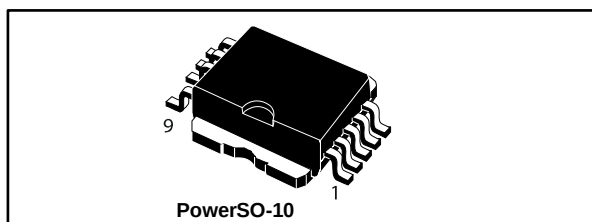


## Quad high-side smart power solid-state relay

Datasheet - production data



### Features

| Type         | $V_{\text{demag}}^{(1)}$     | $R_{\text{DS(on)}}^{(1)}$ | $I_{\text{OUT}}^{(1)}$ | $V_{\text{CC}}$ |
|--------------|------------------------------|---------------------------|------------------------|-----------------|
| VN340SP-33-E | $V_{\text{CC}}-55 \text{ V}$ | $0.2 \Omega$              | 1 A                    | 36 V            |

#### Notes:

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

- Output current: 1 A per channel
- 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

### Description

The VN340SP-33-E is a monolithic device 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.

Table 1: Device summary

| Order code     | Package    | Packing       |
|----------------|------------|---------------|
| VN340SP-33-E   | PowerSO-10 | Tube          |
| VN340SPTR-33-E |            | Tape and reel |

---

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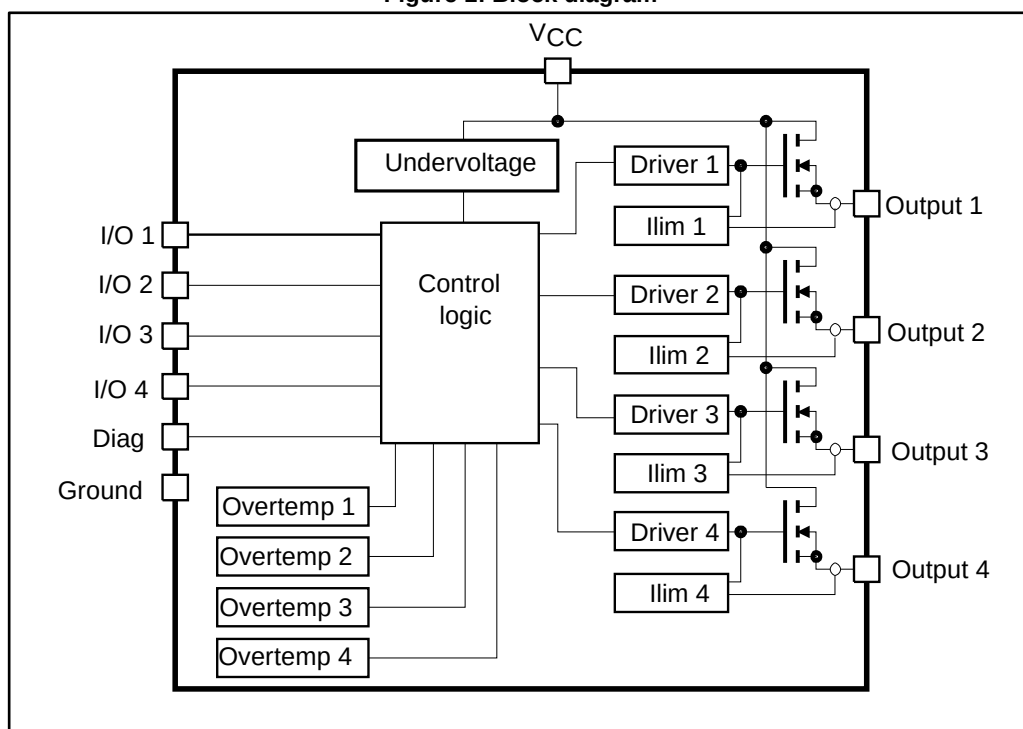
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# 1 Block diagram

Figure 1: Block diagram



## 2 Pin connection

Figure 2: Connection diagram (top view)

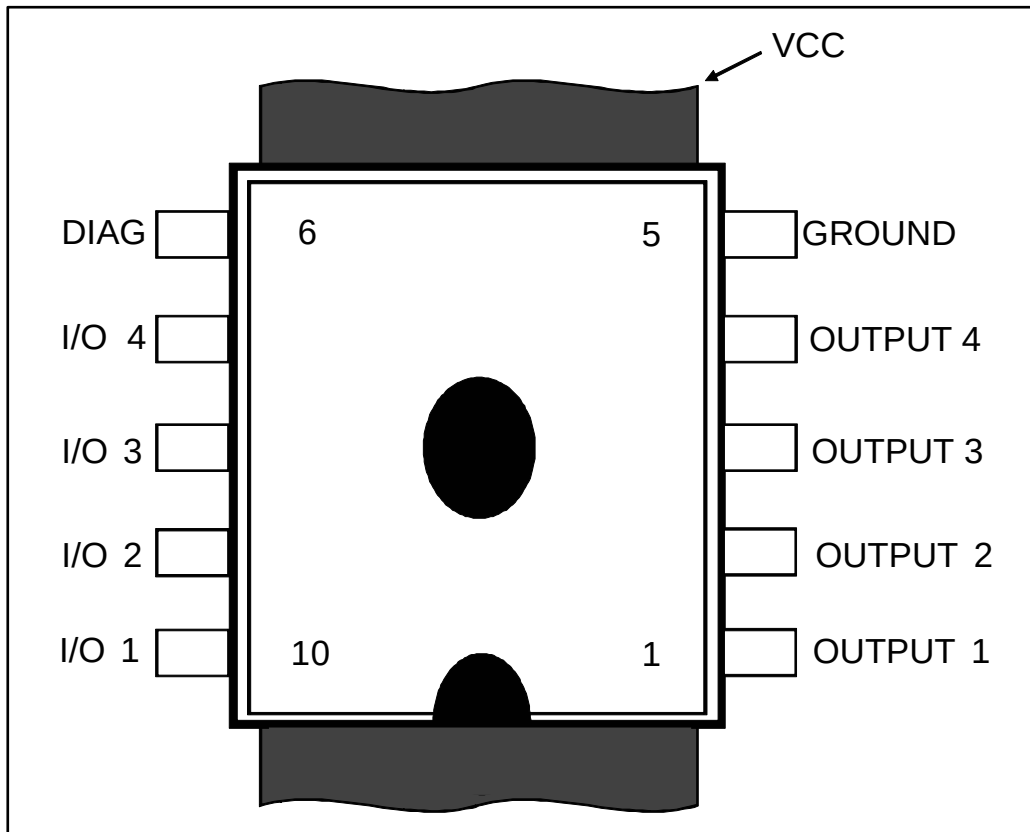
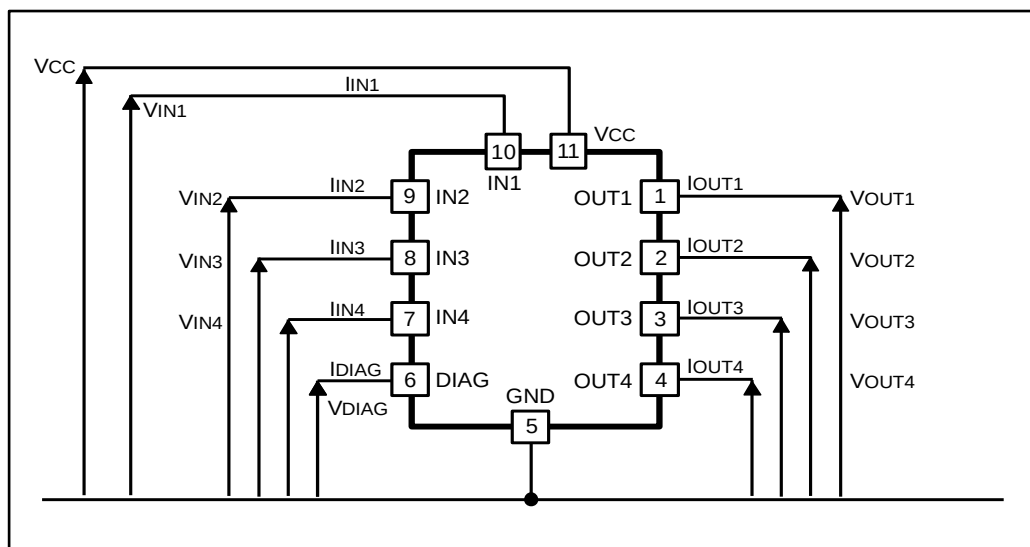


Figure 3: Current and voltage conventions



### 3 Maximum ratings

Table 2: Absolute maximum ratings

| Symbol     | Parameter                                                                                                   | Value              | Unit             |
|------------|-------------------------------------------------------------------------------------------------------------|--------------------|------------------|
| $V_{CC}$   | Power supply voltage                                                                                        | 45                 | V                |
| $-V_{CC}$  | Reverse supply voltage                                                                                      | -4                 | V                |
| $I_{OUT}$  | Output current                                                                                              | Internally limited | A                |
| $I_R$      | Reverse output current (per channel)                                                                        | -6                 | A                |
| $I_{IN}$   | Input current range                                                                                         | -1 to +10          | mA               |
| $I_{DIAG}$ | Diag pin current                                                                                            | -1 to +10          | mA               |
| $V_{ESD}$  | Electrostatic discharge (R = 1.5 kΩ; C = 100 pF)                                                            | 2000               | V                |
| $E_{AS}$   | Single pulse avalanche energy one channel active<br>$T_J = 125^\circ$ , $I_{LOAD} = 0.625$ A                | 10                 | J                |
|            | Single pulse avalanche energy all channel active<br>simultaneously $T_J = 125^\circ$ , $I_{LOAD} = 0.625$ A | 2                  | J                |
| $P_{TOT}$  | Power dissipation at $T_C = 25^\circ\text{C}$                                                               | Internally limited | W                |
| $T_J$      | Junction operating temperature                                                                              | Internally limited | $^\circ\text{C}$ |
| $T_{STG}$  | Storage temperature                                                                                         | -55 to 150         | $^\circ\text{C}$ |

Table 3: Thermal data

| Symbol       | Parameter                                          |      | Value | Unit               |
|--------------|----------------------------------------------------|------|-------|--------------------|
| $R_{th(JC)}$ | Thermal resistance junction-case <sup>(1)</sup>    | Max. | 3     | $^\circ\text{C/W}$ |
| $R_{th(JA)}$ | Thermal resistance junction-ambient <sup>(2)</sup> | Max. | 50    | $^\circ\text{C/W}$ |

**Notes:**<sup>(1)</sup>Per channel.<sup>(2)</sup>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 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                                                                     |                     |                     | 0.4                 |      |
| I <sub>S</sub>      | Supply current             | All channels in OFF-state,<br>V <sub>IN</sub> = 30 V, I <sub>OUT</sub> = 0 V,<br>T <sub>J</sub> = 125 °C                |                     |                     | 1                   | mA   |
|                     |                            |                                                                                                                         |                     |                     | 6                   | mA   |
| V <sub>OL</sub>     | Low state output voltage   | V <sub>IN</sub> = V <sub>IL</sub> ; R <sub>LOAD</sub> > = 10 MΩ                                                         |                     |                     | 1.5                 | μA   |
| 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>  | Output current 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, 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           | I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs |      | 94   | 250  | μs   |
| 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 |      | 34   | 50   | μs   |
| t <sub>f</sub>      | Fall time                             | I <sub>OUT</sub> = 0.5 A, resistive load, input rise time < 0.1 μs |      | 8    | 20   | μs   |



Table 6: Logic inputs

| Symbol        | Parameter                              | Test conditions         | Min. | Typ. | Max. | Unit          |
|---------------|----------------------------------------|-------------------------|------|------|------|---------------|
| $V_{IL}$      | I/O input low level voltage            |                         |      |      | 2    | V             |
| $V_{IH}$      | I/O input high level voltage           |                         | 3.5  |      |      | V             |
| $V_{I(HYST)}$ | I/O input hysteresis voltage           |                         |      | 0.5  |      | V             |
| $I_{IN}$      | I/O input current                      | $V_{IN} = 30\text{ V}$  |      |      | 25   | $\mu\text{A}$ |
| $V_{ICL}$     | I/O 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                  |
| $V_{SCL}$        | Status clamp voltage              | $I_{DIAG} = 1\text{ mA}$                                                            | 32   | 36<br>-0.7 |      |                    |
| $V_{USD}$        | Undervoltage shutdown             |                                                                                     | 5    |            | 8    | V                  |
| $I_{lim}$        | DC short-circuit current          | $V_{CC} = 24\text{ V}$ ; $R_{LOAD} < 10\text{ m}\Omega$                             | 1    |            | 2    | A                  |
| $I_{OVPK}$       | Peak short-circuit current        | $V_{CC} = 24\text{ V}$ ; $V_{IN} = 30\text{ V}$ ;<br>$R_{LOAD} < 10\text{ m}\Omega$ |      |            | 4    | V                  |
| $I_{DIAGH}$      | 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        |      | $^{\circ}\text{C}$ |

**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

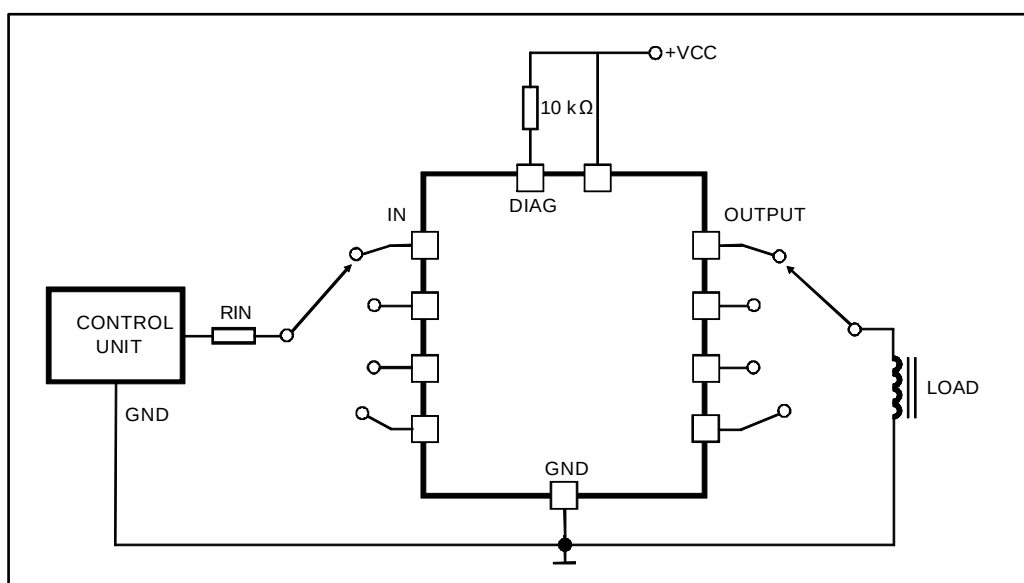


Figure 5: Peak short-circuit test diagram

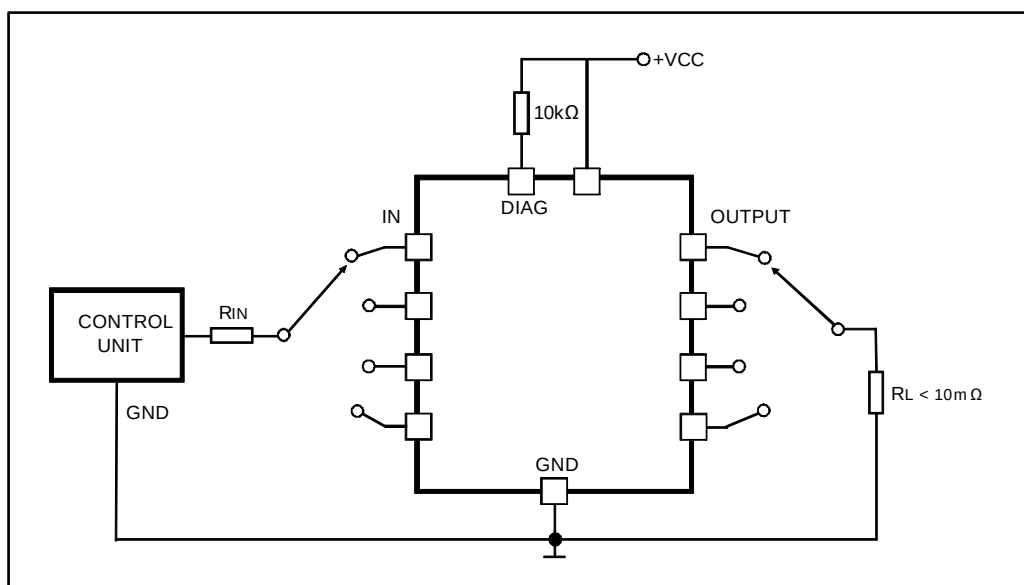
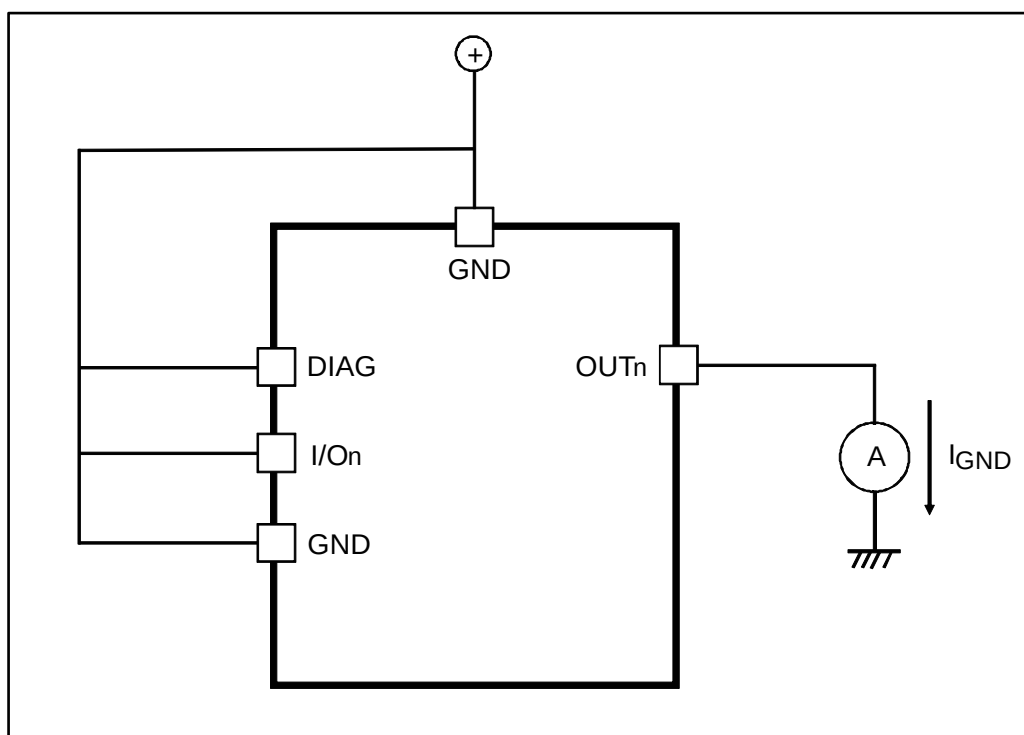


Figure 6:  $I_{LGND}$  test configuration

## 6 Switching time waveforms and truth table

Figure 7: Switching waveforms

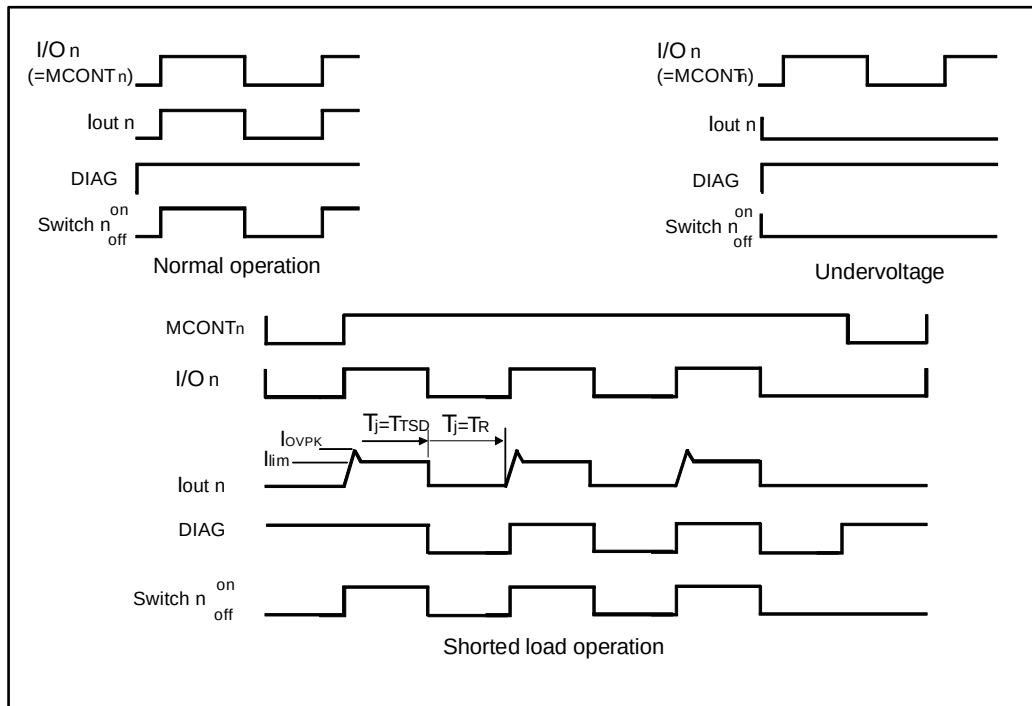


Figure 8: Switching parameter test conditions

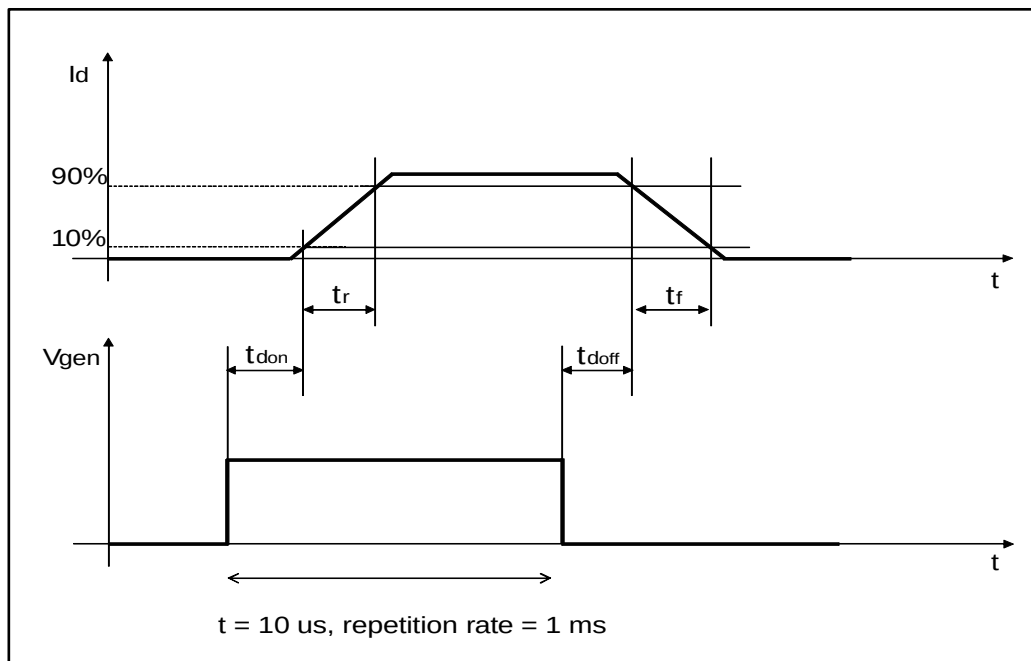
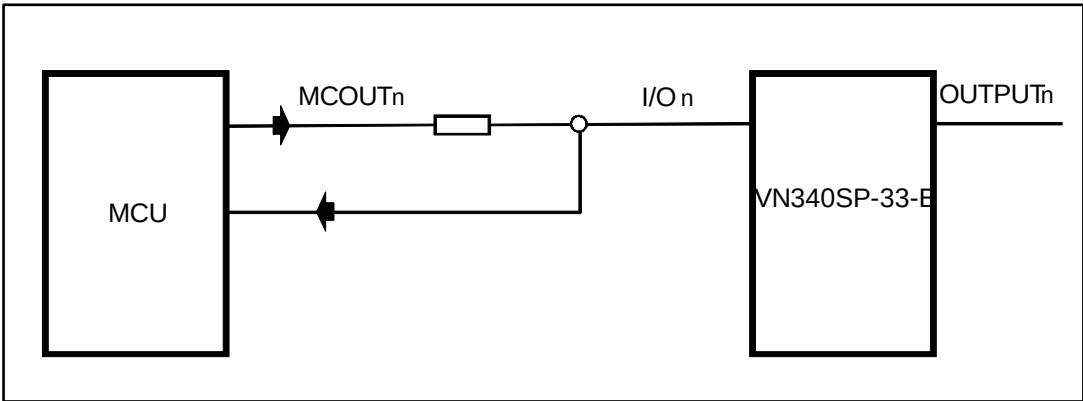


Table 8: Truth table

| Conditions                      | MCOUTn | I/O n | 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          |
|                                 | H      | H     | L       | H          |
| Shorted load current limitation | L      | L     | L       | H          |
|                                 | H      | H     | H       | H          |

Figure 9: Driving circuit



## 7 Package information

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

### 7.1 PowerSO-10 package information

Figure 10: PowerSO-10 package outline

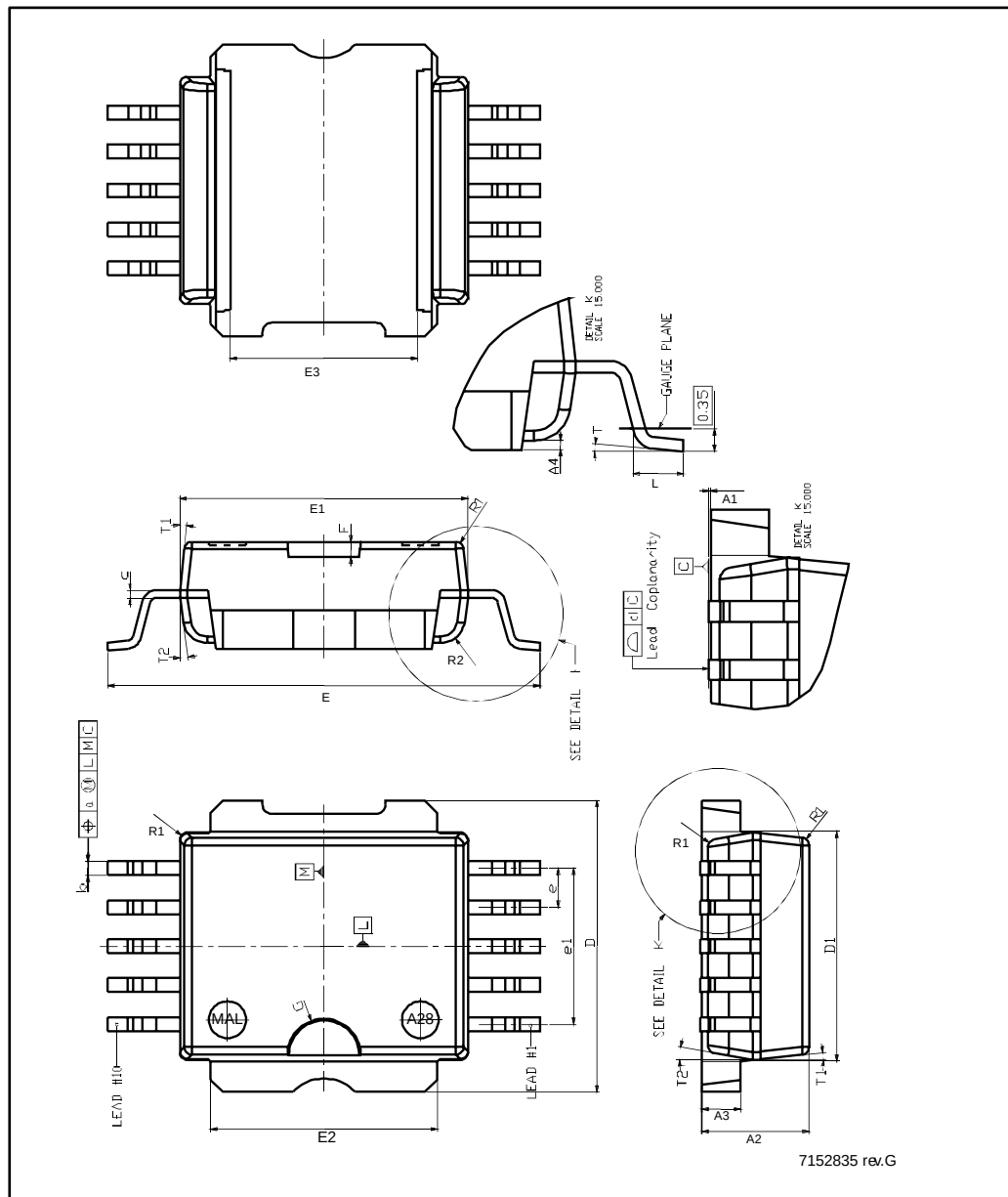


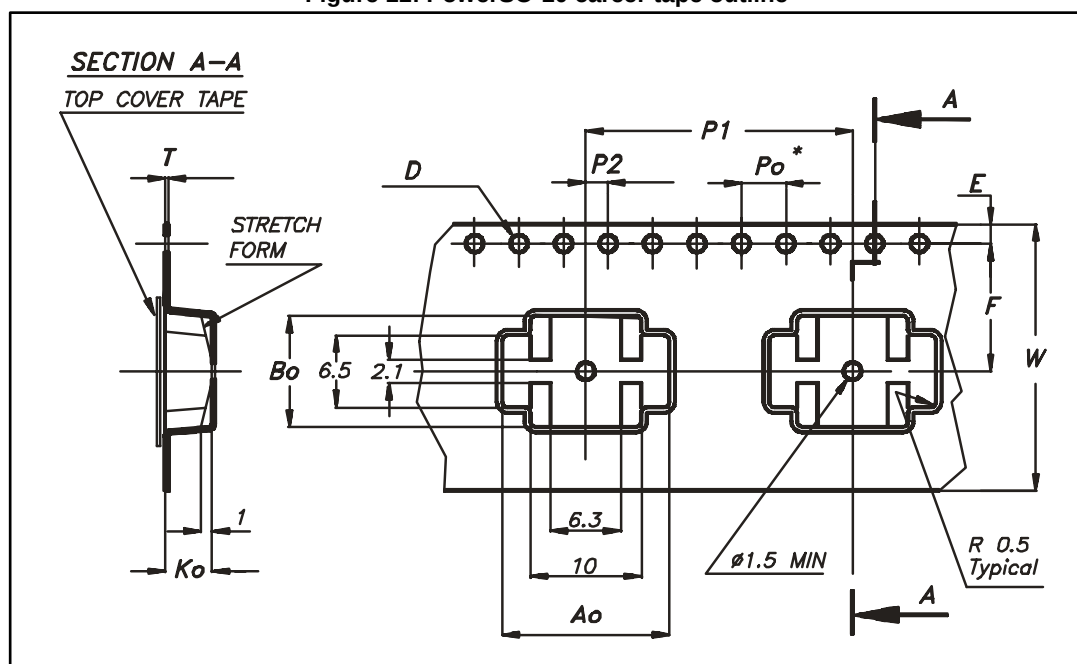
Table 9: PowerSO-10 package mechanical data

| Dim.            | mm    |       |       |
|-----------------|-------|-------|-------|
|                 | Min.  | Typ.  | Max.  |
| A1              | 0.01  | 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>a</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              |       | 10deg |       |

<sup>a</sup> 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



Drawing is not in scale

Table 10: PowerSO-10 career tape dimension mechanical data

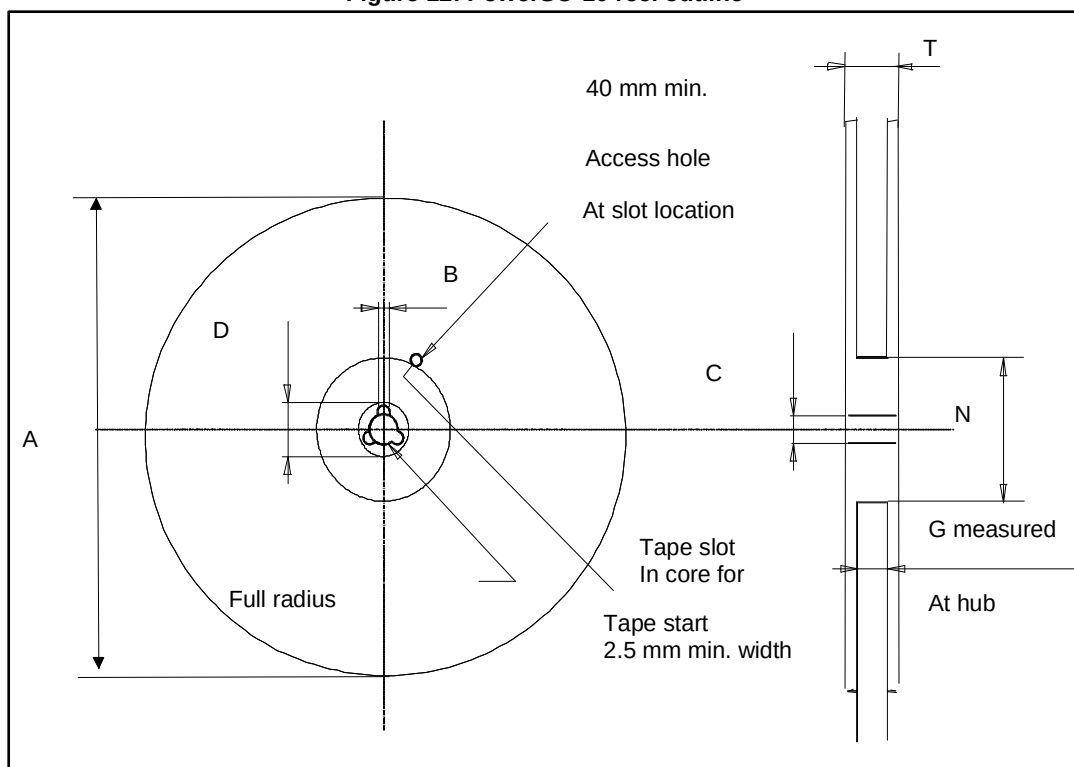
| Dim. | mm    |      |      |
|------|-------|------|------|
|      | Min.  | Typ. | Max. |
| A0   | 14.9  | 15.0 | 15.1 |
| B0   | 9.9   | 10.0 | 10.1 |
| K0   | 4.15  | 4.25 | 4.35 |
| F    | 11.4  | 11.5 | 11.6 |
| E    | 1.65  | 1.75 | 1.85 |
| W    | 23.7  | 24.0 | 24.3 |
| P2   | 1.9   | 2.0  | 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 |



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



Figure 12: 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 |



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

Table 12: PowerSO-10 base and bulk quantity

| Base quantity | Bulk quantity |
|---------------|---------------|
| 600           | 600           |

## 8 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. |

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