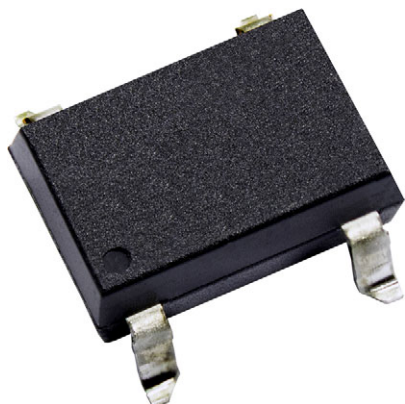


1500 V, 1 Form A Solid-State Relay



DESCRIPTION

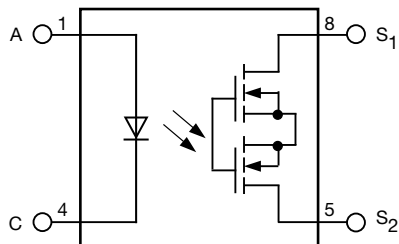
The VORA1150 is an AEC-Q102 qualified 1500 V solid-state relay in an innovative 4-pin SMD-8 package with > 5 mm creepage distance in between the output pins making it suitable for use in 800 V automotive applications. It consists of an infrared emitter that is optically coupled to high voltage MOSFETs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

RoHS
COMPLIANT
HALOGEN
FREE
GREEN
(5-2008)


APPLICATIONS

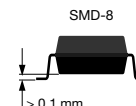
- Battery isolation measurement in electric vehicles
- Pre-charge relay
- On-board charger
- Battery management system
- Solar panel leakage current detection

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

SMD-8, tape and reel

UL, VDE

VORA1150-X017T



ABSOLUTE MAXIMUM RATINGS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, 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	$^{\circ}\text{C}$
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	$^{\circ}\text{C}$
SSR				
Ambient temperature range		T_{amb}	-40 to +125	$^{\circ}\text{C}$
Storage temperature range		T_{stg}	-40 to +150	$^{\circ}\text{C}$
Soldering temperature	$t = 10\text{ s max.}$	T_{sld}	260	$^{\circ}\text{C}$
Repetitive avalanche rating	$t_p = 5\text{ s, duty cycle} < 8.3\% \text{ }^{(1)}$	I_{AVA}	0.9	mA
High pot pulse width	$R_L = 940\text{ k}\Omega, V_L = 2400\text{ V, 5 times over lifetime, recovery time } 60\text{ s}$	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 ($T_{amb} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
INPUT						
Forward voltage	$I_F = 5\text{ mA}$	V_F	-	1.35	1.6	V
Reverse current	$V_R = 5\text{ V}$	I_R	-	-	10	μA
IRED forward current, switch turn - on	$I_L = 50\text{ mA}$	I_{Fon}	-	-	2	mA
IRED forward current, switch turn - off	$V_L = 1500\text{ V, } I_L = 50\text{ }\mu\text{A}$	I_{Foff}	150	200	-	nA
OUTPUT						
On-resistance	$I_F = 5\text{ mA, } I_L = 50\text{ mA}$	R_{ON}	-	100	200	Ω
Off-state leakage current	$I_F = 0\text{ mA, } V_L = \pm 1500\text{ V}$	I_O	-	< 1	1	μA
	$I_F = 0\text{ mA, } V_L = \pm 1500\text{ V, } T_{amb} = 85\text{ }^{\circ}\text{C}$	I_O	-	0.05	-	μA
	$I_F = 0\text{ mA, } V_L = \pm 1200\text{ V, } T_{amb} = 100\text{ }^{\circ}\text{C}$	I_O	-	0.15	-	μA
	$I_F = 0\text{ mA, } V_L = \pm 1000\text{ V, } T_{amb} = 110\text{ }^{\circ}\text{C}$	I_O	-	0.5	-	μA
Output capacitance	$I_F = 0\text{ mA, } V_L = 25\text{ V, } f = 1\text{ MHz}$	C_O	-	10	-	pF
TRANSFER						
Capacitance (input to output)	$V_{IO} = 1\text{ V, } f = 1\text{ MHz}$	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

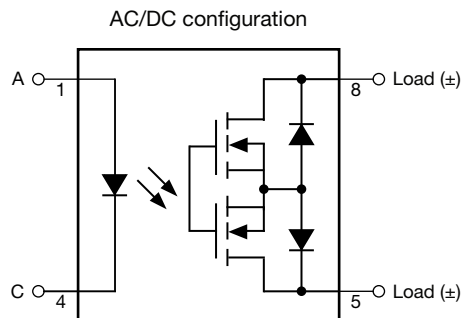


Fig. 1 - Pin Configuration

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

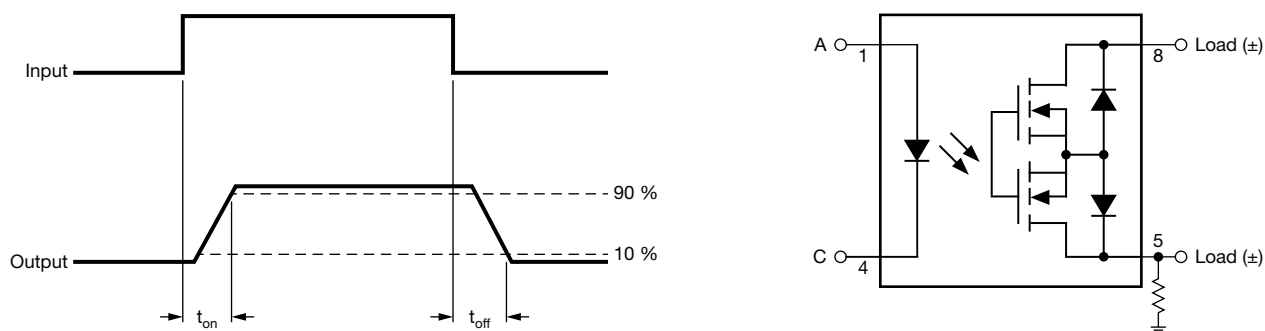


Fig. 2 - Timing Schematic

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.

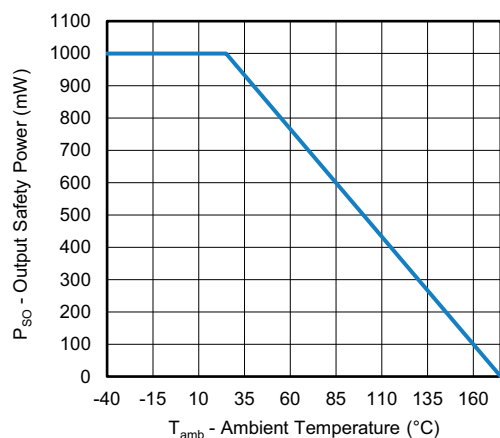


Fig. 3 - Safety Power Dissipation vs. Ambient Temperature

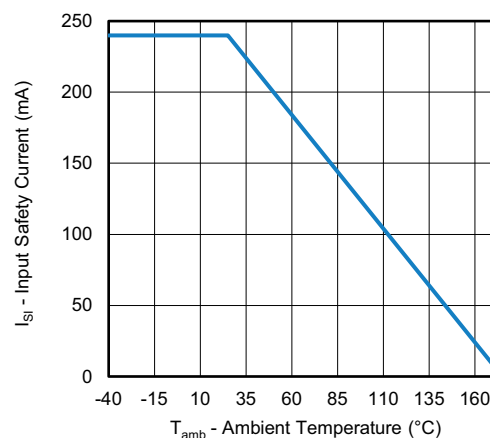


Fig. 4 - Safety Input Current vs. Ambient Temperature

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:

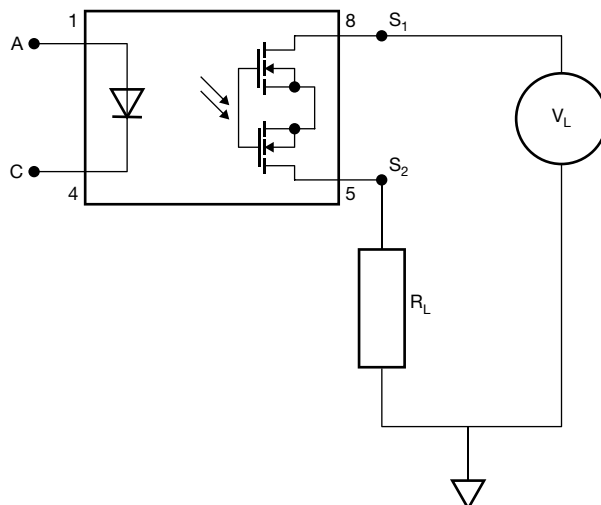


Fig. 5

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

Load resistance $R_L = 940 \text{ k}\Omega \pm 5 \%$

$V_L = 2400 \text{ V}$

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

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

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

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

TYPICAL CHARACTERISTICS ($T_{\text{amb}} = 25^\circ\text{C}$, unless otherwise specified)

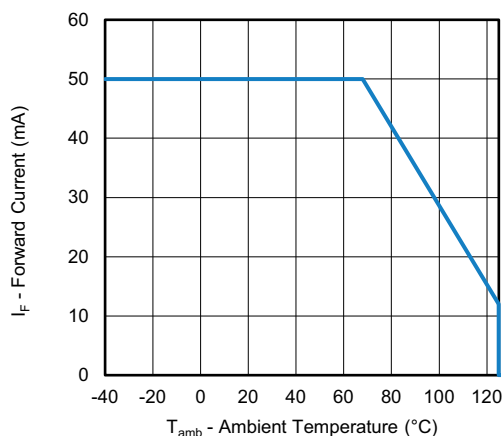


Fig. 6 - Forward Current vs. Ambient Temperature

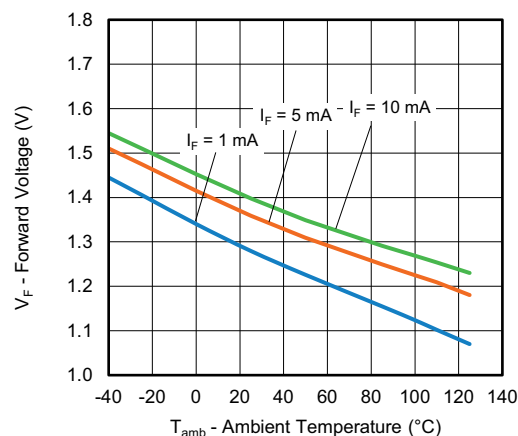


Fig. 7 - Forward Voltage vs. Ambient Temperature

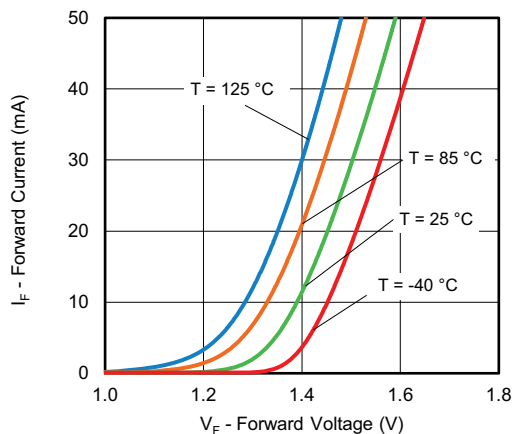


Fig. 8 - Forward Current vs. Forward Voltage

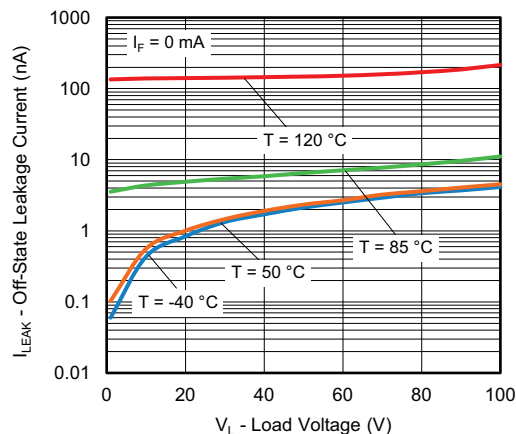


Fig. 11 - Off-State Leakage Current vs. Load Voltage

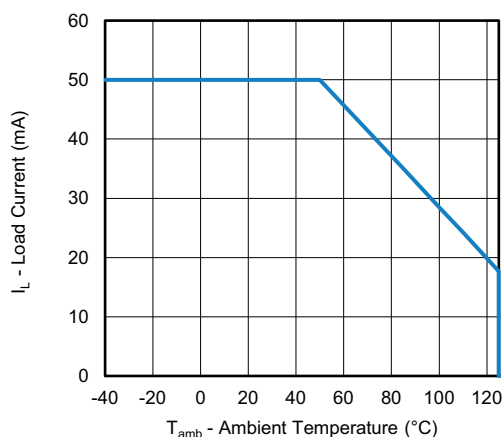


Fig. 9 - Maximum Load Current vs. Ambient Temperature

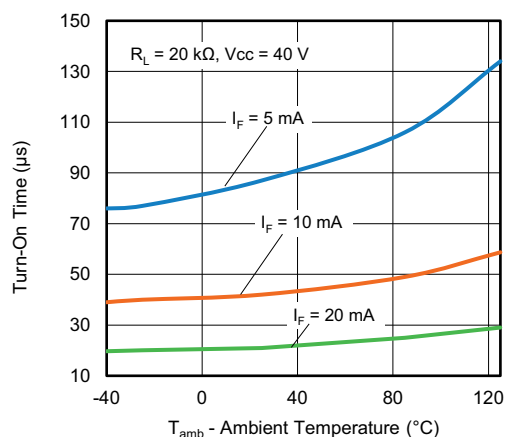


Fig. 12 - Turn-On Time vs. Ambient Temperature

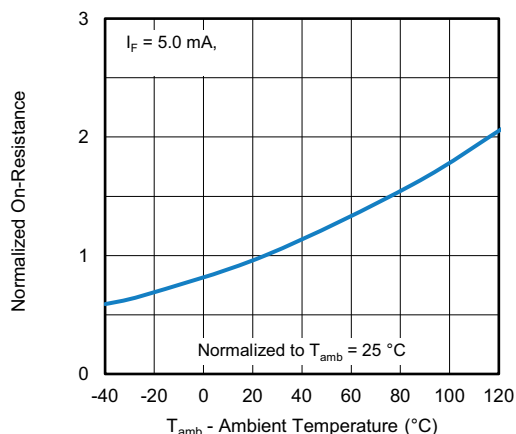


Fig. 10 - Normalized On-Resistance vs. Ambient Temperature

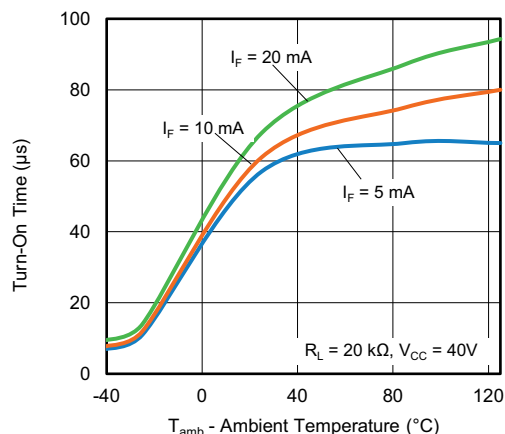


Fig. 13 - Turn-Off Time vs. Ambient Temperature

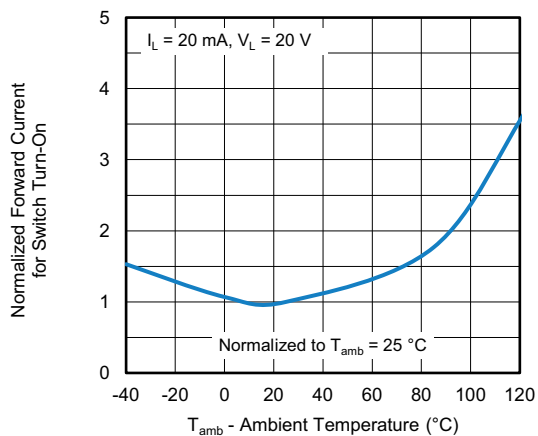


Fig. 14 - Normalized Forward Current for Switch Turn-On vs. Ambient Temperature

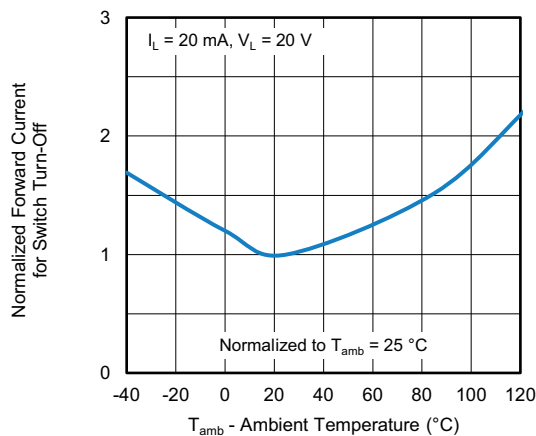


Fig. 15 - Normalized Forward Current for Switch Turn-Off vs. Ambient Temperature

PACKAGE DIMENSIONS (in millimeters)

SMD-8

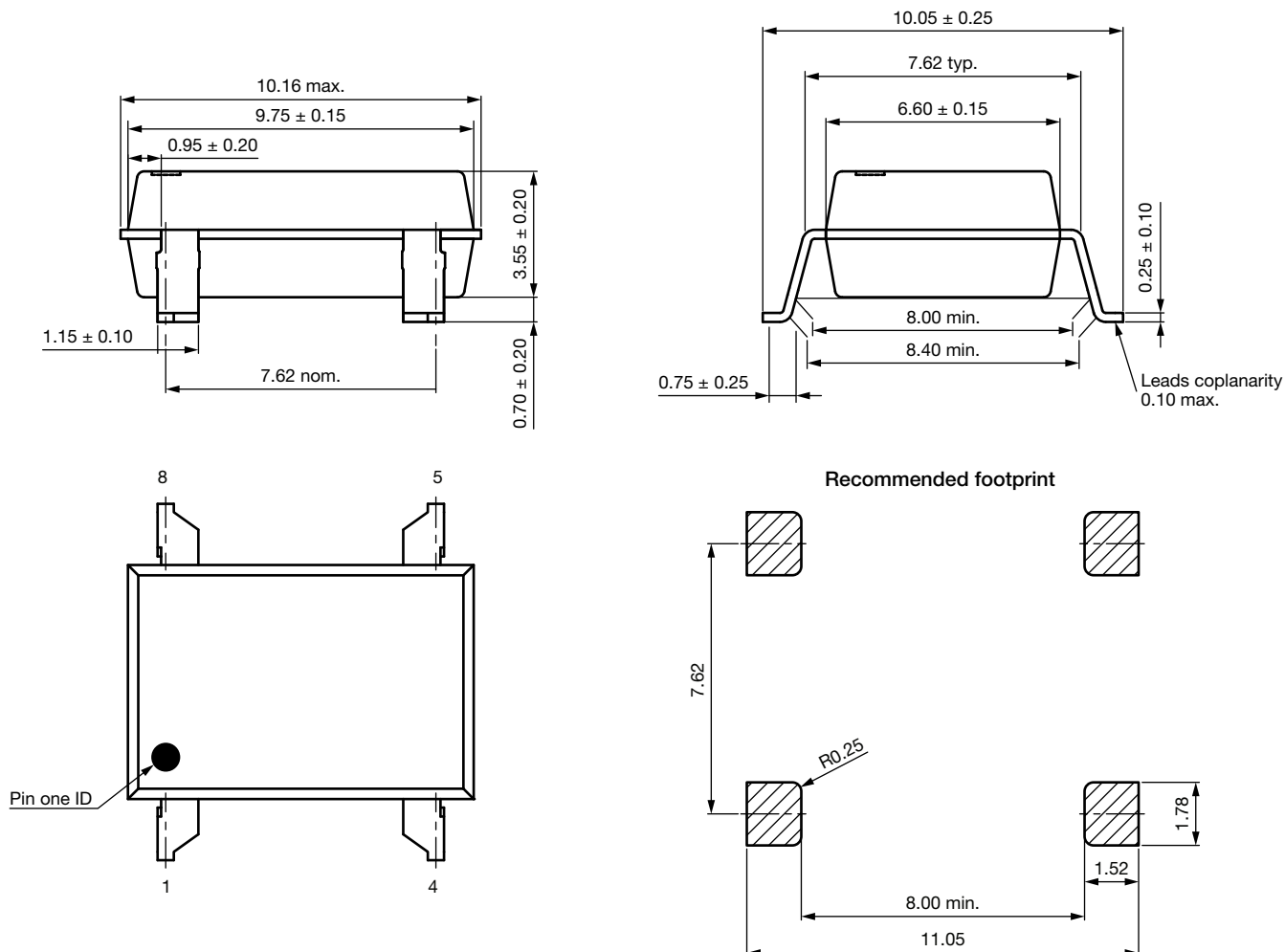


Fig. 16 - Package Drawings

PACKAGE MARKING

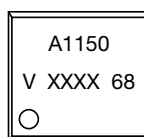
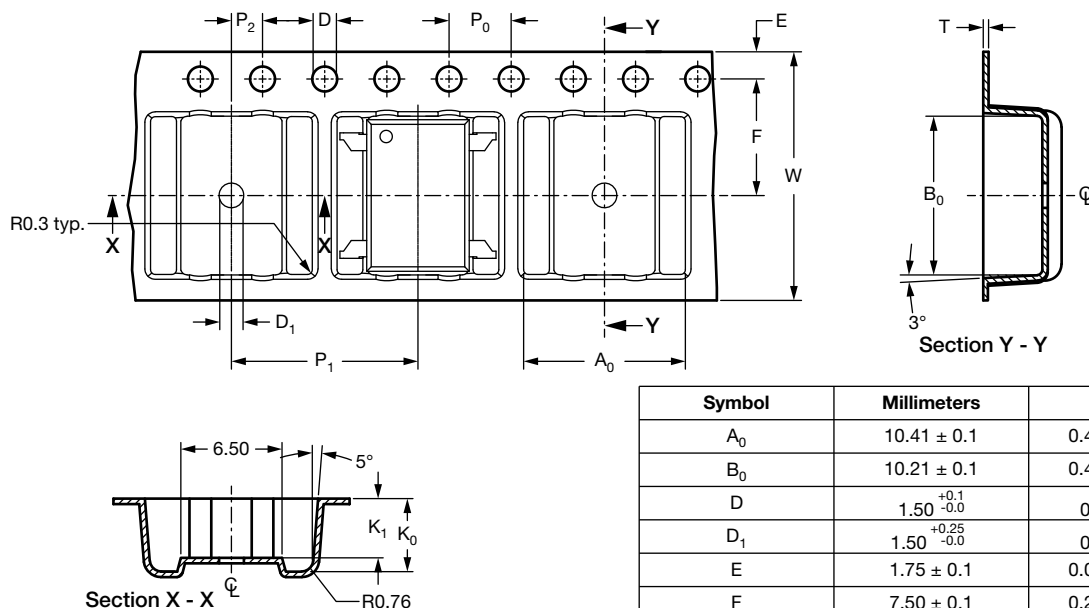


Fig. 17 - VORA1150

PACKING INFORMATION (in millimeters)



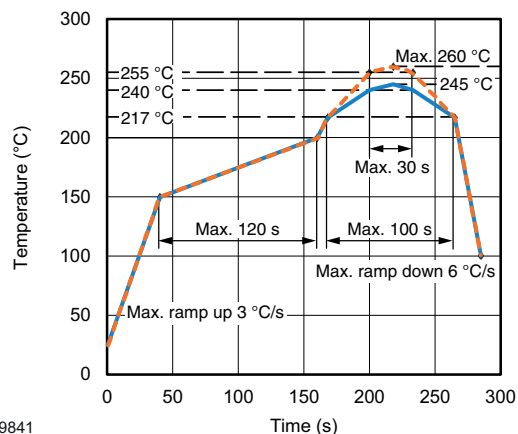
Symbol	Millimeters	Inches
A ₀	10.41 ± 0.1	0.410 ± 0.004
B ₀	10.21 ± 0.1	0.402 ± 0.004
D	1.50 ^{+0.1} _{-0.0}	0.059 ^{+0.004} _{-0.0}
D ₁	1.50 ^{+0.25} _{-0.0}	0.059 ^{+0.010} _{-0.0}
E	1.75 ± 0.1	0.069 ± 0.004
F	7.50 ± 0.1	0.295 ± 0.004
K ₀	4.70 ± 0.1	0.185 ± 0.004
K ₁	3.81 ± 0.1	0.150 ± 0.004
P ₁	12.00 ± 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 cumulative tolerances ± 0.2
- Camber not to exceed 1 mm in 100 mm
- Material: black conductive polystyrene
- K₀ measured from a plane on the inside bottom of the pocket to the top surface of the carrier
- Resistivity = 10⁴ Ω/sq. to 10⁹ Ω/sq.

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

SOLDER PROFILES



19841

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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