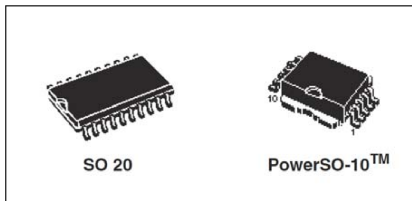


Quad channel high-side driver



Features

- $V_{CC(AMR)} = 41\text{ V}$
- $R_{DS(on)} \leq 0.270\ \Omega$ @ $T_J = 25\text{ }^\circ\text{C}$ (per channel)
- Fast demagnetization of inductive loads, $V_{DEMAG(TYP)} = V_{CC} - 52\text{ V}$
- Very low standby current
- CMOS compatible I/Os
- Per channel process side op. current I_{OUT} up to 0.35A
- Undervoltage and overvoltage shutdown
- Short circuit protection on output channels
- Per-channel thermal shutdown protection and diagnostic
- Protection against loss of ground

Application

- Industrial PC peripheral input/output
- Numerical control machines
- Drivers for all type of loads (resistive, capacitive, inductive)

Description

The VNQ860-E and 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.

Product status link

[VNQ860-E](#)

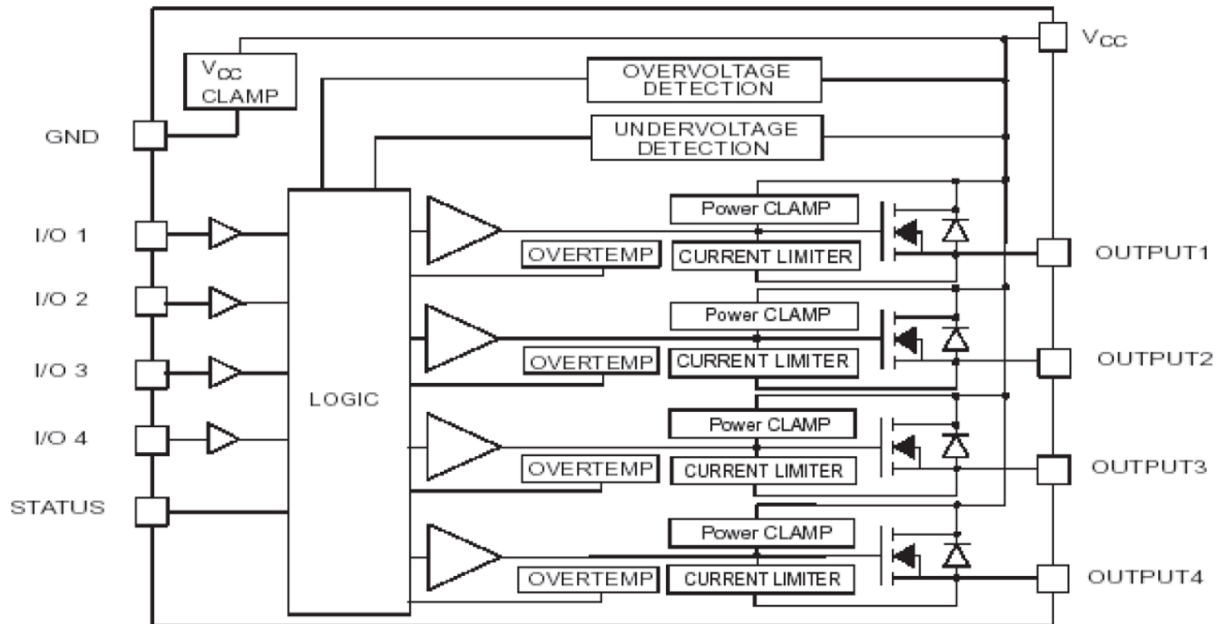
[VNQ860SP-E](#)

Product label



1 Block diagram

Figure 1. Block diagram



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	DC supply voltage	41	V
$-V_{CC}$	Reverse DC supply voltage	-0.3	V
$-I_{GND}$	Reverse DC ground pin	-200	mA
I_{OUT}	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	-2	A
I_{IN}	DC input current	± 10	mA
V_{IN}	Input voltage range	-3/+ V_{CC}	V
V_{STAT}	DC status pin voltage	+ V_{CC}	V
V_{ESD}	Electrostatic discharge ($R = 1.5\text{ k}\Omega$; $C = 100\text{ pF}$)	2000	V
P_{tot}	Power dissipation at $T_c \leq 25\text{ }^\circ\text{C}$	Internally limited ⁽¹⁾	W
T_J	Junction operating temperature	Internally limited ⁽¹⁾	$^\circ\text{C}$
T_c	Case operating temperature	-40 to 150	$^\circ\text{C}$
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$

1. Protection functions are intended to avoid IC damage in fault conditions and are not intended for continuous operation. Continuous and repetitive operation of protection functions may reduce the IC lifetime.

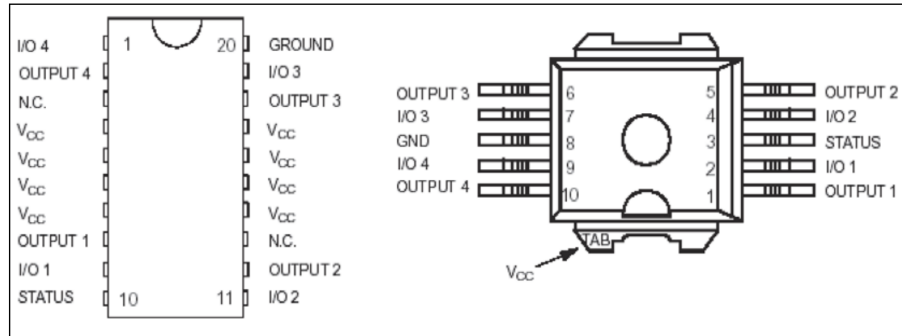
3 Thermal data

Table 2. Thermal data

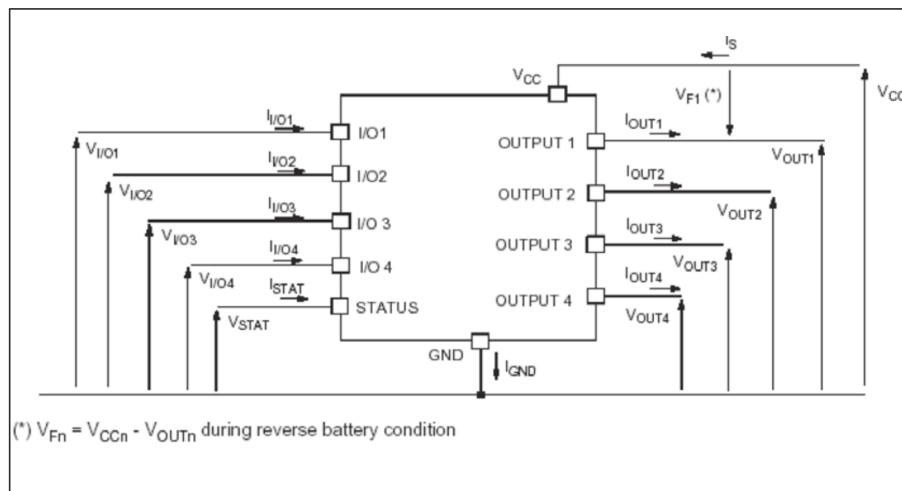
Symbol	Parameter	Max. Values		Unit
		SO20	PowerSO-10	
Rth(j-p)	Thermal resistance junction-pins	8	-	°C/W
Rth(j-a)	Thermal resistance junction-ambient	58	52 ⁽¹⁾ ; 37 ⁽²⁾	
Rth(j-c)	Thermal resistance junction-case	-	1.4	

1. When mounted on FR4 printed circuit board with 0.5 cm² of copper area (at least 35µm thick) connected to all VCC pins.
2. When mounted on FR4 printed circuit board with 6 cm² of copper area (at least 35µm thick) connected to all VCC pins.

4 Pin connection

Figure 2. Configuration diagram (top view)

Table 3. Pin connection

Connection/Pin	Status	N.C.	Output	Input
Floating	X	X	X	X
To ground		X		Through 10 kΩ resistor

Figure 3. Current and Voltage Conventions


5 Electrical characteristics

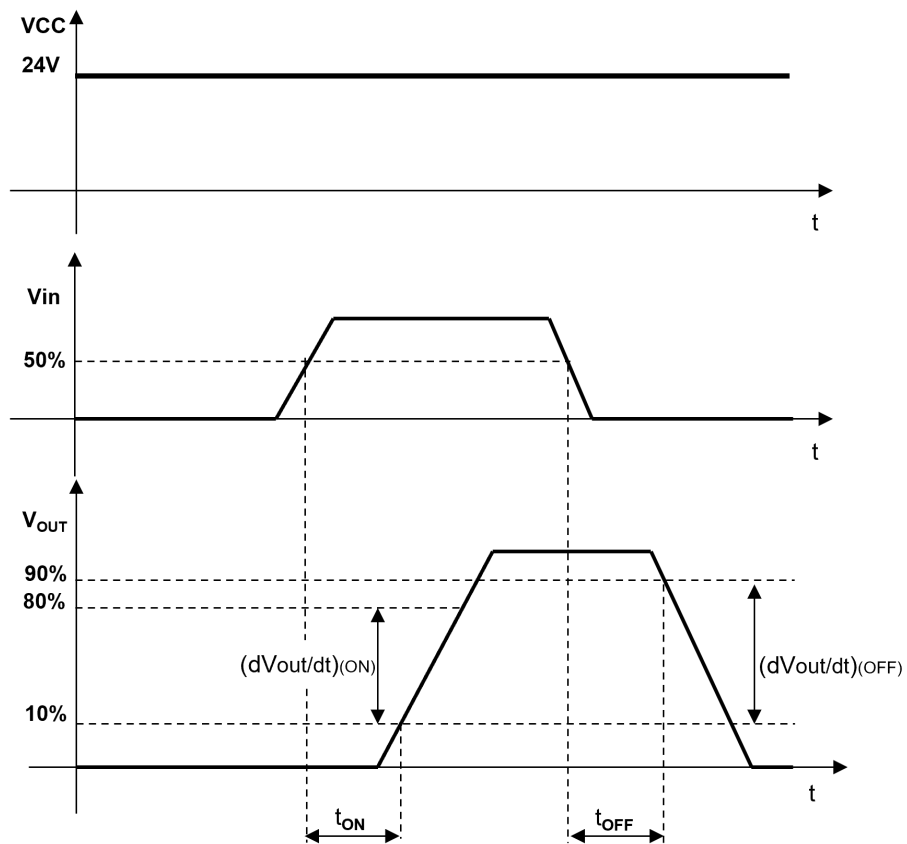
8 V < V_{CC} < 36 V; -40 °C < T_J < 150 °C; unless otherwise specified.

Table 4. Power section

Symbol	Parameter	Test conditions	Min.	Typ.	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			270	mΩ
		I _{OUT} = 0.25 A			540	
I _S	Supply current	OFF state; V _{CC} = 24 V; T _C = 25°C		70	120	μA
		ON state (all channels ON)		5	10	mA
I _{LGND}	Output current at GND disconnection	V _{CC} = V _{STAT} = V _{IN} = V _{GND} = 24V; V _{OUT} = 0 V			1	mA
I _{L(OFF)}	OFF state output current	V _{IN} = V _{OUT} = 0 V	0		10	μA
I _{OUTleak}	OFF state output leakage current	V _{IN} = V _{GND} = 0 V; V _{CC} = V _{OUT} = 24 V; T _A = 25 °C			240	μA
		V _{IN} = V _{GND} = 0 V; V _{CC} = 24 V; V _{OUT} = 10 V; T _A = 25 °C			100	

Table 5. Switching (V_{CC} = 24 V, R_{LOAD} = 96 Ω)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t _(ON)	Turn-on delay time of output current	From V _{IN} rising edge to V _{OUT} = 2.4 V		10		μs
t _(OFF)	Turn-off delay time of output current	From V _{IN} falling edge to V _{OUT} = 21.6 V		40		μs
(dV _{OUT} /dt) _{ON}	Turn-on voltage slope	From V _{OUT} = 2.4 V to 19.2 V		0.75		V/μs
(dV _{OUT} /dt) _{OFF}	Turn-off voltage slope	From V _{OUT} = 21.6 V to 2.4 V		0.25		V/μs

Figure 4. Switching characteristics

Table 6. Protections (per channels)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{LIM}	Current limitation		0.35	0.7	1.1	A
T_{TSD}	Thermal shutdown temperature		150	175	200	°C
T_R	Reset temperature		135			°C
$T_{(hyst)}$	Thermal hysteresis		7	15		°C
V_{demag}	Turn-off output clamp voltage	$I_{OUT} = 0.25 \text{ A}, V_{CC} = 24 \text{ V}$	$V_{CC}-59$	$V_{CC}-52$	$V_{CC}-47$	V

Table 7. Logic Input (per channel)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IL}	Low level input voltage				1.25	V
I_{IL}	Low level input current	$V_{IN} = 1.25 \text{ V}$	1			μA
V_{IH}	High level input voltage		3.25			V
I_{IH}	High level input current	$V_{IN} = 3.25 \text{ V}$			10	μA
$V_{I(HYST)}$	Input hysteresis voltage		0.5			V
I_{IN}	Input current	$V_{IN} = V_{CC} = 36 \text{ V}$			200	μA
V_{OL}	I/O output voltage	$I_{IN} = 5 \text{ mA (fault condition)}$			1	V

Table 8. Status pin

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{STAT}	Status low output voltage	$I_{STAT} = 5 \text{ mA}$ (fault condition)			1	V
I_{LSTAT}	Status leakage current	Normal operation; $V_{STAT} = V_{CC} = 36 \text{ V}$			20	μA
C_{STAT}	Status pin input capacitance	Normal operation; $V_{STAT} = 5 \text{ V}$			100	pF

Table 9. V_{CC} - output diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on voltage	$-I_{OUT} = 0.3 \text{ A}$; $T_J = 150 \text{ }^\circ\text{C}$			1	V

6 Truth table

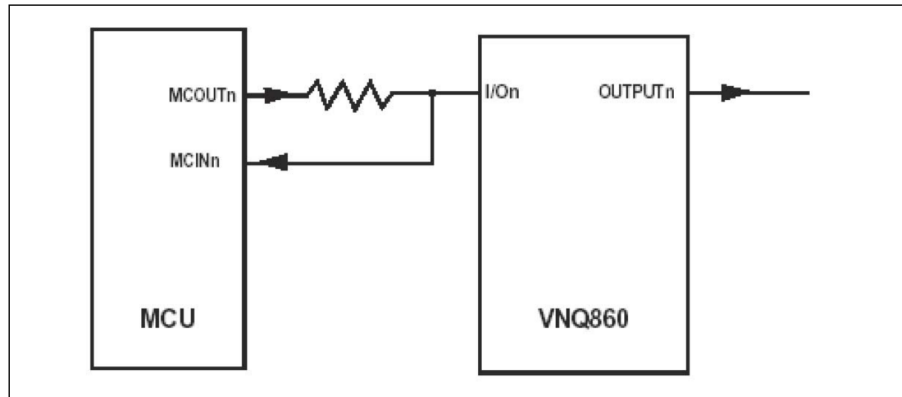
Table 10. Truth table

Conditions	MCOUT _n	(I/O) _n	OUTPUT _n	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

Note: X = don't care

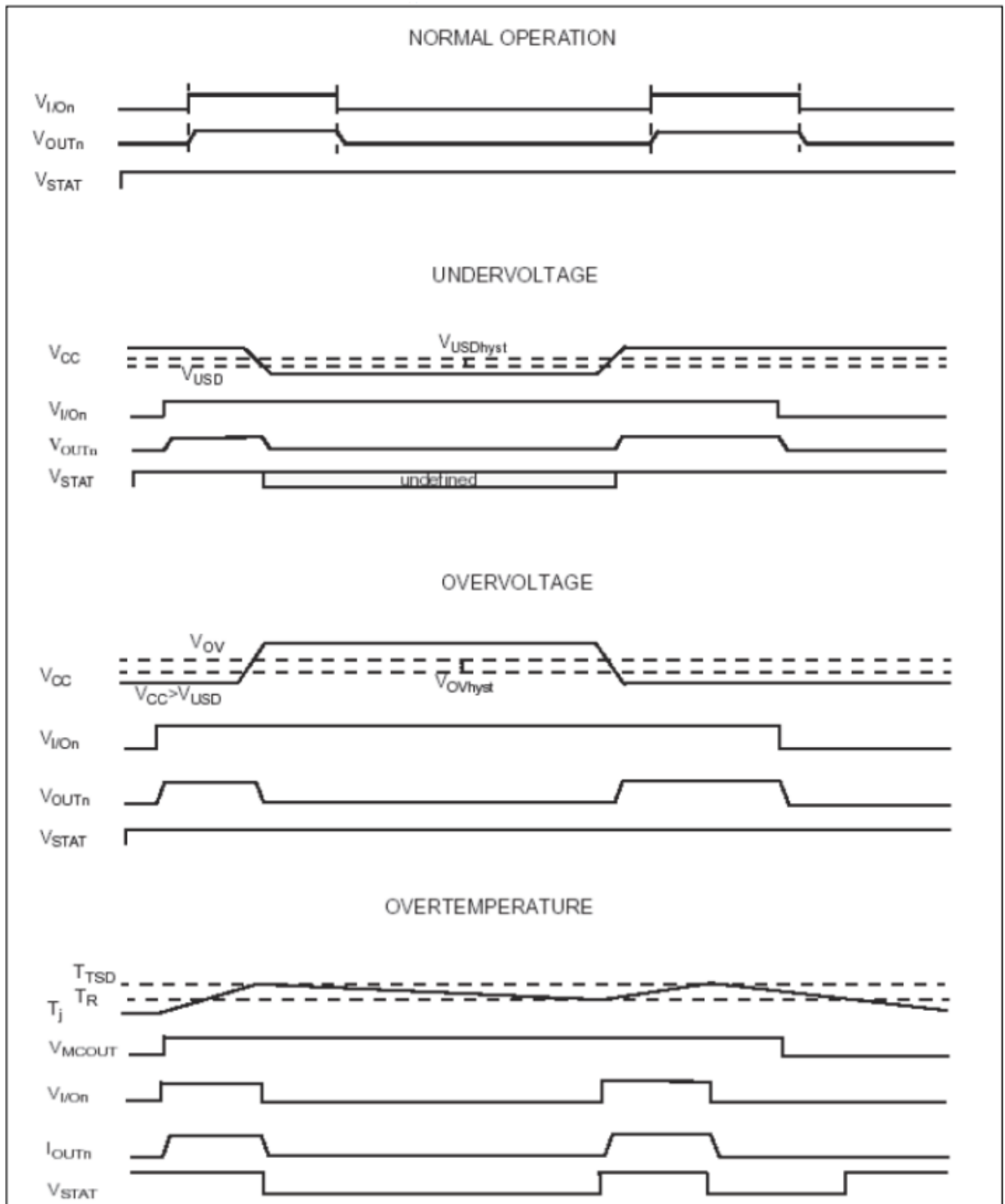
7 Typical application schematic

Figure 5. Typical application schematic



8 Waveforms

Figure 6. Waveforms



9 PowerSO-10™ thermal data

Figure 7. PowerSO-10™ PC board

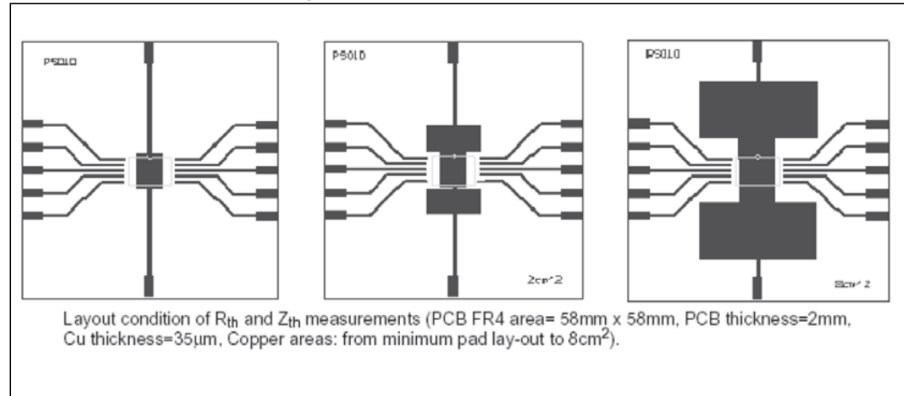
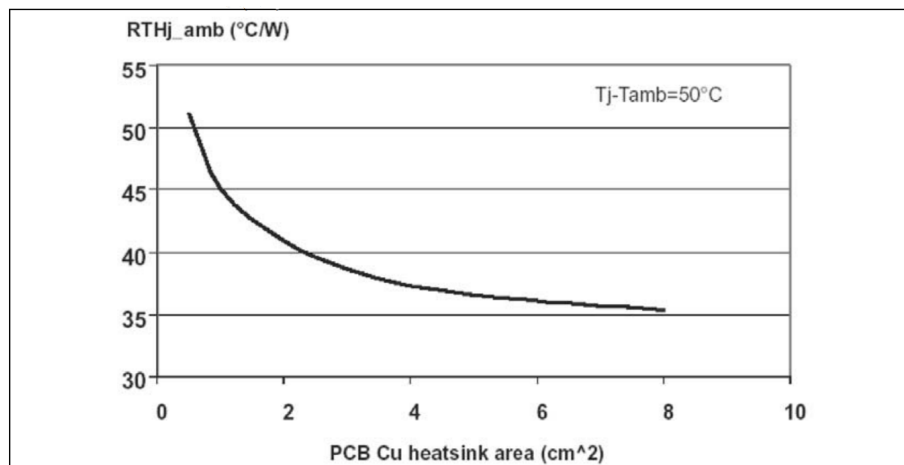


Figure 8. $R_{th(JA)}$ vs PBC copper area in open box free air condition



10 Reverse polarity protection

A solution to protect the IC against a reverse polarity condition is proposed in [Figure 9. Reverse polarity protection](#).

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

$$R_{GND} \leq 600 \text{ mV} / (-I_{S(ON)MAX})$$

Equation 2

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

where $-I_{GND}$ is the DC reverse ground pin current and can be found in [Table 1. Absolute maximum ratings](#).

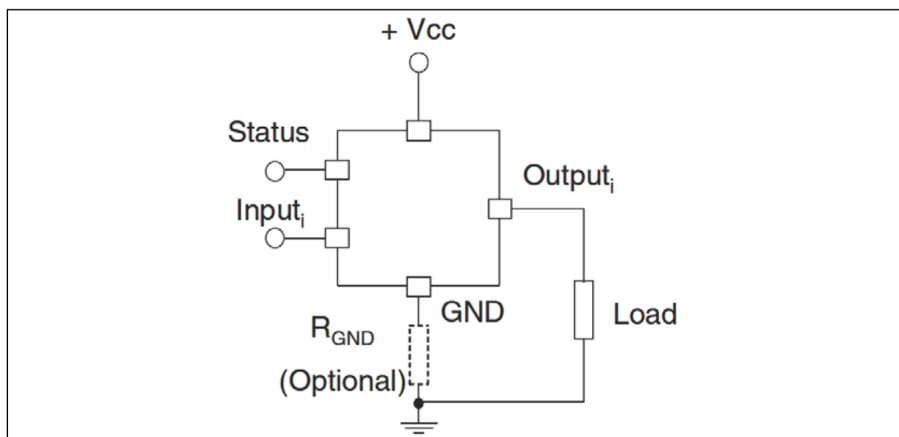
The power dissipated by R_{GND} during reverse polarity is:

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

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} .

Figure 9. Reverse polarity protection



11 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.	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	0.35		0.55	0.013		0.022
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
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 10. PowerSO-10™ package dimensions

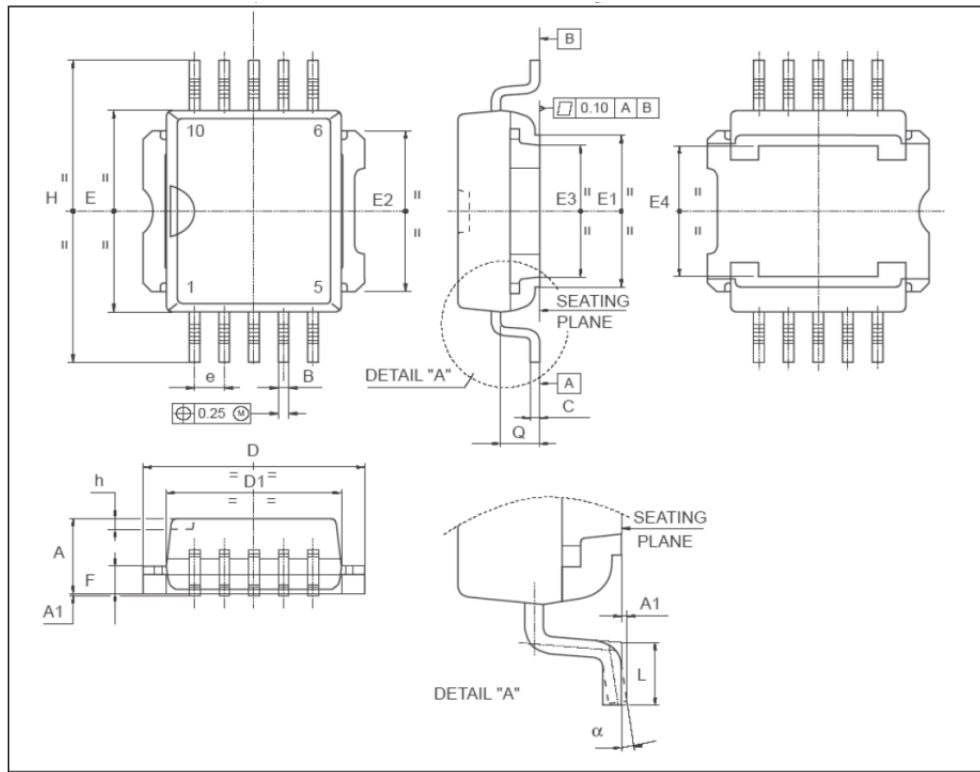


Figure 11. PowerSO-10™ suggested pad and tube shipment (no suffix)

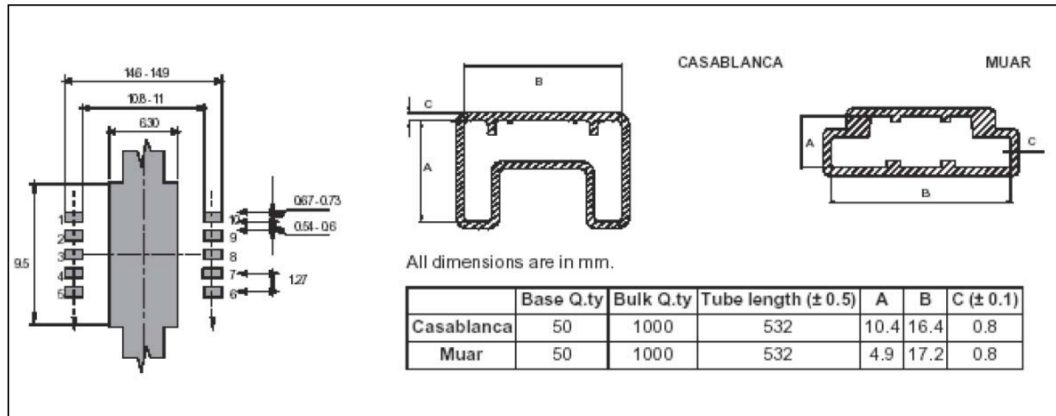


Figure 12. PowerSO-10™ tape and reel shipment (suffix “TR”)

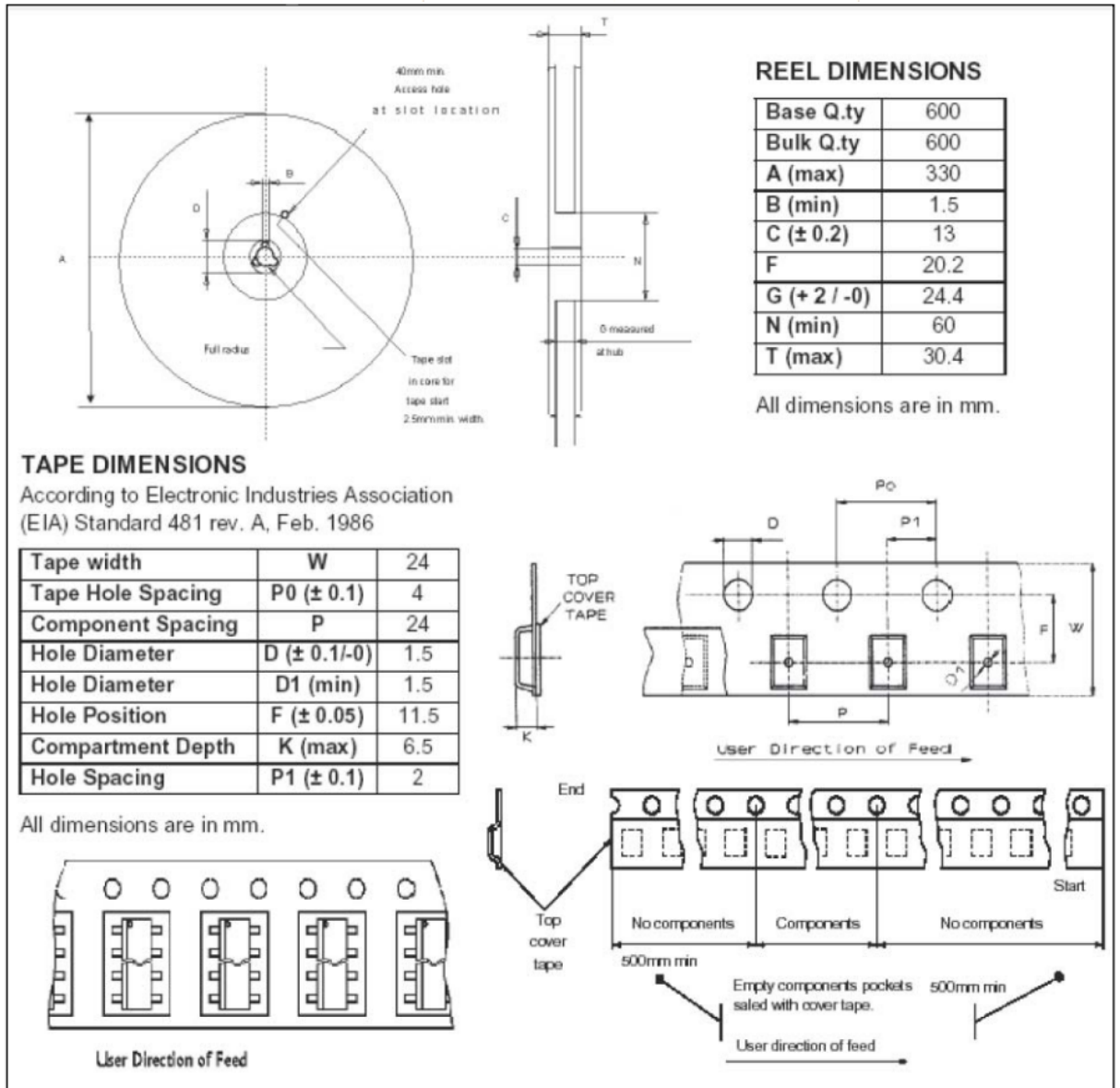


Figure 13. SO20 mechanical data and package dimensions

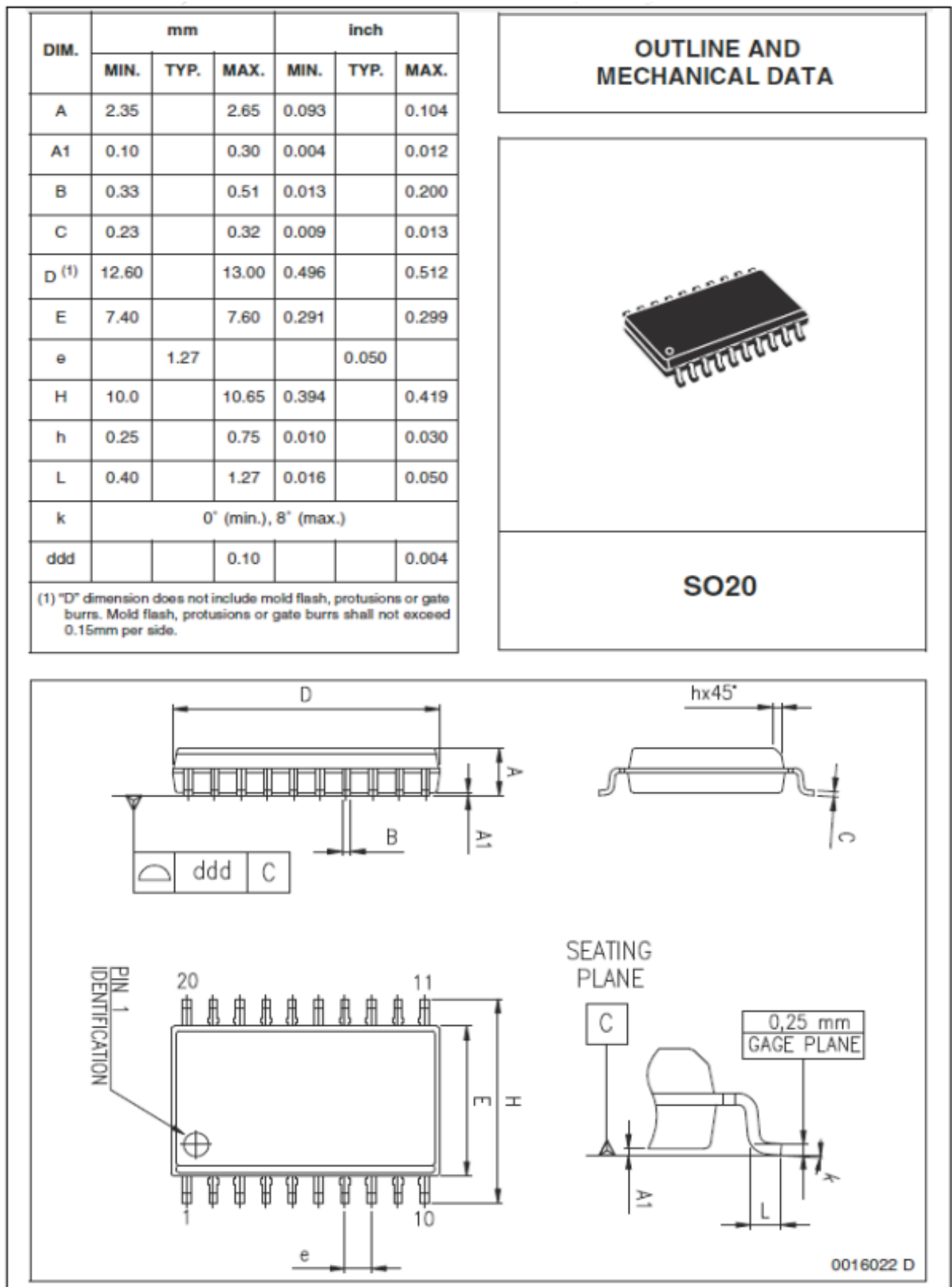


Figure 14. SO20 tube shipment (no suffix)

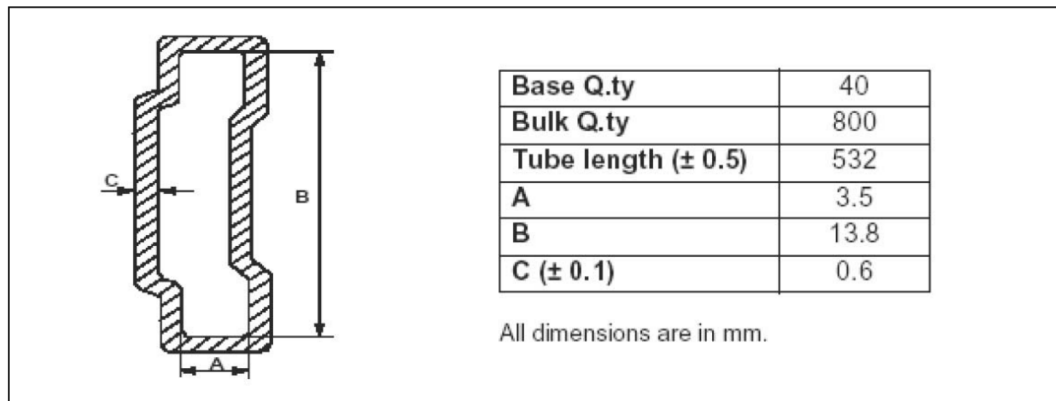
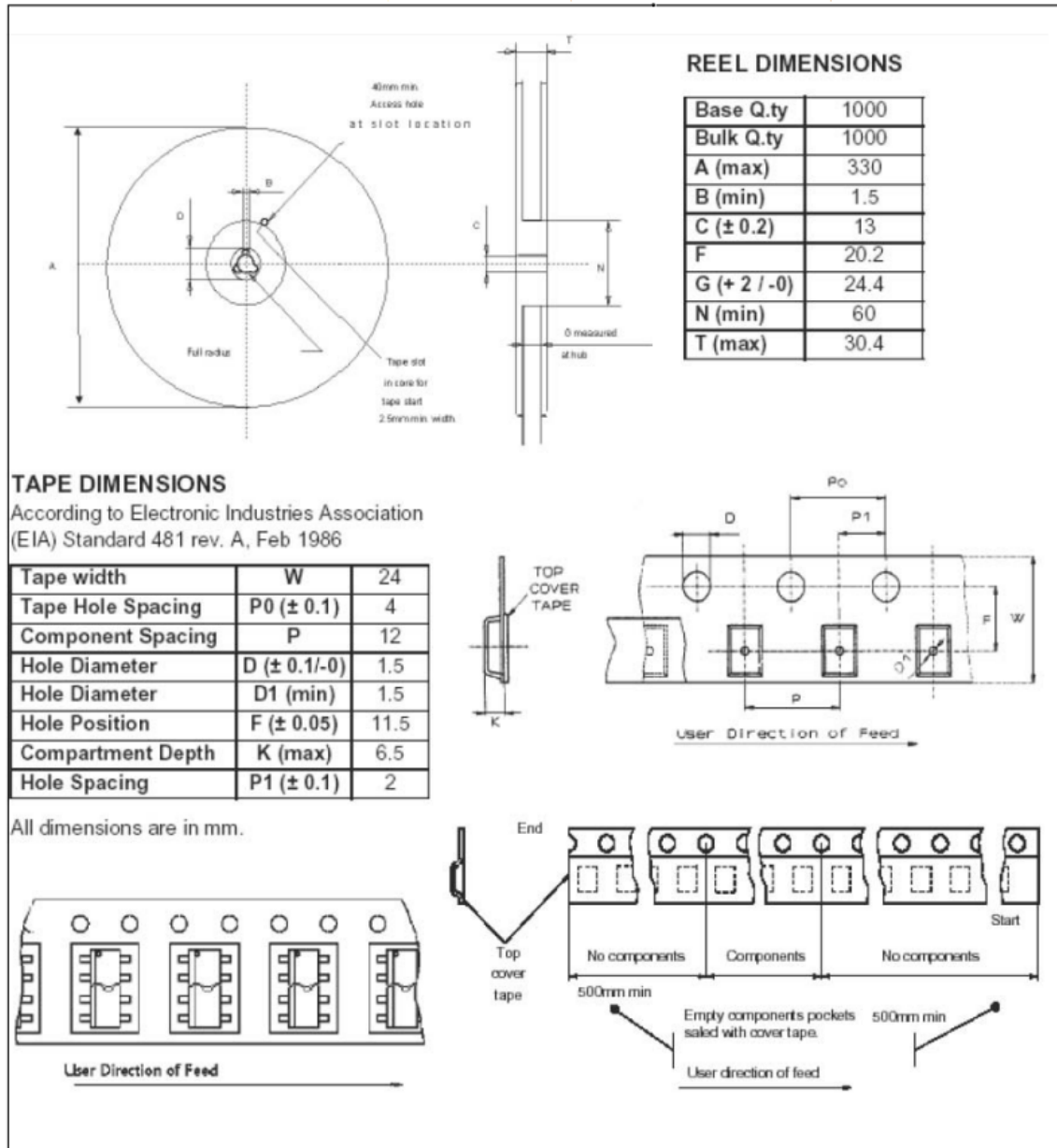


Figure 15. SO20 Tape and reel shipment (suffix "13TR")



12 Ordering information

Table 12. Ordering information

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

Revision history

Table 13. Document revision history

Date	Version	Changes
14-Jul-2005	1	Updates, new template
7-Nov-2005	2	Few updates
7-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 Table 1 and Table 12. Minor text changes
15-Jan-2020	8	Change to Table 8 value.
12-Oct-2021	9	New template; updated Table 1; Table 4: corrected I_{LGND} parameter and test conditions definitions; Table 5: corrected typo in $t_{(OFF)}$ test conditions; changed Figure 4. Switching characteristics and moved in Section 5 Electrical characteristics; minor text changes.

Contents

1	Block diagram	2
2	Absolute maximum ratings	3
3	Thermal data	4
4	Pin connection	5
5	Electrical characteristics	6
6	Truth table	9
7	Typical application schematic	10
8	Waveforms	11
9	PowerSO-10™ thermal data	12
10	Reverse polarity protection	13
11	Package mechanical data	14
12	Ordering information	20
	Revision history	21

List of figures

Figure 1.	Block diagram	2
Figure 2.	Configuration diagram (top view).	5
Figure 3.	Current and Voltage Conventions	5
Figure 4.	Switching characteristics	7
Figure 5.	Typical application schematic	10
Figure 6.	Waveforms.	11
Figure 7.	PowerSO-10™ PC board.	12
Figure 8.	$R_{th(JA)}$ vs PBC copper area in open box free air condition.	12
Figure 9.	Reverse polarity protection.	13
Figure 10.	PowerSO-10™ package dimensions	15
Figure 11.	PowerSO-10™ suggested pad and tube shipment (no suffix)	15
Figure 12.	PowerSO-10™ tape and reel shipment (suffix “TR”)	16
Figure 13.	SO20 mechanical data and package dimensions	17
Figure 14.	SO20 tube shipment (no suffix).	18
Figure 15.	SO20 Tape and reel shipment (suffix “13TR”)	19

List of tables

Table 1.	Absolute maximum ratings	3
Table 2.	Thermal data	4
Table 3.	Pin connection	5
Table 4.	Power section	6
Table 5.	Switching ($V_{CC} = 24\text{ V}$, $R_{LOAD} = 96\ \Omega$)	6
Table 6.	Protections (per channels)	7
Table 7.	Logic Input (per channel)	7
Table 8.	Status pin	8
Table 9.	V_{CC} - output diode	8
Table 10.	Truth table	9
Table 11.	PowerSO-10™ mechanical data	14
Table 12.	Ordering information	20
Table 13.	Document revision history	21

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2021 STMicroelectronics – All rights reserved