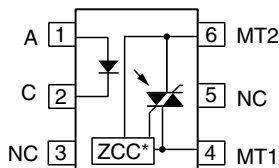
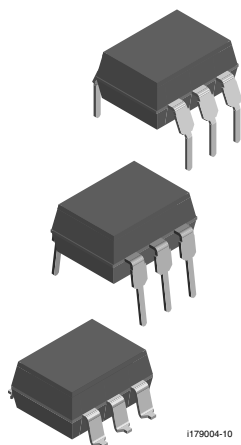


## Optocoupler, Phototriac Output, Zero Crossing



\*Zero crossing circuit



i179030\_3

i179004-10

### 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 kV/μs.

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.

### FEATURES

- High input sensitivity  $I_{FT} = 1 \text{ mA}$
- $I_{TRMS} = 300 \text{ mA}$
- High static dV/dt 10 000 V/μs
- 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 and on on tape and reel
- Zero voltage crossing detector
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC



RoHS  
COMPLIANT

### APPLICATIONS

- Industrial controls
- Office equipment
- Consumer appliances

### AGENCY APPROVALS

- UL file no. E52744 system code H
- DIN EN 60747-5-2 (VDE 0844)/DIN EN 60747-5-5 (pending) available with option 1
- CQC

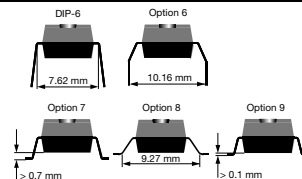
### ORDERING INFORMATION

**B** **R** **T** **2** **#** **x** **-** **X** **0** **#** **#** **T**

PART NUMBER

PACKAGE OPTION

TAPE  
AND  
REEL



| AGENCY<br>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<br>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             | -                       | -                         | -                       | -                       |
| SMD-6, option 8             | -                       | -                       | -                         | -                       | -                       | -                         | BRT23H-X018T            | -                       |

**Note**

(1) 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 $^{\circ}\text{C}$                                                                       |                                                                                  |       |            | 1.33           | mW/ $^{\circ}\text{C}$ |  |
| <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 $^{\circ}\text{C}$                                                                       |                                                                                  |       |            | 6.6            | mW/ $^{\circ}\text{C}$ |  |
| <b>COUPLER</b>                                                                                          |                                                                                  |       |            |                |                        |  |
| Isolation test voltage<br>(between emitter and detector, climate per DIN 500414, part 2, Nov. 74)       | $t = 1 \text{ s}$                                                                |       | $V_{ISO}$  | 5300           | $V_{RMS}$              |  |
| Pollution degree (DIN VDE 0109)                                                                         |                                                                                  |       |            | 2              |                        |  |
| Creepage distance                                                                                       |                                                                                  |       |            | $\geq 7$       | mm                     |  |
| Clearance distance                                                                                      |                                                                                  |       |            | $\geq 7$       | mm                     |  |
| Comparative tracking index per<br>DIN IEC 112/VDE 0303 part 1,<br>group IIIa per DIN VDE 6110           |                                                                                  |       | CTI        | $\geq 175$     |                        |  |
| Isolation resistance                                                                                    | $V_{IO} = 500 \text{ V}, T_{amb} = 25 \text{ }^{\circ}\text{C}$                  |       | $R_{IO}$   | $\geq 10^{12}$ | $\Omega$               |  |
|                                                                                                         | $V_{IO} = 500 \text{ V}, T_{amb} = 100 \text{ }^{\circ}\text{C}$                 |       | $R_{IO}$   | $\geq 10^{11}$ | $\Omega$               |  |
| Storage temperature range                                                                               |                                                                                  |       | $T_{stg}$  | - 40 to + 150  | $^{\circ}\text{C}$     |  |
| Ambient temperature range                                                                               |                                                                                  |       | $T_{amb}$  | - 40 to + 100  | $^{\circ}\text{C}$     |  |
| Soldering temperature (1)                                                                               | max. $\leq 10 \text{ s}$ dip soldering<br>$\geq 0.5 \text{ mm}$ from case bottom |       | $T_{slid}$ | 260            | $^{\circ}\text{C}$     |  |

**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.
- Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).



| <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<br>BRT22<br>BRT23 | $V_{DM}$                                                   |        | 400<br>600<br>800 |          | V                                  |
| Off-state current                                                                                        | $V_D = V_{DRM}$ , $T_{amb} = 100\text{ }^{\circ}\text{C}$ ,<br>$I_F = 0\text{ mA}$        |                         | $I_{D(RMS)}$                                               |        | 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                                                                           |                                                                                           |                         | $\Delta I_{FT1}/\Delta T_j$<br>$\Delta I_{FT2}/\Delta T_j$ |        | 7<br>7            | 14<br>14 | $\mu\text{A/K}$<br>$\mu\text{A/K}$ |
| 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                                  |
| 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                                                  | $V_D = 230 V_{RMS}$ ,<br>$I_D = 300\text{ mA}_{RMS}$ , $T_j = 25\text{ }^{\circ}\text{C}$ |                         | $dV/dt_{crq}$                                              |        | 8                 |          | V/ $\mu\text{s}$                   |
|                                                                                                          | $V_D = 230 V_{RMS}$ ,<br>$I_D = 300\text{ mA}_{RMS}$ , $T_j = 85\text{ }^{\circ}\text{C}$ |                         | $dV/dt_{crq}$                                              |        | 7                 |          | V/ $\mu\text{s}$                   |
| Critical rate of rise of on-state at current commutation                                                 | $V_D = 230 V_{RMS}$ ,<br>$I_D = 300\text{ mA}_{RMS}$ , $T_j = 25\text{ }^{\circ}\text{C}$ |                         | $dI/dt_{crq}$                                              |        | 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                                 |
| Isolation resistance                                                                                     | $V_{IO} = 500\text{ V}$ , $T_{amb} = 25\text{ }^{\circ}\text{C}$                          |                         | $R_{is}$                                                   |        | $\geq 10^{12}$    |          | $\Omega$                           |
|                                                                                                          | $V_{IO} = 500\text{ V}$ , $T_{amb} = 100\text{ }^{\circ}\text{C}$                         |                         | $R_{is}$                                                   |        | $\geq 10^{11}$    |          | $\Omega$                           |
| Trigger current                                                                                          | $V_D = 5\text{ V}$ , F - versions                                                         |                         | $I_{FT}$                                                   |        |                   | 1.2      | mA                                 |
|                                                                                                          | $V_D = 5\text{ V}$ , H - versions                                                         |                         | $I_{FT}$                                                   |        |                   | 2        | mA                                 |
|                                                                                                          | $V_D = 5\text{ V}$ , M - 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 | MIN. | TYP.      | MAX. | UNIT |
|---------------------------------------------------------|----------------|--------|------|-----------|------|------|
| Climatic classification<br>(according to IEC 68 part 1) |                |        |      | 40/100/21 |      |      |
| Comparative tracking index                              |                | CTI    | 175  |           | 399  |      |
| V <sub>IOTM</sub>                                       |                |        | 6000 |           |      | V    |
| V <sub>IORM</sub>                                       |                |        | 630  |           |      | V    |
| P <sub>SO</sub>                                         |                |        |      |           | 200  | mW   |
| I <sub>SI</sub>                                         |                |        |      |           | 400  | mA   |
| T <sub>SI</sub>                                         |                |        |      |           | 175  | °C   |
| Creepage distance                                       | standard DIP-6 |        | 7    |           |      | mm   |
| Clearance distance                                      | standard DIP-6 |        | 7    |           |      | mm   |
| Creepage distance                                       | 400 mil DIP-6  |        | 8    |           |      | mm   |
| Clearance distance                                      | 400 mil DIP-6  |        | 8    |           |      | mm   |

**Note**

- As per IEC 60747-5-2, § 7.4.3.8.1, 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.

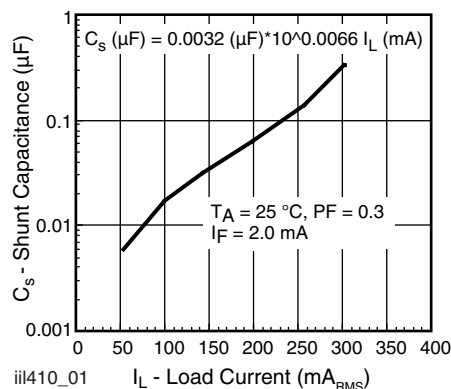


Fig. 1 - Shunt Capacitance vs. Load Current



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

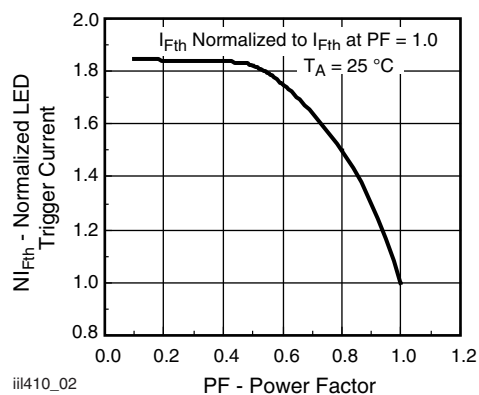


Fig. 2 - Normalized LED Trigger Current vs. Power Factor

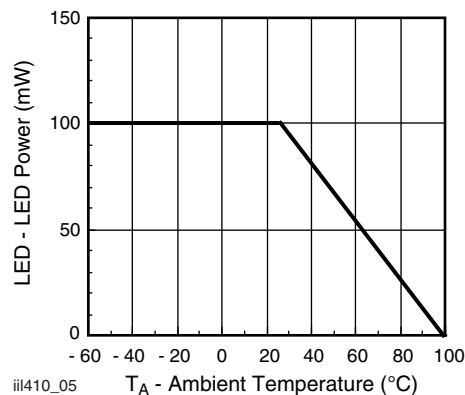


Fig. 5 - Maximum LED Power Dissipation

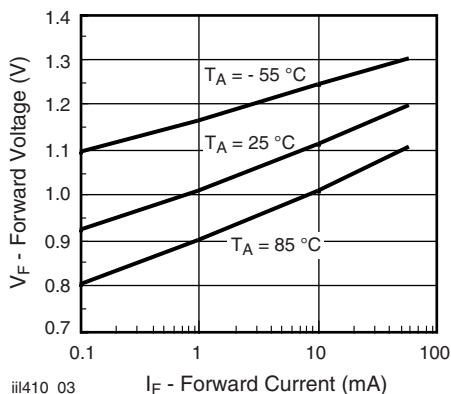


Fig. 3 - Forward Voltage vs. Forward Current

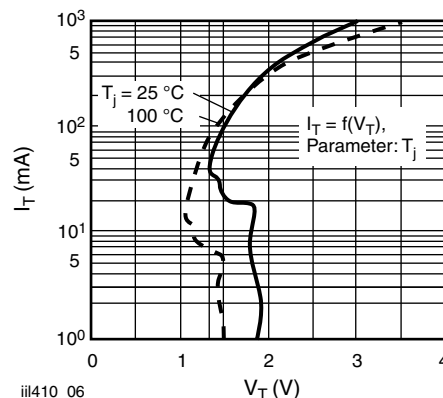


Fig. 6 - Typical Output Characteristics

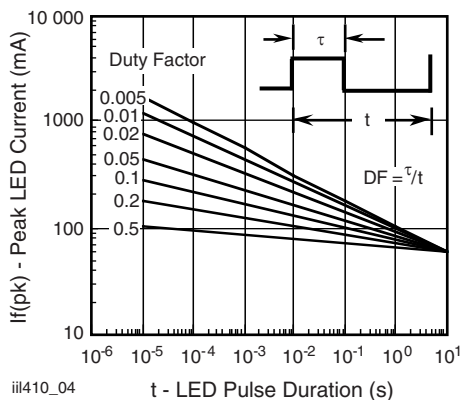


Fig. 4 - Peak LED Current vs. Duty Factor,  $\tau$

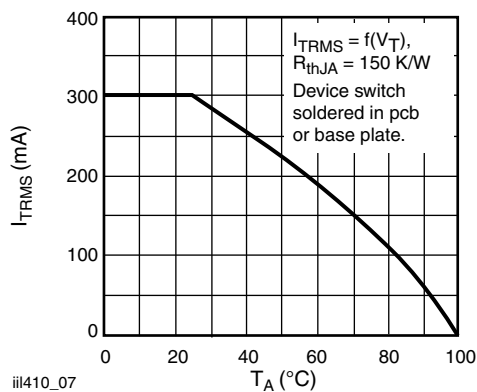


Fig. 7 - Current Reduction

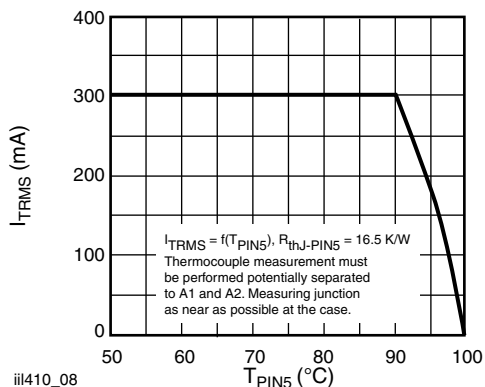


Fig. 8 - Current Reduction

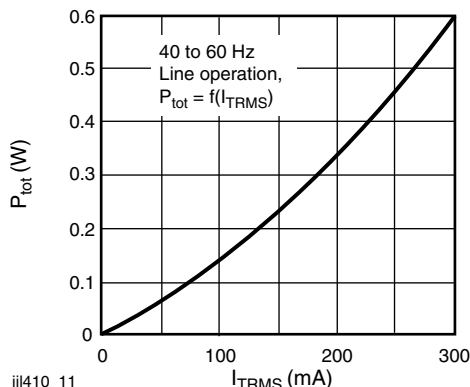


Fig. 11 - Power Dissipation 40 Hz to 60 Hz Line Operation

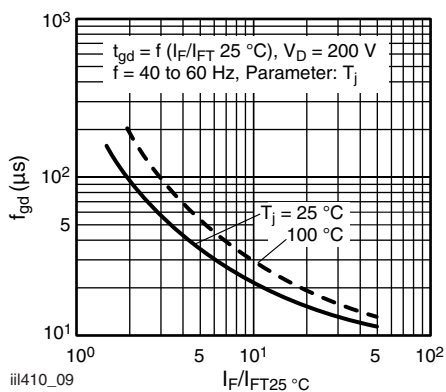


Fig. 9 - Typical Trigger Delay Time

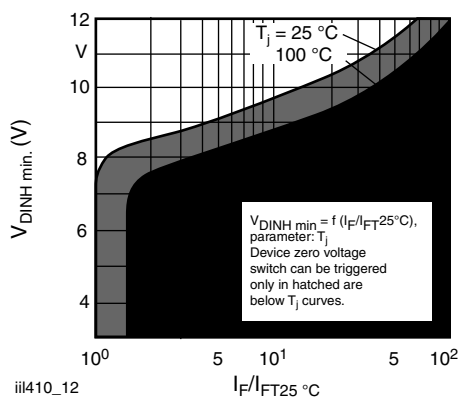


Fig. 12 - Typical Static Inhibit Voltage Limit

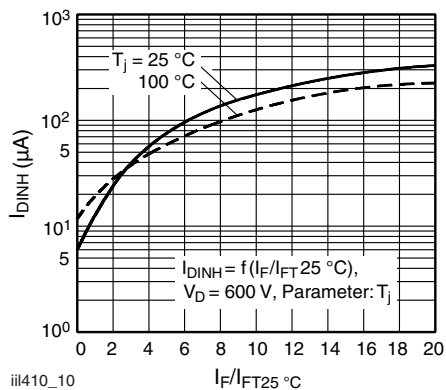


Fig. 10 - Typical Inhibit Current

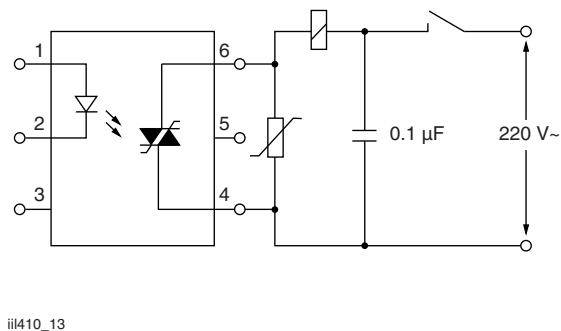
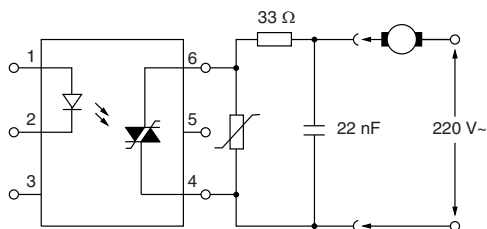
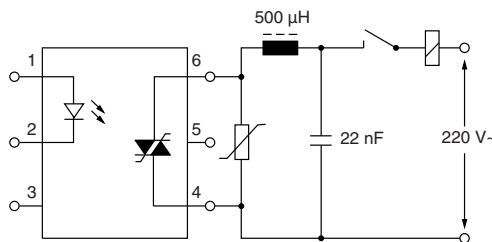


Fig. 13 - Apply a Capacitor to the Supply Pins at the Load-Side



iii410\_14

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



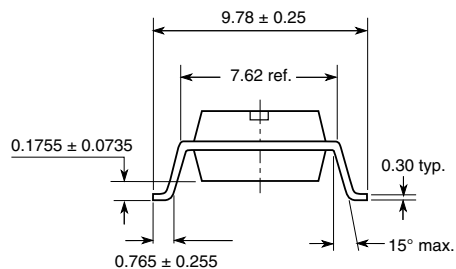
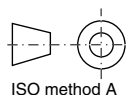
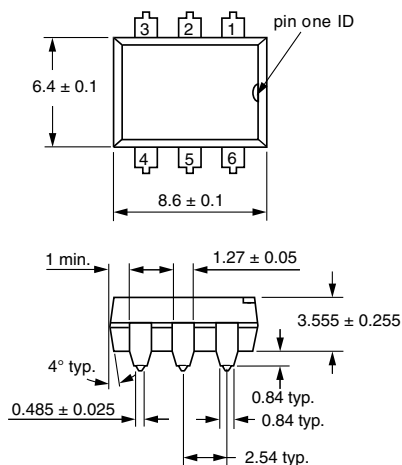
iii410\_15

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

## TECHNICAL INFORMATION

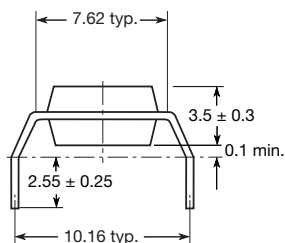
See Application Note for additional information.

## PACKAGE DIMENSIONS in millimeters

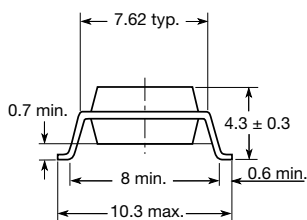


17222

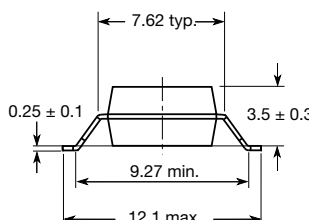
Option 6



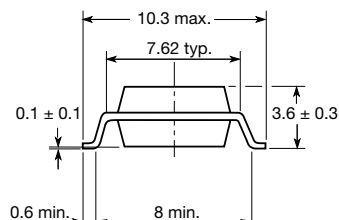
Option 7



Option 8



Option 9



20802-40

## PACKAGE MARKING (example)



### Note

- Basic product marking only, refer to option information document number 83713 for option marking



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