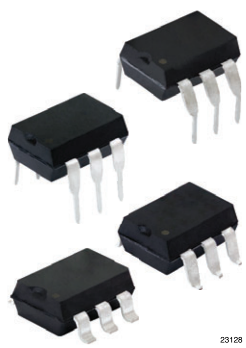
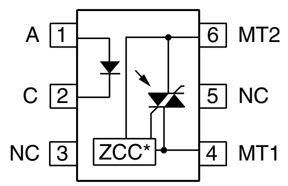
Optocoupler, Phototriac Output, Zero Crossing, High dV/dt, Low Input Current





*Zero crossing circuit

FEATURES

- Low trigger current I_{FT} = 2 mA
- I_{TRMS} = 300 mA
- High static dV/dt ≥ 10 000 V/μs
- Load voltage up to 800 V
- Zero voltage crossing detector
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e3 RoHS COMPLIANT

APPLICATIONS

- Solid-state relay
- Lighting controls
- Temperature controls
- Solenoid / valve controls
- AC motor drives / starters

AGENCY APPROVALS

- UL 1577
- cUL
- DIN EN 60747-5-5 (VDE 0884-5), available with option 1
- FIMKO

LINKS TO ADDITIONAL RESOURCES

Product Page | Design Tools | SPICE Models | Footprints | Schematics

DESCRIPTION

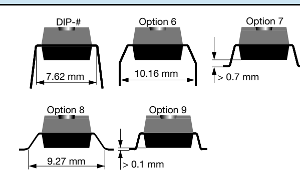
The IL410 and IL4108 consist of an optically coupled GaAs IRLED to a photosensitive thyristor system with integrated noise suppression and zero crossing circuit.

The thyristor system enables low trigger currents of 2 mA and features a dV/dt ratio of greater than 10 kV/μs and load voltages up to 800 V.

The IL410 and IL4108 are a perfect microcontroller friendly solution to isolate low voltage logic from high voltage 120 V_{AC}, 240 V_{AC}, and 380 V_{AC} lines and to control resistive, inductive, or capacitive AC loads like motors, solenoids, high power thyristors or TRIACs, and solid-state relays.

ORDERING INFORMATION

I	L	4	1	0	#	-	X	0	#	#	T
PART NUMBER							PACKAGE OPTION				TAPE AND REEL



AGENCY CERTIFIED / PACKAGE	BLOCKING VOLTAGE V_{DRM} (V)	
UL, cUL, CSA, FIMKO	**600**	**800**
DIP-6	IL410	IL4108
DIP-6, 400 mil, option 6	IL410-X006	-
SMD-6, option 7	IL410-X007T (1)	IL4108-X007T (1)
SMD-6, option 8	IL410-X008T	-
SMD-6, option 9	IL410-X009T	IL4108-X009T (1)
VDE, UL, cUL, CSA, FIMKO	**600**	**800**
DIP-6	IL410-X001	-
DIP-6, 400 mil, option 6	IL410-X016	IL4108-X016
SMD-6, option 7	IL410-X017	IL4108-X017
SMD-6, option 9	IL410-X019T	-

Note

(1) Also available in tubes, do not put T on the end

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)					
PARAMETER	**TEST CONDITION**	**PART**	**SYMBOL**	**VALUE**	**UNIT**
INPUT					
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 from 25 °C				1.33	mW/°C
OUTPUT					
Peak off-state voltage		IL410	V_{DRM}	600	V
		IL4108	V_{DRM}	800	V
RMS on-state current			I_{TM}	300	mA
Single cycle surge current				3	A
Total power dissipation			P_{diss}	500	mW
Derate from 25 °C				6.6	mW/°C
COUPLER					
Pollution degree (DIN VDE 0109)				2	
Storage temperature range			T_{stg}	-55 to +150	°C
Ambient temperature			T_{amb}	-55 to +100	°C
Soldering temperature [(1)]	Max. ≤ 10 s dip soldering ≥ 0.5 mm from case bottom		T_{sld}	260	°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.

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

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)							
PARAMETER	**TEST CONDITION**	**PART**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
INPUT							
Forward voltage	I_F = 10 mA		V_F	-	1.16	1.35	V
Reverse current	V_R = 6 V		I_R	-	0.1	10	µA
Input capacitance	V_F = 0 V, f = 1 MHz		C_{IN}	-	25	-	pF
Thermal resistance, junction to ambient			R_{thja}	-	750	-	°C/W
OUTPUT							
Off-state current	$V_D = V_{DRM}$, T_{amb} = 100 °C, I_F = 0 mA		I_{DRM}	-	10	100	µA
On-state voltage	I_T = 300 mA		V_{TM}	-	1.7	3	V
Surge (non-repetitive), on-state current	f = 50 Hz		I_{TSM}	-	-	3	A
Trigger current 1	V_D = 5 V		I_{FT1}	-	-	2	mA
Trigger current 2	V_D = 220 V_{RMS}, f = 50 Hz, T_j = 100 °C, t_{pIF} > 10 ms		I_{FT2}	-	-	6	mA
Trigger current temp. gradient			$\Delta I_{FT1}/\Delta T_j$	-	7	14	µA/°C
			$\Delta I_{FT2}/\Delta T_j$	-	7	14	µA/°C
Inhibit voltage temp. gradient			$\Delta V_{DINH}/\Delta T_j$	-	-20	-	mV/°C
Off-state current in inhibit state	$I_F = I_{FT1}$, $V_D = V_{DRM}$		I_{DINH}	-	50	200	µA
Holding current			I_H	-	65	500	µA
Latching current	V_T = 2.2 V		I_L	-	-	500	µA
Zero cross inhibit voltage	I_F = rated I_{FT}		V_{IH}	-	15	25	V
Critical rate of rise of off-state voltage	V_D = 0.67 V_{DRM}, T_j = 25 °C		dV/dt_{cr}	10 000	-	-	V/µs
	V_D = 0.67 V_{DRM}, T_j = 80 °C		dV/dt_{cr}	5000	-	-	V/µs
Critical rate of rise of voltage at current commutation	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_J = 25 °C		dV/dt_{crq}	-	8	-	V/µs
	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_J = 85 °C		dV/dt_{crq}	-	7	-	V/µs
Critical rate of rise of on-state current commutation	V_D = 230 V_{RMS}, I_D = 300 mA_{RMS}, T_J = 25 °C		dI/dt_{crq}	-	12	-	A/ms
Thermal resistance, junction to ambient			R_{thja}	-	150	-	°C/W
COUPLER							
Critical rate of rise of coupled input/output voltage	I_T = 0 A, $V_{RM} = V_{DM} = V_{DRM}$		dV_{IO}/dt	10 000	-	-	V/µs
Common mode coupling capacitance			C_{CM}	-	0.01	-	pF
Capacitance (input to output)	f = 1 MHz, V_{IO} = 0 V		C_{IO}	-	0.8	-	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.

SWITCHING CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)							
PARAMETER	**TEST CONDITION**	**PART**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Turn-on time	$V_{RM} = V_{DM} = V_{DRM}$		t_{on}	-	35	-	µs

SAFETY AND INSULATION RATINGS				
PARAMETER	**TEST CONDITION**	**SYMBOL**	**VALUE**	**UNIT**
Climatic classification	According to IEC 68 part 1		55 / 100 / 21	
Comparative tracking index		CTI	175	
Maximum rated withstanding isolation voltage	t = 1 min	V_{ISO}	4420	V_{RMS}
Maximum transient isolation voltage		V_{IOTM}	10 000	V_{peak}
Maximum repetitive peak isolation voltage		V_{IORM}	890	V_{peak}
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C	R_{IO}	$\geq 10^{12}$	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C	R_{IO}	$\geq 10^{11}$	Ω
Output safety power		P_{SO}	400	mW
Input safety current		I_{SI}	275	mA
Safety temperature		T_S	175	°C
Creepage distance			≥ 7	mm
Clearance distance			≥ 7	mm
Insulation thickness		DTI	≥ 0.4	mm

Note

- As per IEC 60747-5-5, § 7.4.3.8.2, 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.

TYPICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

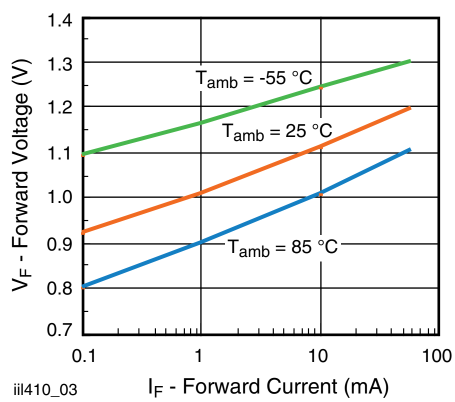


Fig. 1 - Forward Voltage vs. Forward Current

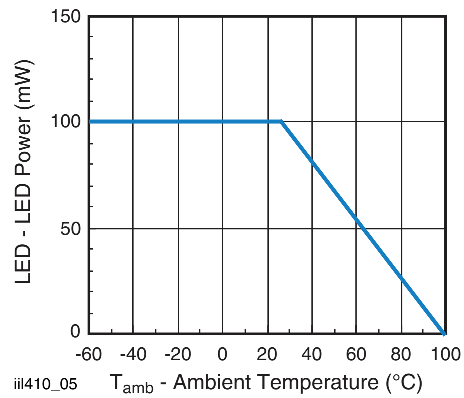


Fig. 3 - Maximum LED Power Dissipation

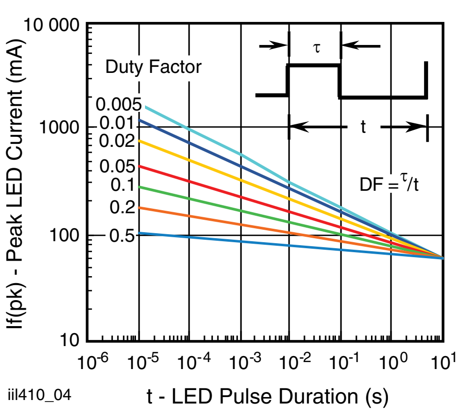


Fig. 2 - Peak LED Current vs. Duty Factor, τ

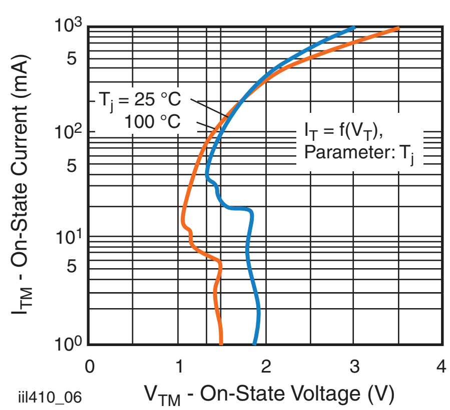


Fig. 4 - Typical Output Characteristics

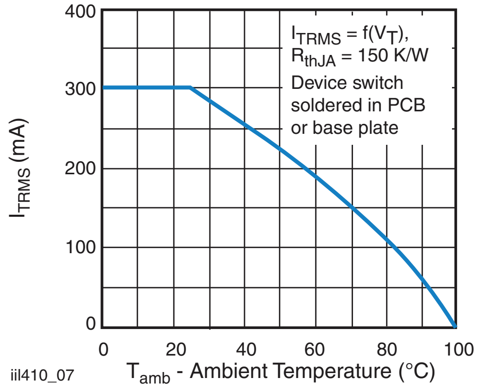


Fig. 5 - Current Reduction

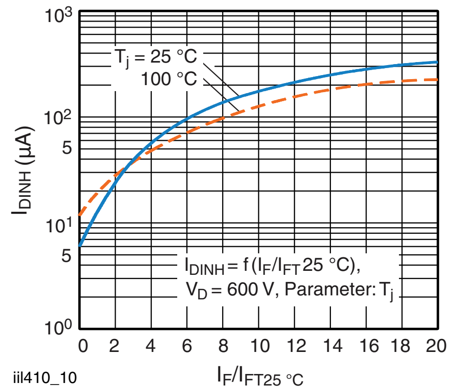


Fig. 8 - Off-State Current in Inhibited State vs. I_F/I_{FT} 25 °C

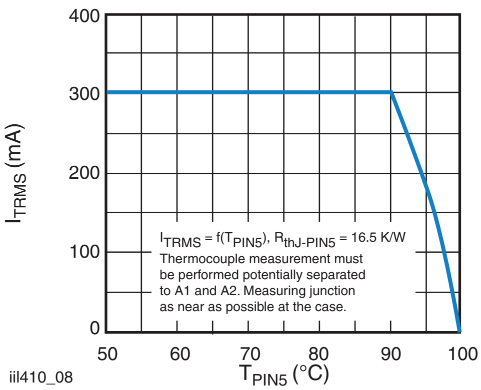


Fig. 6 - Current Reduction

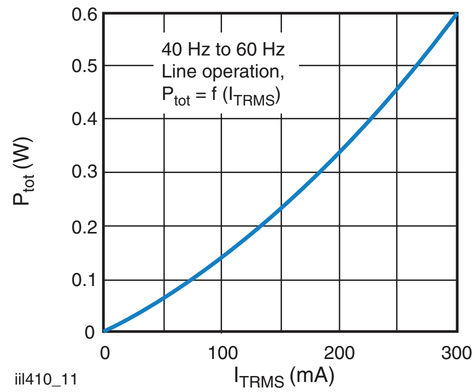


Fig. 9 - Power Dissipation 40 Hz to 60 Hz Line Operation

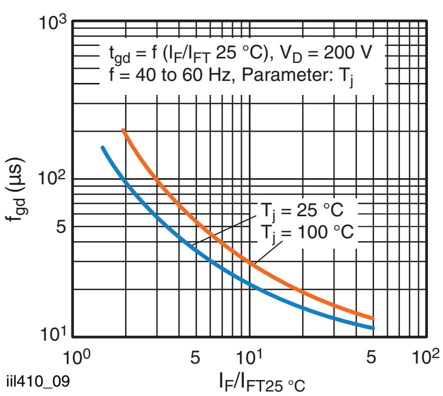


Fig. 7 - Typical Trigger Delay Time

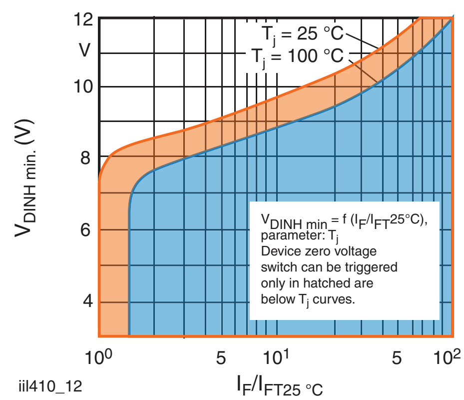


Fig. 10 - Typical Static Inhibit Voltage Limit

TRIGGER CURRENT VS. TEMPERATURE AND VOLTAGE

The trigger current of the IL410, 4108 has a positive temperature gradient and also is dependent on the terminal voltage as shown as the Fig. 11.

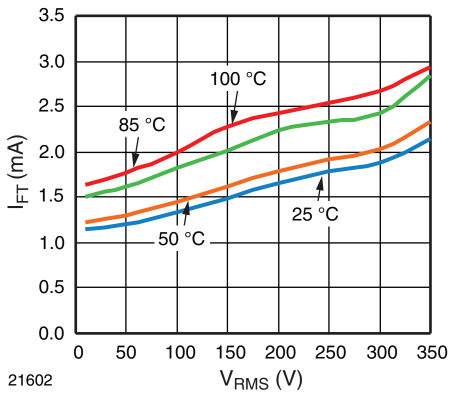


Fig. 11 - Trigger Current vs. Temperature and Operating Voltage (50 Hz)

For the operating voltage 250 V_{RMS} over the temperature range - 40 °C to 85 °C, the I_F should be at least 2.3 x of the I_{FT1} (2 mA, max.).

Considering -30 % degradation over time, the trigger current minimum is I_F = 2 x 2.3 x 130 % = 6 mA.

INDUCTIVE AND RESISTIVE LOADS

For inductive loads, there is phase shift between voltage and current, shown in the Fig. 12.

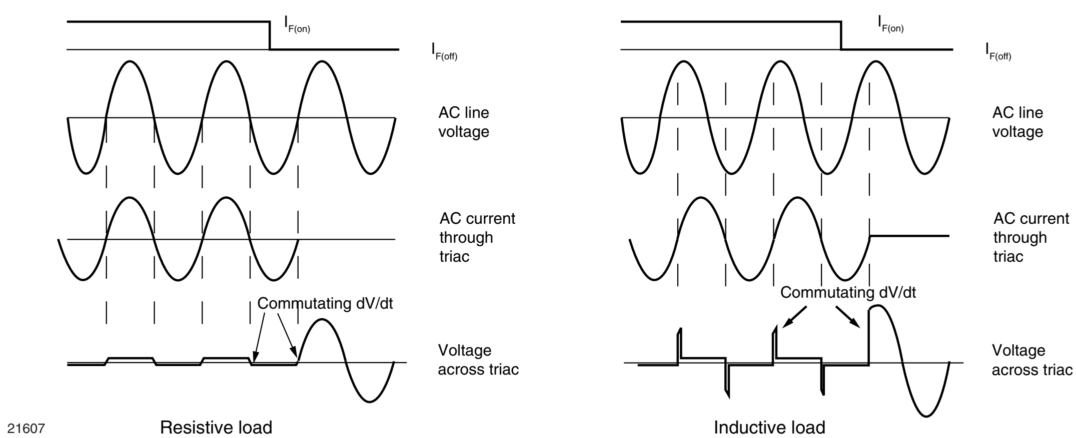


Fig. 12 - Waveforms of Resistive and Inductive Loads

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_{crq}), the triac may resume conduction even if the LED drive current I_F 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. 13.

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_F 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. 14 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.

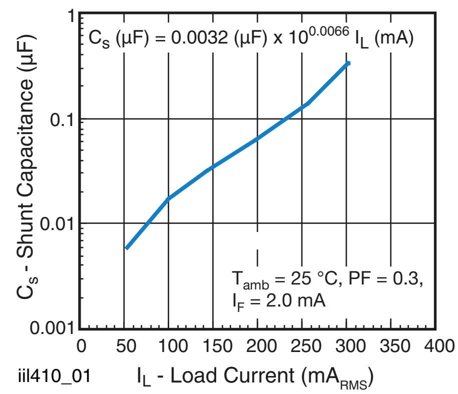


Fig. 13 - Shunt Capacitance vs. Load Current

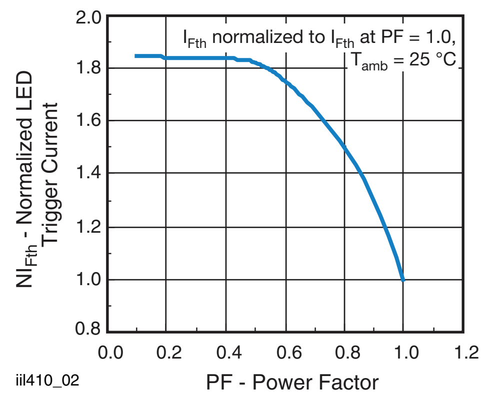


Fig. 14 - Normalized LED Trigger Current vs. Power Factor

APPLICATIONS

Direct switching operation:

The IL410, IL4108 isolated switch is mainly suited to control synchronous motors, valves, relays and solenoids. Fig. 15 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.

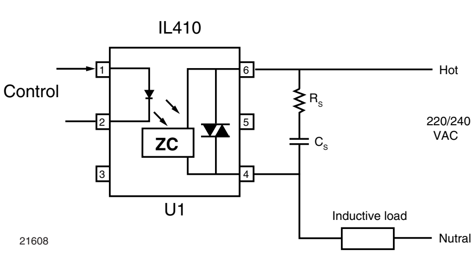


Fig. 15 - Basic Direct Load Driving Circuit

Indirect switching operation:

The IL410, IL4108 switch acts here as an isolated driver and thus enables the driving of power thyristors and power triacs by microprocessors. Fig. 16 shows a basic driving circuit of inductive load. The resister R1 limits the driving current pulse which should not exceed the maximum permissible surge current of the IL410, IL4108. The resister R_G is needed only for very sensitive thyristors or triacs from being triggered by noise or the inhibit current.

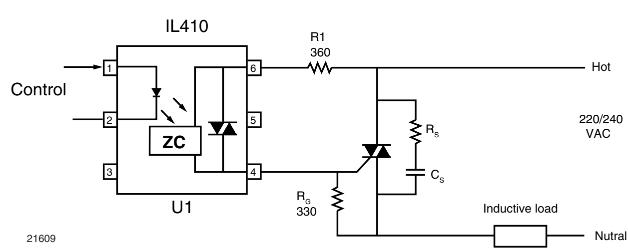
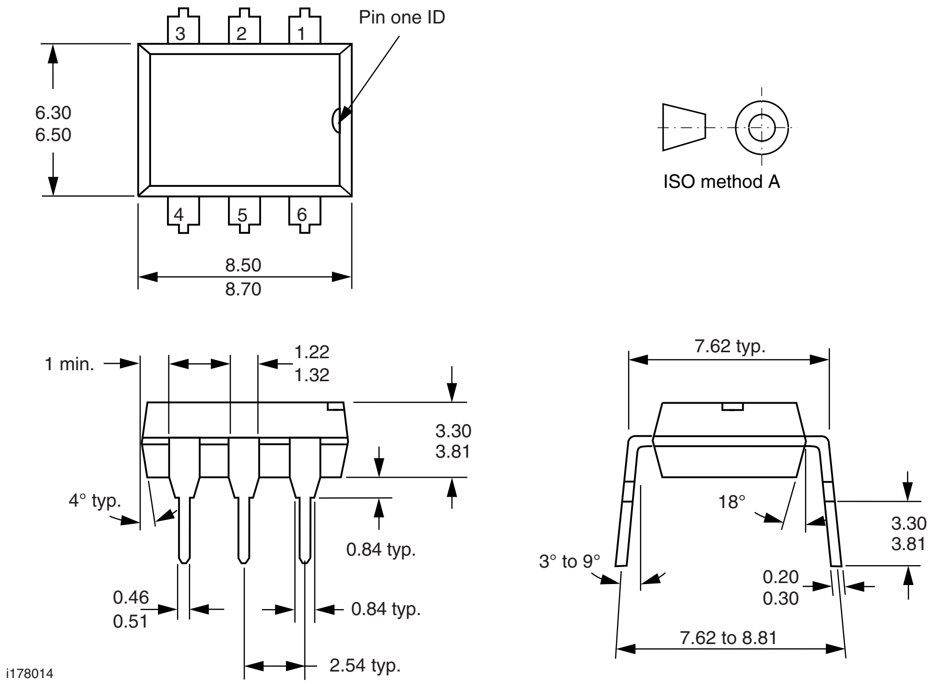
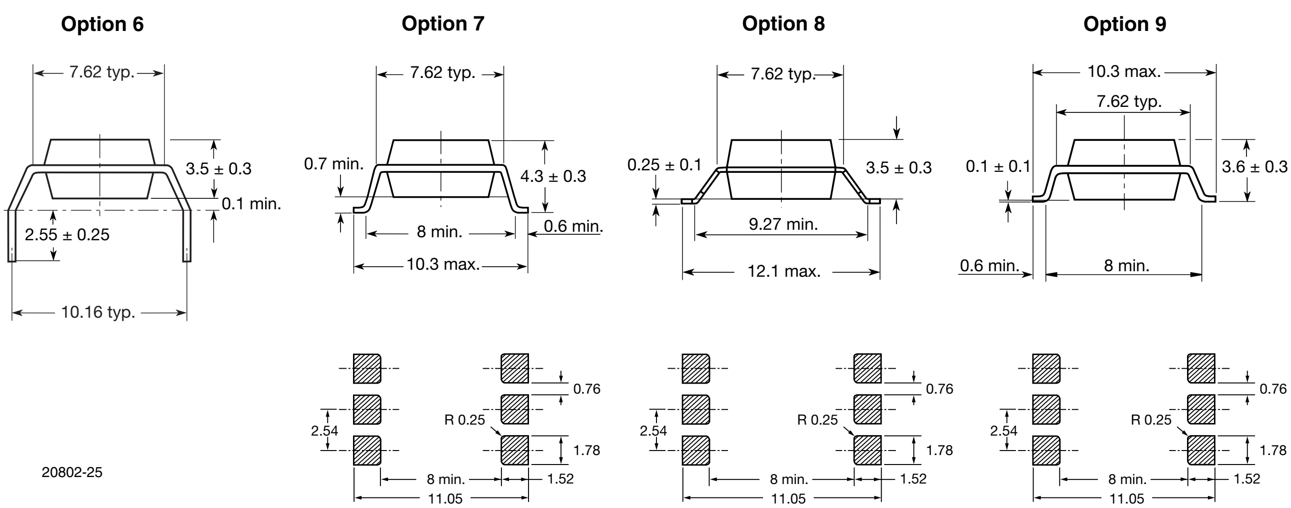


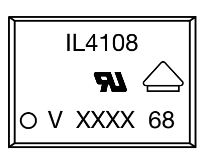
Fig. 16 - Basic Power Triac Driver Circuit

PACKAGE DIMENSIONS in millimeters





PACKAGE MARKING (example)



Notes

- XXXX = LMC (lot marking code)
- Only options 1, 7, and 8 are reflected in the package marking
- The VDE Logo is only marked on option 1 parts
- Tape and reel suffix (T) is not part of the package marking

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