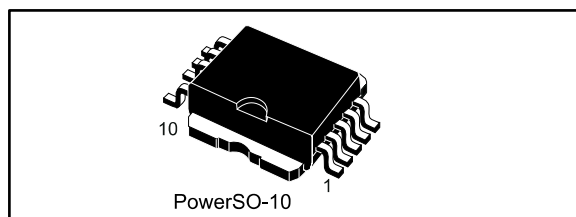


## Quad high-side smart power solid-state relay

Datasheet - production data



- Open drain diagnostic output
- Fast demagnetization of inductive loads
- Conforms to IEC 61131-2

### Description

The VN330SP-E is a monolithic device developed using the VIPower technology, intended to drive four independent resistive or inductive loads with one side connected to ground. Active current limitation prevents dropping of the system power supply in case of shorted load. Built-in thermal shutdown protects the chip from overtemperature and short-circuit. The open drain diagnostic output indicates overtemperature conditions.

### Features

Type	V <sub>demag</sub> <sup>(1)</sup>	R <sub>DS(on)</sub> <sup>(2)</sup>	I <sub>out</sub> <sup>(1)</sup>	V <sub>CC</sub>
VN330SP-E	V <sub>CC</sub> -55 V	0.32 Ω	0.7 A	36 V

#### Notes:

<sup>(1)</sup>Per channel

<sup>(2)</sup>At T<sub>J</sub> = 85 °C

- Output current: 0.7 A per channel
- Digital input clamped at 32 V minimum voltage
- Shorted load and overtemperature protections
- Built-in current limiter
- Undervoltage shutdown

**Table 1: Device summary**

Order code	Package	Packing
VN330SP-E	PowerSO-10	Tube
VN330SPTR-E		Tape and reel

---

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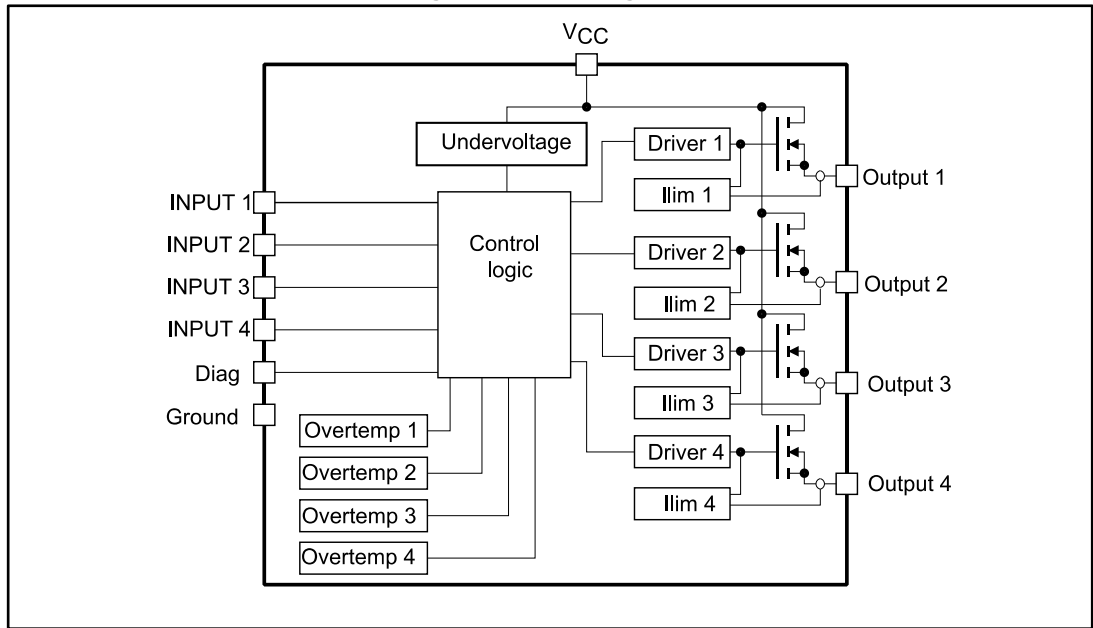
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# 1 Block diagram

Figure 1: Block diagram



## 2 Pin connection

Figure 2: Connection diagram (top view)

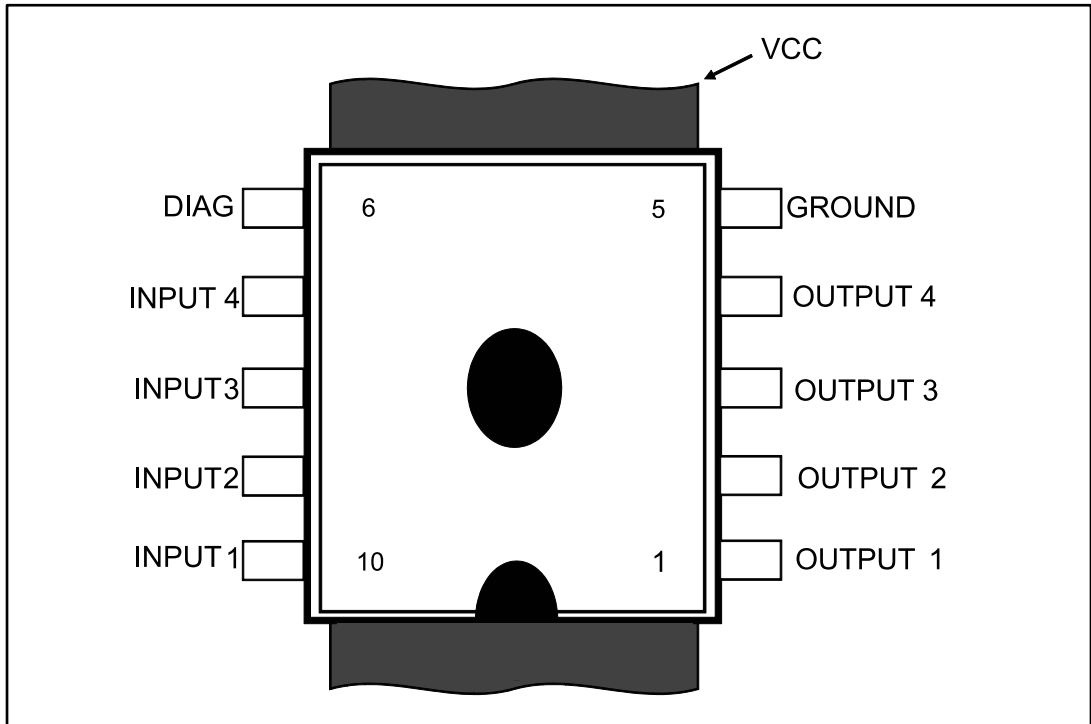
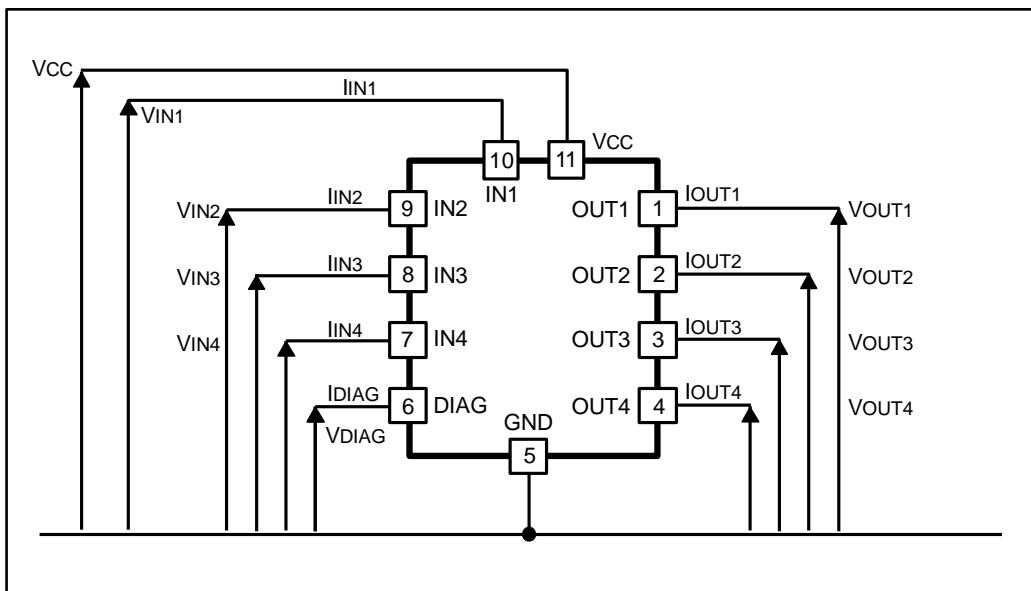


Figure 3: Current and voltage conventions



### 3 Maximum ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Power supply voltage	45	V
-V <sub>CC</sub>	Reverse supply voltage	-0.3	V
I <sub>OUT</sub>	Output current	Internally limited	A
I <sub>R</sub>	Reverse output current (per channel)	-6	A
I <sub>IN</sub>	Input current range	±10	mA
I <sub>DIAG</sub>	DIAG pin current	±10	mA
V <sub>ESD</sub>	Electrostatic discharge (R = 1.5 kΩ; C = 100 pF)	2000	V
E <sub>AS</sub>	Single pulse avalanche energy per channel not simultaneously	400	mJ
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

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R <sub>th(JC)</sub>	Thermal resistance junction-case <sup>(1)</sup>	Max. 2	°C/W
R <sub>th(JA)</sub>	Thermal resistance junction-ambient <sup>(2)</sup>	Max. 50	°C/W

**Notes:**

<sup>(1)</sup>Per channel.

<sup>(2)</sup>When mounted on a four-layer FR-4, with the minimum recommended pad size.

## 4 Electrical characteristics

10 V < V<sub>CC</sub> < 36 V; -40 °C < T<sub>J</sub> < 125 °C; unless otherwise specified

**Table 4: Power section**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>CC</sub>	Supply voltage		10		36	V
R <sub>DS(on)</sub>	On-state resistance	I <sub>OUT</sub> = 0.5 A at T <sub>J</sub> = 25 °C			0.2	Ω
		I <sub>OUT</sub> = 0.5 A at T <sub>J</sub> = 85 °C			0.32	
		I <sub>OUT</sub> = 0.5 A at T <sub>J</sub> = 125 °C			0.44	
I <sub>S</sub>	Supply current	All channels OFF			1	mA
		On-state V <sub>IN</sub> = 5 V, I <sub>OUT</sub> = 0 V, T <sub>J</sub> = -40 °C			15	mA
V <sub>demag</sub>	Output voltage at turn-off	I <sub>OUT</sub> = 0.5 A; L <sub>LOAD</sub> >= 1 mH	V <sub>CC</sub> -65	V <sub>CC</sub> -55	V <sub>CC</sub> -45	V

**Table 5: Switching (V<sub>CC</sub> = 24 V)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>d(ON)</sub>	Turn-on delay time	I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		30	40	μs
		I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			60	
t <sub>r</sub>	Rise time of output current	I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		50	100	μs
		I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			115	
t <sub>d(OFF)</sub>	Turn-off delay time of output current	I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		20	30	μs
		I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			40	
t <sub>f</sub>	Fall time of output current	I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		8	15	μs
		I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			20	
(di/dt) <sub>on</sub>	Turn-on current slope	I <sub>OUT</sub> = 0.5 A			0.5	A/μs
		I <sub>OUT</sub> = I <sub>LIM</sub> , T <sub>J</sub> = 25 °C			2	



Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$(di/dt)_{off}$	Turn-off current slope	$I_{OUT} = 0.5 \text{ A}$			2	A/ $\mu\text{s}$
		$I_{OUT} = I_{LIM}, T_J = 25 \text{ }^\circ\text{C}$			4	

Table 6: Logic inputs

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{IL}$	Input low level voltage				2	V
$V_{IH}$	Input high level voltage		3.5			V
$V_{I(HYST)}$	Input hysteresis voltage			0.5		V
$I_{IN}$	Input current	$V_{IN} = 0 \text{ to } 30 \text{ V}$			600	$\mu\text{A}$
$I_{LGND}$	Output current in ground disconnection	$V_{CC} = V_{INn} = \text{GND} = \text{DIAG} = 24 \text{ V}; T_J = 25 \text{ }^\circ\text{C}$			25	mA
$V_{ICL}$	Input clamp voltage <sup>(1)</sup>	$I_{IN} = 1 \text{ mA}$	32	36		V
		$I_{IN} = -1 \text{ mA}$		-0.7		V

**Notes:**

<sup>(1)</sup>The input voltage is internally clamped at 32 V minimum, the input pins can be connected to a higher voltage by an external resistor, which cannot exceed 10 mA

Table 7: Protection and diagnostic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{DIAG}^{(1)}$	Status voltage output low	$I_{DIAG} = 5 \text{ mA}$ (fault condition)			1	V
$V_{SCL}^{(1)}$	Status clamp voltage	$I_{DIAG} = 1 \text{ mA}$	32	36		
		$I_{DIAG} = -1 \text{ mA}$		-0.7		
$V_{USD}$	Undervoltage shutdown		5		8	V
$V_{OL}$	Low state output voltage	$V_{IN} = V_{IL}$ ; $R_{LOAD} < 10 \text{ m}\Omega$			1.5	V
$I_{LIM}$	DC short-circuit current	$V_{CC} = 24 \text{ V}$ ; $R_{LOAD} < 10 \text{ m}\Omega$	0.7		2.5	A
$I_{OVPK}$	Peak short-circuit current	$V_{CC} = 24 \text{ V}$ ; $V_{IN} = 30 \text{ V}$ ; $R_{LOAD} < 10 \text{ m}\Omega$			4	A
$I_{DIAGH}$	Leakage on DIAG pin in high state	$V_{DIAG} = 24 \text{ V}$			100	$\mu\text{A}$
$I_{LOAD}$	Output leakage current	$V_{CC} = 10 \text{ to } 36 \text{ V}$ ; $V_{IN}=V_{IL}$			50	$\mu\text{A}$
$t_{SC}$	Delay time of current limiter				100	$\mu\text{s}$
$T_{TSD}$	Thermal shutdown temperature		150	170		$^{\circ}\text{C}$
$T_R$	Thermal reset temperature		135	155		$^{\circ}\text{C}$

**Notes:**

<sup>(1)</sup>Status determination > 100  $\mu\text{s}$  after the switching edge.



If the INPUT pin is left floating, the corresponding channel automatically switches off. If GND pin is disconnected, the channel switches off provided that  $V_{CC}$  does not exceed 36 V.

# 5 Test circuits

Figure 4: Avalanche energy test circuit

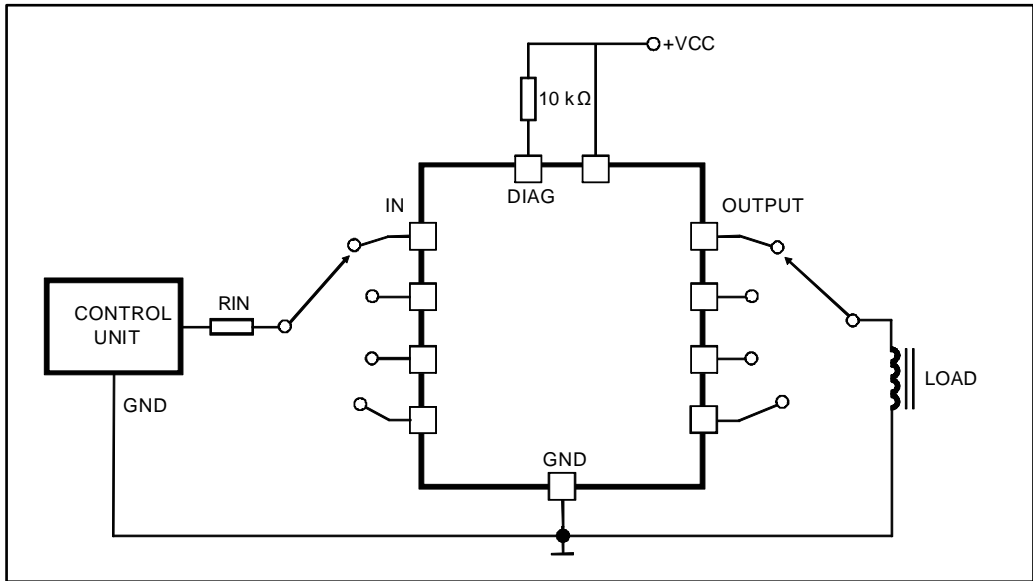
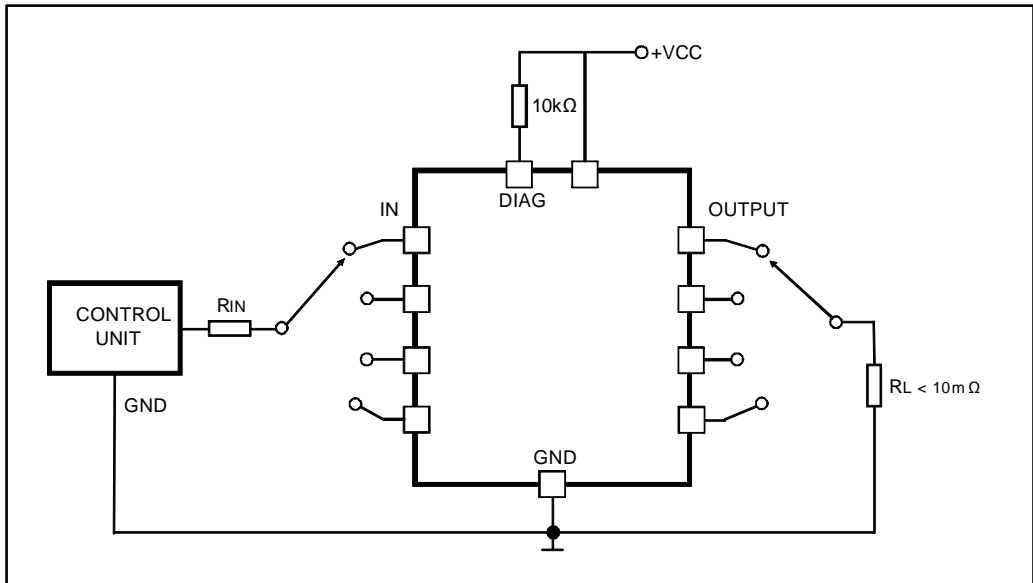


Figure 5: Peak short-circuit test diagram



## 6 Switching time waveforms and truth table

Table 8: Truth table

Conditions	INPUTn	OUTPUTn	Diagnostic
Normal operation	L	L	H
	H	H	H
Overtemperature	L	L	H
	H	L	L
Undervoltage	L	L	H
	H	L	H
Shorted load current limitation	L	L	H
	H	H	H

Figure 6: Switching waveforms

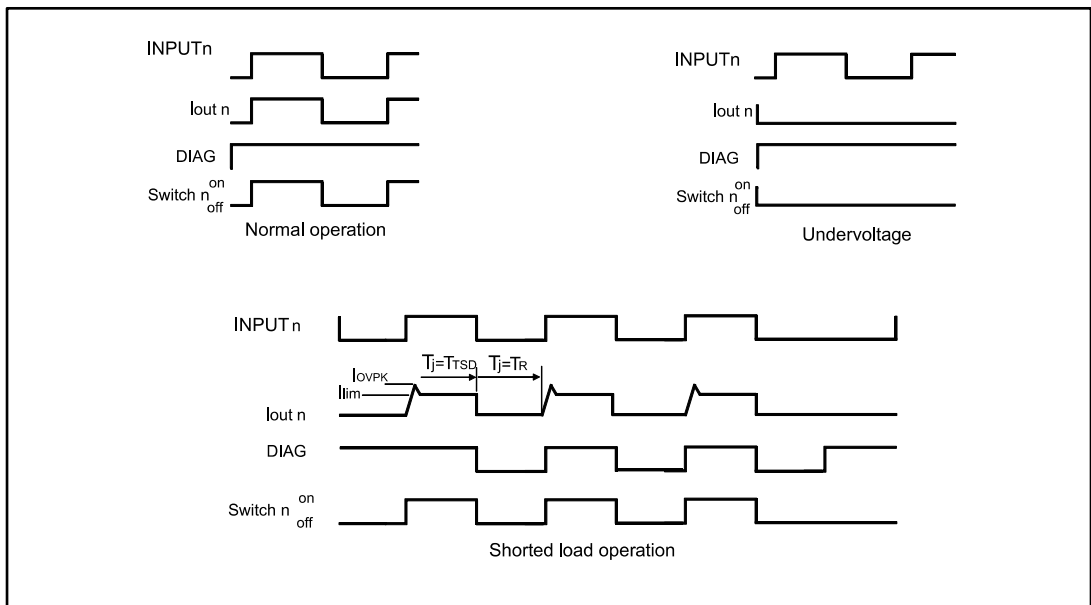


Figure 7: Switching parameter test conditions

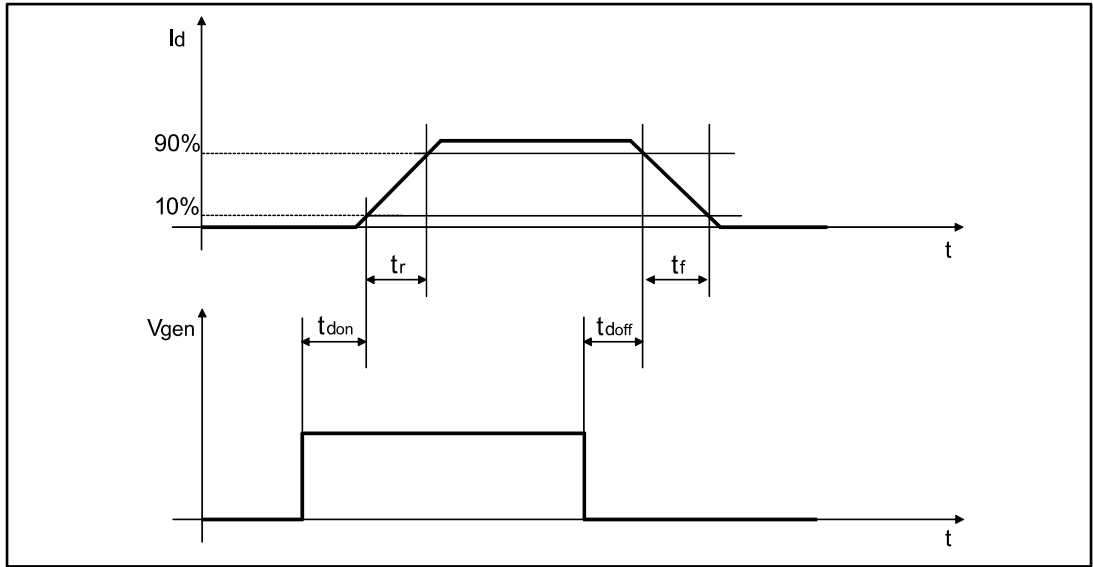
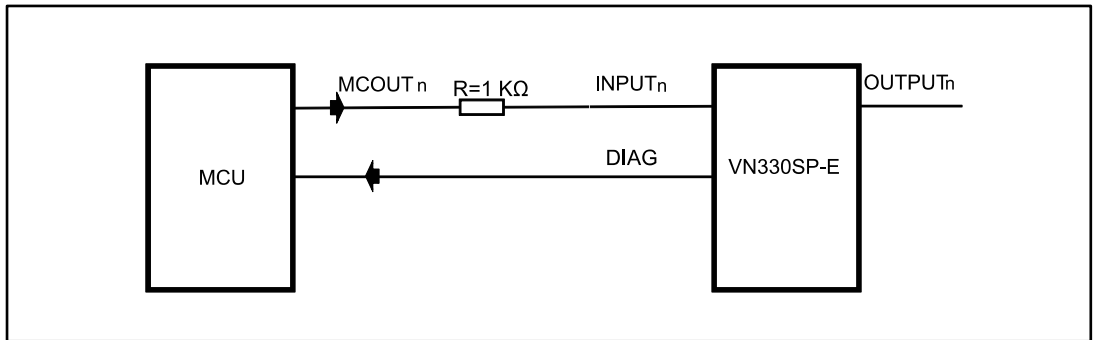


Figure 8: Driving circuit



## 7 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](http://www.st.com). ECOPACK® is an ST trademark.

### 7.1 PowerSO-10 package information

Figure 9: PowerSO-10 package outline

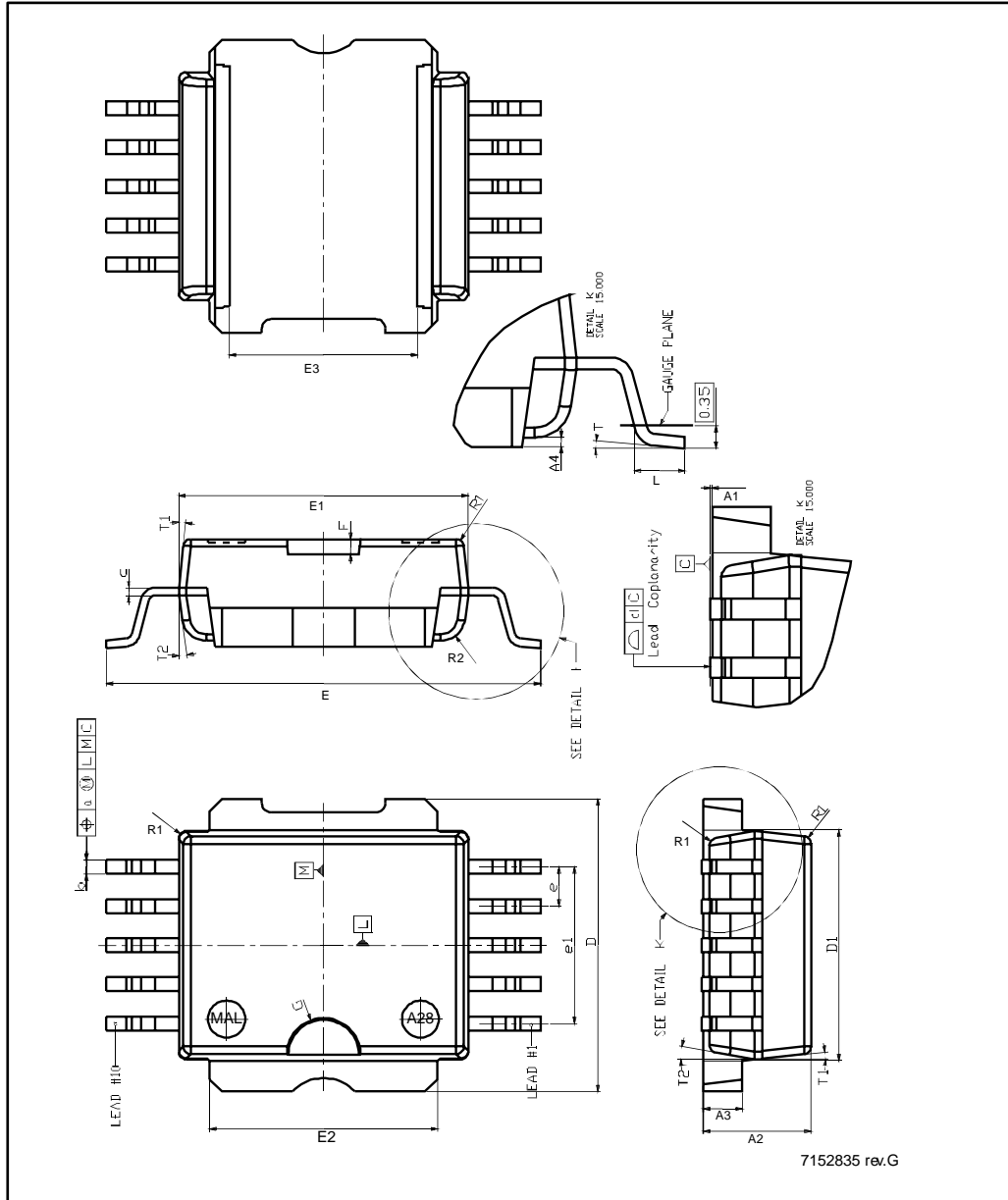


Table 9: PowerSO-10 package mechanical data

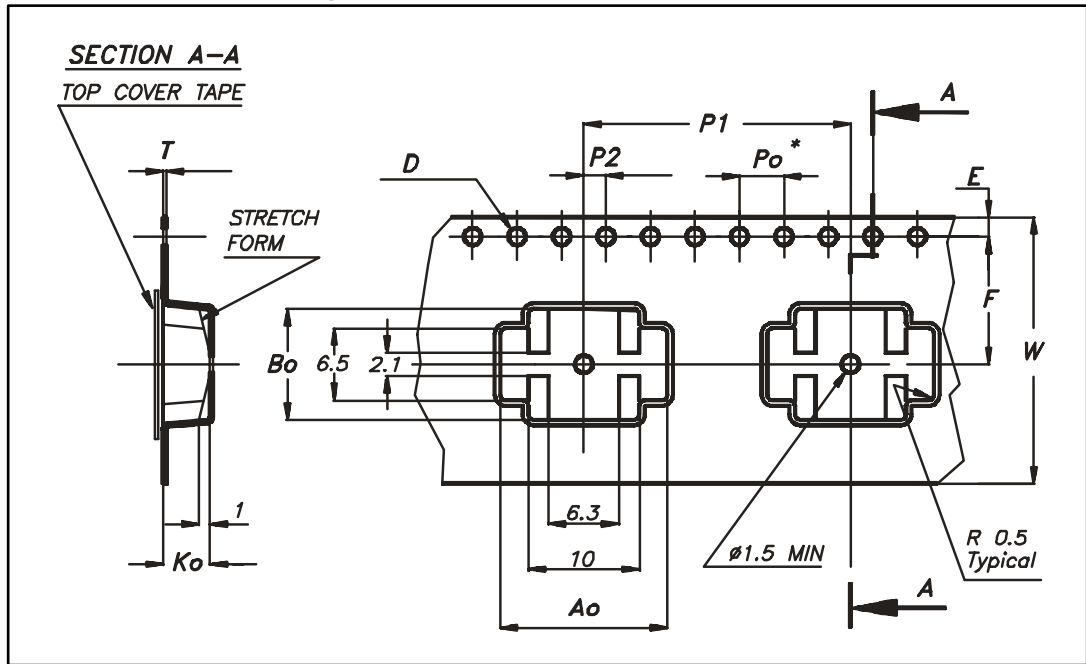
Dim.	mm		
	Min.	Typ.	Max.
A1	0	0.05	0.1
A2	3.4	3.5	3.6
A3	1.2	1.3	1.4
A4	0.15	0.2	0.25
a		0.2	
b	0.37	0.45	0.53
c	0.23	0.27	0.32
D	9.4	9.5	9.6
D1	7.4	7.5	7.6
d	0	0.05	0.1
E	13.85	14.1	14.35
E1 <sup>(1)</sup>	9.3	9.4	9.5
E2	7.3	7.4	7.5
E3	5.9	6.1	6.3
e		1.27	
e1		5.08	
F		0.5	
G		1.2	
L	0.8	1	1.1
R1			0.25
R2		0.8	
T	2 deg	5 deg	8 deg
T1		6 deg	
T2		10 deg	

**Notes:**

<sup>(1)</sup>Resin protrusions are not included (max. value 0.15 mm per side)

## 7.2 PowerSO-10 packing information

Figure 10: PowerSO-10 career tape outline



Drawing is not in scale

Table 10: PowerSO-10 carrier tape dimension mechanical data

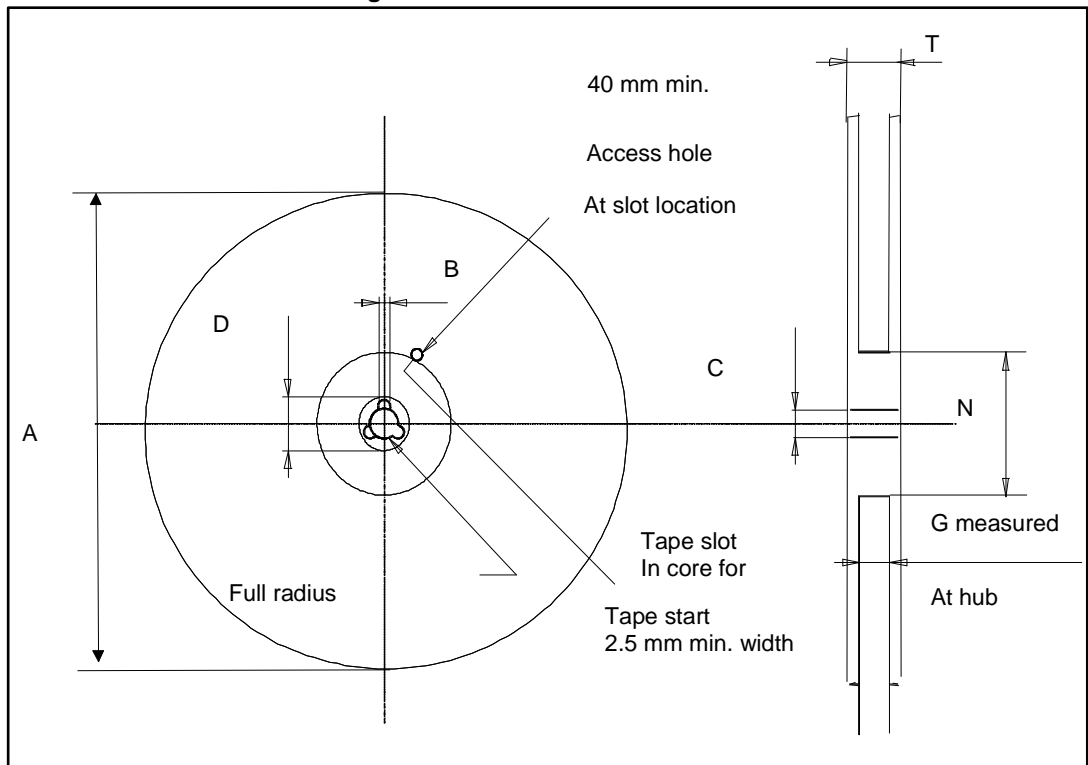
Dim.	mm		
	Min.	Typ.	Max.
A0	14.9	15.0	15.1
B0	9.9	10.0	10.1
K0	4.15	4.25	4.35
F	11.4	11.5	11.6
E	1.65	1.75	1.85
W	23.7	24.0	24.3
P2	1.9	2.0	2.1
P0	3.9	4.0	4.1
P1	23.9	24.0	24.1
T	0.025	0.30	0.35
D(∅)	1.50	1.55	1.60



10 sprocket hole pitch cumulative tolerance  $\pm 0.2$  mm



Figure 11: PowerSO-10 reel outline



Drawing is not in scale

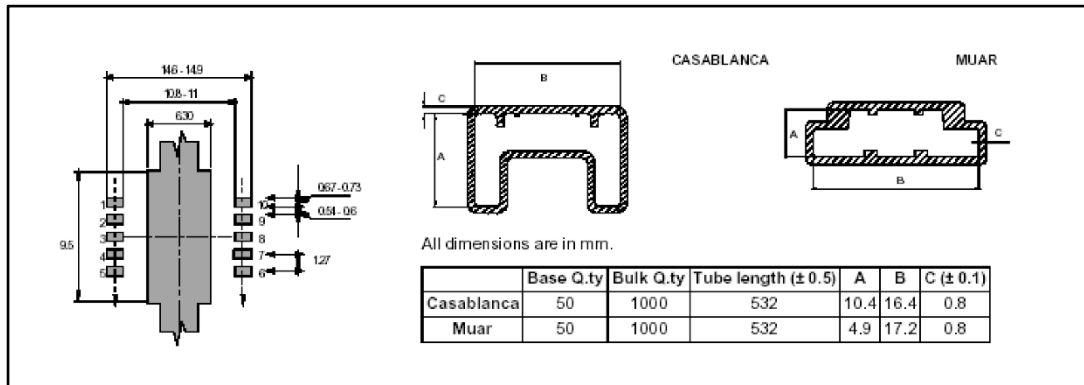
Table 11: PowerSO-10 reel dimension mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			330
B	1.5		
C	12.8	13	13.2
D	20.2		
N	60		
G	23.7	24.4	
T			30.4

Table 12: PowerSO-10 base and bulk quantity in tape and reel

Base quantity	Bulk quantity
600	600

Figure 12: PowerSO-10 suggested pad and tube shipment (no suffix)



10 sprocket hole pitch cumulative tolerance  $\pm 0.2$  mm

## 8 Revision history

Table 13: Document revision history

Date	Revision	Changes
06-Sep-2005	1	Initial release.
31-Oct-2006	2	Typo in electrical characteristics temperature conditions updated <i>on page 5</i>
27-Mar-2007	3	Document reformatted, typo in <i>Note 1 on page 6</i>
14-Feb-2017	4	Updated <i>Table 4: "Power section"</i> . Inserted <i>Figure 12: "PowerSO-10 suggested pad and tube shipment (no suffix)"</i> .

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