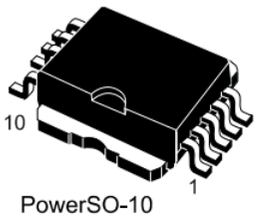
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VN330SP-E

Datasheet

Quad high-side smart power solid-state relay



PowerSO-10

Product status link

VN330SP-E

Product label

SUSTAINABLE TECHNOLOGY

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

Applications

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

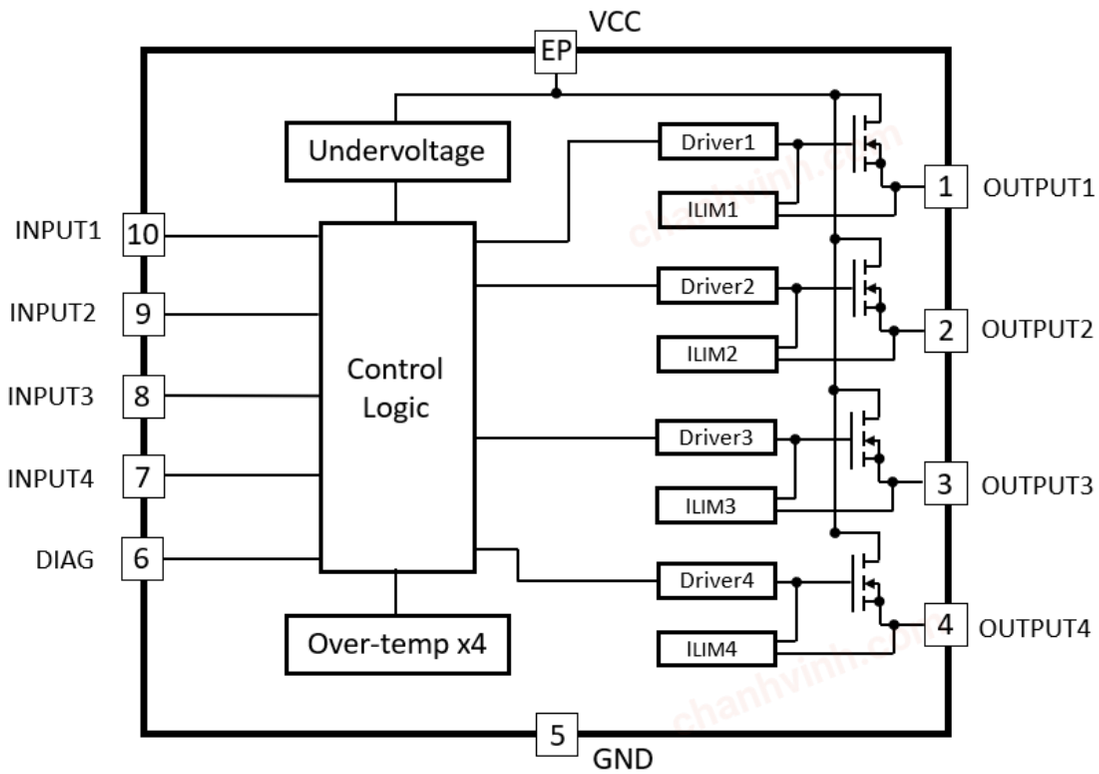
Description

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.

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1 Block diagram

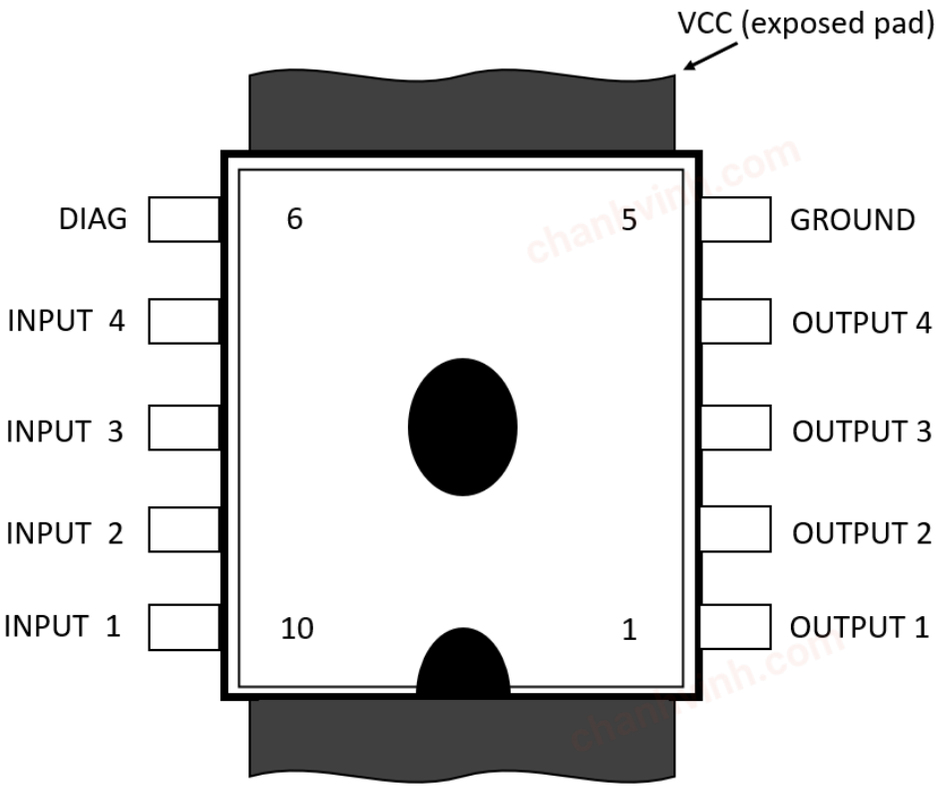
Figure 1. **Block diagram**



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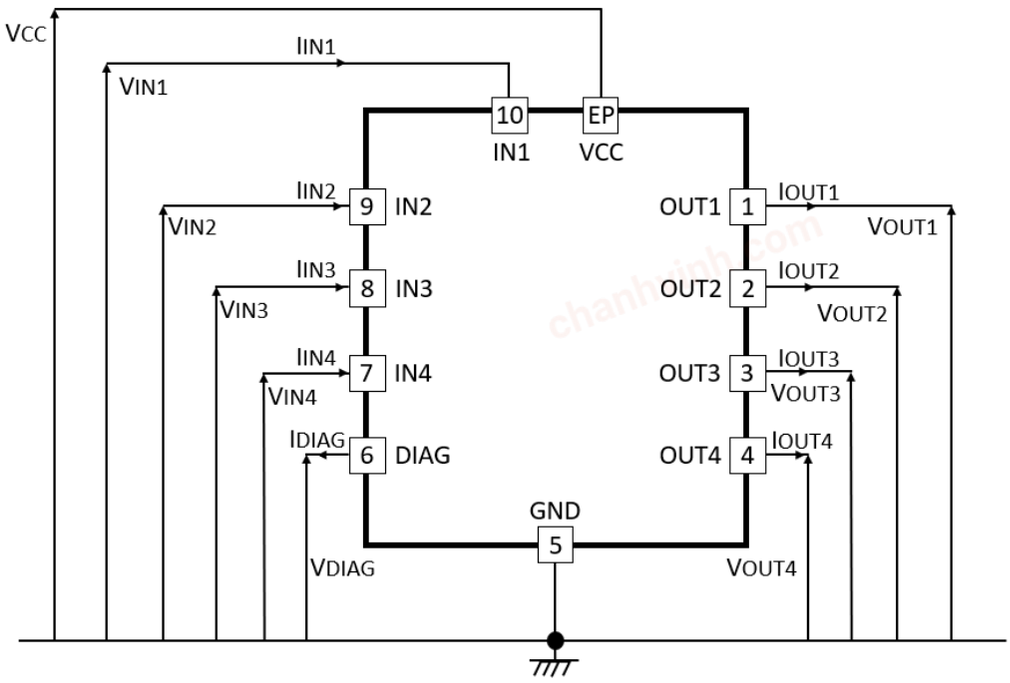
2 Pin connection

Figure 2. **Connection diagram (top view)**



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Figure 3. **Current and voltage conventions**



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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	±10	mA
I_{DIAG}	DIAG pin current	±10	mA
V_{ESD}	Electrostatic discharge (R = 1.5 kΩ; C = 100 pF)	2000	V
E_{AS}	Single pulse avalanche energy, all channels active simultaneously, T_{amb} = 125 °C, I_{LOAD} = 0.625 A	4	J
P_{TOT}	Power dissipation at T_C = 25 °C	Internally limited	W
T_J	Junction operating temperature	Internally limited	°C
T_{STG}	Storage temperature	-55 to 150	°C

Table 2. Thermal data

Symbol	Parameter		Value	Unit
$R_{th(JC)}$	Thermal resistance junction-case (1)	Max.	2	°C/W
$R_{th(JA)}$	Thermal resistance junction-ambient (2)	Max.	50	°C/W

1. *Per channel.*
2. *When mounted on a four-layer FR-4, with the minimum recommended pad size.*

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4 Electrical characteristics

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

Table 3. Power section

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage		10		36	V
$R_{DS(on)}$	On-state resistance	I_{OUT} = 0.5 A at T_J = 25 °C			0.2	Ω
		I_{OUT} = 0.5 A at T_J = 85 °C			0.32	
		I_{OUT} = 0.5 A at T_J = 125 °C			0.44	
I_S	Supply current	All channels OFF			1	mA
		On-state V_{IN} = 5 V, I_{OUT} = 0 V, T_J = -40 °C			15	mA
V_{demag}	Output voltage at turn-off	I_{OUT} = 0.5 A; L_{LOAD} ≥ 1 mH	V_{CC}-65	V_{CC}-55	V_{CC}-45	V

Table 4. Switching (V_{CC} = 24 V, R_{LOAD} = 48Ω, see Figure 8. Switching parameter test conditions)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(ON)}$	Turn-on delay time of output current	Input rise time < 0.1 µs, T_J = 25 °C		30	40	µs
		Input rise time < 0.1 µs, T_J = 125 °C			60	
t_r	Rise time of output current	Input rise time < 0.1 µs, T_J = 25 °C		50	100	µs
		Input rise time < 0.1 µs, T_J = 125 °C			115	
$t_{d(OFF)}$	Turn-off delay time of output current	Input rise time < 0.1 µs, T_J = 25 °C		20	30	µs
		Input rise time < 0.1 µs, T_J = 125 °C			40	
t_f	Fall time of output current	Input rise time < 0.1 µs, T_J = 25 °C		8	15	µs
		Input rise time < 0.1 µs, T_J = 125 °C			20	
$(di/dt)_{on}$	Turn-on current slope	Normal operation			0.5	A/µs
		I_{OUT} = I_{LIM}, T_J = 25 °C			2	
$(di/dt)_{off}$	Turn-off current slope	Normal operation			2	A/µs
		I_{OUT} = I_{LIM}, T_J = 25 °C			4	

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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	µA
I_{LGND}	Output current in ground disconnection	V_{CC}= V_{INn} = V_{GND} = V_{DIAG} = 24 V; T_J = 25 °C			25	mA
V_{ICL}	Input clamp voltage(1)	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} ≥ 10 mΩ			1.5	V
I_{LIM}	DC short-circuit current	V_{CC} = 24 V; R_{LOAD} < 10 mΩ	0.7		2.5	A
I_{OVPK}	Peak short-circuit current	V_{CC} = 24 V; V_{IN} = 30 V; R_{LOAD} < 10 mΩ			4	A
I_{DIAGH}	Leakage on DIAG pin in high state	V_{DIAG} = 24 V			100	µA
I_{LOAD}	Output leakage current	V_{CC} = 10 to 36 V; V_{IN}=V_{IL}			50	µA
t_{SC}	Delay time of current limiter				100	µs
T_{TSD}	Thermal shutdown temperature		150	170		°C
T_R	Thermal reset temperature		135	155		°C

1. *Status determination > 100 µs 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.

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5 Test circuits

Figure 4. **Avalanche energy test circuit**

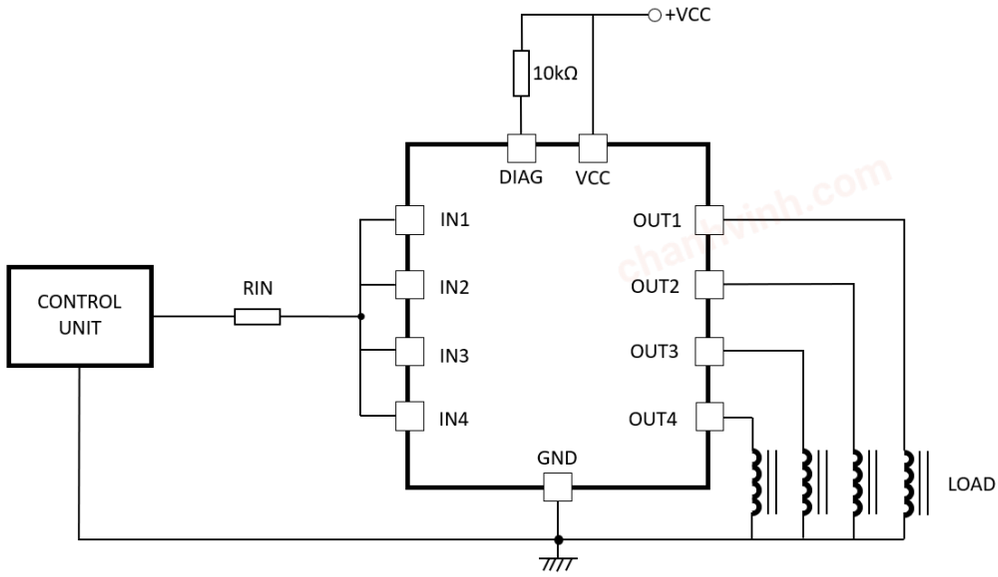
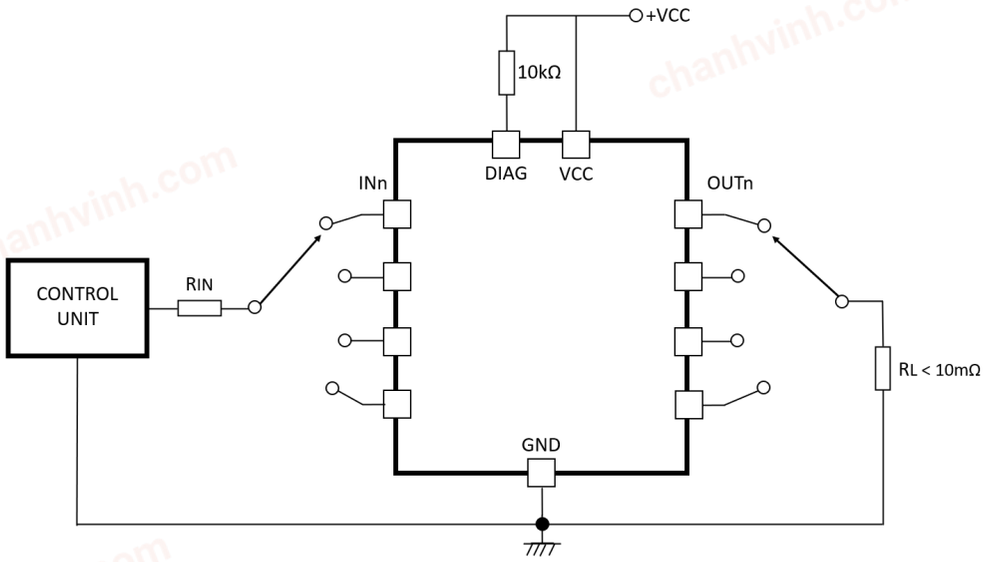


Figure 5. **Peak short-circuit test diagram**



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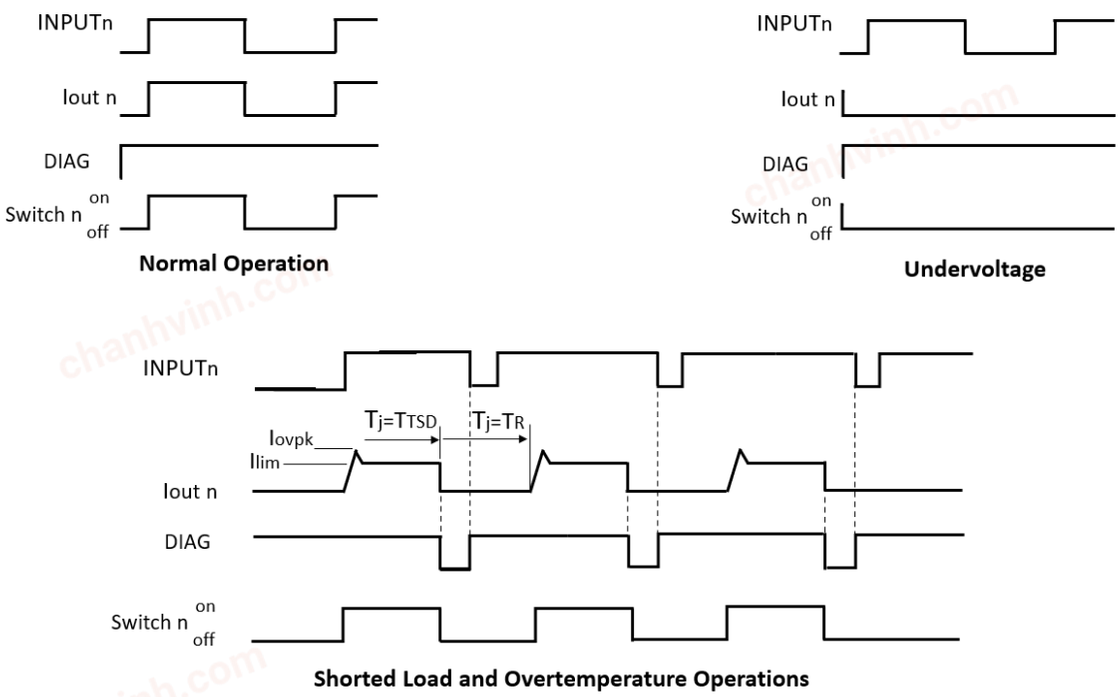
6 Switching time waveforms and truth table

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 (1)
	H	L	H (1)
Shorted load (current limitation)	L	L	H
	H	H (2)	H

1. *DIAG pin is considered pulled-up at application voltage level*
2. $V_{OUT} = R_{LOAD} \times I_{LIM}$

Figure 6. Switching waveforms



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Figure 7. **Switching parameter test conditions**

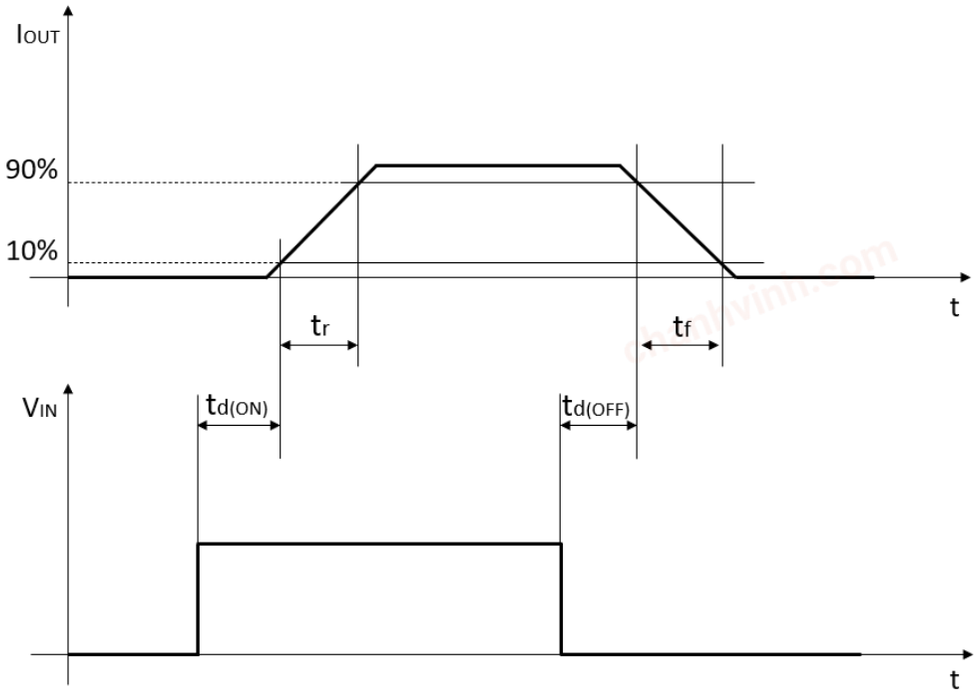
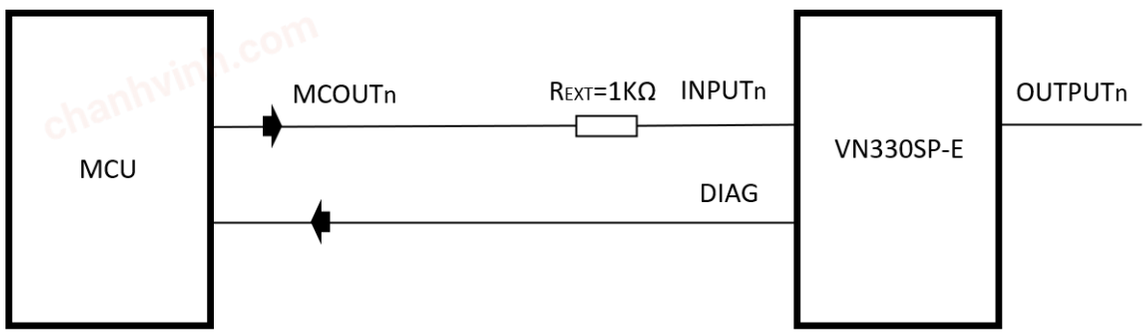


Figure 8. **Driving circuit**



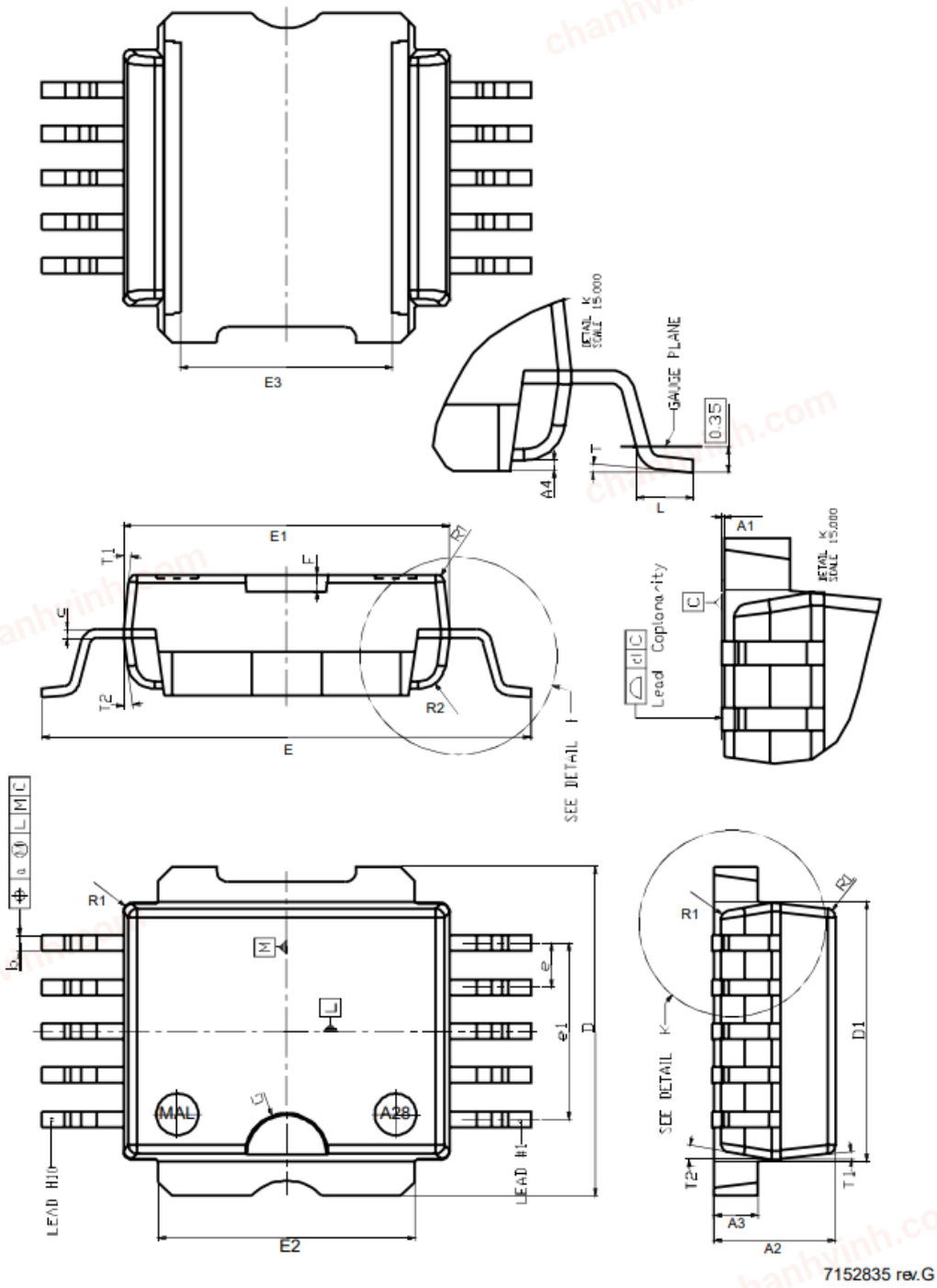
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7 Package information

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. ECOPACK is an ST trademark.

7.1 PowerSO-10 package information

Figure 9. **PowerSO-10 package outline**



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

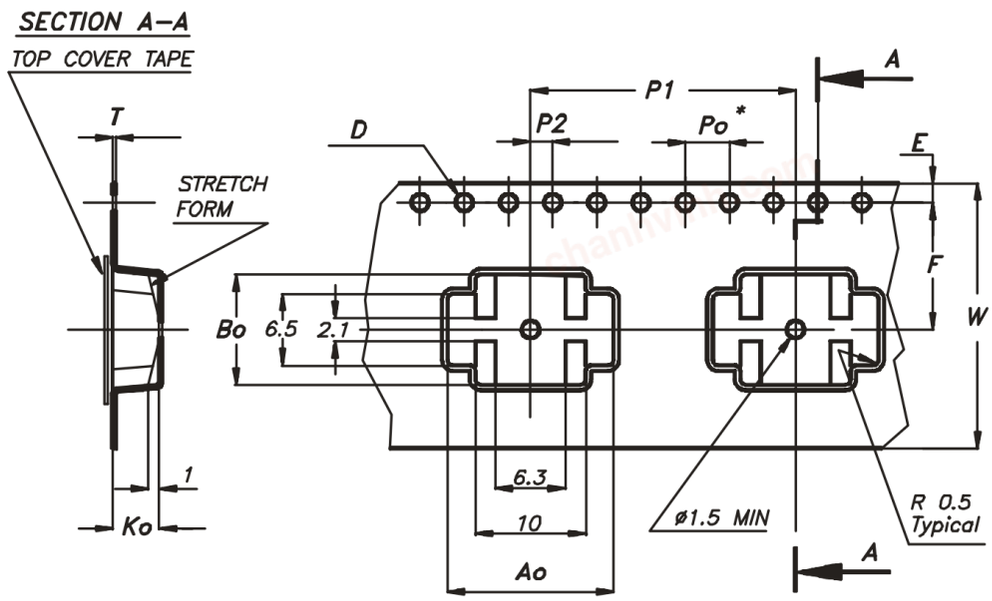
Dim.	mm		
	Min.	Typ.	Max.
A1	0	0.05	0.1
A2	3.4	3.5	3.6
A3	1.2	1.3	1.4
A4	0.15	0.2	0.25
a		0.2	
b	0.37	0.45	0.53
c	0.23	0.27	0.32
D	9.4	9.5	9.6
D1	7.4	7.5	7.6
d	0	0.05	0.1
E	13.85	14.1	14.35
E1(1)	9.3	9.4	9.5
E2	7.3	7.4	7.5
E3	5.9	6.1	6.3
e		1.27	
e1		5.08	
F		0.5	
G		1.2	
L	0.8	1	1.1
R1			0.25
R2		0.8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

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7.2 PowerSO-10 packing information

Figure 10. **PowerSO-10 career tape outline**



Note: Drawing is not in scale

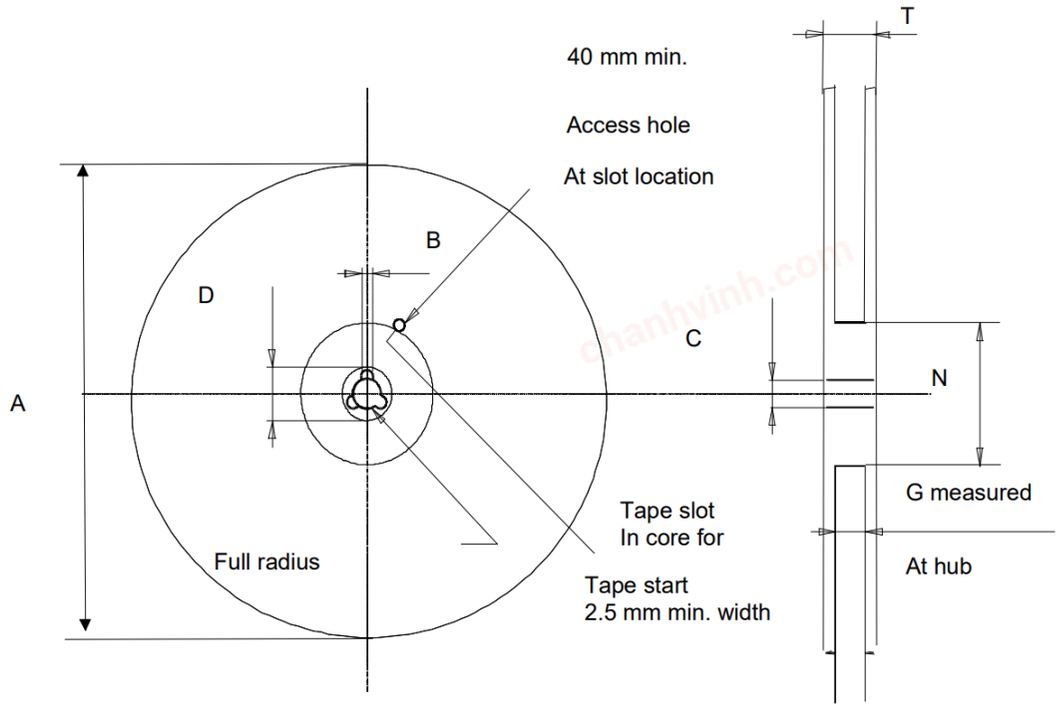
Table 9. **PowerSO-10 career tape dimension mechanical data**

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 ±0.2 mm

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Figure 11. **PowerSO-10 reel outline**



Note: Drawing is not in scale

Table 10. **PowerSO-10 reel dimension mechanical data**

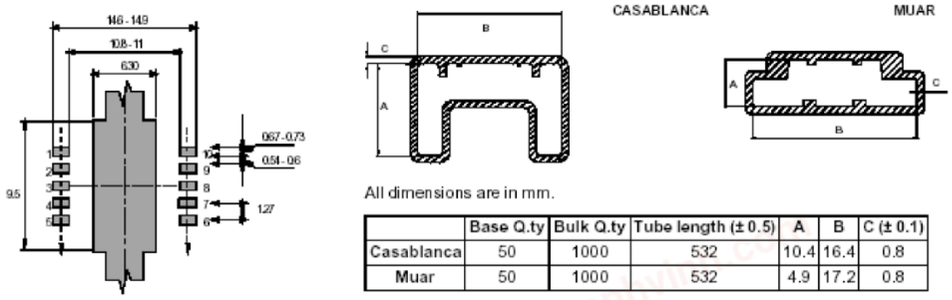
Dim.	mm		
	Min.	Typ.	Max.
A			330
B	1.5		
C	12.8	13	13.2
D	20.2		
N	60		
G	23.7	24.4	
T			30.4

Table 11. **PowerSO-10 base and bulk quantity in tape and reel**

Base quantity	Bulk quantity
600	600

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



All dimensions are in mm.

	Base Q.ty	Bulk Q.ty	Tube length (± 0.5)	A	B	C (± 0.1)
Casablanca	50	1000	532	10.4	16.4	0.8
Muar	50	1000	532	4.9	17.2	0.8

Note: 10 sprocket hole pitch cumulative tolerance ±0.2 mm

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8 Ordering information

Table 12. **Ordering information**

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

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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 page 5*
27-Mar-2007	3	Document reformatted, typo in *Note 1 on page 6*
14-Feb-2017	4	Updated Table 3. Power section. Inserted Figure 13. PowerSO-10 suggested pad and tube shipment (no suffix)
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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