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October 2016

# FOD410, FOD4108, FOD4116, FOD4118 6-Pin DIP High dv/dt Zero-Cross Triac Drivers

## Features

- 300 mA On-State Current
- Zero-Voltage Crossing
- High Blocking Voltage
  - 600 V (FOD410, FOD4116)
  - 800 V (FOD4108, FOD4118)
- High Trigger Sensitivity
  - 1.3 mA (FOD4116, FOD4118)
  - 2 mA (FOD410, FOD4108)
- High Static dv/dt (10,000 V/ $\mu$ s)
- Safety and Regulatory Approvals:
  - UL1577, 5,000 VAC<sub>RMS</sub> for 1 Minute
  - DIN-EN/IEC60747-5-5

## Applications

- Solid-State Relays
- Industrial Controls
- Lighting Controls
- Static Power Switches
- AC Motor Starters

## Description

The FOD410, FOD4108, FOD4116 and FOD4118 devices consist of an infrared emitting diode coupled to a hybrid triac formed with two inverse parallel SCRs which form the triac function capable of driving discrete triacs. The FOD4116 and FOD4118 utilize a high efficiency infrared emitting diode which offers an improved trigger sensitivity. These devices are housed in a standard 6-pin dual in-line (DIP) package.

## Functional Schematic

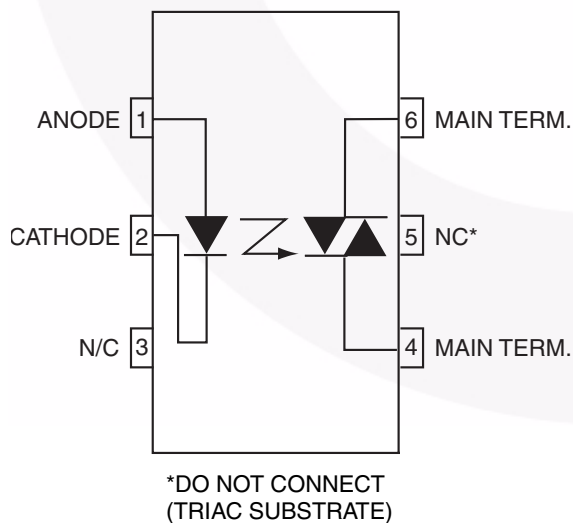


Figure 1. Schematic

## Package Outlines

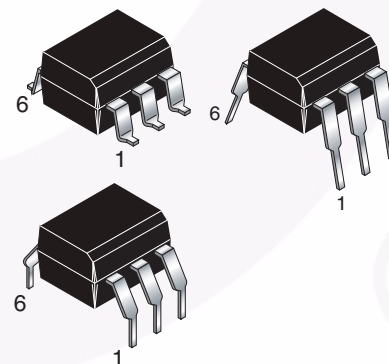


Figure 2. Package Outlines

## Safety and Insulation Ratings

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

| Parameter   |                        | Characteristics |
|---|------------------------|-----------------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 V <sub>RMS</sub> | I-IV            |
|   | < 300 V <sub>RMS</sub> | I-IV            |
| Climatic Classification   |                        | 55/100/21       |
| Pollution Degree (DIN VDE 0110/1.89)  |                        | 2               |
| Comparative Tracking Index  |                        | 175             |

| Symbol                | Parameter  | Value             | Unit              |
|-----------------------|--|-------------------|-------------------|
| V <sub>PR</sub>       | Input-to-Output Test Voltage, Method A, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC  | 1360              | V <sub>peak</sub> |
|                       | Input-to-Output Test Voltage, Method B, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC | 1594              | V <sub>peak</sub> |
| V <sub>IORM</sub>     | Maximum Working Insulation Voltage   | 850               | V <sub>peak</sub> |
| V <sub>IOTM</sub>     | Highest Allowable Over-Voltage   | 6000              | V <sub>peak</sub> |
|                       | External Creepage  | ≥ 7               | mm                |
|                       | External Clearance   | ≥ 7               | mm                |
| DTI                   | Distance Through Insulation (Insulation Thickness)   | ≥ 0.4             | mm                |
| T <sub>S</sub>        | Case Temperature <sup>(1)</sup>  | 175               | °C                |
| I <sub>S,INPUT</sub>  | Input Current <sup>(1)</sup>   | 400               | mA                |
| P <sub>S,OUTPUT</sub> | Output Power <sup>(1)</sup>  | 700               | mW                |
| R <sub>IO</sub>       | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V <sup>(1)</sup>   | > 10 <sup>9</sup> | Ω                 |

**Note:**

1. Safety limit values – maximum values allowed in the event of a failure.

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.  $T_A = 25^\circ\text{C}$  unless otherwise specified.

| Symbol            | Parameter  | Device           | Value          | Unit                       |
|-------------------|--|------------------|----------------|----------------------------|
| $T_{STG}$         | Storage Temperature  | All              | -55 to +150    | $^\circ\text{C}$           |
| $T_{OPR}$         | Operating Temperature  | All              | -55 to +100    | $^\circ\text{C}$           |
| $T_J$             | Junction Temperature   | All              | -55 to +125    | $^\circ\text{C}$           |
| $T_{SOL}$         | Lead Solder Temperature  | All              | 260 for 10 sec | $^\circ\text{C}$           |
| $P_{D(TOTAL)}$    | Total Device Power Dissipation @ $25^\circ\text{C}$              | All              | 500            | mW                         |
|                   | Derate Above $25^\circ\text{C}$                                  | All              | 6.6            | $\text{mW}/^\circ\text{C}$ |
| <b>EMITTER</b>    |  |                  |                |                            |
| $I_F$             | Continuous Forward Current                                       | All              | 30             | mA                         |
| $V_R$             | Reverse Voltage  | All              | 6              | V                          |
| $P_{D(EMITTER)}$  | Total Power Dissipation $25^\circ\text{C}$ Ambient               | All              | 50             | mW                         |
|                   | Derate Above $25^\circ\text{C}$                                  | All              | 0.71           | $\text{mW}/^\circ\text{C}$ |
| <b>DETECTOR</b>   |  |                  |                |                            |
| $V_{DRM}$         | Off-State Output Terminal Voltage                                | FOD410, FOD4116  | 600            | V                          |
|                   |  | FOD4108, FOD4118 | 800            |                            |
| $I_{TSM}$         | Peak Non-Repetitive Surge Current (single cycle 60 Hz sine wave) | All              | 3              | A                          |
| $I_{TM}$          | Peak On-State Current  | All              | 300            | mA                         |
| $P_{D(DETECTOR)}$ | Total Power Dissipation @ $25^\circ\text{C}$ Ambient             | All              | 450            | mW                         |
|                   | Derate Above $25^\circ\text{C}$                                  | All              | 5.9            | $\text{mW}/^\circ\text{C}$ |

## Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified.

### Individual Component Characteristics

| Symbol          | Parameter                                  | Test Conditions                               | Device               | Min.                | Typ.   | Max. | Unit             |
|-----------------|--|---|----------------------|---------------------|--------|------|------------------|
| <b>EMITTER</b>  |  |   |                      |                     |        |      |                  |
| $V_F$           | Input Forward Voltage                      | $I_F = 20\text{ mA}$                          | All                  |                     | 1.25   | 1.50 | V                |
| $I_R$           | Reverse Leakage Current                    | $V_R = 6\text{ V}$                            | All                  |                     | 0.0001 | 10   | $\mu\text{A}$    |
| <b>DETECTOR</b> |  |   |                      |                     |        |      |                  |
| $I_{D(RMS)}$    | Peak Blocking Current Either Direction     | $I_F = 0,$<br>$T_A = 100^\circ\text{C}^{(2)}$ | $V_D = 600\text{ V}$ | FOD410,<br>FOD4116  | 3      | 100  | $\mu\text{A}$    |
|                 |  |   | $V_D = 800\text{ V}$ | FOD4108,<br>FOD4118 |        |      |                  |
| $I_{R(RMS)}$    | Reverse Current                            | $T_A = 100^\circ\text{C}$                     | $V_D = 600\text{ V}$ | FOD410,<br>FOD4116  | 3      | 100  | $\mu\text{A}$    |
|                 |  |   | $V_D = 800\text{ V}$ | FOD4108,<br>FOD4118 |        |      |                  |
| dv/dt           | Critical Rate of Rise of Off-State Voltage | $I_F = 0\text{ A}^{(3)}$<br>(Figure 16)       | $V_D = V_{DRM}$      | All                 | 10,000 |      | V/ $\mu\text{s}$ |

**Notes:**

2. Test voltage must be applied within dv/dt rating.
3. This is static dv/dt. See Figure 16 for test circuit. Commutating dv/dt is a function of the load-driving thyristor(s) only.

## Electrical Characteristics (Continued)

$T_A = 25^\circ\text{C}$  unless otherwise specified.

### Transfer Characteristics

| Symbol       | Parameter   | Test Conditions  | Device                             | Min.                     | Typ. | Max. | Unit             |
|--------------|---|--|------------------------------------|--------------------------|------|------|------------------|
| $I_{FT}$     | LED Trigger Current                                     | Main Terminal Voltage = 5 V <sup>(4)</sup>                   | FOD410, FOD4108                    |                          | 0.65 | 2.0  | mA               |
|              |   |  | FOD4116, FOD4118                   |                          | 0.65 | 1.3  |                  |
| $V_{TM}$     | Peak On-State Voltage, Either Direction                 | $I_{TM} = 300\text{ mA peak}$ , $I_F = \text{Rated } I_{FT}$ | All                                |                          | 2.2  | 3    | V                |
| $I_H$        | Holding Current, Either Direction                       | $V_T = 3\text{ V}$   | All                                |                          | 200  | 500  | $\mu\text{A}$    |
| $I_L$        | Latching Current  | $V_T = 2.2\text{ V}$   | All                                |                          | 5    |      | mA               |
| $t_{ON}$     | Turn-On Time  | PF = 1.0,<br>$I_T = 300\text{ mA}$                           | $V_{RM} = V_{DM} = 424\text{ VAC}$ | FOD410, FOD4116, FOD4118 | 60   |      | $\mu\text{s}$    |
|              |   |  | $V_{RM} = V_{DM} = 565\text{ VAC}$ | FOD4108                  |      |      |                  |
| $t_{OFF}$    | Turn-Off Time   |  | $V_{RM} = V_{DM} = 424\text{ VAC}$ | FOD410, FOD4116, FOD4118 | 52   |      | $\mu\text{s}$    |
|              |   |  | $V_{RM} = V_{DM} = 565\text{ VAC}$ | FOD4108                  |      |      |                  |
| $dv/dt_C$    | Critical Rate of Rise of Voltage at Current Commutation | $V_D = 230\text{ V}_{RMS}$ ,<br>$I_D = 300\text{ mA}_{PK}$   | All                                |                          | 10   |      | V/ $\mu\text{s}$ |
| $di/dt_C$    | Critical Rate of Rise of On-State Current Commutation   | $V_D = 230\text{ V}_{RMS}$ ,<br>$I_D = 300\text{ mA}_{PK}$   | All                                |                          | 9    |      | A/ms             |
| $dv(i_O)/dt$ | Critical Rate of Rise of Coupled Input/Output Voltage   | $I_T = 0\text{ A}$ , $V_{RM} = V_{DM} = 424\text{ VAC}$      | All                                | 10,000                   |      |      | V/ $\mu\text{s}$ |

#### Note:

4. All devices are guaranteed to trigger at an  $I_F$  value less than or equal to max  $I_{FT}$ . Therefore, recommended operating  $I_F$  lies between max  $I_{FT}$  (2 mA for FOD410 and FOD4108 and 1.3 mA for FOD4116 and FOD4118) and the absolute max  $I_F$  (30 mA).

### Zero Crossing Characteristics

| Symbol     | Parameter   | Test Conditions  | Device | Min. | Typ. | Max. | Unit          |
|------------|---|--|--------|------|------|------|---------------|
| $V_{INH}$  | Inhibit Voltage (MT1-MT2 Voltage above which device will not trigger) | $I_F = \text{Rated } I_{FT}$                               | All    |      | 8    | 25   | V             |
| $I_{DRM2}$ | Leakage in Inhibit State  | $I_F = \text{Rated } I_{FT}$ , Rated $V_{DRM}$ , Off-State | All    |      | 20   | 200  | $\mu\text{A}$ |

### Isolation Characteristics

| Symbol    | Parameter                      | Test Conditions                                  | Device | Min.  | Typ. | Max. | Unit               |
|-----------|--------------------------------|--|--------|-------|------|------|--------------------|
| $V_{ISO}$ | Steady State Isolation Voltage | $f = 60\text{ Hz}$ , $t = 1\text{ Minute}^{(5)}$ | All    | 5,000 |      |      | VAC <sub>RMS</sub> |

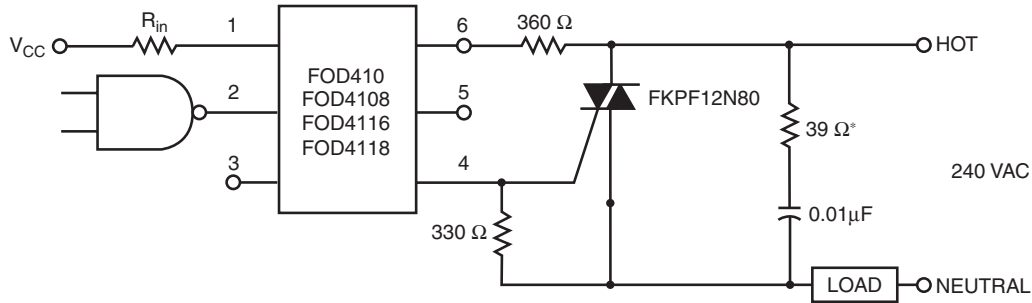
#### Note:

5. Isolation voltage,  $V_{ISO}$ , is an internal device dielectric breakdown rating. For this test, pins 1, 2 and 3 are common, and pins 4, 5 and 6 are common. 5,000 VAC<sub>RMS</sub> for 1 minute duration is equivalent to 6,000 VAC<sub>RMS</sub> for 1 second duration.

## Typical Application

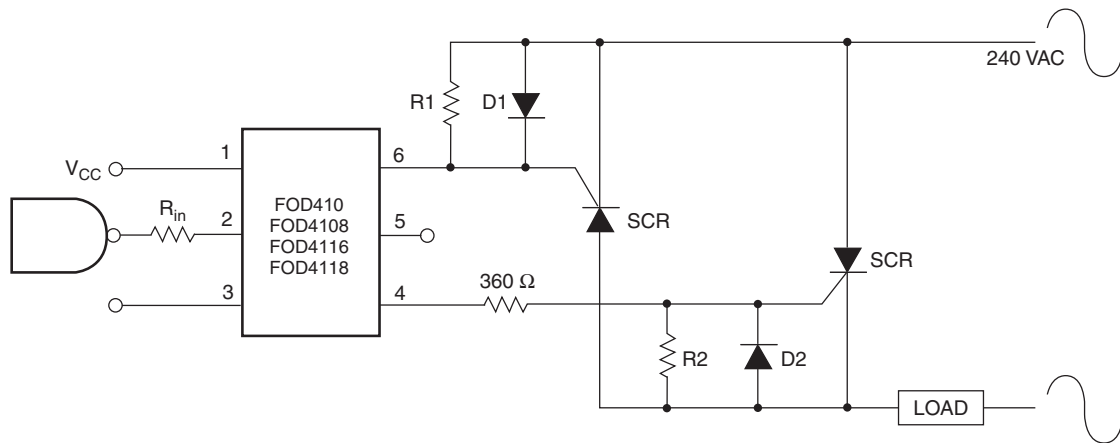
Figure 3 shows a typical circuit for when hot line switch-ing is required. In this circuit the “hot” side of the line is switched and the load connected to the cold or neutral side. The load may be connected to either the neutral or hot line.

$R_{in}$  is calculated so that IF is equal to the rated IFT of the part, 2 mA for FOD410 and FOD4108, 1.3 mA for FOD4116 and FOD4118. The 39  $\Omega$  resistor and 0.01  $\mu$ F capacitor are for snubbing of the triac and may or may not be necessary depending upon the particular triac and load use.



\* For highly inductive loads (power factor < 0.5), change this value to 360 ohms.

**Figure 3. Hot-Line Switching Application Circuit**

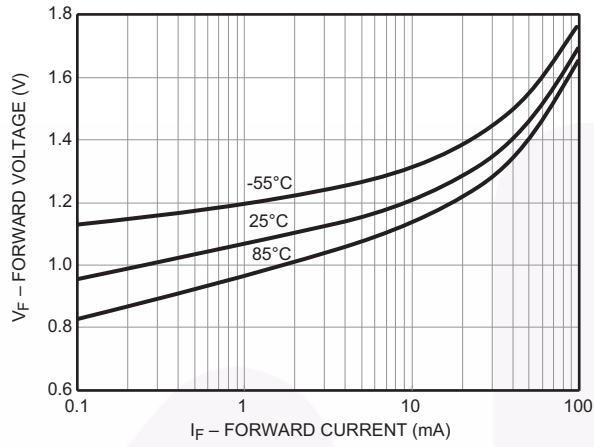


**Figure 4. Inverse-Parallel SCR Driver Circuit**

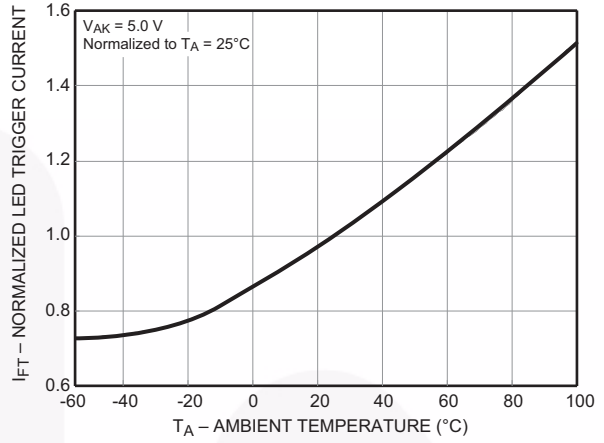
Suggested method of firing two, back-to-back SCR's with a Fairchild triac driver. Diodes can be 1N4001; resistors, R1 and R2, are optional 330  $\Omega$ .

Note: This optoisolator should not be used to drive a load directly. It is intended to be a discrete triac driver device only.

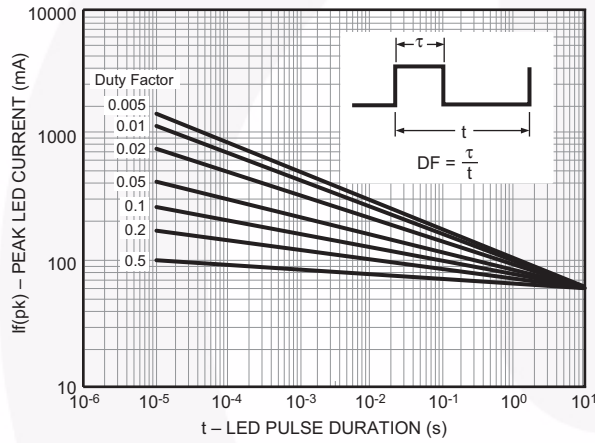
## Typical Performance Characteristics



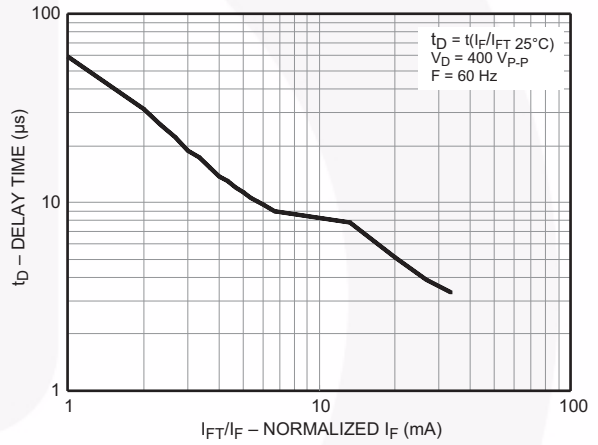
**Figure 5. Forward Voltage ( $V_F$ ) vs. Forward Current ( $I_F$ )**



**Figure 6. Normalized LED Trigger Current ( $I_{FT}$ ) vs. Ambient Temperature ( $T_A$ )**



**Figure 7. Peak LED Current vs. Duty Factor, Tau**



**Figure 8. Trigger Delay Time**



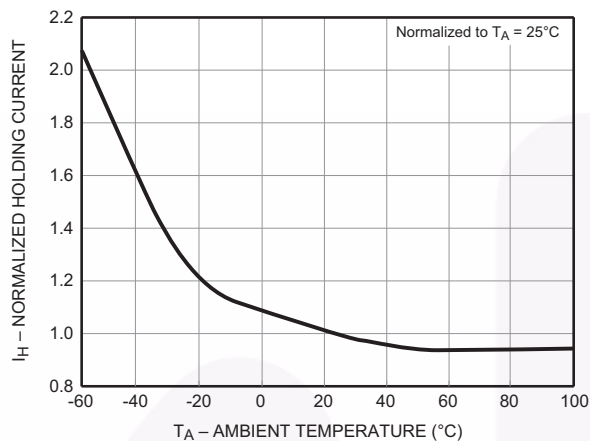
**Figure 9. Pulse Trigger Current**



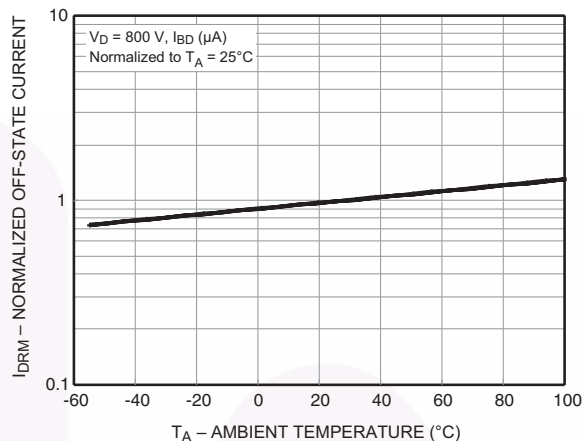
**Figure 10. On-State Voltage ( $V_{TM}$ ) vs. On-State Current ( $I_{TM}$ )**



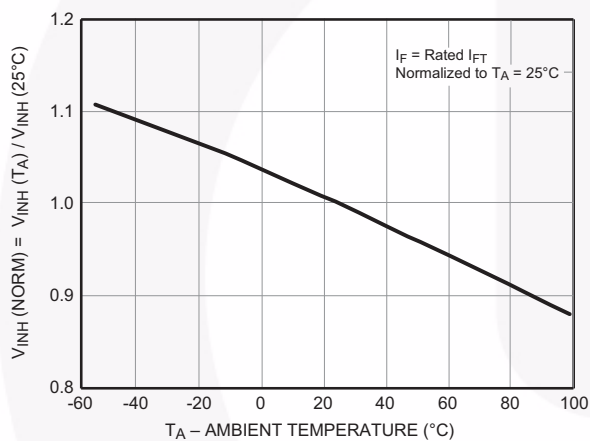
### Typical Performance Characteristics (Continued)



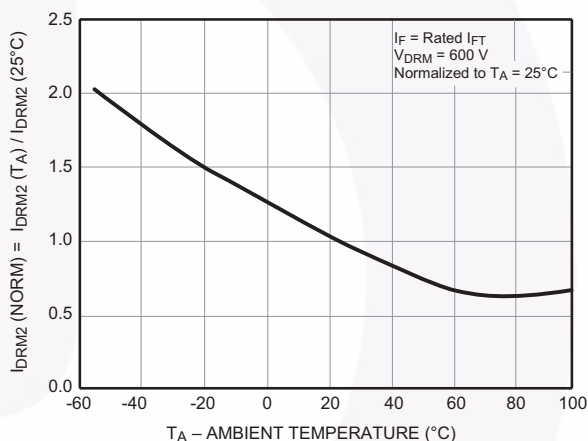
**Figure 11. Normalized Holding Current (I<sub>H</sub>) vs. Ambient Temperature (T<sub>A</sub>)**



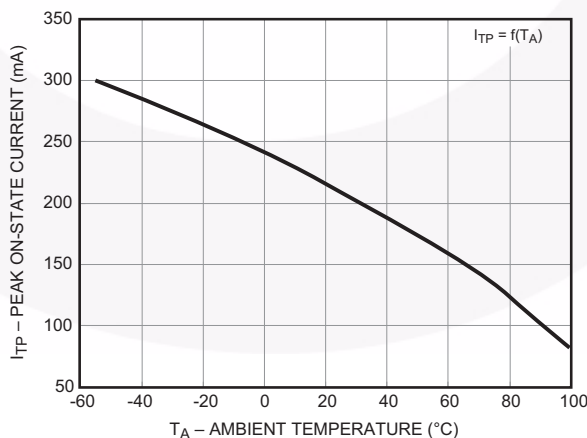
**Figure 12. Normalized Off-State Current (I<sub>DRM</sub>) vs. Ambient Temperature (T<sub>A</sub>)**



**Figure 13. Normalized Inhibit Voltage (V<sub>INH</sub>) vs. Ambient Temperature (T<sub>A</sub>)**



**Figure 14. Normalized Leakage in Inhibit State (I<sub>DRM2</sub>) vs. Ambient Temperature (T<sub>A</sub>)**



**Figure 15. Current Reduction**

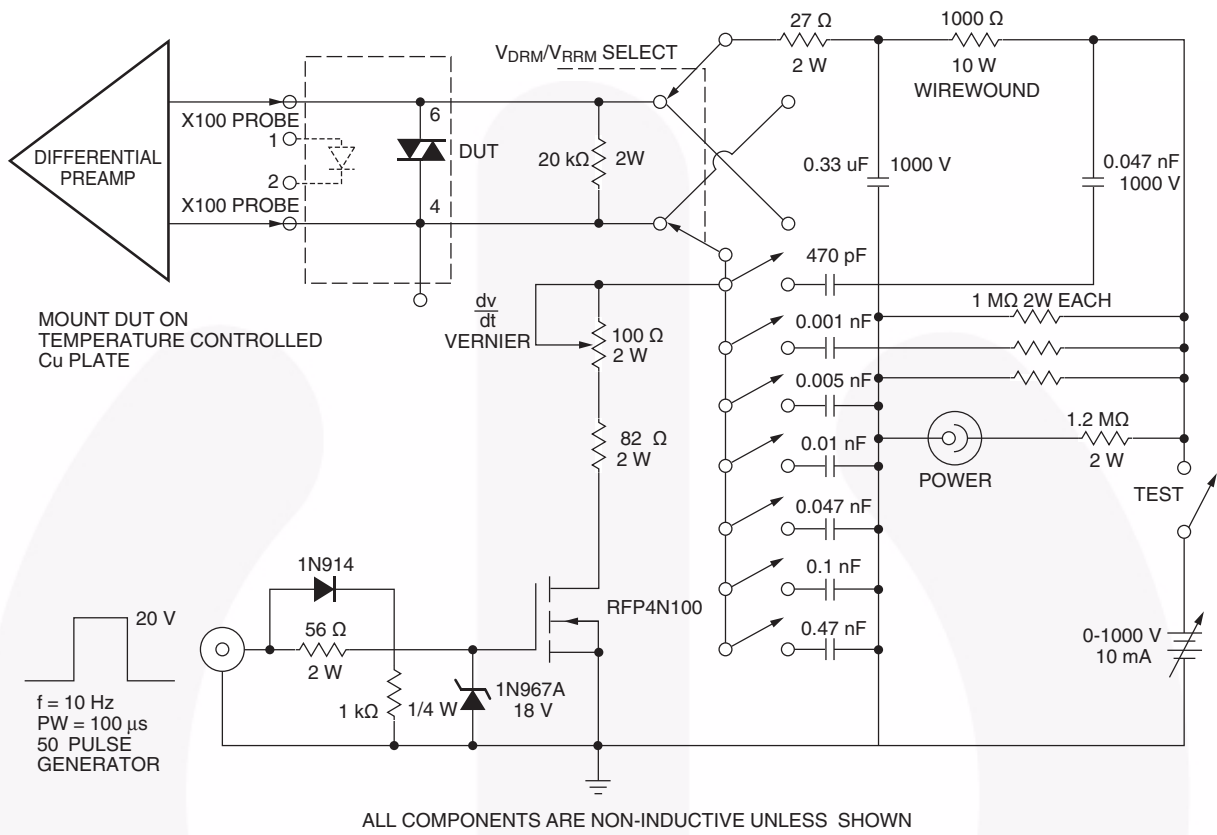
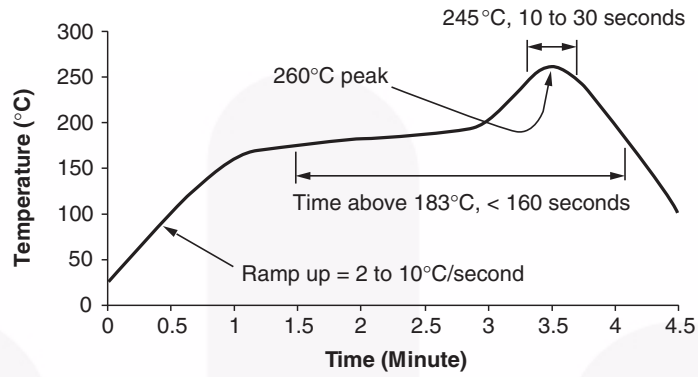


Figure 16. Circuit for Static  $\frac{dv}{dt}$  Measurement of Power Thyristors

## Reflow Profile



- Peak reflow temperature: 260°C (package surface temperature)
- Time of temperature higher than 183°C for 160 seconds or less
- One time soldering reflow is recommended

Figure 17. Reflow Profile

## Ordering Information

| Part Number | Package  | Packing Method             |
|-------------|--|----------------------------|
| FOD410      | DIP 6-Pin  | Tube (50 Units)            |
| FOD410S     | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| FOD410SD    | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| FOD410V     | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| FOD410SV    | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| FOD410SDV   | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| FOD410TV    | DIP 6-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 Option | Tube (50 Units)            |

### Note:

6. The product orderable part number system listed in this table also applies to the FOD4108, FOD4116, and FOD4118 product families.

## Marking Information

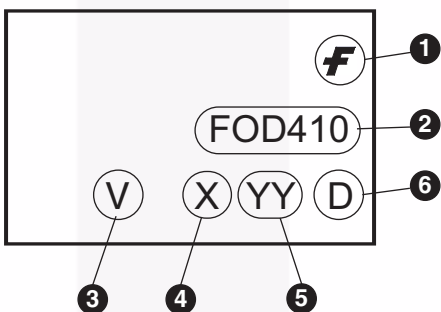
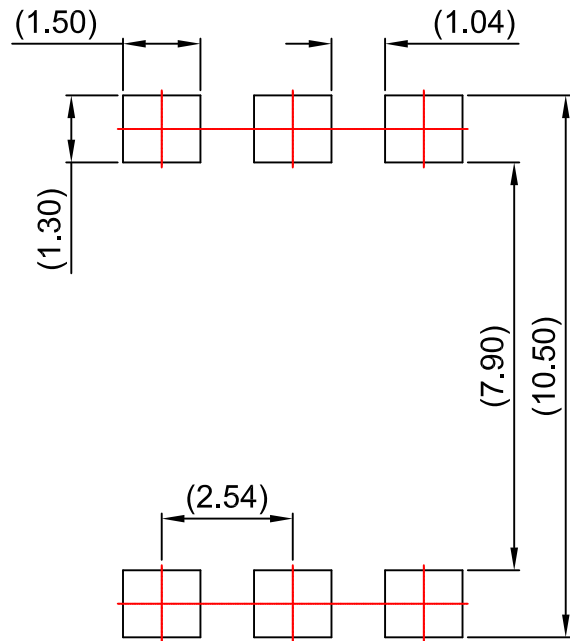


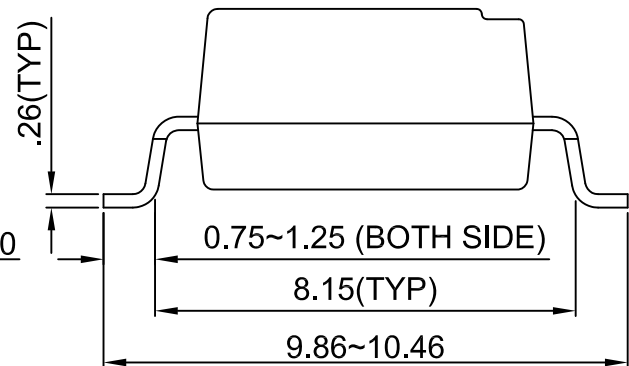
Figure 18. Top Mark

Table 1. Top Mark Definitions

|   |   |
|---|---|
| 1 | Fairchild Logo  |
| 2 | Device Number   |
| 3 | VDE mark. DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4 | One-Digit Year Code, e.g., "6"  |
| 5 | Digit Work Week, Ranging from "01" to "53"  |
| 6 | Assembly Package Code   |



LAND PATTERN RECOMMENDATION



NOTES:

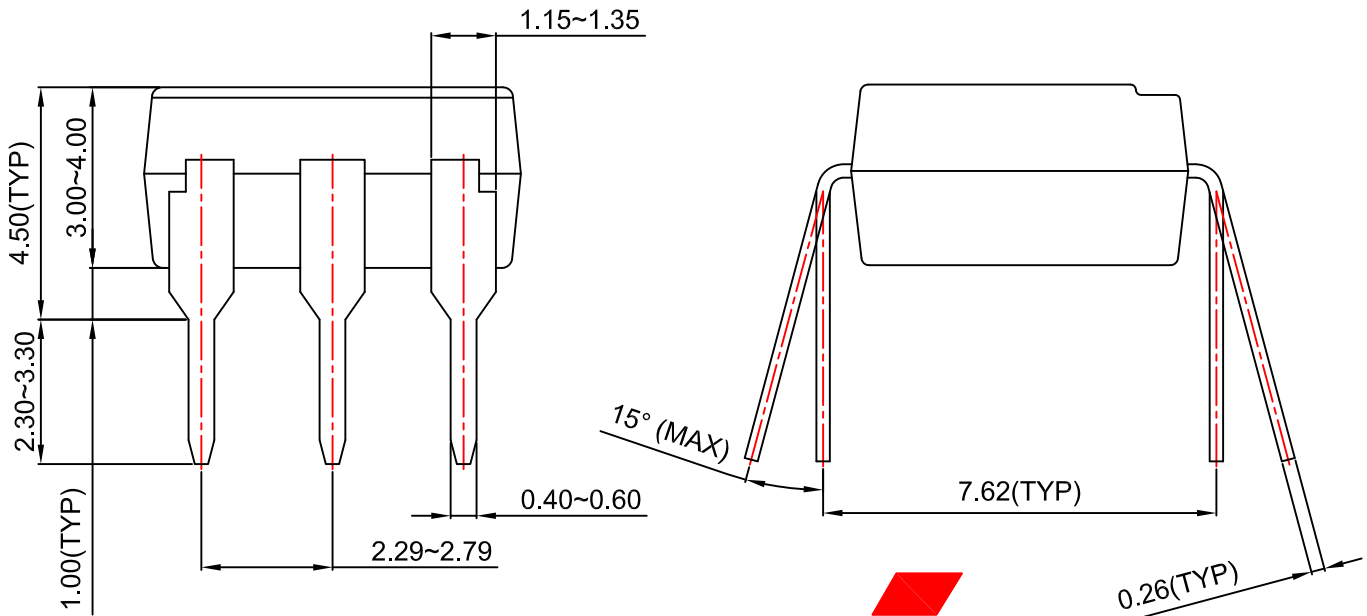
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