

High side driver

Type	R _{DS(on)}	I _{out}	V _{CC}
VN751PT	60 mΩ	2.5 A	36 V

- 
- PPAK

The VN751PT is a monolithic device designed in STMicroelectronics VIPower M0-3 technology, intended for driving any kind of load with one side connected to ground. Active V_{CC} pin voltage clamp protects the device against low energy spikes. Active current limitation combined with thermal shutdown and automatic restart protect the device against overload. Device automatically turns off in case of ground pin disconnection. This device is especially suitable for industrial applications in conformity with IEC 61131-2 programmable controllers international standard.

The diagram illustrates a power MOSFET driver circuit with various protection features. The input signal (INPUT) is connected to an inverter, which drives the gate of the MOSFET. The MOSFET's source is connected to ground (GND), and its drain is connected to the output (OUTPUT). The output is also connected to a load (represented by a resistor and a diode). The MOSFET's gate is connected to a V_{CC} CLAMP, which is connected to the V_{CC} supply. The MOSFET's drain is connected to an OVERVOLTAGE DETECTION circuit, which is connected to the V_{CC} supply. The MOSFET's gate is also connected to an UNDERVOLTAGE DETECTION circuit, which is connected to the V_{CC} supply. The MOSFET's drain is connected to a Power CLAMP, which is connected to the V_{CC} supply. The MOSFET's gate is connected to a CURRENT LIMITER, which is connected to the V_{CC} supply. The MOSFET's gate is also connected to an OVERTEMPERATURE DETECTION circuit, which is connected to the V_{CC} supply. The MOSFET's drain is connected to a STATUS signal, which is connected to the V_{CC} supply.

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1 Maximum ratings

Table 1. Absolute maximum rating

Symbol	Parameter	Value	Unit
V_{CC}	DC supply voltage (overvoltage protected)	45	V
$-V_{CC}$	Reverse DC supply voltage	-0.3	V
$-I_{GND}$	DC reverse ground pin current	-200	mA
I_{OUT}	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	-5	A
I_{IN}	DC input current	+/- 10	mA
I_{STAT}	DC status current	+/- 10	mA
V_{ESD}	Electrostatic discharge ($R = 1.5\text{ k}\Omega$; $C = 100\text{ pF}$)	5000	V
P_{tot}	Power dissipation $T_C = 25\text{ }^{\circ}\text{C}$	Internally limited	W
T_J	Junction operating temperature	Internally limited	$^{\circ}\text{C}$
T_C	Case operating temperature	- 40 to 150	$^{\circ}\text{C}$
T_{stg}	Storage temperature	- 55 to 150	$^{\circ}\text{C}$
E_{AS}	Single-pulse avalanche energy	0.8	J

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient ⁽¹⁾ Max	50	$^{\circ}\text{C/W}$
R_{thJC}	Thermal resistance junction-case Max	3	$^{\circ}\text{C/W}$

1. When mounted on a FR4 printed circuit board with 0.5 cm² of Cu (at least 35 μm thick) connected to all V_{CC} pins.

2 Pin connections

Figure 2. Connection diagram (top view)

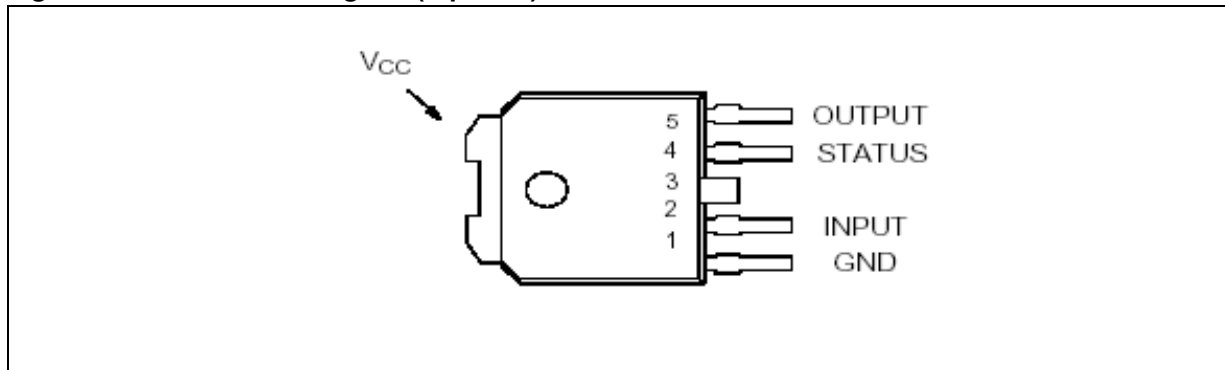
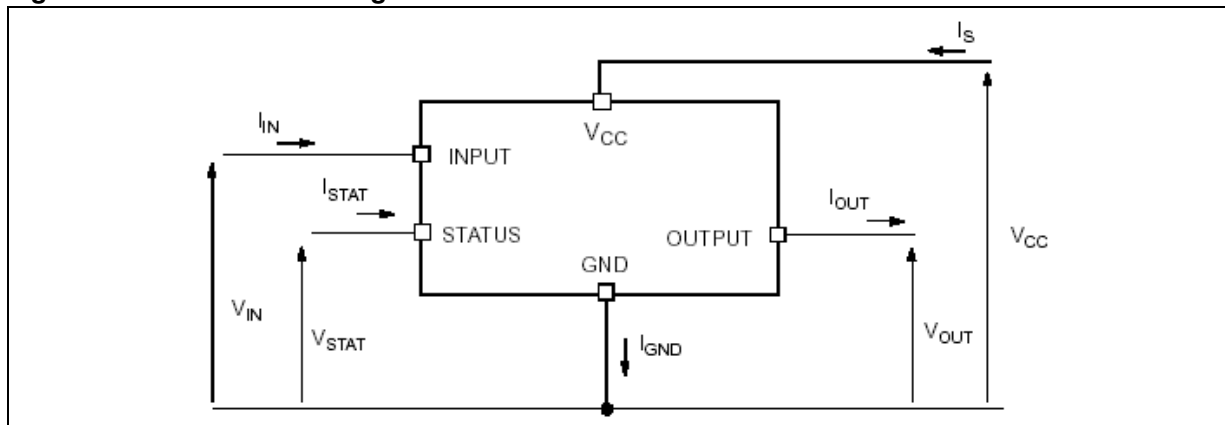


Figure 3. Current and voltage conventions



3 Electrical characteristics

8 V < V_{CC} < 36 V; -40 °C < T_J < 125 °C unless otherwise specified

Table 3. Power

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{CC}	Operating supply voltage		5.5		36	V
V_{USD}	Undervoltage shut-down		3	4	5.5	V
V_{OV}	Overvoltage shut-down		36			V
R_{ON}	On state resistance	$I_{OUT} = 2\text{ A}$; $T_J = 25\text{ °C}$ $I_{OUT} = 2\text{ A}$		60	180	mΩ mΩ
I_S	Supply current	Off State; $V_{CC} = 24\text{ V}$; $T_{CASE} = 25\text{ °C}$ On State; $V_{CC} = 24\text{ V}$ On State; $V_{CC} = 24\text{ V}$; $T_{CASE} = 100\text{ °C}$		10 1.5	20 1.8	μA mA mA
$I_{L(off)}$	OFF state output current	$V_{IN} = V_{OUT} = 0\text{ V}$	0		10	μA

Table 4. Switching ($V_{CC} = 24\text{ V}$)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	$R_L = 12\text{ Ω}$ from V_{IN} rising edge to $V_{OUT} = 2.4\text{ V}$		12		μs
$t_{d(off)}$	Turn-off delay time	$R_L = 12\text{ Ω}$ from V_{IN} falling edge to $V_{OUT} = 21.6\text{ V}$		35		μs
$dV_{OUT}/dt_{(on)}$	Turn-on voltage slope	$R_L = 12\text{ Ω}$ from $V_{OUT} = 2.4\text{ V}$ to $V_{OUT} = 19.2\text{ V}$		0.80		V/μs
$dV_{OUT}/dt_{(off)}$	Turn-off voltage slope	$R_L = 12\text{ Ω}$ from $V_{OUT} = 21.6\text{ V}$ to $V_{OUT} = 2.4\text{ V}$		0.30		V/μs

Table 5. Input pin

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{IL}	Input low level				1.25	V
I_{IL}	Low level input current	$V_{IN} = 1.25\text{ V}$	1			μA
V_{IH}	Input high level		3.25			V
I_{IH}	High level input current	$V_{IN} = 3.25\text{ V}$			10	μA
V_{hyst}	Input hysteresis voltage		0.5			V
I_{IN}	Input current	$V_{IN} = V_{CC} = 5\text{ V}$			10	μA
V_{ICL}	Input clamp voltage	$I_{IN} = 1\text{ mA}$ $I_{IN} = -1\text{ mA}$	6	6.8 -0.7	8	V V

Table 6. Status pin

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{STAT}	Status low output voltage	$I_{STAT} = 1.6\text{ mA}$			0.5	V
I_{LSTAT}	Status leakage current	Normal operation; $V_{STAT} = 5\text{ V}$			10	μA
C_{STAT}	Status pin input capacitance	Normal operation; $V_{STAT} = 5\text{ V}$			100	pF
V_{SCL}	Status clamp voltage	$I_{STAT} = 1\text{ mA}$; $I_{STAT} = -1\text{ mA}$	6	6.8 -0.7	8	V V

Table 7. Protections

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
T_{TSD}	Shut-down temperature		150	175	200	$^{\circ}\text{C}$
T_R	Reset temperature		135			$^{\circ}\text{C}$
T_{hyst}	Thermal hysteresis		7	20		$^{\circ}\text{C}$
I_{lim}	Current limitation	$V_{CC} = 24\text{ V}$, $R_{LOAD} = 10\text{ m}\Omega$, $t = 0.4\text{ ms}$	2.7		6.0	A
V_{demag}	Turn-off output clamp voltage	$R_L = 12\text{ }\Omega$; $L = 6\text{ mH}$	$V_{CC} - 47$	$V_{CC} - 52$	$V_{CC} - 57$	V

4 Waveforms and truth table

Figure 4. Switching time waveforms

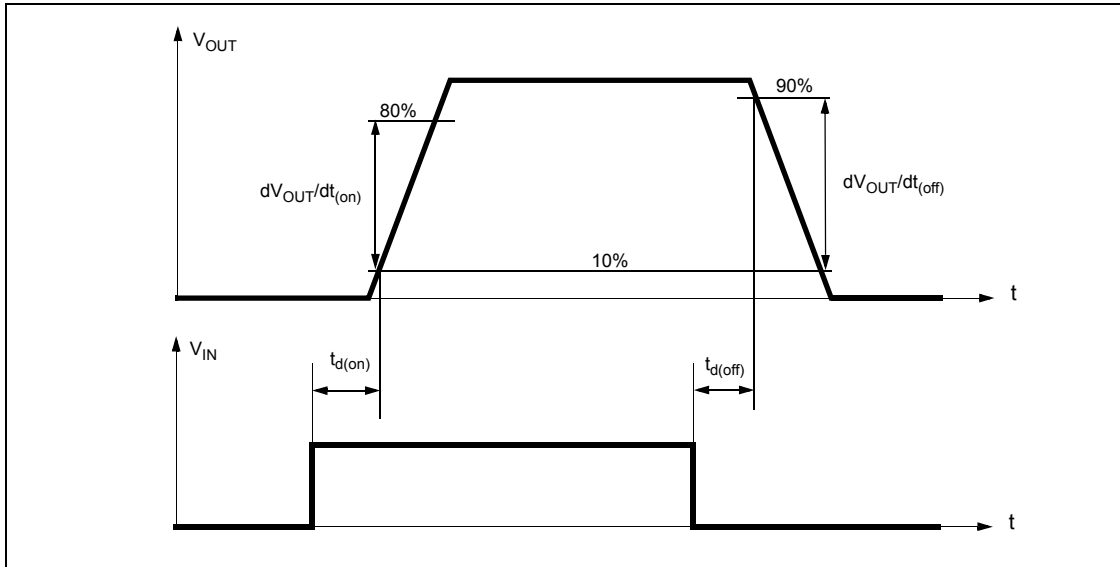
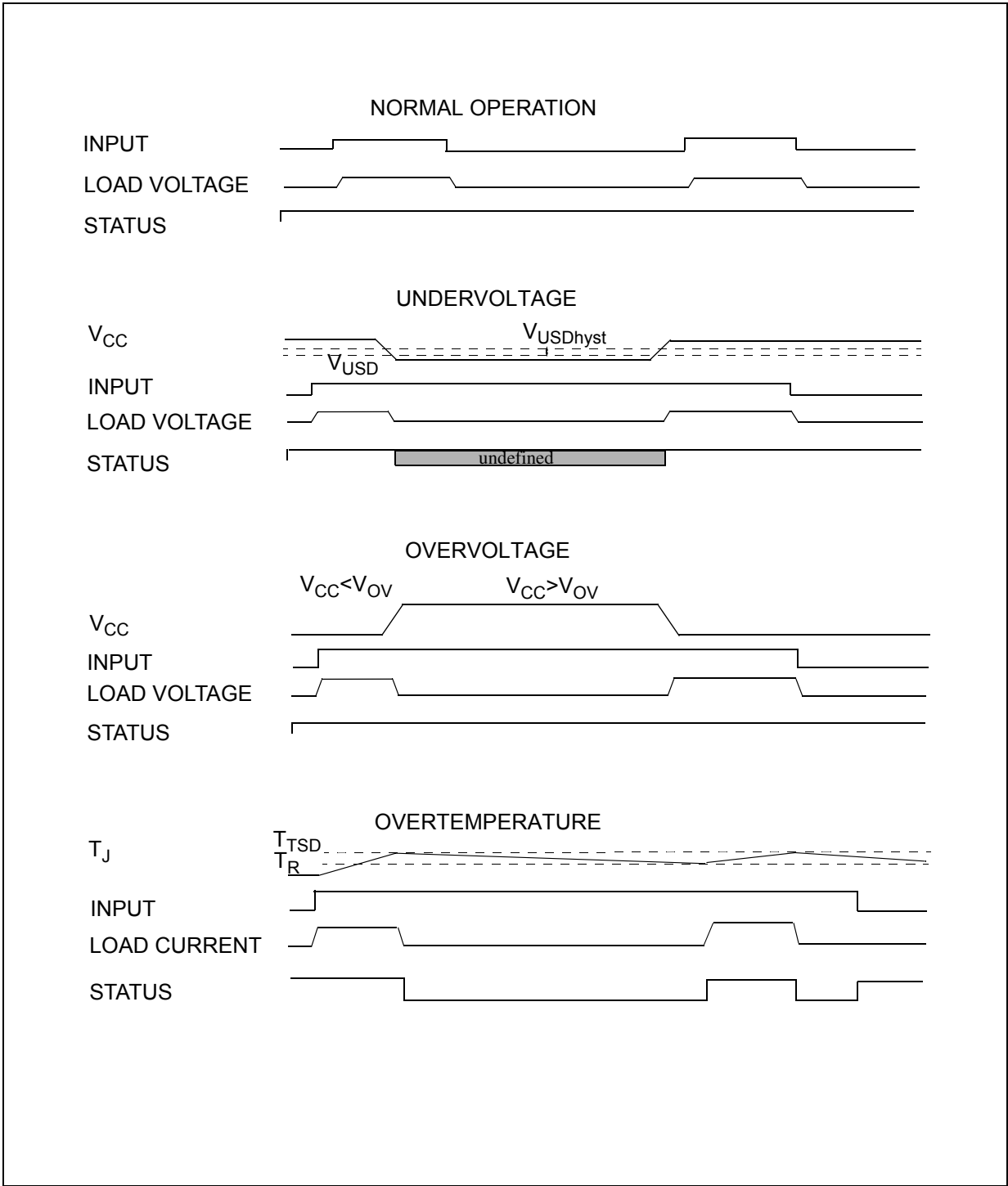


Table 8. Truth table

Conditions	Input	Output	Status
Normal operation	L	L	H
	H	H	H
Current limitation	L	L	H
	H	X	$(T_J < T_{TSD})$ H
	H	X	$(T_J > T_{TSD})$ L
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	X
	H	L	X
Overvoltage	L	L	H
	H	L	H

Figure 5. Waveforms



5 Test circuit

Figure 6. Peak short circuit current test circuit

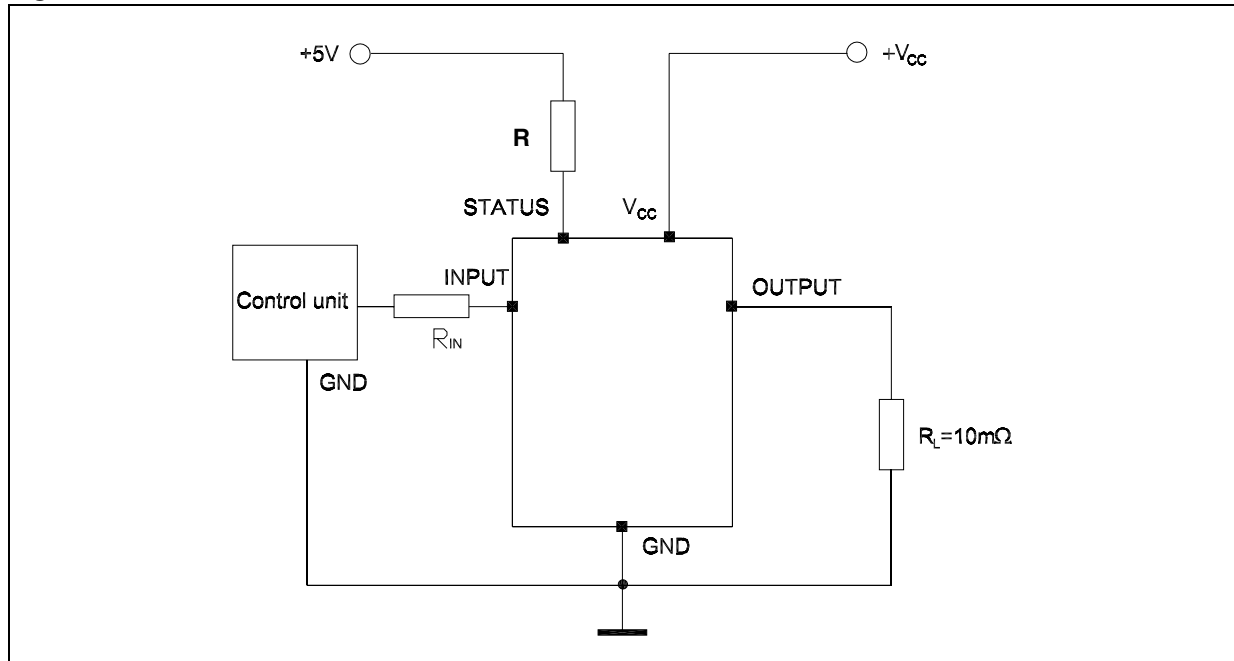
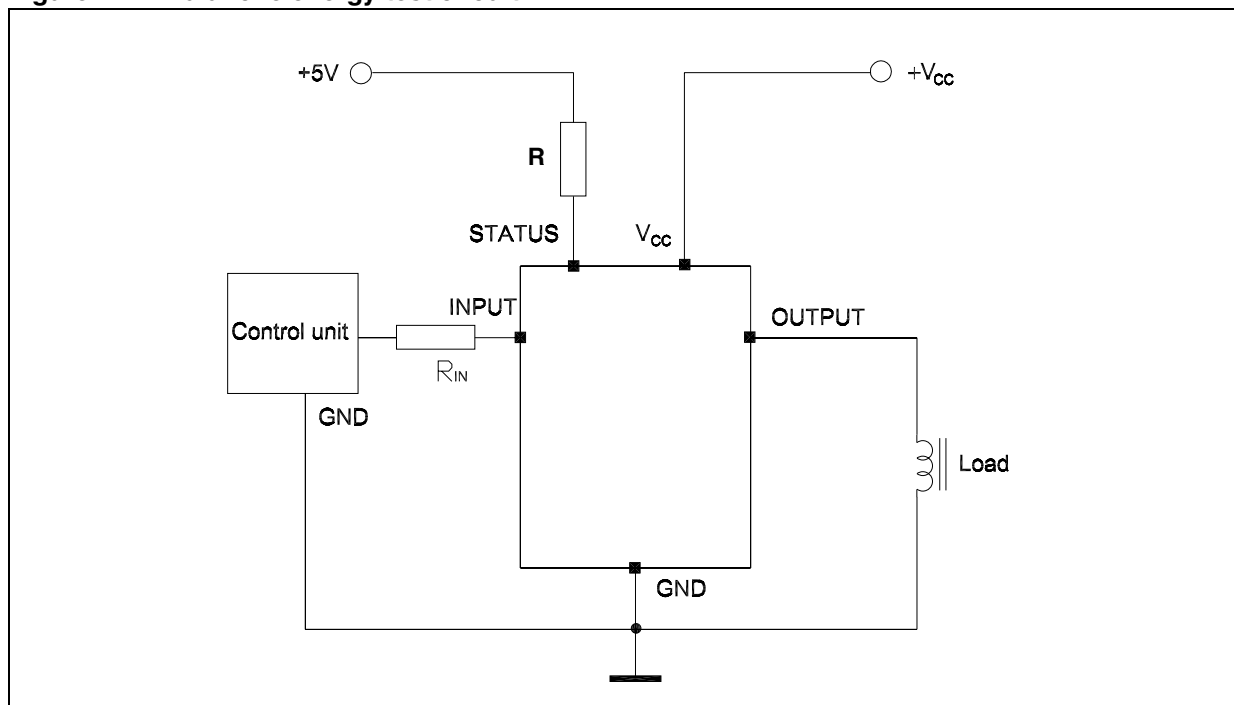
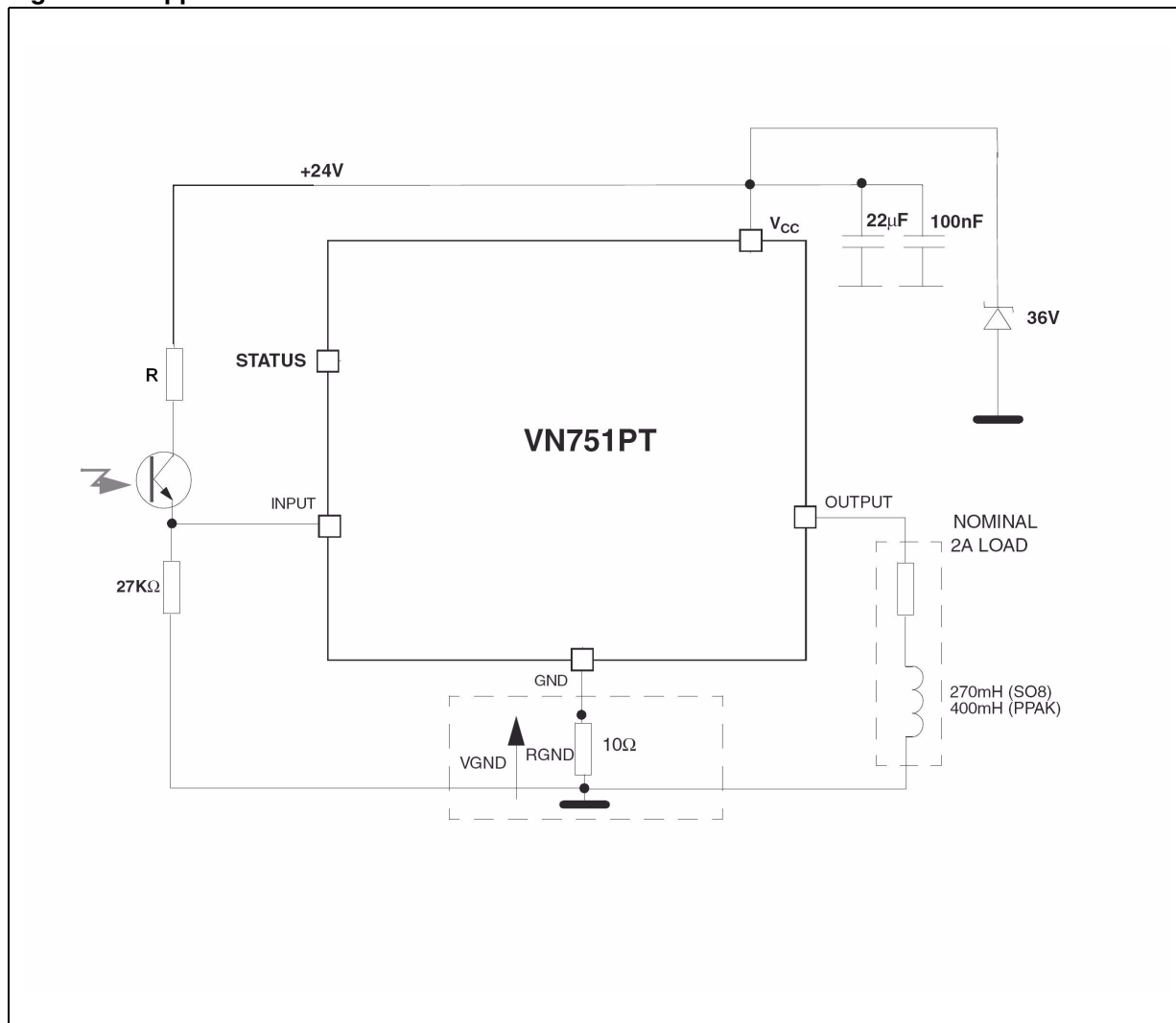


Figure 7. Avalanche energy test circuit



6 Application schematic

Figure 8. Application schematic



7 Reverse polarity protection

A schematic solution to protect the IC against a reverse polarity condition is proposed.

This schematic is effective with any type of load connected to the outputs of the IC.

The R_{GND} resistor value can be selected according to the following conditions to be met:

1. $R_{GND} \leq 600 \text{ mV} / (I_S \text{ in ON state max})$.
2. $R_{GND} \geq (-V_{CC}) / (-I_{GND})$

where $-I_{GND}$ is the DC reverse ground pin current and can be found in the absolute maximum rating section of the device datasheet.

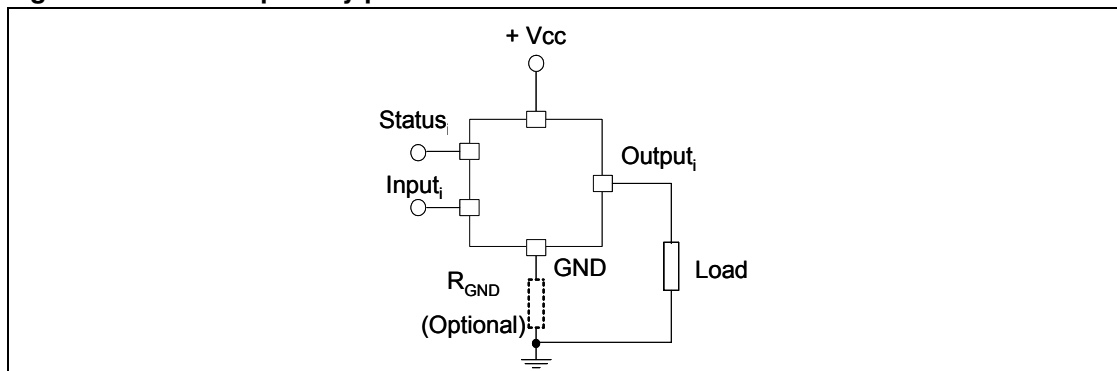
The power dissipation associated to R_{GND} during reverse polarity condition is:

$$PD = (-V_{CC})^2 / R_{GND}$$

This resistor can be shared by several different ICs. In such case I_S value on formula (1) is the sum of the maximum ON-state currents of the different devices.

Please note that if the microprocessor ground and the device ground are separated then the voltage drop across the R_{GND} (given by $I_S \text{ in ON state max} * R_{GND}$) produce a difference between the generated input level and the IC input signal level. This voltage drop will vary depending on how many devices are ON in the case of several high side switches sharing the same R_{GND} .

Figure 9. Reverse polarity protection



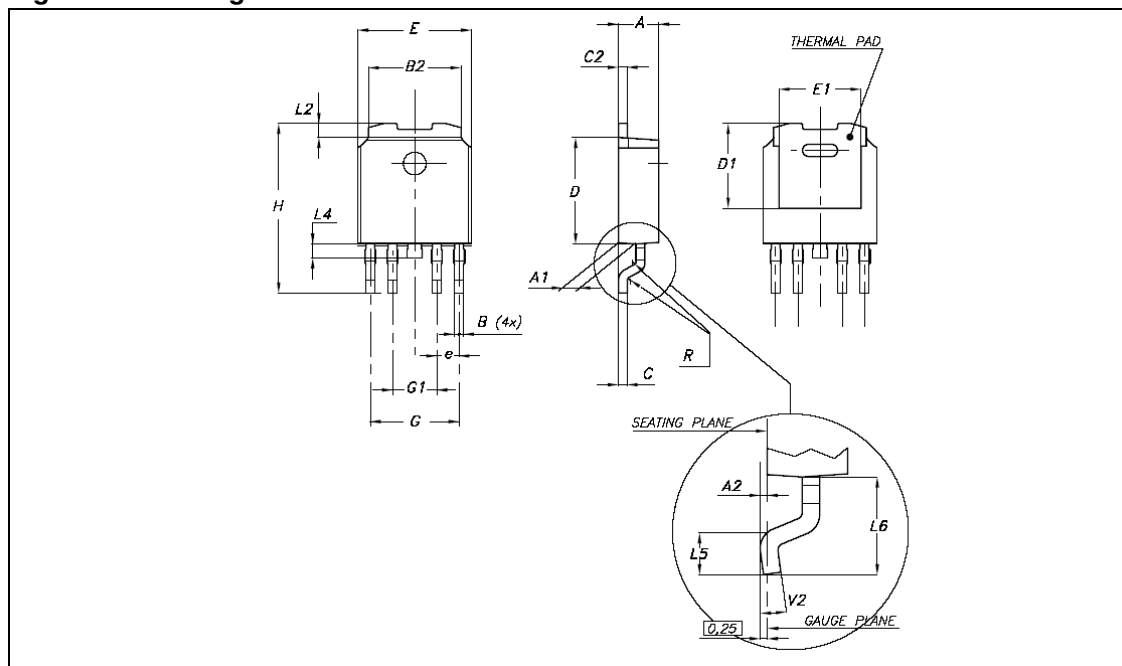
8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® 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

Table 9. PPAK mechanical data

Dim.	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	0°		8°
Package weight	Gr. 0.3		

Figure 10. Package dimensions



9 Order code

Table 10. Order codes

Order codes	Package	Packaging
VN751PT	PPAK	Tube
VN751PT13TR	PPAK	Tape and reel

10 Revision history

Table 11. Document revision history

Date	Revision	Changes
07-Mar-2006	1	Initial release
31-Mar-2006	2	Added V_{SCL}
10-Jul-2006	3	Updated V_{CC} value Table 1 , I_{lim} min value Table 7
12-Mar-2007	4	Typo in Table 4 on page 5 , updated P_{tot} value Table 1 .
15-May-2007	5	Typo in Table 1 on page 3 , V_{ESD}
18-Sep-2007	6	Added I_{STAT} valuein Table 1 on page 3
08-Jul-2008	7	Added Section 7 on page 11

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