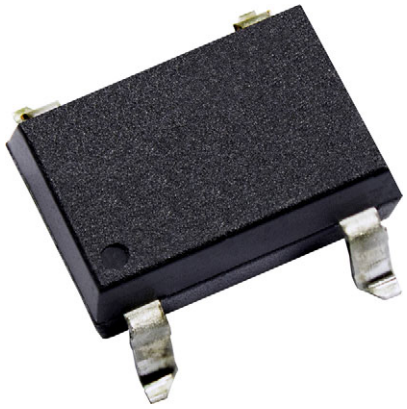
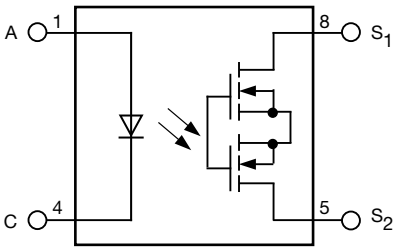
1500 V, 1 Form A Solid-State Relay





DESCRIPTION

The VORA1150 is an AEC-Q102 qualified 1500 V solid-state relay in an innovative 4-pin SMD-8 package with > 5 mm creepage distance in between the output pins making it suitable for use in 800 V automotive applications. It consists of an infrared emitter that is optically coupled to high voltage MOSFETs between the output terminals.

This device provides reinforced isolation and is suitable for use in automotive and industrial applications.

FEATURES

- AEC-Q102 qualified
- Isolation test voltage 5300 V_{RMS}
- Typical R_{ON} 100 Ω
- Load voltage 1500 V
- Load current 50 mA
- Ambient temperature range -40 °C to +125 °C
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE GREEN (5-2008)

APPLICATIONS

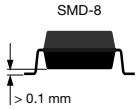
- Battery isolation measurement in electric vehicles
- Pre-charge relay
- On-board charger
- Battery management system
- Solar panel leakage current detection

AGENCY APPROVALS

- UL (pending)
- cUL (pending)
- DIN EN 60747-5-5 (VDE0884-5) (pending)

ORDERING INFORMATION

V	O	R	A	1	1	5	0	-	X	0	1	7	T
PART NUMBER									ORDERING INFORMATION				



PACKAGE	UL, VDE
SMD-8, tape and reel	VORA1150-X017T

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)				
PARAMETER	**CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
INPUT				
IRED continuous forward current		I_F	50	mA
IRED reverse voltage		V_R	5	V
Input power dissipation		P_{diss}	80	mW
Junction temperature		T_J	140	°C
OUTPUT				
Load voltage		V_L	1500	V
Continuous load current		I_L	50	mA
SSR output power dissipation (continuous)		P_{diss}	550	mW
Junction temperature		T_J	140	°C
SSR				
Ambient temperature range		T_{amb}	-40 to +125	°C
Storage temperature range		T_{stg}	-40 to +150	°C
Soldering temperature	t = 10 s max.	T_{sld}	260	°C
Repetitive avalanche rating	t_p = 5 s, duty cycle < 8.3 % (1)	I_{AVA}	0.9	mA
High pot pulse width	R_L = 940 kΩ, V_L = 2400 V, 5 times over lifetime, recovery time 60 s	t_{P_HiPot}	5	s

Notes

- Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.

(1) Cumulative of 5 min over lifetime with 60 s period.

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
INPUT						
Forward voltage	I_F = 5 mA	V_F	-	1.35	1.6	V
Reverse current	V_R = 5 V	I_R	-	-	10	µA
IRED forward current, switch turn - on	I_L = 50 mA	I_{Fon}	-	-	2	mA
IRED forward current, switch turn - off	V_L = 1500 V, I_L = 50 µA	I_{Foff}	150	200	-	nA
OUTPUT						
On-resistance	I_F = 5 mA, I_L = 50 mA	R_{ON}	-	100	200	Ω
Off-state leakage current	I_F = 0 mA, V_L = ± 1500 V	I_O	-	< 1	1	µA
	I_F = 0 mA, V_L = ± 1500 V, T_{amb} = 85 °C	I_O	-	0.05	-	µA
	I_F = 0 mA, V_L = ± 1200 V, T_{amb} = 100 °C	I_O	-	0.15	-	µA
	I_F = 0 mA, V_L = ± 1000 V, T_{amb} = 110 °C	I_O	-	0.5	-	µA
Output capacitance	I_F = 0 mA, V_L = 25 V, f = 1 MHz	C_O	-	10	-	pF
TRANSFER						
Capacitance (input to output)	V_{IO} = 1 V, f = 1 MHz	C_{IO}	-	0.4	-	pF

Note

- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information only and are not part of the testing requirements.

PIN CONFIGURATION

AC/DC configuration

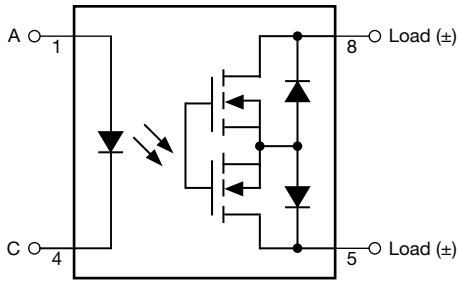
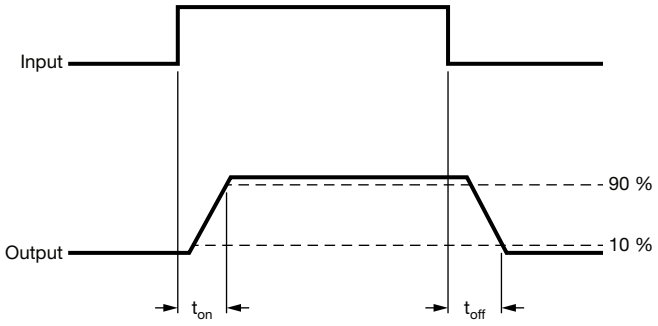


Fig. 1 - Pin Configuration

SWITCHING CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Turn-on time	I_F = 10 mA, R_L = 20 kΩ, V_{DD} = 40 V	t_{on}	-	50	150	µs
Turn-off time	I_F = 10 mA, R_L = 20 kΩ, V_{DD} = 40 V	t_{off}	-	80	250	µs



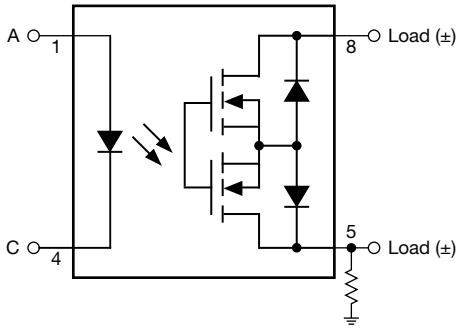


Fig. 2 - Timing Schematic

SAFETY AND INSULATION RATINGS				
PARAMETER	**TEST CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
Climatic classification	According to IEC 68 part 1		40 / 125 / 21	
Pollution degree	According to DIN VDE 0109		2	
Comparative tracking index	Insulation group IIIa	CTI	600	
Maximum rated withstanding isolation voltage	According to UL1577, t = 1 min	V_{ISO}	5300	V_{RMS}
Maximum transient isolation voltage	According to DIN EN 60747-5-5	V_{IOTM}	8000	V_{peak}
Maximum repetitive peak isolation voltage	According to DIN EN 60747-5-5	V_{IORM}	1414	V_{peak}
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C	R_{IO}	≥ 10^{12}	Ω
	V_{IO} = 500 V, T_{amb} = 125 °C	R_{IO}	≥ 10^{11}	Ω
	V_{IO} = 2000 V, T_{amb} = 25 °C	R_{IO}	≥ 10^{12}	Ω
	V_{IO} = 2000 V, T_{amb} = 125 °C	R_{IO}	≥ 10^{11}	Ω
Output safety power		P_{SO}	1000	mW
Input safety current		I_{SI}	240	mA
Safety temperature		T_S	175	°C
Creepage distance	SMD-8		≥ 8	mm
Clearance distance	SMD-8		≥ 8	mm
Insulation thickness		DTI	≥ 0.4	mm
Input to output test voltage, method B	V_{IORM} × 1.875 = V_{PR}, 100 % production test with t_M = 1 s, partial discharge < 5 pC	V_{PR}	2651	V_{peak}
Input to output test voltage, method A	V_{IORM} × 1.6 = V_{PR}, sample test with t_M = 10 s, partial discharge < 5 pC	V_{PR}	2262	V_{peak}

Note

- As per IEC 60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.

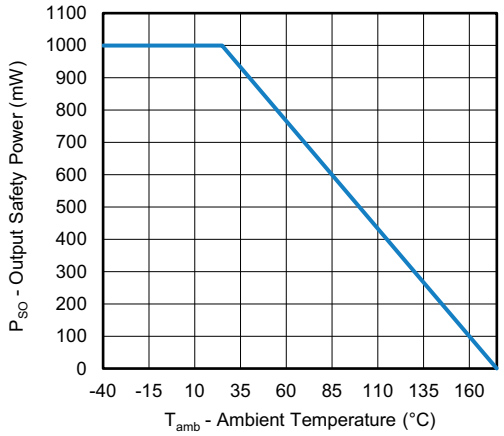


Fig. 3 - Safety Power Dissipation vs. Ambient Temperature

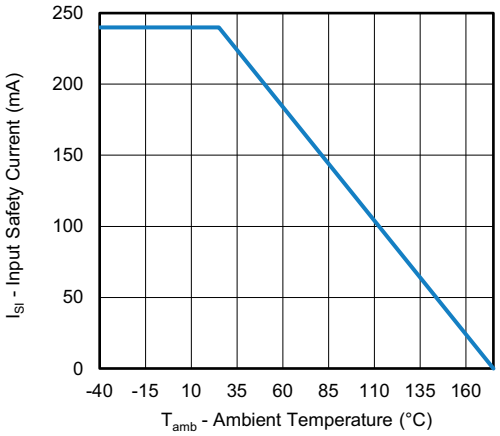


Fig. 4 - Safety Input Current vs. Ambient Temperature

HIPOT TESTING AND AVALANCHE BREAKDOWN

For the calculation of avalanche current flowing through the MOSFET of the solid-state relay and the respective power dissipated in the solid state relay below circuit is referred:

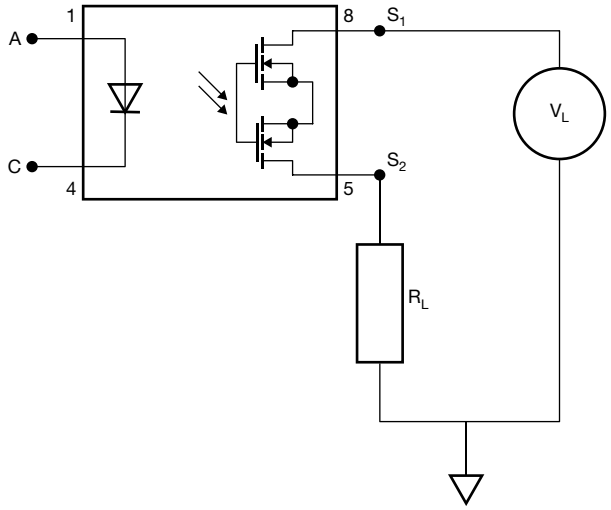


Fig. 5

For the below mentioned conditions, the current through the MOSFETs is calculated as:

Load resistance R_L = 940 kΩ ± 5 %

V_L = 2400 V

MOSFETs breakdown voltage V_{BREAK} = 1500 V (min.)

$$I_{AVA} = \frac{V_R}{R_L} = \frac{V_L - V_{BREAK}}{R_L} = \frac{2400\ V - 1500\ V}{893\ k\Omega} = 1\ mA$$

From the current the power dissipated in the solid-state relay can be calculated as:

$P_{MOS} = V_{BREAK} \times I_{AVA} = 1500\ V \times 1\ mA = 1.5\ W$

TYPICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

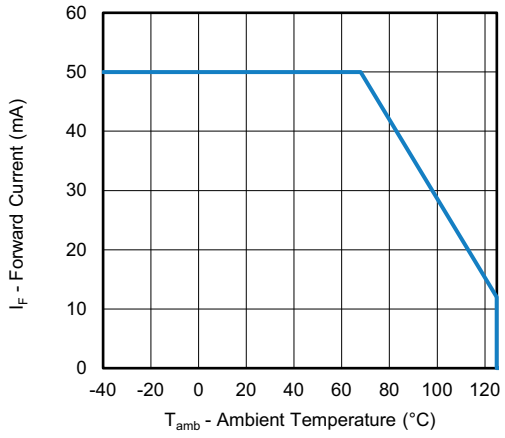


Fig. 6 - Forward Current vs. Ambient Temperature

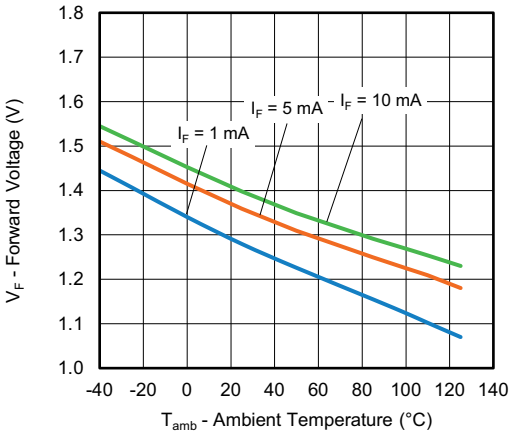


Fig. 7 - Forward Voltage vs. Ambient Temperature

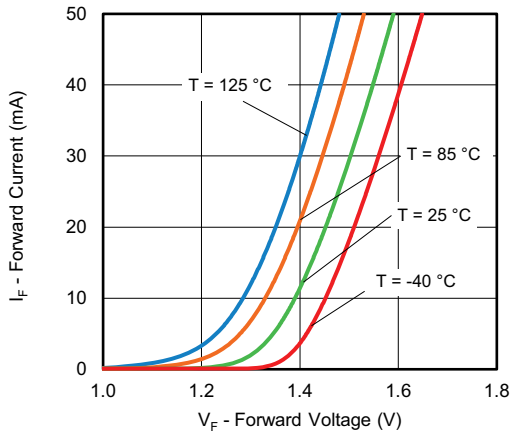


Fig. 8 - Forward Current vs. Forward Voltage

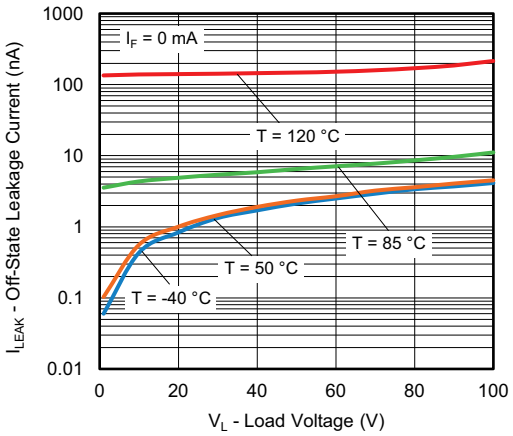


Fig. 11 - Off-State Leakage Current vs. Load Voltage

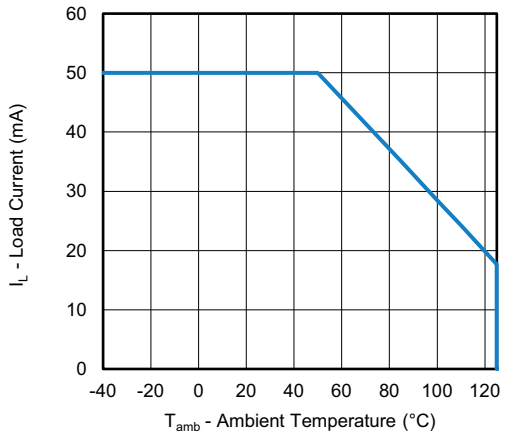


Fig. 9 - Maximum Load Current vs. Ambient Temperature

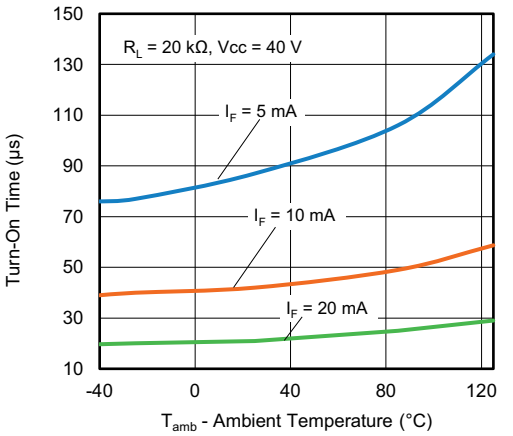


Fig. 12 - Turn-On Time vs. Ambient Temperature

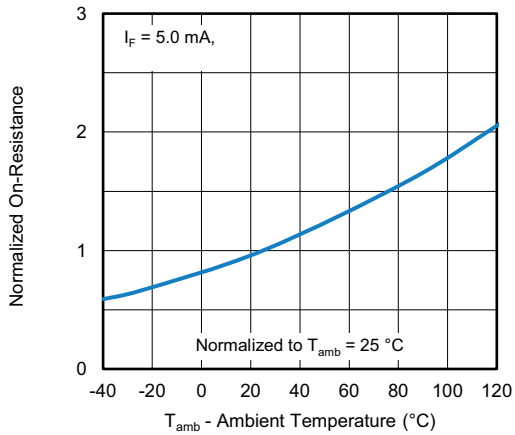


Fig. 10 - Normalized On-Resistance vs. Ambient Temperature

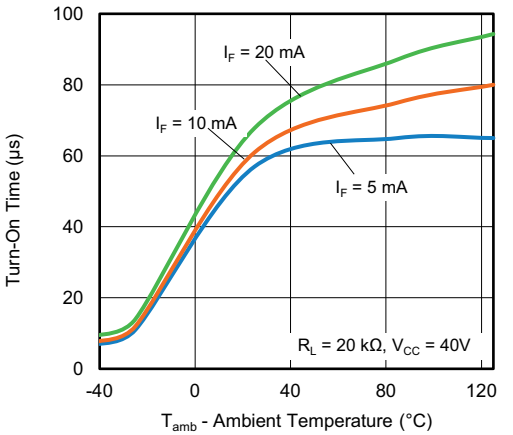


Fig. 13 - Turn-Off Time vs. Ambient Temperature

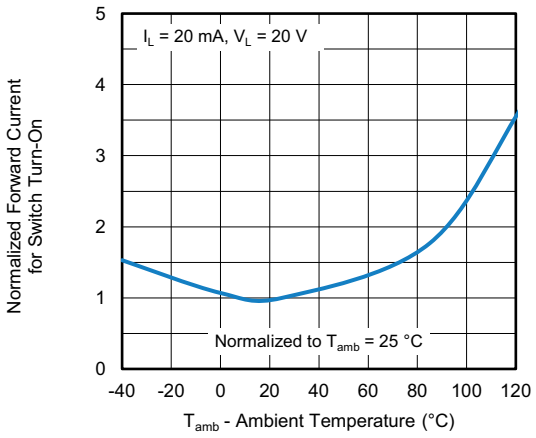


Fig. 14 - Normalized Forward Current for Switch Turn-On vs. Ambient Temperature

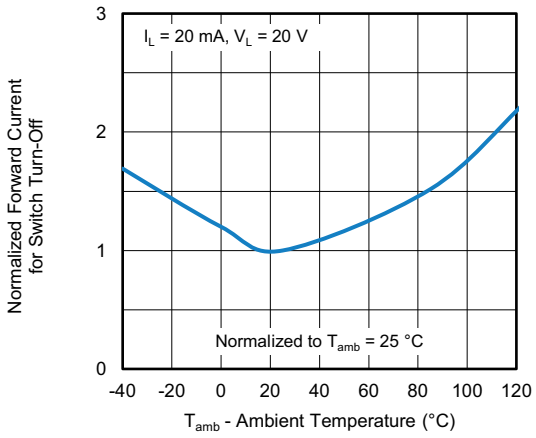


Fig. 15 - Normalized Forward Current for Switch Turn-Off vs. Ambient Temperatur

PACKAGE DIMENSIONS (in millimeters)

SMD-8

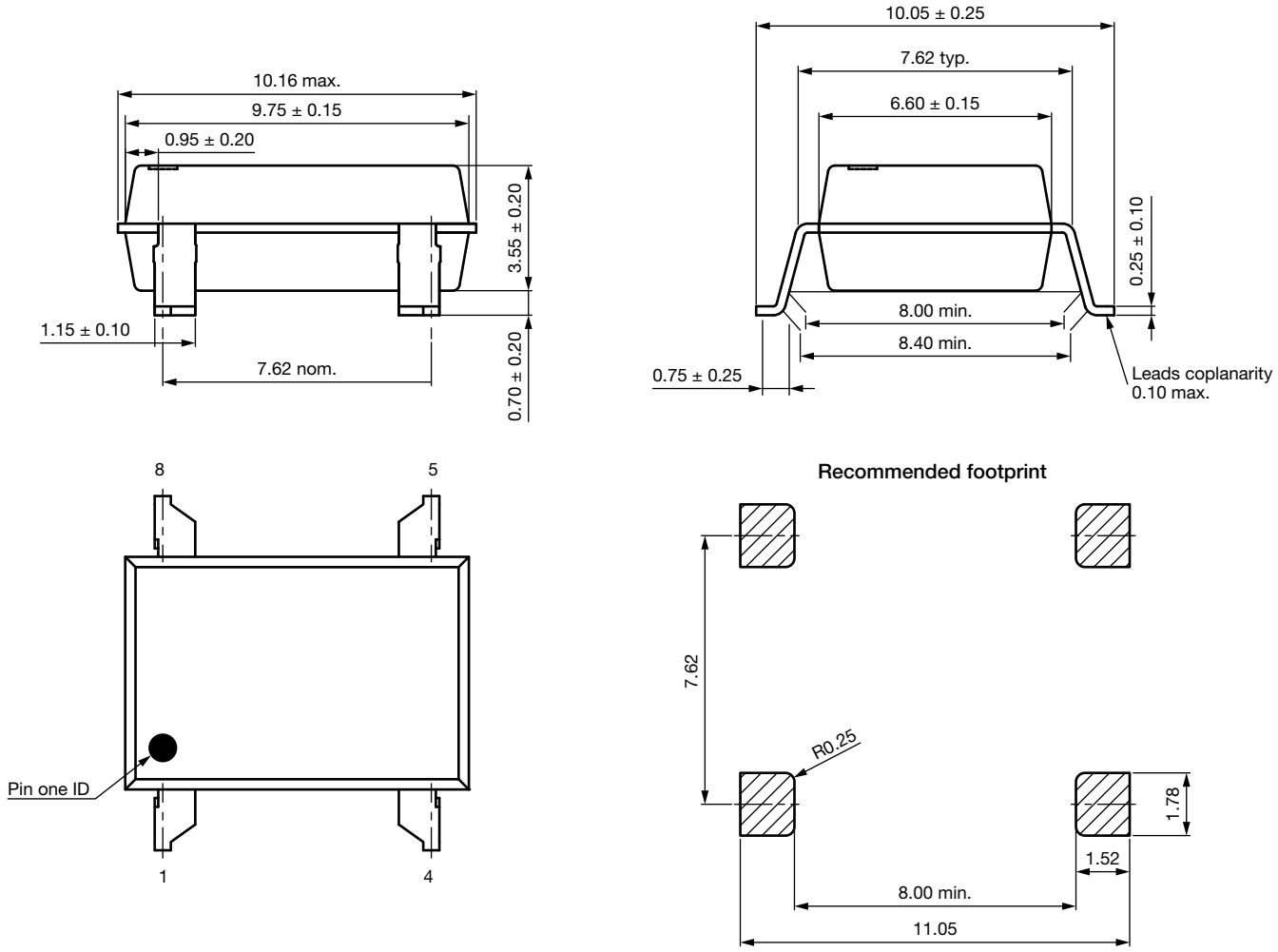


Fig. 16 - Package Drawings

PACKAGE MARKING

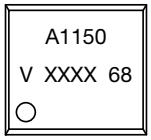
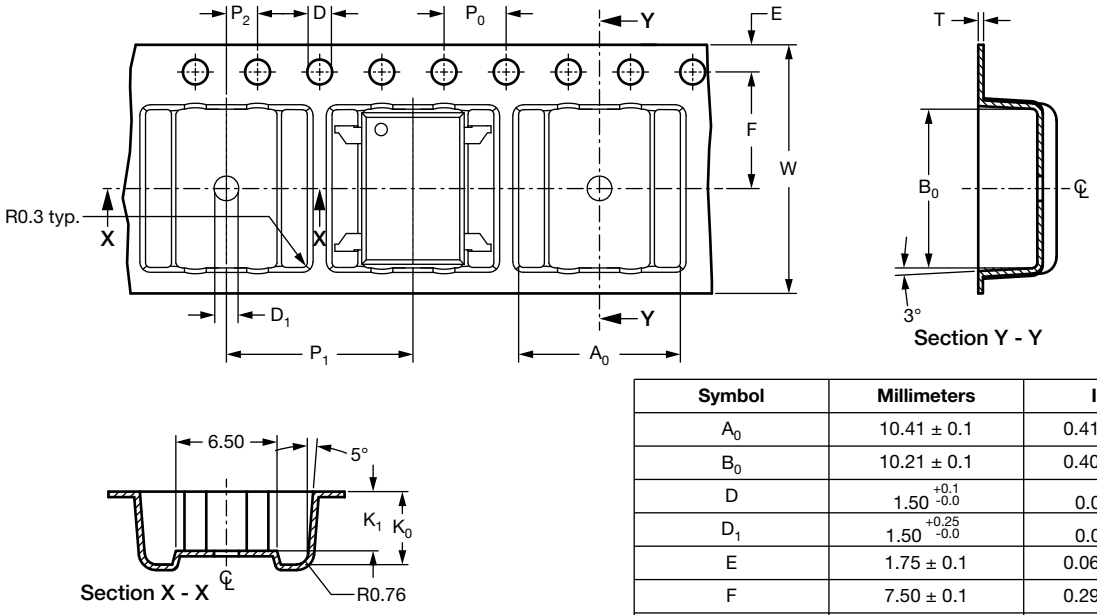


Fig. 17 - VORA1150

PACKING INFORMATION (in millimeters)



Symbol	Millimeters	Inches
A_0	10.41 ± 0.1	0.410 ± 0.004
B_0	10.21 ± 0.1	0.402 ± 0.004
D	$1.50^{+0.1}_{-0.0}$	$0.059^{+0.004}_{-0.0}$
D_1	$1.50^{+0.25}_{-0.0}$	$0.059^{+0.010}_{-0.0}$
E	1.75 ± 0.1	0.069 ± 0.004
F	7.50 ± 0.1	0.295 ± 0.004
K_0	4.70 ± 0.1	0.185 ± 0.004
K_1	3.81 ± 0.1	0.150 ± 0.004
P_1	12.00 ± 0.1	0.472 ± 0.004
P_0	4.00 ± 0.1	0.157 ± 0.004
P_2	2.00 ± 0.1	0.079 ± 0.004
T	0.35 ± 0.05	0.014 ± 0.002
W	16.00 ± 0.3	0.630 ± 0.012

Notes

- 10 sprocket hole pitch cummulative tolerances ± 0.2
- Camber not to exeed 1 mm in 100 mm
- Material: black conductive polystyrene
- K_0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier
- Resistivity = 10^4 Ω/sq. to 10^9 Ω/sq.

Fig. 18 - Tape and Reel Packing (1000 pieces on reel)

SOLDER PROFILES

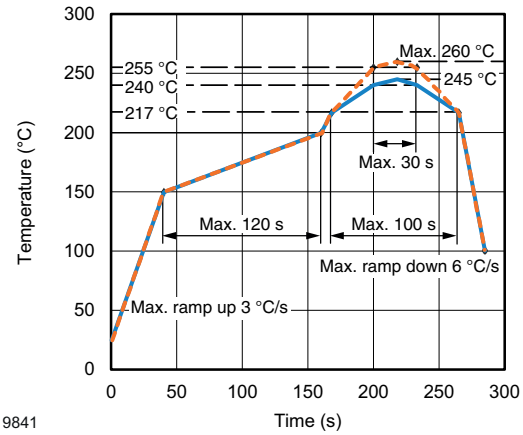


Fig. 19 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020 for SMD Devices

HANDLING AND STORAGE CONDITIONS

ESD level: HBM class 2

Floor life: 168 h

Conditions: T_{amb} < 30 °C, RH < 85 %

Moisture sensitivity level 3, according to J-STD-020

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