

# FOD410, FOD4108, FOD4116, FOD4118

## 6-Pin DIP High dv/dt Zero-Cross Triac Drivers

### 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.

### Features

- 300 mA<sub>peak</sub> 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, FOD4118)
- High Static dv/dt (10,000 V/μs)
- Safety and Regulatory Approvals:
  - UL1577, 5.000 VAC<sub>RMS</sub> for 1 Minute
  - DIN-EN/IEC60747-5-5
- These Devices are Pb-Free and are RoHS Compliant

### Applications

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



**ON Semiconductor®**

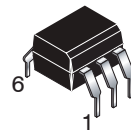
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**PDIP6 GW  
CASE 709AG**

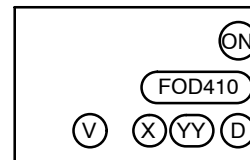


**PDIP6 7.3x6.5, 2.54P  
CASE 646CE**



**PDIP6 7.3x6.5, 2.54P  
CASE 646CF**

### MARKING DIAGRAM



- ON = ON Semiconductor Logo
- FOD410 = Device Number
- V = VDE mark. DIN EN/IEC60747-5-5  
Option (only appears on component ordered with this option)
- X = One-Digit Year Code
- YY = Digit Work Week
- D = Assembly Package Code

### FUNCTIONAL SCHEMATIC



### ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

# FOD410, FOD4108, FOD4116, FOD4118

## SAFETY AND INSULATION RATINGS

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 (Note 1)	175	°C
I <sub>S,INPUT</sub>	Input Current (Note 1)	400	mA
P <sub>S,OUTPUT</sub>	Output Power (Note 1)	700	mW
R <sub>IO</sub>	Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V (Note 1)	> 10 <sup>9</sup>	Ω

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.

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

# FOD410, FOD4108, FOD4116, FOD4118

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C, Unless otherwise specified)

Symbol	Parameter	Device	Value	Unit
T <sub>STG</sub>	Storage Temperature	All	-55 to +150	°C
T <sub>OPR</sub>	Operating Temperature	All	-55 to +100	°C
T <sub>J</sub>	Junction Temperature	All	-55 to +125	°C
T <sub>SOL</sub>	Lead Solder Temperature	All	260 for 10 sec	°C
P <sub>D(TOTAL)</sub>	Total Device Power Dissipation @ 25°C	All	500	mW
	Derate Above 25°C	All	6.6	mW/°C

### EMITTER

I <sub>F</sub>	Continuous Forward Current	All	30	mA
V <sub>R</sub>	Reverse Voltage	All	6	V
P <sub>D(EMITTER)</sub>	Total Power Dissipation 25°C Ambient	All	50	mW
	Derate Above 25°C	All	0.71	mW/°C

### DETECTOR

V <sub>DRM</sub>	Off-State Output Terminal Voltage	FOD410, FOD4116	600	V
		FOD4108, FOD4118	800	
I <sub>TSM</sub>	Peak Non-Repetitive Surge Current (single cycle 60 Hz sine wave)	All	3	A <sub>peak</sub>
I <sub>TM</sub>	Peak On-State Current	All	300	mA <sub>peak</sub>
P <sub>D(DETECTOR)</sub>	Total Power Dissipation @ 25°C Ambient	All	450	mW
	Derate Above 25°C	All	5.9	mW/°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# FOD410, FOD4108, FOD4116, FOD4118

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions	Device	Min	Typ	Max	Unit
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### INDIVIDUAL COMPONENT CHARACTERISTICS

Emitter								
V <sub>F</sub>	Input Forward Voltage	I <sub>F</sub> = 20 mA	All	–	1.25	1.50	V	
I <sub>R</sub>	Reverse Leakage Current	V <sub>R</sub> = 6 V	All	–	0.0001	10	μA	
Detector								
I <sub>D(RMS)</sub>	Peak Blocking Current Either Direction	I <sub>F</sub> = 0, T <sub>A</sub> = 100°C (Note 2)	V <sub>D</sub> = 600 V	FOD410, FOD4116	–	3	100	μA
			V <sub>D</sub> = 800 V	FOD4108, FOD4118				
I <sub>R(RMS)</sub>	Reverse Current	T <sub>A</sub> = 100 °C	V <sub>D</sub> = 600 V	FOD410, FOD4116	–	3	100	μA
			V <sub>D</sub> = 800 V	FOD4108, FOD4118				
dv/dt	Critical Rate of Rise of Off-State Voltage	I <sub>F</sub> = 0 A (Note 3)	V <sub>D</sub> = V <sub>DRM</sub>	All	10,000	–	–	V/μs

### TRANSFER CHARACTERISTICS

I <sub>FT</sub>	LED Trigger Current	Main Terminal Voltage = 5 V (Note 4)		FOD410, FOD4108	–	0.65	2.0	mA
				FOD4116, FOD4118				
V <sub>TM</sub>	Peak On-State Voltage, Either Direction	I <sub>TM</sub> = 300 mA peak, I <sub>F</sub> = Rated I <sub>FT</sub>		All	–	2.2	3	V
I <sub>H</sub>	Holding Current, Either Direction	V <sub>T</sub> = 3 V		All	–	200	500	μA
I <sub>L</sub>	Latching Current	V <sub>T</sub> = 2.2 V		All	–	5	–	mA
t <sub>ON</sub>	Turn-On Time	PF = 1.0, I <sub>T</sub> = 300 mA	V <sub>RM</sub> = V <sub>DM</sub> = 424 VAC	FOD410, FOD4116, FOD4118	–	60	–	μs
			V <sub>RM</sub> = V <sub>DM</sub> = 565 VAC	FOD4108				
t <sub>OFF</sub>	Turn-Off Time		V <sub>RM</sub> = V <sub>DM</sub> = 424 VAC	FOD410, FOD4116, FOD4118	–	52	–	μs
			V <sub>RM</sub> = V <sub>DM</sub> = 565 VAC	FOD4108				
dv/dt <sub>C</sub>	Critical Rate of Rise of Voltage at Current Commutation	V <sub>D</sub> = 230 V <sub>RMS</sub> , I <sub>D</sub> = 300 mA <sub>PK</sub>		All	–	10	–	V/μs
di/dt <sub>C</sub>	Critical Rate of Rise of On-State Current Commutation	V <sub>D</sub> = 230 V <sub>RMS</sub> , I <sub>D</sub> = 300 mA <sub>PK</sub>		All	–	9	–	A/ms
dv(I <sub>O</sub> )/dt	Critical Rate of Rise of Coupled Input / Output Voltage	I <sub>T</sub> = 0 A, V <sub>RM</sub> = V <sub>DM</sub> = 424 VAC		All	10,000	–	–	V/μs

2. Test voltage must be applied within dv/dt rating.
3. This is static dv/dt. Commutating dv/dt is a function of the load-driving thyristor(s) only.
4. All devices are guaranteed to trigger at an I<sub>F</sub> value less than or equal to max I<sub>FT</sub>. Therefore, recommended operating I<sub>F</sub> lies between max I<sub>FT</sub> (2 mA for FOD410 and FOD4108 and 1.3 mA for FOD4116 and FOD4118) and the absolute max I<sub>F</sub> (30 mA).

# FOD410, FOD4108, FOD4116, FOD4118

## 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	$V_{peak}$
$I_{DRM2}$	Leakage in Inhibit State	$I_F = \text{Rated } I_{FT}, \text{ Rated } V_{DRM}, \text{ Off-State}$	All	–	20	200	$\mu A$

## ISOLATION CHARACTERISTICS

$V_{ISO}$	Steady State Isolation Voltage	$f = 60 \text{ Hz}, t = 1 \text{ Minute (Note 5)}$	All	5,000	–	–	$VAC_{RMS}$
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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  $VAC_{RMS}$  for 1 minute duration is equivalent to 6,000  $VAC_{RMS}$  for 1 second duration.

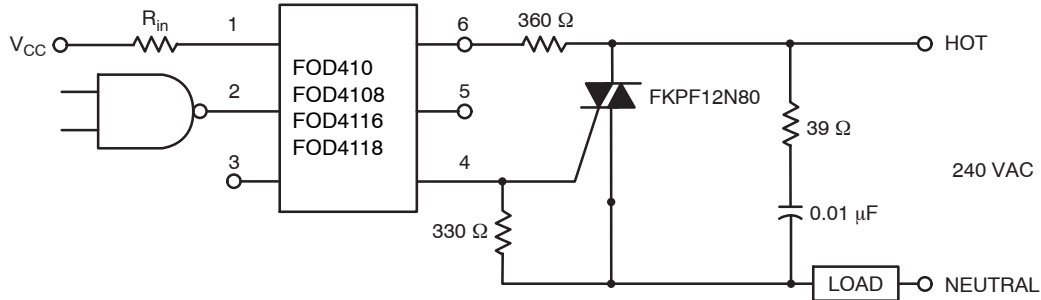
# FOD410, FOD4108, FOD4116, FOD4118

## TYPICAL APPLICATION

Figure 1 shows a typical circuit for when hot line switching 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  $\Omega$ .

**Figure 1. Hot-Line Switching Application Circuit**



**Figure 2. Inverse-Parallel SCR Driver Circuit**

Suggested method of firing two, back-to-back SCR's with a ON Semiconductor 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 CHARACTERISTICS



Figure 3. Forward Voltage ( $V_F$ ) vs. Forward Current ( $I_F$ )

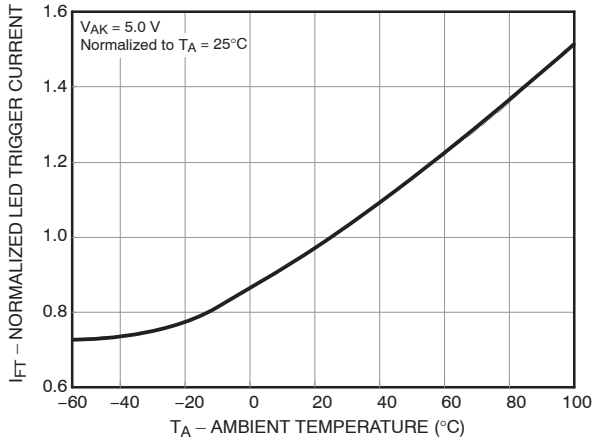


Figure 4. Normalized LED Trigger Current ( $I_{FT}$ ) vs. Ambient Temperature ( $T_A$ )



Figure 5. Peak LED Current vs. Duty Factor, Tau



Figure 6. Trigger Delay Time



Figure 7. Pulse Trigger Current



Figure 8. On-State Voltage ( $V_{TM}$ ) vs. On-State Current ( $I_{TM}$ )

TYPICAL CHARACTERISTICS (continued)



Figure 9. Normalized Holding Current ( $I_H$ ) vs. Ambient Temperature ( $T_A$ )



Figure 10. Normalized Off-State Current ( $I_{DRM}$ ) vs. Ambient Temperature ( $T_A$ )



Figure 11. Normalized Inhibit Voltage ( $V_{INH}$ ) vs. Ambient Temperature ( $T_A$ )



Figure 12. Normalized Leakage in Inhibit State ( $I_{DRM2}$ ) vs. Ambient Temperature ( $T_A$ )

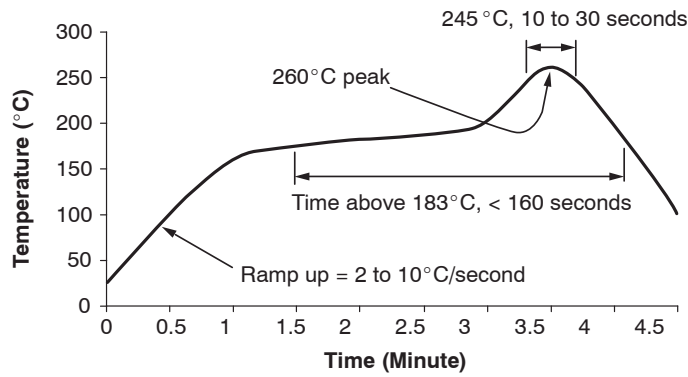


Figure 13. Current Reduction



# FOD410, FOD4108, FOD4116, FOD4118

## REFLOW PROFILE



- Peak reflow temperature: 262°C (package surface temperature)
- Time of temperature higher than 185°C for 160 seconds or less
- One time soldering reflow is recommended

**Figure 14. Reflow Profile**

### ORDERING INFORMATION

Part Number	Package	Shipping <sup>†</sup>
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)

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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