

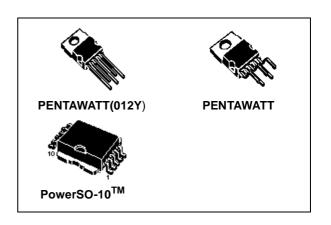
# VN540-E / VN540SP-E VN540-12-E

## SINGLE HIGH SIDE SMART POWER SOLID STATE RELAY

#### **General Features**

Туре	V <sub>demag</sub>	R <sub>DSon</sub>	l <sub>out</sub>	v <sub>cc</sub>
VN540-E VN540SP-E VN540-12-E	V <sub>CC</sub> -55V	50mΩ	2.8A	36V

- OUTPUT CURRENT (CONTINUOUS): 2.8A
- DIGITAL INPUT CLAMPED AT 32V
- PROTECTION AGAINST:
  - LOSS OF GROUND
  - SHORTED LOAD AND OVER-TEMPERATURE
- BUILT-IN CURRENT LIMITER
- UNDERVOLTAGE SHUT-DOWN
- OPEN DRAIN DIAGNOSTIC OUTPUT
- FAST DEMAGNETIZATION OF INDUCTIVE LOADS



## **Description**

The VN540-E, VN540SP-E, VN540-12-E are monolithic devices designed in STMicroelectronics VIPower technology, intended for driving resistive or inductive loads with one side connected to ground. Active current limitation avoids the system power supply dropping in case of shorted load. Built-in thermal shut-down protects the chip from overtemperature. The open drain diagnostic output indicates overtemperature conditions.

### **Block Diagram**

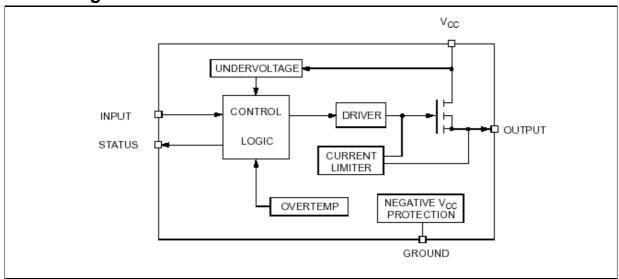


Table 1. Absolute Maximum Rating

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Power supply voltage	45	V
-V <sub>CC</sub>	Reverse supply voltage	-4.0	V
I <sub>OUT</sub>	Maximum DC load current	Internally limited	Α
I <sub>R</sub>	Reverse output current	-10	Α
I <sub>IN</sub>	Input current	± 10	mA
I <sub>STAT</sub>	Status pin current	± 10	mA
V <sub>ESD</sub>	Electrostatic discharge (R = 1.5KW; C = 100pF)	2000	V
P <sub>TOT</sub>	Power dissipation at T <sub>c</sub> = 25°C	Internally limited	w
T <sub>J</sub>	Junction operating temperature	Internally limited	°C
T <sub>STG</sub>	Storage Temperature	-55 to 150	°C
E <sub>AS</sub>	Single pulse avalanche energy	500	

Figure 1. Connection Diagram (Top View)

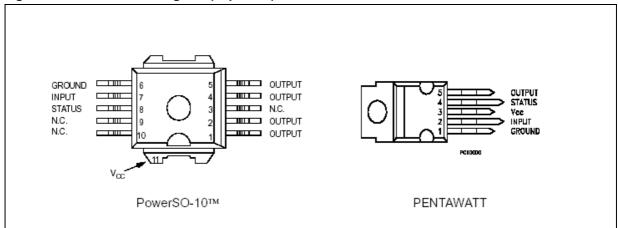
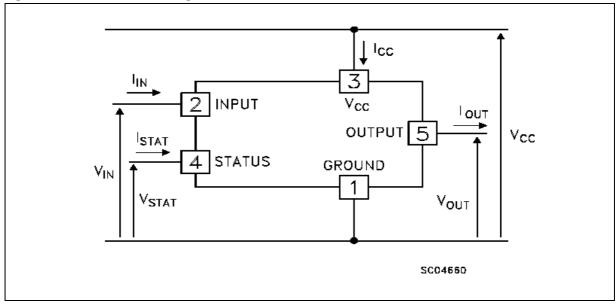


Figure 2. Current and Voltage Conventions



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Table 2. Thermal data

Symbol Parameter		Val	lue	Unit	
Symbol	r ai ailietei	PowerSO-10	Pentawatt	Oille	
R <sub>thJC</sub>	Thermal resistance junction-case	Max	1.5	2.0	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient Max		50	60	°C/W

 $\textbf{Electrical Chracteristics} \; (10 \text{V} < \text{V}_{CC} < 36 \text{V}; \; \text{-}25^{\circ}\text{C} < \text{T}_{J} < 85^{\circ}\text{C}; \; \text{unless otherwise specified})$ 

Table 3. Power Section

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>CC</sub>	Supply voltage		10		36	V
R <sub>ON</sub>	On state resistance	$I_{OUT} = 2.8A; T_J = 25^{\circ}C$			50	mΩ
TON	On state resistance	I <sub>OUT</sub> = 2.8A;			90	$m\Omega$
		OFF state			1	mA
I <sub>S</sub>	Supply current	ON state; $T_J = 125^{\circ}C$			3	mA
		$I_{OUT} = 0A$				
l. a	Output leakage current	Channel OFF			100	^
I <sub>LS</sub>	Output leakage current	$V_{CC} = 45V$			100	μA
l	Output ourrant at turn off	$V_{CC} = V_{IN} = V_{GND} = V_{STAT} = 24V$			2	mA
I <sub>LGND</sub>	Output current at turn-off	$T_{J}$ = - 25°C < $T_{J}$ < 100°C			2	ША
V <sub>OL</sub>	Low state output voltage	$V_{IN} = V_{IL}$ ; $R_{LOAD} >= 10M\Omega$			1.5	V
V <sub>demag</sub>	Output voltage at turn-off	$I_{OUT} = 2.8A$ ; $L_{LOAD} >= 1$ mH	V <sub>CC</sub> -65	V <sub>CC</sub> -55	V <sub>CC</sub> -45	V

Table 4. Switching

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t <sub>d(ON)</sub>	Turn-on delay on output current	$I_{OUT}$ = 2.8A, Resistive Load Input rise time < 0.1 $\mu$ s, $V_{CC}$ = 24V; $T_J$ = 25°C		40		μs
t <sub>r</sub>	Rise time of output current	$I_{OUT}$ = 2.8A, Resistive Load Input rise time < 0.1 $\mu$ s, $V_{CC}$ = 24V; $T_J$ = 25°C		60		μs
t <sub>d(OFF)</sub>	Turn-off delay time of output current	$I_{OUT}$ = 2.8A, Resistive Load Input rise time < 0.1µs, $V_{CC}$ = 24V; $T_J$ = 25°C		60		μs
t <sub>f</sub>	Fall time of Output current	$I_{OUT}$ = 2.8A, Resistive Load Input rise time < 0.1 $\mu$ s, $V_{CC}$ = 24V; $T_J$ = 25°C		25		μs
dl/dt <sub>(on)</sub>	Turn-on current average slope	I <sub>OUT</sub> = 2.8A, I <sub>OUT</sub> = I <sub>LIM</sub> ; 25°C < T <sub>J</sub> < 140°C			0.5 2	A/μs
dI/dt <sub>(off)</sub>	Turn-off current average slope	I <sub>OUT</sub> = 2.8A, I <sub>OUT</sub> = I <sub>LIM</sub> ; 25°C < T <sub>J</sub> < 140°C			2 4	A/μs

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Table 5. Logical Input

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>IL</sub>	Input low level voltage				2.0	V
V <sub>IH</sub>	Input high level voltage		3.5			V
V <sub>I(HYST)</sub>	Input hysteresis voltage			0.5		V
I	land and an and	$V_{IN} = 30V$ $V_{IN} = 2.0V$			300	μΑ
IN	Input current	$V_{IN} = 2.0V$	25			μΑ
V	I/O Input clamp voltage	I <sub>IN</sub> = 1mA	32	36		V
V <sub>ICL</sub>	Note 1	$I_{IN} = -1 \text{mA}$		-0.7		V

Note: 1 The input voltage is internally clamped at 32V minimum, it is possible to connect the input pins to an higher voltage via an external resistor calculate to not exeed 10mA

Table 6. Protection and Diagnostic

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>STAT</sub>	Status output voltage	I <sub>STAT</sub> = 5mA ( Fault condition )			1	V
V <sub>SCL(*)</sub>	Status clamp voltage	I <sub>STAT</sub> = 1mA	32	36		V
SCL( )	Clarac damp voltage	I <sub>STAT</sub> = -1mA		-0.7		V
I <sub>STAT</sub>	Leakage on diagnostic pin in high state	V <sub>STAT</sub> = 5V			10	μΑ
V <sub>USD</sub>	Undervoltage shut down		5.0		8.0	V
I <sub>LIM</sub>	DC Short circuit current	$V_{CC} = 24V; R_{LOAD} < 10m\Omega$	2.8	5.0	8.0	Α
I <sub>OVPK</sub>	Peak short circuit current	$V_{CC} = 24V; V_{IN} = 30; R_{LOAD} < 10m\Omega$			4	Α
t <sub>SC</sub>	Delay time of current limiter				100	μs
T <sub>TSD</sub>	Thermal shut down temperature		150	170		ç
T <sub>R</sub>	Thermal reset temperature		135	155		°C

<sup>(\*)</sup>Status determination > 100ms after the switching edge.

Figure 3. Switching Characteristics

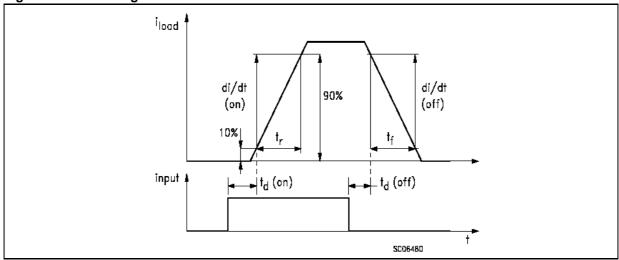


Table 7. Truth Table

	INPUT	ОИТРИТ	STATUS
Normal operation	L	L	H
	H	H	H
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	H
	H	L	H
Shorted load	L	L	H
( Current limitation )	H	H	H

Figure 4. Peak Short Test Circuit

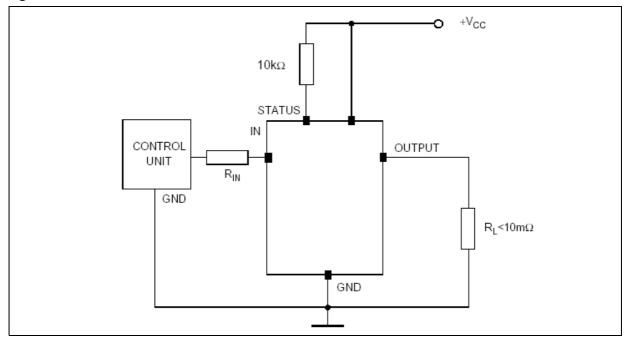


Figure 5. Switching Waveforms

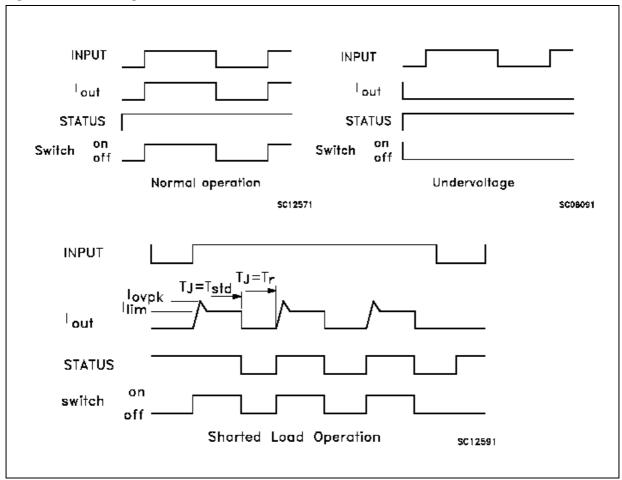
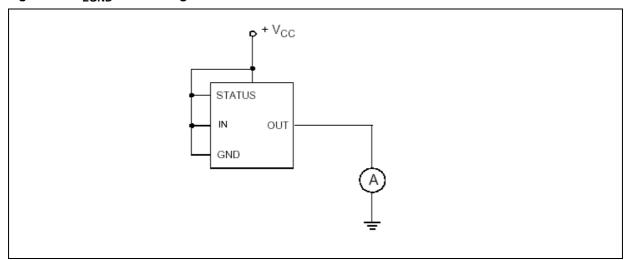


Figure 6. I<sub>LGND</sub> Test Configuration



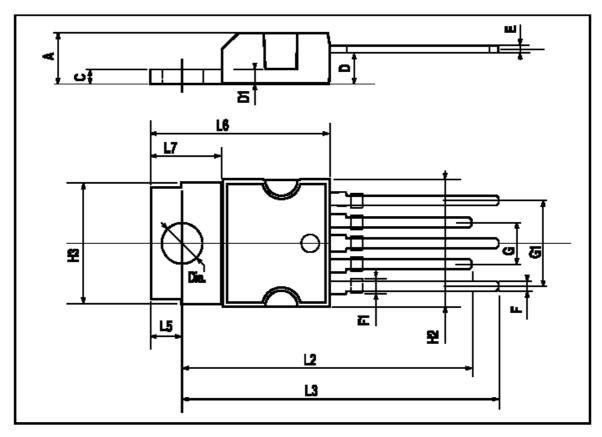
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### **Package Mechanical Data**

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a Lead-free second level interconnect. 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.

# PENTAWATT (IN-LINE) MECHANICAL DATA

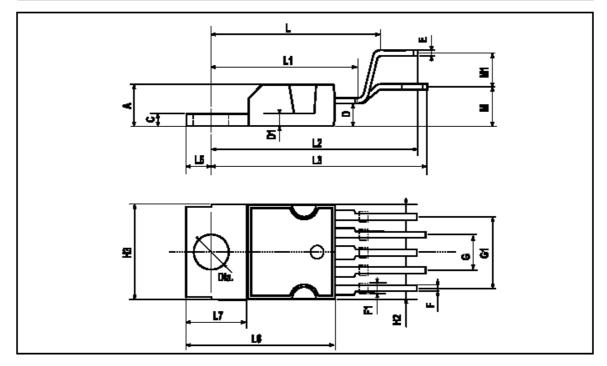
DIM		mm.			inch	
DIM.	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
А			4.8			0.189
С			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.8		1.05	0.031		0.041
F1	1		1.4	0.039		0.055
G	3.2	3.4	3.6	0.126	0.134	0.142
G1	6.6	6.8	7	0.260	0.268	0.276
H2			10.4			0.409
H3	10.05		10.4	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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# PENTAWATT (VERTICAL) MECHANICAL DATA

DIM.		mm.			inch	
DIW.	MIN.	TYP	MAX.	MIN.	TYP.	MAX
Α			4.8			0.189
С			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
Е	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	i	4.5			0.177	
M1	İ	4			0.157	
Diam.	3.65		3.85	0.144	i	0.152

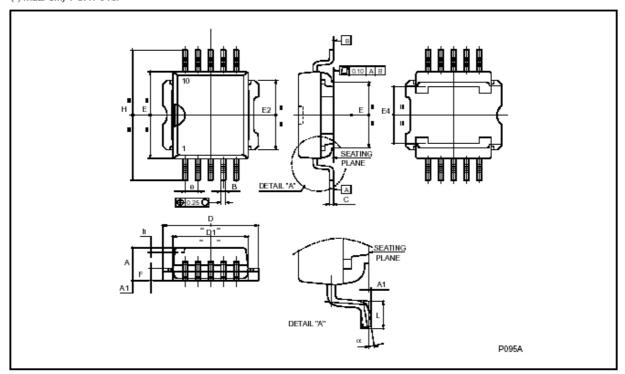


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### PowerSO-10™ MECHANICAL DATA

DIM.	mm.			inch		
DIWI.	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
Α	3.35		3.65	0.132		0.144
A (*)	3.4		3.6	0.134		0.142
A1	0.00		0.10	0.000		0.004
В	0.40		0.60	0.016		0.024
B (*)	0.37		0.53	0.014		0.021
C	0.35		0.55	0.013		0.022
C (*)	0.23		0.32	0.009		0.0126
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
Е	9.30		9.50	0.366		0.374
E2	7.20		7.60	0.283		300
E2 (*)	7.30		7.50	0.287		0.295
E4	5.90		6.10	0.232		0.240
E4 (*)	5.90		6.30	0.232		0.248
е		1.27			0.050	
F	1.25		1.35	0.049		0.053
F (*)	1.20		1.40	0.047		0.055
Н	13.80		14.40	0.543		0.567
H (*)	13.85		14.35	0.545		0.565
h		0.50			0.002	
L	1.20		1.80	0.047		0.070
L (*)	0.80		1.10	0.031		0.043
α	0°		8°	0°		8°
α (*)	2°		8°	2°		80

(\*) Muar only POA P013P



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### VN540-E / VN540SP-E / VN540-12-E

#### Table 8. Order Codes

Package	Tube	Tape and Reel
PowerSO-10 <sup>TM</sup>	VN540SP-E	VN540SPTR-E
PENTAWATT vertical	VN540-E	
PENTAWATT straight	VN540-12-E	

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#### Table 9. Revision History

Date	Revision	Changes
2-Nov-2005	1	Initial release

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