



# VN330SP-32-E

Quad high side smart  
Power solid state relay

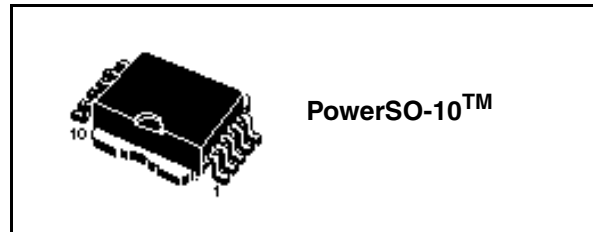
## Features

| Type         | $V_{\text{demag}}^{(1)}$   | $R_{\text{DSon}}^{(1)}$ | $I_{\text{out}}^{(1)}$ | $V_{\text{CC}}$ |
|--------------|----------------------------|-------------------------|------------------------|-----------------|
| VN330SP-32-E | $V_{\text{CC}}-55\text{V}$ | $0.32\Omega^{(2)}$      | 1A                     | 36V             |

1. Per channel.

2. At  $T_J = 85^\circ\text{C}$

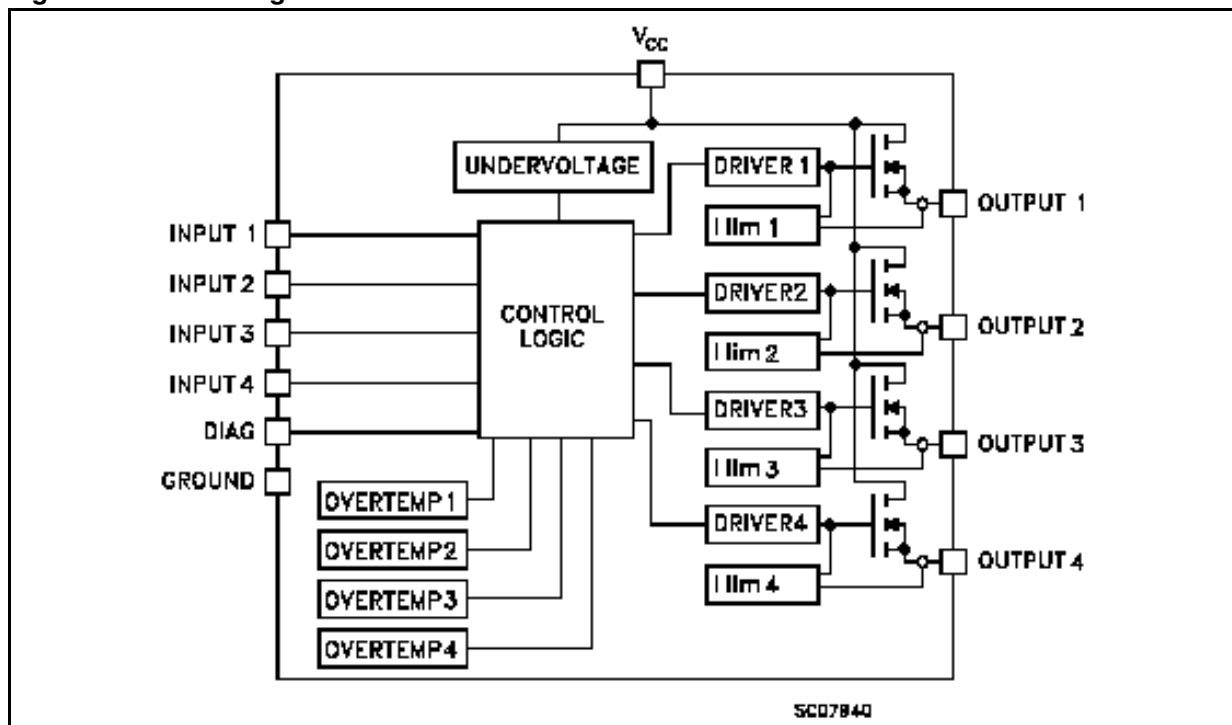
- Output current : 1A per channel
- Digital input clamped at 32V minimum voltage
- Shorted load and overtemperature protections
- Built-in current limiter
- Undervoltage shut-down
- Open drain diagnostic output
- Fast demagnetization of inductive loads
- Conforms to IEC 61131-2



## Description

The VN330SP-32-E is a monolithic device made using STMicroelectronics VIPower technology, intended for driving four independent resistive or inductive loads, with one side connected to ground. Active current limitation avoids dropping the system power supply in case of shorted load. Built-in thermal shut-down protects the chip from overtemperature and short circuit. The open drain diagnostic output indicates overtemperature conditions.

Figure 1. Block diagram



## Contents

|          |                                                       |           |
|----------|-------------------------------------------------------|-----------|
| <b>1</b> | <b>Maximum ratings .....</b>                          | <b>3</b>  |
| <b>2</b> | <b>Pin connections .....</b>                          | <b>4</b>  |
| <b>3</b> | <b>Electrical characteristics .....</b>               | <b>5</b>  |
| <b>4</b> | <b>Test circuits .....</b>                            | <b>7</b>  |
| <b>5</b> | <b>Switching time waveforms and truth table .....</b> | <b>8</b>  |
| <b>6</b> | <b>Package mechanical data .....</b>                  | <b>10</b> |
| <b>7</b> | <b>Order code .....</b>                               | <b>13</b> |
| <b>8</b> | <b>Revision history .....</b>                         | <b>14</b> |

# 1 Maximum ratings

**Table 1. Absolute maximum rating**

| Symbol     | Parameter                                                                                 | Value              | Unit       |
|------------|-------------------------------------------------------------------------------------------|--------------------|------------|
| $V_{CC}$   | Power supply voltage                                                                      | 45                 | V          |
| $-V_{CC}$  | Reverse supply voltage                                                                    | -0.3               | V          |
| $I_{OUT}$  | Output current (continuous)                                                               | Internally limited | A          |
| $I_R$      | Reverse output current (per channel)                                                      | -6                 | A          |
| $I_{IN}$   | Input current (per channel)                                                               | $\pm 10$           | mA         |
| $I_{DIAG}$ | Diag pin current                                                                          | $\pm 10$           | mA         |
| $V_{ESD}$  | Electrostatic discharge ( $R = 1.5K\Omega$ ; $C = 100pF$ )                                | 2000               | V          |
| $E_{AS}$   | Single pulse avalanche energy per channel not simultaneously<br><a href="#">Figure 4.</a> | 400                | mJ         |
| $P_{tot}$  | Power dissipation at $T_c = 25^\circ C$                                                   | Internally limited | w          |
| $T_J$      | Junction operating temperature                                                            | Internally limited | $^\circ C$ |
| $T_{STG}$  | Storage temperature                                                                       | -55 to 150         | $^\circ C$ |

**Table 2. Thermal data**

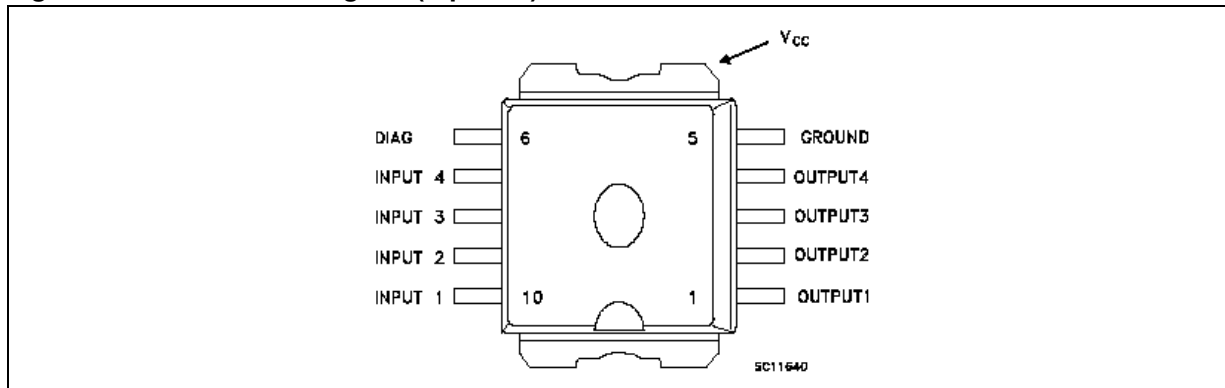
| Symbol     | Parameter                                          | Max Value | Unit         |
|------------|----------------------------------------------------|-----------|--------------|
| $R_{thJC}$ | Thermal resistance junction-case <sup>(1)</sup>    | Max 2     | $^\circ C/W$ |
| $R_{thJA}$ | Thermal resistance junction-ambient <sup>(2)</sup> | Max 50    | $^\circ C/W$ |

1. Per channel

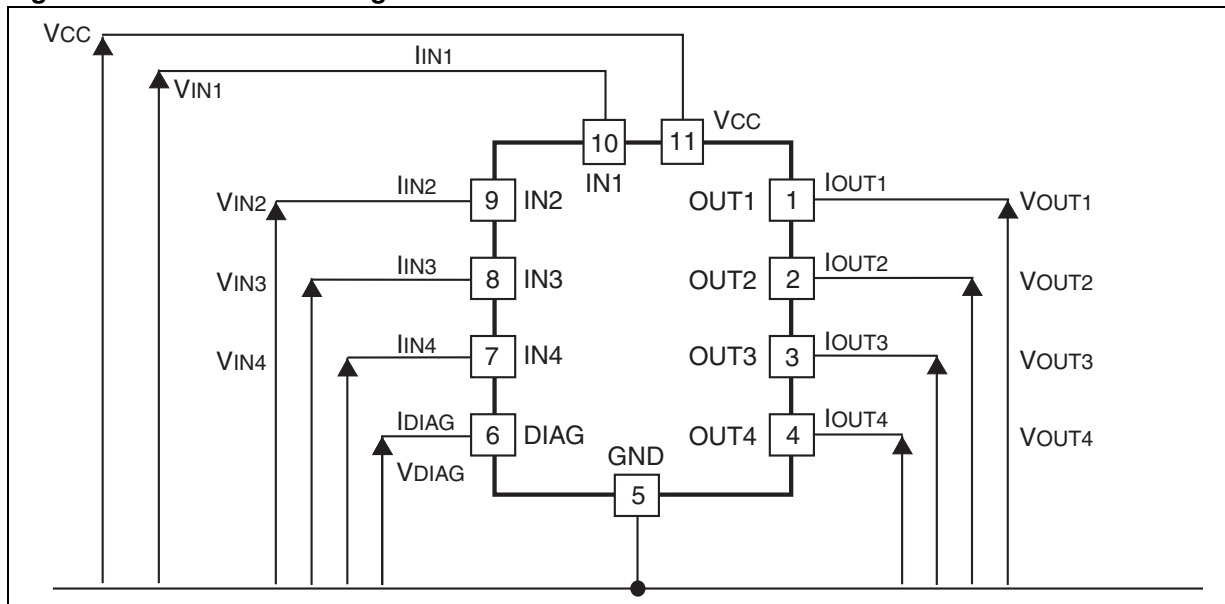
2. When mounted using minimum recommended pad size on FR-4 board

## 2 Pin connections

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



**Figure 3. Current and voltage conventions**



### 3 Electrical characteristics

$10V < V_{CC} < 36V$ ;  $-40^{\circ}C < T_J < 125^{\circ}C$ ; unless otherwise specified

**Table 3. Power section**

| Symbol      | Parameter                  | Test conditions                                                                                                             | Min         | Typ         | Max                | Unit                             |
|-------------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------|-------------|-------------|--------------------|----------------------------------|
| $V_{CC}$    | Supply voltage             |                                                                                                                             | 10          |             | 36                 | V                                |
| $R_{ON}$    | On state resistance        | $I_{OUT} = 0.5A$ ; $T_J = 25^{\circ}C$<br>$I_{OUT} = 0.5A$ ; $T_J = 85^{\circ}C$<br>$I_{OUT} = 0.5A$ ; $T_J = 125^{\circ}C$ |             |             | 0.2<br>0.32<br>0.4 | $\Omega$<br>$\Omega$<br>$\Omega$ |
| $I_S$       | Supply current             | All channels OFF<br>On state; $V_{IN} = 30V$ ; $I_{OUT} = 0V$<br>( $T_J = 125^{\circ}C$ )                                   |             |             | 1<br>6             | mA<br>mA                         |
| $V_{demag}$ | Output voltage at turn-off | $I_{OUT} = 0.5A$ ; $L_{LOAD} \geq 1mH$                                                                                      | $V_{CC}-65$ | $V_{CC}-55$ | $V_{CC}-45$        | V                                |

**Table 4. Switching (  $V_{CC} = 24V$  )**

| Symbol          | Parameter                             | Test conditions                                                                                                 | Min | Typ | Max        | Unit                     |
|-----------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----|-----|------------|--------------------------|
| $t_{d(ON)}$     | Turn-on delay time of Output current  | $I_{OUT} = 0.5A$ , Resistive Load Input rise time $< 0.1\mu s$ ,<br>$T_J = 25^{\circ}C$<br>$T_J = 125^{\circ}C$ |     | 30  | 40<br>60   | $\mu s$<br>$\mu s$       |
| $t_r$           | Rise time of Output current           | $I_{OUT} = 0.5A$ , Resistive Load Input rise time $< 0.1\mu s$ ,<br>$T_J = 25^{\circ}C$<br>$T_J = 125^{\circ}C$ |     | 50  | 100<br>115 | $\mu s$<br>$\mu s$       |
| $t_{d(OFF)}$    | Turn-off delay time of Output current | $I_{OUT} = 0.5A$ , Resistive Load Input rise time $< 0.1\mu s$ ,<br>$T_J = 25^{\circ}C$<br>$T_J = 125^{\circ}C$ |     | 20  | 30<br>40   | $\mu s$<br>$\mu s$       |
| $t_f$           | Fall time of Output current           | $I_{OUT} = 0.5A$ , Resistive Load Input rise time $< 0.1\mu s$ ,<br>$T_J = 25^{\circ}C$<br>$T_J = 125^{\circ}C$ |     | 8   | 15<br>20   | $\mu s$<br>$\mu s$       |
| $(di/dt)_{on}$  | Turn-on current slope                 | $I_{OUT} = 0.5A$ ,<br>$I_{OUT} = I_{LIM}$ , $T_J = 25^{\circ}C$                                                 |     |     | 0.5<br>2   | A/ $\mu s$<br>A/ $\mu s$ |
| $(di/dt)_{off}$ | Turn-off current slope                | $I_{OUT} = 0.5A$ ,<br>$I_{OUT} = I_{LIM}$ , $T_J = 25^{\circ}C$                                                 |     |     | 2<br>4     | A/ $\mu s$<br>A/ $\mu s$ |

**Table 5. Logical input**

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

1. The input voltage is internally clamped at 32V minimum, however, it is possible to connect the input pins to an higher voltage via an external resistor that is calculated not to exceed 10mA.

**Table 6. Protection and diagnostic**

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

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

**Note:** If INPUT pin is floating the corresponding channel will automatically switch OFF. If GND pin is disconnected, the channel will switch OFF provided  $V_{CC}$  not exceed 36V.

## 4 Test circuits

Figure 4. Avalance energy test circuit

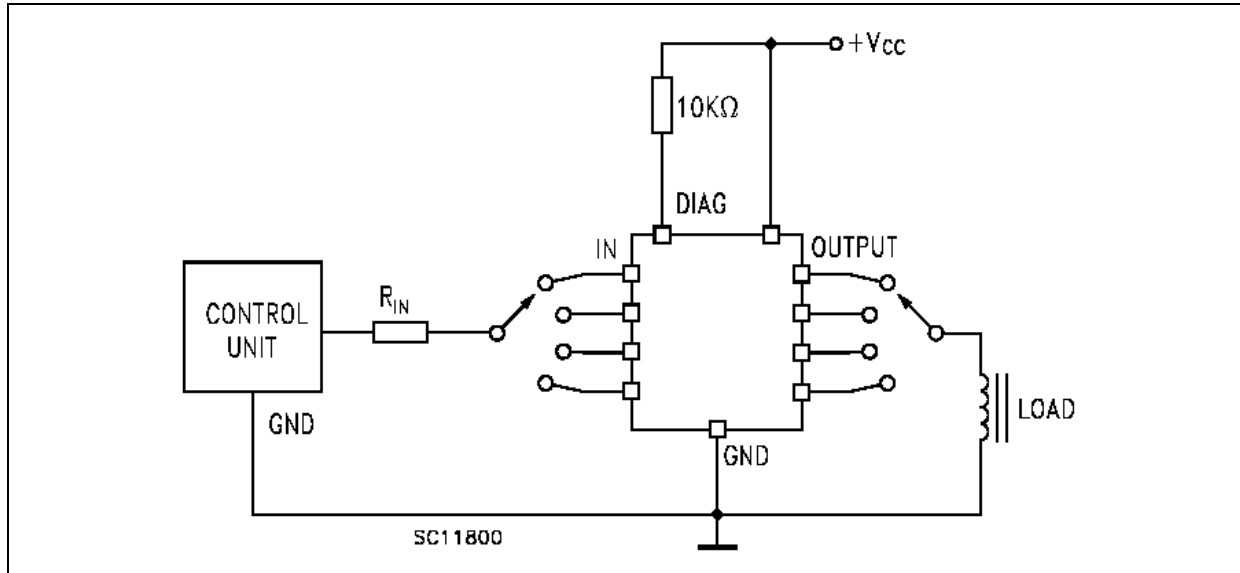
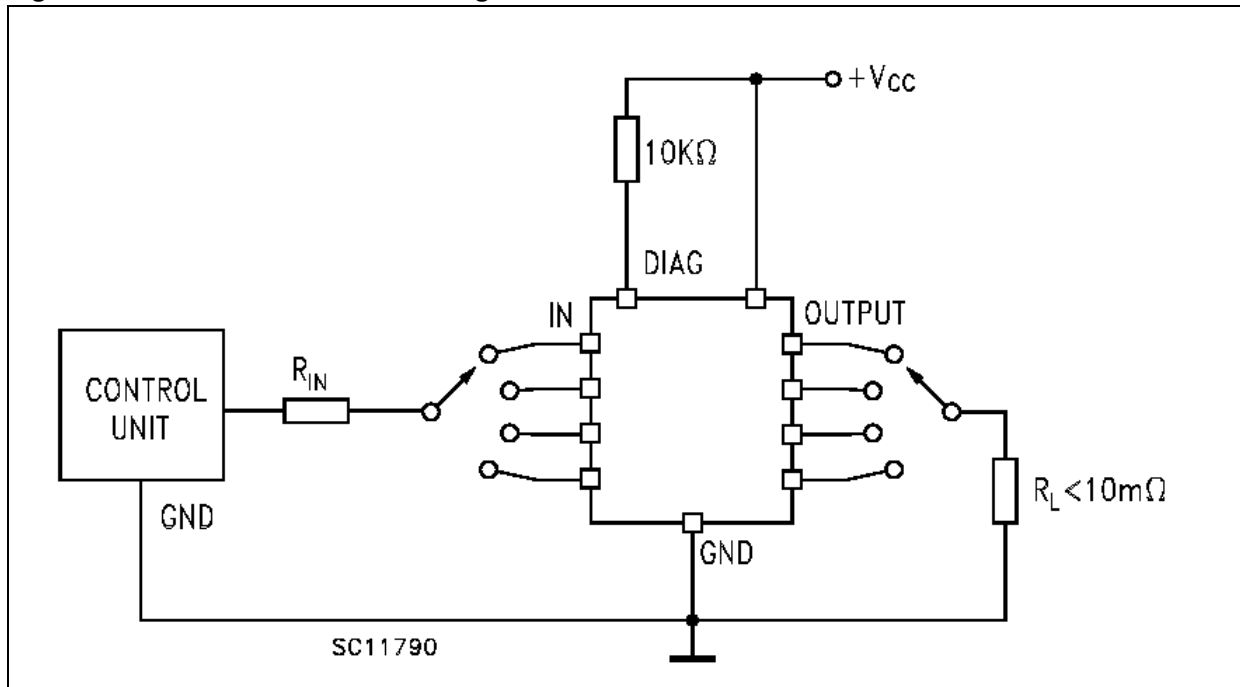


Figure 5. Peak short circuit test diagram



# 5 Switching time waveforms and truth table

Table 7. Truth table

|                                        | 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<br>( Current limitation ) | L      | L       | H          |
|                                        | H      | H       | H          |

Figure 6. Switching waveforms

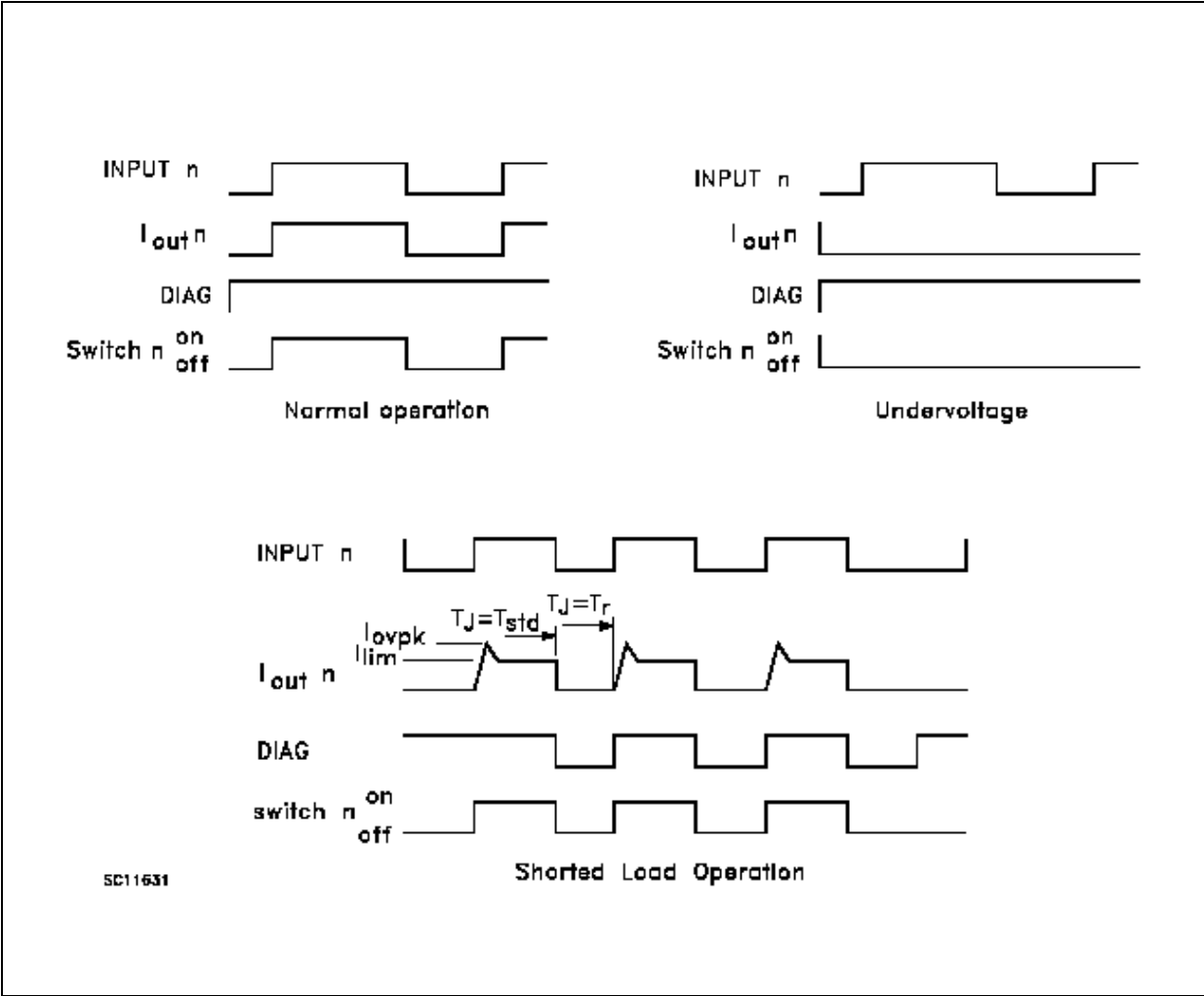


Figure 7. Switching parameter test conditions

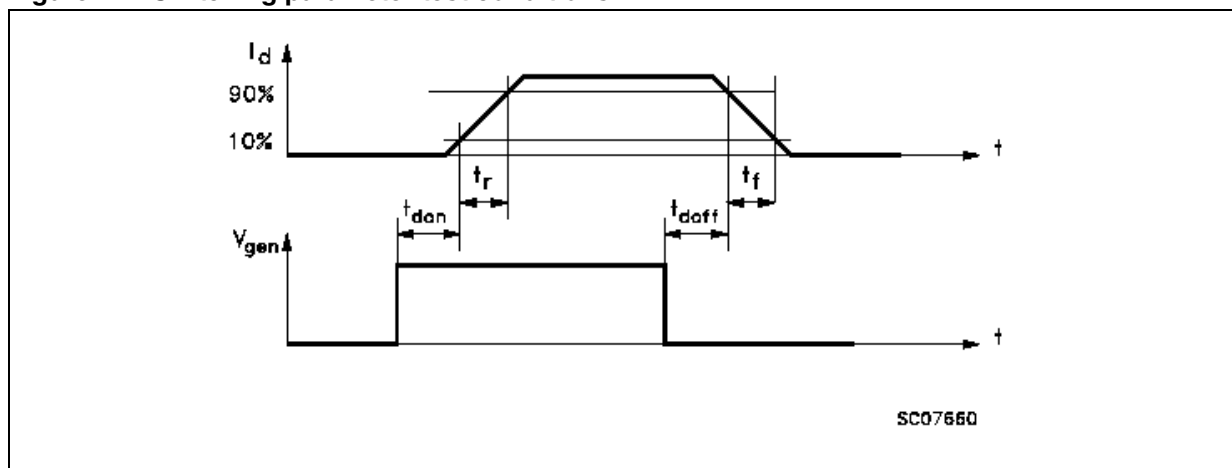
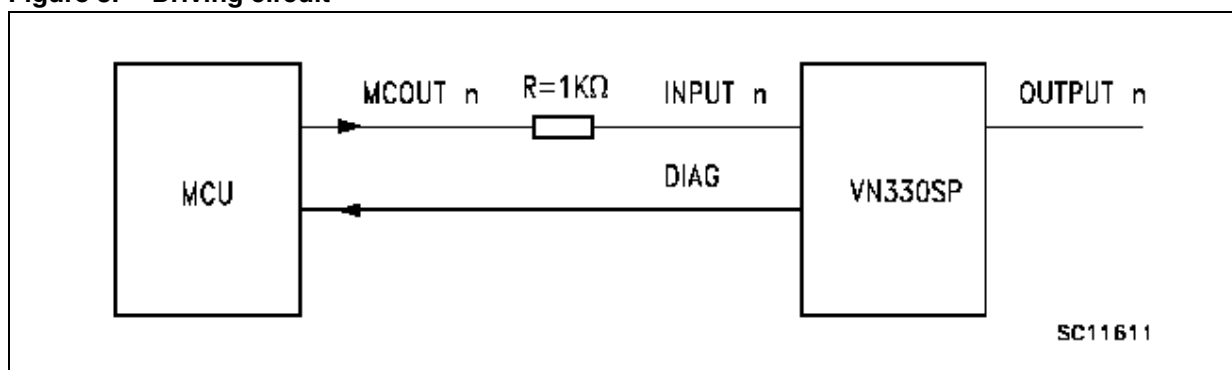


Figure 8. Driving circuit



## 6 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

Table 8. PowerSO-10 Mechanical data

| Dim | Mm    |      |       | Inch  |       |       |
|-----|-------|------|-------|-------|-------|-------|
|     | Min   | Typ  | Max   | Min   | Typ   | Max   |
| A   | 3.35  |      | 3.65  | 0.132 |       | 0.144 |
| A1  | 0.00  |      | 0.10  | 0.000 |       | 0.004 |
| B   | 0.40  |      | 0.60  | 0.016 |       | 0.024 |
| c   | 0.23  |      | 0.32  | 0.009 |       | 0.012 |
| D   | 9.40  |      | 9.60  | 0.370 |       | 0.378 |
| D1  | 7.40  |      | 7.60  | 0.291 |       | 0.300 |
| E   | 9.30  |      | 9.50  | 0.366 |       | 0.374 |
| E1  | 7.20  |      | 7.40  | 0.283 |       | 0.291 |
| E2  | 7.20  |      | 7.60  | 0.283 |       | 0.300 |
| E3  | 6.10  |      | 6.35  | 0.240 |       | 0.250 |
| E4  | 5.90  |      | 6.10  | 0.232 |       | 0.240 |
| e   |       | 1.27 |       |       | 0.050 |       |
| F   | 1.25  |      | 1.35  | 0.049 |       | 0.053 |
| H   | 13.80 |      | 14.40 | 0.543 |       | 0.567 |
| h   |       | 0.50 |       |       | 0.002 |       |
| L   | 1.20  |      | 1.80  | 0.047 |       | 0.071 |
| q   |       | 1.70 |       |       | 0.067 |       |
| a   | 0°    |      | 8°    |       |       |       |

Figure 9. Package dimension

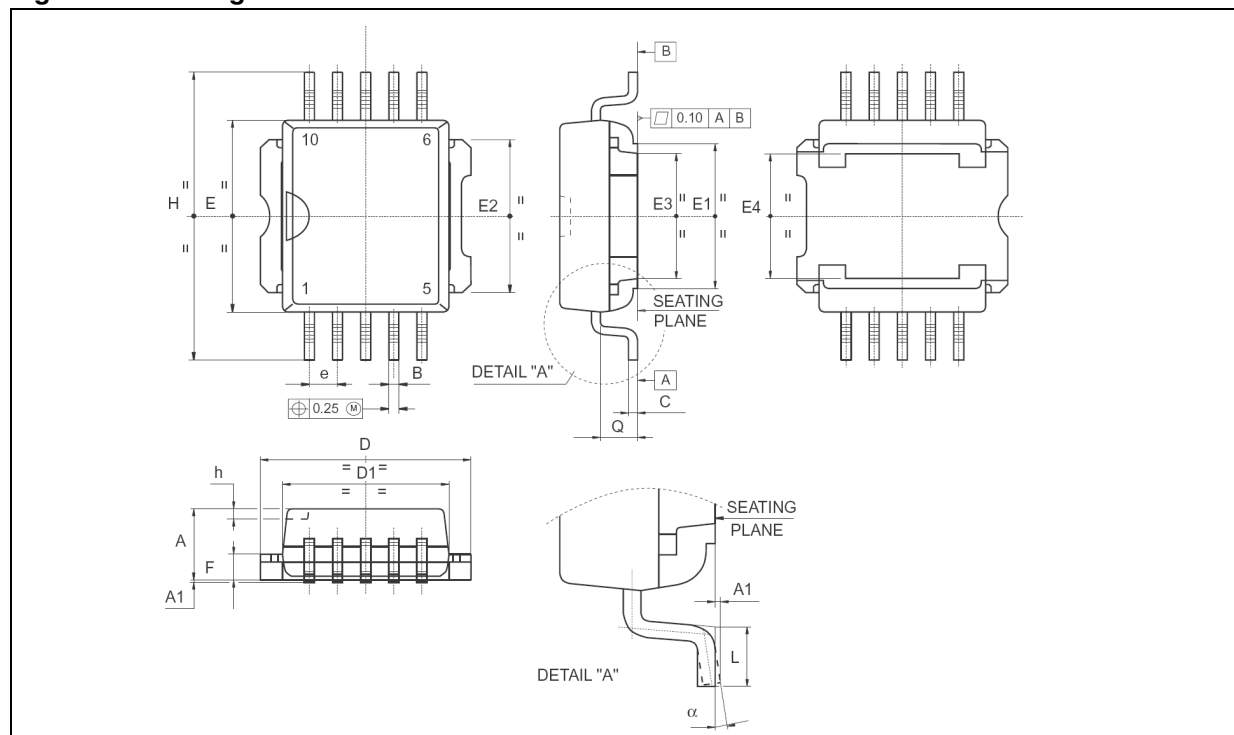


Figure 10. PowerSO-10™ Suggested Pad and Tube Shipment (No Suffix)

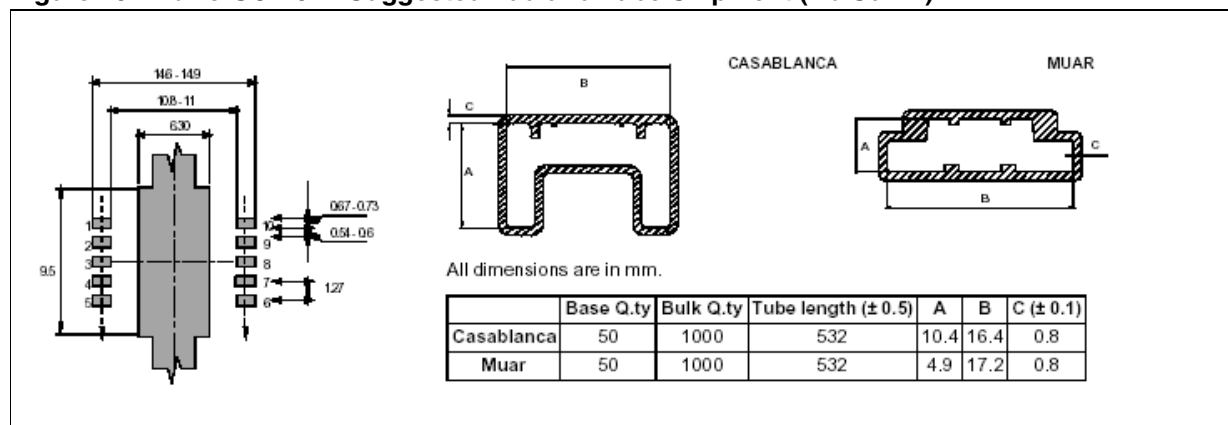
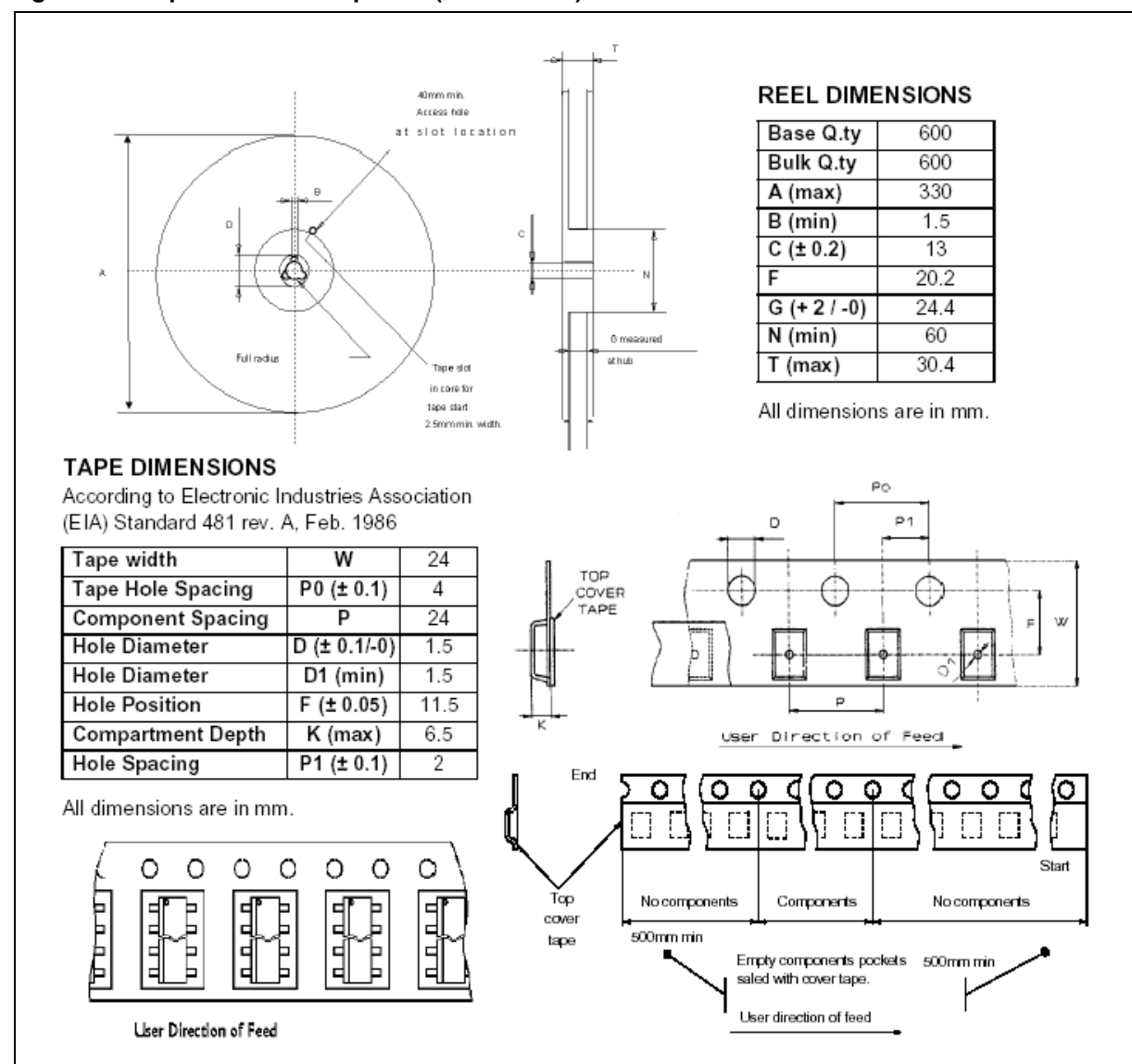


Figure 11. Tape and Reel Shipment (Suffix “TR”)



## 7 Order code

**Table 9. Order code**

| Part number | Package                  | Packaging     |
|-------------|--------------------------|---------------|
| VN330SP-E   | PowerSO-10 <sup>TM</sup> | Tube          |
| VN330SPTR-E | PowerSO-10 <sup>TM</sup> | Tape and reel |

## 8 Revision history

**Table 10. Revision history**

| Date        | Revision | Changes                                                        |
|-------------|----------|----------------------------------------------------------------|
| 5-Sep-2005  | 1        | Initial release                                                |
| 19-Mar-2007 | 2        | Document reformatted, typo in <a href="#">Note 1 on page 6</a> |

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