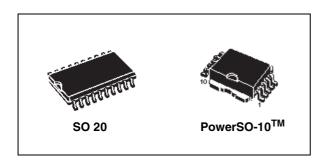


VNQ860-E, VNQ860SP-E

Quad channel high-side driver

Datasheet - production data



Features

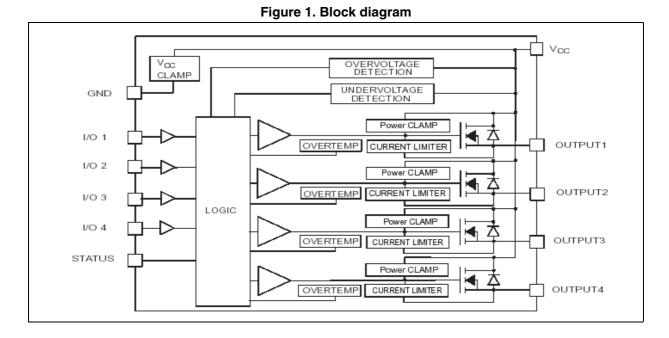
| Туре | R _{DS(on)} ⁽¹⁾ | l _{out} | V _{CC} |
|------------------------|------------------------------------|------------------|-----------------|
| VNQ860-E VNQ860SP-E | 270 mΩ | 0.25 A | 36 V |

- 1. Per each channel
- CMOS compatible I/Os
- Undervoltage and overvoltage shutdown

- Shorted load protection
- Thermal shutdown
- Very low standby current
- · Protection against loss of ground

Description

The VNQ860-E and the VNQ860SP-E are monolithic devices realized in STMicroelectronics VIPower M0-3 technology, intended to drive any kind of load with one side connected to ground. Active current limitation combined with thermal shutdown and automatic restart protect the device against overload. The device automatically turns OFF in case of ground pin disconnection. This device is especially suitable for IEC 61131 compliant industrial applications.



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VNQ860-E VNQ860SP-E Maximum ratings

1 Maximum ratings

Table 1. Absolute maximum ratings

| Cymbol | Parameter | , | Value | Unit | |
|-------------------|--|--------------------|--------------------|------|--|
| Symbol | Farameter | SO20 | PowerSO-10 | Onit | |
| V _{CC} | DC supply voltage | | 41 | V | |
| -V _{CC} | Reverse DC supply voltage | | -0.3 | V | |
| -I _{GND} | DC reverse ground pin | | -200 | mA | |
| I _{OUT} | DC output current | Intern | ally limited | Α | |
| -I _{OUT} | Reverse DC output current | -2 | | Α | |
| I _{IN} | DC input current | ± 10 | | mA | |
| V _{IN} | Input voltage range | -3 | 3/+V _{CC} | V | |
| V _{STAT} | DC status voltage | - | + V _{CC} | V | |
| V _{ESD} | Electrostatic discharge (R = 1.5 kΩ, C = 100 pF) | | 2000 | V | |
| P _{tot} | Power dissipation at T _c <= 25 °C | 16 | 90 | W | |
| TJ | Junction operating temperature | Internally limited | | °C | |
| T _c | Case operating temperature | -40 to 150 | | °C | |
| T _{stg} | Storage temperature | -5 | 5 to 150 | °C | |

Table 2. Thermal data

| Symbol | Parameter | V | Unit | | | | | |
|---------------------|-------------------------------------|---|------------|-------------------|-------------|----|-------------------|------|
| Symbol | raianietei | SO20 | PowerSO-10 | Oiiit | | | | |
| R _{th(JP)} | Thermal resistance junction-pins | Max. | 8 | - | °C/W | | | |
| D | Thermal resistance junction-ambient | Thermal resistance junction ambient May | May 5 | Mov | ent Max. 58 | 58 | 52 ⁽¹⁾ | °C/W |
| R _{th(JA)} | | iviax. | 56 | 37 ⁽²⁾ | C/VV | | | |
| R _{th(JC)} | Thermal resistance junction-case | Max. | - | 1.4 | °C/W | | | |

^{1.} When mounted on FR4 printed circuit board with 0.5 cm 2 of copper area (at least 35 μ thick) connected to all V_{CC} pins.

^{2.} When mounted on FR4 printed circuit board with 6 cm 2 of copper area (at least 35 μ thick) connected to all V_{CC} pins.

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2 Pin connection

Figure 2. Configuration diagram (top view)

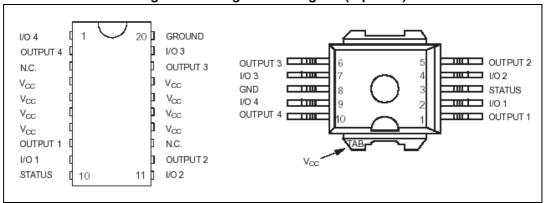
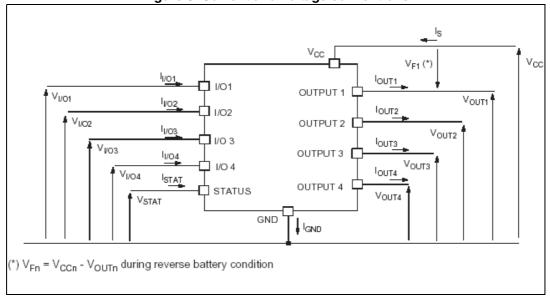


Table 3. Pin connection

| Connection / pin | Status | N.C. | Output | Input |
|------------------|--------|------|--------|------------------------|
| Floating | Х | Х | Х | X |
| To ground | | Х | | Through 10 kΩ resistor |

Figure 3. Current and voltage conventions



3 Electrical characteristics

8 V < V $_{CC}$ < 36 V; -40 $^{\circ}C$ < T $_{J}$ < 150 $^{\circ}C$; unless otherwise specified.

Table 4. Power section

| Symbol | Parameter | Test conditions | Min. | Тур. | Max. | Unit |
|----------------------|-----------------------------------|---|------|---------|------------|----------|
| V _{CC} | Operating supply voltage | | 5.5 | | 36 | V |
| V _{USD} | Undervoltage shutdown | | 3 | 4 | 5.5 | V |
| V _{OV} | Overvoltage shutdown | | 36 | 42 | 48 | V |
| R _{ON} | On state resistance (per channel) | I _{OUT} = 0.25 A; T _J = 25 °C; I _{OUT} = 0.25 A; | | | 270 540 | mΩ |
| I _S | Supply current | OFF state; V _{CC} = 24 V;T _C = 25 °C ON state (all channels ON) | | 70 5 | 120 10 | μA mA |
| I _{LGND} | Output current | V_{CC} - V_{STAT} = V_{IN} = V_{GND} = 24 V_{COUT} = 0 V_{CUT} | | | 1 | mA |
| I _{L(OFF)} | OFF state output current | V _{IN} = V _{OUT} = 0 V | 0 | | 10 | μА |
| I _{OUTleak} | OFF state output leakage current | $V_{IN} = V_{GND} = 0 \text{ V}; V_{CC} = V_{OUT} = 24 \text{ V}; T_A = 25 \text{ °C}$ | | | 240 | μА |
| I _{OUTleak} | OFF state output leakage current | $V_{IN} = V_{GND} = 0 \text{ V}; V_{CC} = 24 \text{ V};$ $V_{OUT} = 10 \text{ V}; T_A = 25 ^{\circ}\text{C}$ | | | 100 | μА |

Table 5. Switching (V_{CC} = 24 V)

| Symbol Parameter Test conditions | | Min. | Тур. | Max. | Unit | |
|--|---------------------------------------|---|------|------|------|-------|
| t _(ON) | Turn-on delay time of output current | $R_L = 96 \Omega$ from V_{IN} rising edge to $V_{OUT} = 2.4 \text{ V}$ | - | 10 | - | μs |
| t _(OFF) | Turn-off delay time of output current | $R_L = 96 \Omega$ from V_{IN} rising edge to $V_{OUT} = 21.6 \text{ V}$ | - | 40 | - | μs |
| (dV _{OUT} /dt) _{on} | Turn-on voltage slope | $R_L = 96 \Omega$ from $V_{OUT} = 2.4 V$ to 19.2 V | - | 0.75 | - | V/ μs |
| (dV _{OUT} /dt) _{off} | Turn-off voltage slope | $R_L = 96 \Omega$ from $V_{OUT} = 21.6 \text{ V}$ to 2.4 V | - | 0.25 | - | V/ μs |

Table 6. Protections (per channel)

| Symbol | Parameter | Test conditions | Min. | Тур. | Max. | Unit |
|---------------------|-------------------------------|---|-------------------------|-------------------------|-------------------------|------|
| I _{lim} | Current limitation | | 0.35 | 0.7 | 1.1 | Α |
| T _(hyst) | Thermal hysteresis | | 7 | 15 | | °C |
| T _{TSD} | Thermal shutdown temperature | | 150 | 175 | 200 | °C |
| T _R | Reset temperature | | 135 | | | °C |
| V_{demag} | Turn-off output clamp voltage | I _{OUT} = 0.25 A, V _{CC} = 24 V | V _{CC} - 59 | V _{CC} - 52 | V _{CC} - 47 | ٧ |

Table 7. Logic input (per channel)

| Symbol | Parameter | Test conditions | Min. | Тур. | Max. | Unit |
|----------------------|--------------------------|--|------|------|------|------|
| V _{IL} | Low level input voltage | | | - | 1.25 | V |
| I _{IL} | Low level input current | V _{IN} = 1.25 V | 1 | - | | μΑ |
| V _{IH} | High level input voltage | | 3.25 | - | | ٧ |
| I _{IH} | High level input current | V _{IN} = 3.25 V | | - | 10 | μΑ |
| V _{I(HYST)} | Input hysteresis voltage | | 0.5 | - | | V |
| I _{IN} | Input current | V _{IN} = V _{CC} = 36 V | | - | 200 | μΑ |
| VOL | I/O output voltage | I _{IN} = 5 mA (fault condition) | | - | 1 | ٧ |

Table 8. Status pin

| Symbol | Parameter | Test conditions | Min. | Тур. | Max. | Unit |
|-------------------|------------------------------|--|------|------|------|------|
| VSTAT | Status low output voltage | I _{STAT} = 5 mA (fault condition) | - | - | 1 | V |
| ILSTAT | Status leakage current | Normal operation; V _{STAT} = V _{CC} = 36 V | 1 | - | 10 | μА |
| C _{STAT} | Status pin input capacitance | Normal operation; V _{STAT} = 5 V | - | - | 100 | pF |

Table 9. V_{CC} - output diode

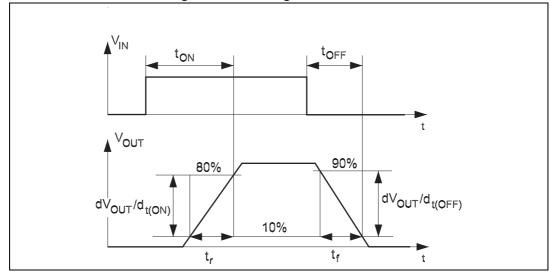
| Symbol | Parameter | Test conditions | Min. | Тур. | Max. | Unit |
|--------|--------------------|--|------|------|------|------|
| VF | Forward on voltage | -I _{OUT} = 0.3 A; T _J = 150 °C | - | - | 1 | ٧ |

4 Truth table and switching characteristics

Table 10. Truth table

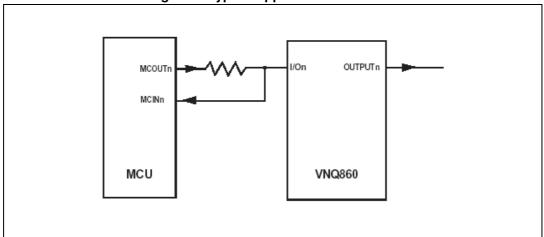
| Conditions | MCOUTn | I/On | OUTPUTn | STATUS |
|--------------------|--------|------------|---------|--------|
| Normal operation | L | L | L | H |
| | H | H | H | H |
| Current limitation | L | L | L | H |
| | H | H | X | H |
| Overtemperature | L | L | L | L |
| | H | Driven low | L | L |
| Undervoltage | L | L | L | X |
| | H | H | L | X |
| Overvoltage | L | L | L | H |
| | H | H | L | H |

Figure 4. Switching characteristics



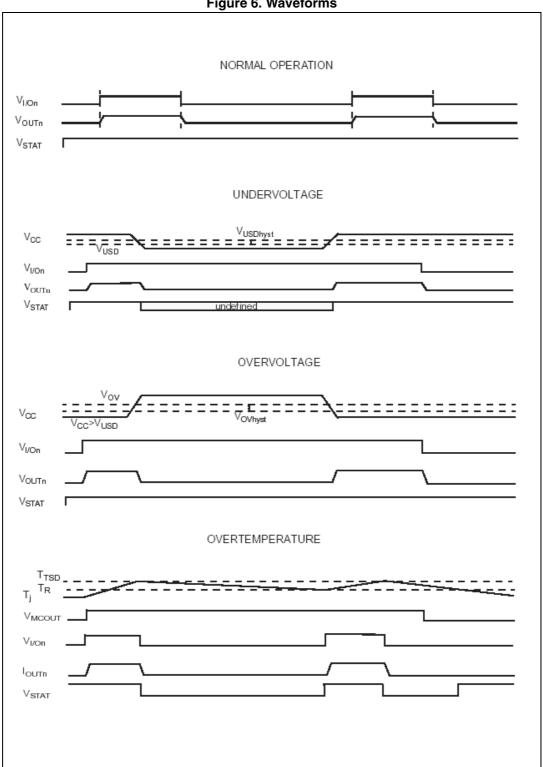
5 Typical application schematic

Figure 5. Typical application schematic



Waveforms 6

Figure 6. Waveforms



7 PowerSO-10™ thermal data

Figure 7. PowerSO-10™ PC board

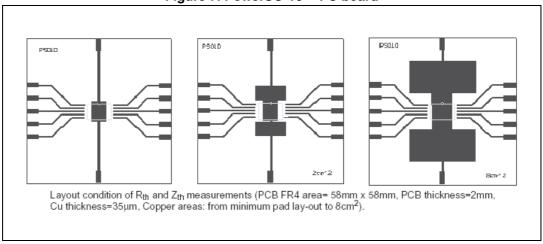
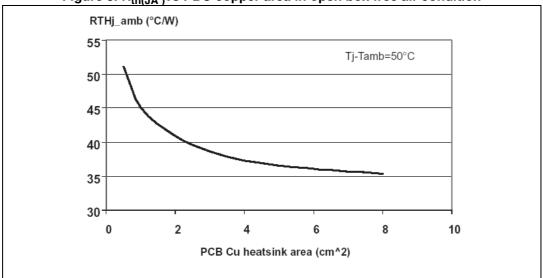


Figure 8. R_{th(JA)}vs PBC copper area in open box free air condition



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8 Reverse polarity protection

A solution to protect the IC against a reverse polarity condition is proposed in Figure 9.

This schematic is valid with any type of load connected to the outputs of the IC.

The R_{GND} resistor value can be selected according to the following conditions:

Equation 1

 $R_{GND} \le 600 \text{ mV} / (I_S \text{ in ON state max.}).$

Equation 2

 $R_{GND} \ge (-V_{CC}) / (-I_{GND})$

where -I_{GND} is the DC reverse ground pin current and can be found in *Table 1: Absolute maximum ratings*.

The power dissipation associated to R_{GND} during the reverse polarity condition is:

$$PD = (-V_{CC})^2/R_{GND}$$

This resistor can be shared by different ICs. In such case, I_S value, indicated in *Equation 1*, is the sum of the maximum ON-state currents of the different devices.

Please note that, if the microprocessor ground and the device ground are separated then the voltage drop across the R_{GND} (given by I_S in ON state max. * R_{GND}) produces a difference between the generated input level and the IC input signal level. This voltage drop varies depending on how many devices are ON in the case of several high-side switches sharing the same R_{GND} .

+ Vcc
Status
Output,
Input,
GND
Load
(Optional)

Figure 9. Reverse polarity protection

9 Package mechanical data

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.

Table 11. PowerSO-10™ mechanical data

| Dim. | mm | | | inch | | |
|------|-------|------|-------|-------|-------|-------|
| | Min | Тур | Max | Min | Тур | Max |
| Α | 3.35 | | 3.65 | 0.132 | | 0.144 |
| A1 | 0.00 | | 0.10 | 0.000 | | 0.004 |
| В | 0.40 | | 0.60 | 0.016 | | 0.024 |
| С | 0.35 | | 0.55 | 0.013 | | 0.022 |
| D | 9.40 | | 9.60 | 0.370 | | 0.378 |
| D1 | 7.40 | | 7.60 | 0.291 | | 0.300 |
| Е | 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 |
| е | | 1.27 | | | 0.050 | |
| F | 1.25 | | 1.35 | 0.049 | | 0.053 |
| Н | 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 | |
| а | 0° | | 8° | | | |

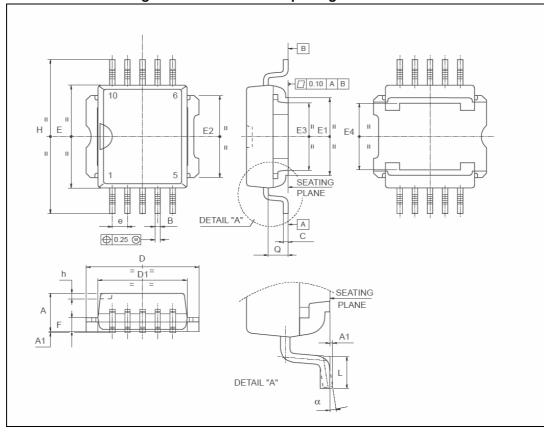
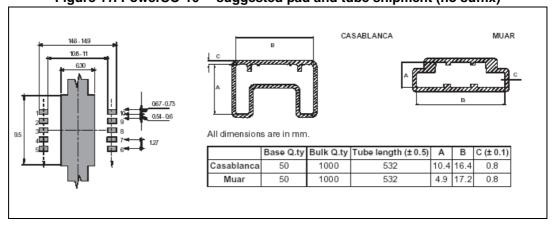


Figure 10. PowerSO-10™ package dimensions

Figure 11. PowerSO-10™ suggested pad and tube shipment (no suffix)



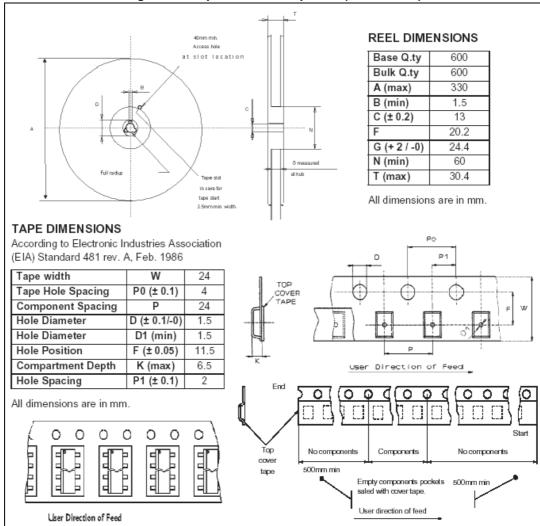


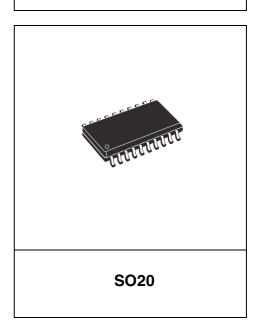
Figure 12. Tape and reel shipment (suffix "TR")

Figure 13. SO20 mechanical data and package dimensions

| mm | | | inch | | |
|----------------------|---|--|--|--|---|
| MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| 2.35 | | 2.65 | 0.093 | | 0.104 |
| 0.10 | | 0.30 | 0.004 | | 0.012 |
| 0.33 | | 0.51 | 0.013 | | 0.200 |
| 0.23 | | 0.32 | 0.009 | | 0.013 |
| 12.60 | | 13.00 | 0.496 | | 0.512 |
| 7.40 | | 7.60 | 0.291 | | 0.299 |
| | 1.27 | | | 0.050 | |
| 10.0 | | 10.65 | 0.394 | | 0.419 |
| 0.25 | | 0.75 | 0.010 | | 0.030 |
| 0.40 | | 1.27 | 0.016 | | 0.050 |
| 0° (min.), 8° (max.) | | | | | |
| | | 0.10 | | | 0.004 |
| | 2.35 0.10 0.33 0.23 12.60 7.40 | MIN. TYP. 2.35 0.10 0.33 0.23 12.60 7.40 1.27 10.0 0.25 0.40 | MIN. TYP. MAX. 2.35 2.65 0.10 0.30 0.33 0.51 0.23 0.32 12.60 13.00 7.40 7.60 1.27 10.65 0.25 0.75 0.40 1.27 0° (min.), | MIN. TYP. MAX. MIN. 2.35 2.65 0.093 0.10 0.30 0.004 0.33 0.51 0.013 0.23 0.32 0.009 12.60 13.00 0.496 7.40 7.60 0.291 10.0 10.65 0.394 0.25 0.75 0.010 0.40 1.27 0.016 0° (min.), 8° (max) | MIN. TYP. MAX. MIN. TYP. 2.35 2.65 0.093 0.004 0.10 0.30 0.004 0.013 0.23 0.51 0.013 0.09 12.60 13.00 0.496 0.0496 7.40 7.60 0.291 0.050 10.0 10.65 0.394 0.050 0.25 0.75 0.010 0.040 0.40 1.27 0.016 0.016 0.* (min.), 8* (max.) 0.000 0.000 |

 [&]quot;D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side.

OUTLINE AND MECHANICAL DATA



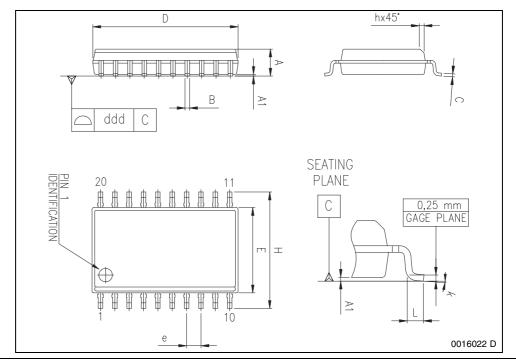
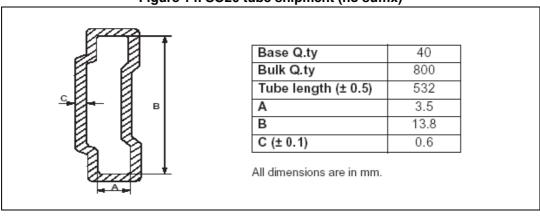
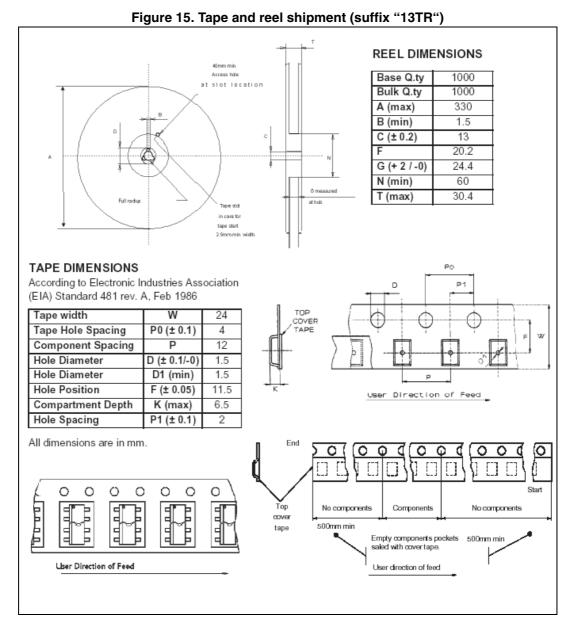


Figure 14. SO20 tube shipment (no suffix)





10 Ordering information

Table 12. Ordering information

| Order codes | Package | Packaging | |
|--------------|-------------|-----------------|--|
| VNQ860-E | SO20 | Tube | |
| VNQ860SP-E | PowerSO-10™ | Tube | |
| VNQ860TR-E | SO20 | Tano and roal | |
| VNQ860SPTR-E | PowerSO-10™ | - Tape and reel | |

11 Revision history

Table 13. Document revision history

| Date | Revision | Changes | |
|-------------|----------|--|--|
| 14-Jul-2005 | 1 | Updates, new template | |
| 7-Nov-2005 | 2 | Few updates | |
| 07-Jul-2008 | 3 | Added Section 8 on page 11 | |
| 28-Apr-2009 | 4 | Updated Figure 13 on page 15 | |
| 05-May-2010 | 5 | Updated coverpage | |
| 31-Aug-2010 | 6 | Updated Table 10 on page 7 | |
| 15-Mar-2013 | 7 | Updated <i>Table 1</i> and <i>Table 12</i> . Minor text changes. | |

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