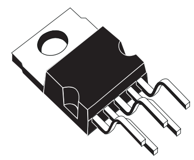
VN05N

High side smart power solid state relay

Features

Type	V_{DSS}	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN05N	60 V	0.18 Ω	13 A	26 V

- Output current (continuous): 13A @ T_c=25°C
- 5V logic level compatible input
- Thermal shutdown
- Under voltage shutdown
- Open drain diagnostic output
- Very low standby power dissipation



PENTAWATT

Description

The VN05N is a monolithic device made using STMicroelectronics VIPower technology, intended for driving resistive or inductive loads with one side grounded. Built-in thermal shutdown 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 1. Device summary

Package	Order codes
PENTAWATT	VN05N

Contents

1 **Block diagram and pin description 5**

2 **Electrical specifications 6**

2.1 Absolute maximum ratings 6

2.2 Thermal data 7

2.3 Electrical characteristics 7

2.4 Electrical characteristics curves 10

3 **Application information 11**

3.1 Functional description 12

3.2 Protecting the device against reverse battery 12

4 **Package and packing information 13**

4.1 ECOPACK® packages 13

4.2 PENTAWATT mechanical data 13

5 **Revision history 15**

List of tables

Table 1. Device summary 1
Table 2. Absolute maximum ratings 6
Table 3. Thermal data. 7
Table 4. Power 7
Table 5. Switching (V_{CC}=13V) 7
Table 6. Logic inputs. 8
Table 7. Protections and diagnostics 8
Table 8. Truth table. 8
Table 9. PENTAWATT mechanical data 14
Table 10. Document revision history 15

List of figures

Figure 1. Block diagram 5
Figure 2. Configuration diagram (top view) 5
Figure 3. Current and voltage conventions 6
Figure 4. Waveforms 9
Figure 5. Over current test circuit 9
Figure 6. R_{DS}(on) vs junction temperature 10
Figure 7. R_{DS}(on) vs supply voltage 10
Figure 8. R_{DS}(on) vs output current 10
Figure 9. Input voltages vs junction temperature 10
Figure 10. Output current derating 10
Figure 11. Open load vs junction temperature 10
Figure 12. Typical application circuit with a schottky diode for reverse supply protection 11
Figure 13. Typical application circuit with separate signal ground 11
Figure 14. PENTAWATT package dimensions 13

1 Block diagram and pin description

Figure 1. Block diagram

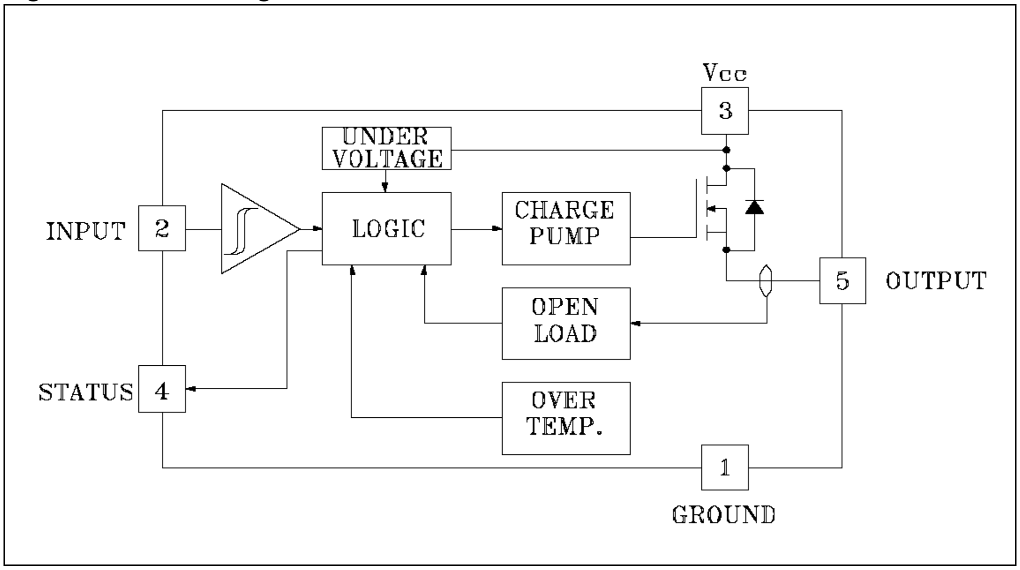
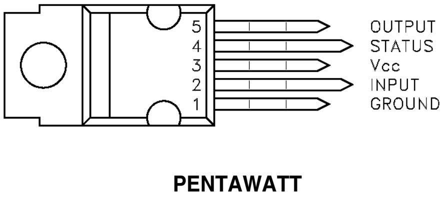
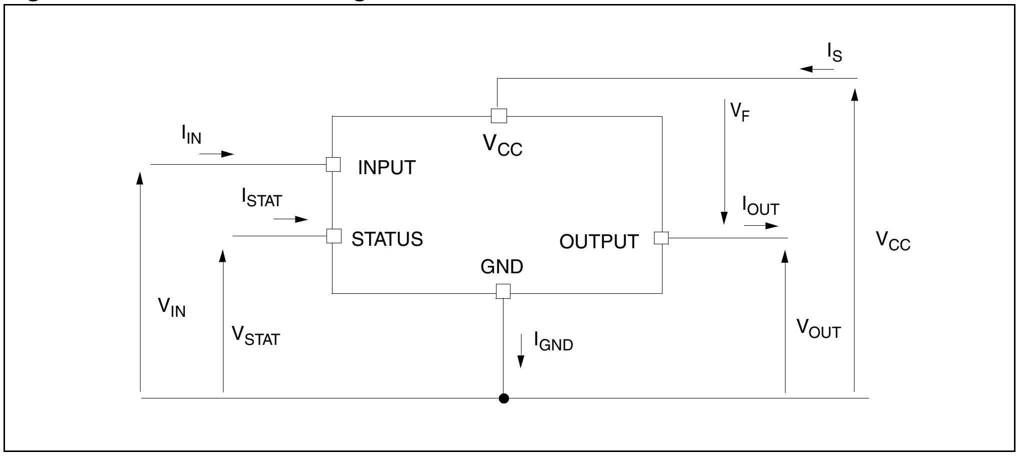


Figure 2. Configuration diagram (top view)



2 Electrical specifications

Figure 3. Current and voltage conventions



2.1 Absolute maximum ratings

Stressing the device above the rating listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to Absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics sure program and other relevant quality document.

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V(BR)DSS	Drain-Source breakdown voltage	60	V
IOUT	Output current (cont.)	13	A
IR	Reverse output current	-13	A
IIN	Input current	±10	mA
$-V_{CC}$	Reverse supply voltage	-4	V
ISTAT	Status current	±10	mA
VESD	Electrostatic discharge (1.5 kΩ, 100 pF)	2000	V
Ptot	Power dissipation at $T_c \leq 25$ °C	56	W
Tj	Junction operating temperature	-40 to 150	°C
Tstg	Storage temperature	-55 to 150	°C

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	Max. value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	2.2	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	60	°C/W

2.3 Electrical characteristics

Values specified in this section are for V_{CC}= 13V; -40°C<Tj<125°C, unless otherwise stated.

Table 4. Power

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage		7		26	V
Ron	On state resistance	I_{OUT} = 6 A I_{OUT} = 6 A Tj = 25°C			0.36 0.18	Ω Ω
I_S	Supply current	Off state Tj ≥ 25 °C On state			50 15	µA mA

Table 5. Switching (V_{CC}=13V)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time of output current	I_{OUT} = 6 A resistive load Input rise time < 0.1 ms Tj=25 °C		15		µs
t_r	Rise time of output current	I_{OUT} = 6 A resistive load Input rise time < 0.1 ms Tj=25 °C		30		µs
$t_{d(off)}$	Turn-off delay time of output current	I_{OUT} = 6 A Resistive load Input rise time < 0.1 ms Tj=25 °C		20		µs
t_f	Fall time of output current	I_{OUT} = 6 A resistive load Input rise time < 0.1 ms Tj=25 °C		10		µs
$dV_{OUT}/dt_{(on)}$	Turn-on current slope	I_{OUT} = 6 A I_{OUT} = IOV			0.5 2	A/µs A/µs
$dV_{OUT}/dt_{(off)}$	Turn-off current slope	I_{OUT} = 6 A I_{OUT} = IOV			2 4	A/µs A/µs

Table 6. Logic inputs

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IL}	Input low level voltage				0.8	V
V_{IH} (1)	Input high level voltage		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

1. 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.

Table 7. Protections and diagnostics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{STAT} (1)	Status voltage output low	I_{STAT} = 1.6 mA			0.4	V
V_{USD}	Under voltage shutdown			6.5		V
V_{SCL} (1)	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 ≤Tc ≤125 °C			60	A
I_{AV}	Average current in short circuit	R_{LOAD} < 10 mΩ Tc= 85 °C		1.4		A
I_{OL}	Open load current level		5		180	mA
T_{TSD}	Thermal shutdown temperature		140			°C
T_R	Reset temperature		125			°C

1. Status determination > 100 µs after the switching edge.

Table 8. Truth table

Conditions	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 4. Waveforms

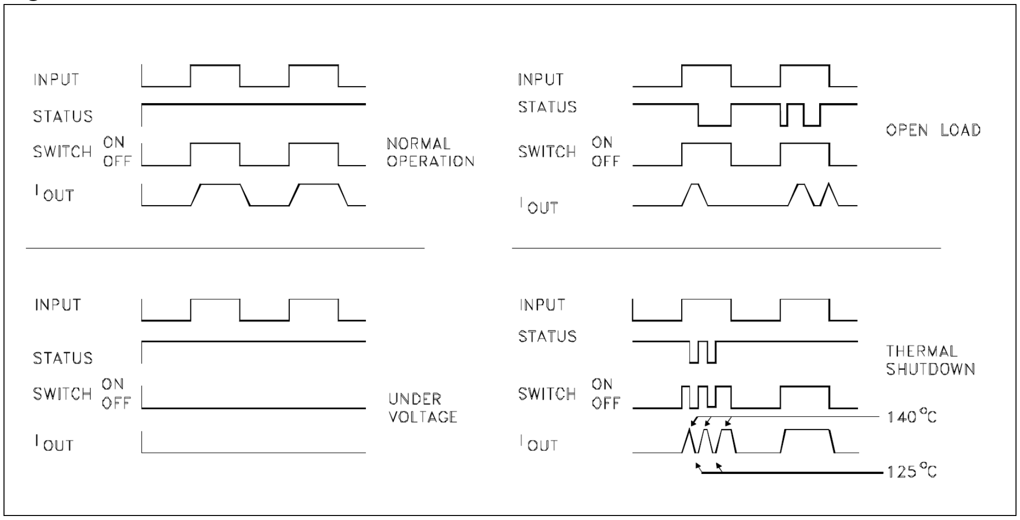
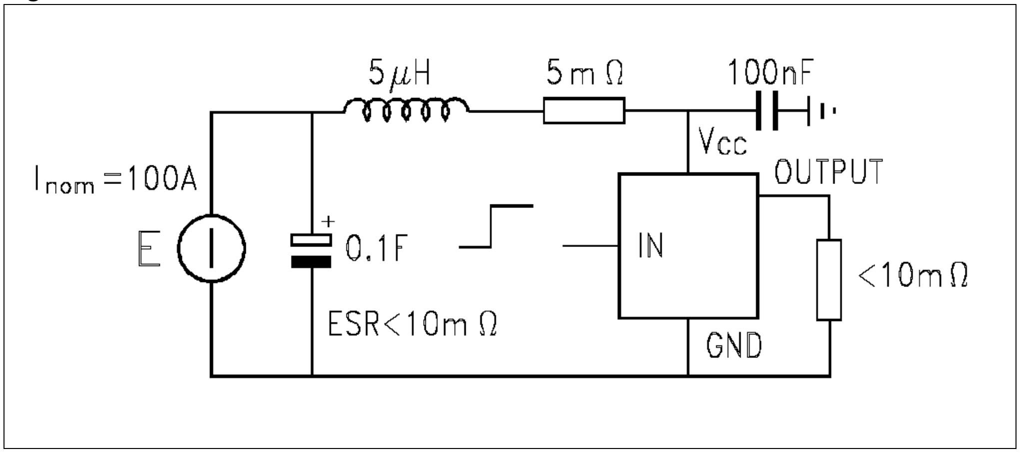


Figure 5. Over current test circuit



2.4 Electrical characteristics curves

Figure 6. $R_{DS(on)}$ vs junction temperature

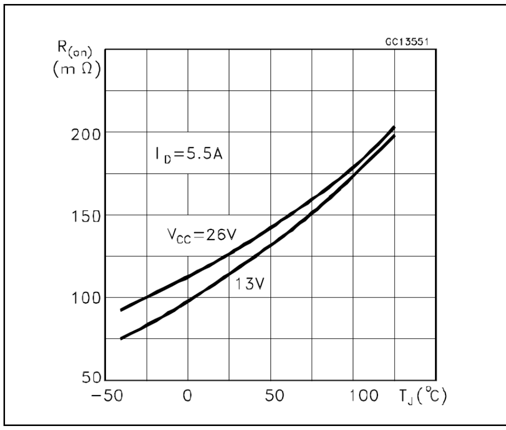


Figure 7. $R_{DS(on)}$ vs supply voltage

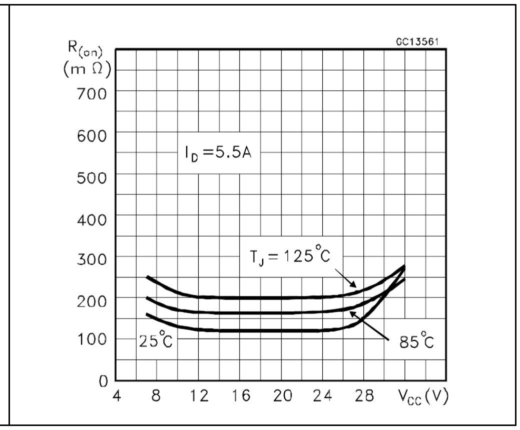


Figure 8. $R_{DS(on)}$ vs output current

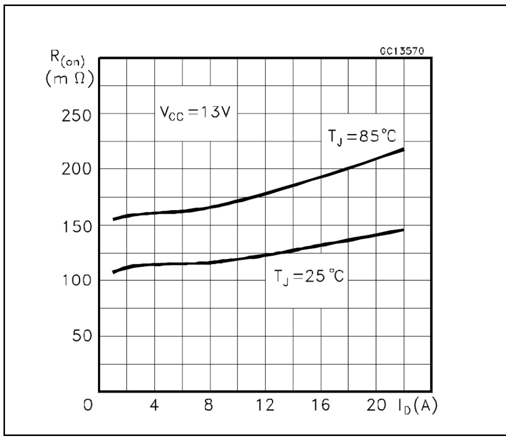


Figure 9. Input voltages vs junction temperature

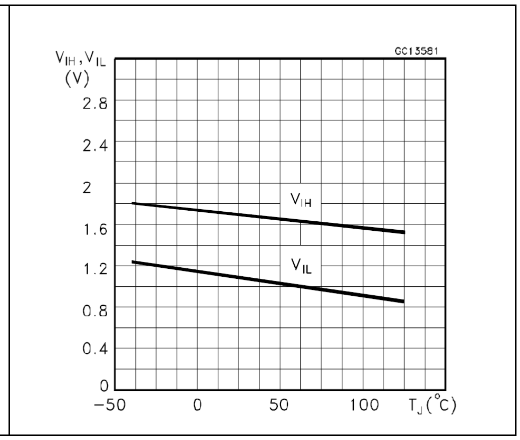


Figure 10. Output current derating

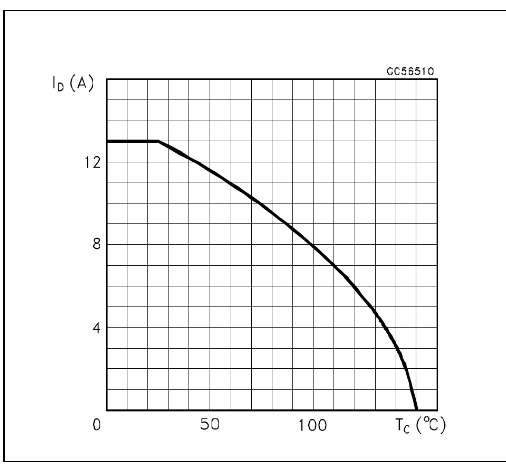
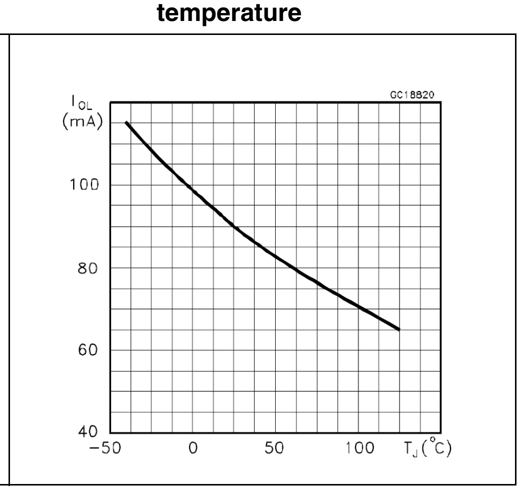


Figure 11. Open load vs junction temperature



3 Application information

Figure 12. Typical application circuit with a schottky diode for reverse supply protection

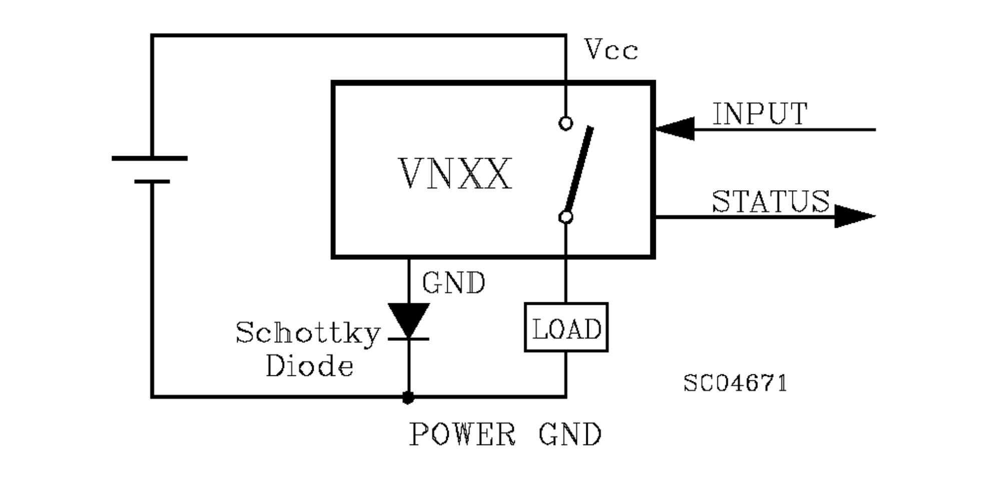
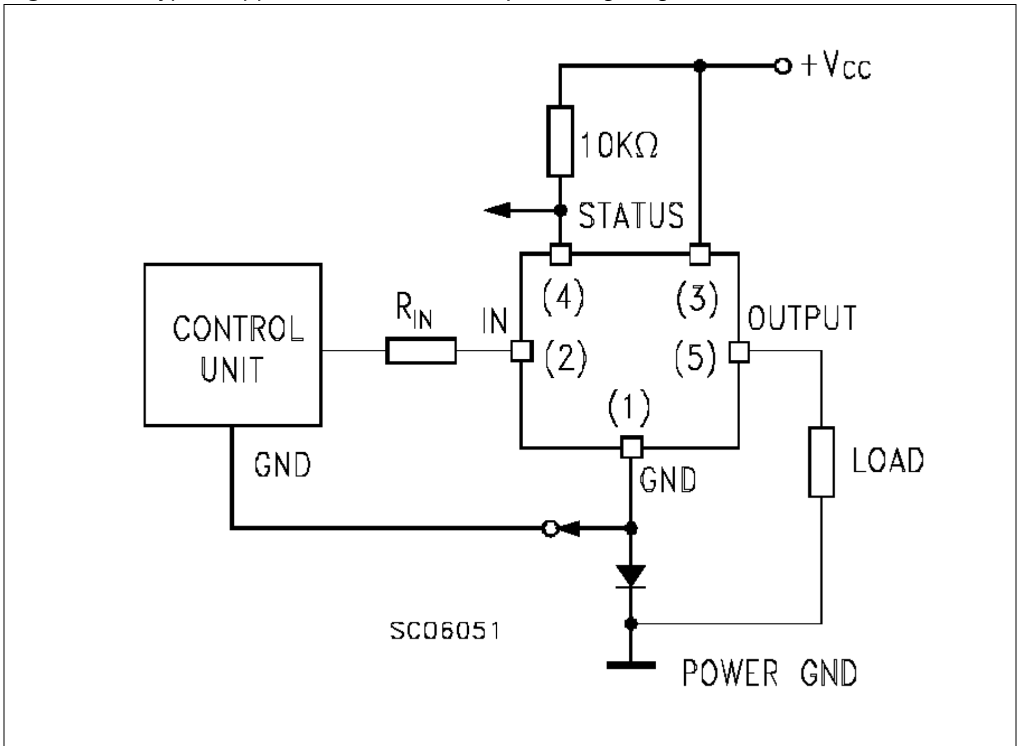


Figure 13. Typical application circuit with separate signal ground



3.1 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.

3.2 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 12.*).

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 *Figure 13.*), 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 occours in the automotive environment.

4 Package and packing information

4.1 ECOPACK® packages

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. ECOPACK® packages are lead-free. The category of Second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

ECOPACK is an ST trademark. ECOPACK specifications are available at www.st.com.

4.2 PENTAWATT mechanical data

Figure 14. PENTAWATT package dimensions

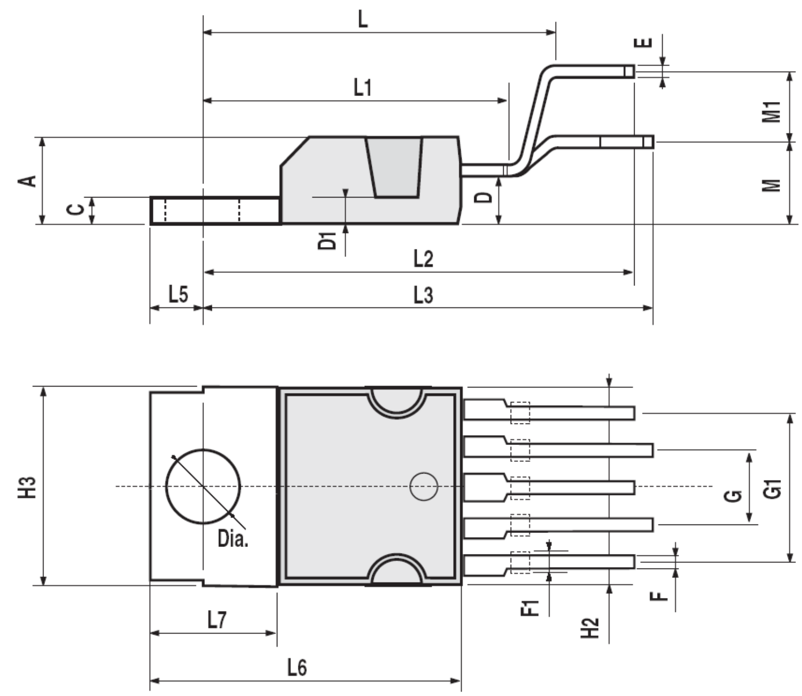


Table 9. PENTAWATT mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			4.8
C			1.37
D	2.4		2.8
D1	1.2		1.35
E	0.35		0.55
F	0.8		1.05
F1	1		1.4
G	3.2	3.4	3.6
G1	6.6	6.8	7
H2			10.4
H3	10.05		10.4
L		17.85	
L1		15.75	
L2		21.4	
L3		22.5	
L5	2.6		3
L6	15.1		15.8
L7	6		6.6
M		4.5	
M1		4	
Diam.	3.65		3.85

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
Sep-1994	1	Initial release.
05-Nov-2008	2	Document converted in corporate template. Added *Section 4.1: ECOPACK® packages*.

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