VN02NSP
VN02NPT

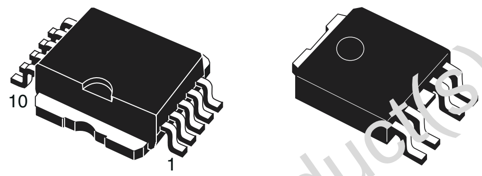
HIGH SIDE SMART POWER SOLID STATE RELAY

Table 1. General Features

Type	V_{DSS}	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN02NSP VN02NPT	60 V	0.4 Ω	6 A	26 V

- OUTPUT CURRENT (CONTINUOUS): 6A @ T_C=25°C
- 5V LOGIC LEVEL COMPATIBLE INPUT
- THERMAL SHUT-DOWN
- UNDER VOLTAGE SHUT-DOWN
- OPEN DRAIN DIAGNOSTIC OUTPUT
- VERY LOW STAND-BY POWER DISSIPATION

Figure 1. Package



DESCRIPTION

The VN02NSP/VN02NPT are monolithic devices made using STMicroelectronics VIPower Technology, intended for driving resistive or inductive loads with one side grounded.

Built-in thermal shut-down protects the chip from over temperature and short circuit.

The input control is 5V logic level compatible.

The open drain diagnostic output indicates open circuit (no load) and over temperature status.

Table 2. Order Codes

Package	Tube	Tape and Reel
PowerSO-10	VN02NSP	VN02NSP13TR
PPAK	VN02NPT	VN02NPT13TR

Figure 2. Block Diagram

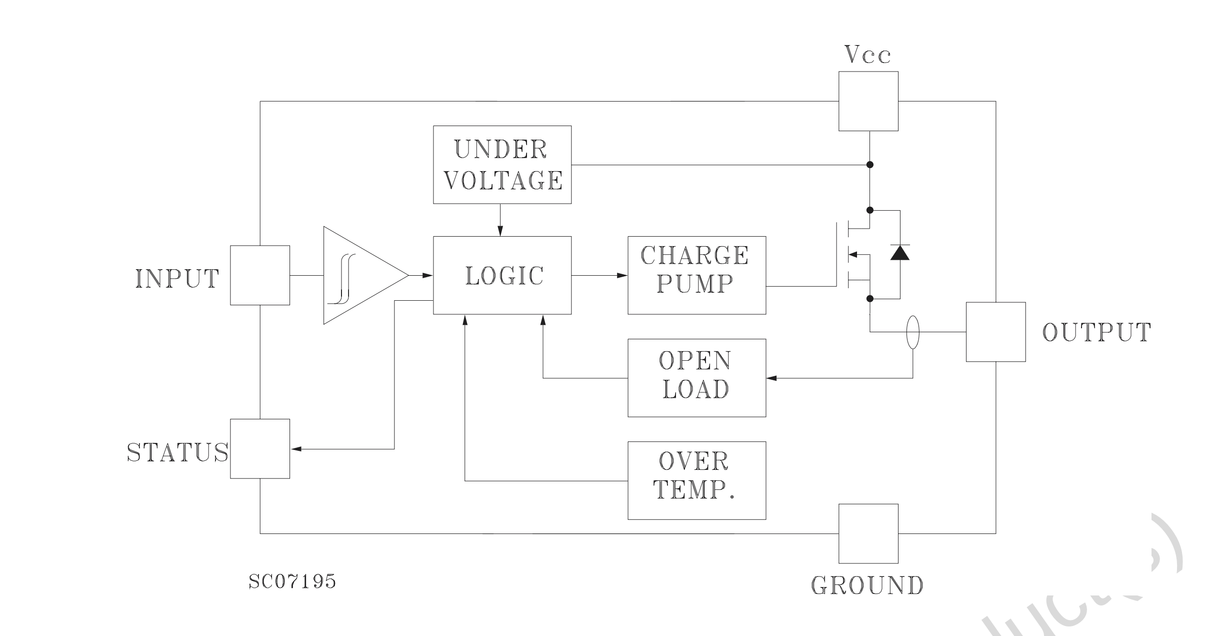


Table 3. Absolute Maximum Ratings

Symbol	Parameter	Value		Unit
		PowerSO-10	PPAK	
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	60		V
I_{OUT}	Output Current (cont.)	6		A
I_R	Reverse Output Current	–6		A
I_{IN}	Input Current	±10		mA
$-V_{CC}$	Reverse Supply Voltage	–4		V
I_{STAT}	Status Current	±10		mA
V_{ESD}	Electrostatic Discharge (1.5 kΩ, 100 pF)	2000		V
P_{tot}	Power Dissipation at $T_c \leq 25$ °C	58	46	W
T_j	Junction Operating Temperature	-40 to 150		°C
T_{stg}	Storage Temperature	-55 to 150		°C

Figure 3. Connection Diagrams

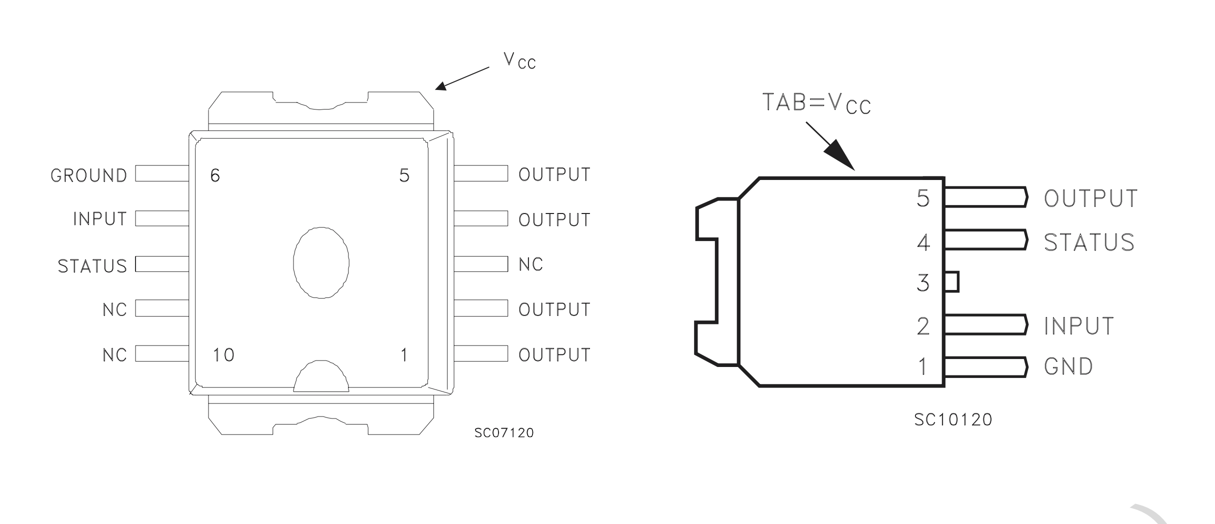


Figure 4. Current and Voltage Conventions

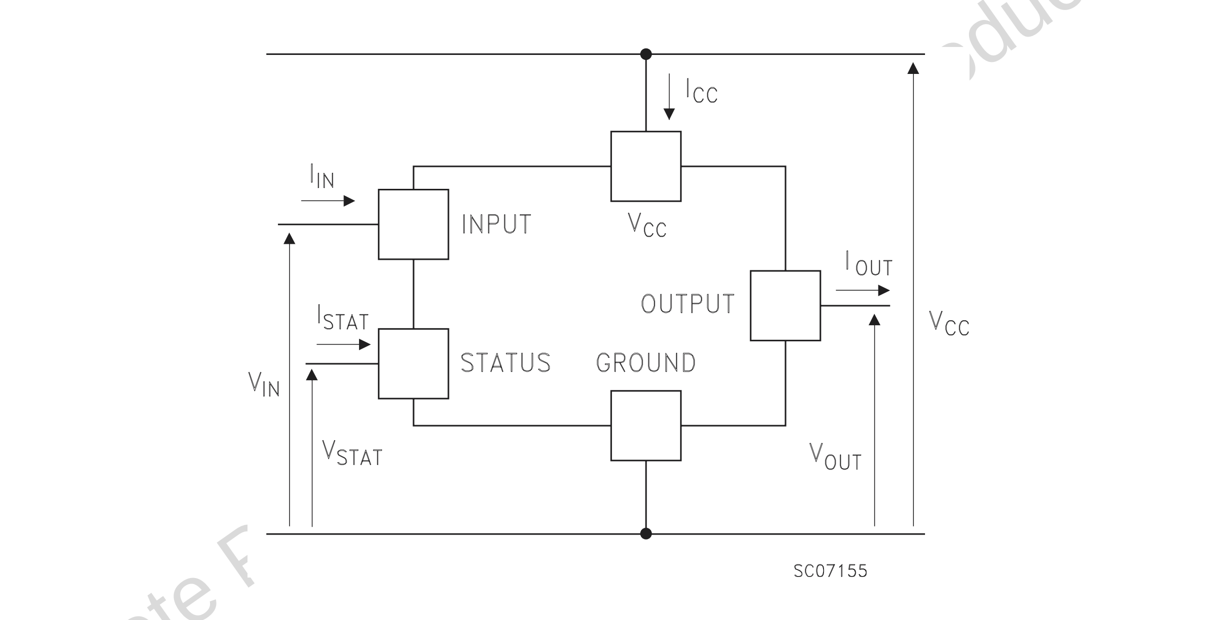


Table 4. Thermal Data

Symbol	Parameter		Value		Unit
			PowerSO-10	PPAK	
$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	2.14	3.33	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient(1)	Max	62.5	100	°C/W

Note: 1. When mounted using minimum recommended pad size on FR-4 board.

ELECTRICAL CHARACTERISTICS

(V_{CC} = 13 V; –40 ≤ Tj ≤ 125 °C unless otherwise specified)

Table 5. Power

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage		7		26	V
R_{on}	On State Resistance	I_{OUT} = 3 A I_{OUT} = 3 A; T_j = 25 °C			0.8 0.4	Ω Ω
I_S	Supply Current	Off State; T_j ≥ 25 °C On State			50 15	µA mA

Table 6. Switching

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time Of Output Current	I_{OUT} = 3 A; Resistive Load Input Rise Time < 0.1 µs; T_j = 25 °C		10		µs
t_r	Rise Time Of Output Current	I_{OUT} = 3 A; Resistive Load Input Rise Time < 0.1 µs; T_j = 25 °C		15		µs
$t_{d(off)}$	Turn-off Delay Time Of Output Current	I_{OUT} = 3 A; Resistive Load Input Rise Time < 0.1 µs; T_j = 25 °C		15		µs
t_f	Fall Time Of Output Current	I_{OUT} = 3 A; Resistive Load Input Rise Time < 0.1 µs; T_j = 25 °C		6		µs
$(di/dt)_{on}$	Turn-on Current Slope	I_{OUT} = 3 A I_{OUT} = I_{OV}			0.5 2	A/µs A/µs
$(di/dt)_{off}$	Turn-off Current Slope	I_{OUT} = 3 A I_{OUT} = I_{OV}			2 4	A/µs A/µs

Table 7. Logic Input

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IL}	Input Low Level Voltage				0.8	V
V_{IH}	Input High Level Voltage		2		Note 2	V
$V_{I(hyst)}$	Input Hysteresis Voltage			0.5		V
I_{IN}	Input Current	V_{IN} = 5 V		250	500	µA
V_{ICL}	Input Clamp Voltage	I_{IN} = 10 mA I_{IN} = –10 mA		6 –0.7		V V

Note: 2. The V_{IH} is internally clamped at 6V about. It is possible to connect this pin to an higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.

ELECTRICAL CHARACTERISTICS (cont'd)

Table 8. Protections and Diagnostics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{STAT}(3)	Status Voltage Output Low	I_{STAT} = 1.6 mA			0.4	V
V_{USD}	Under Voltage Shut Down			6.5		V
V_{SCL}(3)	Status Clamp Voltage	I_{STAT} = 10 mA I_{STAT} = –10 mA		6 –0.7		V V
t_{sc}	Switch-off Time in Short Circuit Condition at Start-Up	R_{LOAD} < 10 mΩ;Tc = 25 °C		1.5	5	ms
I_{OV}	Over Current	R_{LOAD} < 10 mΩ $-40 \leq T_c \leq 125$ °C			28	A
I_{AV}	Average Current in Short Circuit	R_{LOAD} < 10 mΩ; Tc = 85 °C		0.9		A
I_{OL}	Open Load Current Level		5		70	mA
T_{TSD}	Thermal Shut-down Temperature		140			°C
T_R	Reset Temperature		125			°C

Note: 3. Status determination > 100 ms after the switching edge.

FUNCTIONAL DESCRIPTION

The device has a diagnostic output which indicates open circuit (no load) and over temperature conditions. The output signals are processed by internal logic.

To protect the device against short circuit and over-current condition, the thermal protection turns the integrated Power MOS off at a minimum junction temperature of 140 °C. When the temperature returns to about 125 °C the switch is automatically turned on again.

In short circuit conditions the protection reacts with virtually no delay, the sensor being located in the region of the die where the heat is generated.

PROTECTING THE DEVICE AGAINST REVERSE BATTERY

The simplest way to protect the device against a continuous reverse battery voltage (-26V) is to insert a Schottky diode between pin 1 (GND) and ground, as shown in the typical application circuit (Figure 7).

The consequences of the voltage drop across this diode are as follows:

– If the input is pulled to power GND, a negative voltage of $-V_F$ is seen by the device. (V_{IL}, V_{IH} thresholds and V_{STAT} are increased by V_F with respect to power GND).

– The undervoltage shutdown level is increased by V_F.

If there is no need for the control unit to handle external analog signals referred to the power GND, the best approach is to connect the reference potential of the control unit to node (1) (see application circuit in Figure 8), which becomes the common signal GND for the whole control board.

In this way no shift of V_{IH}, V_{IL} and V_{STAT} takes place and no negative voltage appears on the INPUT pin; this solution allows the use of a standard diode, with a breakdown voltage able to handle any ISO normalized negative pulses that occurs in the automotive environment.

Table 9. Truth Table

	Input	Output	Diagnostic
Normal Operation	L H	L H	H H
Open Circuit (No Load)	H	H	L
Over-temperature	H	L	L
Under-voltage	X	L	H

Figure 5. Waveforms

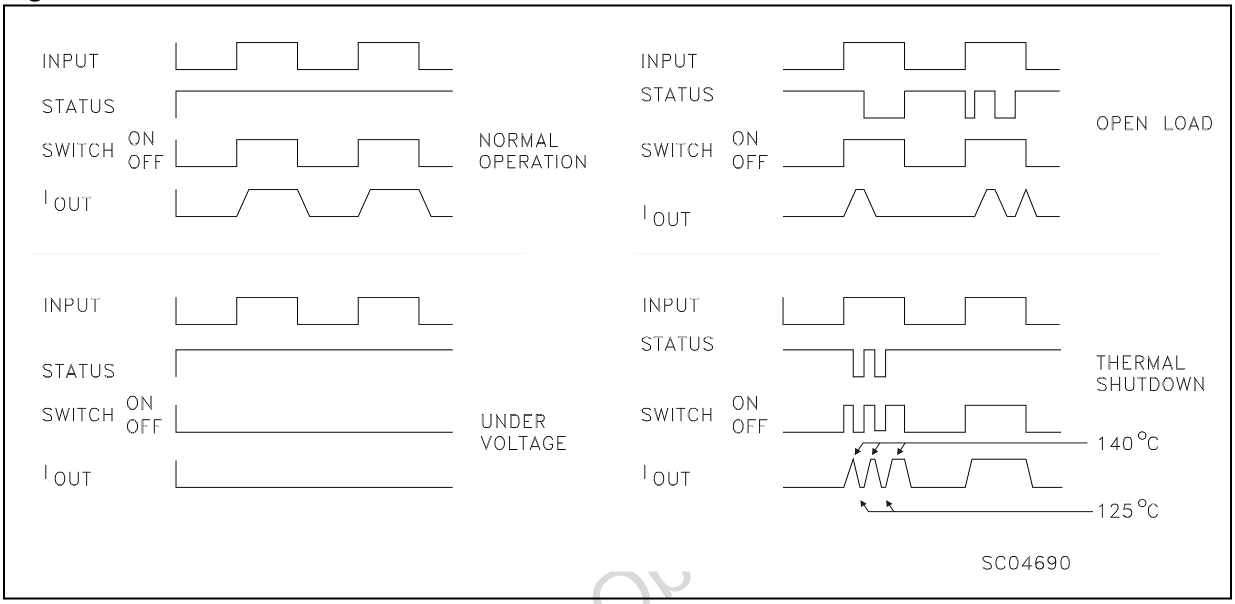


Figure 6. Over Current Test Circuit

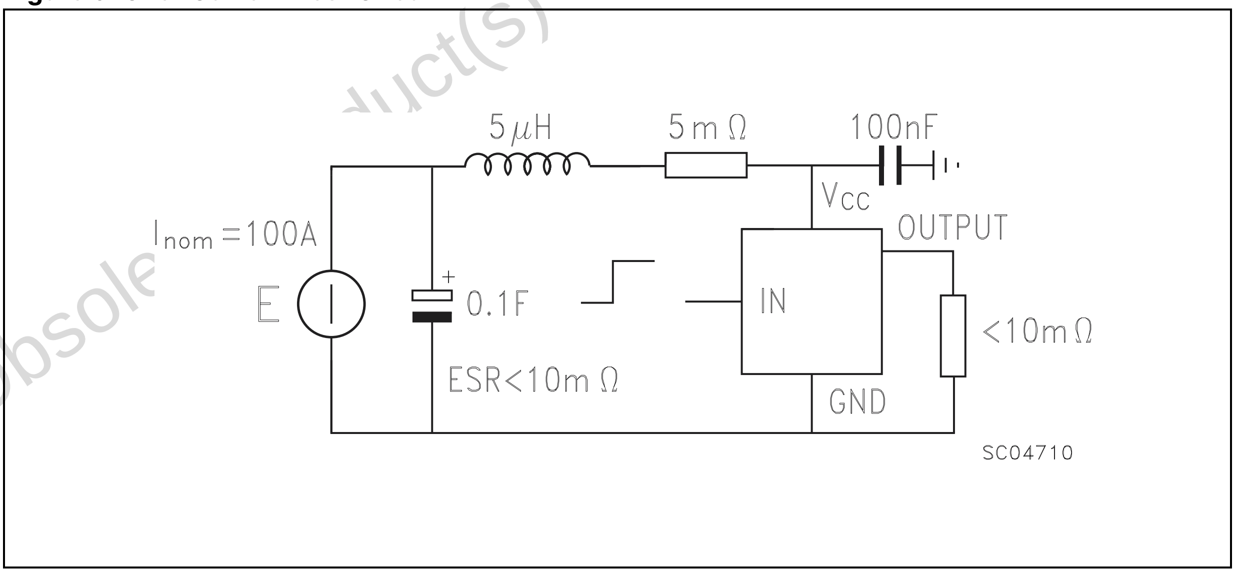


Figure 7. Typical Application Circuit With A Schottky Diode For Reverse Supply Protection

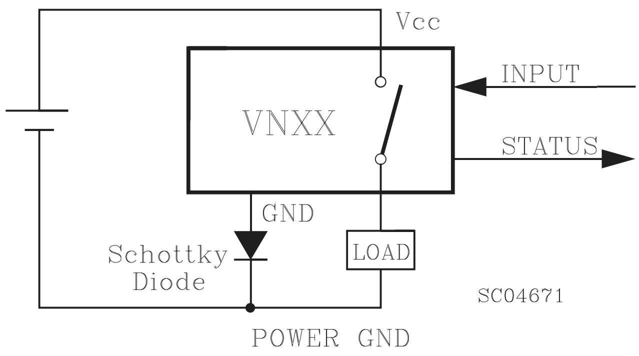


Figure 8. Typical Application Circuit With Separate Signal Ground

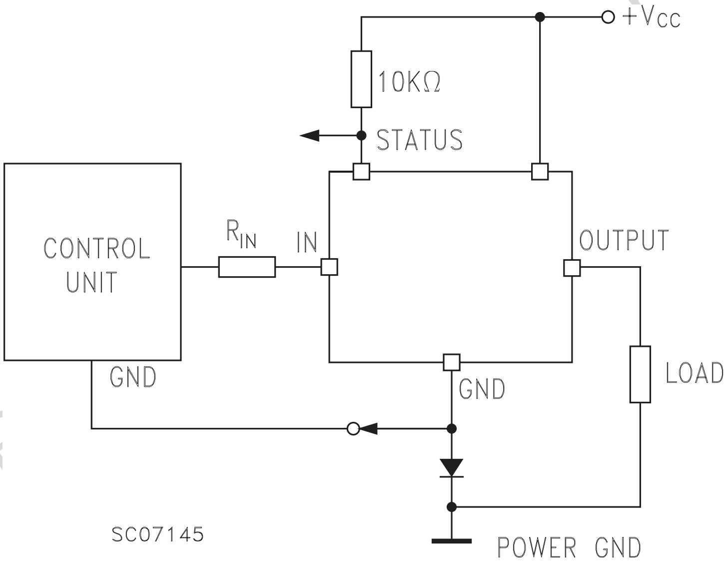


Figure 9. $R_{DS(on)}$ vs Junction Temperature

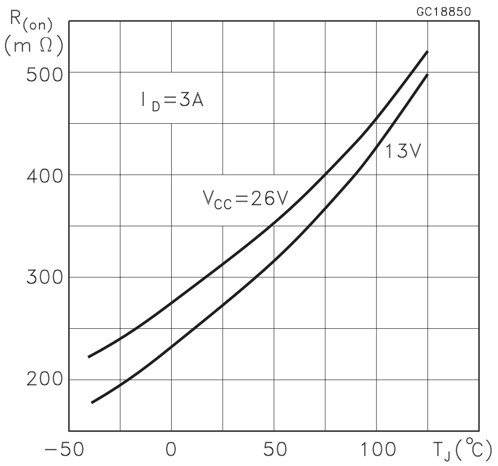


Figure 10. $R_{DS(on)}$ vs Supply Voltage

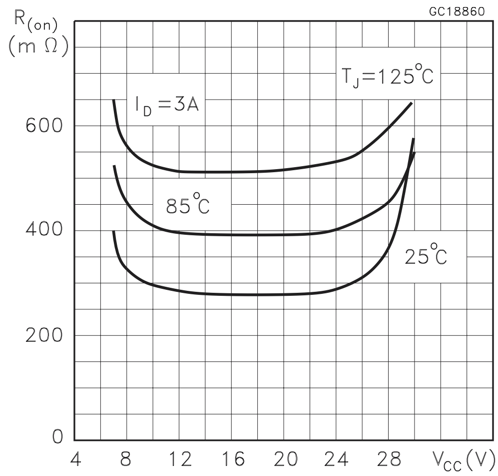


Figure 11. $R_{DS(on)}$ vs Output Current

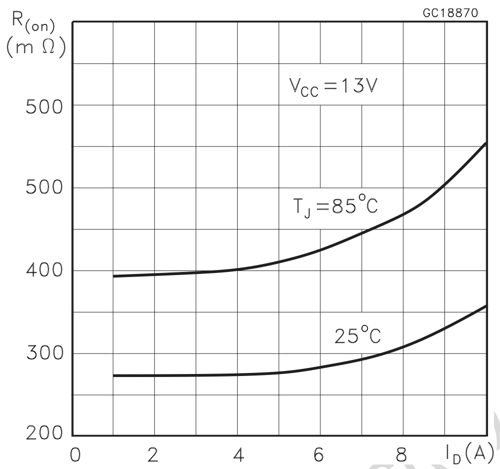


Figure 12. Input voltages vs Junction Temperature

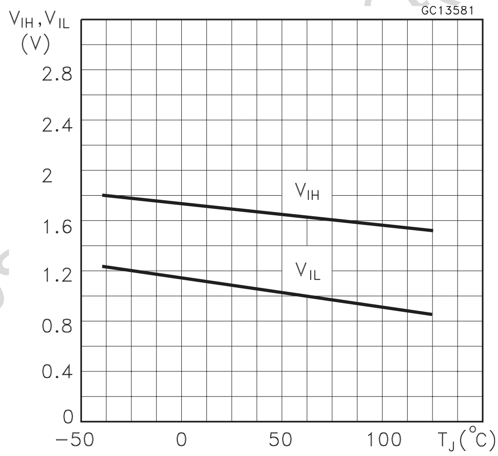


Figure 13. Output Current Derating

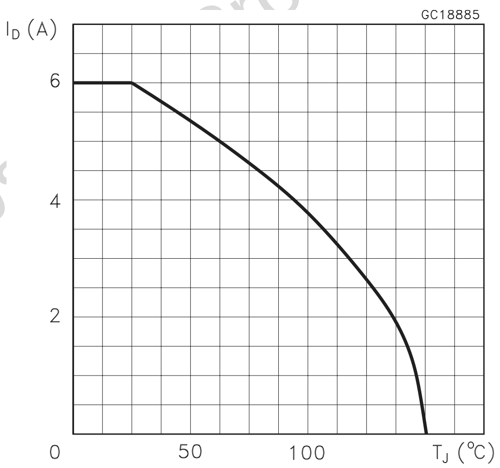
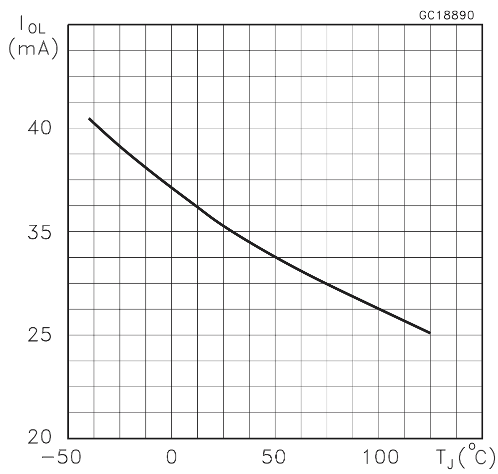


Figure 14. Open Load vs Junction Temperature

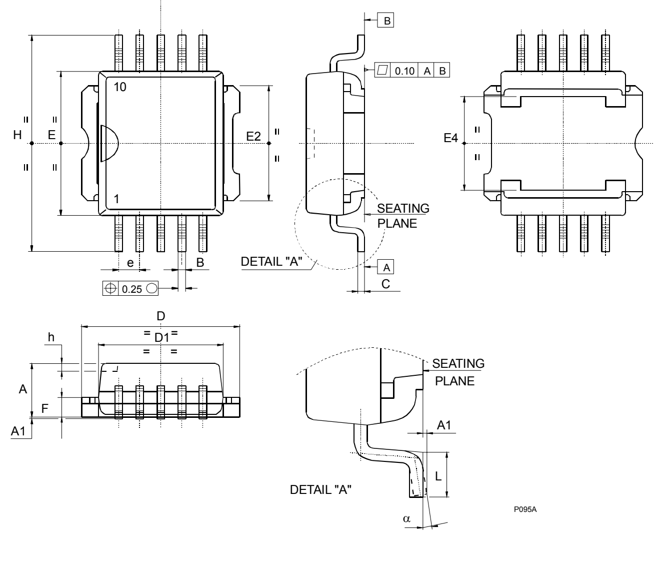


PACKAGE MECHANICAL

Table 10. PowerSO-10 Mechanical Data

Symbol	millimeters		
	Min	Typ	Max
A	3.35		3.65
A (*)	3.4		3.6
A1	0.00		0.10
B	0.40		0.60
B (*)	0.37		0.53
C	0.35		0.55
C (*)	0.23		0.32
D	9.40		9.60
D1	7.40		7.60
E	9.30		9.50
E2	7.20		7.60
E2 (*)	7.30		7.50
E4	5.90		6.10
E4 (*)	5.90		6.30
e		1.27	
F	1.25		1.35
F (*)	1.20		1.40
H	13.80		14.40
H (*)	13.85		14.35
h		0.50	
L	1.20		1.80
L (*)	0.80		1.10
a	0º		8º
α (*)	2º		8º

Figure 15. PowerSO-10 Package Dimensions

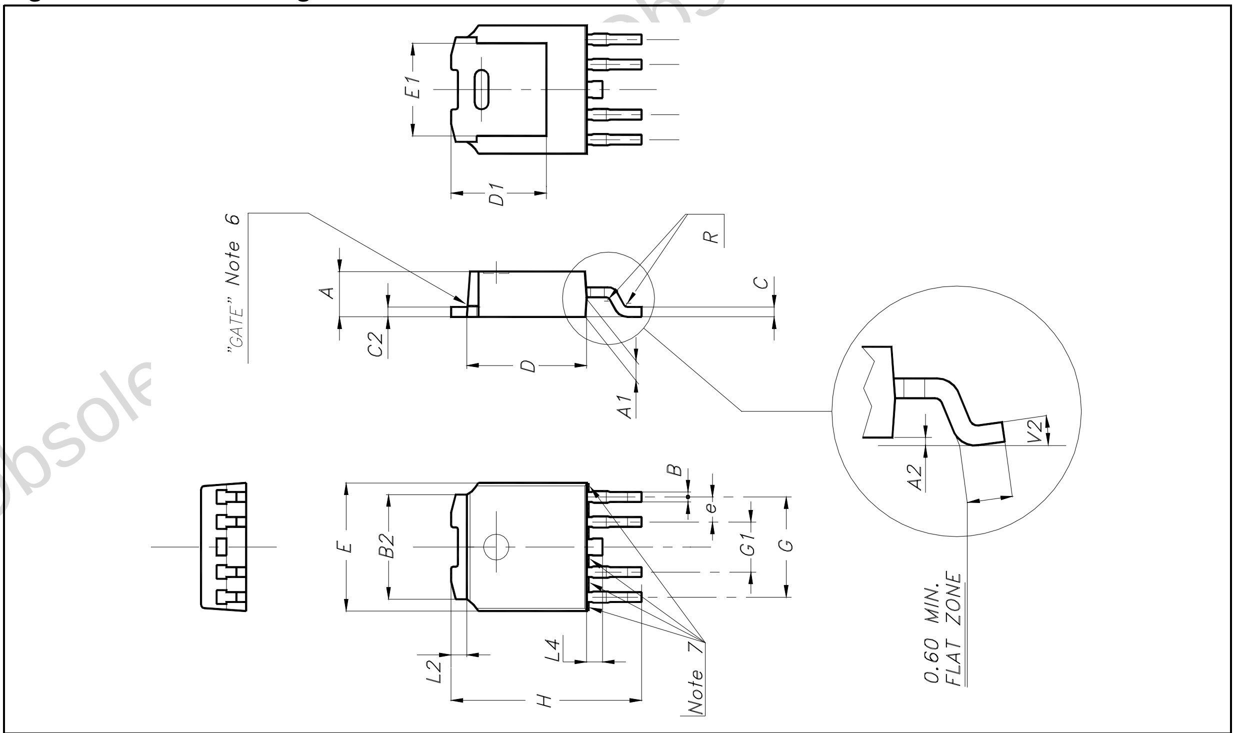


Note: Drawing is not to scale.

Table 11. PPAK Mechanical Data

Symbol	millimeters		
	Min	Typ	Max
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
B	0.40		0.60
B2	5.20		5.40
C	0.45		0.60
C2	0.48		0.60
D1		5.1	
D	6.00		6.20
E	6.40		6.60
E1		4.7	
e		1.27	
G	4.90		5.25
G1	2.38		2.70
H	9.35		10.10
L2		0.8	1.00
L4	0.60		1.00
R		0.2	
V2	0º		8º
Package Weight	Gr. 0.3		

Figure 16. PPAK Package Dimensions



Note: Drawing is not to scale.

REVISION HISTORY

Table 12. Revision History

Date	Revision	Description of Changes
September-1997	1	First Issue
18-June-2004	2	Stylesheet update. No content change.