



# IL4116, IL4117, IL4118



Vishay Semiconductors Optocoupler, Phototriac Output, Zero Crossing, Very Low Input Current

<b>ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup></b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)					
PARAMETER	TEST CONDITION	PART	SYMBOL	VALUE	UNIT
<b>INPUT</b>					
Reverse voltage			$V_R$	6	V
Forward current			$I_F$	60	mA
Surge current			$I_{FSM}$	2.5	A
Power dissipation			$P_{diss}$	100	mW
Derate linearly from 25 °C				1.33	mW/°C
Thermal resistance			$R_{th}$	750	°C/W
<b>OUTPUT</b>					
Peak off-state voltage		IL4116	$V_{DRM}$	600	V
		IL4117	$V_{DRM}$	700	V
		IL4118	$V_{DRM}$	800	V
RMS on-state current			$I_{DRM}$	300	mA
Single cycle surge				3	A
Power dissipation			$P_{diss}$	500	mW
Derate linearly from 25 °C				6.6	mW/°C
Thermal resistance			$R_{th}$	150	°C/W
<b>COUPLER</b>					
Creepage distance				$\geq 7$	mm
Clearance distance				$\geq 7$	mm
Storage temperature			$T_{stg}$	- 55 to + 150	°C
Operating temperature			$T_{amb}$	- 55 to + 100	°C
Isolation test voltage			$V_{ISO}$	5300	$V_{RMS}$
Isolation resistance	$V_{IO} = 500\text{ V}, T_{amb} = 25\text{ }^{\circ}\text{C}$		$R_{IO}$	$\geq 10^{12}$	$\Omega$
	$V_{IO} = 500\text{ V}, T_{amb} = 100\text{ }^{\circ}\text{C}$		$R_{IO}$	$\geq 10^{11}$	$\Omega$
Lead soldering temperature <sup>(2)</sup>	5 s		$T_{sld}$	260	°C

## Notes

- <sup>(1)</sup> 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.
- <sup>(2)</sup> Refer to reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).



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Optocoupler, Phototriac Output, Zero Crossing, Very Low Input Current Vishay Semiconductors

<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	$I_F = 20\text{ mA}$		$V_F$		1.3	1.5	V
Breakdown voltage	$I_R = 10\text{ }\mu\text{A}$		$V_{BR}$	6	30		V
Reverse current	$V_R = 6\text{ V}$		$I_R$		0.1	10	$\mu\text{A}$
Capacitance	$V_F = 0\text{ V}$ , $f = 1\text{ MHz}$		$C_O$		40		pF
Thermal resistance, junction to lead			$R_{thjl}$		750		$^{\circ}\text{C/W}$
<b>OUTPUT</b>							
Repetitive peak off-state voltage	$I_{DRM} = 100\text{ }\mu\text{A}$	IL4116	$V_{DRM}$	600	650		V
		IL4117	$V_{DRM}$	700	750		V
		IL4118	$V_{DRM}$	800	850		V
Off-state voltage	$I_{D(RMS)} = 70\text{ }\mu\text{A}$	IL4116	$V_{D(RMS)}$	424	460		V
		IL4117	$V_{D(RMS)}$	494	536		V
		IL4118	$V_{D(RMS)}$	565	613		V
Off-state current	$V_D = 600$ , $T_{amb} = 100\text{ }^{\circ}\text{C}$		$I_{D(RMS)}$		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
Holding current	$V_T = 3\text{ V}$		$I_H$		65	200	$\mu\text{A}$
Latching current	$V_T = 2.2\text{ V}$		$I_L$			500	$\mu\text{A}$
LED trigger current	$V_{AK} = 5\text{ V}$		$I_{FT}$		0.7	1.3	mA
Zero cross inhibit voltage	$I_F = \text{rated } I_{FT}$		$V_{IH}$		15	25	V
Critical rate of rise off-state voltage	$V_{RM}$ , $V_{DM} = 400\text{ VAC}$		$dV/dt_{cr}$	10 000			$\text{V}/\mu\text{s}$
	$V_{RM}$ , $V_{DM} = 400\text{ VAC}$ , $T_{amb} = 80\text{ }^{\circ}\text{C}$		$dV/dt_{cr}$		2000		$\text{V}/\mu\text{s}$
Critical rate of rise of voltage at current commutation	$V_D = 230\text{ V}_{RMS}$ , $I_D = 300\text{ mA}_{RMS}$ , $T_J = 25\text{ }^{\circ}\text{C}$		$dV/dt_{crq}$		8		$\text{V}/\mu\text{s}$
	$V_D = 230\text{ V}_{RMS}$ , $I_D = 300\text{ mA}_{RMS}$ , $T_J = 85\text{ }^{\circ}\text{C}$		$dV/dt_{crq}$		7		$\text{V}/\mu\text{s}$
Critical rate of rise of on-state current commutation	$V_D = 230\text{ V}_{RMS}$ , $I_D = 300\text{ mA}_{RMS}$ , $T_J = 25\text{ }^{\circ}\text{C}$		$dV/dt_{crq}$		12		A/ms
Thermal resistance, junction to lead			$R_{thjl}$		150		$^{\circ}\text{C/W}$
<b>COUPLER</b>							
Critical state of rise of coupler input-output voltage	$I_T = 0\text{ A}$ , $V_{RM} = V_{DM} = 424\text{ VAC}$		$dV_{(IO)}/dt$	10 000			$\text{V}/\mu\text{s}$
Capacitance (input to output)	$f = 1\text{ MHz}$ , $V_{IO} = 0\text{ V}$		$C_{IO}$		0.8		pF
Common mode coupling capacitance			$C_{CM}$		0.01		pF

### 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.

<b>SWITCHING CHARACTERISTICS</b>							
PARAMETER	TEST CONDITION	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
Turn-on time	$V_{RM} = V_{DM} = 424\text{ VAC}$		$t_{on}$		35		$\mu\text{s}$
Turn-off time	$PF = 1$ , $I_T = 300\text{ mA}$		$t_{off}$		50		$\mu\text{s}$

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

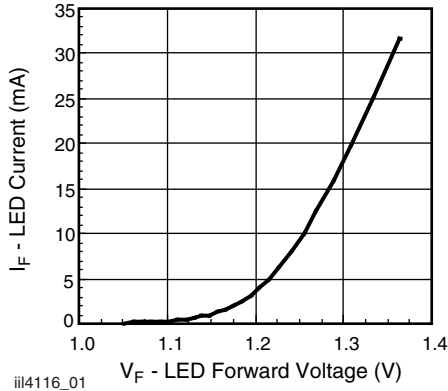


Fig. 1 - LED Forward Current vs. Forward Voltage

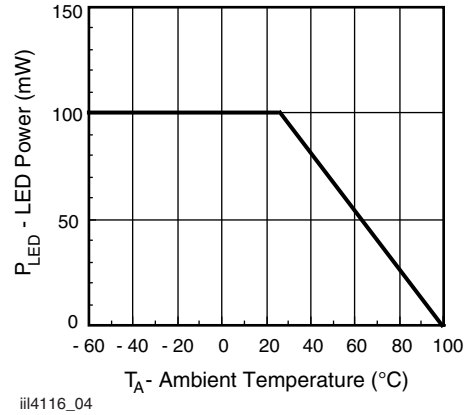


Fig. 4 - Maximum LED Power Dissipation

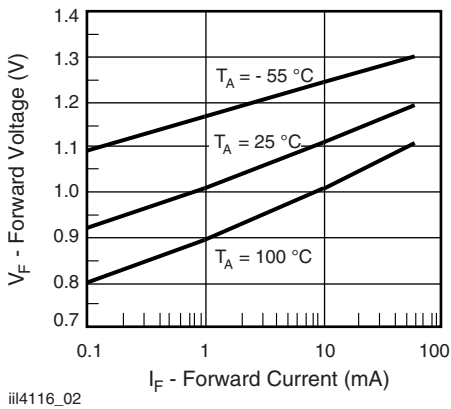


Fig. 2 - Forward Voltage vs. Forward Current

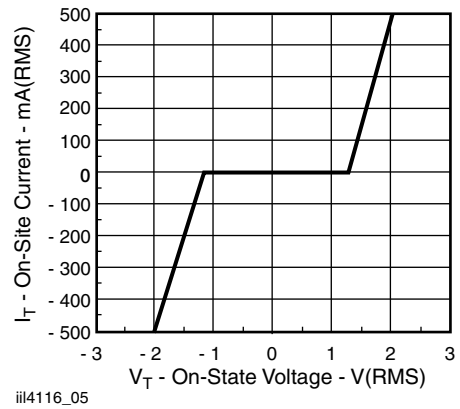


Fig. 5 - On-State Terminal Voltage vs. Terminal Current

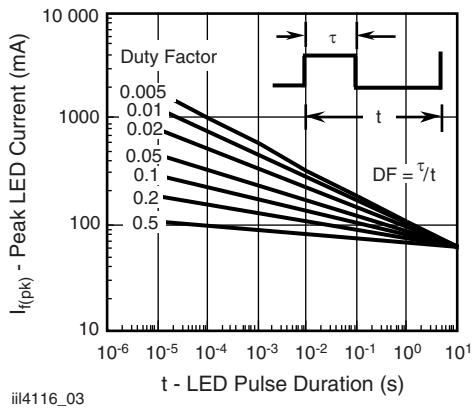


Fig. 3 - Peak LED Current vs. Duty Factor,  $\tau$

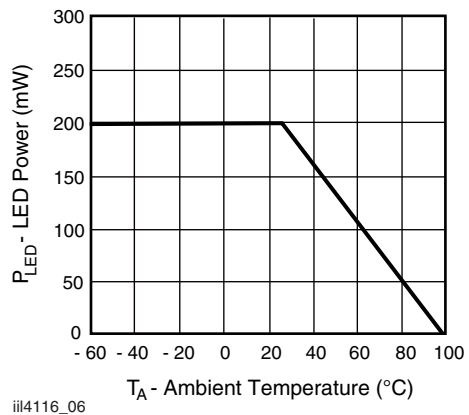


Fig. 6 - Maximum Output Power Dissipation

### TRIGGER CURRENT VS. TEMPERATURE AND VOLTAGE

The trigger current of the IL4116, IL4117, IL4118 has a positive temperature gradient and also is dependent on the terminal voltage as shown as the fig. 7.

For the operating voltage 250 V<sub>RMS</sub> over the temperature range - 40 °C to 85 °C, the I<sub>F</sub> should be at least 2.3 x of the I<sub>FT1</sub> (1.3 mA, max.).

Considering - 30 % degradation over time, the trigger current minimum is I<sub>F</sub> = 1.3 x 2.3 x 130 % = 4 mA

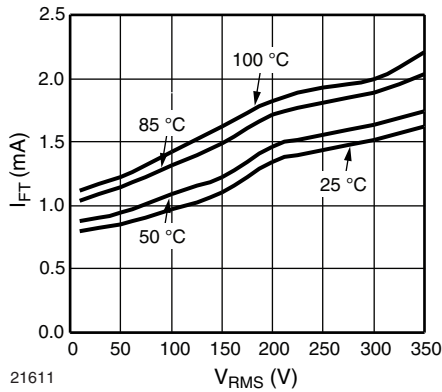


Fig. 7 - Trigger Current vs. Temperature and Operating Voltage (50 Hz)

### INDUCTIVE AND RESISTIVE LOADS

For inductive loads, there is phase shift between voltage and current, shown in the fig. 8.

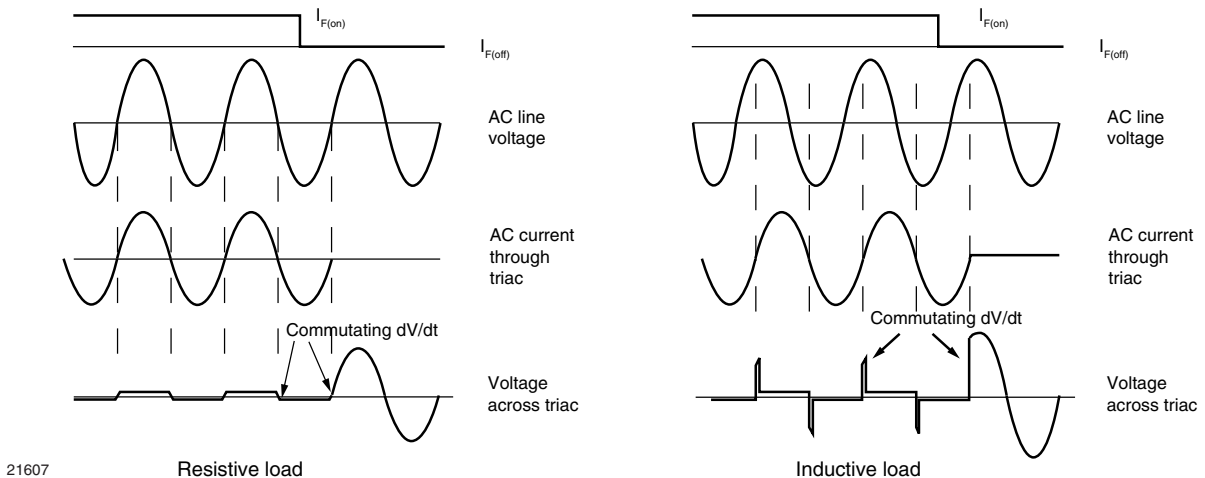


Fig. 8 - Waveforms of Resistive and Inductive Loads

The voltage across the triac will rise rapidly at the time the current through the power handling triac falls below the holding current and the triac ceases to conduct. The rise rate of voltage at the current commutation is called commutating dV/dt. There would be two potential problems for ZC phototriac control if the commutating dV/dt is too high. One is lost control to turn off, another is failed to keep the triac on.

#### Lost control to turn off

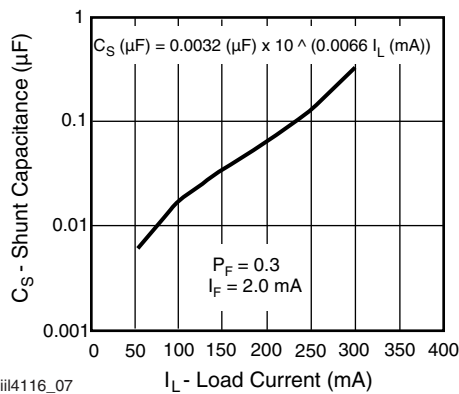
If the commutating dV/dt is too high, more than its critical rate (dV/dt<sub>crit</sub>), the triac may resume conduction even if the LED drive current I<sub>F</sub> is off and control is lost.

In order to achieve control with certain inductive loads of power factors is less than 0.8, the rate of rise in voltage (dV/dt) must be limited by a series RC network placed in parallel with the power handling triac. The RC network is called snubber circuit. Note that the value of the capacitor increases as a function of the load current as shown in fig. 9.

#### Failed to keep on

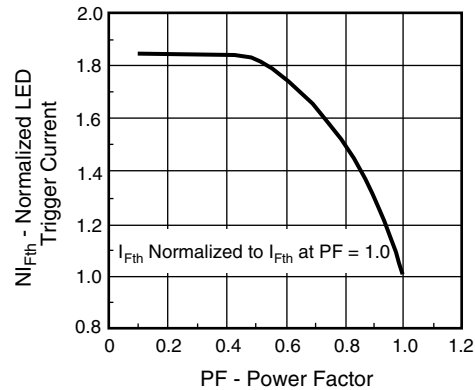
As a zero-crossing phototriac, the commutating dV/dt spikes can inhibit one half of the TRIAC from keeping on. If the spike potential exceeds the inhibit voltage of the zero cross detection circuit, even if the LED drive current I<sub>F</sub> is on.

This hold-off condition can be eliminated by using a snubber and also by providing a higher level of LED drive current. The higher LED drive provides a larger photocurrent which causes the triac to turn-on before the commutating spike has activated the zero cross detection circuit. Fig. 10 shows the relationship of the LED current 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 without the snubber to dump the spike.



iii4116\_07

Fig. 9 - Shunt Capacitance vs. Load Current vs. Power Factor



iii4116\_08

Fig. 10 - Normalized LED Trigger Current

### APPLICATIONS

#### Direct switching operation:

The IL4116, IL4117, IL4118 isolated switch is mainly suited to control synchronous motors, valves, relays and solenoids. Fig. 11 shows a basic driving circuit. For resistive load the snubber circuit  $R_S C_S$  can be omitted due to the high static  $dV/dt$  characteristic.

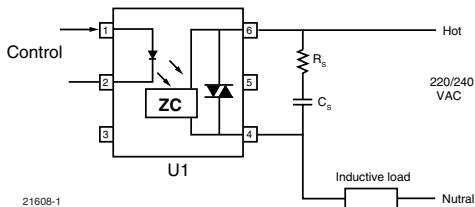


Fig. 11 - Basic Direct Load Driving Circuit

#### Indirect switching operation:

The IL4116, IL4117, IL4118 switch acts here as an isolated driver and thus enables the driving of power thyristors and power triacs by microprocessors. Fig. 12 shows a basic driving circuit of inductive load. The resistor  $R_1$  limits the driving current pulse which should not exceed the maximum permissible surge current of the IL4116, IL4117, IL4118. The resistor  $R_G$  is needed only for very sensitive thyristors or triacs from being triggered by noise or the inhibit current.

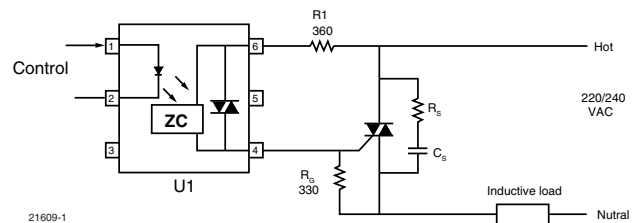


Fig. 12 - Basic Power Triac Driver Circuit





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