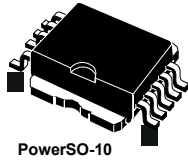


## Quad high-side smart power solid-state relay



PowerSO-10

## Product status link

[VN340SP-E & VN340SP-33-E](#)

## Product label



## Features

- Operating output current: 0.7 A (VN340SP-E) or 1 A (VN340SP-33-E)
- Digital I/O clamped at 32 V minimum voltage
- Shorted load and overtemperature protections
- Protection against loss of ground
- Built-in current limiter
- Undervoltage shutdown
- Open drain diagnostic output
- Fast demagnetization of inductive loads
- Conforms to IEC 61131-2

## Applications

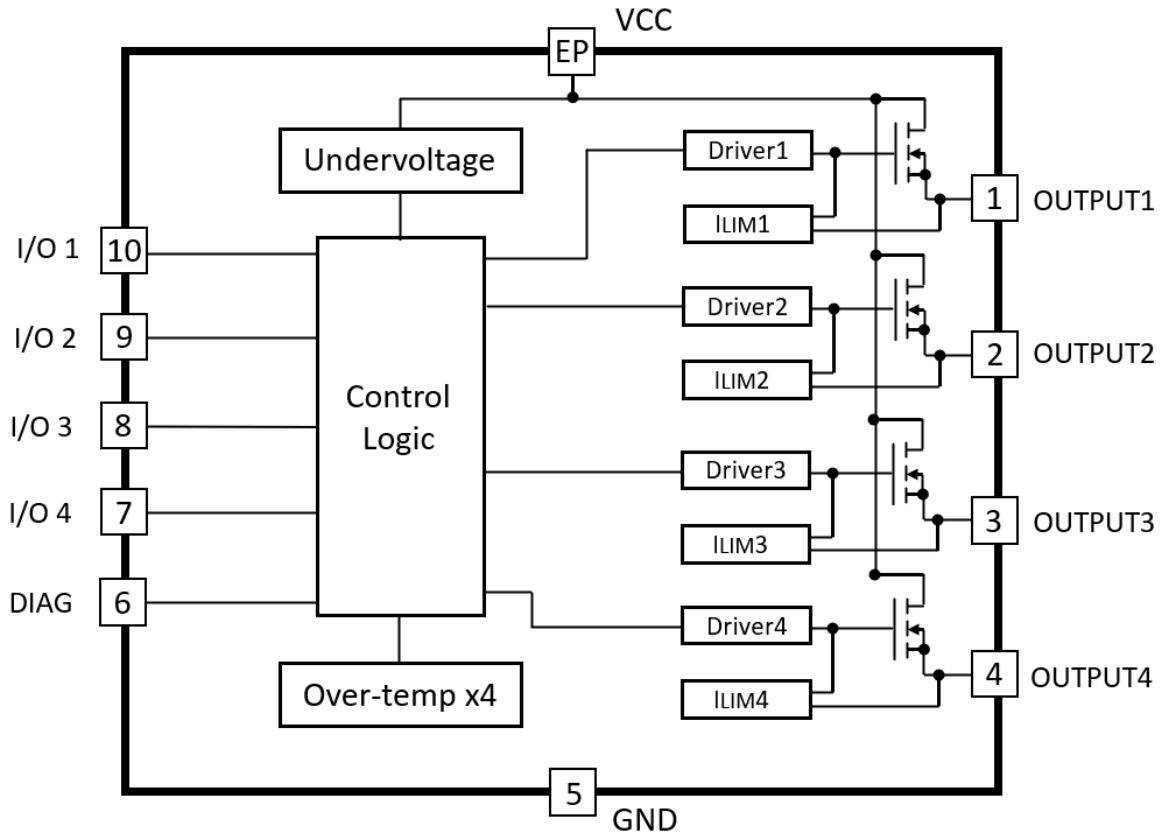
- Vending machines
- Industrial PC peripheral input/output
- Numerical control machines
- General high-side switch applications

## Description

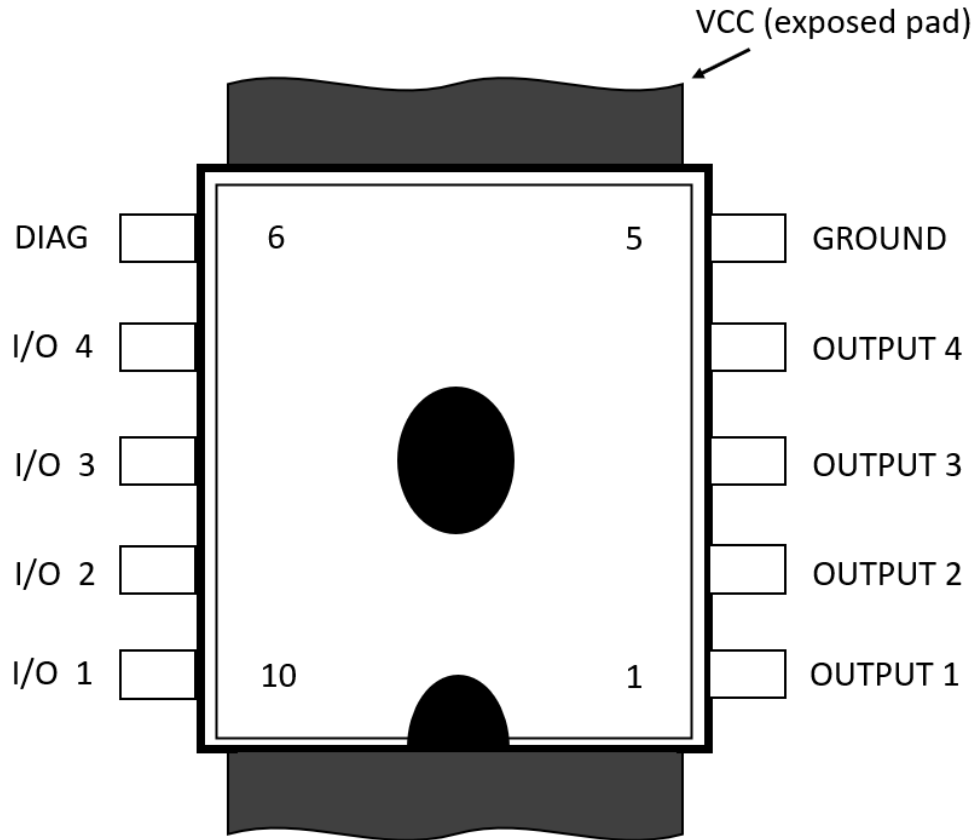
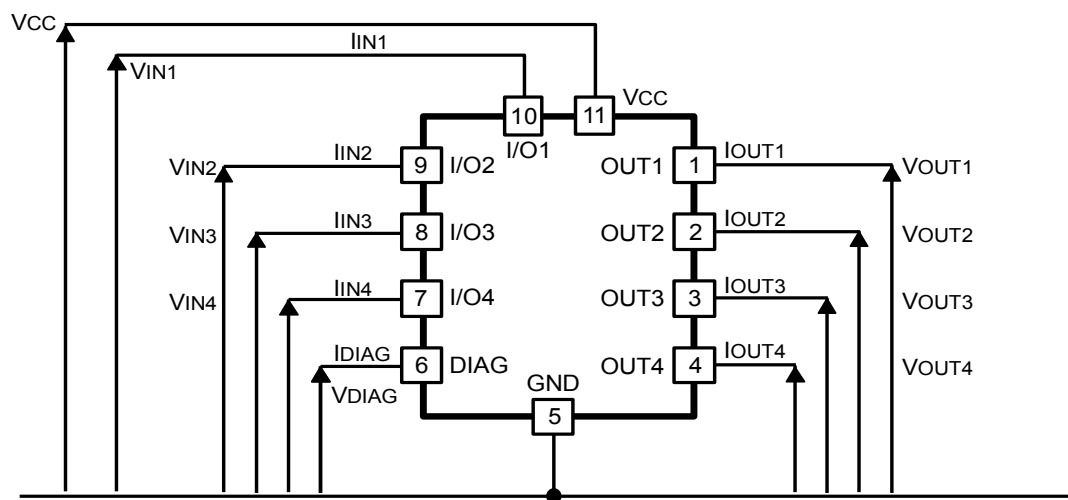
VN340SP-E & VN340SP-33-E are monolithic devices developed using STMicroelectronics' VIPower technology, intended to drive four independent resistive or inductive loads with one side connected to ground. Active current limitation prevents dropping of the system power supply in case of shorted load. Built-in thermal shutdown protects the chip from overtemperature and short-circuit. The open drain diagnostic output indicates overtemperature conditions. Each I/O is pulled down when the overtemperature condition of the relative channel is verified.

# 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 <sub>CC</sub>	Power supply voltage	45	V
-V <sub>CC</sub>	Reverse supply voltage	-4	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	-1 to +10	mA
I <sub>DIAG</sub>	Diag pin current	-1 to +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, one channel active, T <sub>J</sub> = 125 °C, I <sub>LOAD</sub> = 0.625 A	10	J
	Single pulse avalanche energy all channels active simultaneously, T <sub>J</sub> = 125 °C, I <sub>LOAD</sub> = 0.625 A	2	J
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 2. Thermal data**

Symbol	Parameter	Max Value	Unit
R <sub>th(JC)</sub>	Thermal resistance junction-case <sup>(1)</sup>	3	°C/W
R <sub>th(JA)</sub>	Thermal resistance junction-ambient <sup>(2)</sup>	50	°C/W

1. Per channel.

2. When mounted on a four-layer FR4, 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 @ T <sub>J</sub> = 25 °C			0.2	Ω
		I <sub>OUT</sub> = 0.5 A @ T <sub>J</sub> = 85 °C			0.32	
		I <sub>OUT</sub> = 0.5 A @ T <sub>J</sub> = 125 °C			0.4	
I <sub>S</sub>	Supply current	All channels in OFF-state			1	mA
		V <sub>IN</sub> = 30 V, I <sub>OUT</sub> = 0 V, T <sub>J</sub> = 125 °C			6	
V <sub>OL</sub>	Low state output voltage	V <sub>IN</sub> = V <sub>IL</sub> ; R <sub>LOAD</sub> > = 10 MΩ			1.5	V
I <sub>LGND</sub>	Output current at turn-off	V <sub>CC</sub> = V <sub>IN</sub> = V <sub>GND</sub> = V <sub>STAT</sub> = 18 to 30 V, T <sub>A</sub> = - 25 °C to 85 °C			2	mA
V <sub>demag</sub>	Demagnetization voltage	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, T<sub>J</sub> = 25 °C)**

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		52	100	μs
t <sub>r</sub>	Rise time of output current			94	250	
t <sub>d(OFF)</sub>	Turn-off delay time of output current			34	50	
t <sub>f</sub>	Fall time			8	20	

**Table 5. Logic inputs**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>IL</sub>	I/O input low level voltage				2	V
V <sub>IH</sub>	I/O input high level voltage		3.5			V
V <sub>I(HYST)</sub>	I/O input hysteresis voltage			0.5		V
I <sub>IN</sub>	I/O input current	V <sub>IN</sub> = 30 V			25	μA
V <sub>ICL</sub>	I/O input clamp voltage <sup>(1)</sup>	I <sub>IN</sub> = 1 mA	32	36		V
		I <sub>IN</sub> = -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	$I_{DIAG} = 5 \text{ mA}$ (fault condition)			1	V
$V_{SCL}$	Status clamp voltage	$I_{DIAG} = 1 \text{ mA}$	32	36		V
		$I_{DIAG} = -1 \text{ mA}$		-0.7		V
$V_{USD}$	Undervoltage shutdown		5		8	V
$I_{lim}$	DC short-circuit current	$V_{CC} = 24 \text{ V}; R_{LOAD} < 10 \text{ m}\Omega$	0.7 <sup>(2)</sup>		2	A
			1 <sup>(3)</sup>			
$I_{OVPK}$	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	$V_{DIAG} = 24 \text{ V}$			25	$\mu\text{A}$
$I_{LOAD}$	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	$\mu\text{s}$
$T_{TSD}$	Junction shutdown temperature		150	170		$^{\circ}\text{C}$
$T_R$	Junction reset temperature		135	155		$^{\circ}\text{C}$

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

2. VN340SP-E

3. VN340SP-33-E

**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

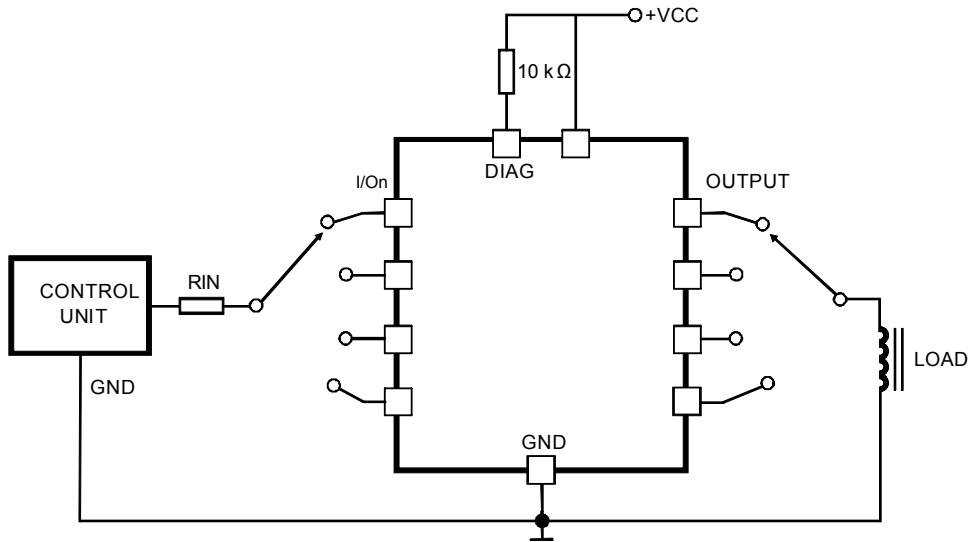
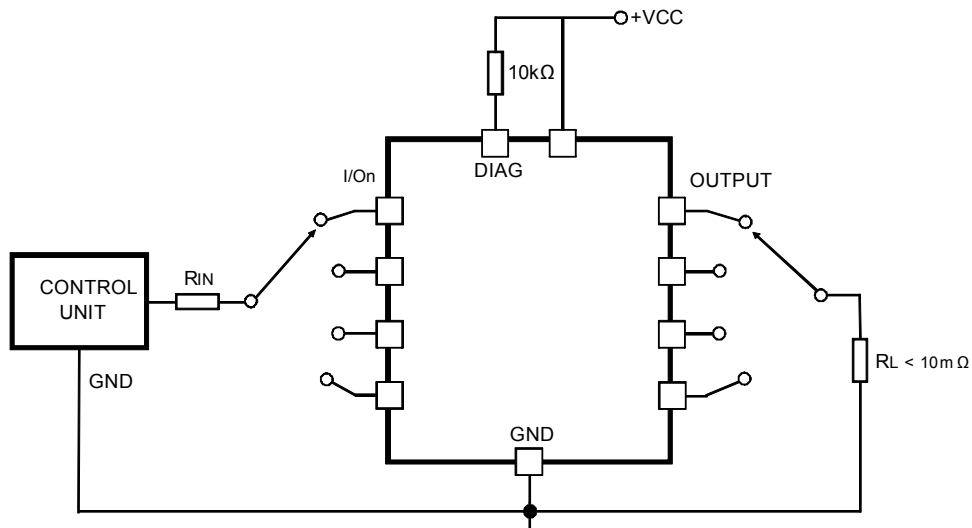
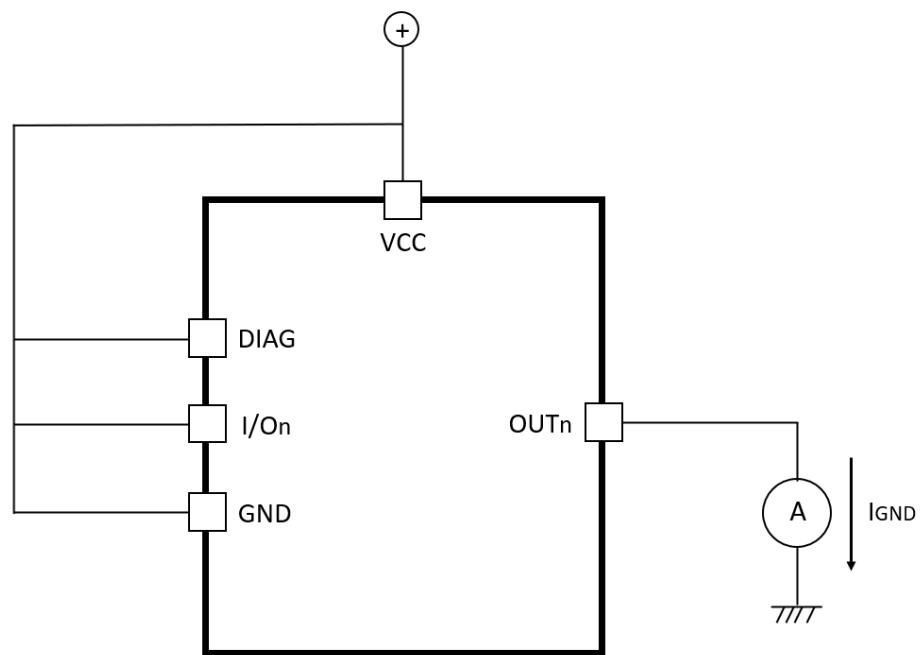
**Figure 4. Avalanche energy test circuit**

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


Figure 6.  $I_{L_{GND}}$  test configuration





## 6 Switching time waveforms and truth table

Figure 7. Switching waveforms

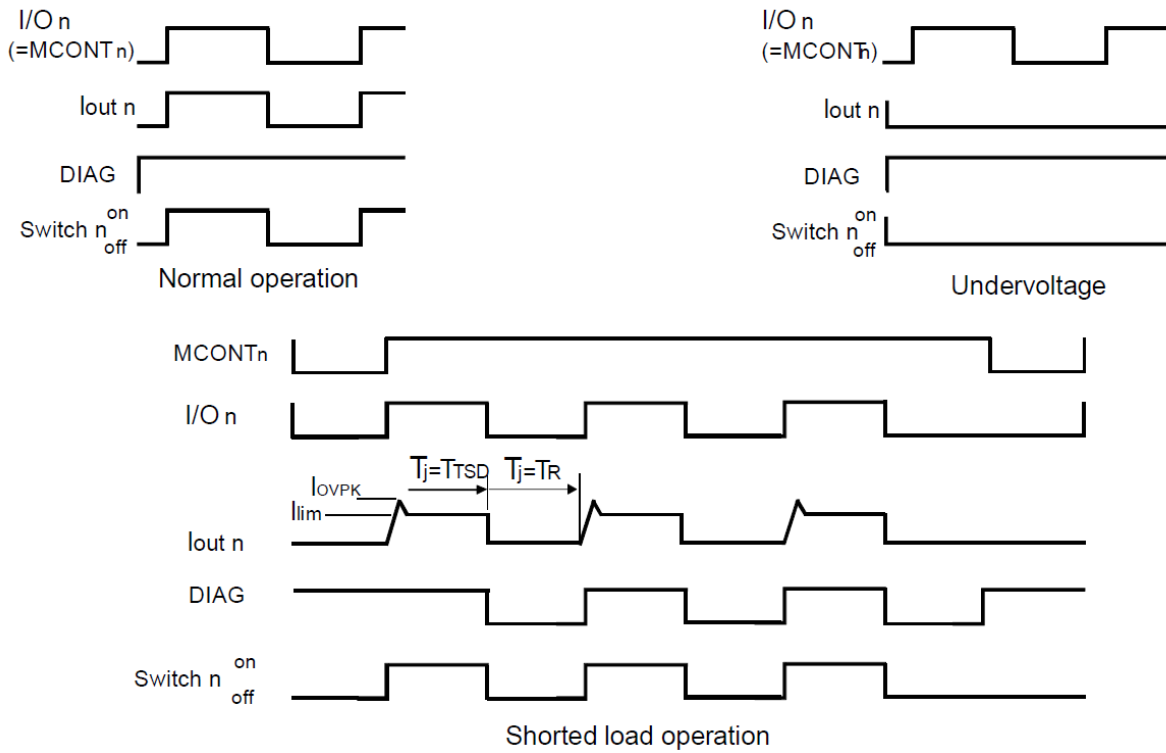


Figure 8. Switching parameter test conditions

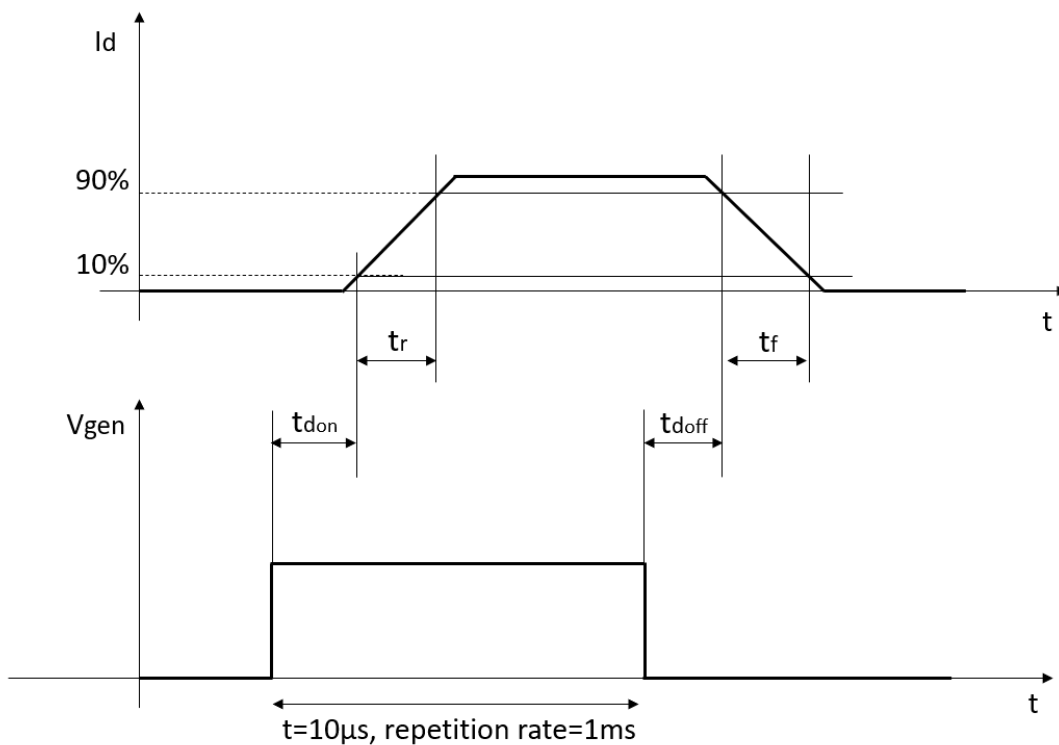


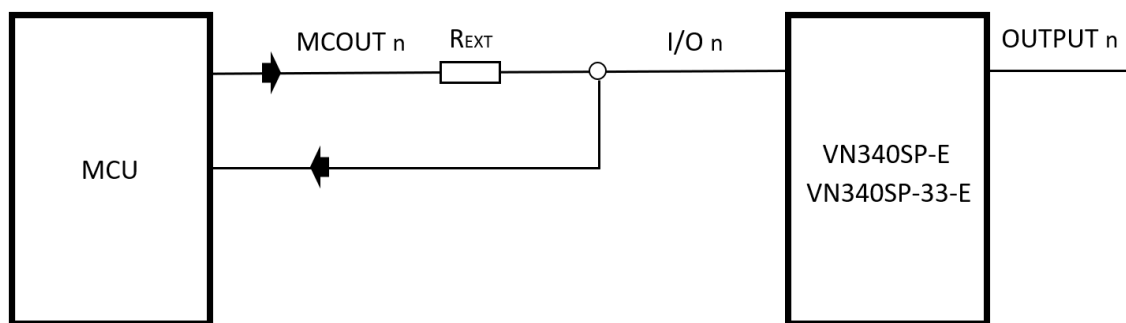
Table 7. Truth table

Conditions	MCOUTn	I/On	OUTPUTn	Diagnostic
Normal operation	L	L	L	H
	H	H	H	H
Junction overtemperature	L	L	L	H
	H	L	L	L
Undervoltage	L	L	L	H <sup>(1)</sup>
	H	H	L	H <sup>(1)</sup>
Shorted load (current limitation)	L	L	L	H
	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 9. Driving circuit



Notes:

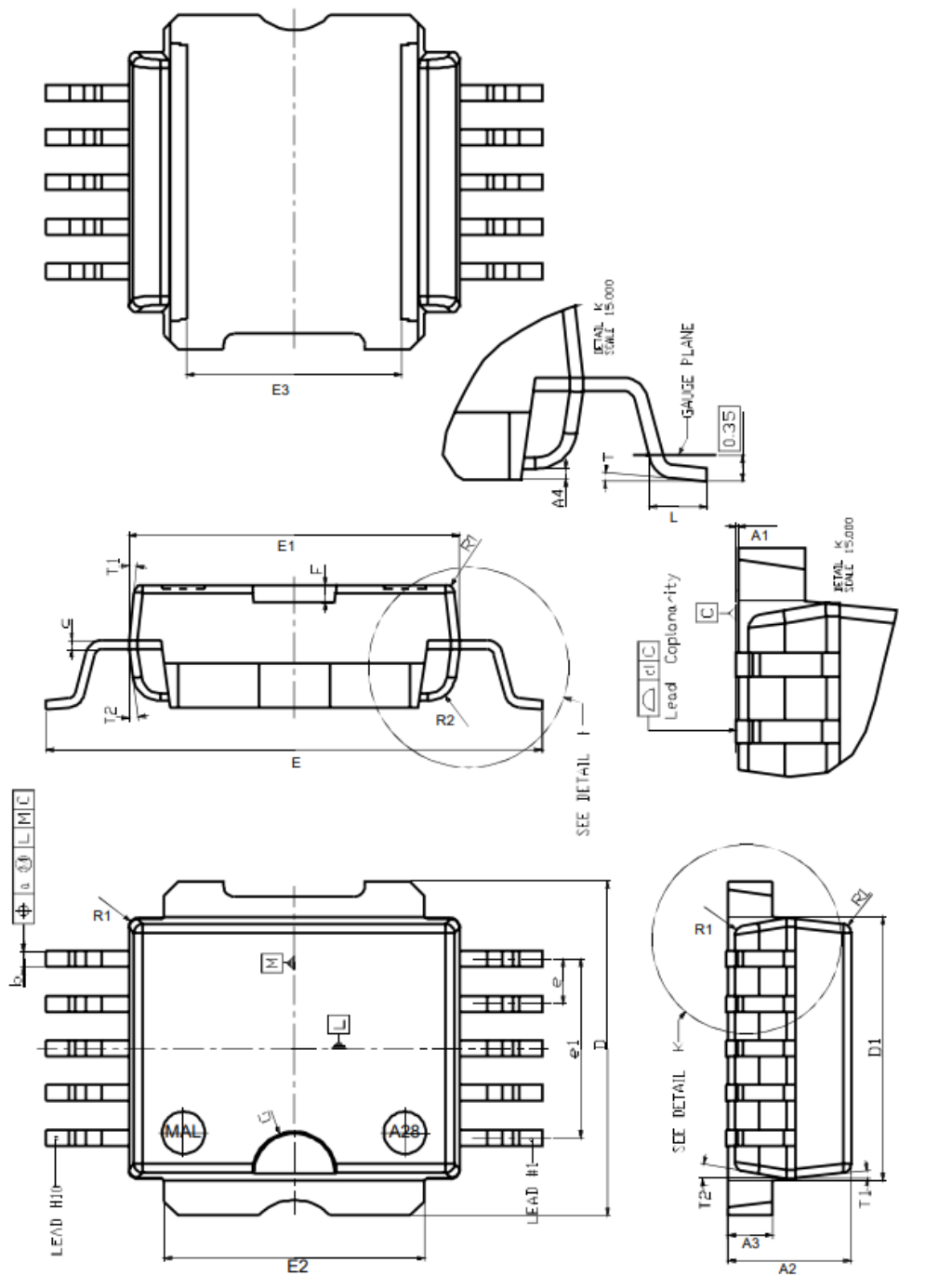
- The I/Os are internally pulled-down
- $R_{EXT}$  is for enhancement of EMI robustness

## 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 10. PowerSO-10 package outline



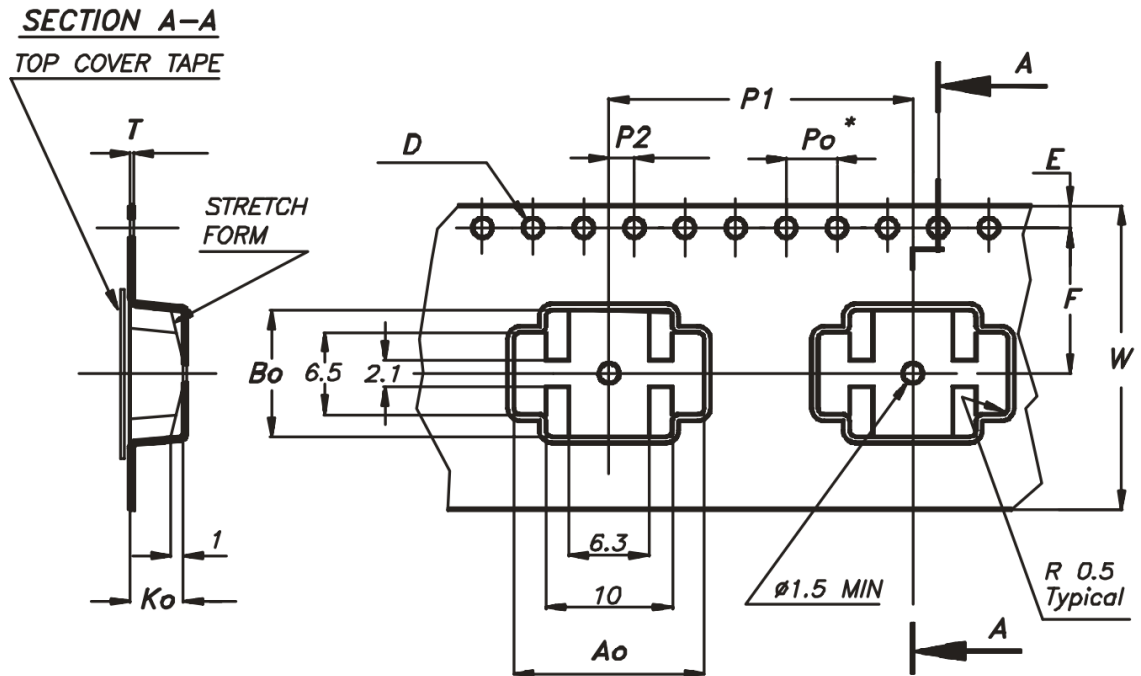
7152835 rev.G

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

Dim.	mm		
	Min.	Typ.	Max.
A1	0	0.05	0.08
A2	3.45	3.5	3.55
A3	1.24	1.28	1.32
A4	0.15	0.2	0.25
a		0.2	
b	0.4	0.45	0.5
c	0.24	0.27	0.3
D	9.45	9.52	9.59
D1	7.42	7.5	7.58
d	0	0.04	0.09
E	13.9	14.1	14.3
E1 <sup>(1)</sup>	9.33	9.4	9.47
E2	7.4	7.42	7.5
E3	5.95	6.1	6.25
e	1.22	1.27	1.32
e1		5.08	
F		0.5	
G		1.2	
L	0.85	1	1.1
R1			0.25
R2		0.8	
T	3 deg	5 deg	7 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 11. PowerSO-10 career tape outline**


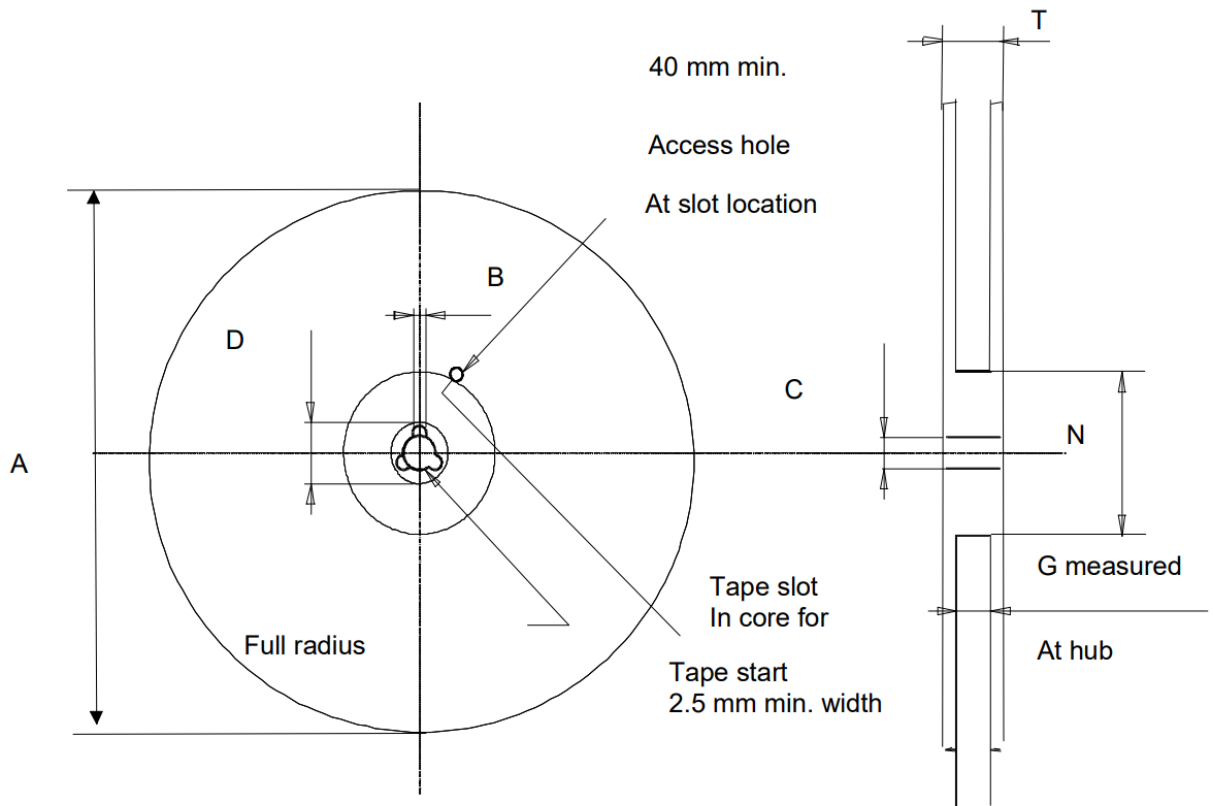
Note: Drawing is not in scale

**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(∅)	1.50	1.55	1.60

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

Figure 12. 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

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

Table 11. PowerSO-10 base and bulk quantity

Base quantity	Bulk quantity
600	600

## 8 Ordering information

Table 12. Ordering information

Part Number	Package	Packaging
VN340SP-E	PowerSO-10	Tube
VN340SPTR-E		Tape and reel
VN340SP-33-E		Tube
VN340SPTR-33-E		Tape and reel

## Revision history

**Table 13. Document revision history**

Date	Revision	Changes
05-Sep-2005	1	Initial release.
19-Mar-2007	2	Document reformatted, typo in note 1.
22-Aug-2008	3	Updated table 9.
07-Sep-2015	4	Updated the table of absolute maximum ratings.
1-Sep-2022	5	Merged VN340SP-33 and VN340SP DS; some minor changes



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