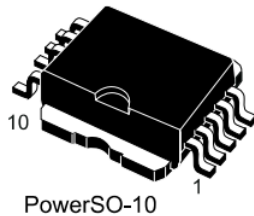


## Quad high-side smart power solid-state relay



### Features

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

#### Product status link

[VN330SP-E](#)

#### Product label



### Applications

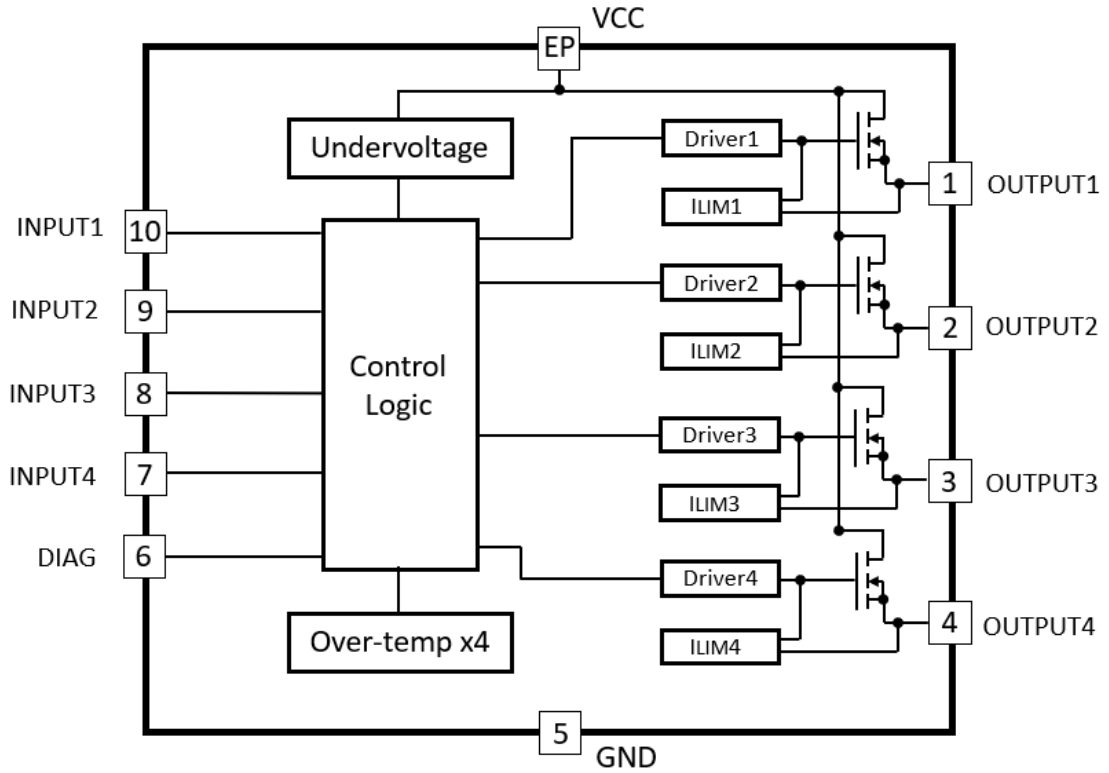
- Programmable logic control
- Industrial PC peripheral input/output
- Numerical control machines

### Description

The VN330SP-E is a monolithic device developed using 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.

# 1 Block diagram

Figure 1. Block diagram



## 2 Pin connection

Figure 2. Connection diagram (top view)

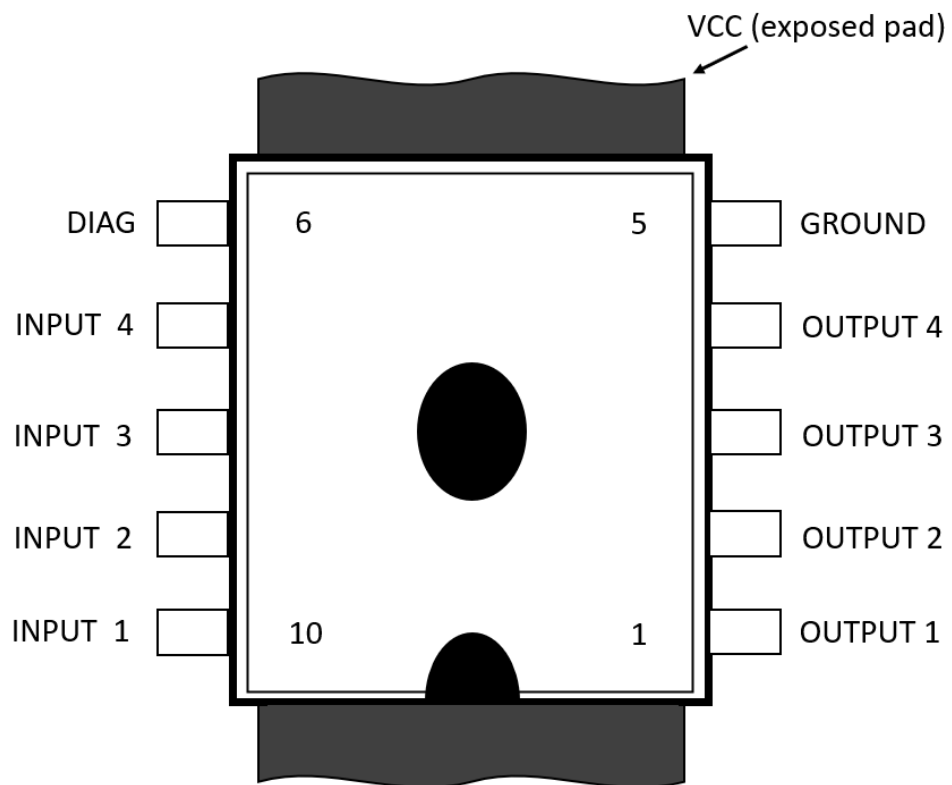
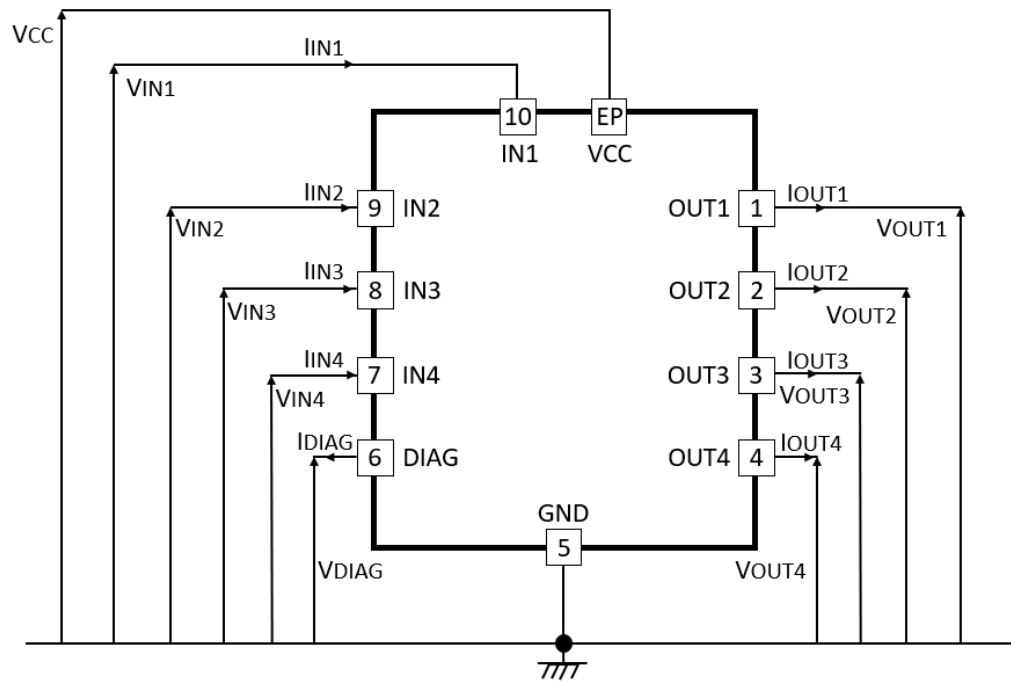


Figure 3. Current and voltage conventions



### 3 Maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CC}$	Power supply voltage	45	V
$-V_{CC}$	Reverse supply voltage	-0.3	V
$I_{OUT}$	Output current	Internally limited	A
$I_R$	Reverse output current (per channel)	-6	A
$I_{IN}$	Input current range	$\pm 10$	mA
$I_{DIAG}$	DIAG pin current	$\pm 10$	mA
$V_{ESD}$	Electrostatic discharge (R = 1.5 k $\Omega$ ; C = 100 pF)	2000	V
$E_{AS}$	Single pulse avalanche energy, all channels active simultaneously, $T_{amb} = 125\text{ }^{\circ}\text{C}$ , $I_{LOAD} = 0.625\text{ A}$	4	J
$P_{TOT}$	Power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	Internally limited	W
$T_J$	Junction operating temperature	Internally limited	$^{\circ}\text{C}$
$T_{STG}$	Storage temperature	-55 to 150	$^{\circ}\text{C}$

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{th(JC)}$	Thermal resistance junction-case <sup>(1)</sup>	Max. 2	$^{\circ}\text{C}/\text{W}$
$R_{th(JA)}$	Thermal resistance junction-ambient <sup>(2)</sup>	Max. 50	$^{\circ}\text{C}/\text{W}$

1. Per channel.
2. 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 3. 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 4. Switching (V<sub>CC</sub> = 24 V, R<sub>LOAD</sub> = 48Ω, see Figure 8. Switching parameter test conditions)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>d(ON)</sub>	Turn-on delay time of output current	Input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		30	40	μs
		Input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			60	
t <sub>r</sub>	Rise time of output current	Input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		50	100	μs
		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	Input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		20	30	μs
		Input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			40	
t <sub>f</sub>	Fall time of output current	Input rise time < 0.1 μs, T <sub>J</sub> = 25 °C		8	15	μs
		Input rise time < 0.1 μs, T <sub>J</sub> = 125 °C			20	
(di/dt) <sub>on</sub>	Turn-on current slope	Normal operation			0.5	A/μs
		I <sub>OUT</sub> = I <sub>LIM</sub> , T <sub>J</sub> = 25 °C			2	
(di/dt) <sub>off</sub>	Turn-off current slope	Normal operation			2	A/μs
		I <sub>OUT</sub> = I <sub>LIM</sub> , T <sub>J</sub> = 25 °C			4	

**Table 5. 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	$V_{IN} = 0$ to 30 V			600	$\mu$ A
$I_{LGND}$	Output current in ground disconnection	$V_{CC} = V_{IN} = V_{GND} = V_{DIAG} = 24$ V; $T_J = 25$ °C			25	mA
$V_{ICL}$	Input clamp voltage <sup>(1)</sup>	$I_{IN} = 1$ mA	32	36		V
		$I_{IN} = -1$ mA		-0.7		

1. 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 6. Protection and diagnostic**

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

1. Status determination > 100  $\mu$ s after the switching edge.

**Note:** 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

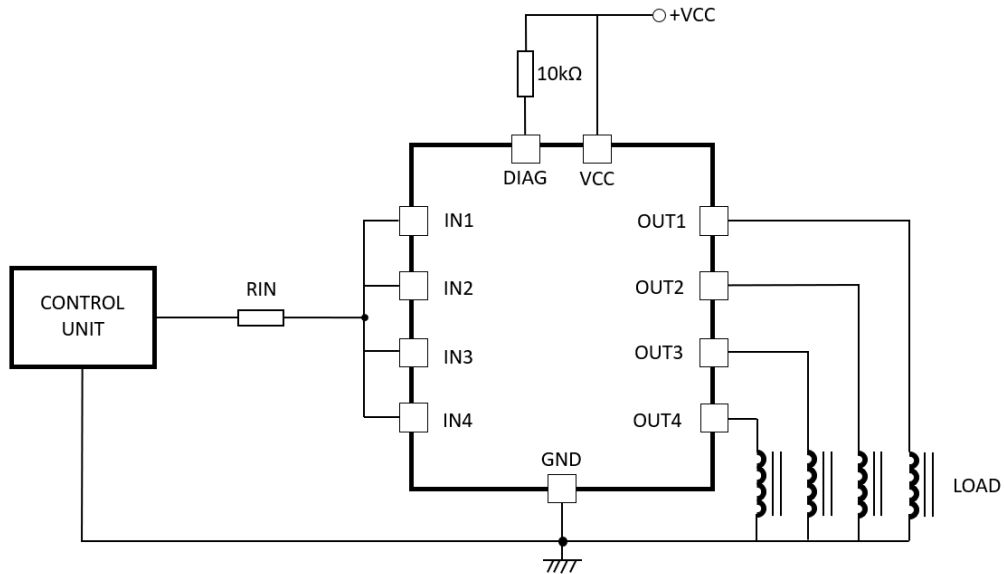
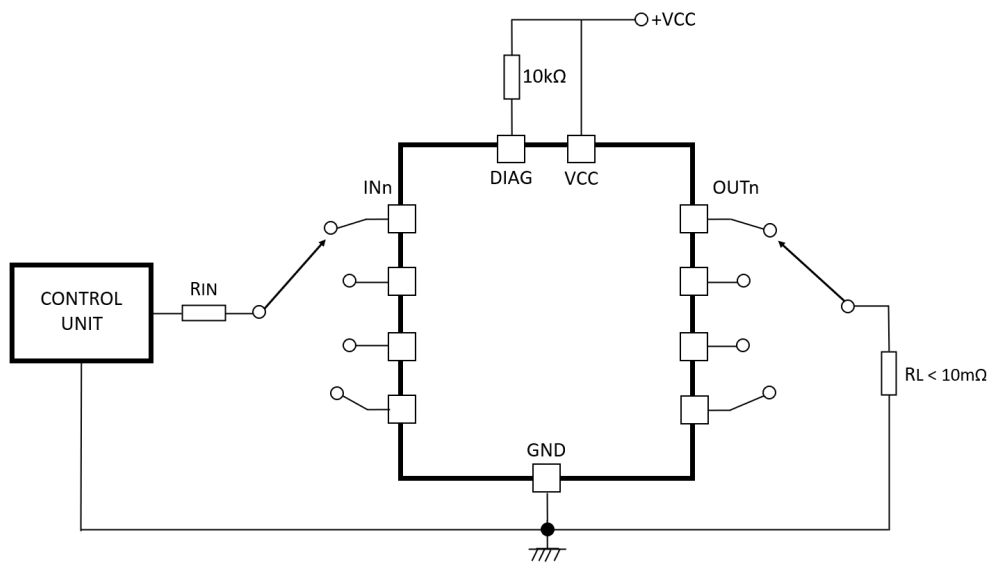


Figure 5. Peak short-circuit test diagram





## 6 Switching time waveforms and truth table

**Table 7. 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 <sup>(1)</sup>
	H	L	H <sup>(1)</sup>
Shorted load (current limitation)	L	L	H
	H	H <sup>(2)</sup>	H

1. DIAG pin is considered pulled-up at application voltage level

2.  $V_{OUT} = R_{LOAD} \times I_{LIM}$

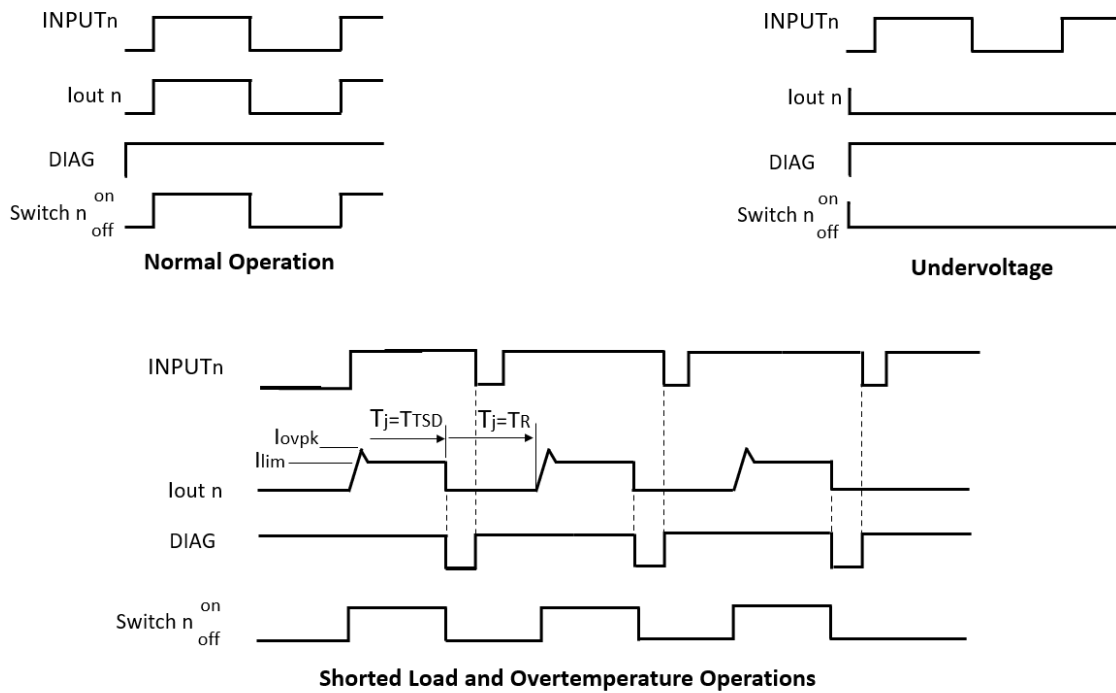
**Figure 6. Switching waveforms**


Figure 7. Switching parameter test conditions

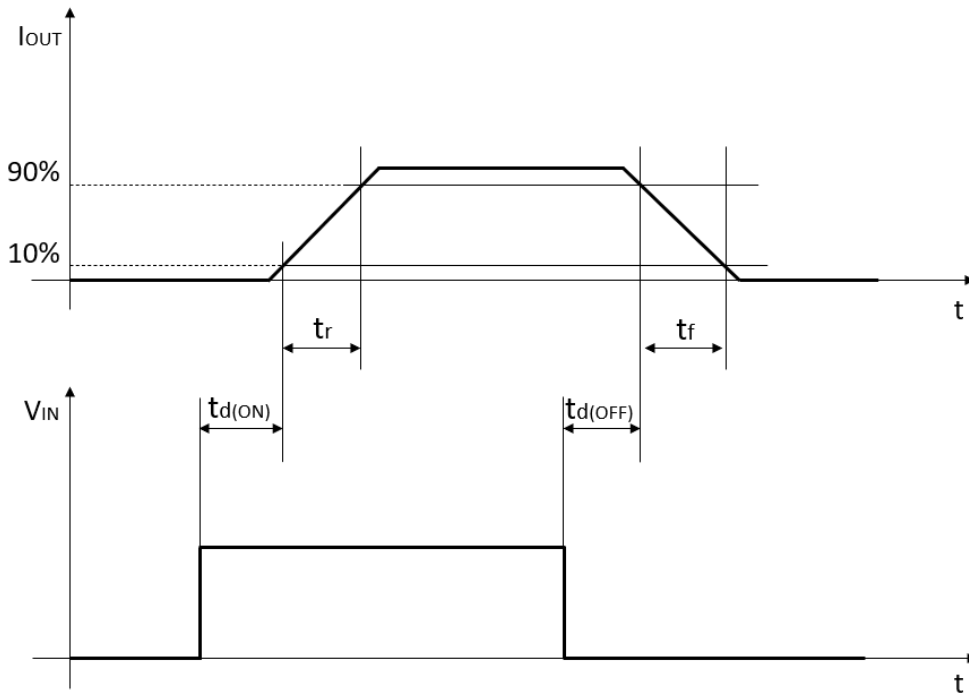
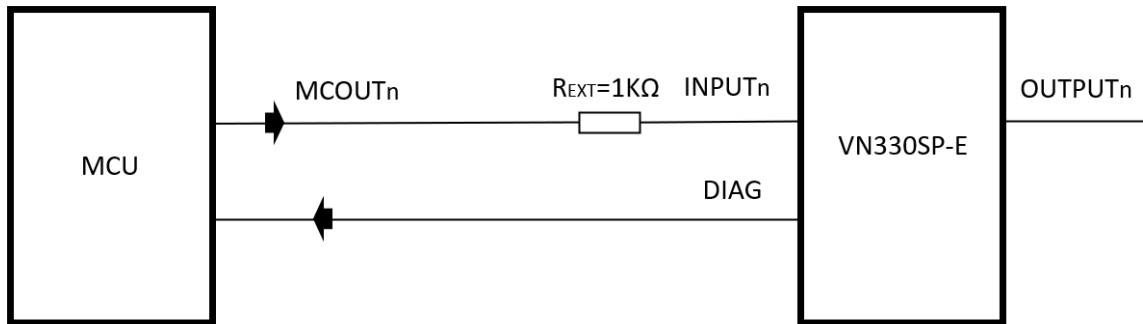


Figure 8. Driving circuit

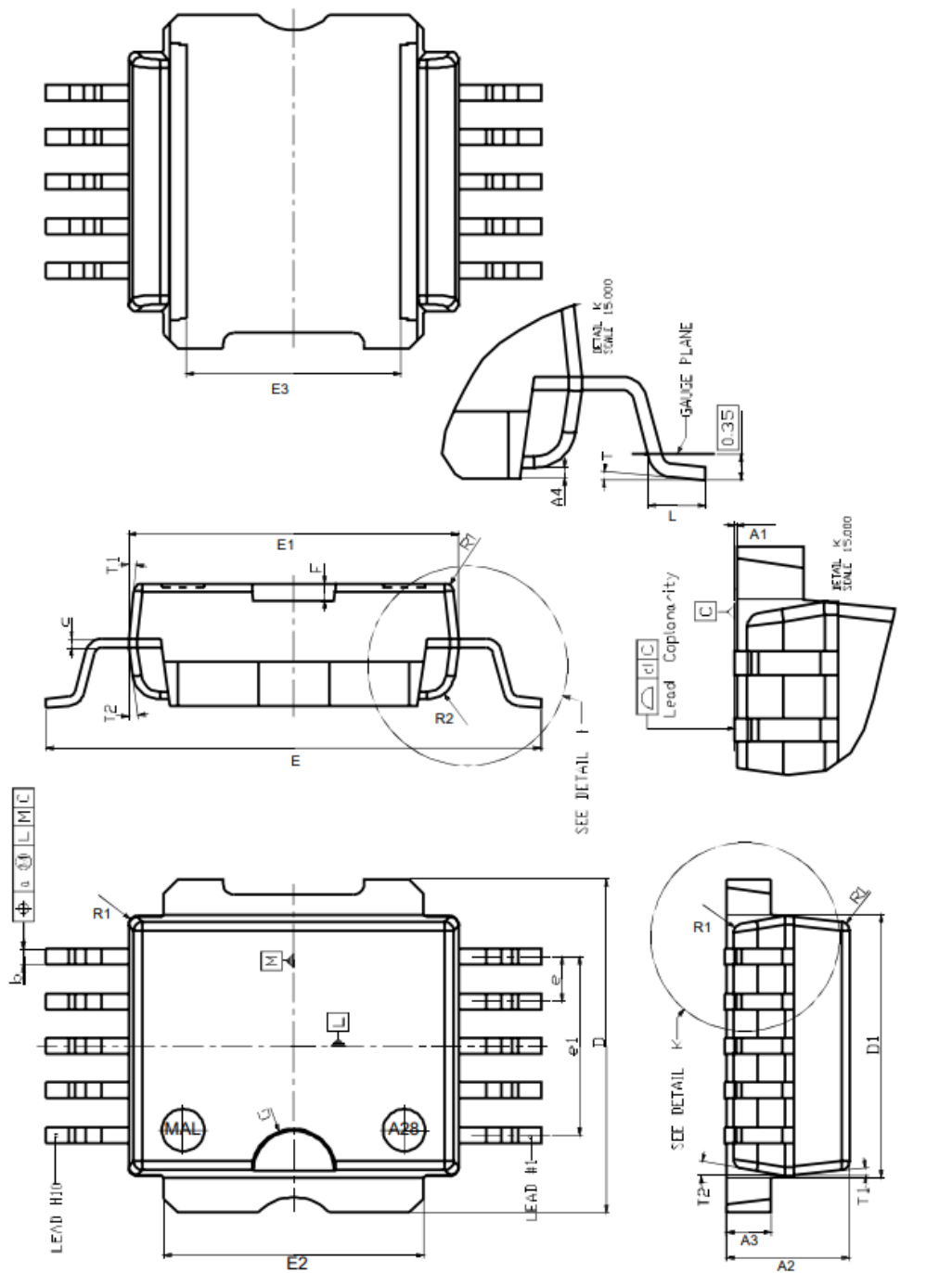


## 7 Package information

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



7152835 rev.G

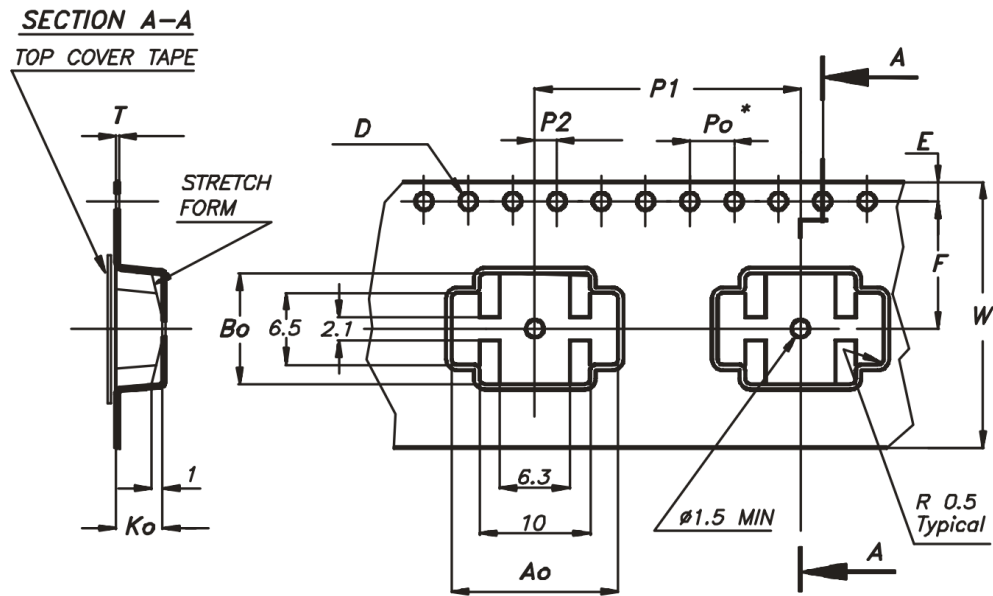
**Table 8. PowerSO-10 package mechanical data**

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	

1. 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



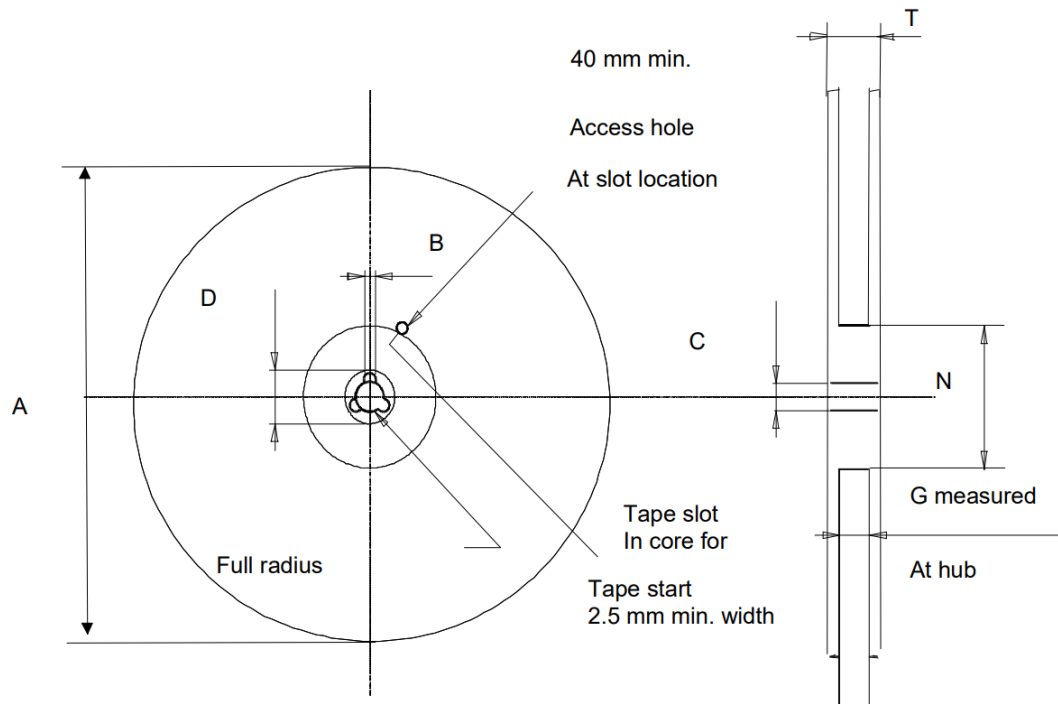
Note: Drawing is not in scale

Table 9. PowerSO-10 career 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(Ø)	1.50	1.55	1.60

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

Figure 11. PowerSO-10 reel outline



Note: Drawing is not in scale

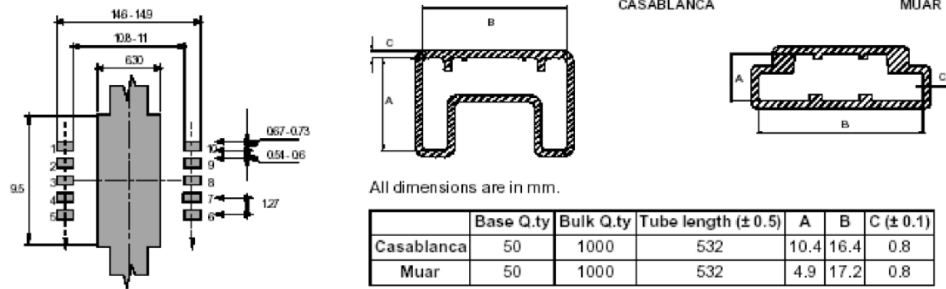
Table 10. PowerSO-10 reel dimension mechanical data

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 11. 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)



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

## 8 Ordering information

Table 12. Ordering information

Part number	Package	Packaging
VN330SP-E	PowerSO-10	Tube
VN330SPTR-E		Tape and reel



## 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 on <i>page 5</i>
27-Mar-2007	3	Document reformatted, typo in <i>Note 1 on page 6</i>
14-Feb-2017	4	Updated <b>Table 3. Power section</b> . Inserted <b>Figure 13. PowerSO-10 suggested pad and tube shipment (no suffix)</b>
03-May-2022	5	Document reformatted; updated description and value of EAS in table 1; changed fig.4; some minor typo corrected

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