristics (typ.)



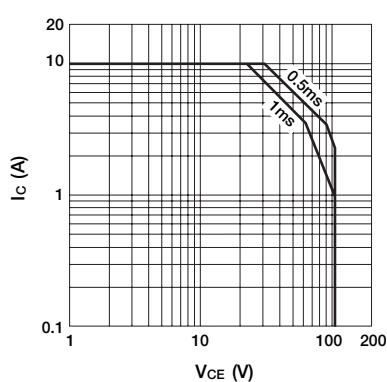
■ I<sub>C</sub>—V<sub>EC</sub> Temperature Characteristics (typ.)



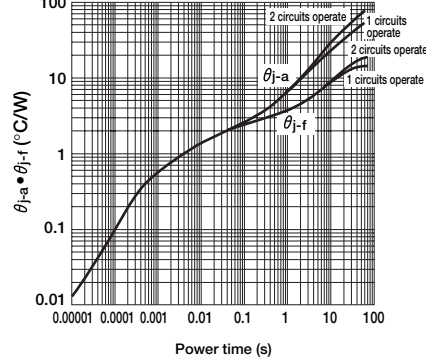
■ I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



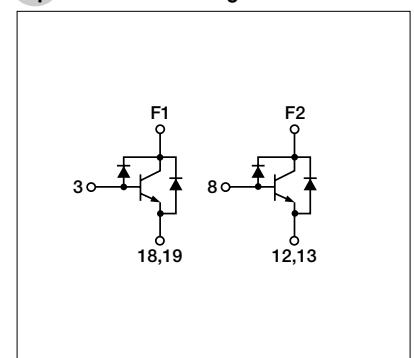
■ Safe Operating Area (single pulse)



■ Transient thermal resistance characteristics  
(82•36•1mm at the time of mounting the recommended pattern of the glass epoxy board)



## Equivalent Circuit Diagram



# Power Transistor Array STA315A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	35±5	V
V <sub>CE0</sub>	36±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	2 (pulse 3*)	A
I <sub>B</sub>	30	mA
P <sub>T</sub>	3 (Ta=25°C) 13.5 (Tc=25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* P<sub>W</sub> ≤ 1ms, Duty ≤ 25%

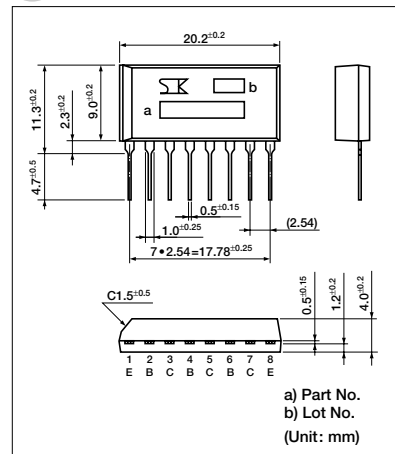
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 30V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	2.7max	mA
V <sub>CE0</sub>	I <sub>C</sub> = 25mA	31 to 41	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 0.7A	400min	
V <sub>CE (sat)</sub>	I <sub>C</sub> = 0.5A, I <sub>B</sub> = 5mA	0.2max	V
	I <sub>C</sub> = 1A, I <sub>B</sub> = 5mA	0.5max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 2A	2.5max	V
R <sub>B</sub>		800±120	Ω
R <sub>BE</sub>		2.0±0.4	kΩ
Es/b	L = 10mH, single pulse	50min	mJ

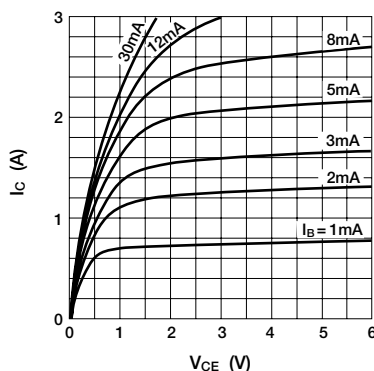
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	5	0	1.0	8.5	2.5

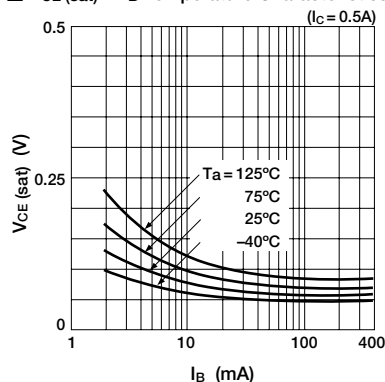
## External Dimensions STA3 (LF400A)



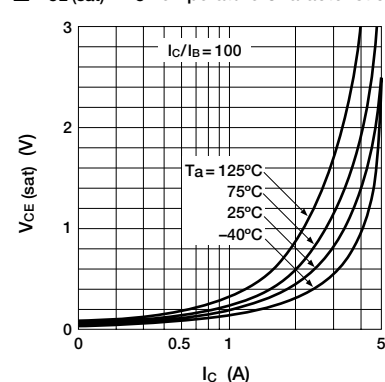
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



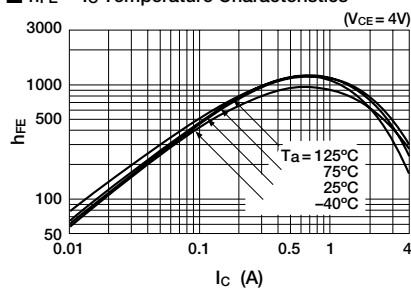
### V<sub>CE (sat)</sub> — I<sub>B</sub> Temperature Characteristics



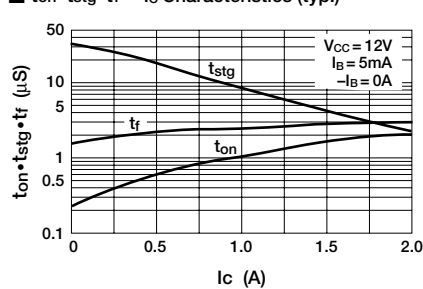
### V<sub>CE (sat)</sub> — I<sub>C</sub> Temperature Characteristics



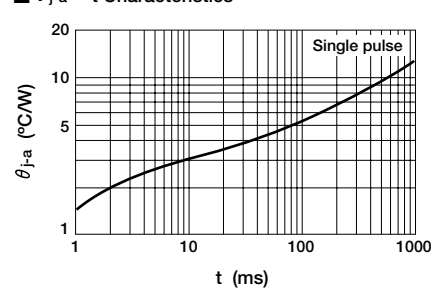
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics



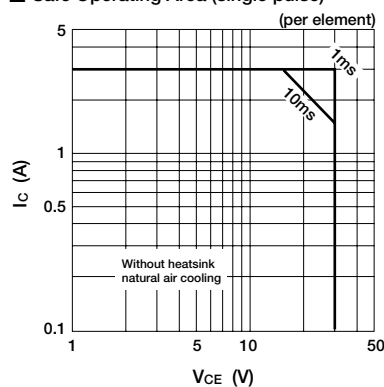
### t<sub>on</sub> • t<sub>stg</sub> • t<sub>f</sub> — I<sub>C</sub> Characteristics (typ.)



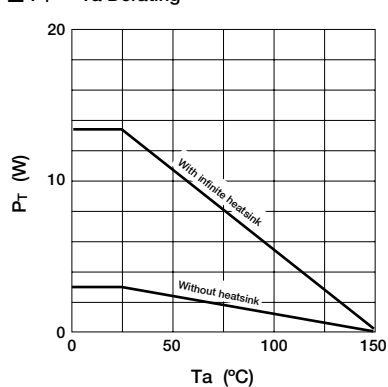
### θ<sub>J-a</sub> — t Characteristics



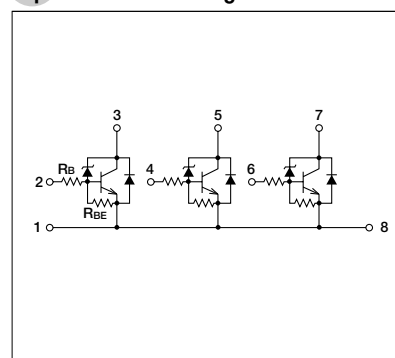
### Safe Operating Area (single pulse)



### P<sub>T</sub> — T<sub>a</sub> Derating



## Equivalent Circuit Diagram



# Power Transistor Array STA335A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	35±5	V
V <sub>CE0</sub>	35±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	3	A
I <sub>B</sub>	1	A
P <sub>T</sub>	2.5 (Ta=25°C) 12 (Tc=25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

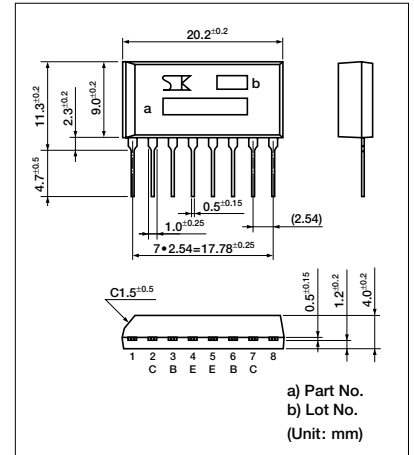
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 30V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	10max	μA
V <sub>CE0</sub>	I <sub>C</sub> = 25mA	35±5	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 0.5A	500min	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 1A, I <sub>B</sub> = 5mA	0.5max	V
Es/b	L = 10mH, single pulse	150min	mJ

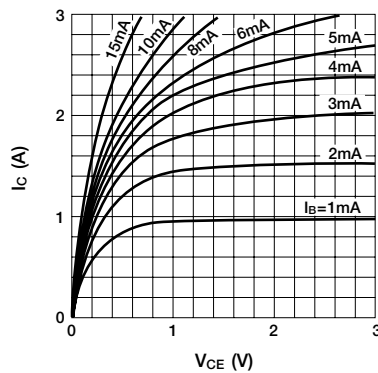
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	5	5	1.3	4.7	1.2

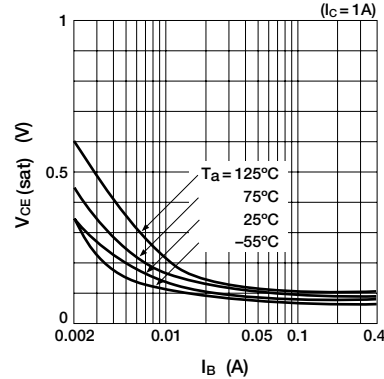
## External Dimensions STA3 (LF400A)



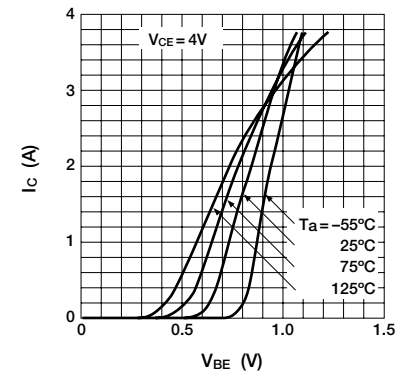
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



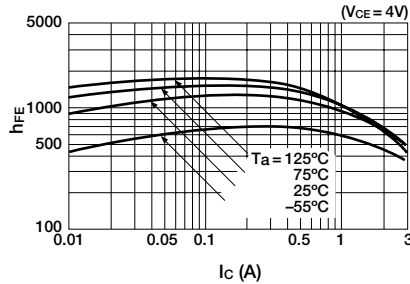
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics



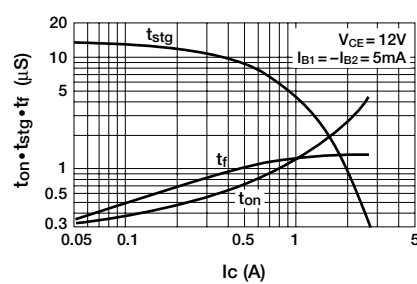
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



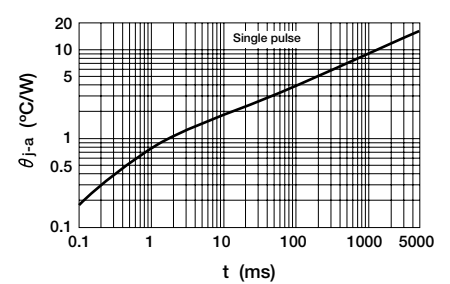
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



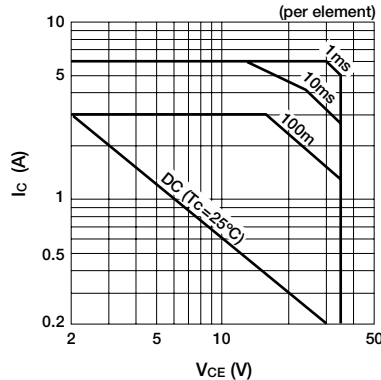
### t<sub>on</sub>•t<sub>stg</sub>•t<sub>f</sub> — I<sub>C</sub> Characteristics (typ.)



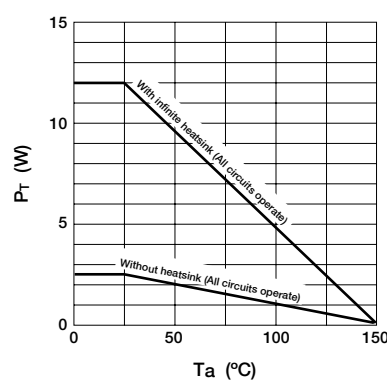
### θ<sub>J-a</sub> — t Characteristics



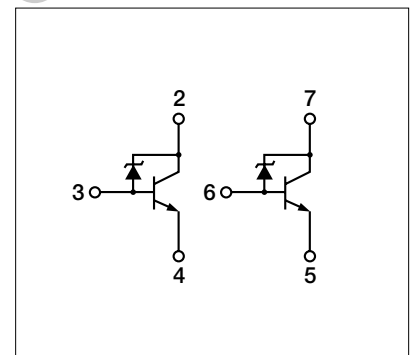
### Safe Operating Area (single pulse)



### P<sub>T</sub> — Ta Derating



## Equivalent Circuit Diagram



# Power Transistor Array STA415A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	35±5	V
V <sub>CE0</sub>	36±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	2 (pulse 3*)	A
I <sub>B</sub>	30	mA
P <sub>T</sub>	4 (Ta = 25°C)	W
	18 (Tc = 25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* P<sub>W</sub> ≤ 1ms, Duty ≤ 25%

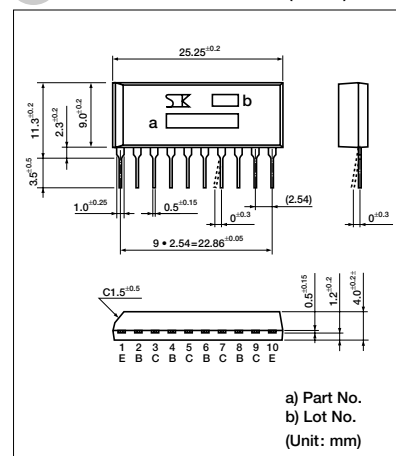
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 30V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	2.7max	mA
V <sub>CE0</sub>	I <sub>C</sub> = 25mA	31 to 41	V
h <sub>FE</sub>	V <sub>CE</sub> = 4V, I <sub>C</sub> = 0.7A	400min	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 0.5A, I <sub>B</sub> = 5mA	0.2max	V
	I <sub>C</sub> = 1A, I <sub>B</sub> = 5mA	0.5max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 2A	2.5max	V
R <sub>B</sub>		800±120	Ω
R <sub>BE</sub>		2.0±0.4	kΩ
Es/b	L = 10mH, single pulse	50min	mJ

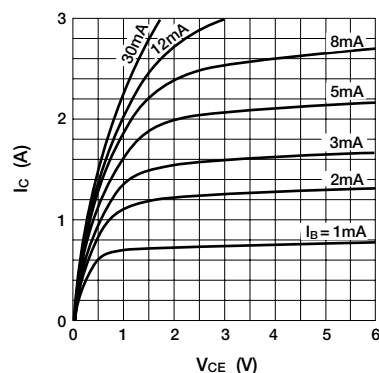
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	5	0	1.0	8.5	2.5

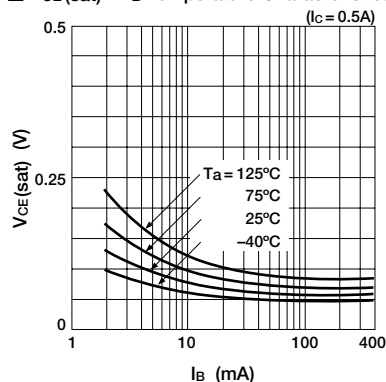
## External Dimensions STA4 (LF412)



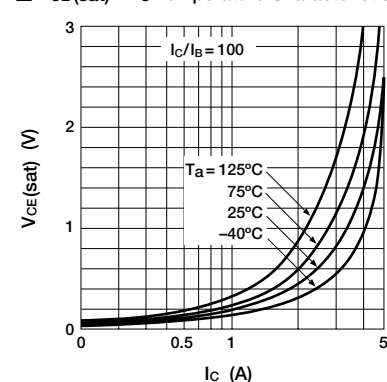
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



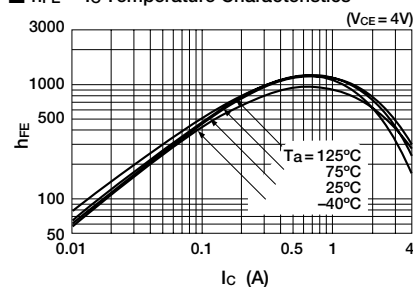
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics



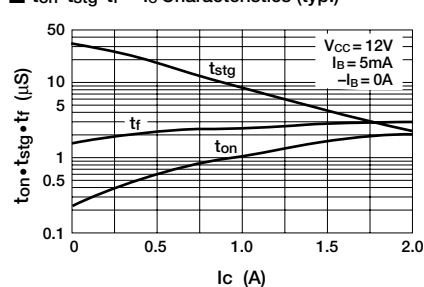
### V<sub>CE(sat)</sub> — I<sub>C</sub> Temperature Characteristics



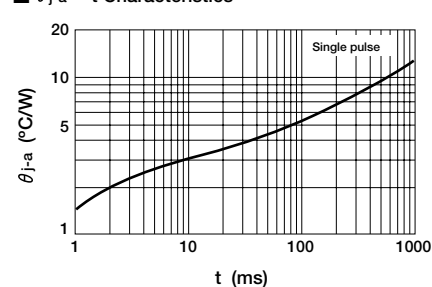
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics



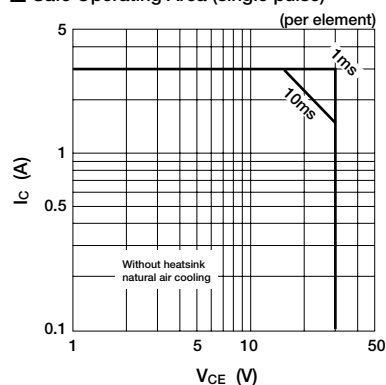
### t<sub>on</sub>•t<sub>stg</sub>•t<sub>f</sub> — I<sub>C</sub> Characteristics (typ.)



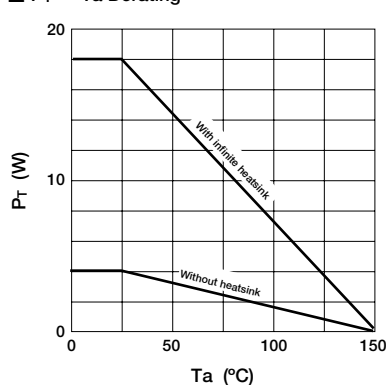
### θ<sub>J-a</sub> — t Characteristics



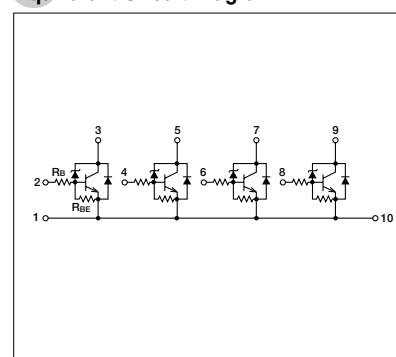
### Safe Operating Area (single pulse)



### P<sub>T</sub> — T<sub>a</sub> Derating



## Equivalent Circuit Diagram



# Power Transistor Array STA460C

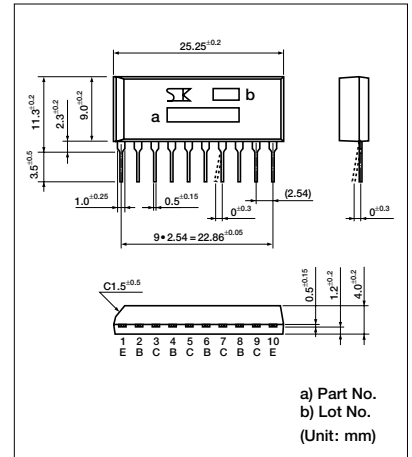
## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	60±10	V
V <sub>CE0</sub>	60±10	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6	A
I <sub>CP</sub>	±10 (P <sub>W</sub> ≤ 1ms, D <sub>u</sub> ≤ 50%)	A
P <sub>T</sub>	3.2 (Ta = 25°C) 18 (Tc = 25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-40 to +15	°C

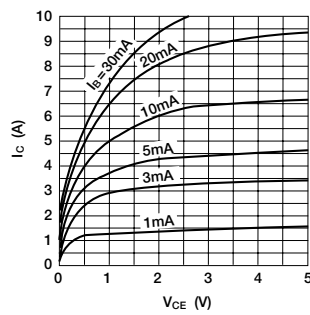
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> = 50V			10	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V			10	μA
V <sub>CE0</sub>	I <sub>C</sub> = 50mA	50	60	70	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 1A	700	1500	3000	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 1.5A, I <sub>B</sub> = 15mA		0.09	0.15	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 6A		1.25	1.5	V
Es/b	L = 10mH, single pulse	200			mJ

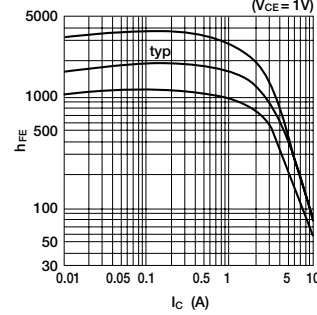
## External Dimensions STA4 (LF412)



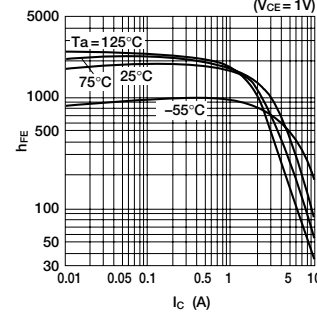
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



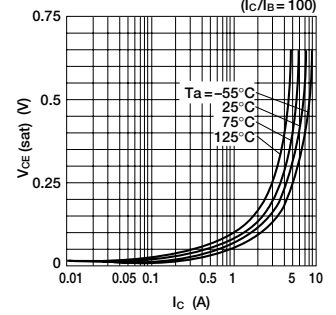
### h<sub>FE</sub> — I<sub>C</sub> Characteristics (typ.)



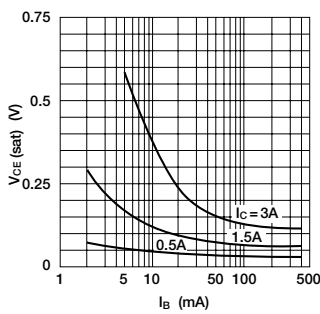
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



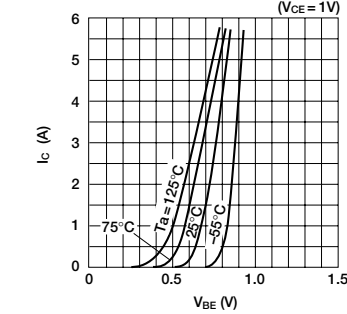
### V<sub>CE(sat)</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



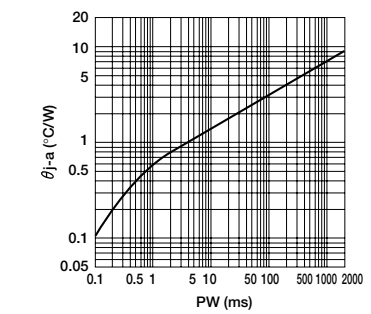
### V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics (typ.)



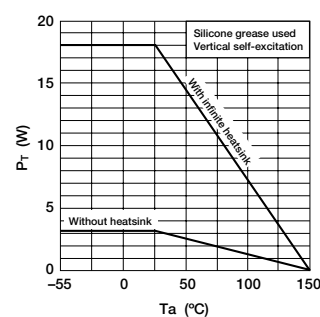
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



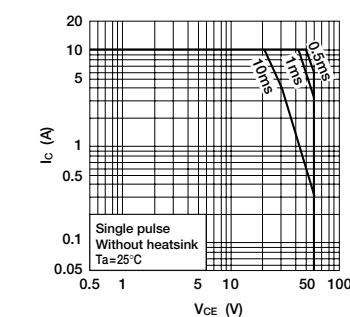
### θ<sub>JA</sub> — PW Characteristics



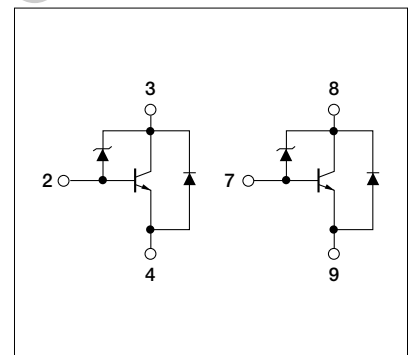
### P<sub>T</sub> — Ta Derating



### Safe Operating Area



## Equivalent Circuit Diagram



# Power Transistor Array STA461C

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	65±5	V
V <sub>CE0</sub>	65±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6 (pulse ±10)	A
I <sub>B</sub>	1	A
P <sub>T</sub>	3.2 (Ta = 25°C)	W
	18 (Tc = 25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

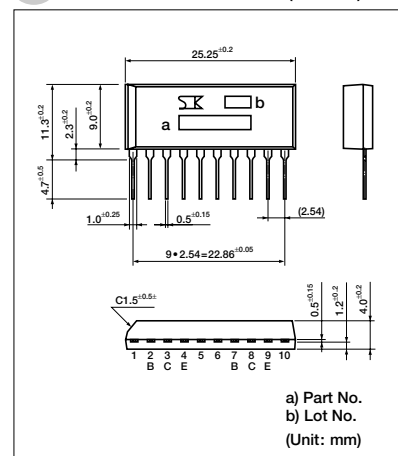
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 60V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	10max	μA
V <sub>CE0</sub>	I <sub>C</sub> = 50mA	60 to 70	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 1A	400 to 1500	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 1.5A, I <sub>B</sub> = 15mA	0.15max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 6A	1.5max	V
Es/b	L = 10mH, single pulse	80min	mJ

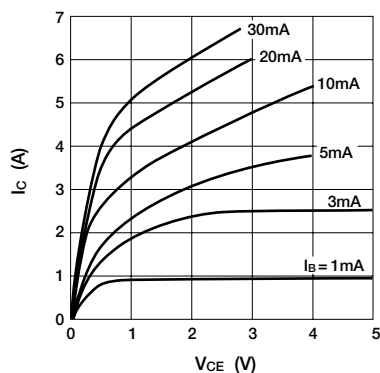
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	30	-30	0.2	3.9	0.2

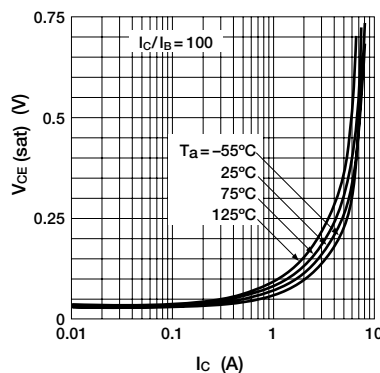
## External Dimensions STA4 (LF400B)



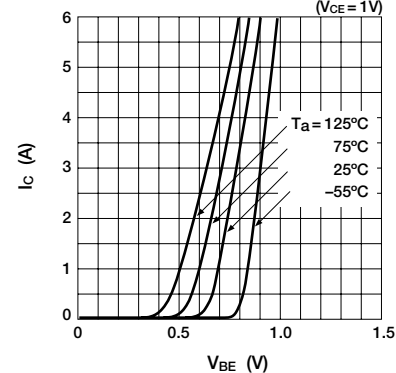
### I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



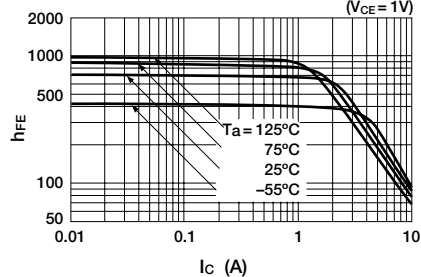
### V<sub>CE(sat)</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



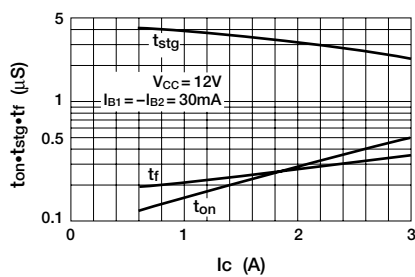
### I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



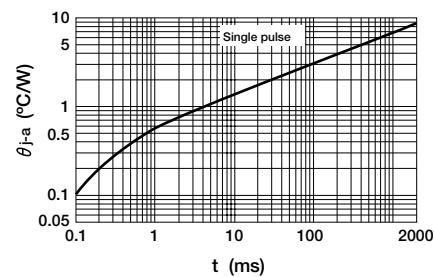
### h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



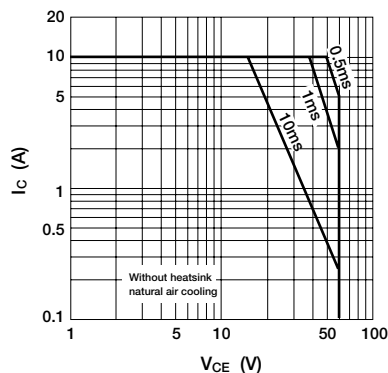
### t<sub>on</sub> • t<sub>stg</sub> • t<sub>f</sub> — I<sub>C</sub> Characteristics



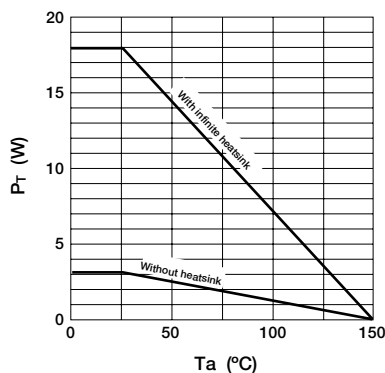
### θ<sub>J-a</sub> — t Characteristics



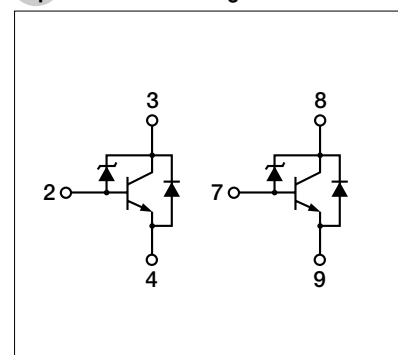
### Safe Operating Area (single pulse)



### P<sub>T</sub> — T<sub>a</sub> Derating



## Equivalent Circuit Diagram



# Power Transistor Array STA463C

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	115±10	V
V <sub>CE0</sub>	115±10	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	±6 (pulse ±10)	A
I <sub>B</sub>	1	A
P <sub>T</sub>	3.2 (Ta=250°C) 18 (Tc=25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

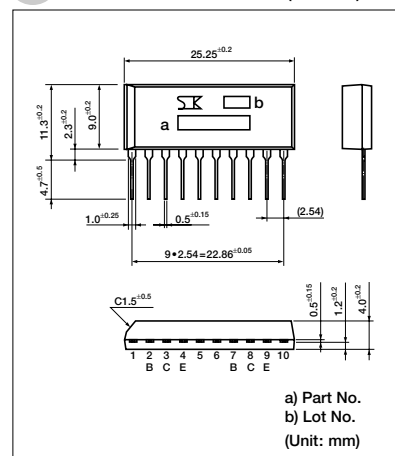
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings	Unit
I <sub>CB0</sub>	V <sub>CB</sub> = 105V	10max	μA
I <sub>EB0</sub>	V <sub>EB</sub> = 6V	10max	μA
V <sub>CE0</sub>	I <sub>C</sub> = 50mA	105 to 125	V
h <sub>FE</sub>	V <sub>CE</sub> = 1V, I <sub>C</sub> = 1A	400 to 1500	
V <sub>CE(sat)</sub>	I <sub>C</sub> = 1.2A, I <sub>B</sub> = 12mA	0.12max	V
V <sub>FEC</sub>	I <sub>FEC</sub> = 6A	1.5max	V
Es/b	L = 10mH, single pulse	45min	mJ

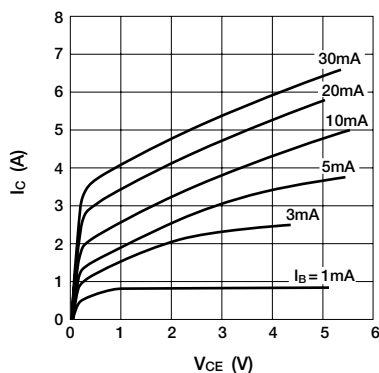
## Typical Switching Characteristics

V <sub>CC</sub> (V)	R <sub>L</sub> (Ω)	I <sub>C</sub> (A)	V <sub>BB1</sub> (V)	V <sub>BB2</sub> (V)	I <sub>B1</sub> (mA)	I <sub>B2</sub> (mA)	t <sub>on</sub> (μs)	t <sub>stg</sub> (μs)	t <sub>f</sub> (μs)
12	12	1	10	-5	30	-30	0.2	5.7	0.4

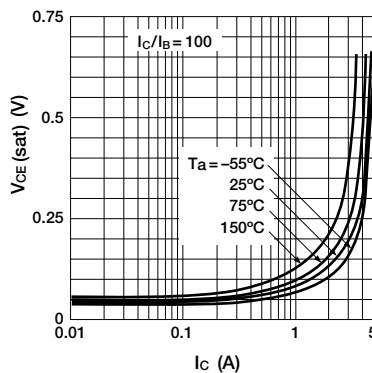
## External Dimensions STA4 (LF400B)



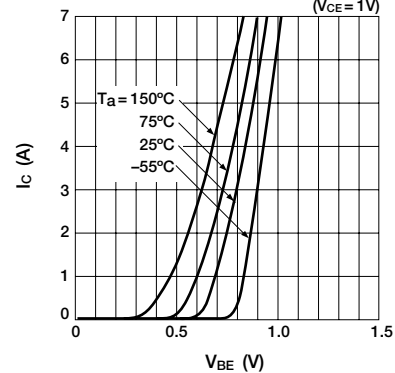
## I<sub>C</sub> — V<sub>CE</sub> Characteristics (typ.)



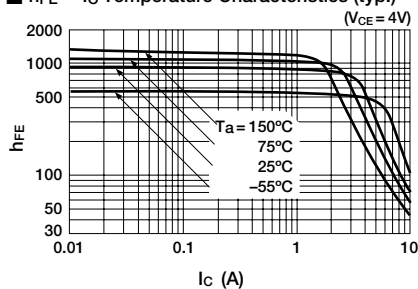
## V<sub>CE(sat)</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



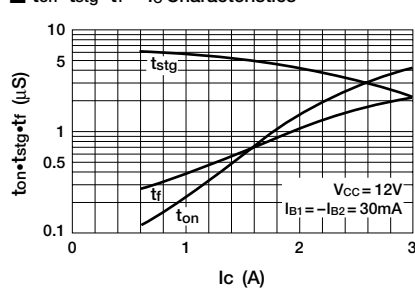
## I<sub>C</sub> — V<sub>BE</sub> Temperature Characteristics (typ.)



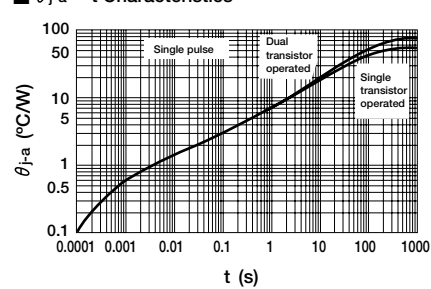
## h<sub>FE</sub> — I<sub>C</sub> Temperature Characteristics (typ.)



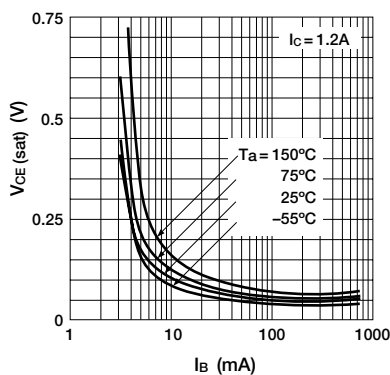
## t<sub>on</sub> • t<sub>stg</sub> • t<sub>f</sub> — I<sub>C</sub> Characteristics



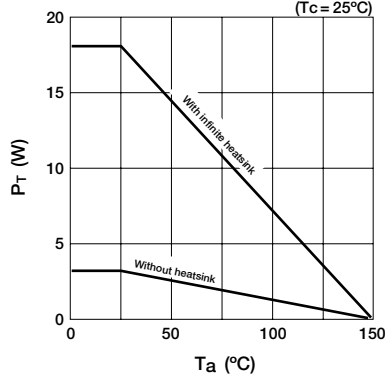
## θ<sub>J-a</sub> — t Characteristics



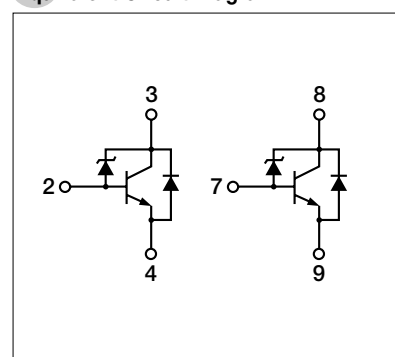
## V<sub>CE(sat)</sub> — I<sub>B</sub> Temperature Characteristics (typ.)



## P<sub>T</sub> — Ta Derating



## Equivalent Circuit Diagram



# Power Transistor Array STA464C

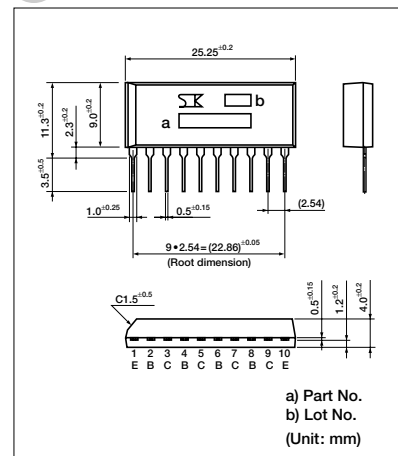
## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>CB0</sub>	65±5	V
V <sub>CE0</sub>	65±5	V
V <sub>EB0</sub>	6	V
I <sub>C</sub>	6 (pulse 10)	A
I <sub>B</sub>	1	A
P <sub>C</sub>	20 (T <sub>C</sub> =25°C) 4 (T <sub>a</sub> =25°C)	W
T <sub>J</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

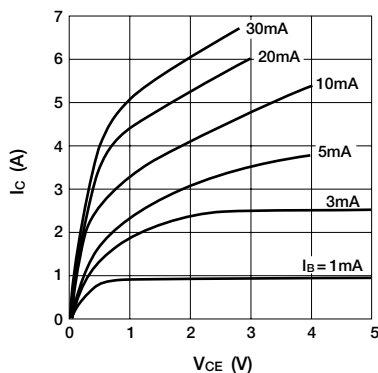
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
I <sub>CB0</sub>	V <sub>CB</sub> =60V			10	μA
I <sub>EB0</sub>	V <sub>EB</sub> =6V			10	μA
V <sub>CE0</sub>	I <sub>C</sub> =50mA	60	65	70	V
h <sub>FE</sub>	V <sub>CE</sub> =1V, I <sub>C</sub> =1A	400	800	1500	
V <sub>CE(sat)</sub>	I <sub>C</sub> =1.5A, I <sub>B</sub> =15mA		0.09	0.15	V
V <sub>FEC</sub>	I <sub>FEC</sub> =6A		1.25	1.5	V
Es/b	L=10mH	80			mJ

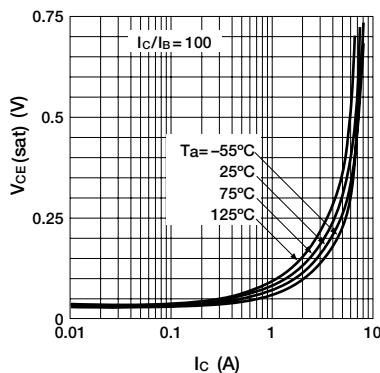
## External Dimensions STA4



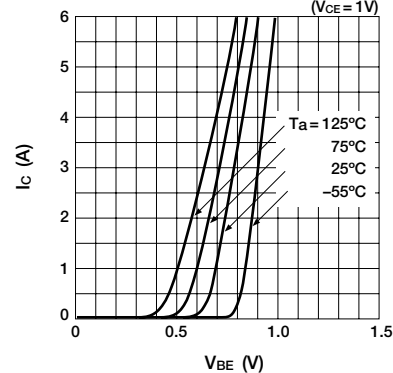
## I<sub>C</sub>—V<sub>CE</sub> Characteristics (typ.)



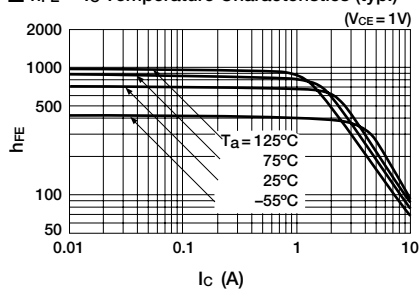
## V<sub>CE(sat)</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



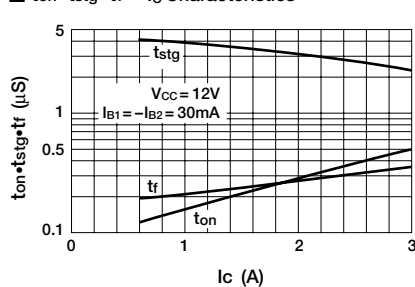
## I<sub>C</sub>—V<sub>BE</sub> Temperature Characteristics (typ.)



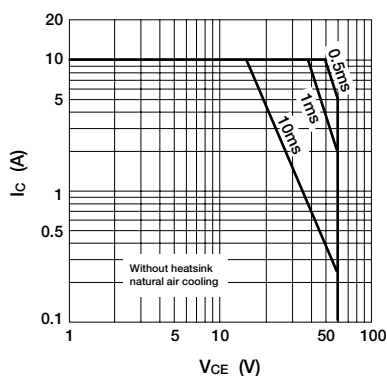
## h<sub>FE</sub>—I<sub>C</sub> Temperature Characteristics (typ.)



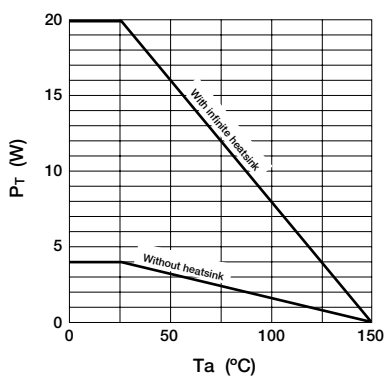
## t<sub>on</sub>•t<sub>stg</sub>•t<sub>r</sub>—I<sub>C</sub> Characteristics



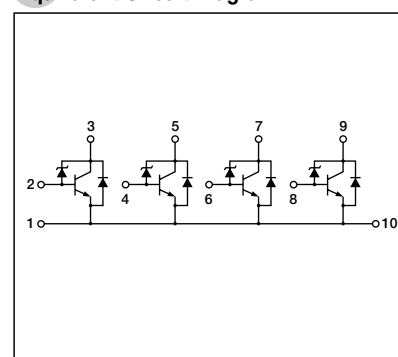
## Safe Operating Area (single pulse)



## P<sub>T</sub>—T<sub>a</sub> Derating



## Equivalent Circuit Diagram



# MOS FET 2SK3710 (under development)

## Features

- ON resistance 0.0060Ω max.
- Built-in G-S bidirectional Zener diode
- Trench MOS structure

## Applications

- Power steering motor
- Various motors
- Replaces mechanical relays

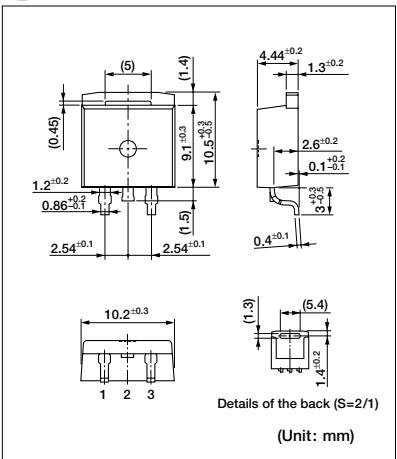
## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	60	V
V <sub>GSS</sub>	20	V
I <sub>D</sub>	70	A
I <sub>D</sub> (pulse)	140	A
P <sub>D</sub>	130	W
EAS	400	mJ
T <sub>ch</sub>	150	°C
Tstg	-55 to +150	°C

## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100μA	60			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V		±10		μA
I <sub>DSS</sub>	V <sub>DS</sub> = 60V, V <sub>GS</sub> = 0V		100		μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	2	4		V
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 35A		5.0	6.0	mΩ
V <sub>SD</sub>	I <sub>SD</sub> = 50A		0.9	1.5	V
t <sub>rr</sub>	I <sub>SD</sub> = 25A, di/dt = 50A/μs		110		ns
C <sub>iss</sub>	V <sub>DS</sub> = 10V		9400		pF
C <sub>oss</sub>	V <sub>GS</sub> = 10V		1400		pF
Crss	f = 1.0MHz		1100		pF

## External Dimensions T0220S



# MOS FET 2SK3711

## Features

- ON resistance 0.006Ω max.
- Built-in G-S bidirectional Zener diode
- Trench MOS structure

## Applications

- Power steering motor
- Various motors
- Replaces mechanical relays

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	60	V
V <sub>GSS</sub>	20	V
I <sub>D</sub>	70	A
I <sub>D</sub> (pulse)	140	A
P <sub>D</sub>	130	W
EAS	To be defined	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* 1: P<sub>W</sub>≤100μs, duty cycle ≤1%

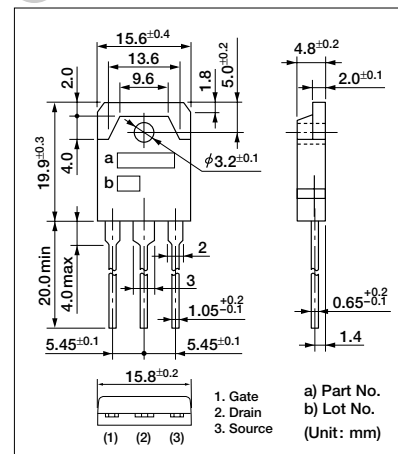
\* 2: V<sub>DD</sub>=20V, L=1mH, I<sub>L</sub>=20A, unclamped, R<sub>G</sub>=50Ω

\* Contact your sales rep for the details of warranty at T<sub>ch</sub>=175°C

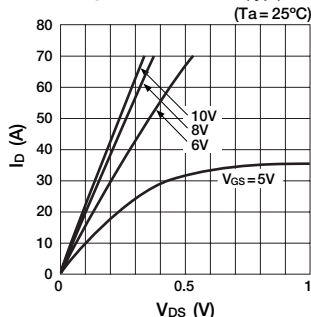
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> =100μA	60			V
I <sub>GSS</sub>	V <sub>GS</sub> =+20V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> =60V, V <sub>GS</sub> =0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> =10V, I <sub>D</sub> =250μA	2		4	V
R <sub>DS(ON)</sub>	V <sub>GS</sub> =10V, I <sub>D</sub> =35A		5.0	6.0	mΩ
V <sub>SD</sub>	I <sub>SD</sub> =50A		0.9	1.2	V
t <sub>rr</sub>	I <sub>SD</sub> =25A, di/dt=50A/μs		70		ns
C <sub>iss</sub>	V <sub>DS</sub> =10V		7800		pF
C <sub>oss</sub>	V <sub>GS</sub> =10V		1250		pF
Cr <sub>ss</sub>	f=1.0MHz		990		pF

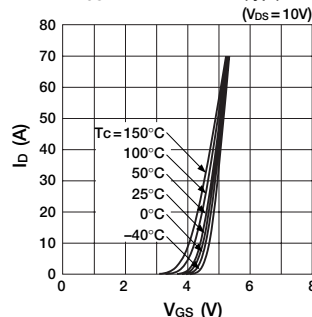
## External Dimensions TO-3P



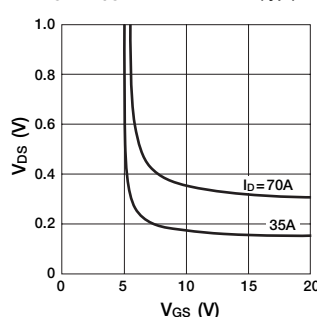
### I<sub>D</sub>—V<sub>DS</sub> Characteristics (typ.)



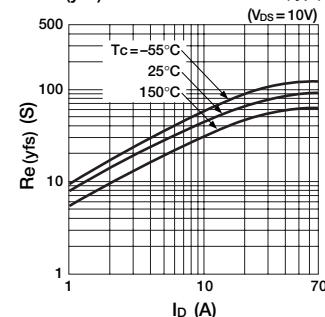
### I<sub>D</sub>—V<sub>GS</sub> Characteristics (typ.)



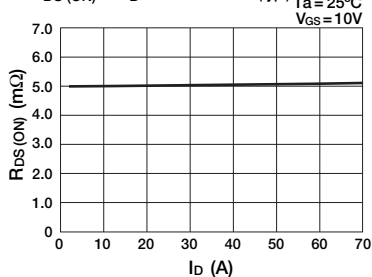
### V<sub>DS</sub>—V<sub>GS</sub> Characteristics (typ.)



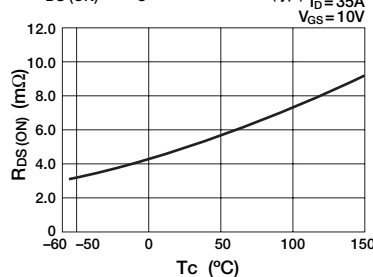
### Re (yfs) — I<sub>D</sub> Characteristics (typ.)



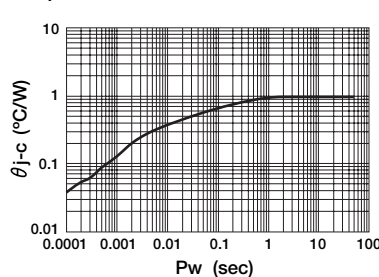
### R<sub>DS(ON)</sub> — I<sub>D</sub> Characteristics (typ.)



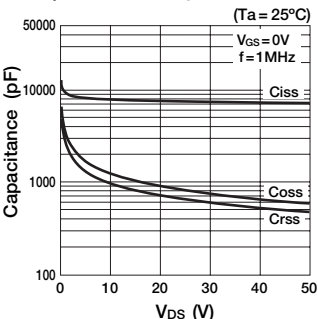
### R<sub>DS(ON)</sub> — T<sub>C</sub> Characteristics (typ.)



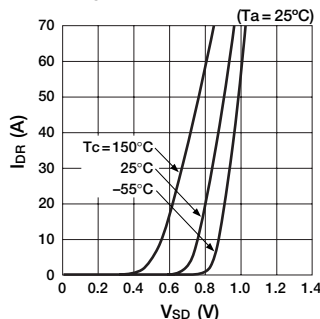
### θ<sub>J-C</sub> — P<sub>W</sub> Characteristics



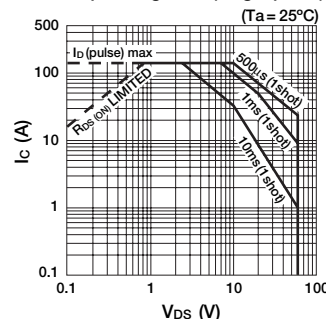
### Capacitance — V<sub>DS</sub> Characteristics



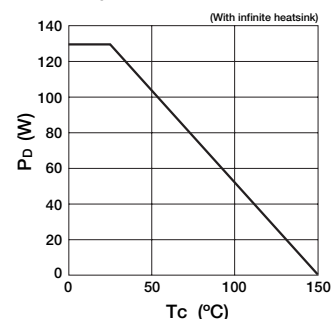
### I<sub>DR</sub> — V<sub>SD</sub> Characteristics



### Safe Operating Area (single pulse)



### P<sub>D</sub> — T<sub>C</sub> Characteristics



# MOS FET 2SK3724 (under development)

## Features

- ON resistance 0.005Ω max.
- Built-in G-S bidirectional Zener diode
- Trench MOS structure

## Applications

- Power steering motor
- Various motors
- Replaces mechanical relays

## Absolute Maximum Ratings (Ta=25°C)

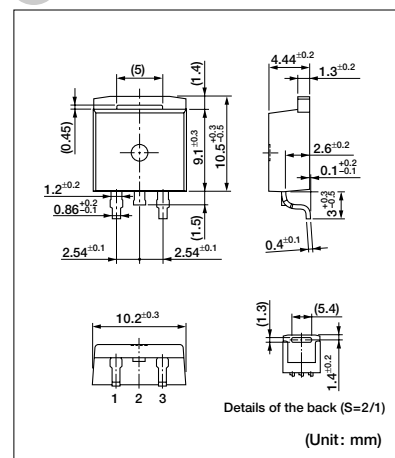
Symbol	Ratings	Unit
V <sub>DS</sub>	60	V
V <sub>GS</sub>	20	V
I <sub>D</sub>	80	A
I <sub>D</sub> (pulse)	160	A
P <sub>D</sub>	60	W
EAS	To be defined	mJ
T <sub>ch</sub> *	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* Contact your sales rep for the details of warranty at T<sub>ch</sub>=175°C

## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100μA	60			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V		±10		μA
I <sub>DSS</sub>	V <sub>DS</sub> = 60V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	1		2	V
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 40A		4.0	5.0	mΩ
V <sub>SD</sub>	I <sub>SD</sub> = 50A		0.9	1.5	V
t <sub>rr</sub>	I <sub>SD</sub> = 25A, di/dt = 50A/μs		To be defined		ns
C <sub>iss</sub>	V <sub>DS</sub> = 10V		10600		pF
C <sub>oss</sub>	V <sub>GS</sub> = 10V		1600		pF
Crss	f = 1.0MHz		1300		pF

## External Dimensions TO220S



# MOS FET 2SK3800

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	40	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±70	A
I <sub>D</sub> (pulse)*1	±140	A
P <sub>D</sub>	80 (Tc=25°C)	W
EAS*2	400	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-40 to +150	°C

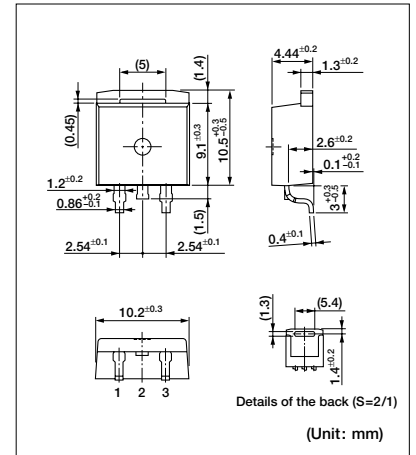
\* 1: P<sub>W</sub> ≤ 100 μs, duty cycle ≤ 1%

\* 2: V<sub>DD</sub> = 20V, L = 1mH, I<sub>L</sub> = 20A, unclamped, R<sub>θ</sub> = 50°C/W

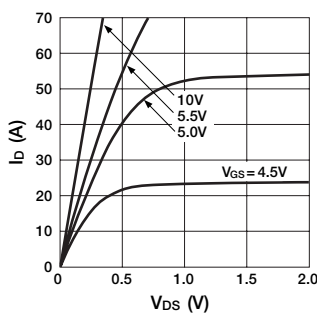
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100 μA, V <sub>GS</sub> = 0V	40			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±15V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	2.0	3.0	4.0	V
R <sub>e</sub> (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 35A	30	50		S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 35A		5.0	6.0	mΩ
C <sub>iss</sub>	V <sub>DS</sub> = 10V		5100		pF
C <sub>oss</sub>	f = 1.0MHz		1200		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		860		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 35A		100		ns
t <sub>r</sub>	V <sub>DD</sub> = 20V, R <sub>G</sub> = 22Ω		100		ns
t <sub>d</sub> (off)	R <sub>L</sub> = 0.57Ω, V <sub>GS</sub> = 10V		300		ns
t <sub>f</sub>			130		ns
V <sub>SD</sub>	I <sub>SD</sub> = 50A, V <sub>GS</sub> = 0V		0.9	1.2	V
t <sub>rr</sub>	I <sub>SD</sub> = 25A, di/dt = 50A/μs		110		ns
R <sub>th</sub> (ch-c)				1.56	°C/W
R <sub>th</sub> (ch-a)				62.5	°C/W

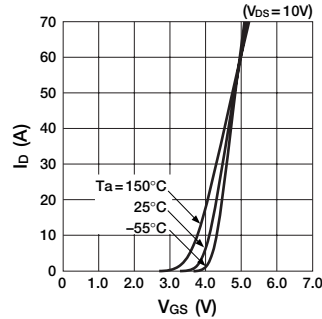
## External Dimensions TO220S



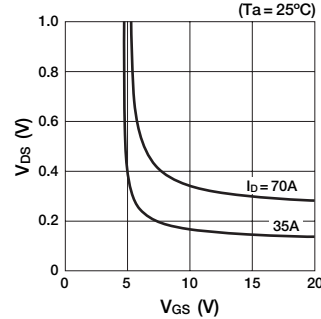
■ I<sub>D</sub> — V<sub>DS</sub> Characteristics (typ.)



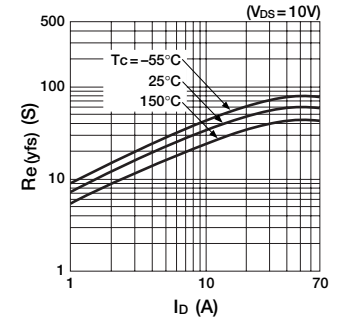
■ I<sub>D</sub> — V<sub>GS</sub> Characteristics (typ.)



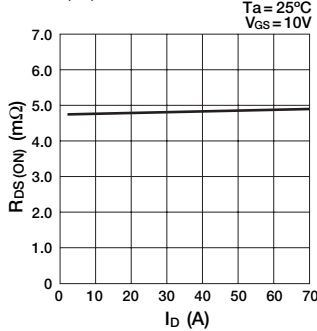
■ V<sub>DS</sub> — V<sub>GS</sub> Characteristics (typ.)



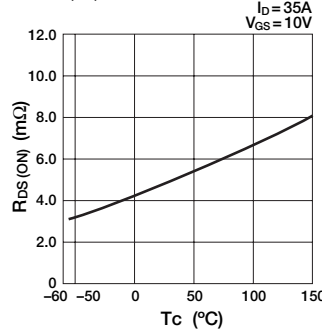
■ R<sub>e</sub> (yfs) — I<sub>D</sub> Characteristics (typ.)



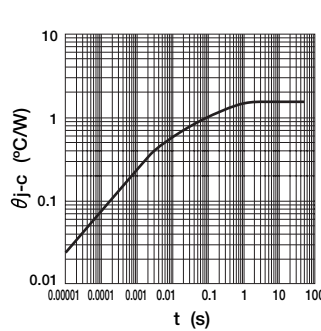
■ R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics (typ.)



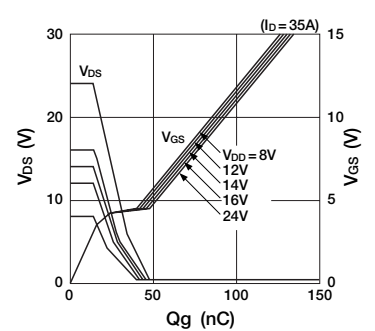
■ R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics (typ.)



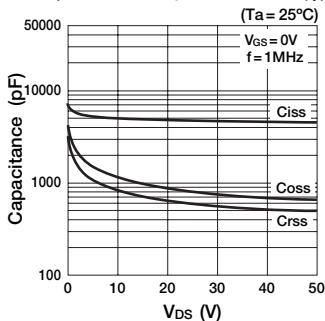
■ θ<sub>J-C</sub> — t Characteristics (Single pulse)



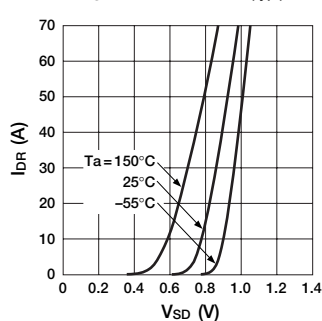
■ Dynamic I/O Characteristics (typ.)



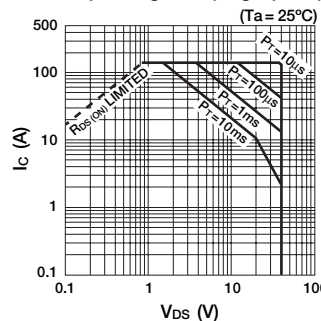
■ Capacitance — V<sub>DS</sub> Characteristics (typ.)



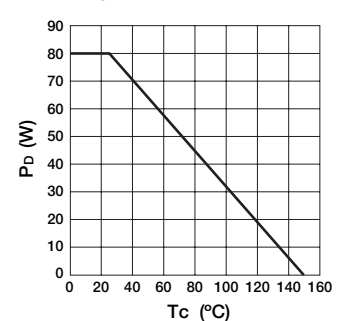
■ I<sub>DR</sub> — V<sub>SD</sub> Characteristics (typ.)



■ Safe Operating Area (single pulse)



■ P<sub>D</sub> — T<sub>C</sub> Characteristics



### Absolute Maximum Ratings (T<sub>a</sub>=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	40	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±70	A
I <sub>D</sub> (pulse) <sup>+1</sup>	±140	A
P <sub>D</sub>	100 (T <sub>C</sub> =25°C)	W
EAS <sup>+1</sup>	400	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-40 to +150	°C

\* 1:  $P_W \leq 100 \mu s$ , duty cycle  $\leq 1\%$

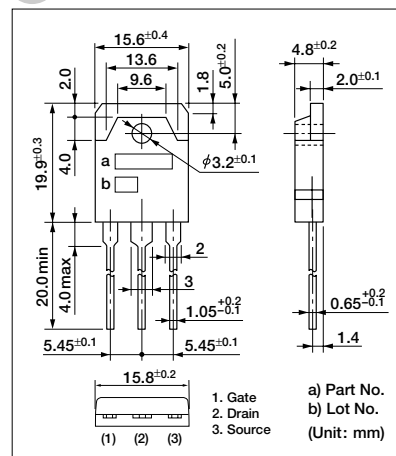
\* 2:  $V_{DD}=20V$ ,  $L=1mH$ ,  $I_L=20A$ , unclamped,  
 $R_G=50\Omega$

## Electrical Characteristics

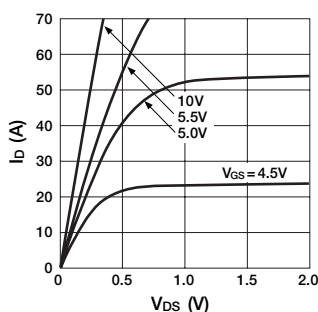
( $T_a=25^{\circ}\text{C}$ )

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V(BR) DSS	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	40			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±15V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	2.0	3.0	4.0	V
Re (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 35A	30	50		S
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 35A		5.0	6.0	mΩ
C <sub>iss</sub>	V <sub>DS</sub> = 10V f = 1.0MHz V <sub>GS</sub> = 0V		5100		pF
C <sub>oss</sub>			1200		pF
C <sub>rss</sub>			860		pF
t <sub>d (on)</sub>			100		ns
t <sub>r</sub>	I <sub>D</sub> = 35A V <sub>DD</sub> = 20V, R <sub>G</sub> = 22Ω R <sub>L</sub> = 0.57Ω, V <sub>GS</sub> = 10V		100		ns
t <sub>d (off)</sub>			300		ns
t <sub>f</sub>			130		ns
V <sub>SD</sub>	I <sub>SD</sub> = 50A, V <sub>GS</sub> = 0V		0.9	1.5	V
t <sub>rr</sub>	I <sub>SD</sub> = 25A, di/dt = 50A/μs		100		ns
R <sub>th (ch-c)</sub>				1.25	°C/W
R <sub>th (ch-a)</sub>				35.71	°C/W

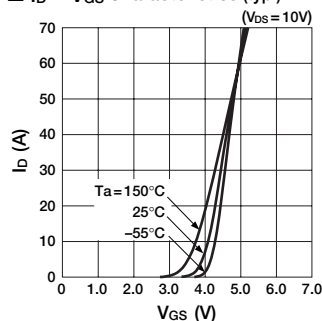
## External Dimensions TO-3P



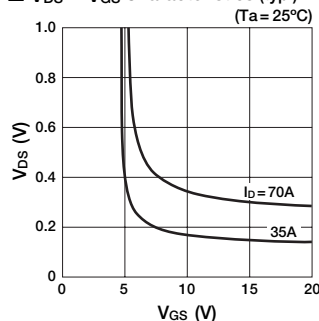
■  $I_D$ — $V_{DS}$  Characteristics (typ.)



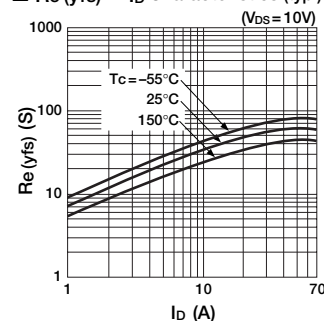
■  $I_D - V_{GS}$  Characteristics (typ.)



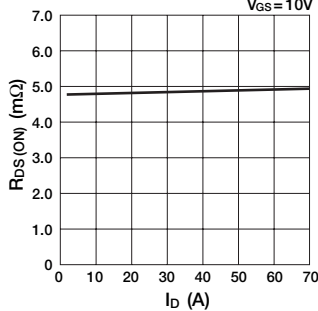
■  $V_{DS}-V_{GS}$  Characteristics (typ.)



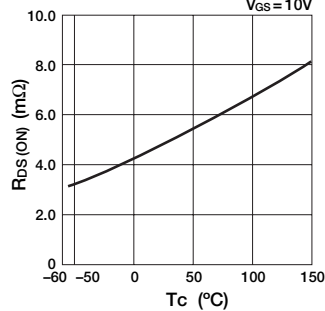
■ Re (v<sub>fs</sub>) — I<sub>D</sub> Characteristics (typ.)



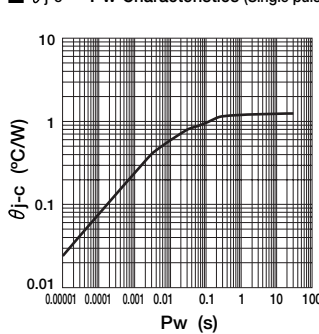
■  $R_{DS(ON)} - I_D$  Characteristics (typ.)  
 $T_a = 25^\circ\text{C}$   
 $V_{GS} = 10\text{V}$



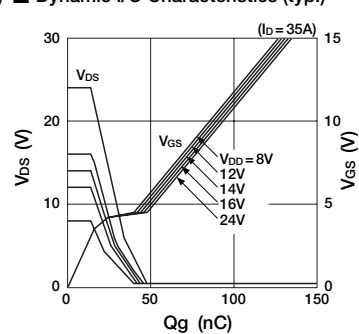
■ **R<sub>DS(ON)</sub> — T<sub>C</sub> Characteristics (typ.)**  
I<sub>D</sub> = 35A  
V<sub>GS</sub> = 10V



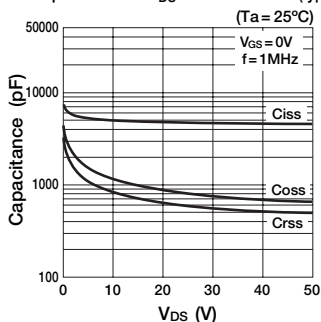
■  $\theta_{j-c}$  — Pw Characteristics (Single pulse)



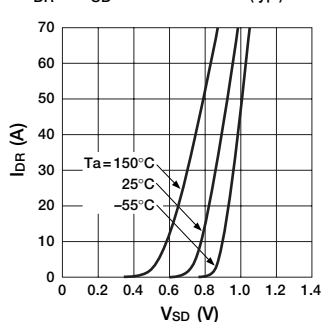
### ■ Dynamic I/O Characteristics (typ.)



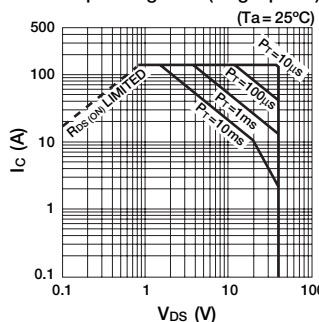
■ Capacitance— $V_{DS}$  Characteristics (typ.)



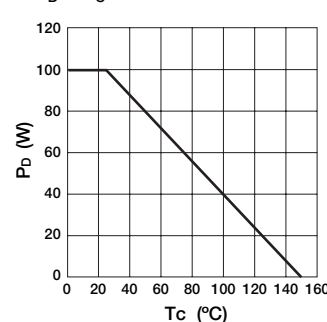
### ■ $I_{DR}-V_{SD}$ Characteristics (typ.)



■ Safe Operating Area (single pulse)



### ■ $P_D$ — $T_C$ Characteristics



# MOS FET 2SK3803 (under development)

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	40	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±85	A
I <sub>D (pulse)</sub> *1	±170	A
P <sub>D</sub>	100 (Tc=25°C)	W
EAS*2	730	mJ
T <sub>ch</sub>	150	°C
Tstg	-55 to +150	°C

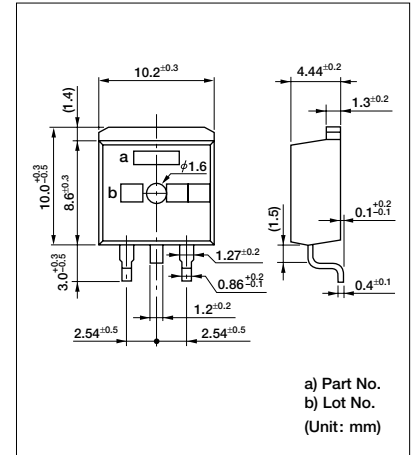
\* 1: P<sub>W</sub> ≤ 100 μs, duty cycle ≤ 1 %

\* 2: V<sub>DD</sub> = 20V, L = 1mH, I<sub>L</sub> = 20A, unclamped,  
R<sub>G</sub> = 50Ω

## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100 μA, V <sub>GS</sub> = 0V	40			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±15V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	2.0		4.0	V
R <sub>e (yfs)</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 42A	50			S
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 42A		2.1	3.0	mΩ
C <sub>iss</sub>	V <sub>DS</sub> = 10V		10500		pF
C <sub>oss</sub>	f = 1.0MHz		2400		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		1900		pF
t <sub>d (on)</sub>	I <sub>D</sub> = 42A		90		ns
t <sub>r</sub>	V <sub>DD</sub> = 20V, R <sub>G</sub> = 22Ω		230		ns
t <sub>d (off)</sub>	V <sub>GS</sub> = 10V		490		ns
t <sub>f</sub>			760		ns
V <sub>SD</sub>	I <sub>SD</sub> = 50A, V <sub>GS</sub> = 0V		0.85	1.2	V
t <sub>rr</sub>	I <sub>SD</sub> = 25A, di/dt = 50A/μs		90		ns

## External Dimensions TO220S



# MOS FET 2SK3851

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DS</sub>	60	V
V <sub>GS</sub>	±20	V
I <sub>D</sub>	±85	A
I <sub>D</sub> (pulse)*1	±280	A
P <sub>D</sub>	150	W
EAS*2	280	mJ
T <sub>ch</sub>	150	°C
Tstg	-55 to +150	°C

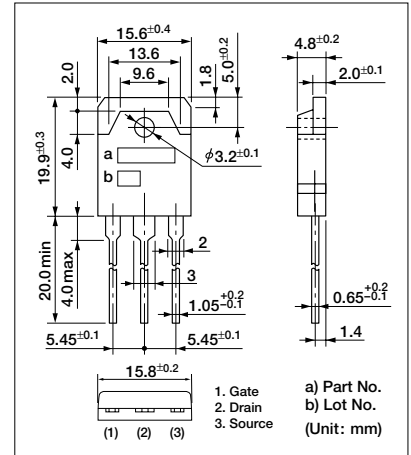
\*1: P<sub>W</sub> ≤ 100 μs, duty cycle ≤ 1%

\*2: V<sub>DD</sub> = 20V, L = 1mH, I<sub>L</sub> = 20A, unclamped

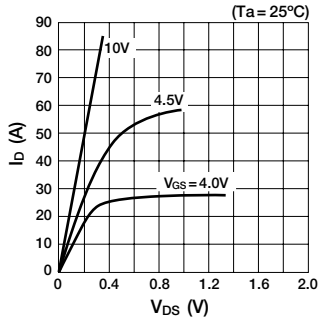
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR)</sub> DSS	I <sub>D</sub> = 100 μA, V <sub>GS</sub> = 0V	60			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 60V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	2.0	2.5	3.0	V
Re (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 42A	30			S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 42A		4.0	4.7	mΩ
Ciss	V <sub>DS</sub> = 10V		11500		pF
Coss	f = 1.0MHz		1500		pF
Crss	V <sub>GS</sub> = 0V		1100		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 42A		60		ns
t <sub>r</sub>	V <sub>DD</sub> = 16V		25		ns
t <sub>d</sub> (off)	R <sub>G</sub> = 22Ω		370		ns
t <sub>f</sub>	V <sub>GS</sub> = 10V		65		ns
V <sub>SD</sub>	I <sub>SD</sub> = 50A, V <sub>GS</sub> = 0V		0.87	1.5	V
t <sub>rr</sub>	I <sub>SD</sub> = 50A, di/dt = 100A/μs		70		ns

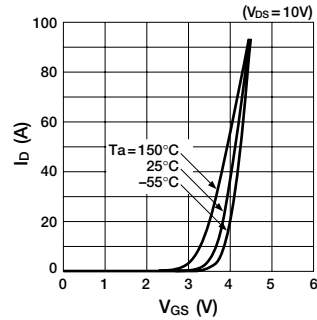
## External Dimensions TO-3P



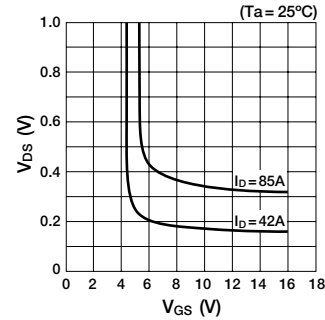
### I<sub>D</sub>—V<sub>DS</sub> Characteristics (Ta=25°C)



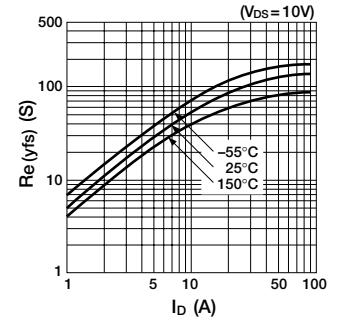
### I<sub>D</sub>—V<sub>GS</sub> Characteristics (V<sub>DS</sub> = 10V)



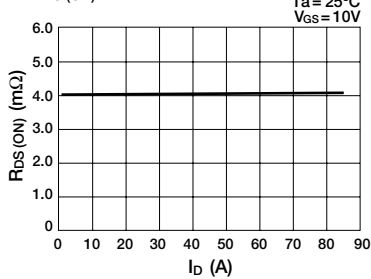
### V<sub>DS</sub>—V<sub>GS</sub> Characteristics (Ta=25°C)



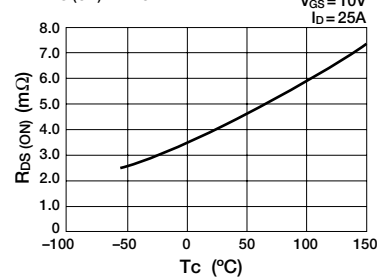
### Re (yfs) — I<sub>D</sub> Characteristics (V<sub>DS</sub> = 10V)



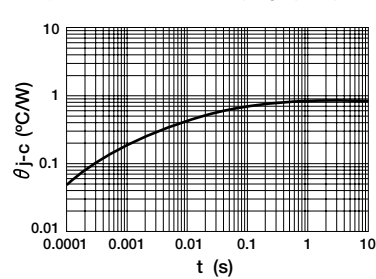
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics (Ta=25°C, V<sub>GS</sub> = 10V)



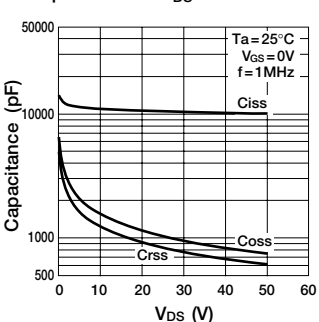
### R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics (V<sub>GS</sub> = 10V, I<sub>D</sub> = 25A)



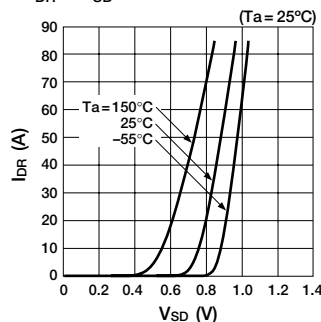
### θ<sub>J-C</sub> — t Characteristics (Single pulse)



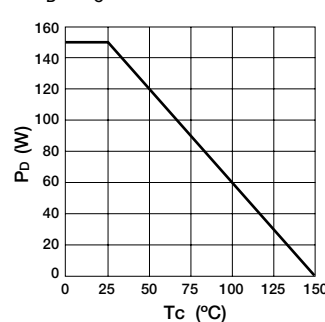
### Capacitance—V<sub>DS</sub> Characteristics (Ta=25°C, V<sub>GS</sub> = 0V, f = 1MHz)



### I<sub>DR</sub>—V<sub>SD</sub> Characteristics (Ta=25°C)



### P<sub>D</sub>—T<sub>C</sub> Characteristics



# MOS FET FKV460S

## Absolute Maximum Ratings (Ta=25°C)

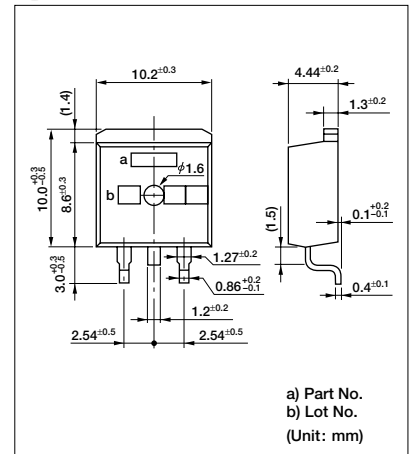
Symbol	Ratings	Unit
V <sub>DSS</sub>	40	V
V <sub>GSS</sub>	+20, -10	V
I <sub>D</sub>	±60	A
I <sub>D (pulse)*</sub>	±180	A
P <sub>D</sub>	60 (Tc=25°C)	W
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* P<sub>W</sub> ≤ 100μs, duty ≤ 1%

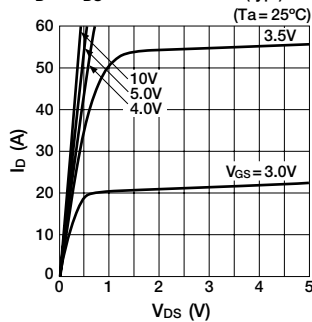
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	40			V
I <sub>GSS</sub>	V <sub>GS</sub> = +20V			+10	μA
	V <sub>GS</sub> = -10V			-5	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.3		2.3	V
R <sub>e (yfs)</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 25A	20.0			S
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 25A		7	9	mΩ
C <sub>iss</sub>	V <sub>DS</sub> = 10V		2800		pF
C <sub>oss</sub>	f = 1.0MHz		1400		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		600		pF
t <sub>d (on)</sub>	I <sub>D</sub> = 25A		20		ns
t <sub>r</sub>	V <sub>DD</sub> = 12V		600		ns
t <sub>d (off)</sub>	R <sub>L</sub> = 0.48Ω		250		ns
t <sub>f</sub>	V <sub>GS</sub> = 10V		100		ns
V <sub>SD</sub>	I <sub>SD</sub> = 50A, V <sub>GS</sub> = 0V	1.0	1.5		V

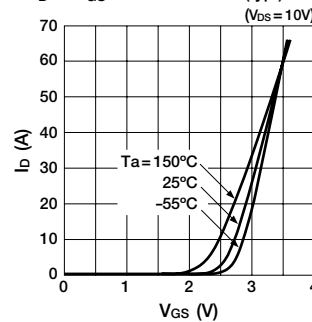
## External Dimensions TO220S



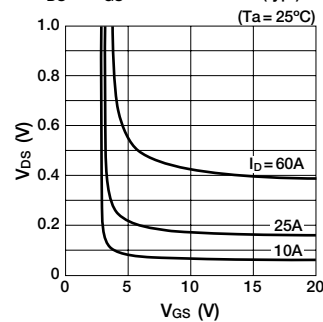
### I<sub>D</sub> — V<sub>DS</sub> Characteristics (typ.)



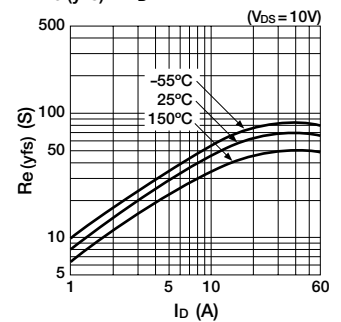
### I<sub>D</sub> — V<sub>GS</sub> Characteristics (typ.)



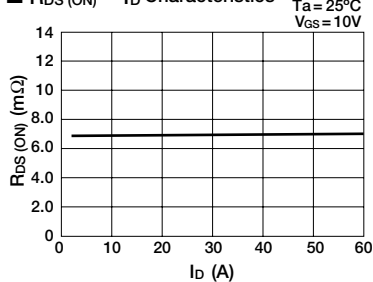
### V<sub>DS</sub> — V<sub>GS</sub> Characteristics (typ.)



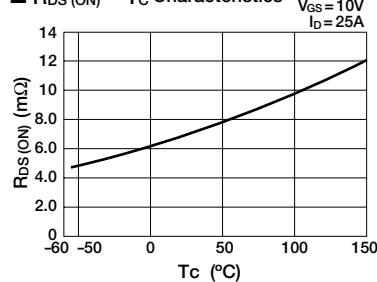
### R<sub>e (yfs)</sub> — I<sub>D</sub> Characteristics



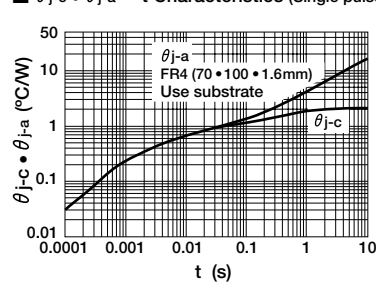
### R<sub>DS (ON)</sub> — I<sub>D</sub> Characteristics



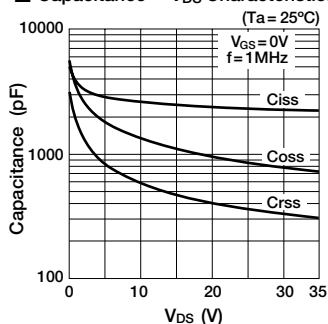
### R<sub>DS (ON)</sub> — T<sub>C</sub> Characteristics



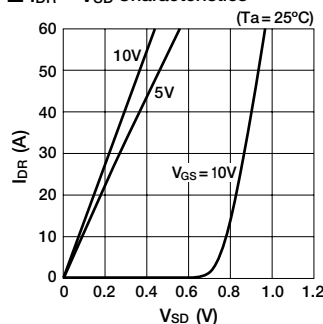
### θ<sub>J-C</sub> • θ<sub>J-A</sub> — t Characteristics (Single pulse)



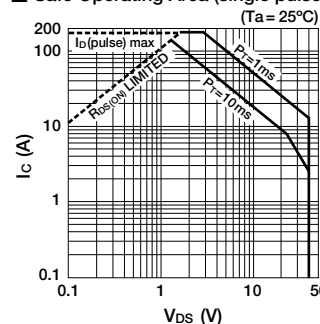
### Capacitance — V<sub>DS</sub> Characteristics



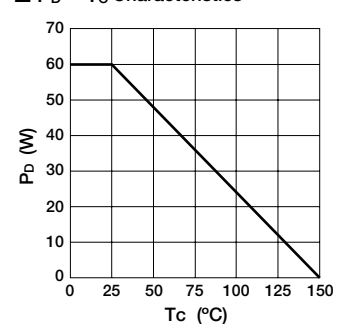
### I<sub>DR</sub> — V<sub>SD</sub> Characteristics



### Safe Operating Area (single pulse)



### P<sub>D</sub> — T<sub>C</sub> Characteristics



# MOS FET FKV660S

### Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	60	V
V <sub>GSS</sub>	+20, -10	V
I <sub>D</sub>	±60	A
I <sub>D(pulse)</sub> <sup>**</sup>	±180	A
P <sub>D</sub>	60 (T <sub>c</sub> =25°C)	W
T <sub>ch</sub>	150	°C
T <sub>sta</sub>	-40 to +150	°C

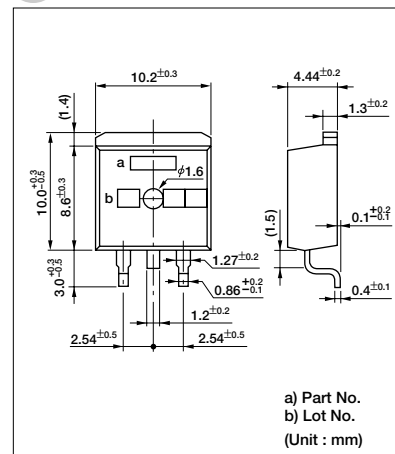
※ $P_W \leq 100\mu s$ , duty  $\leq 1\%$

## Electrical Characteristics

(Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
$V_{(BR)DSS}$	$I_D=100\mu A, V_{GS}=0V$	60			V
$I_{GSS}$	$V_{GS}=+20V$			+10	$\mu A$
	$V_{GS}=-10V$			-5	
$I_{DSS}$	$V_{DS}=60V, V_{GS}=0V$			100	$\mu A$
$V_{TH}$	$V_{DS}=10V, I_D=250\mu A$	1.0		2.5	V
$R_e(f_{fs})$	$V_{DS}=10V, I_D=25A$	20			S
$R_{DS(ON)}$	$V_{GS}=10V, I_D=25A$		11	14	$m\Omega$
$C_{iss}$	$V_{DS}=10V$		2500		pF
$f=1.0MHz$			900		pF
$C_{rss}$	$V_{GS}=0V$		150		pF
$t_{d(on)}$	$I_D=25A$		50		ns
$t_r$	$V_{DD}=12V$		400		ns
$t_{d(off)}$	$R_L=0.48\Omega$		400		ns
$t_f$	$V_{GS}=10V$		300		ns
$V_{SD}$	$I_{SN}=50A, V_{GS}=0V$		1.0	1.5	V

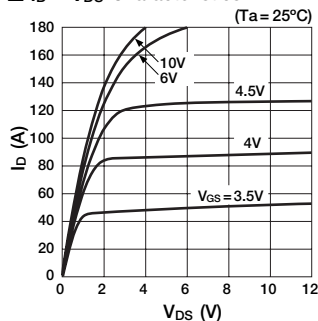
## External Dimensions TO220S



a) Part No.  
b) Lot No.  
(Unit : mm)

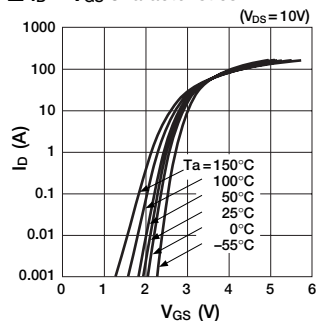
### ■ $I_D$ — $V_{DS}$ Characteristics

( $T_a = 25^\circ\text{C}$ )



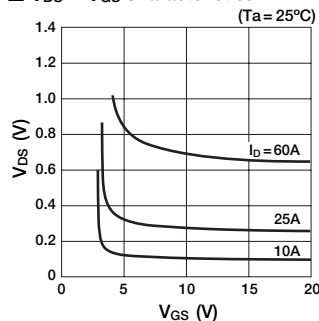
### ■ $I_D$ — $V_{GS}$ Characteristics

( $V_{DS} = 10V$ )

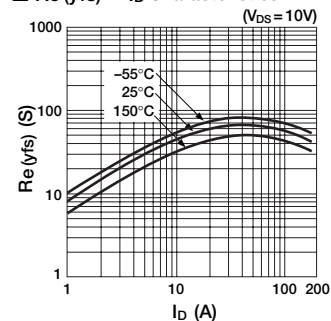


### ■ $V_{DS}-V_{GS}$ Characteristics

(Ta = 25°C)

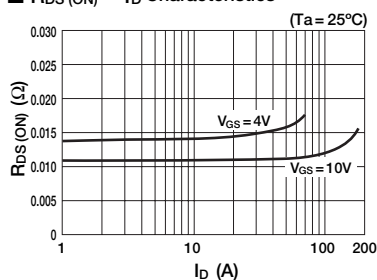


### ■ Re (yfs) — I<sub>D</sub> Characteristics

 $(V_{DS} = 10V)$ 

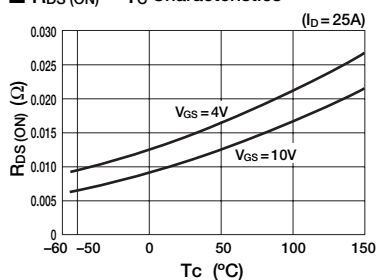
### ■ $R_{DS(ON)}$ — $I_D$ Characteristics

( $T_a = 25^\circ\text{C}$ )



### ■ $R_{DS(ON)}$ — $T_C$ Characteristics

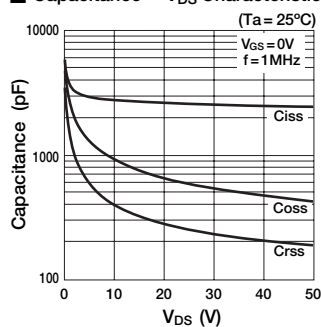
( $I_D = 25A$ )



### ■ Capacitance— $V_{DS}$ Characteristics

( $T_a = 25^\circ\text{C}$ )

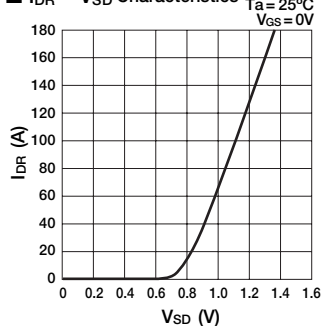
$V_{GS} = 0V$   
 $f = 1MHz$



### ■ $I_{DB}-V_{SD}$ Characteristics

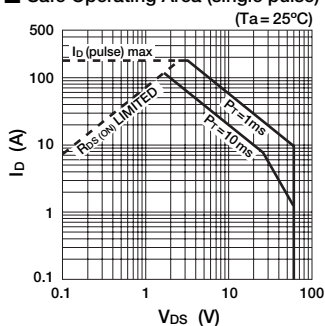
Ta = 25°C  
V<sub>GS</sub> = 0V

VGS = 0V		
	/	



■ Safe Operating Area (single pulse)

( $T_a = 25^\circ\text{C}$ )



## Surface-mount MOS FET Array SDK06

### Absolute Maximum Ratings (T<sub>a</sub>=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	52±5	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±3	A
I <sub>D</sub> (pulse) *1	±6	A
P <sub>T</sub>	3 (T <sub>C</sub> =25°C, 4 circuits operate)	W
E <sub>AS</sub> *2	40	mJ
T <sub>ch</sub>	150	°C
T <sub>sta</sub>	-55 to +150	°C

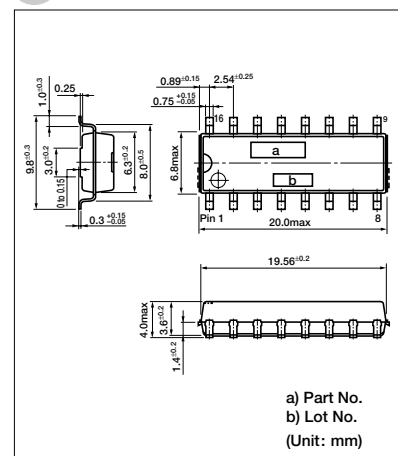
\*1  $P_W \leq 100\mu s$ , duty  $\leq 1\%$

\*2  $V_{DD}=12V$ ,  $L=10mH$ , unclamped,  $R_G=10\Omega$

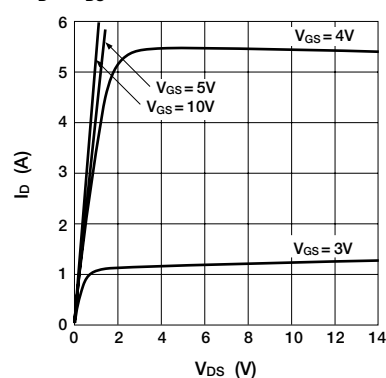
## Electrical Characteristics

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V(BR) DSS	I <sub>D</sub> = 1mA, V <sub>GS</sub> = 0V	47	52	57	V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±1.0	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.0	1.8	2.5	V
Re (yrs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1.0A	1.0			S
R <sub>DS (ON)</sub>	V <sub>GS</sub> = 10V, I <sub>D</sub> = 1.0A		0.2	0.25	Ω
	V <sub>GS</sub> = 4V, I <sub>D</sub> = 1.0A		0.25	0.3	Ω
Ciss	V <sub>DS</sub> = 10V		200		pF
Coss	f = 1.0MHz		120		pF
Crss	V <sub>GS</sub> = 0V		20		pF
t <sub>d (on)</sub>	I <sub>D</sub> = 1A		2.0		μs
t <sub>r</sub>	V <sub>DD</sub> = 12V R <sub>L</sub> = 12Ω		7.4		μs
t <sub>d (off)</sub>	V <sub>GS</sub> = 5V		3.3		μs
t <sub>f</sub>	R <sub>G1</sub> = 50Ω, R <sub>G2</sub> = 10kΩ		4.2		μs
V <sub>SD</sub>	I <sub>SD</sub> = 1A, V <sub>GS</sub> = 0V		1.0	1.5	V

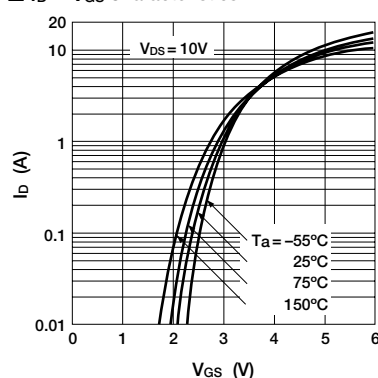
## External Dimensions SMD-16A



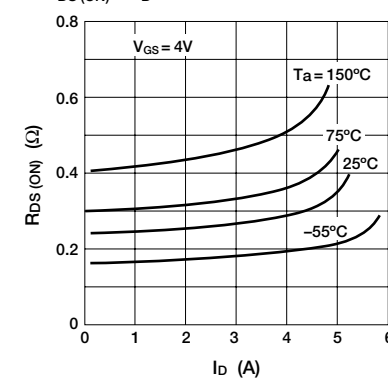
### ■ $I_D$ — $V_{DS}$ Characteristics



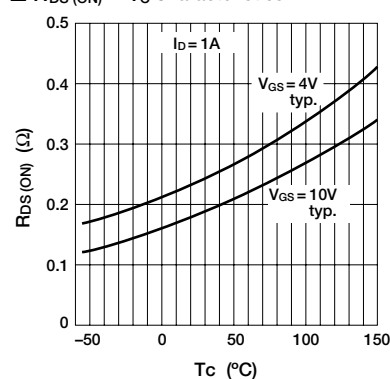
### ■ $I_D$ — $V_{GS}$ Characteristics



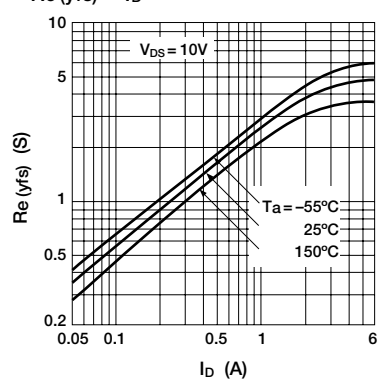
### ■ $R_{DS(ON)}-I_D$ Characteristics



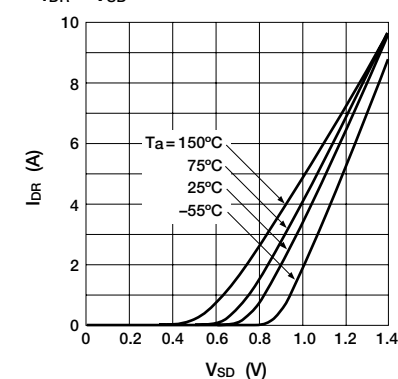
### ■ $R_{DS(ON)}$ — $T_C$ Characteristics



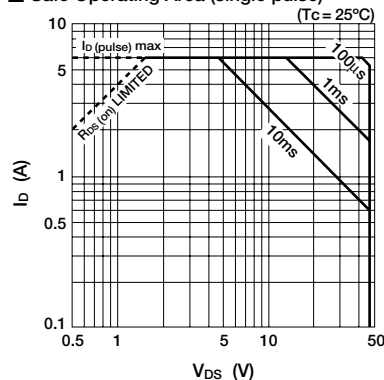
### ■ Re (vfs) — $I_D$ Characteristics



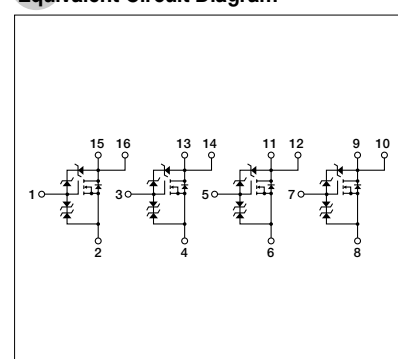
### ■ $I_{DB}-V_{SD}$ Characteristics



■ Safe Operating Area (single pulse)



### Equivalent Circuit Diagram



# Surface-mount MOS FET Array SDK08

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	50	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±4.5	A
I <sub>D</sub> (pulse)*1	±9	A
P <sub>T</sub>	4 (Tc=25°C, 4 circuits operate)	W
E <sub>AS</sub> *2	80	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

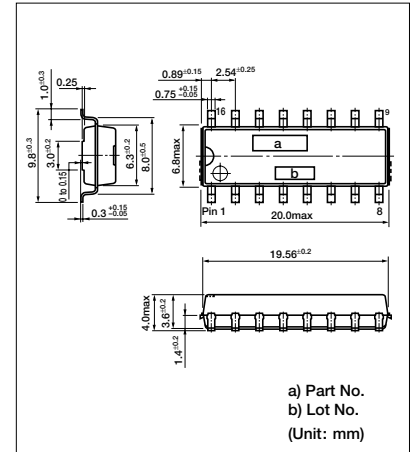
\*1 P<sub>W</sub> ≤ 100μs, duty ≤ 1%

\*2 V<sub>DD</sub> = 12V, L = 10mH, unclamped, R<sub>G</sub> = 50Ω

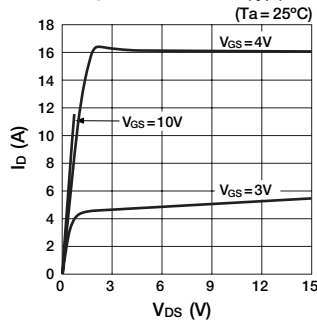
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR)</sub> DSS	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	50			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±100	nA
I <sub>DSS</sub>	V <sub>DS</sub> = 50V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	1.3	1.8	2.3	V
Re (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 4.0A	5.0	9.0	13.0	S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 4.0A		0.07	0.08	Ω
	V <sub>GS</sub> = 4V, I <sub>D</sub> = 4.0A		0.09	0.1	Ω
C <sub>iss</sub>	V <sub>DS</sub> = 10V		700		pF
C <sub>oss</sub>	f = 1.0MHz		300		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		90		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 4A		50		ns
t <sub>r</sub>	V <sub>DD</sub> = 12V		80		ns
	R <sub>L</sub> = 3Ω				
t <sub>d</sub> (off)	V <sub>GS</sub> = 5V		60		ns
t <sub>f</sub>	R <sub>G</sub> = 50Ω		40		ns
V <sub>SD</sub>	I <sub>SD</sub> = 6A, V <sub>GS</sub> = 0V	1.0	1.5		V

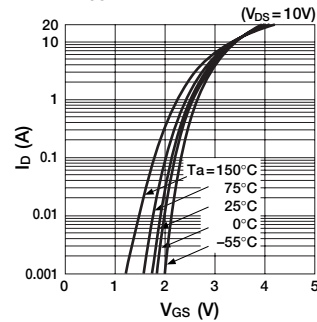
## External Dimensions SMD-16A



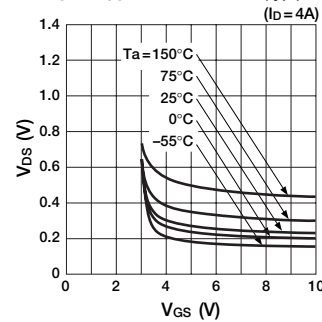
### I<sub>D</sub> — V<sub>DS</sub> Characteristics (typ.)



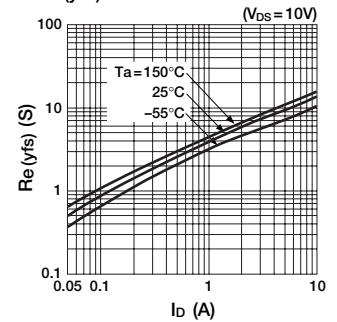
### I<sub>D</sub> — V<sub>GS</sub> Characteristics



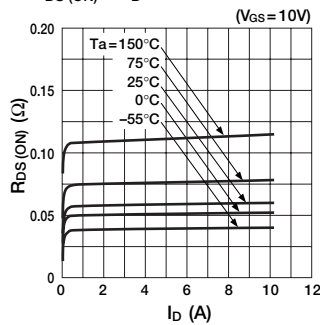
### V<sub>DS</sub> — V<sub>GS</sub> Characteristics (typ.)



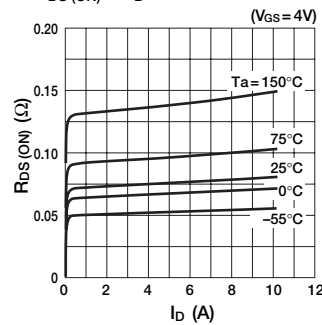
### Re (yfs) — I<sub>D</sub> Characteristics



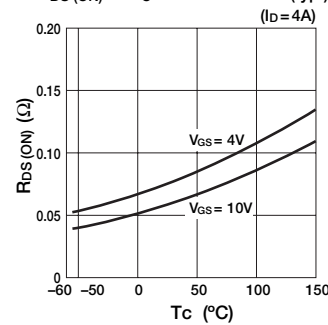
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics



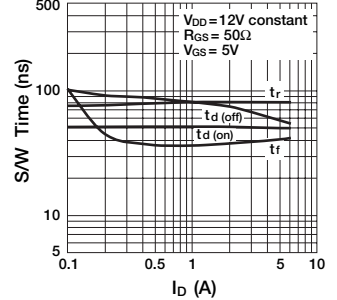
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics



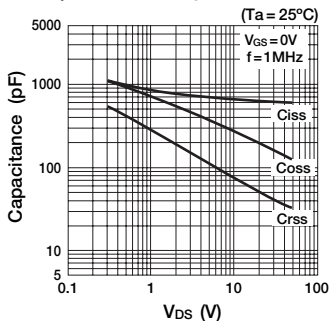
### R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics (typ.)



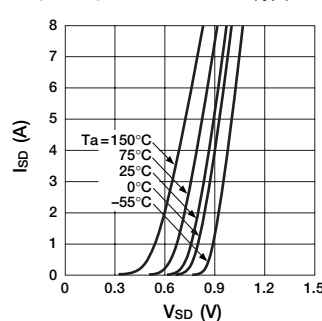
### S/W Time — I<sub>D</sub> Characteristics (single pulse) (Ta=25°C)



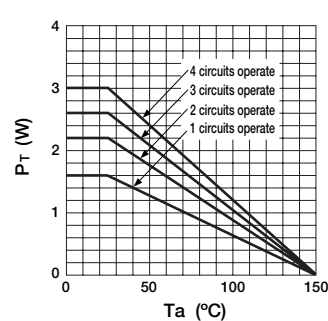
### Capacitance — V<sub>DS</sub> Characteristics



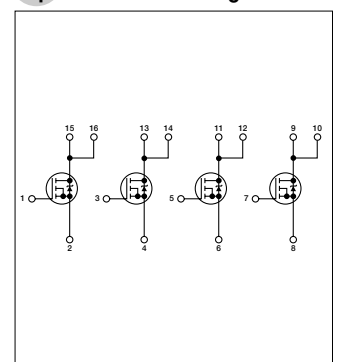
### I<sub>SD</sub> — V<sub>SD</sub> Characteristics (typ.)



### P<sub>T</sub> — Ta Characteristics



## Equivalent Circuit Diagram



# Surface-mount MOS FET Array SDK09

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	120	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±6	A
I <sub>D</sub> (pulse)*1	±10	A
P <sub>T</sub>	3 (Tc=25°C, 4 circuits operate)	W
E <sub>AS</sub> *2	80	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

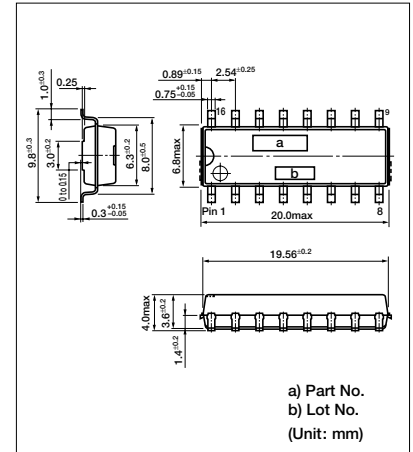
\*1 P<sub>W</sub> ≤ 100μs, duty ≤ 1%

\*2 V<sub>DD</sub> = 12V, L = 10mH, unclamped, R<sub>G</sub> = 50Ω

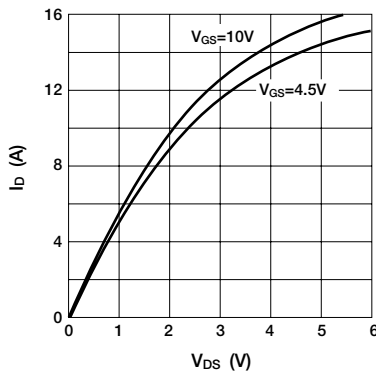
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR)</sub> DSS	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	120			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±5	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 120V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.0		2.0	V
Re (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 4A	5.0			S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 4A		0.15	0.2	Ω
	V <sub>GS</sub> = 4V, I <sub>D</sub> = 4A		0.2	0.25	
Ciss	V <sub>DS</sub> = 10V		400		pF
Coss	f = 1.0MHz		130		pF
Crss	V <sub>GS</sub> = 0V		30		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 4A		100		ns
t <sub>r</sub>	V <sub>DD</sub> = 12V		300		ns
t <sub>d</sub> (off)	R <sub>L</sub> = 3Ω		250		ns
t <sub>f</sub>	V <sub>GS</sub> = 5V		200		ns
	R <sub>G</sub> = 50Ω				
V <sub>SD</sub>	I <sub>SD</sub> = 6A, V <sub>GS</sub> = 0V	1.0	1.5		V

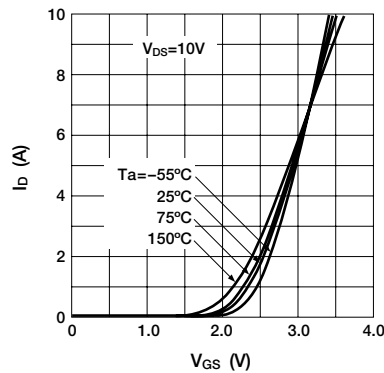
## External Dimensions SMD-16A



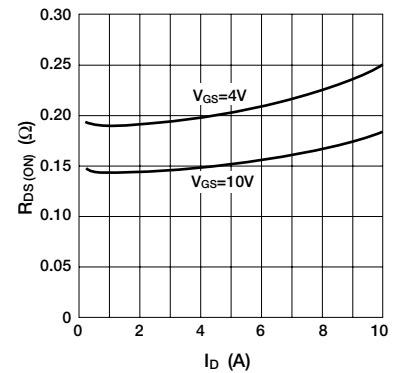
### I<sub>D</sub> — V<sub>DS</sub> Characteristics



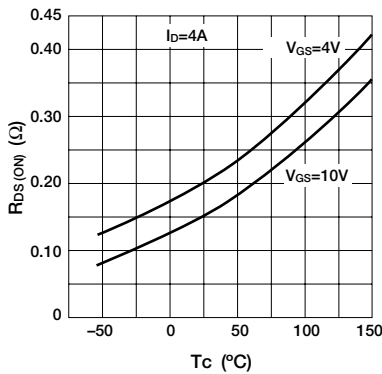
### I<sub>D</sub> — V<sub>GS</sub> Characteristics



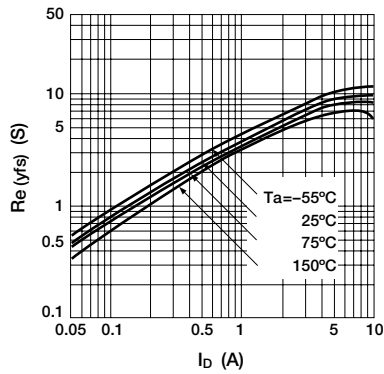
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics



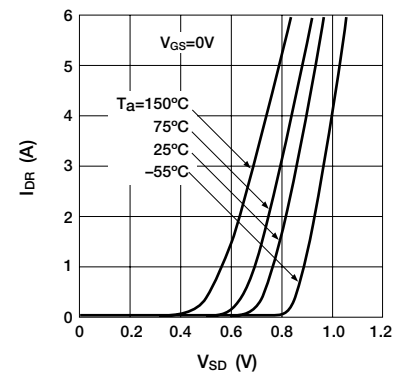
### R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics



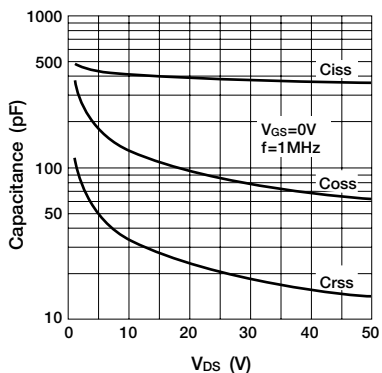
### Re (yfs) — I<sub>D</sub> Characteristics



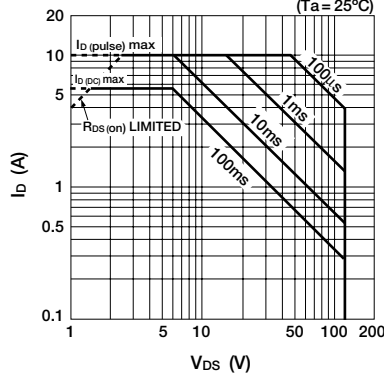
### I<sub>DR</sub> — V<sub>SD</sub> Characteristics



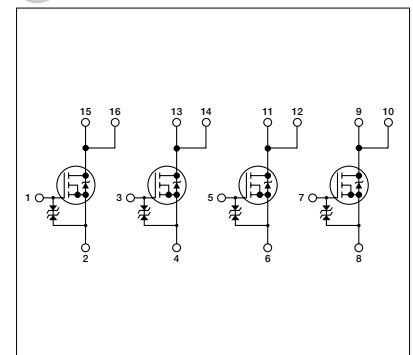
### Capacitance — V<sub>DS</sub> Characteristics



### Safe Operating Area (single pulse)



## Equivalent Circuit Diagram



# MOS FET Array SLA5027

### Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	60	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±12	A
I <sub>D</sub> (pulse)*1	±48	A
P <sub>T</sub>	5 (Ta=25°C, 4 circuits operate)	W
	60 (Tc=25°C, 4 circuits operate)	W
E <sub>AS</sub> *2	250	mJ
θ <sub>J-C</sub>	2.08	°C/W
V <sub>ISO</sub>	(Fin to lead terminal) AC1000	Vrms
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\*1  $P_W \leq 250\mu s$ ,  $duty \leq 1\%$

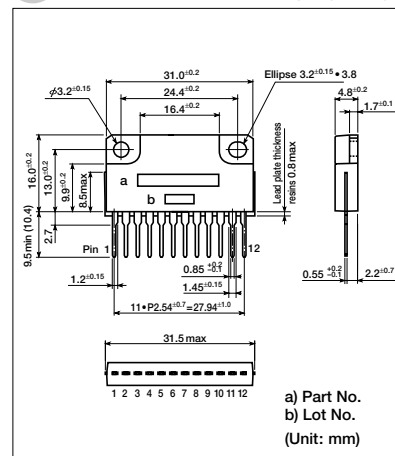
\*2  $V_{DD}=30V$ ,  $L=10mH$ , unclamped,  $R_G=50\Omega$

## Electrical Characteristics

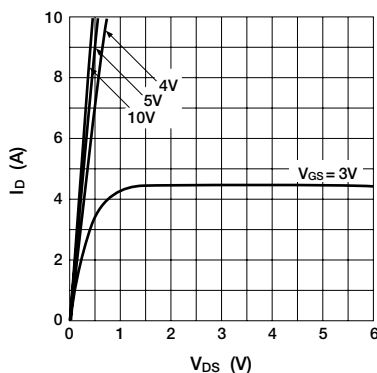
(Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
$V_{(BR)} DSS$	$I_D = 100\mu A, V_{GS} = 0V$	60			V
$I_{GSS}$	$V_{GS} = \pm 20V$			$\pm 100$	$\mu A$
$I_{DSS}$	$V_{DS} = 60V, V_{GS} = 0V$			100	$\mu A$
$V_{TH}$	$V_{DS} = 10V, I_D = 1mA$	1.0	1.5	2.0	V
$R_e (yfs)$	$V_{DS} = 10V, I_D = 8A$	6.0	12.0		S
$R_{DS (ON)}$	$V_{GS} = 4V, I_D = 8A$		0.07	0.08	$\Omega$
$C_{iss}$	$V_{DS} = 10V$		1100		pF
$C_{oss}$	$f = 1.0MHz$		500		pF
$C_{rss}$	$V_{GS} = 0V$		170		pF
$t_d (on)$	$I_D = 8A$		50		ns
$t_r$	$V_{DD} \approx 30V$ $R_L = 3.75\Omega$		250		ns
$t_d (off)$	$V_{GS} = 5V$		250		ns
$t_f$	$R_G = 50\Omega$		180		ns
$V_{SD}$	$I_{SD} = 10A, V_{GS} = 0V$	1.0	1.5		V

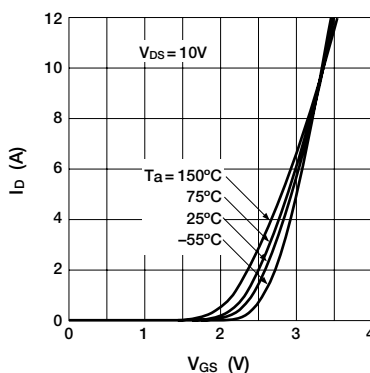
### External Dimensions SLA 12pin (LF800)



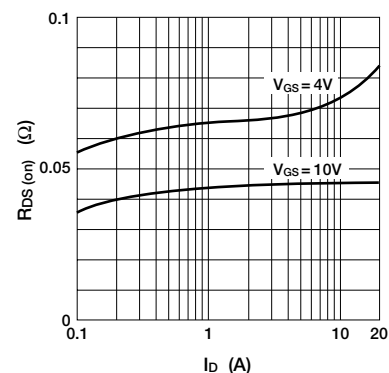
### ■ $I_D$ — $V_{DS}$ Characteristics



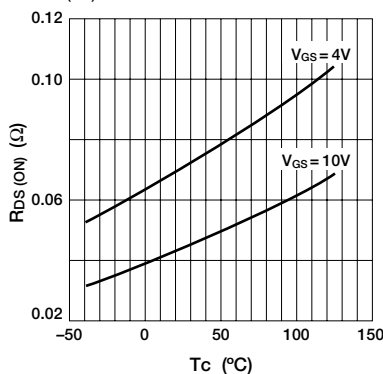
### ■ $I_D$ — $V_{GS}$ Characteristics



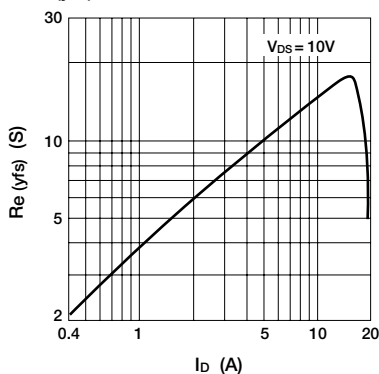
### ■ $R_{DS(ON)}$ — $I_D$ Characteristics



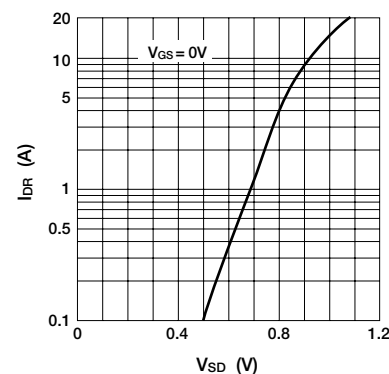
### ■ R<sub>DS(ON)</sub>—T<sub>C</sub> Characteristics



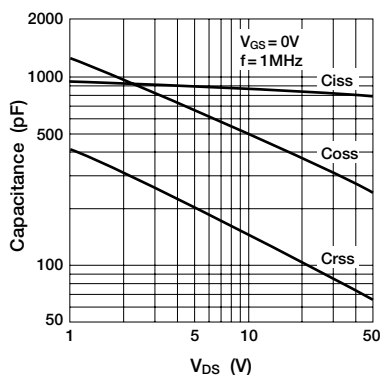
### ■ Re (yfs)—I<sub>D</sub> Characteristics



### ■ $I_{DR}-V_{SD}$ Characteristics

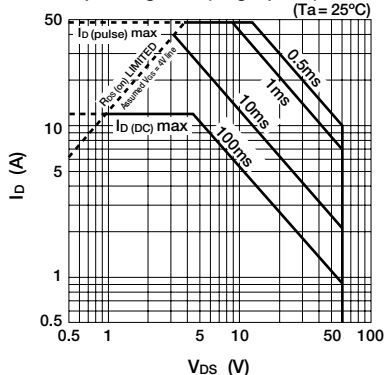


### ■ Capacitance— $V_{DS}$ Characteristics

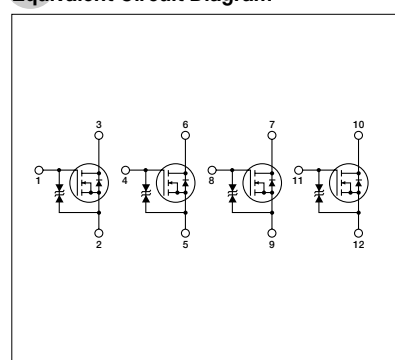


■ Safe Operating Area (single pulse)

( $T_a = 25^\circ\text{C}$ )



### Equivalent Circuit Diagram



# MOS FET Array SLA5098 (under development)

## Absolute Maximum Ratings (Ta=25°C)

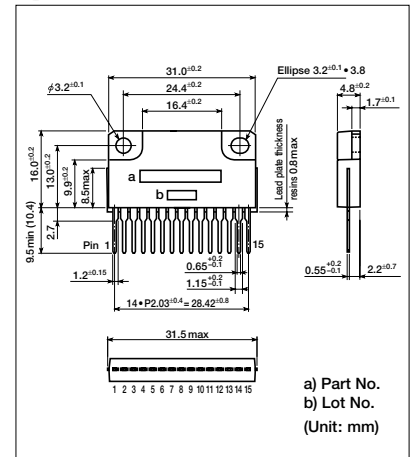
Symbol	Ratings	Unit
V <sub>DSS</sub>	40	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	20	A
I <sub>D</sub> (pulse)*	40	A
EAS	To be defined	mJ
IAS	To be defined	A
P <sub>T</sub>	5 (Without heatsink, Ta=25°C, All circuits operate)	W
	90 (Ta=25°C, All circuits operate)	W
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

\* P<sub>W</sub> ≤ 100μs, duty ≤ 1%

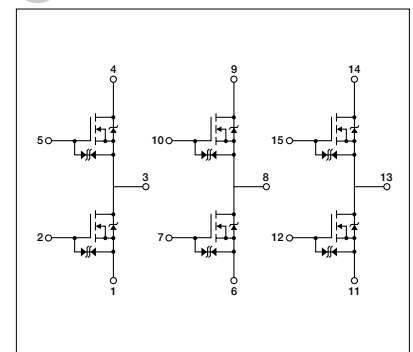
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	40			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±15V			±10	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.5		2.5	V
R <sub>e</sub> (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 10A	10			S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A			17	mΩ
C <sub>iss</sub>	V <sub>DS</sub> = 10V		1450		pF
C <sub>oss</sub>	f = 1.0MHz		420		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		260		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 10A V <sub>DD</sub> = 14V R <sub>L</sub> = 1.4Ω		40		ns
t <sub>r</sub>	V <sub>GS</sub> = 10V		40		ns
t <sub>d</sub> (off)	R <sub>G</sub> = 50Ω		200		ns
t <sub>f</sub>			100		ns
V <sub>SD</sub>	I <sub>SD</sub> = 10A, V <sub>GS</sub> = 0V		0.85	1.2	V
t <sub>rr</sub>	I <sub>SD</sub> = 10A, V <sub>GS</sub> = 0V di/dt = 100A/μs		45		ns

## External Dimensions STA4 (LF412)



## Equivalent Circuit Diagram



# MOS FET Array SMA5113

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DS</sub>	450	V
V <sub>GS</sub>	±30	V
I <sub>D</sub>	±7	A
I <sub>D</sub> (pulse)*1	±28	A
P <sub>T</sub>	4 (Ta=25°C, All circuits operate, No Fin) 35 (Tc=25°C, All circuits operate, ∞ Fin)	W
E <sub>AS</sub> *2	130	mJ
I <sub>AS</sub>	7	A
θ <sub>J-a</sub>	31.2 (Junction - Ambient, Ta=25°C, All circuits operate)	°C/W
θ <sub>J-c</sub>	3.57 (Junction - Case, Ta=25°C, All circuits operate)	°C/W
T <sub>ch</sub>	150	°C
Tstg	-55 to +150	°C

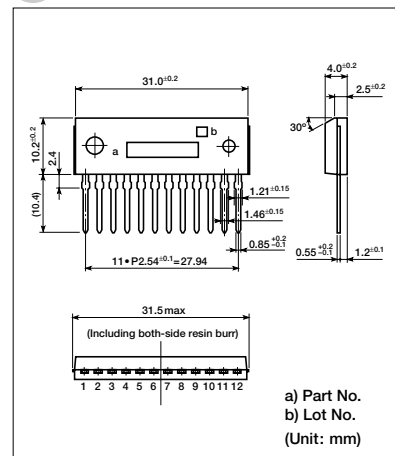
\*1 P<sub>W</sub> ≤ 100μs, duty ≤ 1%

\*2 V<sub>DD</sub> = 30V, L = 5mH, I<sub>L</sub> = 7A, unclamped, R<sub>G</sub> = 50Ω

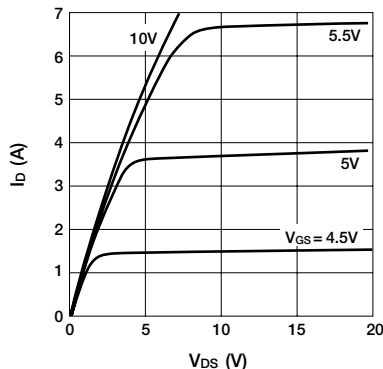
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR)</sub> DSS	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	450			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±30V			±100	nA
I <sub>DSS</sub>	V <sub>DS</sub> = 450V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1mA	2.0		4.0	V
R <sub>e</sub> (yfs)	V <sub>DS</sub> = 20V, I <sub>D</sub> = 3.5A	3.5	5.0		S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 3.5A		0.84	1.1	Ω
C <sub>iss</sub>	V <sub>DS</sub> = 10V f = 1.0MHz		720		pF
C <sub>oss</sub>	V <sub>GS</sub> = 0V		150		pF
Cr <sub>ss</sub>			65		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 3.5A V <sub>DD</sub> ÷ 200V		25		ns
t <sub>r</sub>	R <sub>L</sub> = 57Ω		40		ns
t <sub>d</sub> (off)	V <sub>GS</sub> = 10V		70		ns
t <sub>f</sub>	R <sub>G</sub> = 50Ω		50		ns
V <sub>SD</sub>	I <sub>SD</sub> = 7A, V <sub>GS</sub> = 0V		1.0	1.5	V

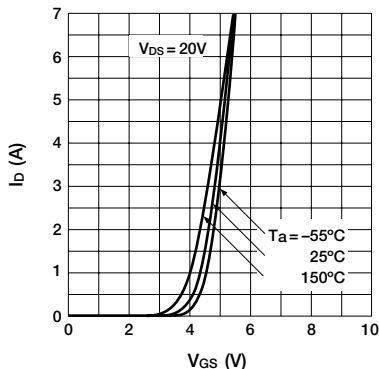
## External Dimensions SMA (LF1000)



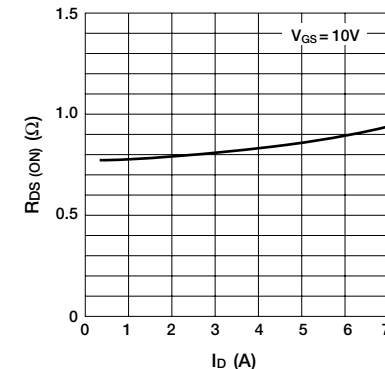
### I<sub>D</sub>—V<sub>DS</sub> Characteristics



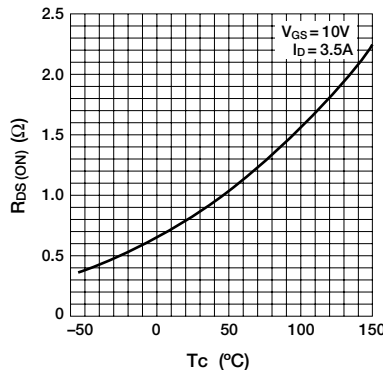
### I<sub>D</sub>—V<sub>GS</sub> Characteristics



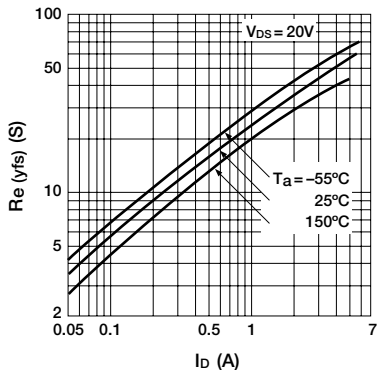
### R<sub>DS</sub> (ON)—I<sub>D</sub> Characteristics



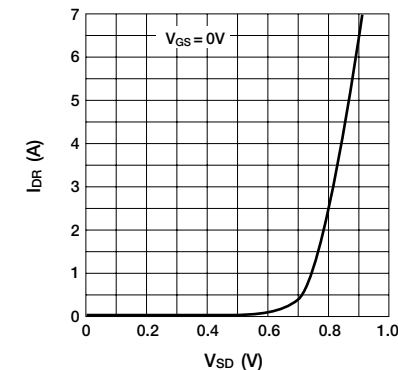
### R<sub>DS</sub> (ON)—T<sub>C</sub> Characteristics



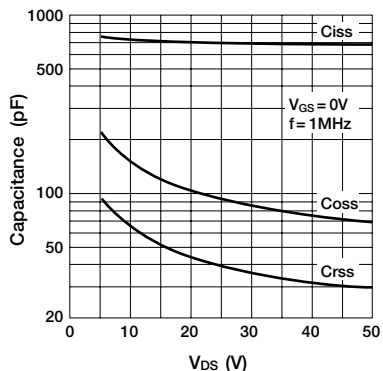
### R<sub>e</sub> (yfs)—I<sub>D</sub> Characteristics



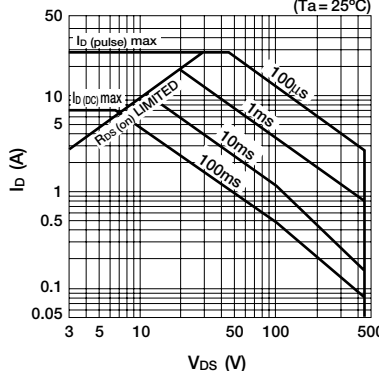
### I<sub>DR</sub>—V<sub>SD</sub> Characteristics



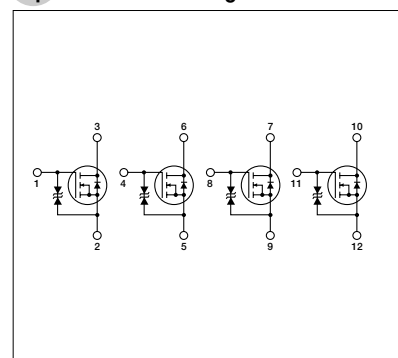
### Capacitance—V<sub>DS</sub> Characteristics



### Safe Operating Area (single pulse)



## Equivalent Circuit Diagram



# MOS FET Array STA508A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	120	V
V <sub>GS</sub>	±20	V
I <sub>D</sub>	±6	A
I <sub>D</sub> (pulse)*1	±10	A
P <sub>T</sub>	4 (Ta = 25°C)	W
	20 (Tc = 25°C)	W
E <sub>AS</sub> *2	80	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

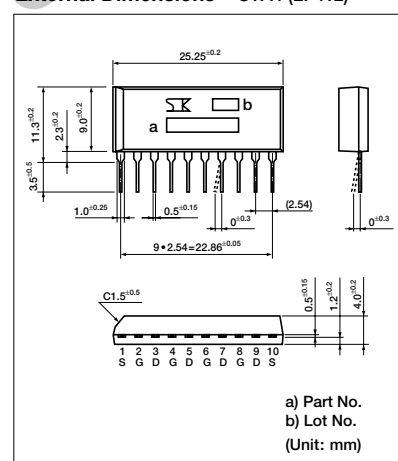
\*1 P<sub>W</sub> ≤ 100μs, duty ≤ 1%

\*2 V<sub>DD</sub> = 12V, L = 10mH, unclamped, R<sub>G</sub> = 50Ω

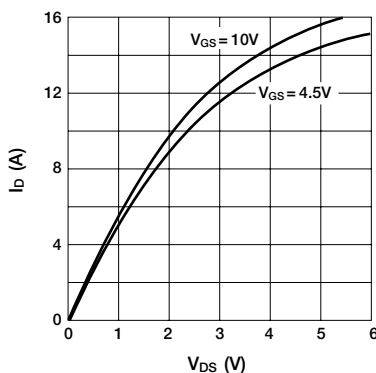
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR) DSS</sub>	I <sub>D</sub> = 100μA, V <sub>GS</sub> = 0V	120			V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±5	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 120V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.0		2.0	V
R <sub>e</sub> (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 4.0A	5.0			S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 4.0A		0.15	0.2	Ω
	V <sub>GS</sub> = 4V, I <sub>D</sub> = 4.0A		0.2	0.25	Ω
C <sub>iss</sub>	V <sub>DS</sub> = 10V		400		pF
C <sub>oss</sub>	f = 1.0MHz		130		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		30		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 4A		100		ns
t <sub>r</sub>	V <sub>DD</sub> = 12V		300		ns
	R <sub>L</sub> = 3Ω				
t <sub>d</sub> (off)	V <sub>GS</sub> = 5V		250		ns
t <sub>f</sub>	R <sub>G</sub> = 50Ω		200		ns
V <sub>SD</sub>	I <sub>SD</sub> = 6A, V <sub>GS</sub> = 0V	1.0	1.5		V

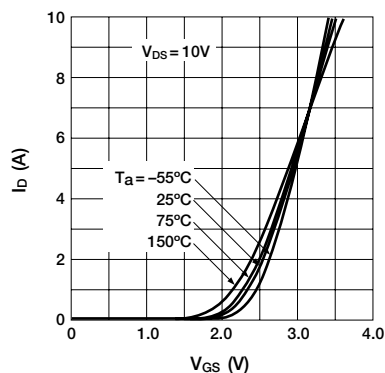
## External Dimensions STA4 (LF412)



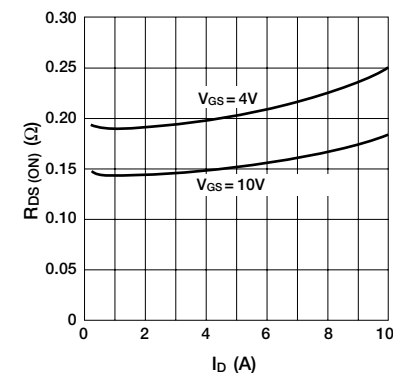
### I<sub>D</sub> — V<sub>DS</sub> Characteristics



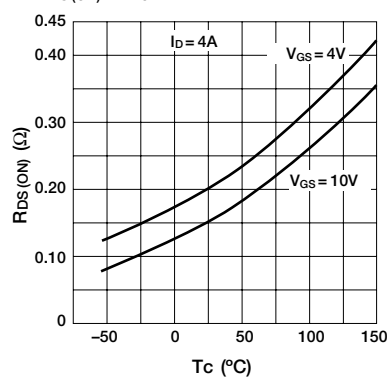
### I<sub>D</sub> — V<sub>GS</sub> Characteristics



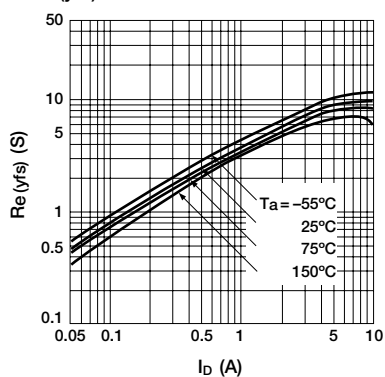
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics



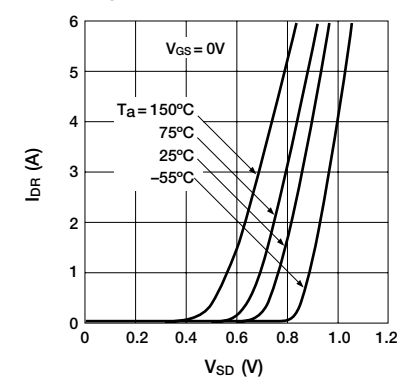
### R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics



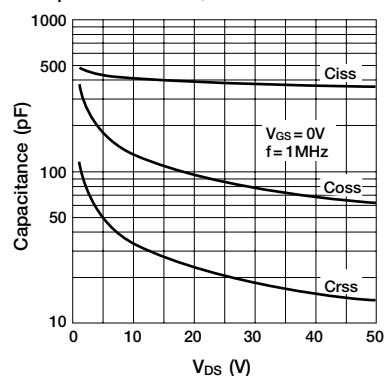
### R<sub>e</sub> (yfs) — I<sub>D</sub> Characteristics



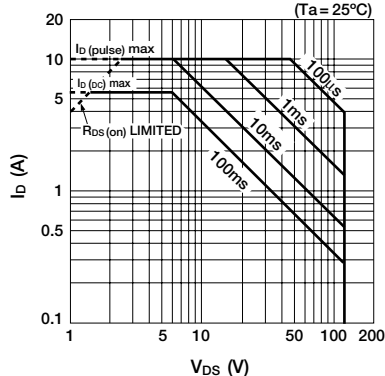
### I<sub>DR</sub> — V<sub>SD</sub> Characteristics



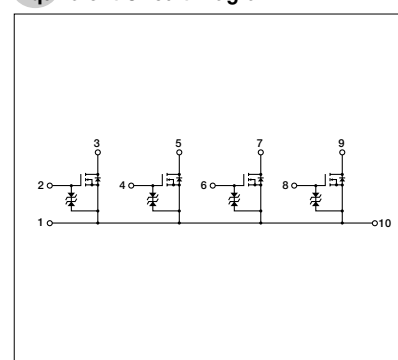
### Capacitance — V<sub>DS</sub> Characteristics



### Safe Operating Area (single pulse)



## Equivalent Circuit Diagram



# MOS FET Array STA509A

## Absolute Maximum Ratings (Ta=25°C)

Symbol	Ratings	Unit
V <sub>DSS</sub>	52±5	V
V <sub>GSS</sub>	±20	V
I <sub>D</sub>	±3	A
I <sub>D</sub> (pulse) *1	±6	A
P <sub>T</sub>	4 (Ta = 25°C)	W
	20 (Tc = 25°C)	W
E <sub>AS</sub> *2	40	mJ
T <sub>ch</sub>	150	°C
T <sub>stg</sub>	-55 to +150	°C

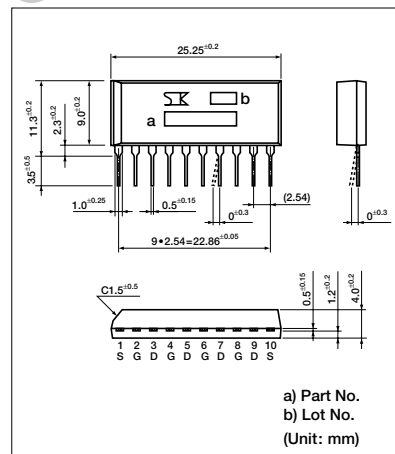
\*1 P<sub>W</sub> ≤ 100μs, duty ≤ 1%

\*2 V<sub>DD</sub> = 12V, L = 10mH, unclamped, R<sub>G</sub> = 10Ω

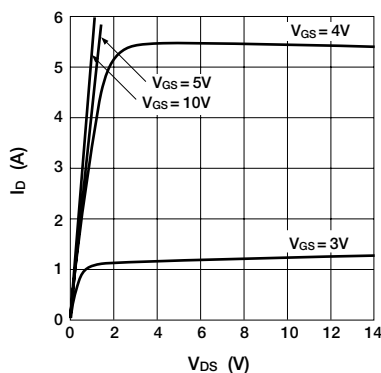
## Electrical Characteristics (Ta=25°C)

Symbol	Test Conditions	Ratings			Unit
		min	typ	max	
V <sub>(BR)</sub> DSS	I <sub>D</sub> = 1mA, V <sub>GS</sub> = 0V	47	52	57	V
I <sub>GSS</sub>	V <sub>GS</sub> = ±20V			±1.0	μA
I <sub>DSS</sub>	V <sub>DS</sub> = 40V, V <sub>GS</sub> = 0V			100	μA
V <sub>TH</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 250μA	1.0		2.5	V
R <sub>e</sub> (yfs)	V <sub>DS</sub> = 10V, I <sub>D</sub> = 1.0A	1.0			S
R <sub>DS</sub> (ON)	V <sub>GS</sub> = 10V, I <sub>D</sub> = 1.0A		0.2	0.25	Ω
	V <sub>GS</sub> = 4V, I <sub>D</sub> = 1.0A		0.25	0.3	Ω
C <sub>iss</sub>	V <sub>DS</sub> = 10V		200		pF
C <sub>oss</sub>	f = 1.0MHz		120		pF
C <sub>rss</sub>	V <sub>GS</sub> = 0V		20		pF
t <sub>d</sub> (on)	I <sub>D</sub> = 1A V <sub>DD</sub> = 12V		2.0		μs
t <sub>r</sub>	R <sub>L</sub> = 12Ω		7.4		μs
t <sub>d</sub> (off)	V <sub>GS</sub> = 5V		3.3		μs
t <sub>f</sub>	R <sub>G1</sub> = 50Ω, R <sub>G2</sub> = 10Ω		4.2		μs
V <sub>SD</sub>	I <sub>SD</sub> = 6A, V <sub>GS</sub> = 0V	1.0	1.5		V

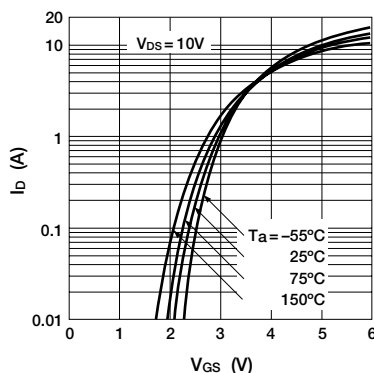
## External Dimensions STA



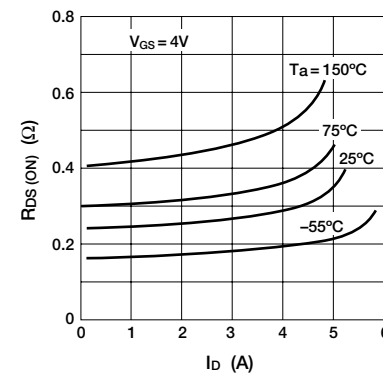
### I<sub>D</sub> — V<sub>DS</sub> Characteristics



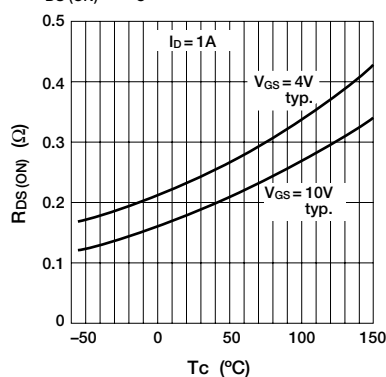
### I<sub>D</sub> — V<sub>GS</sub> Characteristics



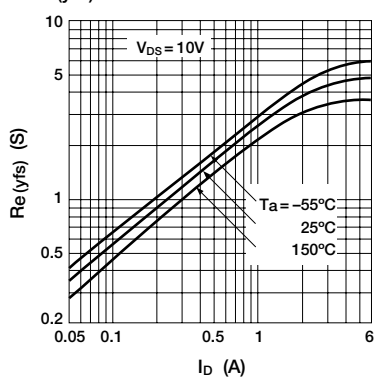
### R<sub>DS</sub> (ON) — I<sub>D</sub> Characteristics



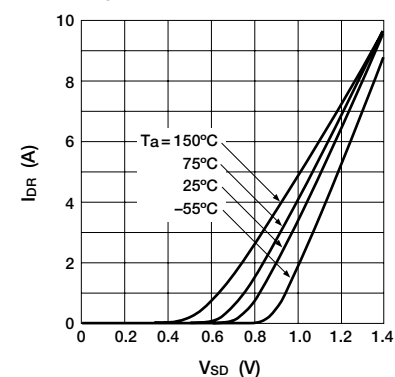
### R<sub>DS</sub> (ON) — T<sub>C</sub> Characteristics



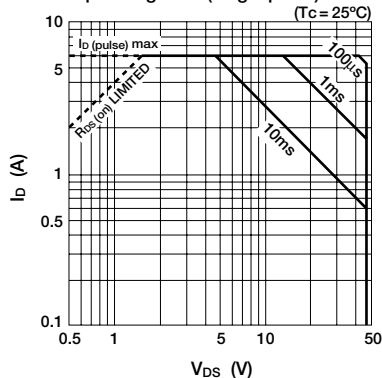
### R<sub>e</sub> (yfs) — I<sub>D</sub> Characteristics



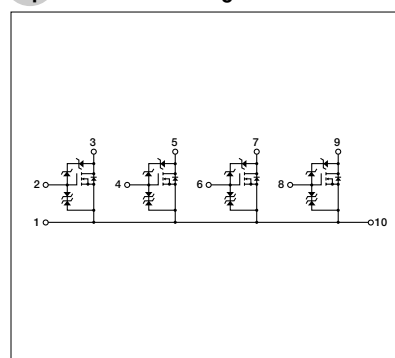
### I<sub>DR</sub> — V<sub>SD</sub> Characteristics



### Safe Operating Area (single pulse)



## Equivalent Circuit Diagram



# Thyristor with built-in reverse diode for HID lamp ignition TFC561D

## Features

- Repetitive peak off-state voltage:  $V_{DRM}=600V$
- Repetitive peak surge on-state current:  $I_{TRM}=430A$
- Critical rate-of-rise of on-state current:  $di/dt=1200A/\mu s$
- Gate trigger current:  $I_{GT}=20mA$  max
- With built-in reverse diode

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Repetitive peak off-state voltage	$V_{DRM}$	600	V	$T_J=-40$ to $+125^{\circ}C$ , $R_{GK}=1k\Omega$
Repetitive surge peak on-state current	$I_{TRM}$	430	A	$V_D \leq 430V$ , 100kcycle, * $W_p=1.3\mu s$ , $T_a=125^{\circ}C$
Critical rate-of-rise of on-state current	$di/dt$	1200	A/ $\mu s$	*
Peak forward gate current	$I_{FGM}$	2.0	A	$f \geq 50Hz$ , duty $\leq 10\%$
Peak gate power loss	$P_{GM}$	5.0	W	$f \geq 50Hz$ , duty $\leq 10\%$
Average gate power loss	$P_G(AV)$	0.5	W	
Peak reverse gate voltage	$V_{RGM}$	5	V	$f \geq 50Hz$
Diode repetitive peak surge forward current	$I_{FRM}$	240	A	$V_D \leq 430V$ , 100kcycle, * $W_p=1.3\mu s$ , $T_a=125^{\circ}C$
Junction temperature	$T_J$	$-40$ to $+125$	$^{\circ}C$	
Storage temperature	$T_{stg}$	$-40$ to $+125$	$^{\circ}C$	

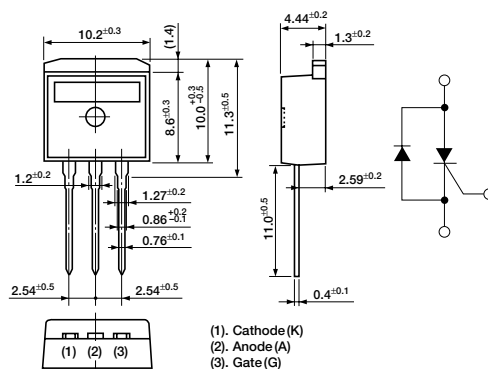
\* The surge current for  $T=10ms$  /cycle shall be applied 50 cycles successively, and an interval time shall follow to cool down the junction temperature of the device to  $125^{\circ}C$ . This process shall be repeated up to 100K cycles.

## Electrical Characteristics

( $T_J=25^{\circ}C$ )

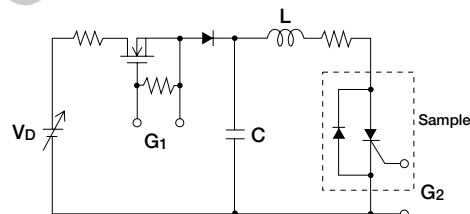
Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
On-state voltage	$V_{TM}$			1.4	V	$I_T=10A$
Gate trigger voltage	$V_{GT}$			1.5	V	$V_D=6V$ , $R_L=10\Omega$
Gate trigger current	$I_{GT}$			20	mA	$V_D=6V$ , $R_L=10\Omega$
Gate non-trigger voltage	$V_{GD}$	0.1			V	$V_D=480V$ , $T_J=125^{\circ}C$
Holding current	$I_H$	2	10.0		mA	$R_{G-K}=1k\Omega$ , $T_J=25^{\circ}C$
Off-state current (1)	$I_{DRM}(1)$			100	$\mu A$	$V_D=V_{DRM}$ , $R_{G-K}=1k\Omega$ , $T_J=25^{\circ}C$
Off-state current (2)	$I_{DRM}(2)$			1	mA	$V_D=V_{DRM}$ , $R_{G-K}=1k\Omega$ , $T_J=125^{\circ}C$
Thermal resistance	$R_{th}$			4.0	$^{\circ}C/W$	Junction to case
Diode forward voltage	$V_F$			1.4	V	$I_F=10A$

## External Dimensions (unit: mm)



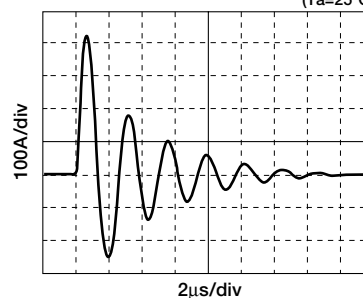
Weight: Approx. 1.5g

## Measurement circuit



## Current waveform (1cycle)

( $T_a=25^{\circ}C$ )



# Thyristor with built-in reverse diode for HID lamp ignition TFC562D

## Features

- Repetitive peak off-state voltage:  $V_{DRM}=600V$
- Repetitive peak surge on-state current:  $I_{TRM}=600A$
- Critical rate-of-rise of on-state current:  $di/dt=1600A/\mu s$
- Gate trigger current:  $I_{GT}=20mA$  max
- With built-in reverse diode

## Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
Repetitive peak off-state voltage	$V_{DRM}$	600	V	$T_J = -40$ to $+125^\circ C$ , $R_{GK} = 1k\Omega$
Repetitive surge peak on-state current	$I_{TRM}$	600	A	$T_a = 100^\circ C$ , $V_D \leq 430V$ , $W_p = 1.05\mu s$ , $I_G = 70mA$ , $di/dt = 0.5A/\mu s$ , 100cycle*, See the examples of current waveforms
Critical rate-of-rise of on-state current	$di/dt$	1600	A/ $\mu s$	
Peak forward gate current	$I_{FGM}$	2	A	$f \geq 50Hz$ , duty $\leq 10\%$
Peak gate power loss	$P_{GM}$	5	W	$f \geq 50Hz$ , duty $\leq 10\%$
Average gate power loss	$P_{G(AV)}$	0.5	W	
Peak reverse gate voltage	$V_{RGM}$	5	V	$f \geq 50Hz$
Diode repetitive peak surge forward current	$I_{FRM}$	460	A	$T_a = 100^\circ C$ , $V_D \leq 430V$ , $W_p = 1.05\mu s$ , 100cycle*, See the examples of current waveforms
Junction temperature	$T_J$	$-40$ to $+125$	$^\circ C$	
Storage temperature	$T_{stg}$	$-40$ to $+125$	$^\circ C$	

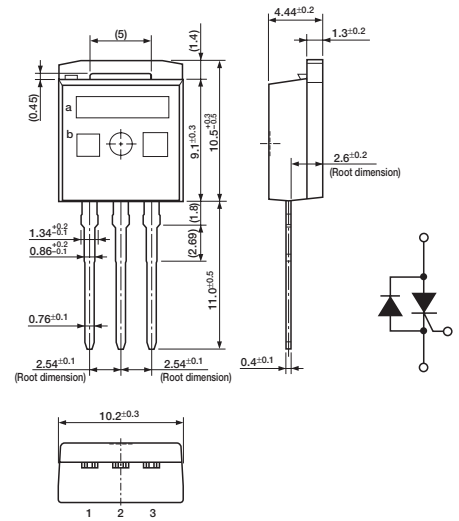
\* The surge current for  $T=10ms$  /cycle shall be applied 50 cycles successively, and an interval time shall follow to cool down the junction temperature of the device to  $125^\circ C$ . This process shall be repeated up to 100K cycles.

## Electrical Characteristics

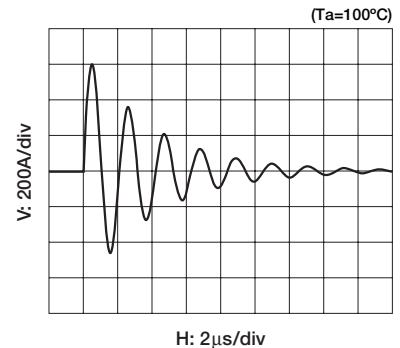
( $T_J=25^\circ C$ )

Parameter	Symbol	Ratings			Unit	Conditions
		min	typ	max		
On-state voltage	$V_{TM}$			1.4	V	$I_T = 10A$
Gate trigger voltage	$V_{GT}$			1.5	V	$V_D = 6V$ , $R_L = 10\Omega$
Gate trigger current	$I_{GT}(1)$			20	mA	$V_D = 6V$ , $R_L = 10\Omega$
Gate non-trigger voltage	$V_{GD}$	0.1			V	$V_D = 480V$ , $T_J = 125^\circ C$
Holding current	$I_H$	2	5		mA	$R_{G-K} = 1k\Omega$ , $T_J = 25^\circ C$
Off-state current (1)	$I_{DRM}(1)$			10	$\mu A$	$V_D = V_{DRM}$ , $R_{G-K} = 1k\Omega$ , $T_J = 25^\circ C$
Off-state current (2)	$I_{DRM}(2)$			1	mA	$V_D = V_{DRM}$ , $R_{G-K} = 1k\Omega$ , $T_J = 125^\circ C$
Thermal resistance	$R_{th}$			4.0	$^\circ C/W$	Junction to case, With infinite heatsink
Diode forward voltage	$V_F$			1.4	V	$I_F = 10A$

## External Dimensions (unit: mm)



## Current waveform (1cycle)



\* A single cycle operation consists of a continuous impression of 50 rounds with period  $T = 10ms$  followed by a rest time for the junction temperature of the element to cool down to  $100^\circ C (= T_a)$ . Repeat this cycle operation.

# Rectifier Diodes for Alternators

## Normal Type

Part No.	Absolute maximum ratings					Electrical Characteristics					Fig. No.
	V <sub>RM</sub> (V)	I <sub>F</sub> (AV) (A)	I <sub>FSM</sub> (A)	T <sub>j</sub>	T <sub>stg</sub>	V <sub>F</sub> (V) max	Condition I <sub>F</sub> (A)	I <sub>R</sub> (mA) max	V <sub>Z</sub> (V)	Condition I <sub>Z</sub> (mA)	
				(°C)							
SG-9CNS	200	20	200	−40 to +150		1.10	20	0.25	—	—	1
SG-9CNR											
SG-9LCNS	200	30	300	−40 to +150		1.10	30	0.25	—	—	2
SG-9LCNR											
SG-9LLCNS	200	35	350	−40 to +150		1.10	35	0.25	—	—	
SG-9LLCNR											
SG-10LS	200	30	300	−40 to +150		1.2	100	0.25	—	—	
SG-10LR											
SG-10LXS	150	35	350	−40 to +150		1.05	100	0.25	—	—	3
SG-10LXR											
SG-10LLS	200	40	400	−40 to +150		1.05	100	0.25	—	—	
SG-10LLR											
SG-10LLXS	150	45	450	−40 to +150		1.0	100	0.25	—	—	
SG-10LLXR											

## Zener Type

Part No.	Absolute maximum ratings					Electrical Characteristics					Fig. No.
	V <sub>RM</sub> (V)	I <sub>F</sub> (A) (A)	I <sub>FSM</sub> (A)	T <sub>j</sub>	T <sub>stg</sub>	V <sub>F</sub> (V) max	Condition I <sub>F</sub> (A)	I <sub>R</sub> (mA) max	V <sub>Z</sub> (V)	Condition I <sub>Z</sub> (mA)	
				(°C)							
SG-9CZS	17	20	200	−40 to +200		1.10	20	0.05	23±3	10	1
SG-9CZR											
SG-9LLCZS	17	35	350	−40 to +200		1.10	35	0.05	23±3	10	2
SG-9LLCZR											
SG-10LZ23S	17	30	300	−40 to +150		1.2	100	0.05	23±3	10	3
SG-10LZ23R											
SG-10LLZ23S	17	40	400	−40 to +150		1.05	100	0.05	23±3	10	
SG-10LLZ23R											
SG-14LXZS	16	35	350	−40 to +200		1.15	100	0.05	22±3	100	4
SG-14LXZR											

## External Dimensions (unit: mm)

Fig. 1

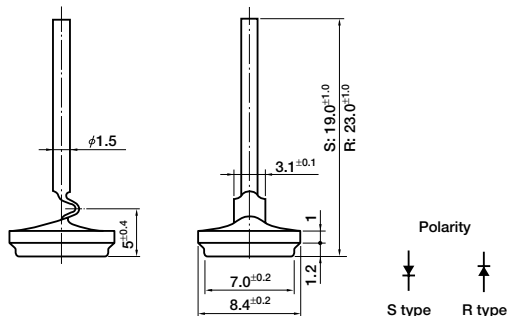


Fig. 2

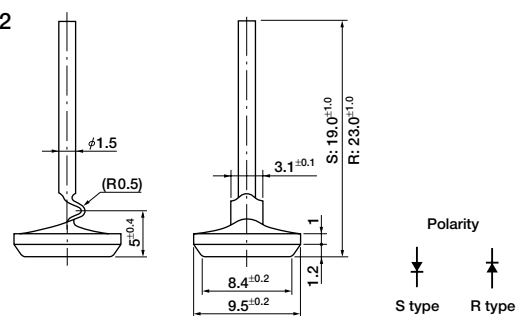


Fig. 3

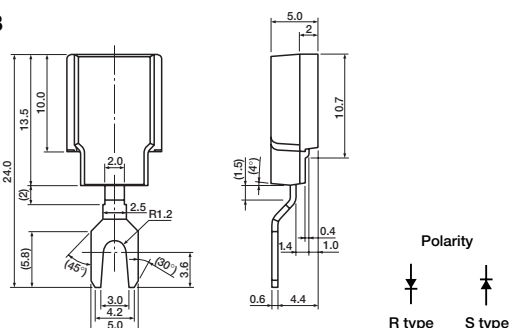
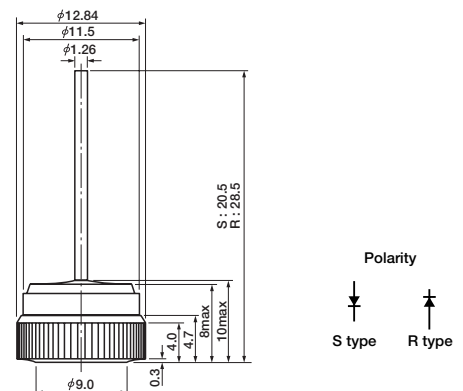


Fig. 4



# High-voltage Diodes for Igniters

Part No.	Absolute Maximum Ratings					Electrical Characteristics (Ta=25°C)				Fig. No.	
	V <sub>RM</sub> (kV)	I <sub>F</sub> (A) 50 Hz half-wave signal average	I <sub>RSM</sub> (mA) Peak value of single shot triangular wave with 100μs half-power bandwidth	I <sub>RSM</sub> (A) Peak value of 50 Hz half-wave signal	T <sub>j</sub>	T <sub>stg</sub>	V <sub>F</sub> (V) max	Condition I <sub>F</sub> (mA)	I <sub>R</sub> (μA) V <sub>R</sub> =V <sub>RM</sub> max		V <sub>Z</sub> (kV) I <sub>R</sub> =100μA
					(°C)						
SHV-01JN	0.5	30	30	3	-40 to +150		1	10	10	0.55 to 1.0	2
SHV-05J	2.5	30	30	3			5			2.6 to 5.0	1
SHV-06JN	3.0	30	10	3			6			3.2 to 6.0	2

## External Dimensions (unit: mm)

Fig. 1 (SHV-05J)

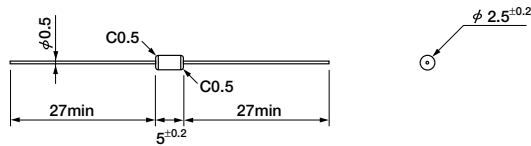
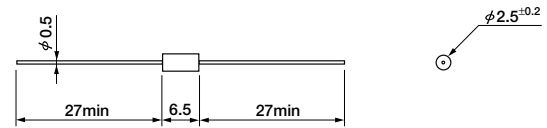


Fig. 2 (SHV-06JN)



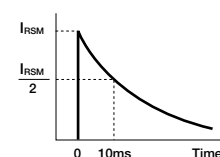
# Power Zener Diode

(Ta=25°C)

Part No.	Absolute Maximum Ratings					Electrical Characteristics			Fig. No.	Remarks
	P (W)	P <sub>R</sub> (W)	V <sub>DC</sub> (V)	I <sub>ZSM</sub> (A)	T <sub>j</sub> Tstg (°C)	V <sub>Z</sub> (V) 1mA instantaneous current	Condition I <sub>Z</sub> (mA)	I <sub>R</sub> V <sub>R</sub> =V <sub>DC</sub> (μA) max		
SFPZ-68	1	50 (5ms)	20	2	-40 to +150	25.0 to 31.0	1	10	1	Surface-mount type
SJPZ-K28*	1		20	2	-55 to +150	25.0 to 31.0	1	10	2	
SJPZ-E18*	1	85 (500μs)	13	—	-55 to +150	16.8 to 19.1	1	10	2	
SJPZ-E27*	1		20	—	-55 to +150	25.1 to 28.9	1	10	2	
SJPZ-E33*	1		25	—	-55 to +150	31.0 to 35.0	1	10	2	
SJPZ-E36*	1		27	—	-55 to +150	34.0 to 38.0	1	10	2	
PZ628	5	1500 (5ms)	20	65*1	-40 to +150	25.0 to 31.0	10	50	3	Axial type
SZ-10N27	5	—	22	70*1	-55 to +175	24 to 30	10	10	4	Surface-mount type
SZ-10N40*	5	—	22	40*1	-55 to +175	36 to 40	10	10	4	
SZ-10NN27	6	—	22	90*1	-55 to +175	24 to 30	10	10	4	
SZ-10NN40*	6	—	22	55*1	-55 to +175	36 to 40	10	10	4	

\* under development

\*1: I<sub>ZSM</sub> conditions



## External Dimensions (unit: mm)

Fig. 1

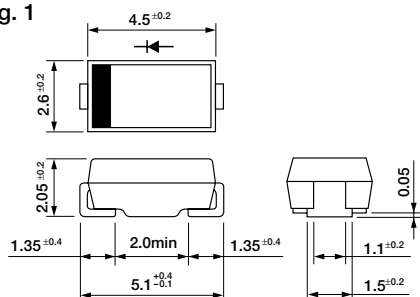


Fig. 2

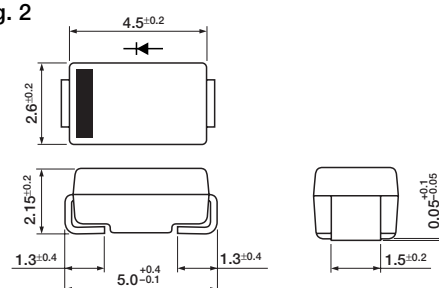


Fig. 3

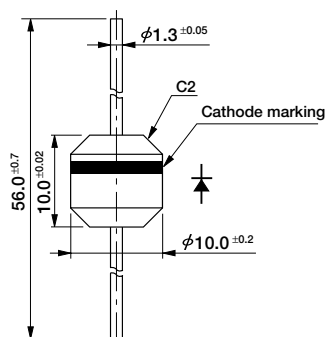
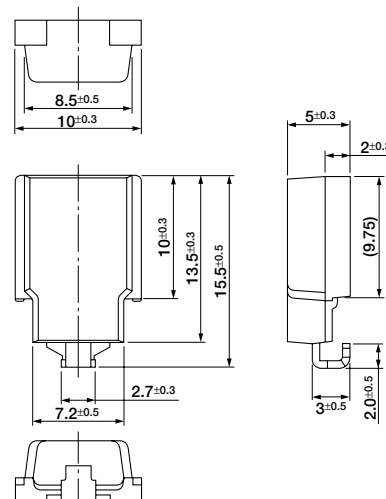


Fig. 3



# General-purpose Diodes

## Rectifier Diodes

### ■ Surface-mount

Part No.	V <sub>RM</sub> (V)	I <sub>F</sub> (AV) (A)	I <sub>FSM</sub> (A) Peak value of 50 Hz half-wave signal	T <sub>j</sub> (°C)	Tstg (°C)	V <sub>F</sub> (V) max	I <sub>R</sub> (μA)		I <sub>R</sub> (H) (mA)		R <sub>th(j-l)</sub> (°C/W)	Package	Weight (g)
							Condition I <sub>F</sub> (A)	V <sub>R</sub> =V <sub>RM</sub> max	V <sub>R</sub> =V <sub>RM</sub> max	Condition T <sub>a</sub> (°C)			
SFPM-52	200	0.9	30	-40 to +150		1.0	1.0	10	50	100	20	1	0.072
SFPM-62		1.0	45			0.98	1.0	10	50	100	20	1	0.072
SFPM-54	400	0.9	30			1.0	1.0	10	50	100	20	1	0.072
SFPM-64		1.0	45			0.98	1.0	10	50	100	20	1	0.072

## Ultra Fast Recovery Rectifier Diodes

### ■ Surface-mount

Part No.	V <sub>RM</sub> (V)	I <sub>F</sub> (AV) (A)	I <sub>FSM</sub> (A) Peak value of 50 Hz half-wave signal	T <sub>j</sub> (°C)	Tstg (°C)	V <sub>F</sub> (V)		I <sub>R</sub> (μA)	I <sub>R</sub> (H) (mA)	t <sub>rr</sub> ① (ns)		t <sub>rr</sub> ② (ns)		R <sub>th</sub> (j-l) (°C/W)	Package	Weight (g)	
						max	Condition I <sub>F</sub> (A)	V <sub>R</sub> =V <sub>RM</sub> max	V <sub>R</sub> =V <sub>RM</sub> max	Condition T <sub>a</sub> (°C)	Condition I <sub>F</sub> /I <sub>RP</sub> (mA)	Condition I <sub>F</sub> /I <sub>RP</sub> (mA)					
SFPL-52	200	0.9	25	-40 to +150		0.98	1.0	10	1	150 (T <sub>j</sub> )	50	100/100	35	100/200	20	1	0.072
SFPL-62		1.0	25			0.98	2.0	10	1	150 (T <sub>j</sub> )	50	100/100	35	100/200	20	1	0.072
MPL-102S		10.0	65			0.98	5.0	100	0.2	150	40	100/100	30	100/200	2.5	2	1.4
MP2-202S		20.0	110			0.98	10.0	200	0.4	150	50	100/100	35	100/200	2.5	2	1.4
SFPL-64	400	1.0	25			1.3	1.0	10	0.05	150	50	100/100	30	100/200	20	1	0.072

## Schottky Barrier Diodes

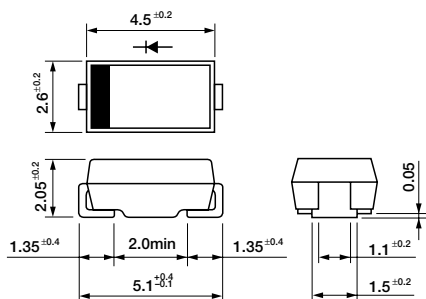
### ■ Surface-mount

Part No.	V <sub>RM</sub> (V)	I <sub>F</sub> (AV) (A)	I <sub>FSM</sub> (A) Peak value of 50 Hz half-wave signal	T <sub>j</sub> (°C)	Tstg (°C)	V <sub>F</sub> (V) max	I <sub>R</sub> (μA)		I <sub>R</sub> (H) (mA)		R <sub>th(j-l)</sub> (°C/W)	Package	Weight (g)
							Condition I <sub>F</sub> (A)	V <sub>R</sub> =V <sub>RM</sub> max	V <sub>R</sub> =V <sub>RM</sub> max	Condition T <sub>a</sub> (°C)			
SFPJ-53*	30	1.0	30	-40 to +150		0.45	1.0	1.0	35	150	20	1	0.072
SFPJ-63	30	2.0	40			0.45	2.0	2.0	70	150	20	1	0.072
SFPJ-73	30	3.0	50			0.45	3.0	3.0	100	150	20	1	0.072
SFPB-54	40	1.0	30			0.55	1.0	1	35	150	20	1	0.072
SFPB-64	40	2.0	60			0.55	2.0	5	70	150	20	1	0.072
SFPE-64	40	2.0	40			0.6	2.0	0.2	70	150	20	1	0.072
SFPB-74	40	3.0	60			0.5	2.0	5	100	150	20	1	0.072
SFPB-56	60	0.7	10			0.62	0.7	1	30	150	20	1	0.072
SFPW-56	60	1.5	25			0.7	1.5	1	70	150	20	1	0.072
SFPB-66	60	2.0	25			0.69	2.0	1	55	150	20	1	0.072
SFPB-76	60	2.0	40			0.62	2.0	2	70	150	20	1	0.072
SFPB-59	90	0.7	10			0.81	0.7	1	30	150	20	1	0.072
SFPB-69	90	1.5	40			0.81	1.5	2	55	150	20	1	0.072

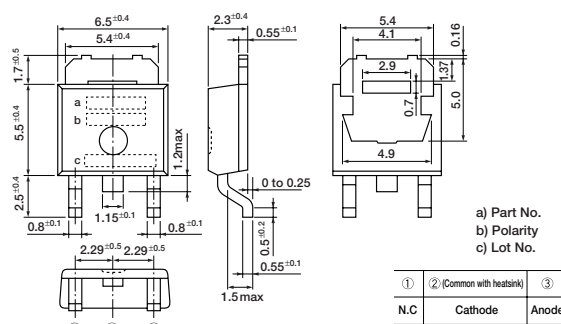
\* under development

### External Dimensions (unit: mm)

#### 1: (Surface-mount SFP)

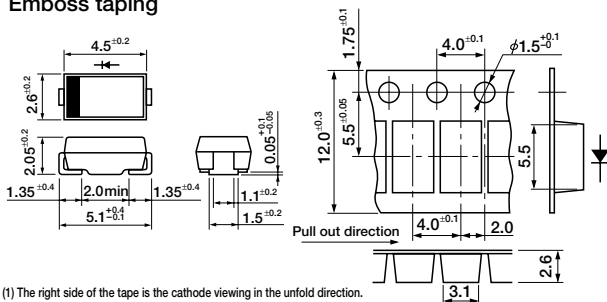
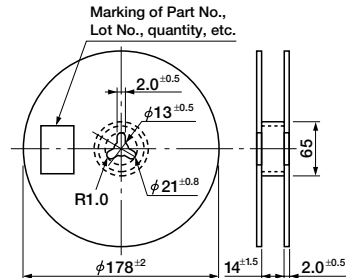


#### 2: (TO-220S)



●



### Taping Specifications

Taping Name	Taping Dimensions (mm)	Packaging Dimensions (mm) and Markings	Packaging Quantity
<div>V</div> <div>A suffix "V" is added to Part No. for tape packaging.</div>	<div>Emboss taping</div> <div><p>Technical drawing of the embossed tape showing top, side, and cross-sectional views with dimensions in mm. Dimensions include: 4.5<sup>+0.2</sup>, 2.6<sup>+0.2</sup>, 2.05<sup>+0.2</sup>, 1.35<sup>+0.4</sup>, 2.0<sup>min</sup>, 5.1<sup>+0.4</sup>, 1.1<sup>+0.2</sup>, 1.5<sup>+0.2</sup>, 0.05<sup>+0.1</sup>, 12.0<sup>+0.3</sup>, 5.5<sup>+0.05</sup>, 4.0<sup>+0.1</sup>, 1.5<sup>+0.1</sup>, 5.5, 4.0<sup>+0.1</sup>, 2.0, 3.1, 2.6, and 1.75<sup>+0.1</sup>. A pull-out direction arrow is shown.</p></div>	<div>Reel</div> <div><p>Technical drawing of the reel showing top and side views with dimensions in mm. Dimensions include: 2.0<sup>+0.5</sup>, <math>\phi 13^{+0.5}</math>, <math>\phi 21^{+0.8}</math>, R1.0, <math>\phi 178^{+2}</math>, 14<sup>+1.5</sup>, 2.0<sup>+0.5</sup>, 65, and 2.0. A marking area is indicated with the text: "Marking of Part No., Lot No., quantity, etc."</p></div>	<div>1,800 pcs. per reel</div>

### Power Surface-mount - Taping Specifications

Taping Name	Taping Dimensions (mm)	Packaging Dimensions (mm) and Markings	Packaging Quantity
<b>VL</b>  A suffix "VL" is added to Part No. for tape packaging.	<p>Pull out direction →</p> <p>Dimensions (mm):            Top view:            - Total width: 21.5 ±0.1            - Component width: 14.4 ±0.1            - Spacing between components: 4 ±0.1            - Distance from edge to first component: 10.8 ±0.1            - Distance between components: 12 ±0.1            - Distance from last component to edge: 4.9 ±0.1            - Hole diameter: φ1.5 ±0.1            - Seal part length: 17.5 ±0.1            - Bottom dimensions: 11.5 ±0.1, 24 ±0.3, 12.5 ±0.1            - Thickness: 5.4 max, 0.4 ±0.1</p>	<div style="display: flex; justify-content: space-between;"> <div> <p>Part No.</p> <p>Quantity</p> <p>Taping name (type)</p> <p>Lot No.</p> </div> <div> <p>Materials</p> <p>Disc: both-face white corrugated cardboard</p> <p>Core: foamed styrol</p> </div> </div> <p>Front View Dimensions (mm):        - Outer diameter: φ36        - Inner diameter: φ16        - Mounting hole diameter: φ4        - Mounting hole pitch: P4        - Angle: 120°</p> <p>Side View Dimensions (mm):        - Disc thickness: 4.300 ±0.1        - Core thickness: 1.3 ±0.1        - Mounting flange height: 25.5 ±0.1        - Mounting flange outer diameter: φ28.5 ±0.1</p> <p>Bottom View Dimensions (mm):        - Mounting hole diameter: φ4        - Mounting hole pitch: P4        - Flange outer diameter: φ28.5 ±0.1        - Flange inner diameter: φ16 ±0.1        - Flange thickness: 1.3 ±0.1</p>	3,000 pcs. per reel
<b>VR</b>  A suffix "VR" is added to Part No. for tape packaging.	<p>Pull out direction →</p> <p>Dimensions (mm):            Same as VL diagram.</p>	<p>Same as VL diagram.</p>	3,000 pcs. per reel

### High-voltage diodes for ignition - Taping Specifications

Taping Name	Taping Dimensions (mm)	Packaging Dimensions (mm) and Markings	Packaging Quantity
<p><b>V1</b></p> <p>A suffix "V1" is added to Part No. for tape packaging.</p>	<p><b>Axial taping</b></p> 		<p><b>5,000 pcs. per reel</b></p>



# 3

## LEDs

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<b>3-2. Bi-Color LED Lamps</b>	137
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# General-purpose LEDs

## Uni-Color LED Lamps

### Absolute Maximum Ratings

(Ta=25°C)

Parameter	Unit	Ratings						Conditions
		GaP	GaAsP	GaAlAs	AlGaInP	InGaN	GaN	
P <sub>D</sub>	mW	75				120		
I <sub>F</sub>	mA	30						
ΔI <sub>F</sub>	mA/°C	-0.45						Above 25°C
I <sub>FP</sub>	mA	100				70		f=1kHz, tw=100μs
V <sub>R</sub>	V	3			5			
Top	°C	-30 to +85				-30 to +80		
Tstg	°C	-30 to +100						

Outline	Emitting color	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)							Contact mount	Fig. No.
				V <sub>F</sub> (V)		I <sub>v</sub> (mcd)	Condition I <sub>F</sub> (mA)	Peak wavelength λ <sub>p</sub> (nm)	Dominant wavelength λ <sub>p</sub> (nm)	Chip material		
				typ	max			typ	typ			
5φ Round	Deep red	SEL1110R	Diffused red	2.0	2.5	2.8	5	700	625	GaP	×	1
		SEL1110W	Diffused white			2.8					×	
		SEL1110S	Tinted red			4.5					×	
	High-intensity red	SEL1610W	Diffused white	1.75	2.2	250	20	660	642	GaAlAs	×	
		SEL1610C	Clear			300					×	
	Red	SEL1210R	Diffused red	1.9	2.5	26	20	630	620	GaAsP	×	
		SEL1210S	Tinted red			75					×	
	Amber	SEL1810D	Diffused orange	1.9	2.5	18	10	610	605	GaAsP	×	
		SEL1810A	Tinted orange			37					×	
	Orange	SEL1910D	Diffused orange	1.9	2.5	14	10	587	590	GaAsP	×	
		SEL1910A	Tinted orange			25					×	
	Yellow	SEL1710Y	Diffused yellow	2.0	2.5	22	10	570	571	GaP	×	
		SEL1710K	Tinted yellow			65					×	
	Green	SEL1410G	Diffused green	2.0	2.5	32	20	560	567	GaP	×	
		SEL1410E	Tinted green			84					×	
	Pure green	SEL1510C	Clear	2.0	2.5	50	20	555	559	GaP	×	
	Red	SEL1210RM	Diffused red	1.9	2.5	36	20	630	620	GaAsP	×	2
		SEL1210SM	Tinted red			75					×	
	Amber	SEL1810DM	Diffused orange	1.9	2.5	18	10	610	605	GaAsP	×	
		SEL1810AM	Tinted orange			37					×	
	Orange	SEL1910DM	Diffused orange	1.9	2.5	19	10	587	590	GaAsP	×	
		SEL1910AM	Tinted orange			34					×	
	Yellow	SEL1710KM	Tinted yellow	2.0	2.5	65	10	570	571	GaP	×	
	Green	SEL1410GM	Diffused green	2.0	2.5	30	20	560	567	GaP	×	
		SEL1410EM	Tinted green			84					×	
	Pure green	SEL1510CM	Clear	2.0	2.5	50	20	555	559	GaP	×	
	Ultra high-intensity red	SELU1210CXM	Clear	2.0	2.5	280	20	635	625	AlGaInP	×	3
	Ultra high-intensity orange	SELU1910CXM-S	Clear	2.0	2.5	450	20	591	589	AlGaInP	×	
	Ultra high-intensity pure green	SELU1D10CXM	Clear	3.3	4.0	2000	20	525	530	InGaIn	×	
	Ultra high-intensity blue	SELU1E10CXM	Clear	3.3	4.0	600	20	468	470	InGaIn	×	
	Ultra high-intensity blue	SELS1E10CXM-M	Clear	3.7	4.2	1000	20	468	470	InGaIn	×	
	Ultra high-intensity red	SELU1250CM	Clear	2.0	2.5	900	20	635	625	AlGaInP	○	4
	Red	SEL1250SM	Tinted red	1.9	2.5	75	20	630	620	GaAsP	○	
		SEL1250RM	Diffused red			48					○	
	Amber	SEL1850AM	Tinted orange	1.9	2.5	90	20	610	605	GaAsP	○	
		SEL1850DM	Diffused orange			60					○	
	Orange	SEL1950KM	Tinted orange	1.9	2.5	96	20	587	590	GaAsP	○	
	Green	SEL1450EKM	Tinted green	2.0	2.5	190	20	560	567	GaP	○	
		SEL1450GM-YG	Diffused green			120					○	
	Pure green	SEL1550CM	Clear	2.0	2.5	72	20	555	559	GaP	○	
	Ultra high-intensity pure green	SELU1D50CM	Clear	3.3	4.0	6000	20	525	530	InGaIn	×	
	Ultra high-intensity blue	SELU1E50CM	Clear	3.3	4.0	1850	20	468	470	InGaIn	×	
	High-intensity red	SEL1615C	Clear	1.75	2.2	170	20	660	642	GaAlAs	×	5
4.6×5.6φ Egg-shaped	Ultra high-intensity red	SELU1253CMKT	Clear	2.0	2.5	200	20	635	625	AlGaInP	×	6
	Green	SEL1453CEMKT	Tinted green	2.0	2.5	140	20	560	567	GaP	×	
4φ Round	Deep red	SEL4110S	Tinted red	2.0	2.5	2.4	5	700	625	GaP	×	7
		SEL4110R	Diffused red			1.7					×	
	Red	SEL4210S	Tinted red	1.9	2.5	30	20	630	620	GaAsP	×	
		SEL4210R	Diffused red			17					×	
	Amber	SEL4810A	Tinted orange	1.9	2.5	20	10	610	605	GaAsP	×	
		SEL4810D	Diffused orange			15					×	
	Orange	SEL4910A	Tinted orange	1.9	2.5	26	10	587	590	GaAsP	×	
		SEL4910D	Diffused orange			16					×	
	Yellow	SEL4710K	Tinted yellow	2.0	2.5	36	10	570	571	GaP	×	
SEL4710Y	Diffused yellow	14	×									

## General-purpose LEDs

### Uni-Color LED Lamps

Outline	Emitting color	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)							Contact mount	Fig. No.
				V <sub>F</sub> (V)		I <sub>V</sub> (mcd)	Condition I <sub>F</sub> (mA)	Peak wavelength λ <sub>p</sub> (nm)	Dominant wavelength λ <sub>p</sub> (nm)	Chip material		
				typ	max			typ	typ			
4φ Round	Green	SEL4410E	Tinted green	2.0	2.5	87	20	560	567	GaP	×	7
		SEL4410G	Diffused green			34					×	
	Ultra high-intensity green	SELU4410CKT-S	Clear	2.1	2.5	170	20	560	562	AlGaInP	×	
	Pure green	SEL4510C	Clear	2.0	2.5	45	20	555	559	GaP	×	
	Deep red	SEL4114S	Tinted red	2.0	2.5	3.8	10	700	625	GaP	○	8
		SEL4114R	Diffused red			2.8					○	
	Red	SEL4214S	Tinted red	1.9	2.5	40	20	630	620	GaAsP	○	
		SEL4214R	Diffused red			24					○	
	Amber	SEL4814A	Tinted orange	1.9	2.5	20	10	610	605	GaAsP	○	
		SEL4814D	Diffused orange			15					○	
	Orange	SEL4914A	Tinted orange	1.9	2.5	26	10	587	590	GaAsP	○	
		SEL4914D	Diffused orange			11					○	
	Yellow	SEL4714K	Tinted yellow	2.0	2.5	38	10	570	571	GaP	○	
		SEL4714Y	Diffused yellow			27					○	
	Green	SEL4414E	Tinted green	2.0	2.5	69	20	560	567	GaP	○	
		SEL4414G	Diffused green			48					○	
Pure green	SEL4514C	Clear	2.0	2.5	26	20	555	559	GaP	○		
3φ Round	Deep red	SEL6110S	Tinted red	2.0	2.5	3.9	10	700	625	GaP	○	9
		SEL6110R	Diffused red			2.6					○	
	Red	SEL6210S	Tinted red	1.9	2.5	41	20	630	620	GaAsP	○	
		SEL6210R	Diffused red			18					○	
	Amber	SEL6810A	Tinted orange	1.9	2.5	22	10	610	605	GaAsP	○	
		SEL6810D	Diffused orange			9.6					○	
	Ultra high-intensity orange	SELU6910C-S	Clear	2.0	2.5	550	20	591	589	AlGaInP	○	
	Orange	SEL6910A	Tinted orange	1.9	2.5	22	10	587	590	GaAsP	○	
		SEL6910D	Diffused orange			11					○	
	Yellow	SEL6710K	Tinted yellow	2.0	2.5	37	10	570	571	GaP	○	
		SEL6710Y	Diffused yellow			11					○	
	Green	SEL6410E	Tinted green	2.0	2.5	90	20	560	567	GaP	○	
		SEL6410G	Diffused green			30					○	
	Pure green	SEL6510C	Clear	2.0	2.5	42	20	555	559	GaP	○	
		SEL6510G	Diffused green			9.6					○	
	Blue	SEL6E10C	Clear	4.0	4.8	60	20	430	466	GaN	○	
Ultra high-intensity deep red	SELU6614C-S	Clear	2.0	2.5	150	20	650	639	AlGaInP	○	10	
	SELU6614W-S	Diffused white			90					○		
Ultra high-intensity red	SELU6214C	Clear	2.0	2.5	180	20	635	625	AlGaInP	○		
Red	SEL6214S	Tinted red	1.9	2.5	18	20	630	620	GaAsP	○		
Amber	SEL6814A	Tinted orange	1.9	2.5	9.0	10	610	605	GaAsP	○		
Ultra high-intensity light amber	SELS6B14C	Clear	2.0	2.5	120	20	600	596	AlGaInP	○		
Ultra high-intensity orange	SELU6914C-S	Clear	2.0	2.5	180	20	591	589	AlGaInP	○		
Orange	SEL6914A	Tinted orange	1.9	2.5	8.0	10	587	590	GaAsP	○		
	SEL6914W	Diffused white			5.0					○		
Ultra high-intensity yellow	SELU6714C	Clear	2.1	2.5	60	20	572	571	AlGaInP	○		
	SEL6714K	Tinted yellow			66					○		
Yellow	SEL6714W	Diffused white	2.0	2.5	30	20	570	571	GaP	○		
	SEL6414E	Tinted green			42					○		
Ultra high-intensity green	SELU6414G-S	Diffused green	2.1	2.5	30	20	560	562	AlGaInP	○		
Deep green	SEL6414E-TG	Tinted green	2.0	2.5	18	20	558	564	GaP	○		
Pure green	SEL6514C	Clear	2.0	2.5	12	20	555	559	GaP	○		
Ultra high-intensity pure green	SELS6D14C	Clear	3.3	4.0	300	20	518	525	InGaIn	○		
Ultra high-intensity blue	SELS6E14C-M	Clear	3.7	4.2	70	20	468	470	InGaIn	○		
Red	SEL6215S	Tinted red	1.9	2.5	45	20	630	620	GaAsP	○	11	
Orange	SEL6915A	Tinted orange	1.9	2.5	60	20	587	590	GaAsP	○		
Yellow	SEL6715C	Clear	2.0	2.5	90	20	570	571	GaP	○		
Green	SEL6415E	Tinted green	2.0	2.5	81	20	560	567	GaP	○		
Pure green	SEL6515C	Clear	2.0	2.5	44	20	555	559	GaP	○		
Deep red	SEL2110S	Tinted red	2.0	2.5	4	10	700	625	GaP	×	12	
	SEL2110R	Diffused red			1.8					×		
	SEL2110W	Diffused white			1.8					×		
High-intensity red	SEL2610C	Clear	1.75	2.2	60	20	660	642	GaAlAs	×		
Ultra high-intensity deep red	SELU2610C-S	Clear	2.0	2.5	300	20	650	639	AlGaInP	×		
Red	SEL2210S	Tinted red	1.9	2.5	40	20	630	620	GaAsP	×		
	SEL2210R	Diffused red			15					×		
	SEL2210W	Diffused white			15					×		
Amber	SEL2810A	Tinted orange	1.9	2.5	22	10	610	605	GaAsP	×		
	SEL2810D	Diffused orange			9.0					×		
Ultra high-intensity light amber	SELU2B10A-S	Tinted orange	2.0	2.5	300	20	598	595	AlGaInP	×		

## Uni-Color LED Lamps

Outline	Emitting color	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)							Contact mount	Fig. No.
				V <sub>F</sub> (V)		I <sub>V</sub> (mcd)	Condition I <sub>F</sub> (mA)	Peak wavelength λ <sub>p</sub> (nm)	Dominant wavelength λ <sub>p</sub> (nm)	Chip material		
				typ	max			typ	typ			
3φ Round	Orange	SEL2910A	Tinted orange	1.9	2.5	16	10	587	590	GaAsP	×	12
		SEL2910D	Diffused orange			8.0					×	
	Ultra high-intensity yellow	SELU2710C	Clear	2.1	2.5	270	20	572	571	AlGaInP	×	
	Yellow	SEL2710K	Tinted yellow	2.0	2.5	40	10	570	571	GaP	×	
		SEL2710Y	Diffused yellow			14					×	
	Green	SEL2410E	Tinted green	2.0	2.5	77	20	560	567	GaP	×	
		SEL2410G	Diffused green			20					×	
	Pure green	SEL2510C	Clear	2.0	2.5	43	20	555	559	GaP	×	
		SEL2510G	Diffused green			8.2					×	
	Ultra high-intensity pure green	SELU2D10C	Clear	3.3	4.0	1200	20	525	530	InGaN	×	
	Ultra high-intensity blue	SELU2E10C	Clear	3.3	4.0	400	20	468	470	InGaN	×	
	Blue	SEL2E10C	Clear	4.0	4.8	60	20	430	466	GaN	×	
	Ultra high-intensity red	SELU2215R-S	Diffused red	2.0	2.5	380	20	632	624	AlGaInP	×	
	Red	SEL2215S	Tinted red	1.9	2.5	45	20	630	620	GaAsP	×	
		SEL2215R	Diffused red			38					×	
	Amber	SEL2815A	Tinted orange	1.9	2.5	80	10	610	605	GaAsP	×	
		SEL2815D	Diffused orange			60					×	
	Orange	SEL2915A	Tinted orange	1.9	2.5	81	10	587	590	GaAsP	×	
SEL2915D		Diffused orange	53			×						
Yellow	SEL2715K	Tinted yellow	2.0	2.5	130	10	570	571	GaP	×		
	SEL2715Y	Diffused yellow			110					×		
Green	SEL2415E	Tinted green	2.0	2.5	110	20	560	567	GaP	×		
	SEL2415G	Diffused green			72					×		
Pure green	SEL2515C	Clear	2.0	2.5	52	20	555	559	GaP	×		
Inverted-cone typ for surface illumination	Red	SEL1213C	Tinted red	1.9	2.5	7.0	20	630	620	GaAsP	×	14
	Amber	SEL1813A	Tinted orange	1.9	2.5	8.0	20	610	605	GaAsP	×	
	Orange	SEL1913K	Tinted light orange	1.9	2.5	8.0	20	587	590	GaAsP	×	
	Yellow	SEL1713K	Tinted yellow	2.0	2.5	15	20	570	571	GaP	×	
	Green	SEL1413E	Tinted green	2.0	2.5	12	20	560	567	GaP	×	
	Pure green	SEL1513E	Tinted light green	2.0	2.5	5.0	20	555	559	GaP	×	
	Ultra high-intensity red	SELU6213C-S	Clear	2.0	2.5	30	20	632	624	AlGaInP	○	15
	Ultra high-intensity light amber	SELS6B13W	Diffused white	2.0	2.5	60	20	600	596	AlGaInP	○	
	Green	SEL6413E	Tinted green	2.0	2.5	14	20	560	567	GaP	○	
	Deep green	SEL6413E-TG	Tinted green	2.0	2.5	6	20	558	564	GaP	○	
	Pure green	SEL6513C	Clear	2.0	2.5	5.0	20	555	559	GaP	○	
	High-intensity red	SEL2613CS-S	Tinted light red	1.75	2.2	20	20	660	642	GaAlAs	×	16
	Red	SEL2213C	Tinted red	1.9	2.5	7.0	20	630	620	GaAsP	×	
	Amber	SEL2813A	Tinted orange	1.9	2.5	8.0	20	610	605	GaAsP	×	
	Orange	SEL2913K	Tinted orange	1.9	2.5	8.0	20	587	590	GaAsP	×	
	Yellow	SEL2713K	Tinted yellow	2.0	2.5	17	20	570	571	GaP	×	
	Green	SEL2413E	Tinted green	2.0	2.5	14	20	560	567	GaP	×	
		SEL2413G	Diffused green			12					×	
Pure green	SEL2513E	Tinted green	2.0	2.5	5.0	20	555	559	GaP	×		
5mm Pitch lead rectangular	High-intensity red	SEL5620C	Clear	1.75	2.2	100	20	660	642	GaAlAs	○	17
	Ultra high-intensity deep red	SELU5620S-S	Tinted red	2.0	2.5	100	20	650	639	AlGaInP	○	
	Ultra high-intensity red	SELU5220C-S	Clear	2.0	2.5	120	20	632	624	AlGaInP	○	
	Red	SEL5220S	Tinted red	1.9	2.5	20	20	630	620	GaAsP	○	
	Ultra high-intensity amber	SELU5820C-S	Clear	2.0	2.5	150	20	611	605	AlGaInP	○	
	Amber	SEL5820A	Tinted orange	1.9	2.5	12	20	610	605	GaAsP	○	
	Ultra high-intensity light amber	SELU5B20C	Clear	2.0	2.5	120	20	600	596	AlGaInP	○	
	Orange	SEL5920A	Tinted orange	1.9	2.5	12	20	587	590	GaAsP	○	
	Ultra high-intensity yellow	SELU5720C	Clear	2.1	2.5	50	20	572	571	AlGaInP	○	
	Green	SEL5420E	Tinted green	2.0	2.5	20	20	560	567	GaP	○	
	Pure green	SEL5520C	Clear	2.0	2.5	6.0	20	555	559	GaP	○	
	Blue	SEL5E20C	Clear	4.0	4.8	10	20	430	466	GaN	○	
5mm Pitch lead bow-shaped	Ultra high-intensity red	SELS5223C	Clear	2.0	2.5	100	20	635	625	AlGaInP	○	18
	Red	SEL5223S	Tinted red	1.9	2.5	25	20	630	620	GaAsP	○	
	Amber	SEL5823A	Tinted orange	1.9	2.5	35	20	610	605	GaAsP	○	
	Ultra high-intensity light amber	SELS5B23C	Clear	2.0	2.5	135	20	600	596	AlGaInP	○	
	Ultra high-intensity orange	SELS5923C	Clear	2.0	2.5	145	20	591	589	AlGaInP	○	
	Orange	SEL5923A	Tinted orange	1.9	2.5	35	20	587	590	GaAsP	○	
	Ultra high-intensity yellow	SELU5723C	Clear	2.1	2.5	155	20	572	571	AlGaInP	○	
	Yellow	SEL5723C	Clear	2.0	2.5	60	20	570	571	GaP	○	
	Green	SEL5423E	Tinted green	2.0	2.5	40	20	560	567	GaP	○	
	Pure green	SEL5523C	Clear	2.0	2.5	13	20	555	559	GaP	○	
	Ultra high-intensity blue	SELU5E23C	Clear	3.3	4.0	180	20	468	470	InGaN	○	
	Blue	SEL5E23C	Clear	4.0	4.8	20	20	430	466	GaN	○	

## Bi-Color LED Lamps

### Absolute Maximum Ratings

(Ta=25°C)

Parameter	Unit	Ratings					Conditions
		GaP	GaAsP	GaAlAs	AlGaInP	InGaN	
P <sub>D</sub>	mW	75				120	Also applies to simultaneous lighting
I <sub>F</sub>	mA	30					
ΔI <sub>F</sub>	mA/°C	-0.45					Above 25°C
I <sub>FP</sub>	mA	100					f=1kHz, tw=100μs
V <sub>R</sub>	V	3			5		
Top	°C	-30 to +85					
Tstg	°C	-30 to +100					

Outline	Part No.	Emitting color	Lens color	Electro-optical characteristics (Ta=25°C)							Common	Contact mount	Fig. No.
				V <sub>F</sub> (V)		I <sub>V</sub> (mcd)	Condition I <sub>F</sub> (mA)	Peak wavelength λ <sub>p</sub> (nm)	Dominant wavelength λ <sub>p</sub> (nm)	Chip material			
				typ	max								
5φ Round	SML11516C	Deep red	Clear	2.0	2.5	15	20	700	625	GaP	Cathode	×	19
		Pure green		2.0	2.5	50	20	555	559	GaP	Cathode	×	
	SML1516W	Deep red	Diffused white	2.0	2.5	6.0	20	700	625	GaP	Cathode	×	
		Pure green		2.0	2.5	20	20	555	559	GaP	Cathode	×	
	SML1216C	Red	Clear	1.9	2.5	65	20	630	620	GaAsP	Cathode	×	
		Green		2.0	2.5	90	20	560	567	GaP	Cathode	×	
	SML1216W	Red	Diffused white	1.9	2.5	60	20	630	620	GaAsP	Cathode	×	
		Green		2.0	2.5	60	20	560	567	GaP	Cathode	×	
	SML1816W	Amber	Diffused white	1.9	2.5	50	20	610	605	GaAsP	Cathode	×	
		Green		2.0	2.5	60	20	560	567	GaP	Cathode	×	
	SML19416W	Orange	Diffused white	1.9	2.5	45	20	587	590	GaAsP	Cathode	×	
		Green		2.0	2.5	60	20	560	567	GaP	Cathode	×	
	SMLU12E16C	Ultra high-intensity red	Clear	2.0	2.5	500	20	632	624	AlGaInP	Cathode	×	
		Ultra high-intensity blue		3.3	4.0	400	20	468	470	InGaN	Cathode	×	
SMLU12E16W	Ultra high-intensity red	Diffused white	2.0	2.5	250	20	632	624	AlGaInP	Cathode	×		
	Ultra high-intensity blue		3.3	4.0	150	20	468	470	InGaN	Cathode	×		
SMLU12D16W	Ultra high-intensity red	Diffused white	2.0	2.5	250	20	632	624	AlGaInP	Cathode	×		
	Ultra high-intensity pure green		3.3	4.0	700	20	525	530	InGaN	Cathode	×		
SMLU18D16C	Ultra high-intensity amber	Clear	2.0	2.5	800	20	611	605	AlGaInP	Cathode	×		
	Ultra high-intensity pure green		3.3	4.0	2000	20	525	530	InGaN	Cathode	×		
SMLU18D16W-S	Ultra high-intensity amber	Diffused white	2.0	2.5	300	20	611	605	AlGaInP	Cathode	×		
	Ultra high-intensity pure green		3.3	4.0	500	20	525	530	InGaN	Cathode	×		
3.3×6 Rectangular	SML72420C	Red	Clear	1.9	2.5	15	20	630	620	AGaAsP	Cathode	○	20
		Green		2.0	2.5	20	20	560	567	GaP	Cathode	○	
	SML78420C	Amber	Clear	1.9	2.5	10	20	610	605	GaAsP	Cathode	○	
Green		2.0		2.5	20	20	560	567	GaP	Cathode	○		
SML79420C	Orange	Clear	1.9	2.5	10	20	587	590	GaAsP	Cathode	○		
	Green		2.0	2.5	20	20	560	567	GaP	Cathode	○		
3.3×6 Bow-shaped	SML72423C	Red	Clear	1.9	2.5	25	20	630	620	GaAsP	Cathode	○	21
		Green		2.0	2.5	35	20	560	567	GaP	Cathode	○	
	SML72923C	Red	Clear	1.9	2.5	25	20	630	620	GaAsP	Cathode	○	
		Orange		1.9	2.5	25	20	587	590	GaAsP	Cathode	○	
	SML78423C	Amber	Clear	1.9	2.5	25	20	610	605	GaAsP	Cathode	○	
		Green		2.0	2.5	35	20	560	567	GaP	Cathode	○	
	SML79423C	Orange	Clear	1.9	2.5	25	20	587	590	GaAsP	Cathode	○	
		Green		2.0	2.5	35	20	560	657	GaP	Cathode	○	
	SMLS79723C	Ultra high-intensity orange	Clear	2.0	2.5	150	20	590	590	AlGaInP	Cathode	○	
		Yellow		2.0	2.5	40	20	570	571	GaP	Cathode	○	
SMLU72423C-S	Ultra high-intensity red	Clear	2.0	2.5	120	20	635	625	AlGaInP	Cathode	○		
	Ultra high-intensity green		2.2	2.5	30	20	560	567	AlGaInP	Cathode	○		
SMLU79423C-S	Ultra high-intensity orange	Clear	2.0	2.5	150	20	590	590	AlGaInP	Cathode	○		
	Ultra high-intensity green		2.2	2.5	30	20	560	567	AlGaInP	Cathode	○		

# Surface Mount LEDs

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Unit	Ratings						Conditions
		GaP	GaAsP	GaAlAs	AlGaInP	InGaN	GaN	
I <sub>F</sub>	mA	30						
ΔI <sub>F</sub>	mA/°C	-0.45						Above 25°C
I <sub>FP</sub>	mA	70						f=1kHz, tw=100μs
V <sub>R</sub>	V	4				5		
Top	°C	-30 to +85				-25 to +85		
Tstg	°C	-30 to +100						

## Uni-Color Surface Mount LEDs

Outline	Emitting color	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)							Fig. No.
				VF (V)		IV (mcd)	Condition IF (mA)	Peak wavelength λp (nm)	Dominant wavelength λp (nm)	Chip material	
				typ	max	typ		typ	typ		
Side view (flat lens type)	Red	SEC4201C	Clear	1.9	2.5	10	20	630	620	GaAsP	22
	Amber	SEC4801C	Clear	1.9	2.5	16	20	610	605	GaAsP	
	Orange	SEC4901C	Clear	1.9	2.5	13	20	587	590	GaAsP	
	Yellow	SEC4701C	Clear	2.0	2.5	25	20	570	571	GaP	
	Green	SEC4401C	Clear	2.0	2.5	22	20	560	567	GaP	
	Deep green	SEC4401E-TG	Tinted green	2.0	2.5	11	20	558	564	GaP	
	Pure green	SEC4501C	Clear	2.0	2.5	8.0	20	555	559	GaP	
	Ultra high-intensity blue	SECU4E01C	Clear	3.3	4.0	50	20	468	470	InGaN	
Side view (inner lens type)	Red	SEC4203C	Clear	1.9	2.5	15	20	630	620	GaAsP	23
	Amber	SEC4803C	Clear	1.9	2.5	20	20	610	605	GaAsP	
	Orange	SEC4903C	Clear	1.9	2.5	15	20	587	590	GaAsP	
	Yellow	SEC4703C	Clear	2.0	2.5	35	20	570	571	GaP	
	Green	SEC4403C	Clear	2.0	2.5	33	20	560	567	GaP	
	Deep green	SEC4403E-TG	Tinted green	2.0	2.5	15	20	558	564	GaP	
	Pure green	SEC4503C	Clear	2.0	2.5	10	20	555	559	GaP	
3×1.5 (flat lens type)	Deep red	SEC1101C	Clear	2.0	2.5	1.5	20	700	625	GaP	24
	High-intensity red	SEC1601C	Clear	1.7	2.2	25	20	660	642	GaAlAs	
	Red	SEC1201C	Clear	1.9	2.5	10	20	630	620	GaAsP	
	Amber	SEC1801C	Clear	1.9	2.5	16	20	610	605	GaAsP	
	Orange	SEC1901C	Clear	1.9	2.5	13	20	587	590	GaAsP	
	Yellow	SEC1701C-YG	Clear	2.0	2.5	25	20	570	571	GaP	
	Green	SEC1401C	Clear	2.0	2.5	22	20	560	567	GaP	
	Deep green	SEC1401E-TG	Tinted green	2.0	2.5	11	20	558	564	GaP	
	Pure green	SEC1501C	Clear	2.0	2.5	8.0	20	555	559	GaP	
	Ultra high-intensity pure green	SECU1D01C	Clear	3.3	4.0	150	20	525	525	InGaN	
	Ultra high-intensity blue	SECU1E01C	Clear	3.3	4.0	50	20	470	468	InGaN	
Blue	SEC1E01C	Clear	3.9	4.8	6.0	20	430	466	GaN		
3×1.5 (inner lens type)	High-intensity red	SEC1603C	Clear	1.7	2.2	35	20	660	642	GaAlAs	25
	Ultra high-intensity red	SECS1203C	Clear	1.9	2.5	100	20	635	625	AlGaInP	
	Red	SEC1203C	Clear	1.9	2.5	15	20	630	620	GaAsP	
	Ultra high-intensity amber	SECS1803C	Clear	1.9	2.5	10	3	615	607	AlGaInP	
	Amber	SEC1803C	Clear	1.9	2.5	20	20	610	605	GaAsP	
	Ultra high-intensity orange	SECS1903C	Clear	1.9	2.5	70	20	590	590	AlGaInP	
	Orange	SEC1903C	Clear	1.9	2.5	15	20	587	590	GaAsP	
	Yellow	SEC1703C	Clear	2.0	2.5	35	20	570	571	GaP	
	Green	SEC1403C	Clear	2.0	2.5	33	20	560	567	GaP	
	Deep green	SEC1403E-TG	Tinted green	2.0	2.5	15	20	558	564	GaP	
	Pure green	SEC1503C	Clear	2.0	2.5	10	20	555	559	GaP	

## Surface Mount LEDs

## Uni-color / Bi-color Surface Mount LEDs with two elements

Outline	Part No.	Emitting color	Lens color	Electro-optical characteristics (Ta=25°C)							Fig. No.
				V <sub>F</sub> (V)		I <sub>V</sub> (mcd)	Condition I <sub>F</sub> (mA)	Peak wavelength λ <sub>p</sub> (nm)	Dominant wavelength λ <sub>p</sub> (nm)	Chip material	
				typ	max	typ		typ	typ		
3×2.5 (flat lens type)	SEC2422C	Red	Clear	1.9	2.5	10	20	630	620	GaAsP	26
		Green		2.0	2.5	20	20	560	567	GaP	
	SEC2442C	Green	Clear	2.0	2.5	20	20	560	567	GaP	
		Green		2.0	2.5	20	20	560	567	GaP	
	SEC2462C	High-intensity red	Clear	1.7	2.2	20	20	660	642	GaAlAs	
		Green		2.0	2.5	20	20	560	567	GaP	
	SEC2492C	Orange	Clear	1.9	2.5	10	20	587	590	GaAsP	
		Green		2.0	2.5	20	20	560	567	GaP	
	SEC2552C	Pure green	Clear	2.0	2.5	5.0	20	555	559	GaP	
		Pure green		2.0	2.5	5.0	20	555	559	GaP	
	SEC2592C	Orange	Clear	1.9	2.5	10	20	587	590	GaAsP	
		Pure green		2.0	2.5	5.0	20	555	559	GaP	
SEC2762C-YG	High-intensity red	Clear	1.7	2.2	20	20	660	642	GaAlAs		
	Yellow		2.0	2.5	20	20	570	571	GaP		
3×2.5 (inner lens type)	SEC2484C	Amber	Clear	1.9	2.5	20	20	610	605	GaAsP	27
		Green		2.0	2.5	30	20	560	567	GaP	
	SEC2554C	Pure green	Clear	2.0	2.5	10	20	555	559	GaP	
		Pure green		2.0	2.5	10	20	555	559	GaP	
	SEC2494C	Orange	Clear	1.9	2.5	20	20	587	590	GaAsP	
		Green		2.0	2.5	30	20	560	567	GaP	
	SEC2764C	High-intensity red	Clear	1.7	2.2	50	20	660	642	GaAlAs	
		Yellow		2.0	2.5	50	20	570	571	GaP	
	SEC2774C	Yellow	Clear	2.0	2.5	50	20	570	571	GaP	
		Yellow		2.0	2.5	50	20	570	571	GaP	

## Infrared LEDs

### Absolute Maximum Ratings

(Ta=25°C)

Parameter	Unit	Ratings	Conditions
$I_F$	mA	150	
$\Delta I_F$	mA/°C	-1.33	Above 25°C
$I_{FP}$	mA	1000	f=1kHz, $t_w=10\mu s$
$V_R$	V	5	
Top	°C	-30 to +85	
Tstg	°C	-30 to +100	

### Infrared LEDs

Outline	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)					Chip material	Contact mount	Fig. No.
			$V_F$ (V)		Radiant intensity $I_e$ (mW/sr)	Condition	Peak wavelength $\lambda_p$ (nm)			
			typ	max			typ			
5φ Round	SID1010CM	Clear	1.3	1.5	130	(Constant voltage) $V_{CC}=3V$ , $R=2.2\Omega$	940	GaAs	×	28
	SID1K10CM	Clear	1.3	1.5	200		940	GaAs	×	
	SID1010CXM	Clear	1.3	1.5	80		940	GaAs	×	
	SID1K10CXM	Clear	1.3	1.5	110		940	GaAs	×	
	SID1050CM	Clear	1.3	1.5	250		940	GaAs	○	29
	SID303C	Clear	1.3	1.5	80		940	GaAs	×	
	SID313BP	Transparent light purple	1.3	1.5	130		940	GaAs	×	
	SID1003BQ	Transparent light navy blue	1.3	1.5	180		940	GaAs	×	
	SID307BR	Transparent dark navy blue	1.3	1.5	200		940	GaAs	×	
	SID1G307C	Clear	1.5	1.8	50		850	GaAs	×	
3φ Round	SID2010C	Clear	1.3	1.5	7	$I_F=50mA$	940	GaAs	×	31
	SID2K10C	Clear	1.3	1.5	14		940	GaAs	×	
3×1.5 (inner lens type) chip	SEC1G03C	Clear	1.5	1.8	3		850	GaAs	—	25

# Ultraviolet LEDs

## Absolute Maximum Ratings

(Ta=25°C)

Parameter	Unit	Ratings	Conditions
IF	mA	30	
ΔIF	mA/°C	−0.45	Above 25°C
IFP	mA	100	f=1kHz, tw=10μs
IR	mA	100	Max. rating of built-in Zener diode
Top	°C	−30 to +85	
Tstg	°C	−30 to +100	

## Ultraviolet Surface Mount LEDs

Outline	Part No.	Lens color	Electro-optical characteristics (Ta=25°C)							Fig. No.	
			V <sub>F</sub> (V)		I <sub>V</sub> (mcd)	Peak wavelength λ <sub>p</sub> (nm)	Electrostatic withstand voltage		Chip material		
							(V)	Condition			
			typ	max	typ	Condition I <sub>F</sub> (mA)	typ	typ	Condition		
2.8×3.5	SECU1V0AC	Clear	3.7	4.0	2.2	20	385	4000	100pF, 1.5kΩ	InGaN	32

## Multi-chip LED Module (under development)

### Absolute Maximum Ratings

(Per element Ta=25°C)

Parameter	Unit	Ratings	Conditions
I <sub>F</sub>	mA	40	With an infinite heatsink mounted
ΔI <sub>F</sub>	mA/°C	-0.25	
I <sub>FP</sub>	mA	100	f=1kHz, tw=10μs
V <sub>R</sub>	V	5	
T <sub>opr</sub>	°C	-30 to +85	
T <sub>stg</sub>	°C	-30 to +100	

Part No.	Colors compliant with JIS-Z9112	Color temperature [°K] 20mA	Total flux [lm] 20mA	Chromaticity x, y 20mA	Fig. No.
SEP8WD4001	Cool white	6400	30	0.32, 0.33	33
SEP8WN4001	Natural white	5000	30	0.34, 0.35	
SEP8WE4001	White	4200	30	0.37, 0.37	
SEP8WW4001	Warm white	3450	25	0.41, 0.38	
SEP8WL4001	Light bulb	2875	25	0.44, 0.41	

# General-purpose LEDs - External Dimensions

(Unit: mm)

Fig.1

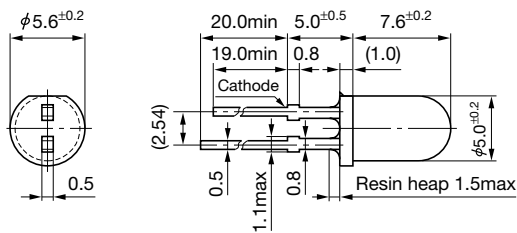


Fig.2

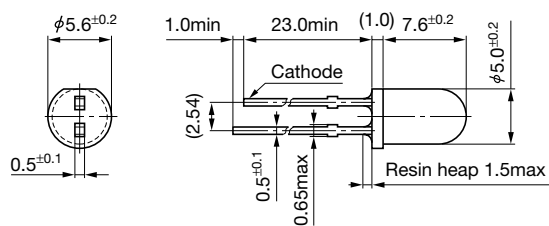


Fig.3

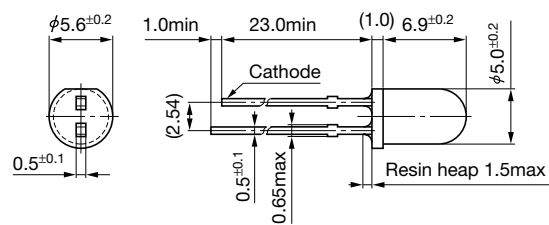


Fig.4

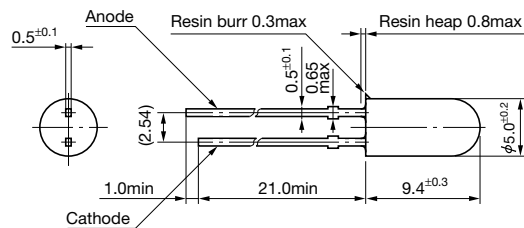


Fig.5

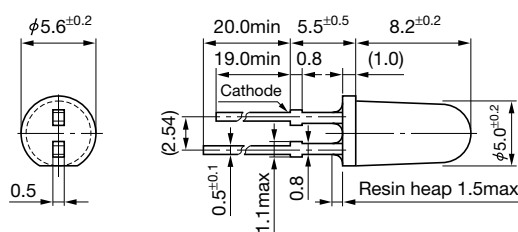


Fig.6

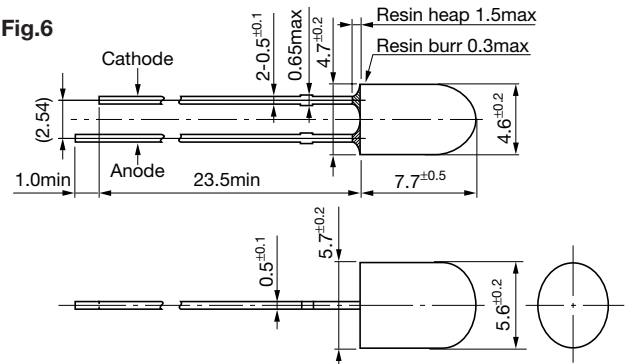


Fig.7

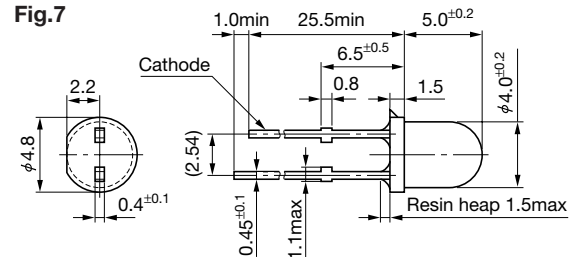


Fig.8

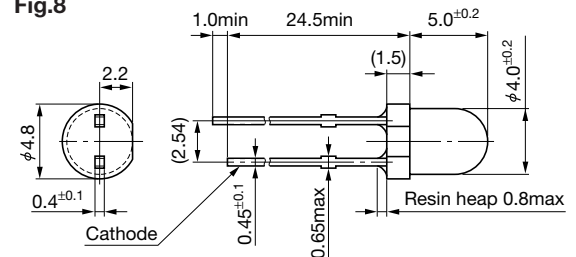


Fig.9

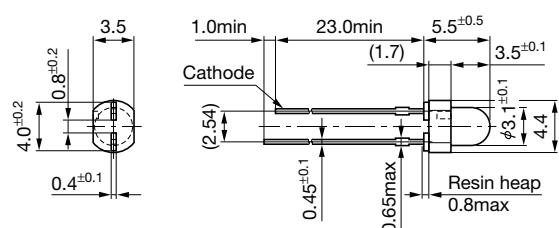
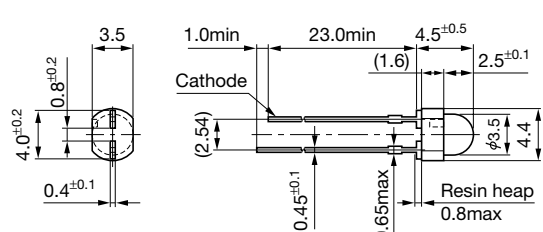


Fig.10



# General-purpose LEDs - External Dimensions

(Unit: mm)

Fig.11

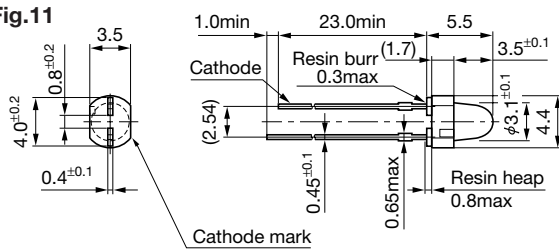


Fig.16

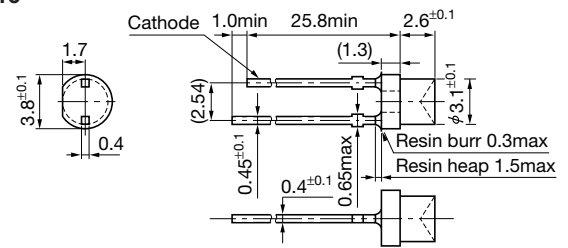


Fig.12

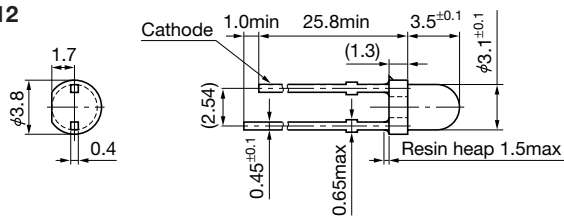


Fig.17

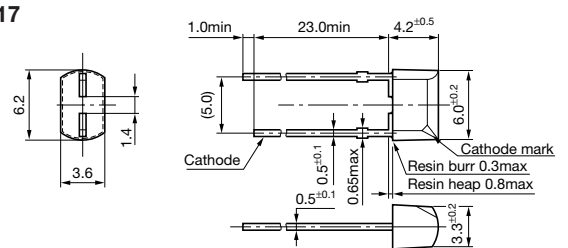


Fig.13

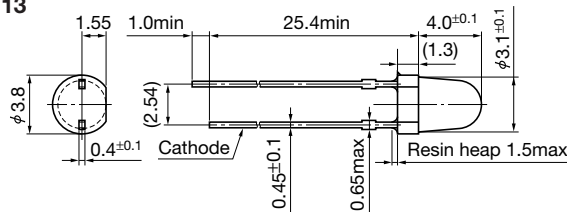


Fig.18

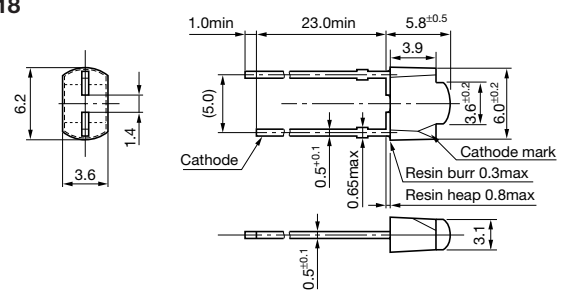


Fig.14

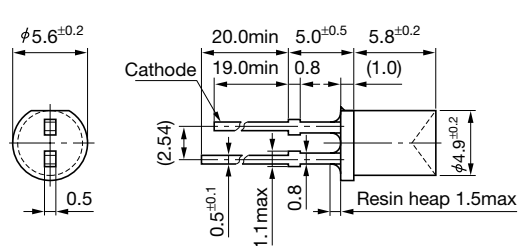


Fig.19

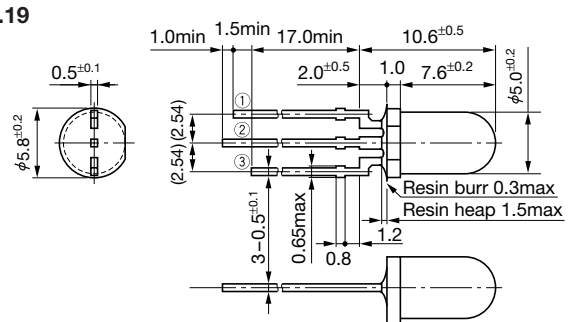


Fig.15

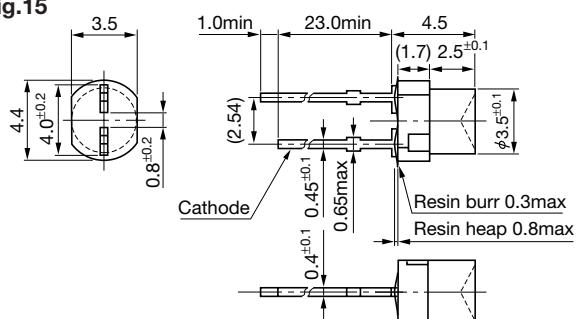
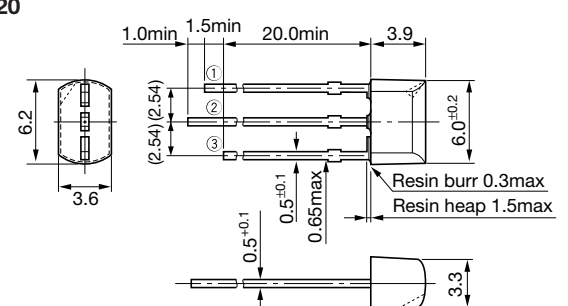
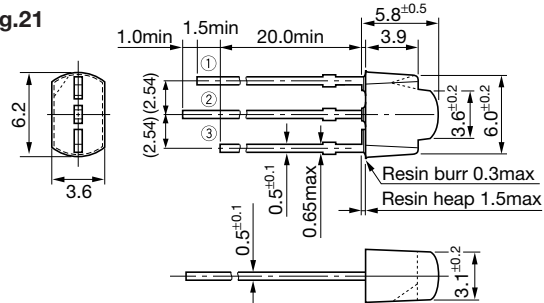


Fig.20

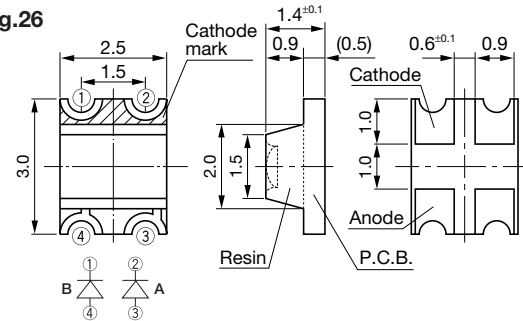


(Unit: mm)

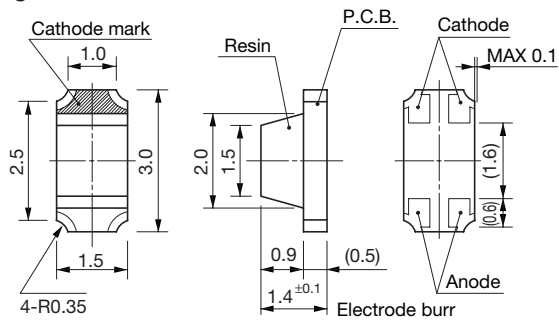
**Fig.21**



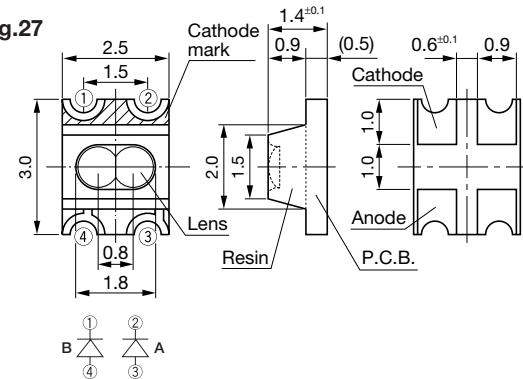
**Fig.26**



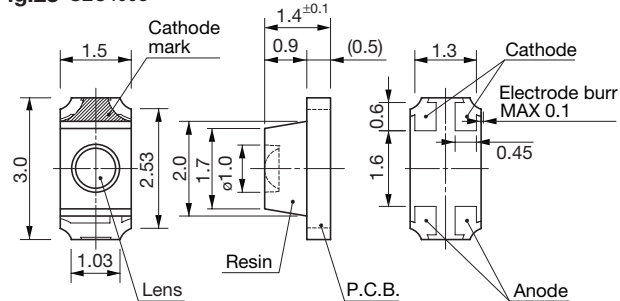
**Fig.22 SEC4001**



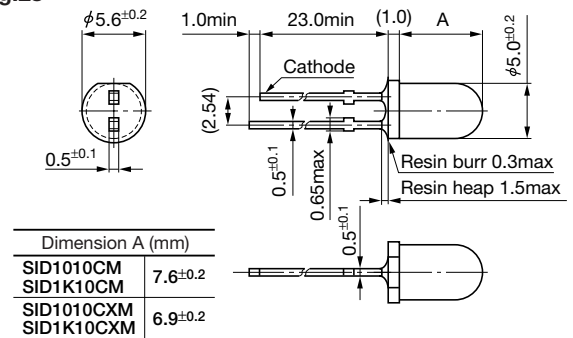
**Fig.27**



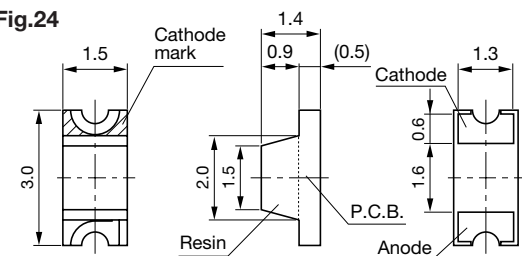
**Fig.23 SEC4003**



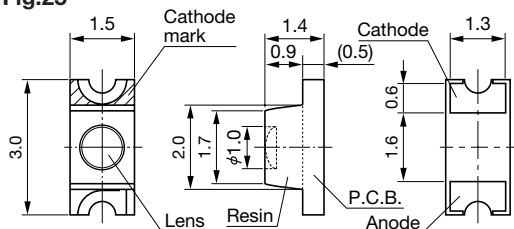
**Fig.28**



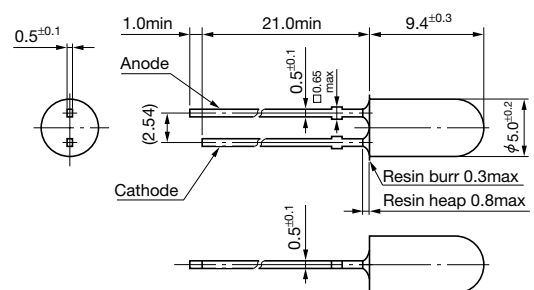
**Fig.24**



**Fig.25**



**Fig.29**



(Unit: mm)

Fig.30

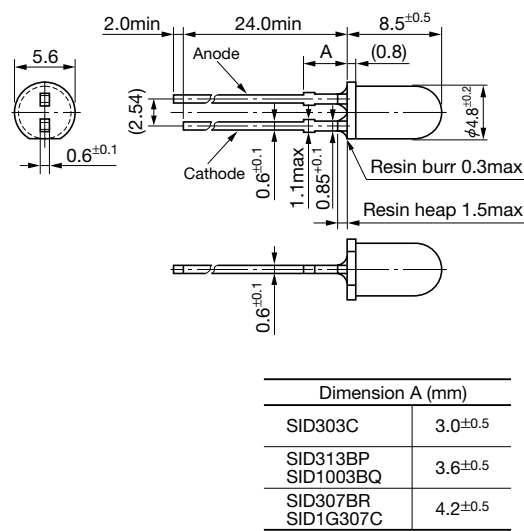


Fig.32

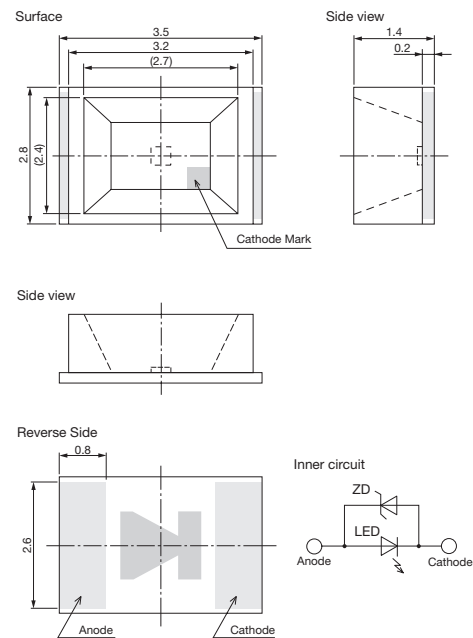


Fig.31

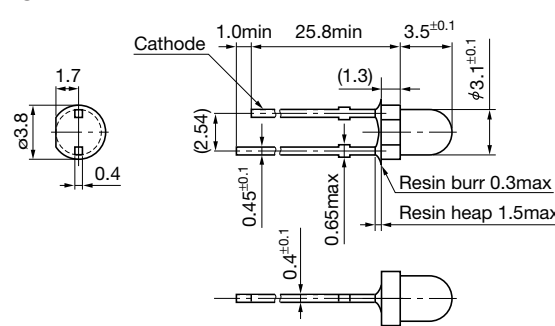
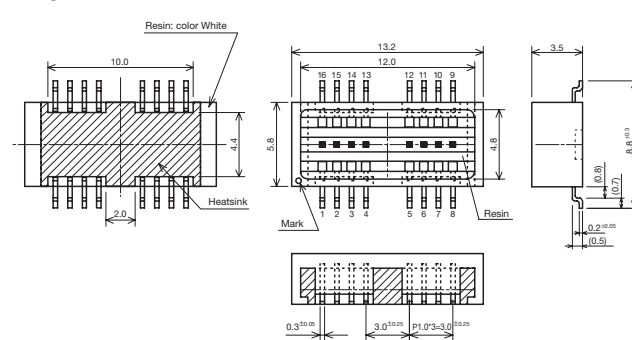


Fig.33



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