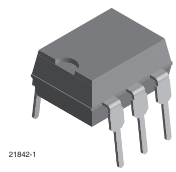
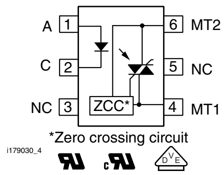
Optocoupler, Phototriac Output, Zero Crossing, High dV/dt, Low Input Current





DESCRIPTION

The IL410 and IL4108 consists of a GaAs IRLED optically coupled to a photosensitive zero crossing TRIAC network. The TRIAC consists of two inverse parallel connected monolithic SCRs. These three semiconductors are assembled in a six pin dual in-line package.

High input sensitivity is achieved by using an emitter follower phototransistor and a cascaded SCR predriver resulting in an LED trigger current of less than 2 mA (DC).

The use of a proprietary dV/dt clamp results in a static dV/dt of greater than 10 kV/ms. This clamp circuit has a MOSFET that is enhanced when high dV/dt spikes occur between MT1 and MT2 of the TRIAC. When conducting, the FET clamps the base of the phototransistor, disabling the first stage SCR predriver.

The zero cross line voltage detection circuit consists of two enhancement MOSFETS and a photodiode. The inhibit voltage of the network is determined by the enhancement voltage of the N-channel FET. The P-channel FET is enabled by a photocurrent source that permits the FET to conduct the main voltage to gate on the N-channel FET. Once the main voltage can enable the N-channel, it clamps the base of the phototransistor, disabling the first stage SCR predriver.

The 600 V, 800 V blocking voltage permits control of off-line voltages up to 240 V_{AC}, with a safety factor of more than two, and is sufficient for as much as 380 V_{AC}.

The IL410, IL4108 isolates low-voltage logic from 120 V_{AC}, 240 V_{AC}, and 380 V_{AC} lines to control resistive, inductive, or capacitive loads including motors, solenoids, high current thyristors or TRIAC and relays.

FEATURES

- High input sensitivity
- I_{FT} = 2 mA, PF = 1.0
- I_{FT} = 5 mA, PF ≤ 1.0
- 300 mA on-state current
- Zero voltage crossing detector
- 600 V, 800 V blocking voltage
- High static dV/dt 10 kV/μs
- Very low leakage < 10 μA
- Isolation test voltage 5300 V_{RMS}
- Small 6 pin DIP package
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Pb-free
e3
RoHS
COMPLIANT

APPLICATIONS

- Solid-state relays
- Industrial controls
- Office equipment
- Consumer appliances

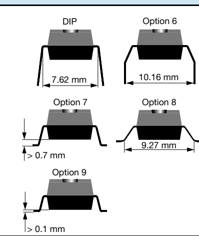
AGENCY APPROVALS

- UL1577, file no. E52744 system code H or J, double protection
- CSA 93751
- DIN EN 60747-5-5 (VDE 0884) available with option 1

ORDERING INFORMATION

I	L	4	1	0	#	-	X	0	#	#	T

PART NUMBER (I L 4 1 0 #) — PACKAGE OPTION (X 0 # #) — TAPE AND REEL (T)



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

Note

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

ABSOLUTE MAXIMUM RATINGS (1) (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					
Isolation test voltage between emitter and detector	t = 1 s		V_{ISO}	5300	V_{RMS}
Pollution degree (DIN VDE 0109)				2	
Creepage distance				≥ 7	mm
Clearance distance				≥ 7	mm
Comparative tracking index per DIN IEC112/VDE 0303 part 1, group IIIa per DIN VDE 6110			CTI	≥ 175	
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C		R_{IO}	≥ 10^{12}	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C		R_{IO}	≥ 10^{11}	Ω
Storage temperature range			T_{stg}	- 55 to + 150	°C
Ambient temperature			T_{amb}	- 55 to + 100	°C
Soldering temperature (2)	max. ≤ 10 s dip soldering ≥ 0.5 mm from case bottom		T_{sld}	260	°C

Notes

(1) 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.

(2) 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 voltage	$I_{D(RMS)}$ = 70 µA	IL410	$V_{D(RMS)}$	424	460		V
		IL4108	$V_{D(RMS)}$	565			V
Repetitive peak off-state voltage	I_{DRM} = 100 µA	IL410	V_{DRM}	600			V
		IL4108	V_{DRM}	800			V
Off-state current	$V_D = V_{DRM}$, T_{amb} = 100 °C, I_F = 0 mA		$I_{D(RMS)1}$		10	100	µA
On-state voltage	I_T = 300 mA		V_{TM}		1.7	3	V
On-state current	PF = 1, $V_{T(RMS)}$ = 1.7 V		I_{TM}			300	mA
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_{OP} = 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_{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
Turn-on time	$V_{RM} = V_{DM} = V_{D(RMS)}$		t_{on}		35		µs
Turn-off time	PF = 1, I_T = 300 mA		t_{off}		50		µs
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_{crq}	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, $V_{RM} = V_{DM} = V_{D(RMS)}$		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
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

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.

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

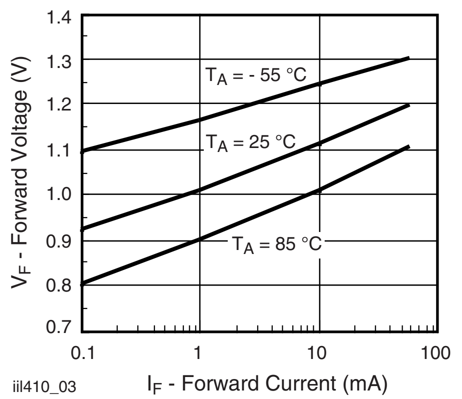


Fig. 1 - Forward Voltage vs. Forward Current

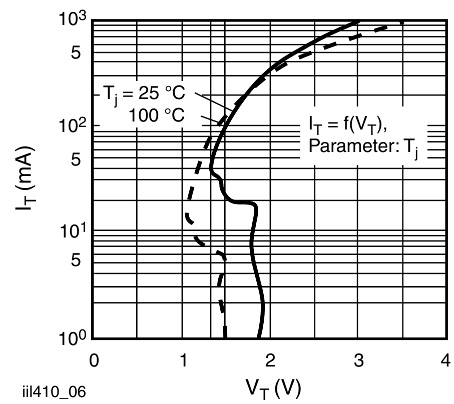


Fig. 4 - Typical Output Characteristics

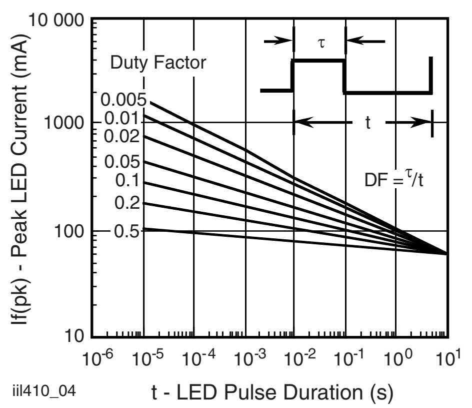


Fig. 2 - Peak LED Current vs. Duty Factor, τ

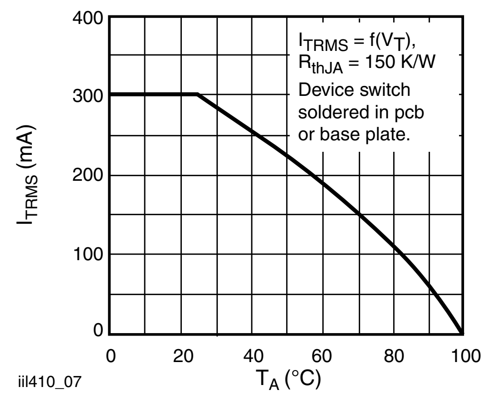


Fig. 5 - Current Reduction

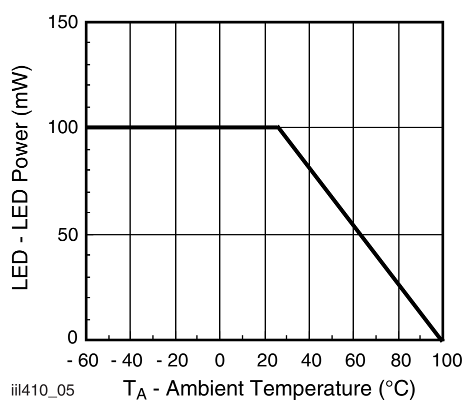


Fig. 3 - Maximum LED Power Dissipation

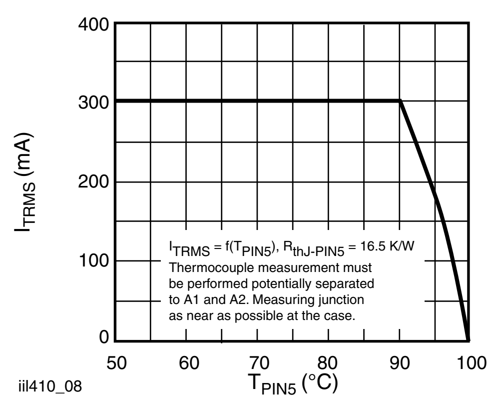


Fig. 6 - Current Reduction

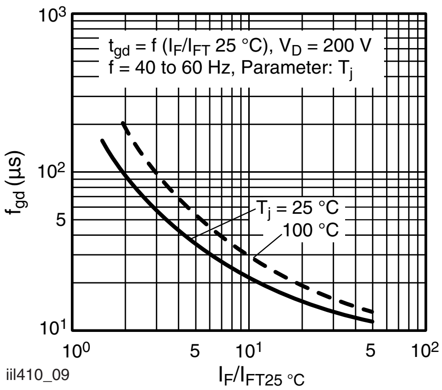


Fig. 3 - Typical Trigger Delay Time

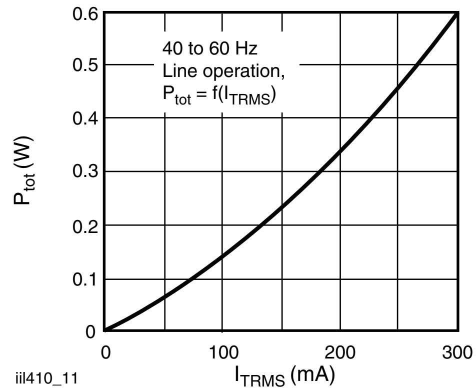


Fig. 8 - Power Dissipation 40 Hz to 60 Hz Line Operation

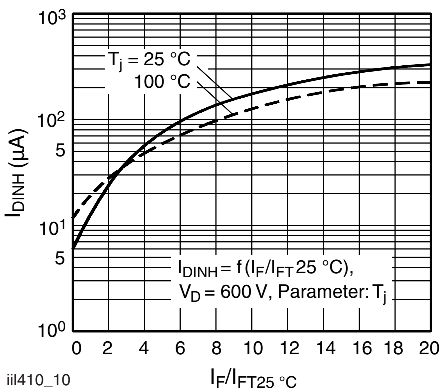


Fig. 7 - Off-State Current in Inhibited State vs. I_F/I_{FT} 25 °C

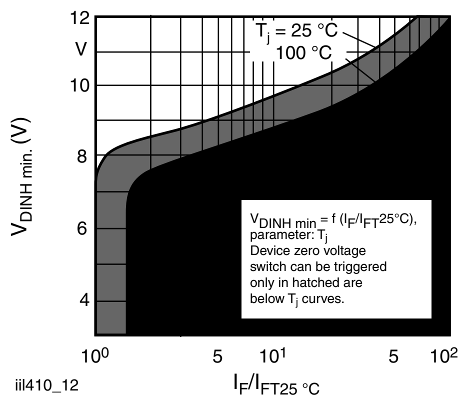


Fig. 9 - Typical Static Inhibit Voltage Limit

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.

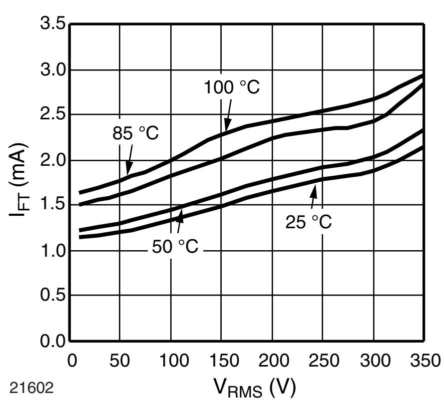


Fig. 11 - Trigger Current vs.
Temperature and Operating Voltage (50 Hz)

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} (1.3 mA, max.).

Considering - 30 % degradation over time, the trigger current minimum is I_F = 1.3 x 2.3 x 130 % = 4 mA

INDUCTIVE AND RESISTIVE LOADS

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

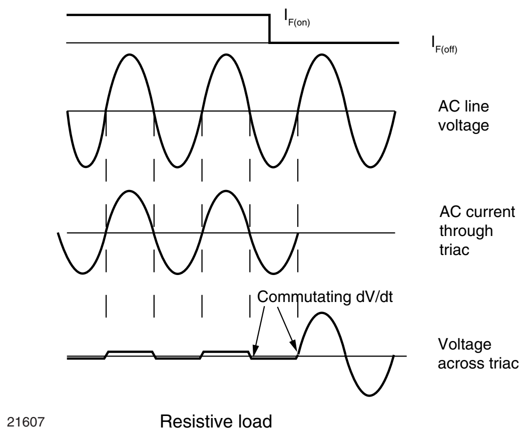


Fig. 12 - Waveforms of Resistive and Inductive Loads

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.

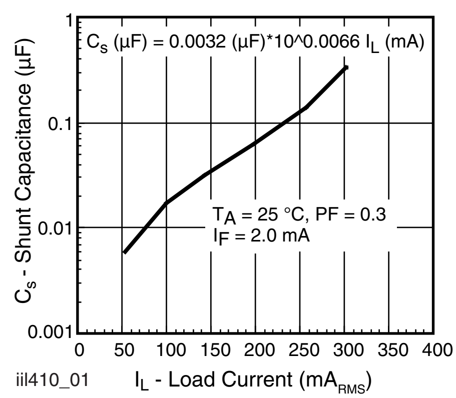


Fig. 10 - Shunt Capacitance vs. Load Current

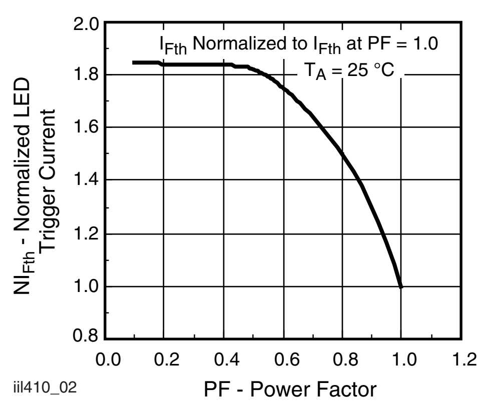


Fig. 11 - Normalized LED Trigger Current vs. Power Factor

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.

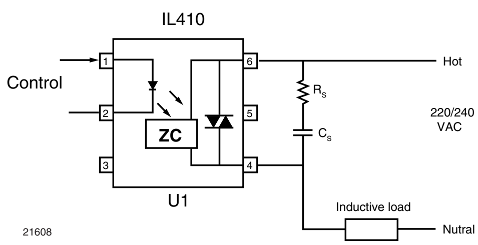


Fig. 15 - Basic Direct Load Driving Circuit

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.

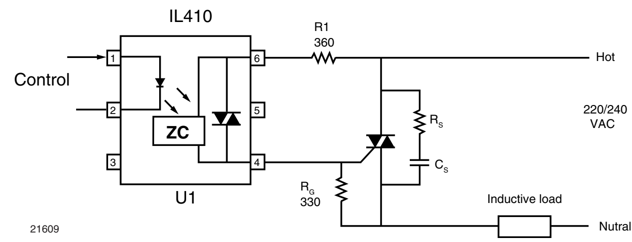
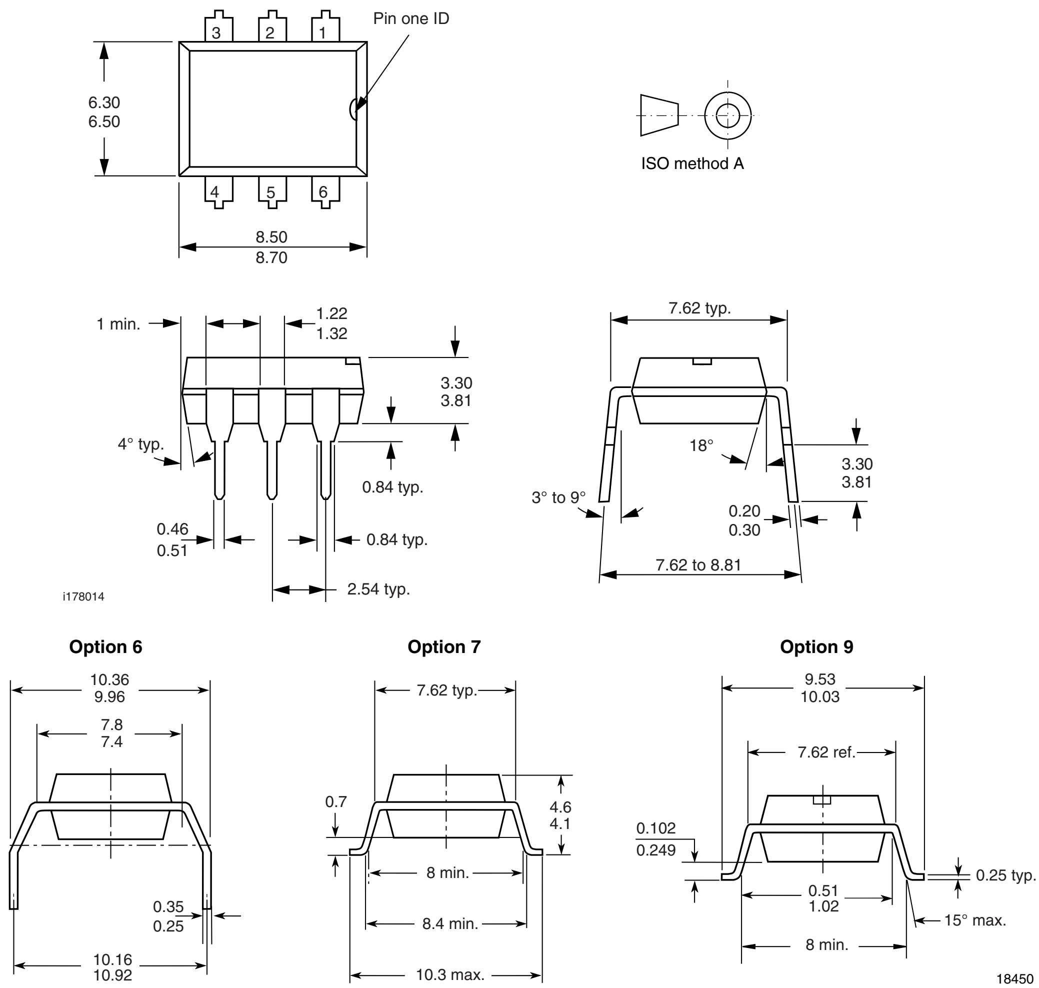


Fig. 16 - Basic Power Triac Driver Circuit

PACKAGE DIMENSIONS in millimeters



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