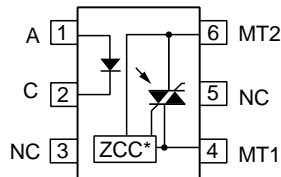


# Optocoupler, Phototriac Output, Zero Crossing



23128



\*Zero crossing circuit


**RoHS**  
COMPLIANT

## FEATURES

- High input sensitivity  $I_{FT} = 1 \text{ mA}$
- $I_{TRMS} = 300 \text{ mA}$
- High static  $dV/dt$   $10\,000 \text{ V}/\mu\text{s}$
- Electrically insulated between input and output circuit
- Microcomputer compatible
- Trigger current
  - ( $I_{FT} < 1.2 \text{ mA}$ ) BRT22F, BRT23F
  - ( $I_{FT} < 2 \text{ mA}$ ) BRT21H, BRT22H, BRT23H
  - ( $I_{FT} < 3 \text{ mA}$ ) BRT21M, BRT22M, BRT23M
- Available surface mount an<sup>d</sup> on tape and reel
- Zero voltage crossing detector
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

## APPLICATIONS

- Industrial controls
- Office equipment
- Consumer appliances

## AGENCY APPROVALS

- [UL 1577](#)
- [cUL 1577](#)
- [DIN EN 60747-5-5 \(VDE 0884-5\) available with option 1](#)

## DESIGN SUPPORT TOOLS

[click logo to get started](#)


## DESCRIPTION

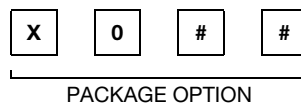
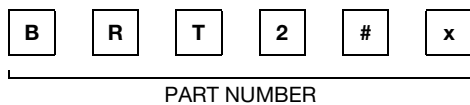
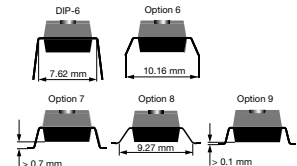
The BRT21, BRT22, BRT23 product family consists of AC switch optocouplers with zero voltage detectors with two electrically insulated lateral power ICs which integrate a thyristor system, a photo detector and noise suppression at the output and an IR GaAs diode input.

High input sensitivity is achieved by using an emitter follower phototransistor and a SCR predriver resulting in an LED trigger current of less than 2 mA or 3 mA (DC). Inverse parallel SCRs provide commutating  $dV/dt$  greater than  $10 \text{ kV}/\mu\text{s}$ .

The zero cross line voltage detection circuit consists of two MOSFETS and a photodiode.

The BRT21, BRT22, BRT23 product family isolates low-voltage logic from 120, 230, and 380 VAC lines to control resistive, inductive or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

## ORDERING INFORMATION


 TAPE  
AND  
REEL


AGENCY CERTIFIED/PACKAGE	$V_{DRM} \text{ (V)}$								
	$\leq 400$		$\leq 600$			$\leq 800$			
UL	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$	$I_{FT} = 1.2 \text{ mA}$	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$	$I_{FT} = 1.2 \text{ mA}$	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$	
DIP-6	BRT21H	BRT21M	BRT22F	BRT22H	BRT22M	BRT23F	BRT23H	BRT23M	
DIP-6, 400 mil, option 6	-	-	BRT22F-X006	-	-	BRT23F-X006	BRT23H-X006	-	
SMD-6, option 7	BRT21H-X007	-	BRT22F-X007T <sup>(1)</sup>	BRT22H-X007T <sup>(1)</sup>	-	BRT23F-X007T <sup>(1)</sup>	BRT23H-X007T <sup>(1)</sup>	BRT23M-X007T	
SMD-6, option 9	-	-	BRT22F-X009T <sup>(1)</sup>	-	-	BRT23F-X009T	-	-	



AGENCY CERTIFIED/PACKAGE	$V_{DRM}$ (V)							
	$\leq 400$		$\leq 600$			$\leq 800$		
UL, VDE	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$	$I_{FT} = 1.2 \text{ mA}$	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$	$I_{FT} = 1.2 \text{ mA}$	$I_{FT} = 2 \text{ mA}$	$I_{FT} = 3 \text{ mA}$
DIP-6	-	-	BRT22F-X001	BRT22H-X001	-	-	BRT23H-X001	-
DIP-6, option 6	BRT21H-X016	BRT21M-X016	BRT22F-X016	BRT22H-X016	BRT22M-X016	-	BRT22H-X016	BRT23M-X016
SMD-6, option 7	-	-	BRT22F-X017T	BRT22H-X017 <sup>(1)</sup>	-	-	-	-
SMD-6, option 8	-	-	-	-	-	-	BRT23H-X018T	-

**Note**

<sup>(1)</sup> Also available in tube, do not put T on the end

<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_{amb} = 25 \text{ }^\circ\text{C}$ , unless otherwise specified)						
PARAMETER	TEST CONDITION	PART	SYMBOL	VALUE	UNIT	
<b>INPUT</b>						
Reverse voltage	$I_R = 10 \text{ } \mu\text{A}$		$V_R$	6	V	
Forward current			$I_F$	60	mA	
Surge current			$I_{FSM}$	2.5	A	
Power dissipation			$P_{diss}$	100	mW	
Derate from 25 °C				1.33	mW/°C	
<b>OUTPUT</b>						
Peak off-state voltage		BRT21	$V_{DRM}$	400	V	
		BRT22	$V_{DRM}$	600	V	
		BRT23	$V_{DRM}$	800	V	
On state RMS current			$I_{TRM}$	300	mA	
Single cycle surge current				3	A	
Power dissipation			$P_{diss}$	600	mW	
Derate from 25 °C				6.6	mW/°C	
<b>COUPLER</b>						
Storage temperature range			$T_{stg}$	-40 to +150	°C	
Ambient temperature range			$T_{amb}$	-40 to +100	°C	
Soldering temperature	Max. $\leq 10 \text{ s}$ dip soldering $\geq 0.5 \text{ mm}$ from case bottom		$T_{sld}$	260	°C	

**Note**

- 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



<b>ELECTRICAL CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)							
PARAMETER	TEST CONDITION	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>INPUT</b>							
Forward voltage	$I_F = 10\text{ mA}$		$V_F$	-	1.16	1.35	V
Reverse current	$V_R = 6\text{ V}$		$I_R$	-	0.1	10	$\mu\text{A}$
Capacitance	$f = 1\text{ MHz}, V_F = 0\text{ V}$		$C_O$	-	25	-	pF
Thermal resistance, junction to ambient			$R_{thJA}$	-	750	-	K/W
<b>OUTPUT</b>							
Peak off-state voltage	$I_{D(RMS)} = 100\text{ }\mu\text{A}$	BRT21	$V_{DM}$	-	400	-	V
		BRT22		-	600	-	
		BRT23		-	800	-	
Off-state current	$V_D = V_{DRM}, T_{amb} = 100\text{ }^{\circ}\text{C}, I_F = 0\text{ mA}$		$I_{D(RMS)}$	-	10	100	$\mu\text{A}$
On-state voltage	$I_T = 300\text{ mA}$		$V_{TM}$	-	1.7	3	V
On-state current	$PF = 1, V_{T(RMS)} = 1.7\text{ V}$		$I_{TM}$	-	-	300	mA
Surge (non-repetitive), on-state current	$f = 50\text{ Hz}$		$I_{TSM}$	-	-	3	A
Trigger current temp. gradient			$\Delta I_{FT1}/\Delta T_j$	-	7	14	$\mu\text{A/K}$
			$\Delta I_{FT2}/\Delta T_j$	-	7	14	$\mu\text{A/K}$
Inhibit voltage temp. gradient			$\Delta V_{DINH}/\Delta T_j$	-	-20	-	mV/K
Off-state current in inhibit state	$I_F = I_{FT1}, V_{DRM}$		$I_{DINH}$	-	50	200	$\mu\text{A}$
Holding current			$I_H$	-	65	500	$\mu\text{A}$
Latching current	$V_T = 2.2\text{ V}$		$I_L$	-	5	-	mA
Zero cross inhibit voltage	$I_F = \text{rated } I_{FT}$		$V_{IH}$	-	15	25	V
<b>OUTPUT (continued)</b>							
Turn-on time	$V_{RM} = V_{DM} = V_{D(RMS)}$		$t_{on}$	-	35	-	$\mu\text{s}$
Turn-off time	$PF = 1, I_T = 300\text{ mA}$		$t_{off}$	-	50	-	$\mu\text{s}$
Critical rate of rise of off-state voltage	$V_D = 0.67 V_{DRM}, T_j = 25\text{ }^{\circ}\text{C}$		$dV/dt_{cr}$	10 000	-	-	V/ $\mu\text{s}$
	$V_D = 0.67 V_{DRM}, T_j = 80\text{ }^{\circ}\text{C}$		$dV/dt_{cr}$	5000	-	-	V/ $\mu\text{s}$
Critical rate of rise of voltage at current commutation	$V_D = 230 V_{RMS}, I_D = 300\text{ mA}_{RMS}, T_j = 25\text{ }^{\circ}\text{C}$		$dV/dt_{crq}$	-	8	-	V/ $\mu\text{s}$
	$V_D = 230 V_{RMS}, I_D = 300\text{ mA}_{RMS}, T_j = 85\text{ }^{\circ}\text{C}$		$dV/dt_{crq}$	-	7	-	V/ $\mu\text{s}$
Critical rate of rise of on-state at current commutation	$V_D = 230 V_{RMS}, I_D = 300\text{ mA}_{RMS}, T_j = 25\text{ }^{\circ}\text{C}$		$dI/dt_{crq}$	-	12	-	A/ms
Thermal resistance, junction-to-ambient			$R_{thJA}$	-	125	-	K/W
<b>COUPLER</b>							
Critical rate of rise of coupled input / output voltage	$I_T = 0\text{ A}, V_{RM} = V_{DM} = V_{D(RMS)}$		$dV_{IO}/dt$	-	10 000	-	V/ $\mu\text{s}$
Common mode coupling capacitance			$C_{CM}$	-	0.01	-	pF
Capacitance (input to output)	$f = 1\text{ MHz}, V_{IO} = 0\text{ V}$		$C_{IO}$	-	0.8	-	pF
Trigger current	$V_D = 5\text{ V}, F\text{-versions}$		$I_{FT}$	-	-	1.2	mA
	$V_D = 5\text{ V}, H\text{-versions}$		$I_{FT}$	-	-	2	mA
	$V_D = 5\text{ V}, M\text{-versions}$		$I_{FT}$	-	-	3	mA

**Note**

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

SAFETY AND INSULATION RATINGS				
PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
Climatic classification	According to IEC 68 part 1		40 / 100 / 21	
Pollution degree	According to DIN VDE 0109		2	
Comparative tracking index	Insulation group IIIa	CTI	175	
Maximum rated withstanding isolation voltage	According to UL1577, t = 1 min	V <sub>ISO</sub>	4420	V <sub>RMS</sub>
Tested withstanding isolation voltage	According to UL1577, t = 1 s	V <sub>ISO</sub>	5300	V <sub>RMS</sub>
Maximum transient isolation voltage	According to DIN EN 60747-5-5	V <sub>IOTM</sub>	6000	V <sub>peak</sub>
Maximum repetitive peak isolation voltage	According to DIN EN 60747-5-5	V <sub>IORM</sub>	630	V <sub>peak</sub>
Isolation resistance	V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 25 °C	R <sub>IO</sub>	≥ 10 <sup>12</sup>	Ω
	V <sub>IO</sub> = 500 V, T <sub>amb</sub> = 100 °C	R <sub>IO</sub>	≥ 10 <sup>11</sup>	Ω
Output safety power		P <sub>SO</sub>	200	mW
Input safety current		I <sub>SI</sub>	400	mA
Input safety temperature		T <sub>S</sub>	175	°C
Creepage distance	DIP-6; SMD-6, option 7; SMD-6 option 9		≥ 7	mm
Clearance distance			≥ 7	mm
Creepage distance	DIP-6, option 6; SMD-6, option 8		≥ 8	mm
Clearance distance			≥ 8	mm
Insulation thickness		DTI	≥ 0.4	mm

**Note**

- As per IEC 60747-5-5, § 7.4.3.8.2, 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

**POWER FACTOR CONSIDERATIONS**

A snubber is not needed to eliminate false operation of the TRIAC driver because of the high static and commutating dV/dt with loads between 1.0 and 0.8 power factors. When inductive loads with power factors less than 0.8 are being driven, include a RC snubber or a single capacitor directly across the device to damp the peak commutating dV/dt spike. Normally a commutating dV/dt causes a turning-off device to stay on due to the stored energy remaining in the turning-off device.

But in the case of a zero voltage crossing optotriac, the commutating dV/dt spikes can inhibit one half of the TRIAC from turning on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, half of the TRIAC will be held off and not turn-on. This hold-off condition can be eliminated by using a snubber or capacitor placed directly across the optotriac as shown in figure 1. Note that the value of the capacitor increases as a function of the load current.

The hold-off condition also can be eliminated by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causes the phototransistor to turn-on before the commutating spike has activated the zero cross network. Figure 2 shows the relationship of the LED drive for power factors of less than 1.0. The curve shows that if a device requires 1.5 mA for a resistive load, then 1.8 times 2.7 mA that amount would be required to control an inductive load whose power factor is less than 0.3.

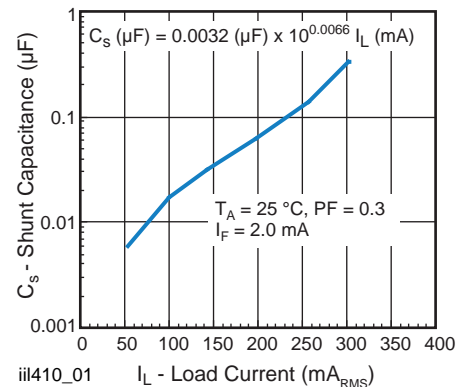


Fig. 1 - Shunt Capacitance vs. Load Current



TYPICAL CHARACTERISTICS (T<sub>amb</sub> = 25 °C, unless otherwise specified)

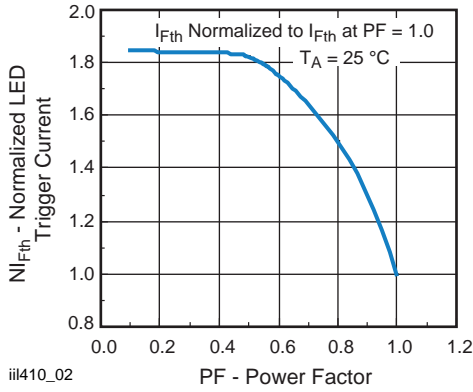


Fig. 2 - Normalized LED Trigger Current vs. Power Factor

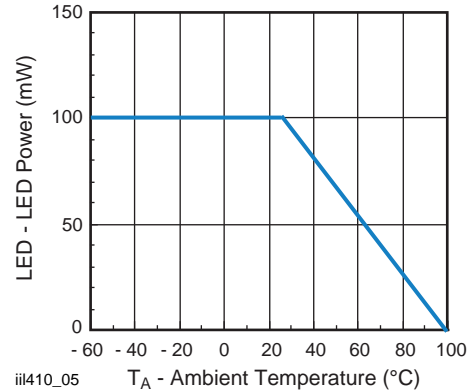


Fig. 5 - Maximum LED Power Dissipation

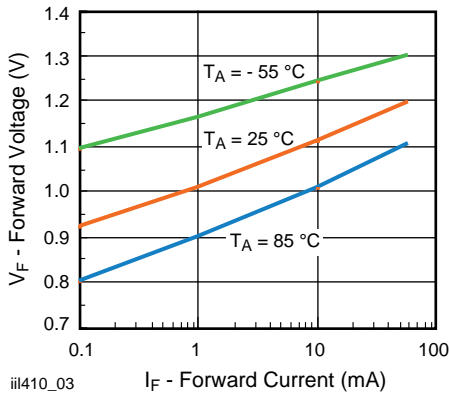


Fig. 3 - Forward Voltage vs. Forward Current

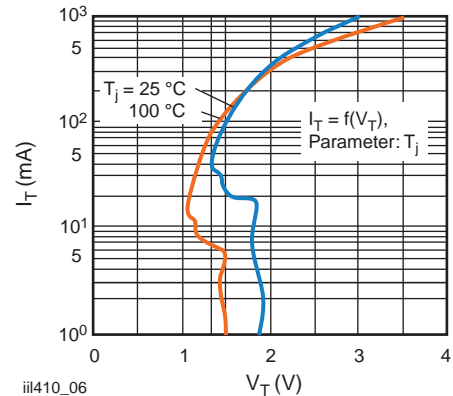


Fig. 6 - Typical Output Characteristics

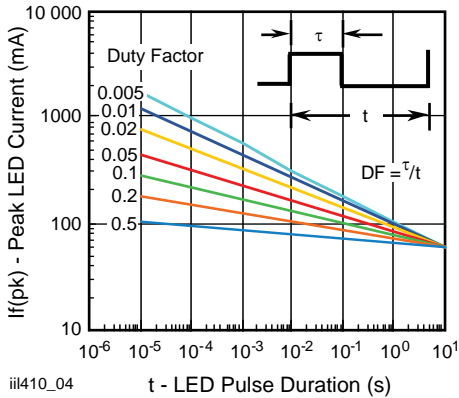


Fig. 4 - Peak LED Current vs. Duty Factor, τ

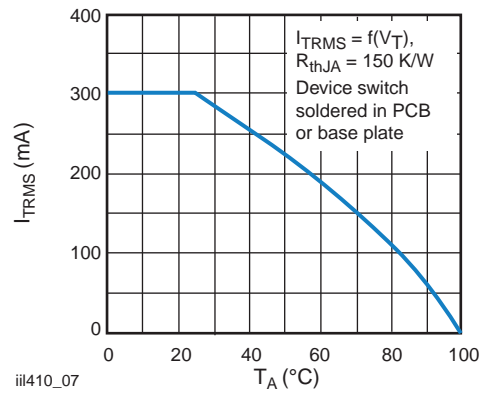


Fig. 7 - Current Reduction

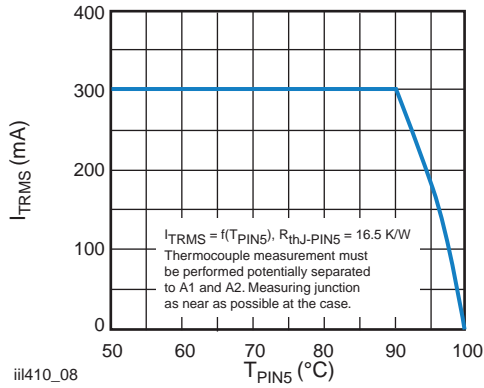


Fig. 8 - Current Reduction

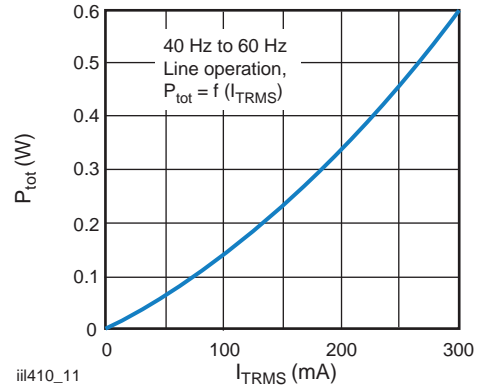


Fig. 11 - Power Dissipation 40 Hz to 60 Hz Line Operation

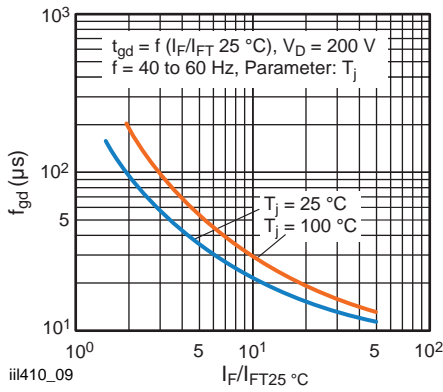


Fig. 9 - Typical Trigger Delay Time

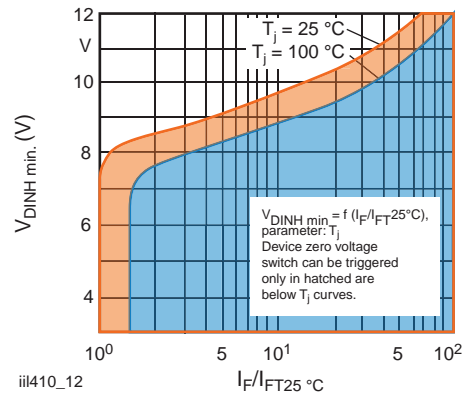


Fig. 12 - Typical Static Inhibit Voltage Limit

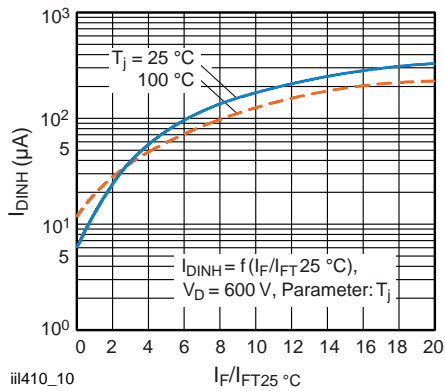


Fig. 10 - Typical Inhibit Current

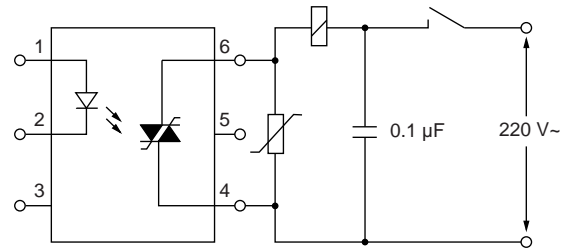
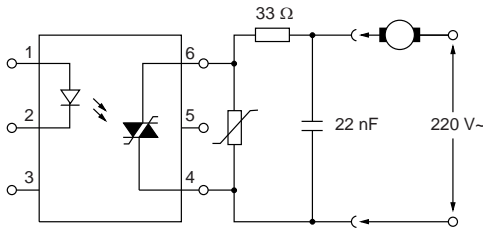
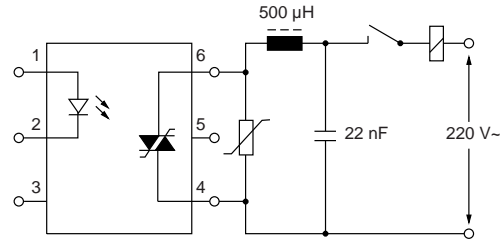


Fig. 13 - Apply a Capacitor to the Supply Pins at the Load-Side



iii410\_14

Fig. 14 - Connect a Series Resistor to the Output and Bridge Both by a Capacitor



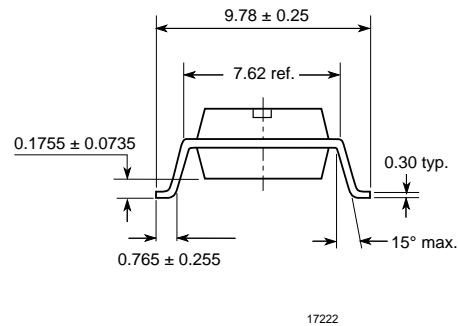
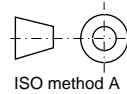
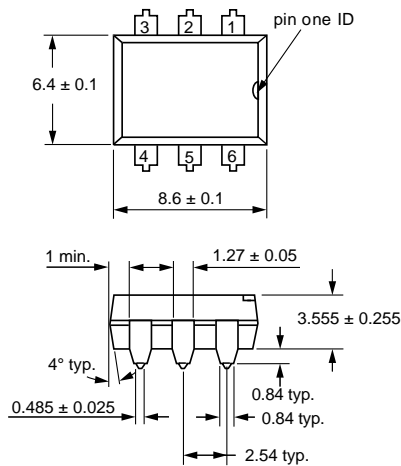
iii410\_15

Fig. 15 - Connect a Choke of Low Winding Cap. in Series, e.g., a Ringcore Choke, with Higher Load Currents

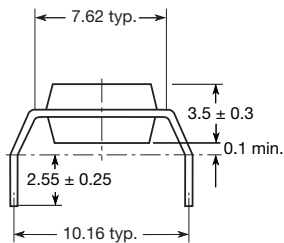
## TECHNICAL INFORMATION

See Application Note for additional information.

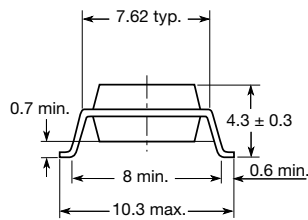
## PACKAGE DIMENSIONS in millimeters



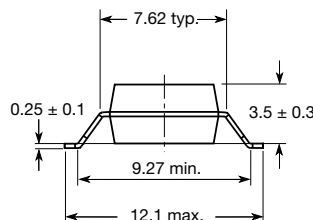
Option 6



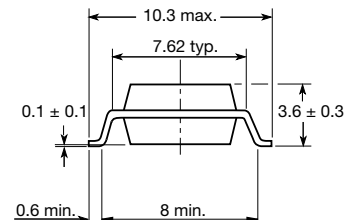
Option 7



Option 8



Option 9



20802-40

## PACKAGE MARKING (example)

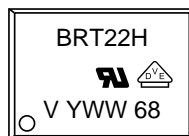
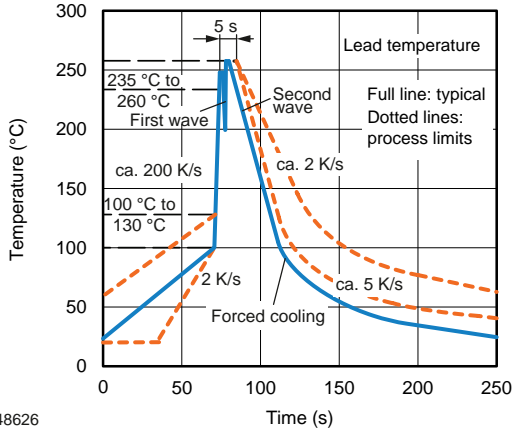


Fig. 16 - Example of BRT22H-X017

## Notes

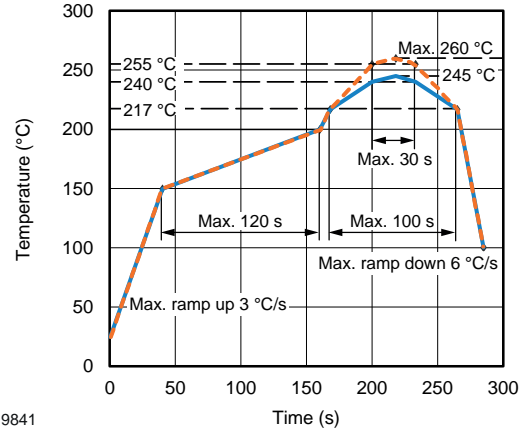
- "YWW" is the date code marking (Y = year code, WW = week code)
- VDE logo is only marked on option 1 parts
- Tape and reel suffix (T) is not part of the package marking

**SOLDER PROFILES**



948626

Fig. 17 - Wave Soldering Double Wave Profile According to J-STD-020 for DIP Devices



19841

Fig. 18 - 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: unlimited

Conditions:  $T_{amb} < 30\text{ }^{\circ}\text{C}$ , RH < 85 %

Moisture sensitivity level 1, according to J-STD-020





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