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October 2016

# FOD420, FOD4208, FOD4216, FOD4218 6-Pin DIP High dv/dt Random Phase Triac Drivers

## Features

- 300 mA On-State Current
- High Blocking Voltage
  - 600 V (FOD420, FOD4216)
  - 800 V (FOD4208, FOD4218)
- High Trigger Sensitivity
  - 1.3 mA (FOD4216, FOD4218)
  - 2 mA (FOD420, FOD4208)
- 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

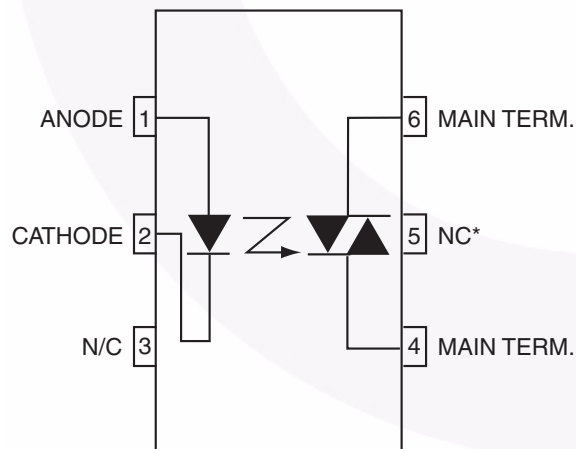
## Description

The FOD420, FOD4208, FOD4216 and FOD4218 devices consist of an infrared emitting diode coupled to a hybrid random phase triac formed with two inverse parallel SCRs which form the triac function capable of driving discrete triacs. The FOD4216 and FOD4218 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.

## Applications

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

## Functional Schematic



\*DO NOT CONNECT  
(TRIAC SUBSTRATE)

Figure 1. Schematic

## Package Outlines

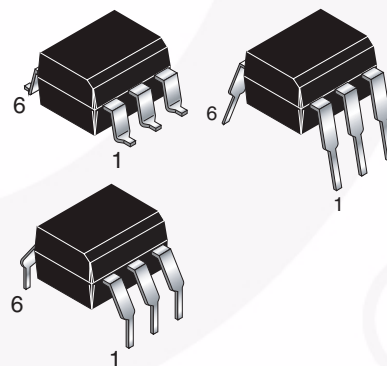


Figure 2. Package Outlines

## 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	FOD420, FOD4216	600	V
		FOD4208, FOD4218	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		1.28	1.50	V
$I_R$	Reverse Leakage Current	$V_R = 6\text{ V}$	All		0.01	10	$\mu\text{A}$
<b>DETECTOR</b>							
$I_{D(RMS)}$	Peak Blocking Current, Either Direction	$I_F = 0,$ $T_A = 100^\circ\text{C}^{(2)}$	$V_D = 600\text{ V}$	FOD420, FOD4216	3	100	$\mu\text{A}$
			$V_D = 800\text{ V}$	FOD4208, FOD4218			
$I_{R(RMS)}$	Reverse Current	$T_A = 100^\circ\text{C}$	$V_D = 600\text{ V}$	FOD420, FOD4216	3	100	$\mu\text{A}$
			$V_D = 800\text{ V}$	FOD4208, FOD4218			
dv/dt	Critical Rate of Rise of Off-State Voltage	$I_F = 0\text{ A}^{(3)}$ (Figure 14)	$V_D = V_{DRM}$	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 14 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>	FOD420, FOD4208		0.75	2.0	mA
			FOD4216, FOD4218		0.75	1.3	
$V_{TM}$	Peak On-State Voltage, Either Direction	$I_{TM} = 300$ mA peak, $I_F = \text{Rated } I_{FT}$	All		2.2	3	V
$I_H$	Holding Current, Either Direction	$V_T = 3$ V	All		200	500	$\mu\text{A}$
$I_L$	Latching Current	$V_T = 2.2$ V	All		5		mA
$t_{ON}$	Turn-On Time	PF = 1.0, $I_T = 300$ mA	$V_{RM} = V_{DM} = 424$ VAC	FOD420, FOD4216, FOD4218	60		$\mu\text{s}$
			$V_{RM} = V_{DM} = 565$ VAC	FOD4208			
$t_{OFF}$	Turn-Off Time	PF = 1.0, $I_T = 300$ mA	$V_{RM} = V_{DM} = 424$ VAC	FOD420, FOD4216, FOD4218	52		$\mu\text{s}$
			$V_{RM} = V_{DM} = 565$ VAC	FOD4208			
$dv/dt_C$	Critical Rate of Rise of Voltage at Current Commutation	$V_D = 230$ V <sub>RMS</sub> , $I_D = 300$ mA <sub>PK</sub>	All		10		V/ $\mu\text{s}$
$di/dt_C$	Critical Rate of Rise of On-State Current Commutation	$V_D = 230$ V <sub>RMS</sub> , $I_D = 300$ mA <sub>PK</sub>	All		9		A/ms
$dv(i_O)/dt$	Critical Rate of Rise of Coupled Input/Output Voltage	$I_T = 0$ A, $V_{RM} = V_{DM} = 424$ 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 FOD420 and FOD4208 and 1.3 mA for FOD4216 and FOD4218) and the absolute max  $I_F$  (30 mA).

### Isolation Characteristics

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

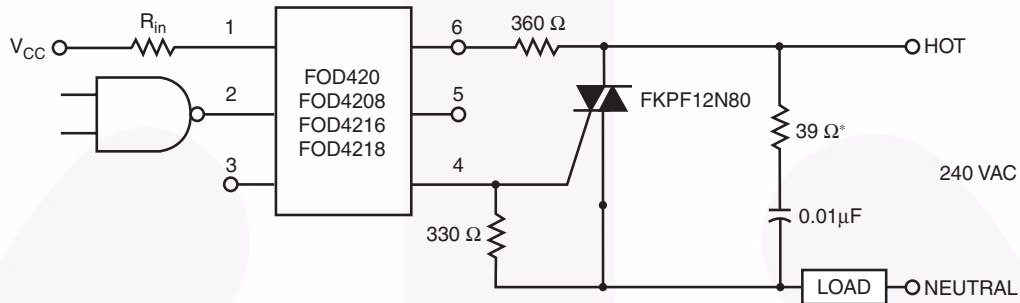
#### Note:

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

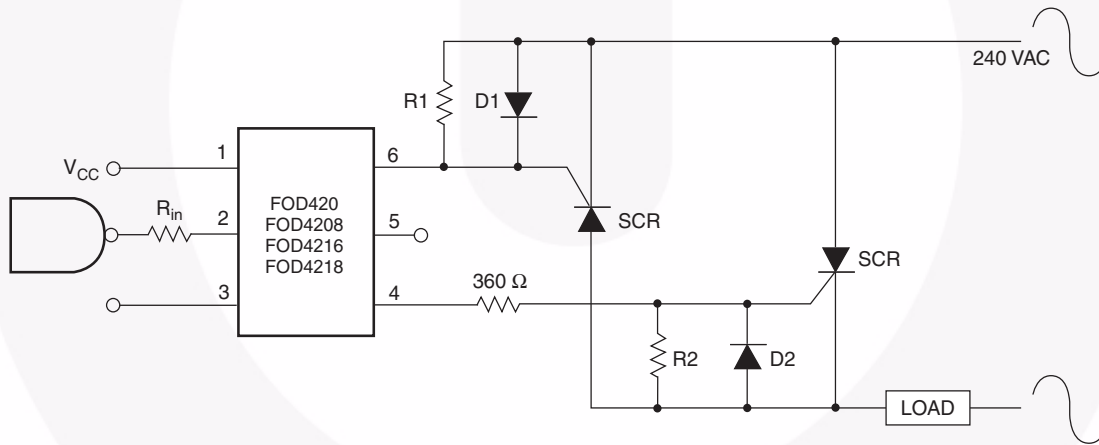
Figure 3 shows a typical circuit for when hot line switch-ing is required. In this circuit the “hot” side of the line is switched and the load connected to the cold or neutral side. The load may be connected to either the neutral or hot line.

R<sub>in</sub> is calculated so that IF is equal to the rated IFT of the part, 2 mA for FOD420 and FOD4208, 1.3 mA for FOD4216 and FOD4218. The 39 Ω resistor and 0.01 μF 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**

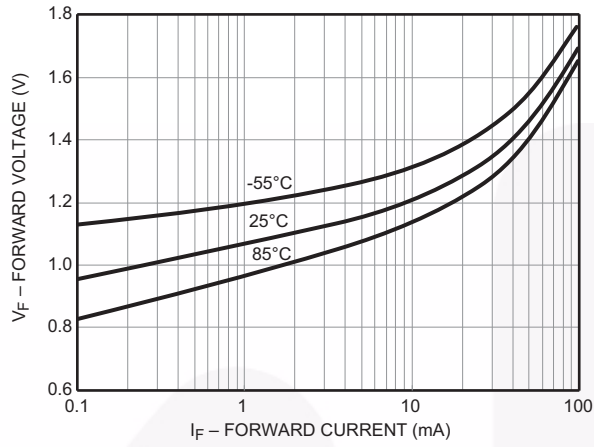


**Figure 4. Inverse-Parallel SCR Driver Circuit**

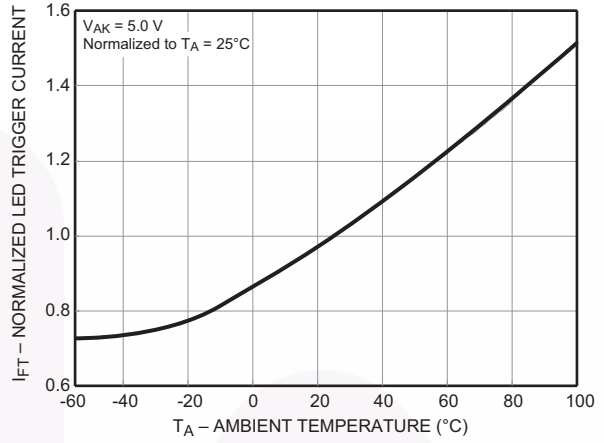
Suggested method of firing two, back-to-back SCR's with a Fairchild triac driver. Diodes can be 1N4001; resistors, R1 and R2, are optional 330 Ω.

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

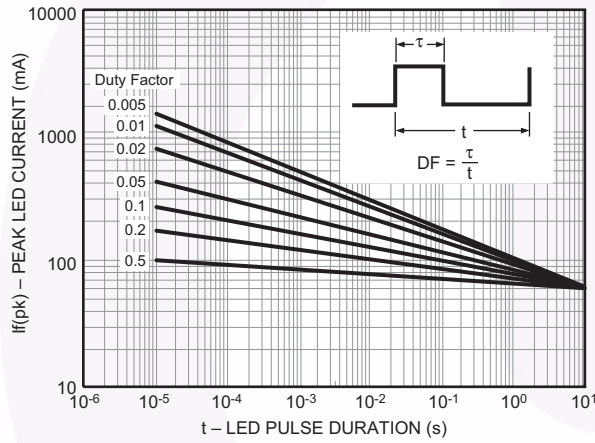
## Typical Performance Characteristics



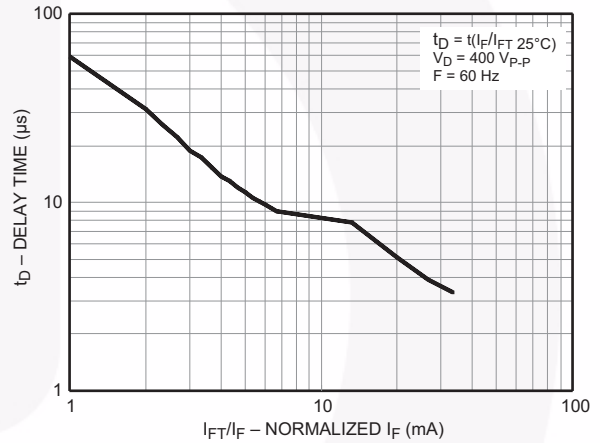
**Figure 5. Forward Voltage ( $V_F$ ) vs. Forward Current ( $I_F$ )**



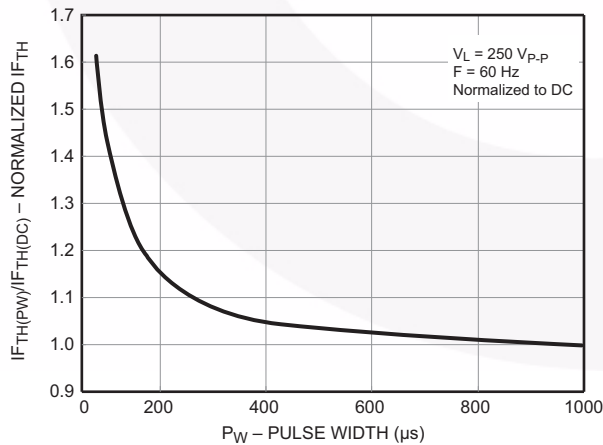
**Figure 6. Normalized LED Trigger Current ( $I_{FT}$ ) vs. Ambient Temperature ( $T_A$ )**



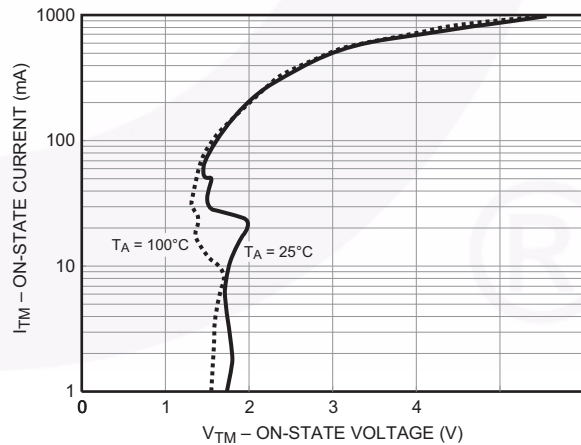
**Figure 7. Peak LED Current vs. Duty Factor, Tau**



**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)

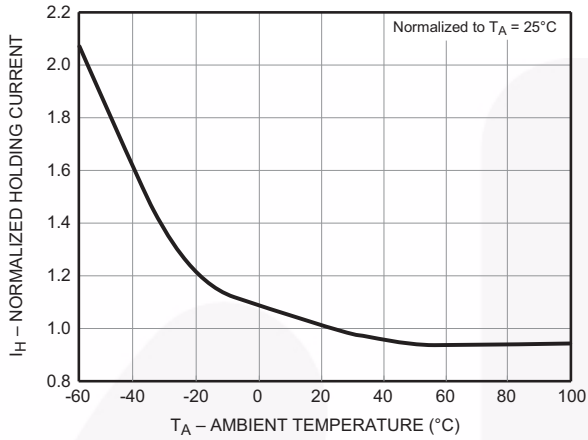


Figure 11. Normalized Holding Current (I<sub>H</sub>) vs. Ambient Temperature (T<sub>A</sub>)

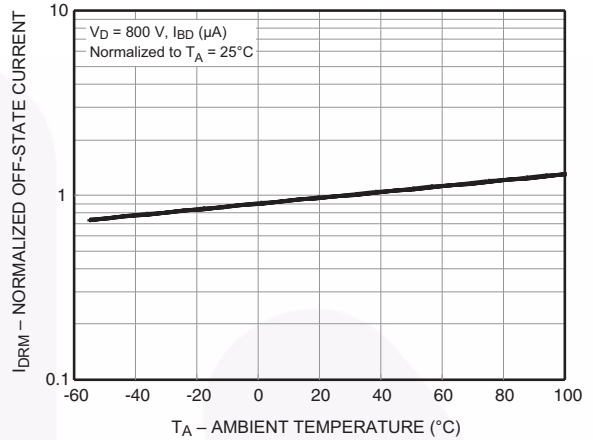


Figure 12. Normalized Off-State Current (I<sub>DRM</sub>) vs. Ambient Temperature (T<sub>A</sub>)

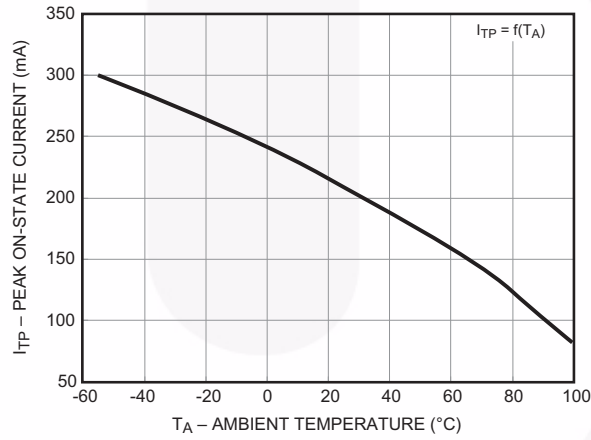


Figure 13. Current Reduction

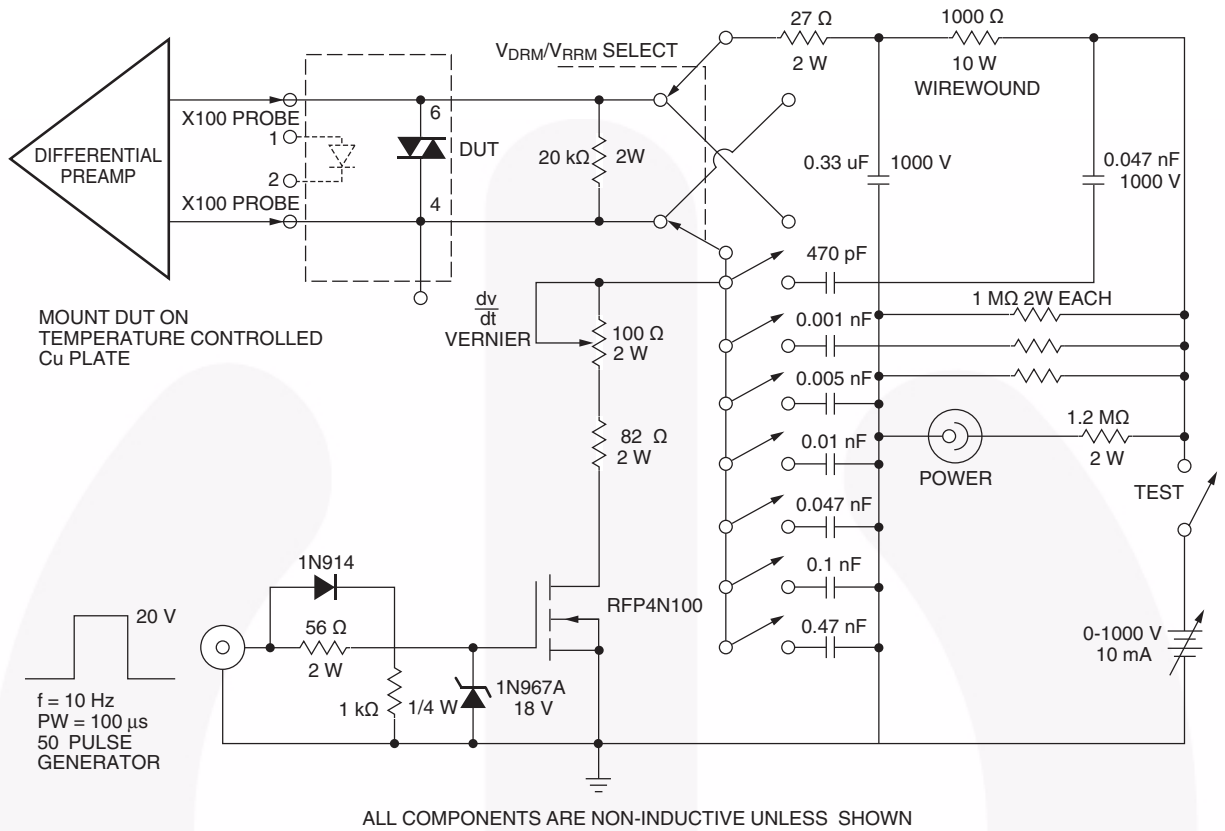
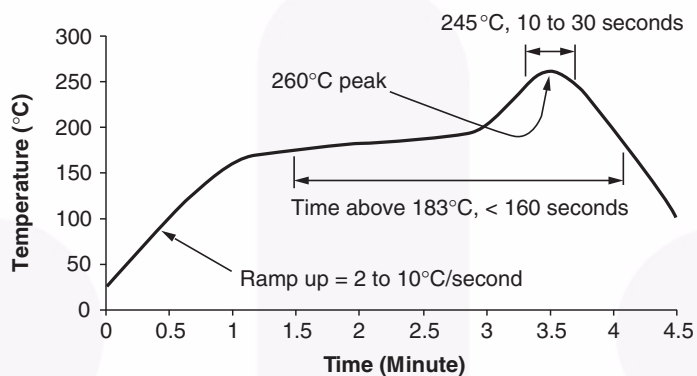


Figure 14. Circuit for Static  $\frac{dv}{dt}$  Measurement of Power Thyristors

## 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 15. Reflow Profile



## Ordering Information

Part Number	Package	Packing Method
FOD420	DIP 6-Pin	Tube (50 Units)
FOD420S	SMT 6-Pin (Lead Bend)	Tube (50 Units)
FOD420SD	SMT 6-Pin (Lead Bend)	Tape and Reel (1000 Units)
FOD420V	DIP 6-Pin, DIN EN/IEC60747-5-5 Option	Tube (50 Units)
FOD420SV	SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option	Tube (50 Units)
FOD420SDV	SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option	Tape and Reel (1000 Units)
FOD420TV	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 FOD4208, FOD4216, and FOD4218 product families.

## Marking Information

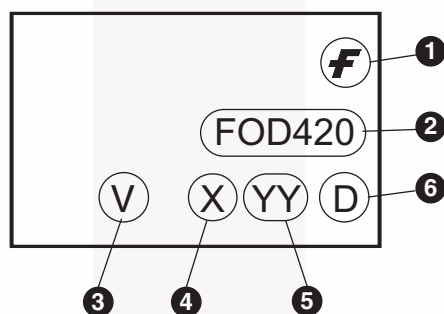


Figure 16. Top Mark

Table 1. Top Mark Definitions

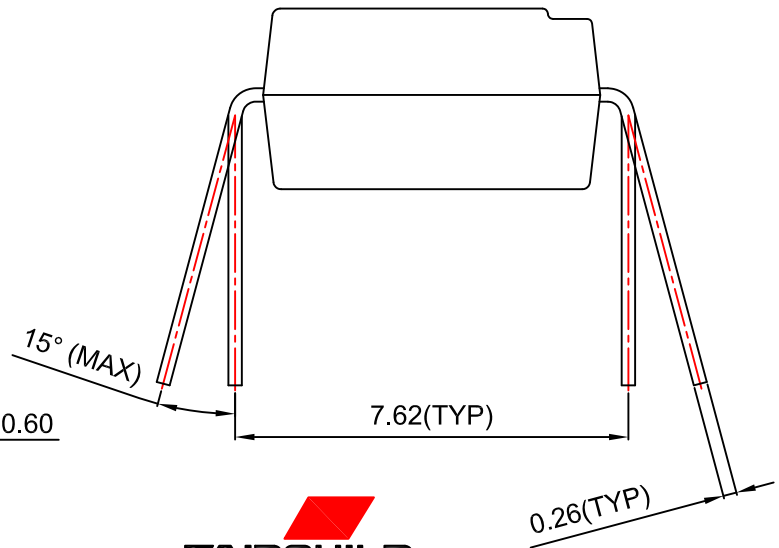
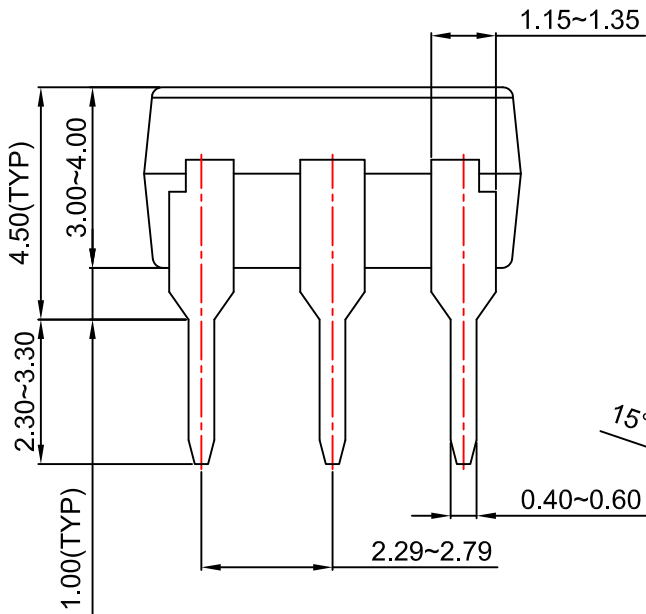
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4	One-Digit Year Code, e.g., "6"
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6	Assembly Package Code





NOTES:

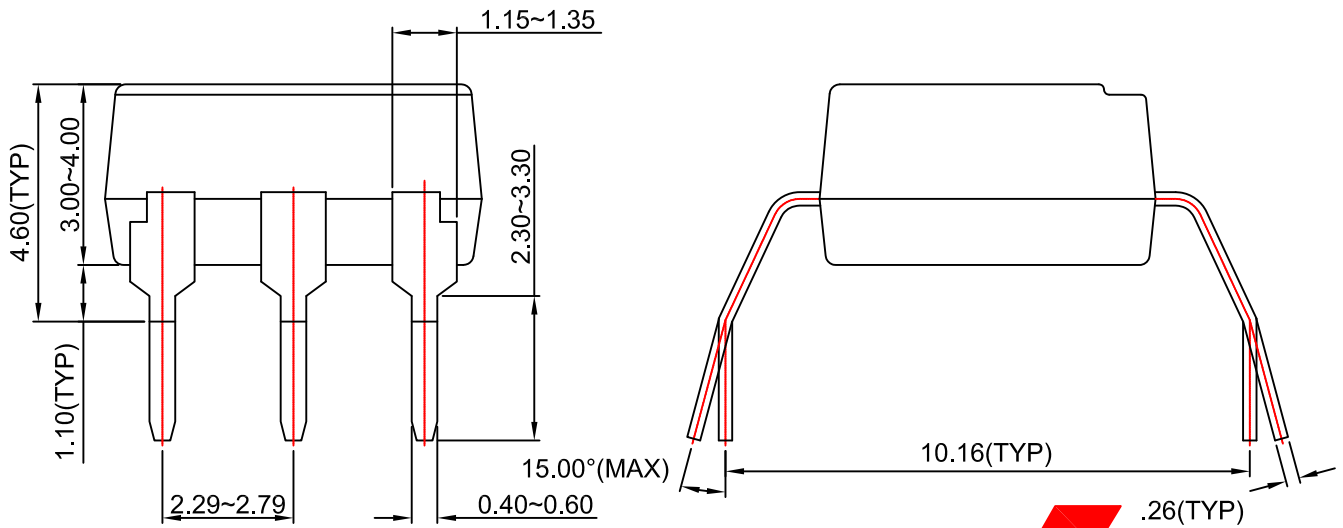
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