

Features

- 8 V to 36 V supply voltage range
- Up to $I_{OUT} = 2.5$ A operating current
- $R_{DS(on)}$: 60 m Ω
- CMOS compatible input
- Thermal shutdown
- Shorted load protection
- Undervoltage and overvoltage shutdown
- Protection against loss of ground
- Fast demagnetization of inductive loads
- Very low standby current
- Compliance to 61000-4-4 IEC test up to 4 kV
- Open drain status output

Description

The VN751PT is a monolithic device developed using STMicroelectronics' VIPower M03 technology, intended to drive any kind of load with one side connected to ground. Active VCC 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. The 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 controller international standard.

Table 1. Device summary

Order code	Package	Packing
VN751PT	PPAK	Tube
VN751PTTR		Tape and reel

Contents

1	Block diagram	5
2	Pin connection	6
3	Maximum ratings	7
4	Electrical characteristics	8
5	Test circuits	10
6	Switching time waveforms and truth table	11
7	Application schematic	13
8	Reverse polarity protection	14
9	Active VDS clamp	15
10	Package information	18
	10.1 PPAK package information	18
	10.2 PPAK packing information	20
11	Revision history	22

List of tables

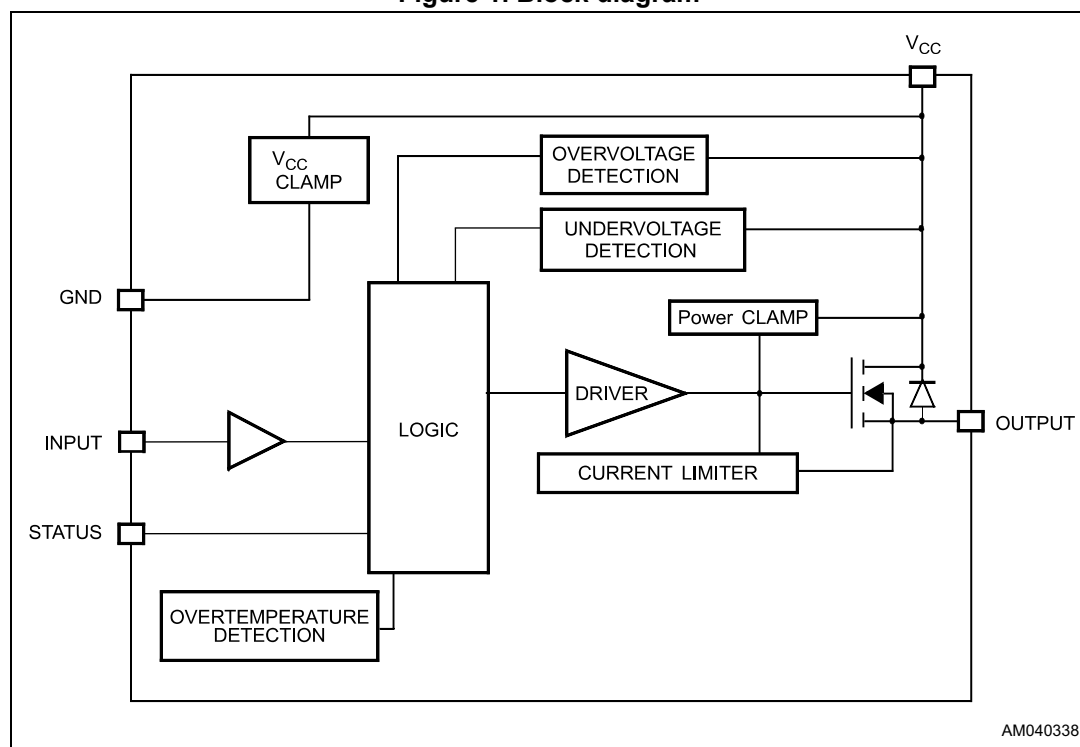
Table 1.	Device summary	1
Table 2.	Absolute maximum ratings	7
Table 3.	Thermal data.	7
Table 4.	Power	8
Table 5.	Switching ($V_{CC} = 24\text{ V}$).	8
Table 6.	Input pin	8
Table 7.	Status pin	9
Table 8.	Protection	9
Table 9.	Truth table.	11
Table 10.	PPAK package mechanical data	19
Table 11.	PPAK tape and reel mechanical data	21
Table 12.	Document revision history	22

List of figures

Figure 1.	Block diagram	5
Figure 2.	Connection diagram (top view)	6
Figure 3.	Current and voltage conventions	6
Figure 4.	Peak short-circuit current	10
Figure 5.	Avalanche energy test circuit	10
Figure 6.	Switching time waveforms	11
Figure 7.	Waveforms	12
Figure 8.	Application schematic	13
Figure 9.	Reverse polarity protection	14
Figure 10.	Active clamp equivalent principle schematic	15
Figure 11.	Fast demagnetization waveforms	16
Figure 12.	Typical demagnetization energy (single pulse) at $V_{CC} = 24\text{ V}$ and $T_{AMB} = 125\text{ °C}$	17
Figure 13.	PPAK package outline ^{(1), (2), (3), (4), (5)}	18
Figure 14.	PPAK tape outline	20
Figure 15.	PPAK reel outline	21

1 Block diagram

Figure 1. Block diagram



2 Pin connection

Figure 2. Connection diagram (top view)

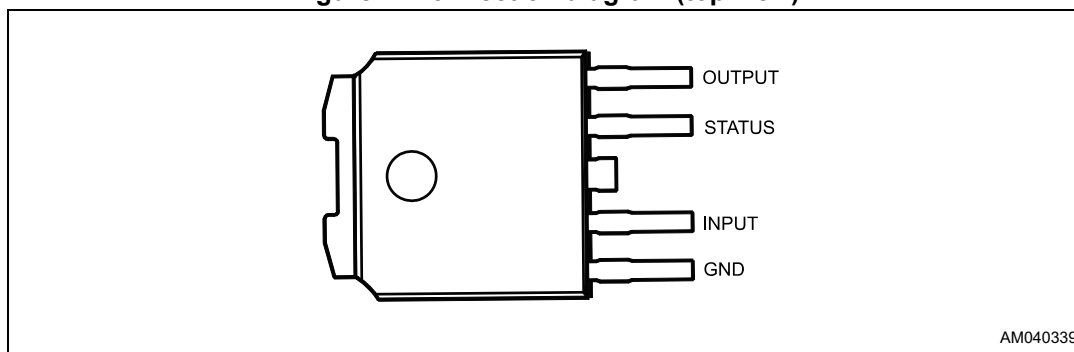
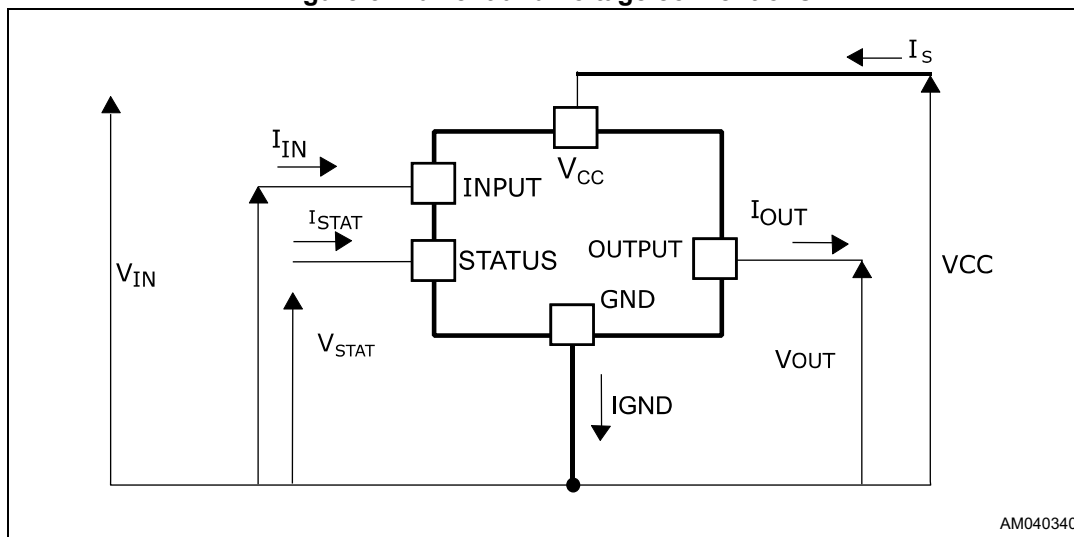


Figure 3. Current and voltage conventions



3 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Power supply voltage	45	V
$-V_{CC}$	Reverse 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 -	1 to +10	mA
I_{STAT}	DC status current -	1 to +10	mA
V_{ESD}	Electrostatic discharge (R = 1.5 k Ω ; C = 100 pF)	5000	V
E_{AS}	Single pulse avalanche energy ($T_{amb} = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 24\text{ V}$, $I_{load} = 2.0\text{ A}$)	5.5	J
P_{TOT}	Power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	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	$^{\circ}\text{C}$

Table 3. Thermal data

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

1. When mounted on a standard single-sided FR-4 board with 0.5 cm² of Cu (at least 35 μm) thick connected to all VCC pins.

4 Electrical characteristics

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

Table 4. Power

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage	-	5.5	-	36	V
$R_{DS(on)}$	On-state resistance	$I_{OUT} = 2$ A at $T_J = 25$ °C	-	60	-	mΩ
		$I_{OUT} = 2$ A	-	-	180	
$I_S^{(1)}$	Supply current	OFF-state, $V_{CC} = 24$ V, $T_J = 25$ °C,	-	10	20	μA
		ON-state, $V_{CC} = 24$ V, $T_J = 25$ °C,	-	3.5	-	mA
		ON-state, $V_{CC} = 24$ V, $T_J = 100$ °C	-	-	3.8	mA
V_{USD}	Undervoltage shutdown	-	3	4	5.5	V
V_{OV}	Overvoltage shutdown	-	36	-	-	V
$I_{L(off)}$	Off-state output current	$V_{IN} = V_{OUT} = 0$ V	0	-	10	μA

1. Status: floating.

Table 5. Switching ($V_{CC} = 24$ V)

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

Table 6. Input pin

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

Table 7. 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	$I_{STAT} = 1 \text{ mA}$	6	6.8	8	μA
		$I_{STAT} = -1 \text{ mA}$	-	-0.7	-	V

Table 8. Protection

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{demag}	Turn-off output clamp voltage	$R_L = 12 \Omega$; $L = 6 \text{ mH}$	$V_{CC} - 47$	$V_{CC} - 52$	$V_{CC} - 57$	V
T_{TSD}	Shutdown temperature	-	150	175	200	$^{\circ}\text{C}$
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
T_{hyst}	Thermal hysteresis	-	7	20	-	$^{\circ}\text{C}$
T_R	Reset temperature	-	135	-	-	$^{\circ}\text{C}$

5 Test circuits

Figure 4. Peak short-circuit current

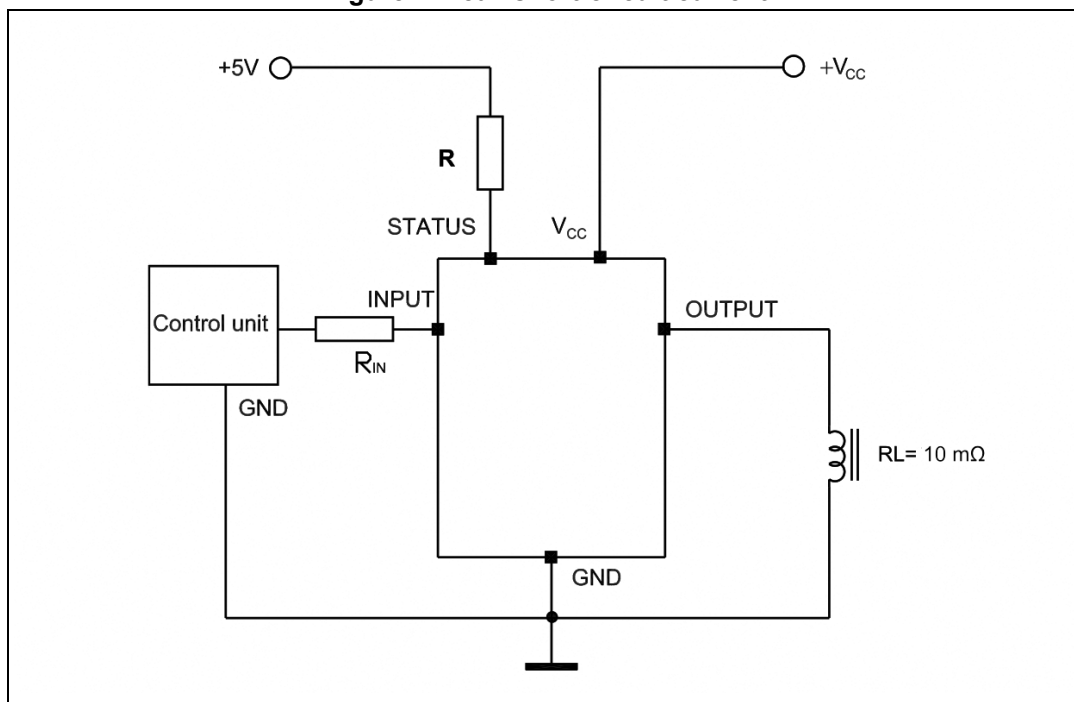
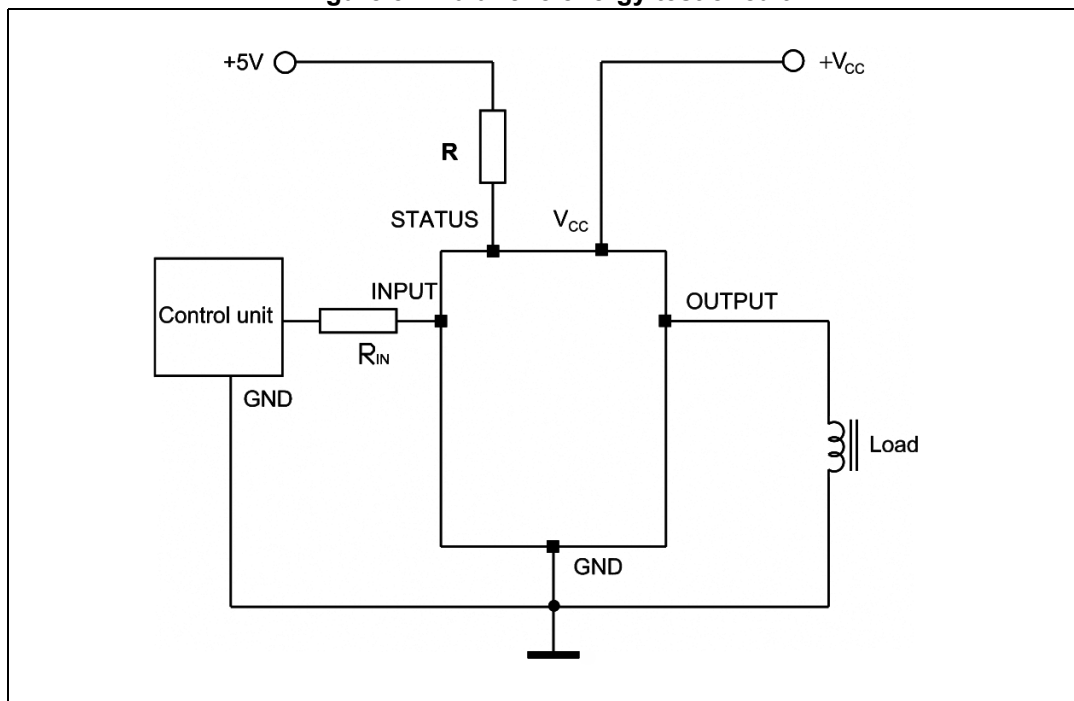


Figure 5. Avalanche energy test circuit



6 Switching time waveforms and truth table

Figure 6. Switching time waveforms

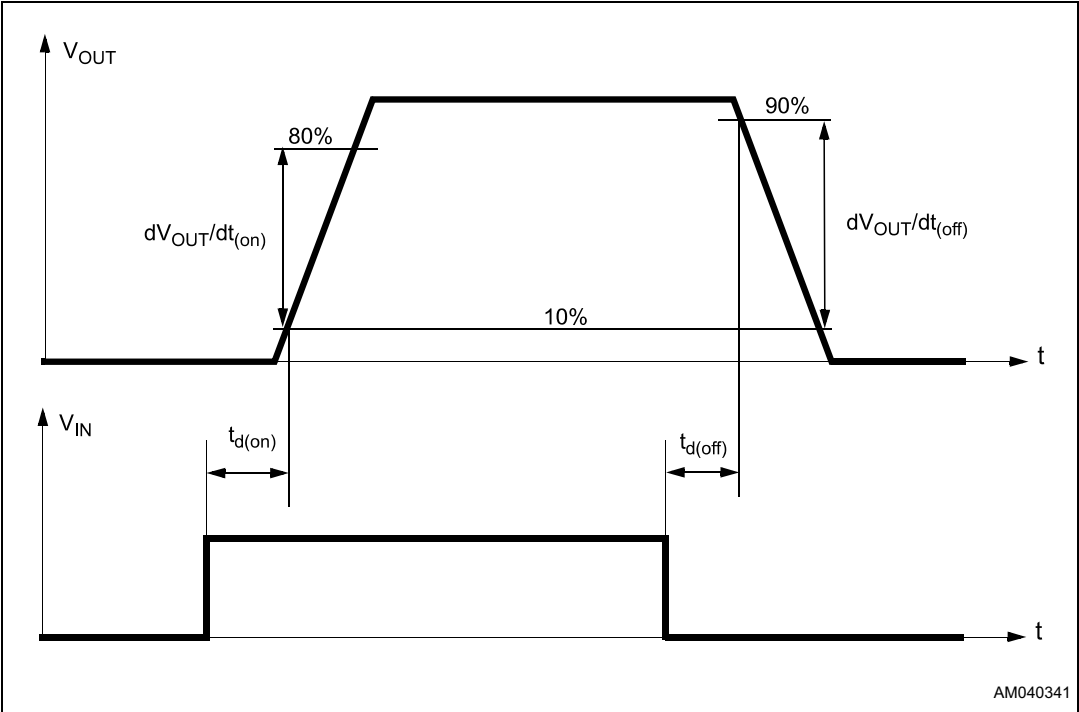
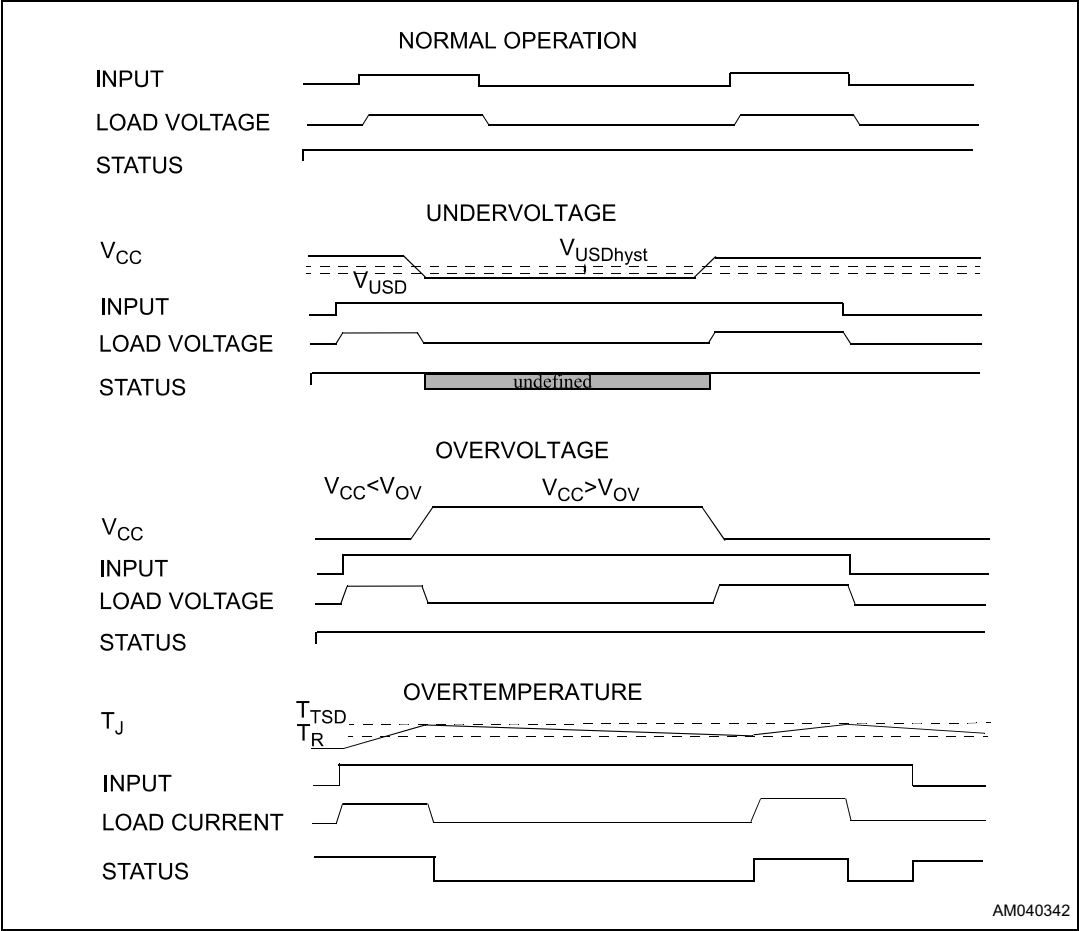


Table 9. Truth table

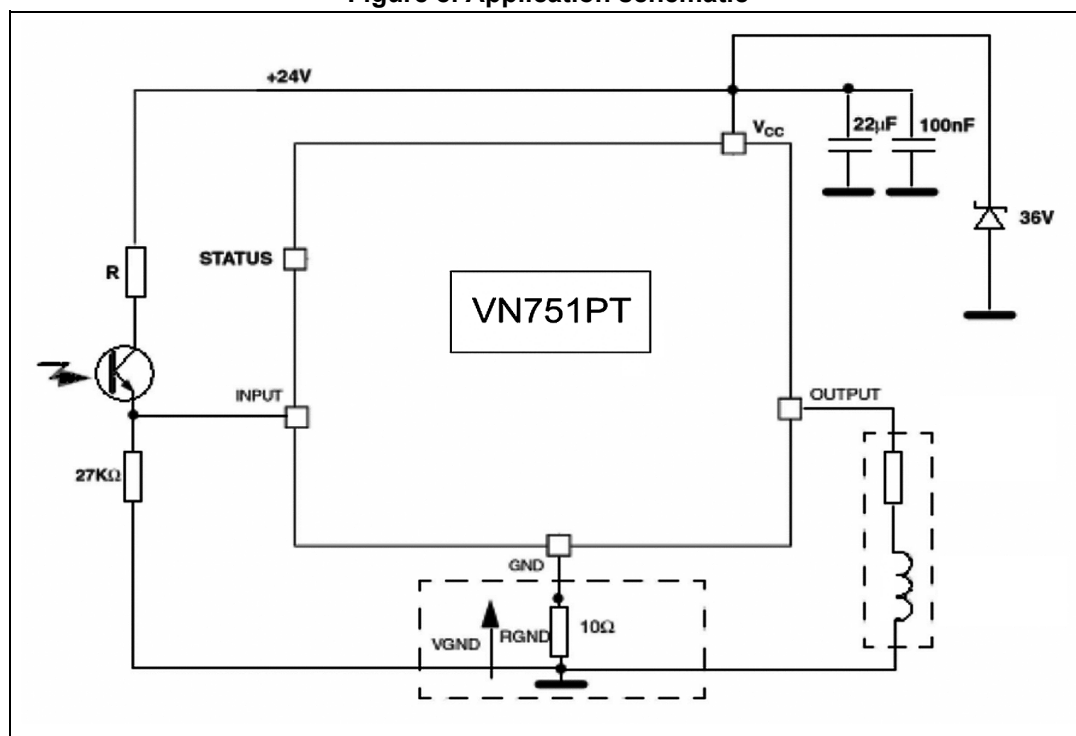
Conditions	Input	Output	Status
Normal operation	L	L	H
	H	H	H
Current limitation	L	L	H
	H	X	$(T_J < T_{TSD})$ H
	H	X	$(T_J > T_{TSD})$ L
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	X
	H	L	X
Overvoltage	L	L	H
	H	L	H

Figure 7. Waveforms



7 Application schematic

Figure 8. Application schematic



8 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:

Equation 1

$$R_{GND} \leq 600 \text{ mV} / (I_S \text{ in ON-state max.})$$

Equation 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:

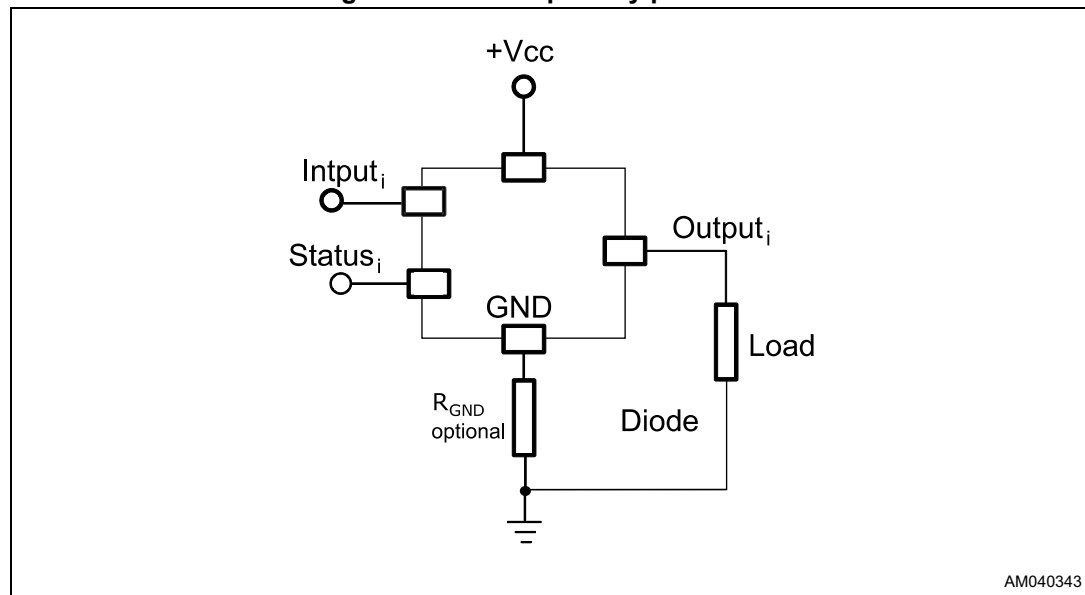
Equation 3

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

This resistor can be shared by several different ICs.

In such case I_S value in [Equation 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, the voltage drop across the R_{GND} (given by I_S in ON-state max. * R_{GND}) produces a difference between the generated input level and the IC input signal level. This voltage drop varies depending on how many devices are ON in case of several high-side switches sharing the same R_{GND} .

Figure 9. Reverse polarity protection



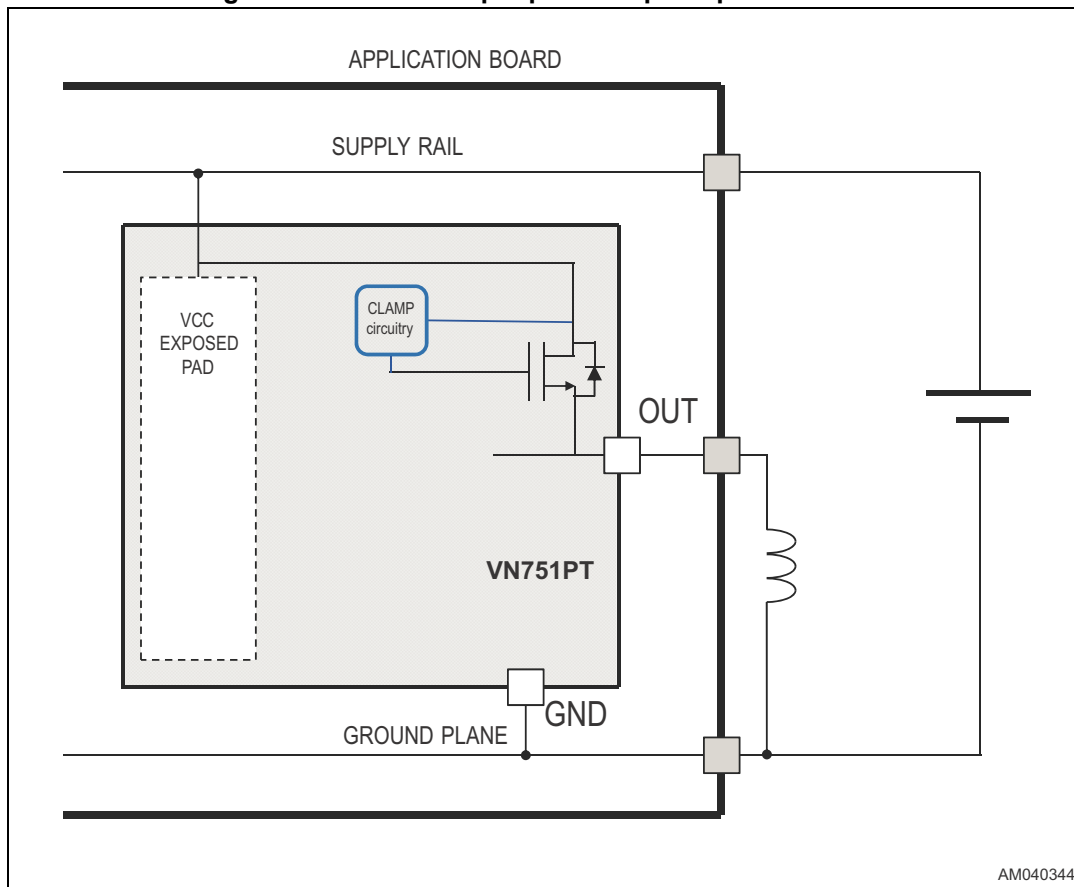
AM040343

9 Active VDS clamp

Active clamp is also known as fast demagnetization of inductive loads or fast current decay. When a high-side driver turns off an inductance, an undervoltage is detected on output.

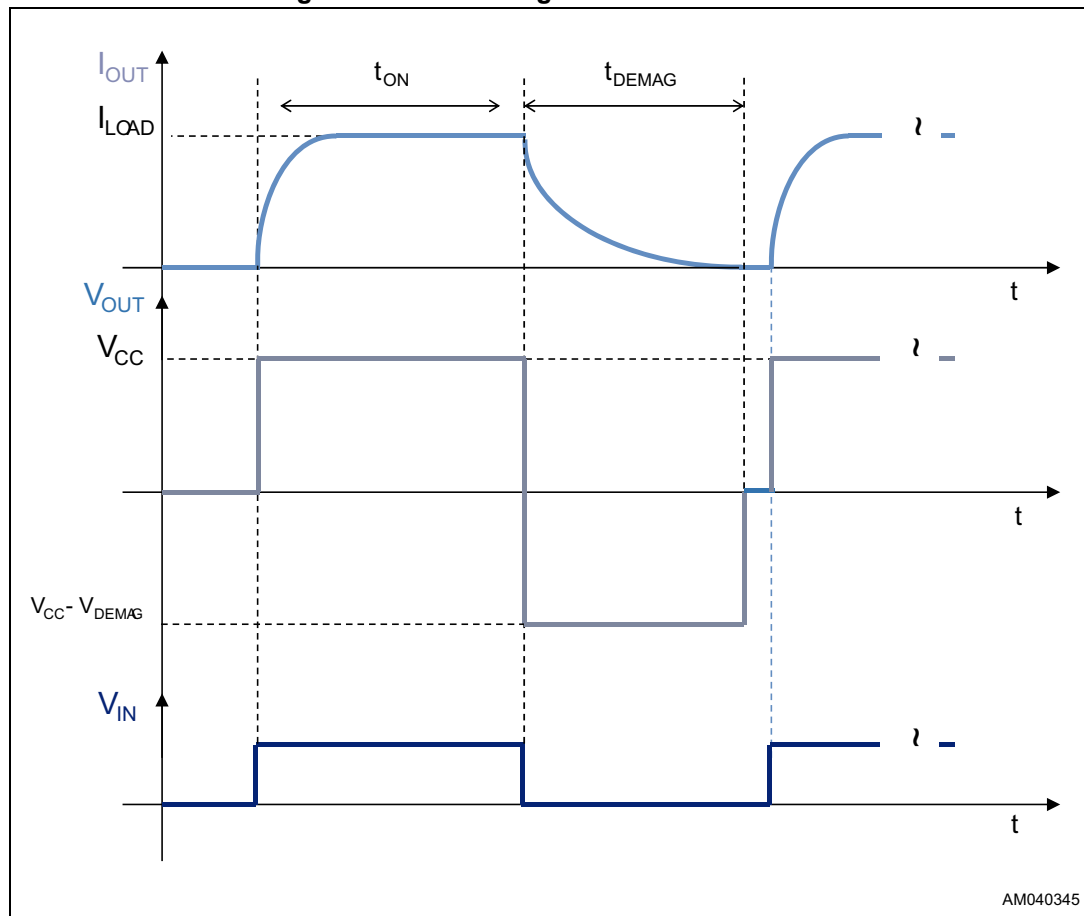
The OUT pin is pulled down to V_{demag} . The conduction state is modulated by an internal circuitry in order to keep the OUT pin voltage at about V_{demag} until the load energy has been dissipated. The energy is dissipated both in IC internal switch and in load resistance.

Figure 10. Active clamp equivalent principle schematic

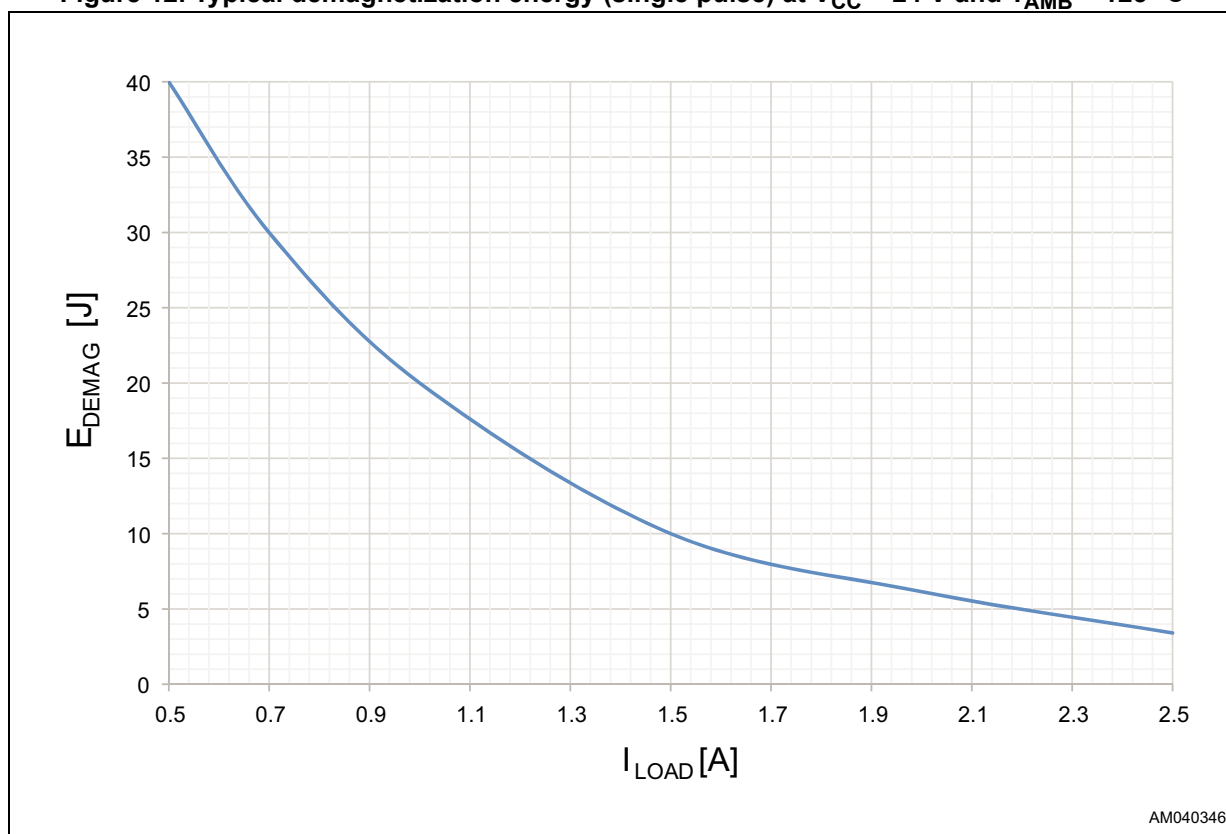


AM040344

Figure 11. Fast demagnetization waveforms



The demagnetization of inductive load causes a huge electrical and thermal stress to the IC. The curve plotted below shows the maximum demagnetization energy that the IC can support in a single demagnetization pulse with $V_{CC} = 24\text{ V}$ and $T_{AMB} = 125\text{ }^{\circ}\text{C}$. If higher demagnetization energy is required then an external free-wheeling Schottky diode has to be connected between OUT (cathode) and GND (anode) pins. Note that in this case the fast demagnetization is inhibited.

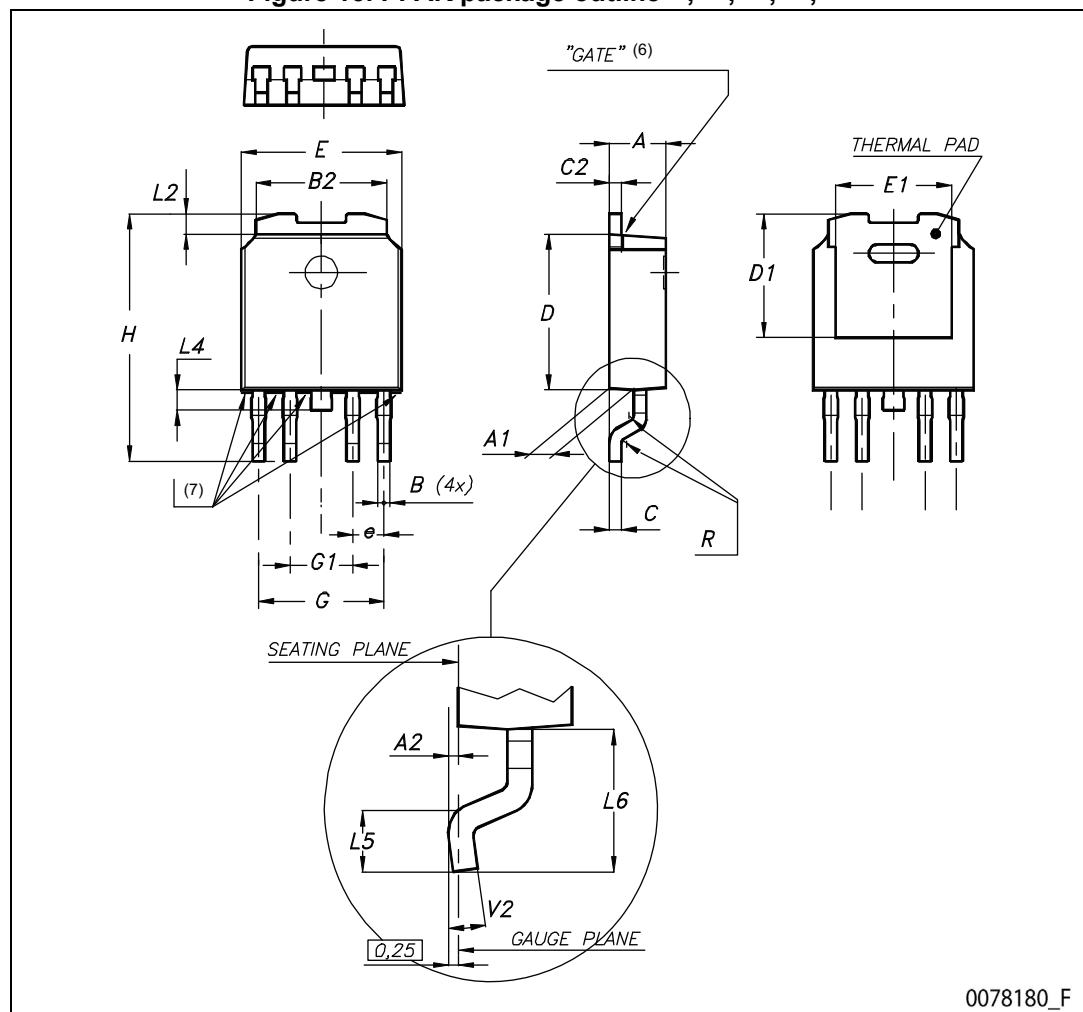
Figure 12. Typical demagnetization energy (single pulse) at $V_{CC} = 24\text{ V}$ and $T_{AMB} = 125\text{ °C}$ 

10 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

10.1 PPAK package information

Figure 13. PPAK package outline^{(1), (2), (3), (4), (5)}



1. Burrs larger than 0.25 mm are not allowed on the upper surface of the dissipater (FRONT). On the lower surface (REAR) the maximum allowed is: 0.05 mm.
2. The side of the dissipater to be connected to the external dissipater must be flat within 30 micron.
3. The leads size is comprehensive of the thickness of the leads finishing material.
4. Package outline exclusive of any mold flashes dimensions.
5. Package outline exclusive of metal burrs dimensions.
6. Max. resin gate protrusion: 0.5 mm.
7. Max. resin protrusion: 0.25 mm.

Table 10. PPAK package mechanical data

Symbol	Dimensions (mm)		
	Min.	Typ.	Max.
A	2.2	-	2.4
A1	0.9	-	1.1
A2	0.03	-	0.23
B	0.4	-	0.6
B2	5.2	-	5.4
C	0.45	-	0.6
C2	0.48	-	0.6
D	6	-	6.2
D1	-	5.1	-
E	6.4	-	6.6
E1	-	4.7	-
e	-	1.27	-
G	4.9	-	5.25
G1	2.38	-	2.7
H	9.35	-	10.1
L2	-	0.8	1
L4	0.6	-	1
L5	1	-	-
L6	-	2.8	-
R	-	0.20	-
V2	0°	-	8°

10.2 PPAK packing information

Figure 14. PPAK tape outline

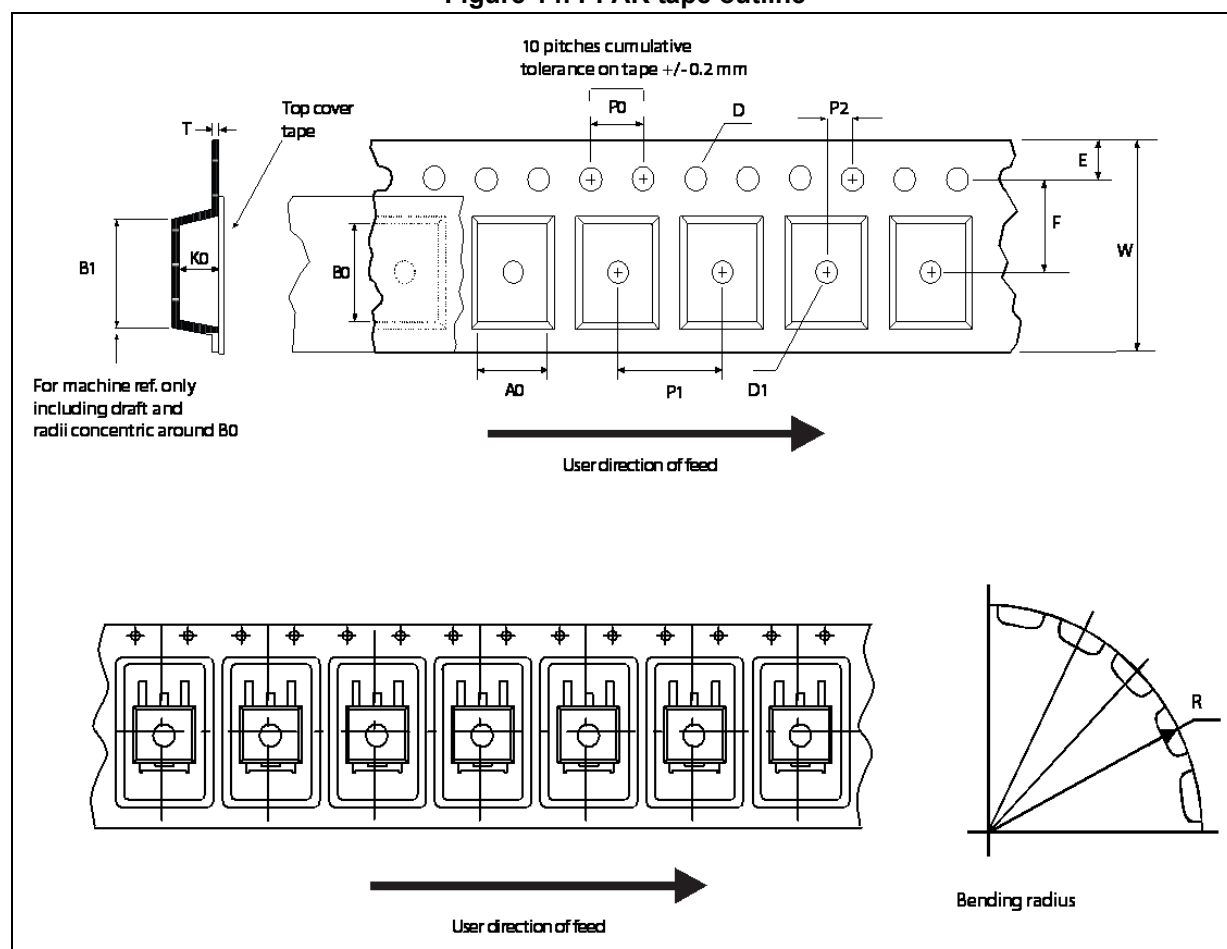


Figure 15. PPAK reel outline

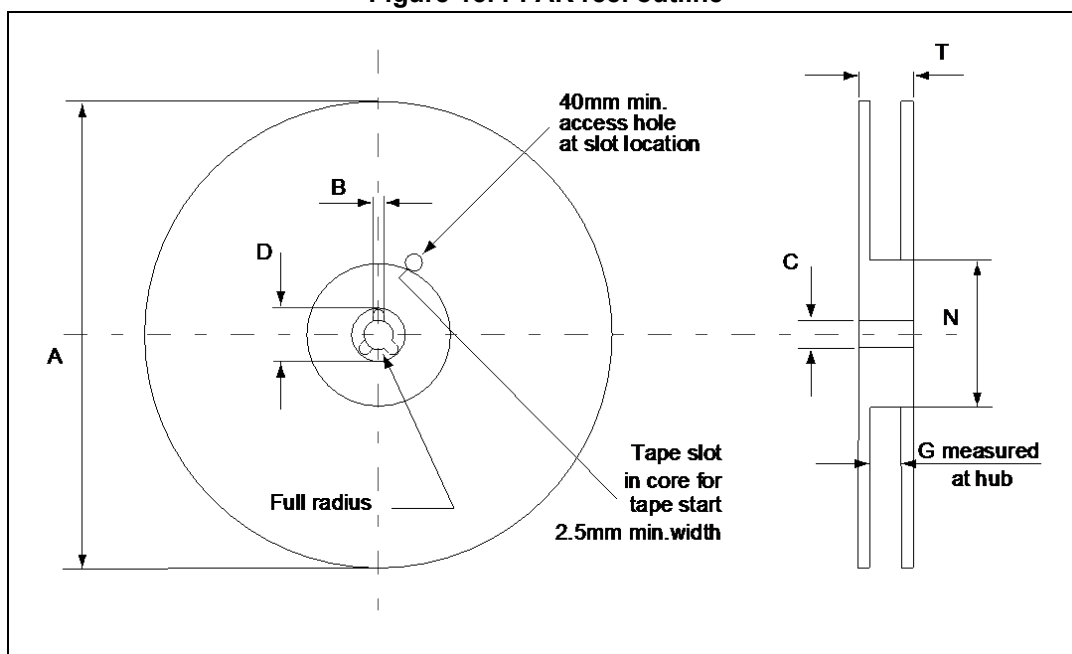


Table 11. PPAK tape and reel mechanical data

Tape			Reel		
	Dimensions (mm)			Dimensions (mm)	
Symbol	Min.	Max.	Symbol	Min.	Max.
A0	6.8	7	A	-	330
B0	10.4	10.6	B	1.5	-
B1	-	12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	-
D1	1.5	-	G	16.4	18.4
E	1.65	1.85	N	50	-
F	7.4	7.6	T	-	22.4
K0	2.55	2.75	-	-	-
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1	-	-	-
R	40	-	-	-	-
T	0.25	0.35	-	-	-
W	15.7	16.3	-	-	-

11 Revision history

Table 12. 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 <i>table 1</i> , I_{lim} min. value <i>table 7</i> .
12-Mar-2007	4	Typo in <i>table 4</i> , updated P_{tot} value <i>table 1</i> .
15-May-2007	5	Typo in <i>table 1</i> , V_{ESD} .
18-Sep-2007	6	Added I_{STAT} value in <i>table 1</i> .
08-Jul-2008	7	Added <i>section 7</i> .
30-Nov-2009	8	Updated <i>cover page</i> and <i>section 6</i> .
12-Jul-2016	9	Updated <i>Table 4: "Power"</i> .
09-May-2018	10	Updated <i>Section : Features on page 1</i> . Updated <i>Table 2 on page 7</i> (updated E_{AS} parameter and value). Updated <i>Figure 8 on page 13</i> (removed output values). Added <i>Section 9 on page 15</i> . Added notes below <i>Figure 13 on page 18</i> . Minor modifications throughout document.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2018 STMicroelectronics – All rights reserved

