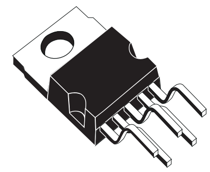
VN02AN

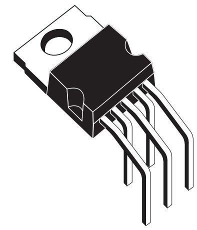
HIGH SIDE SMART POWER SOLID STATE RELAY

TYPE	V_{DSS}	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN02AN	60 V	0.35 Ω	7 A	36 V

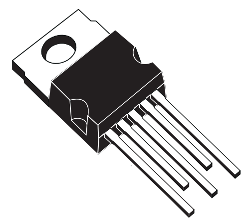
- OUTPUT CURRENT (CONTINUOUS): 7A @ T_c=25^{o}C
- LOGIC LEVEL 5V COMPATIBLE INPUT
- THERMAL SHUT-DOWN
- UNDER VOLTAGE PROTECTION
- OPEN DRAIN DIAGNOSTIC OUTPUT
- FAST DEMAGNETIZATION OF INDUCTIVE LOAD



PENTAWATT (vertical)



PENTAWATT (horizontal)



PENTAWATT (in-line)

ORDER CODES:

PENTAWATT vertical	VN02AN
PENTAWATT horizontal	VN02AN(011Y)
PENTAWATT in-line	VN02AN(012Y)

DESCRIPTION

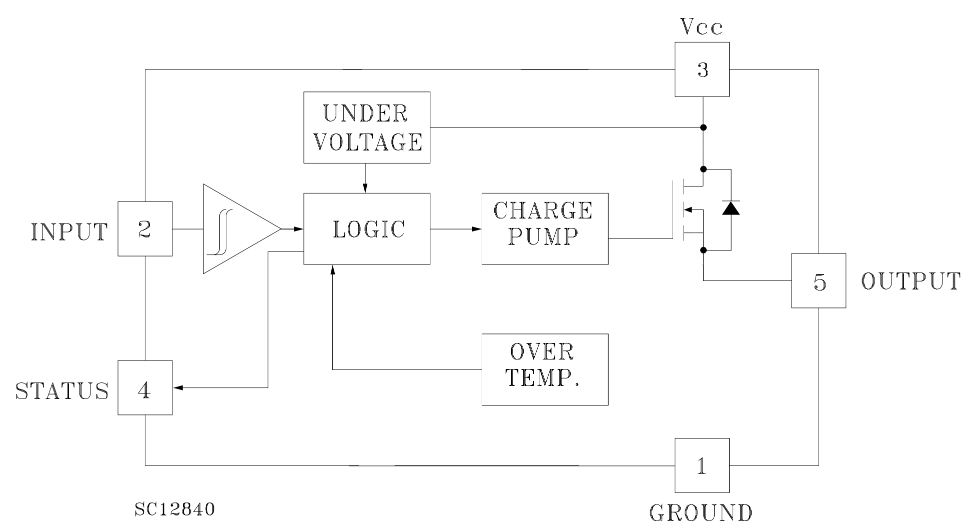
The VN02AN is a monolithic device made using STMicroelectronics VIPower Technology, intended for driving resistive or inductive loads with one side grounded.

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

The diagnostic output indicates an over temperature status.

Fast turn-off of inductive load is achieved by negative (-18 V) load voltage at turn-off.

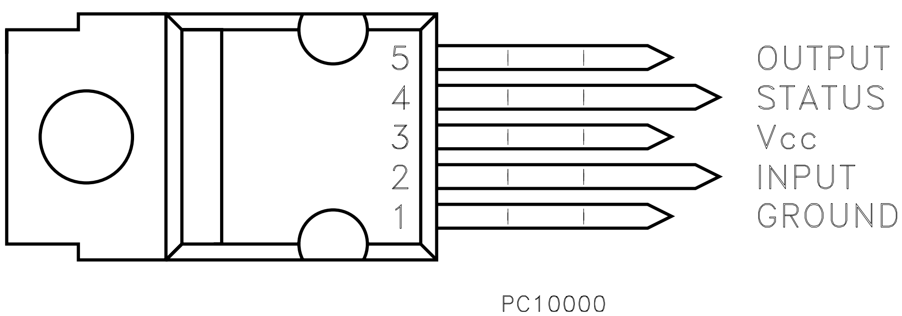
BLOCK DIAGRAM



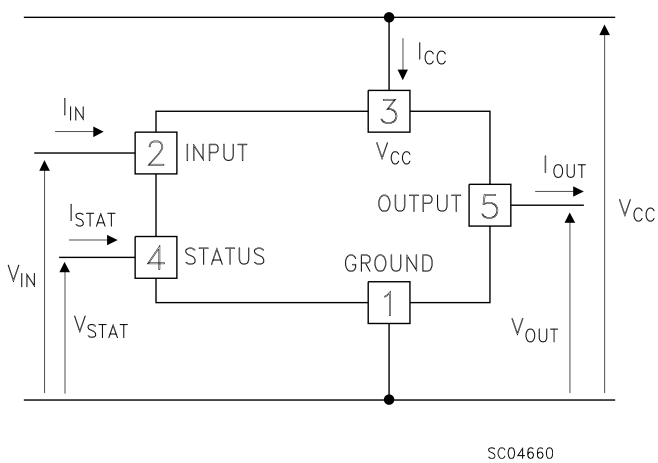
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	60	V
I_{OUT}	Output Current (cont.)	7	A
I_R	Reverse Output Current	-7	A
I_{IN}	Input Current	±10	mA
$-V_{CC}$	Reverse Supply Voltage	-4	V
I_{STAT}	Status Current (sink)	±10	mA
V_{ESD}	Electrostatic Discharge (1.5 kΩ, 100 pF)	2000	V
P_{tot}	Power Dissipation at $T_c \leq 25$ °C	31	W
T_j	Junction Operating Temperature	-40 to 150	°C
T_{stg}	Storage Temperature	-55 to 150	°C

CONNECTION DIAGRAMS



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

$R_{thj-case}$	Thermal Resistance Junction-case Max	4	$^oC/W$
$R_{thj-amb}$	Thermal Resistance Junction-ambient Max	60	$^oC/W$

ELECTRICAL CHARACTERISTICS (V_{CC} = 9 to 36 V; T_{case} = 25 ^oC unless otherwise specified)

POWER

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{CC} *	Supply Voltage	-40 ^oC < T_j < 125 ^oC	7		36	V
R_{on}	On State Resistance	I_{OUT} = 3 A I_{OUT} = 1 A V_{CC} = 30 V T_j = 125 ^oC			0.35 0.6	Ω Ω
I_S	Supply Current	Off State V_{CC} = 30 V On State V_{CC} = 30 V On State V_{CC} = 30 V T_j = 125 ^oC			1 9 7	mA mA mA

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		15		μs
t_r	Rise Time Of Output Current	I_{OUT} = 3 A Resistive Load Input Rise Time < 0.1 μs		15		μs
$t_{d(off)}$	Turn-off Delay Time Of Output Current	I_{OUT} = 3 A Resistive Load Input Rise Time < 0.1 μs		14		μs
t_f	Fall Time Of Output Current	I_{OUT} = 3 A Resistive Load Input Rise Time < 0.1 μs		4.5		μs
$(di/dt)_{on}$	Turn-on Current Slope	I_{OUT} = 3 A 25 ^oC < T_j < 125 ^oC I_{OUT} = I_{OV} 25 ^oC < T_j < 125 ^oC			0.5 1	A/μs A/μs
$(di/dt)_{off}$	Turn-off Current Slope	I_{OUT} = 3 A 25 ^oC < T_j < 125 ^oC I_{OUT} = I_{OV} 25 ^oC < T_j < 125 ^oC			1.5 4	A/μs A/μs
V_{DEMAG}	Inductive Load Clamp Voltage	I_{OUT} = 3 A -40 ^oC < T_j < 125 ^oC	-24	-18	-14	V

LOGIC INPUT (-40 $^oC \le T_j \le$ 125 ^oC unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IL}	Input Low Level Voltage				0.8	V
V_{IH}	Input High Level Voltage		2		(*)	V
$V_{I(hyst.)}$	Input Hysteresis Voltage			0.5		V
I_{IN}	Input Current	V_{IN} = 5 V V_{IN} = 2 V V_{IN} = 0.8 V	 25	250	600 300	μA μA μA
V_{ICL}	Input Clamp Voltage	I_{IN} = 10 mA I_{IN} = -10 mA	5.5	6 -0.7	 -0.3	V V

ELECTRICAL CHARACTERISTICS (continued)

PROTECTION AND DIAGNOSTICS (-40 $^oC \leq T_j \leq 125$ ^oC unless otherwise specified)

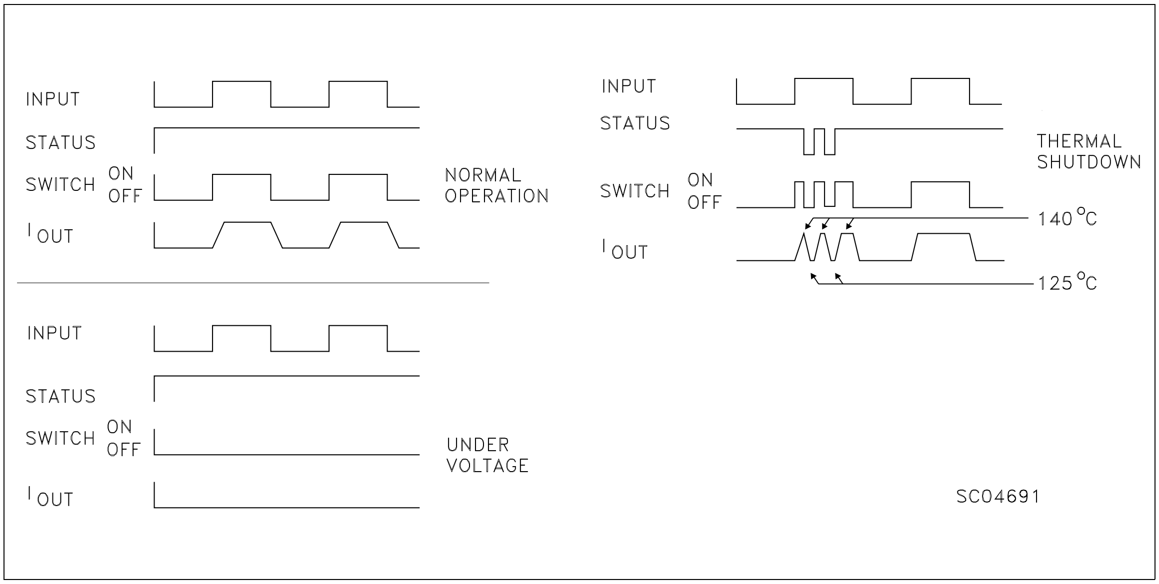
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status Voltage Output Low	I_{STAT} = 1.6 mA			0.4	V
I_{STAT}	Status Leakage Current	V_{STAT} = 5 V			10	µA
V_{USD}	Under Voltage Shut Down		3.5	6	7	V
V_{SCL}	Status Clamp Voltage	I_{STAT} = 10 mA I_{STAT} = -10 mA	5.5	6 -0.7	 -0.3	V V
I_{OV}	Over Current	R_{LOAD} < 10 mΩ		15		A
I_{av}	Average Current In Short Circuit	R_{LOAD} < 10 mΩ T_c = 85 ^oC		0.6		A
I_{DOFF}	Leakage Current	V_{CC} = 30 V			1	mA
T_{TSD}	Thermal Shut-down Temperature		140			^oC
T_R	Reset Temperature		125			^oC

(*) The Vih is internally clamped at about 6V. It is possible to connect this pin to a higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.

TRUTH TABLE

	INPUT	DIAGNOSTIC	OUTPUT
Normal Operation	L H	H H	L H
Over-temperature	H	L	L
Under-voltage	X	H	L

Figure 1: Waveforms



FUNCTIONAL DESCRIPTION

The device has a diagnostic output which indicates over temperature conditions.

The truth table shows input, diagnostic output status and output voltage level in normal operation and fault conditions. The output signals are processed by internal logic.

To protect the device against short circuit and over current conditions, the thermal protection turns the integrated Power MOS off at a minimum junction temperature of 140 ^{o}C. When the temperature returns to 125 ^{o}C the switch is automatically turned on again. To ensure the protection in all V_{CC} conditions and in all the junction temperature range it is necessary to limit the voltage drop across Drain and Source (pin 3 and 5) at 28V according to:

$V_{ds} = V_{CC} - I_{OV} * (R_i + R_w + R_l)$

where:

R_i = internal resistence of Power Supply
R_w = Wires resistance
R_l = Short Circuit resistance

Driving inductive loads, an internal function of the device ensures the fast demagnetization with typical voltage (V_{demag}) of -18V.

This function allows the reduction of the power dissipation according to the formula:

$P_{dem} = 0.5 * L_{load} * (I_{load})^2 * [(V_{CC} + V_{dem})/V_{dem}] * f$

where f = Switching Frequency

Based on this formula it is possible to know the value of inductance and/or current to avoid a thermal shut-down.

PROTECTING THE DEVICE AGAINST REVERSE BATTERY

The simpliest way to protect the device against a continuous reverse battery voltage (-36V) is to insert a Schottky diode between pin 1 (GND) and ground, as shown in the typical application circuit (Fig. 3). 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 Vstat are increased by V_f with respect to power GND).

The undervoltage shut-down 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 fig. 4), which becomes the common signal GND for the whole control board avoiding shift of V_{ih}, V_{il} and V_{stat}. This solution allows the use of a standard diode.

Figure 2: Over Current Test Circuit

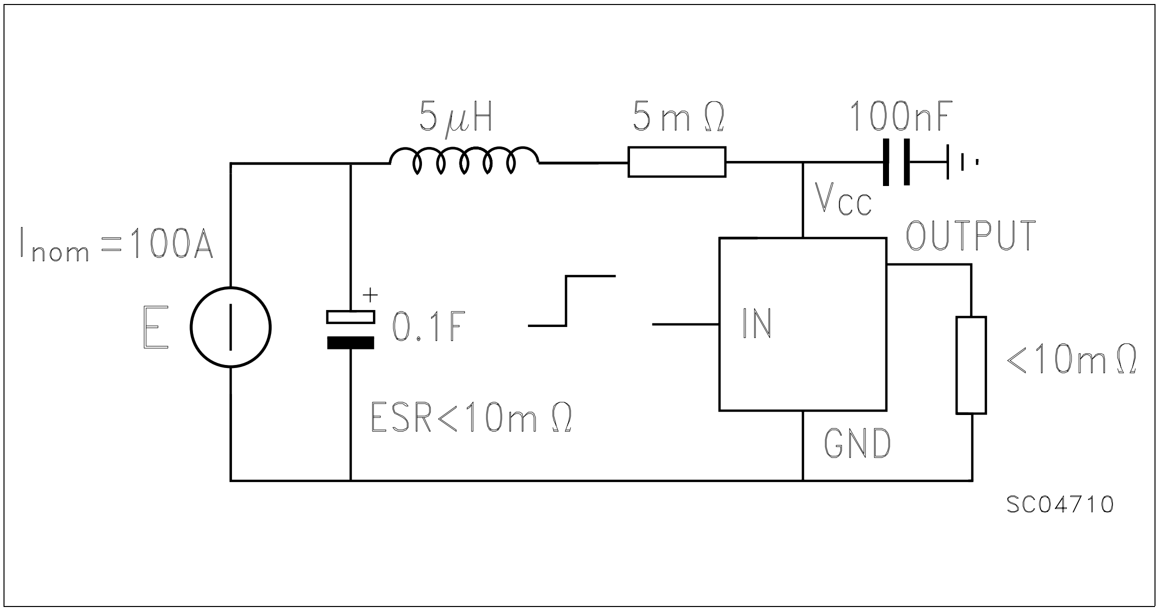


Figure 3: Typical Application Circuit With A Schottky Diode For Reverse Supply Protection

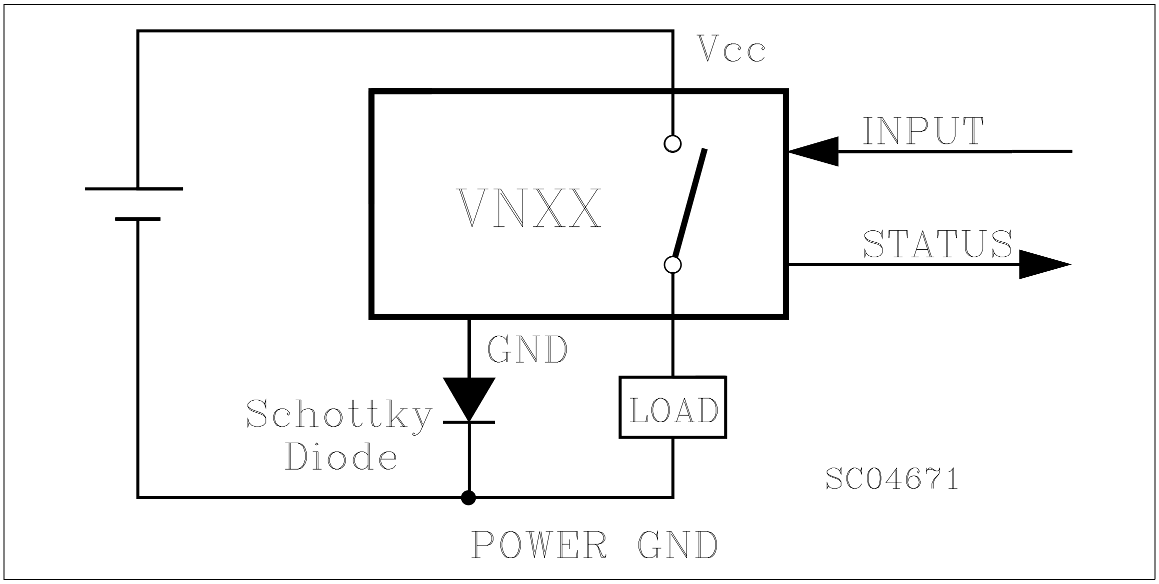
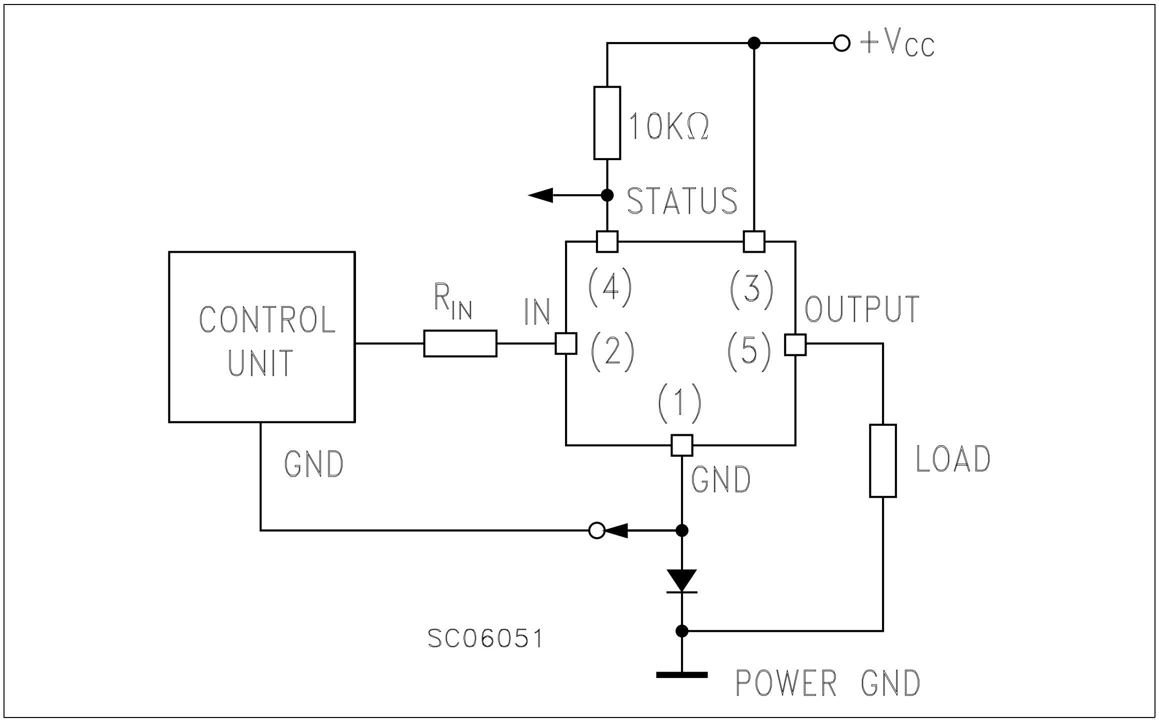
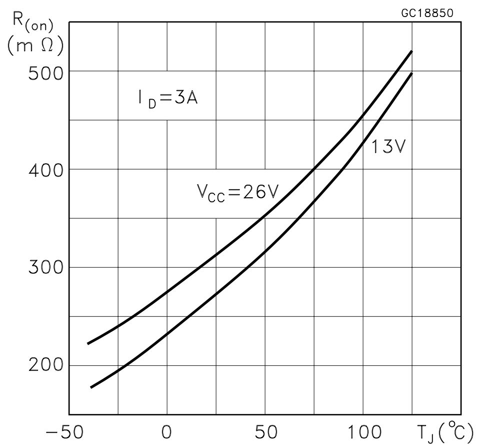


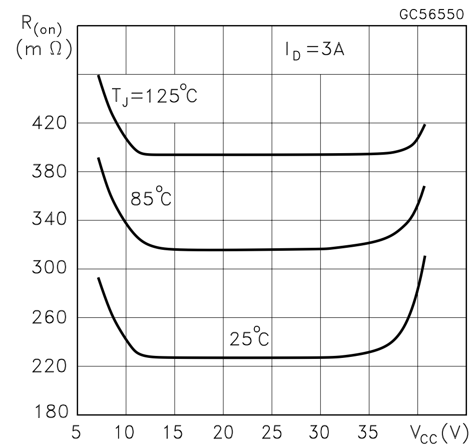
Figure 4: Typical Application Circuit With Separate Signal Ground



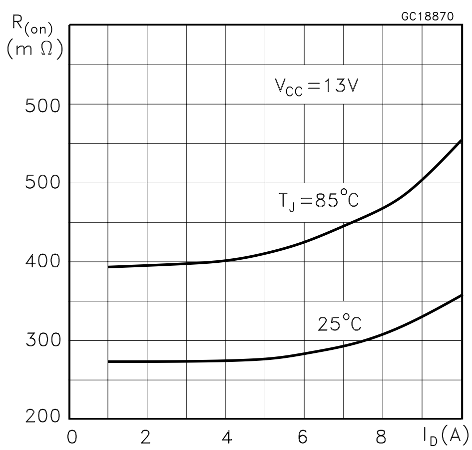
$R_{DS(on)}$ vs Junction Temperature



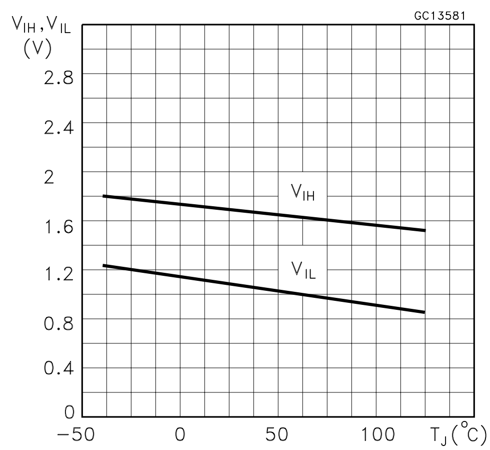
$R_{DS(on)}$ vs Supply Voltage



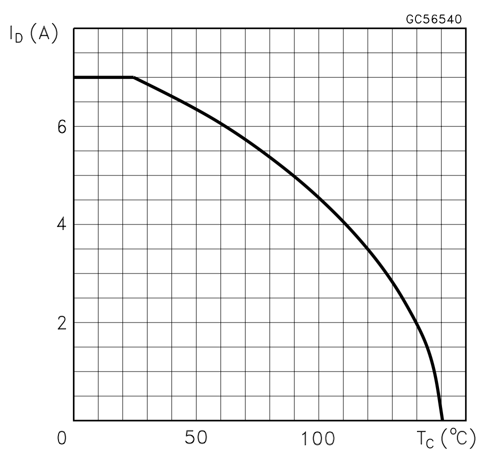
$R_{DS(on)}$ vs Output Current



Input Voltages vs Junction Temperature

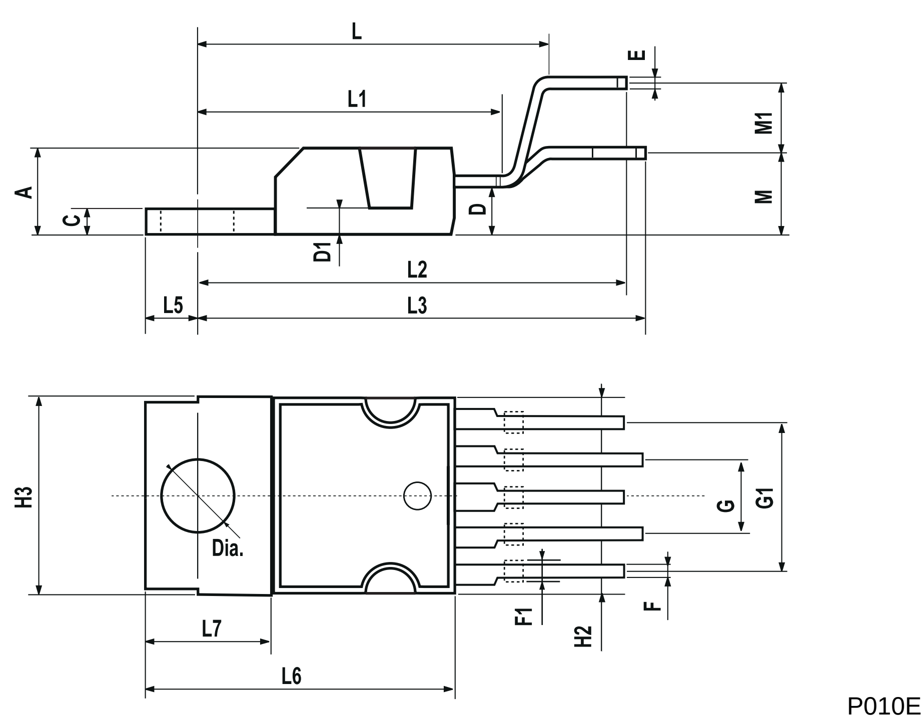


Output Current Derating



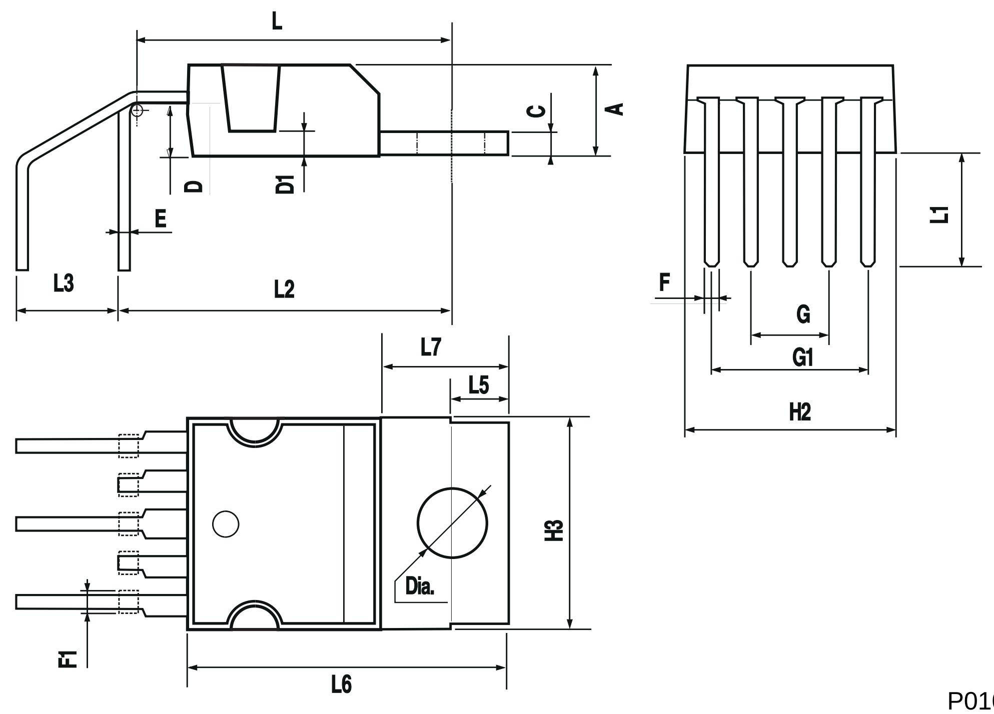
PENTAWATT (VERTICAL) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G	3.2	3.4	3.6	0.126	0.134	0.142
G1	6.6	6.8	7	0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		17.85			0.703	
L1		15.75			0.620	
L2		21.4			0.843	
L3		22.5			0.886	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
M		4.5			0.177	
M1		4			0.157	
Dia	3.65		3.85	0.144		0.152



PENTAWATT (HORIZONTAL) MECHANICAL DATA

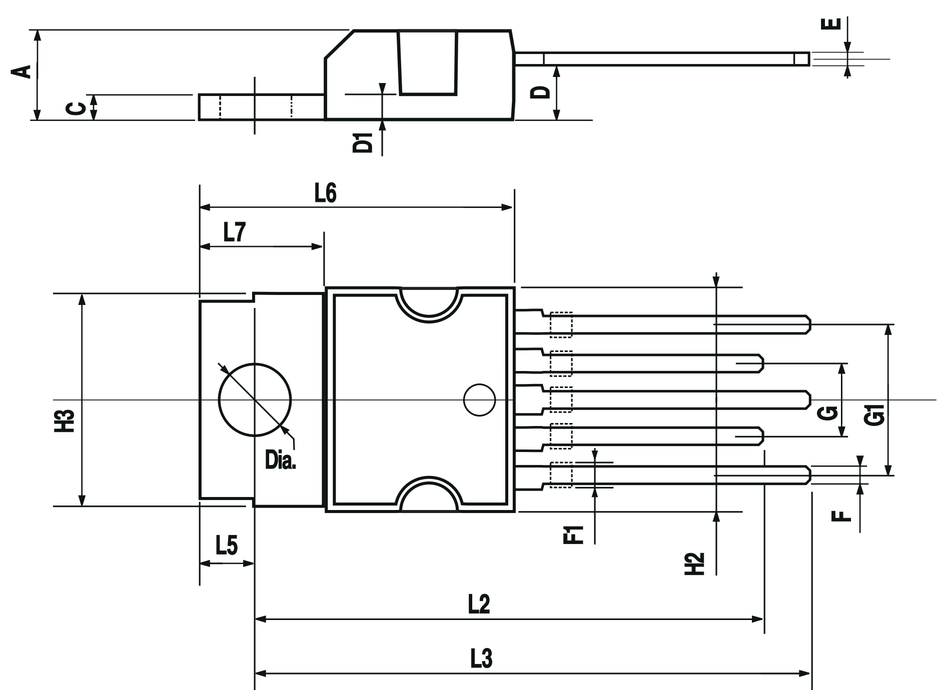
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G	3.2	3.4	3.6	0.126	0.134	0.142
G1	6.6	6.8	7	0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L	14.2		15	0.559		0.590
L1	5.7		6.2			0244
L2	14.6		15.2			0.598
L3	3.5		4.1	0.137		0.161
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
Dia	3.65		3.85	0.144		0.152



P010F

PENTAWATT (IN-LINE) MECHANICAL DATA

DIM.	mm			inch		
	MIN	TYP	MAX	MIN	TYP	MAX
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G	3.2	3.4	3.6	0.126	0.134	0.142
G1	6.6	6.8	7	0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L2	23.05	23.4	23.8	0.907	0.921	0.937
L3	25.3	25.65	26.1	0.996	1.010	1.028
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
Diam.	3.65		3.85	0.144		0.152



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