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September 2016

MID400
AC Line Monitor Logic-Out Device

Features

- Direct operation from any line voltage with the use of an external resistor.
- Externally adjustable time delay
- Externally adjustable AC voltage sensing level
- Logic level compatibility
- Safety and Regulatory Approvals:
  – UL1577, 2,500 VAC_{RMS} for 1 Minute
  – DIN-EN/IEC60747-5-5, 630 V Peak Working Insulation Voltage

Applications

- Monitoring of the AC/DC "line-down" condition
- "Closed-loop" interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

Description

The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a logic low condition.

The MID400 has been designed solely for the use as an AC line monitor. It is recommended for use in any AC-to-DC control application where excellent optical iso- lation, solid state reliability, TTL compatibility, small size, low power, and low frequency operations are required.

Functional Schematic

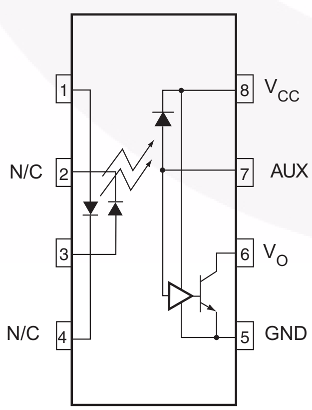


Figure 1. Schematic

Package Outlines

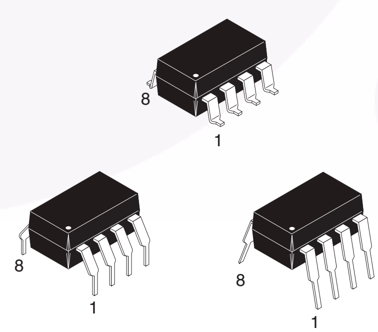


Figure 2. Package Outlines

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_{RMS}	I–IV
	< 300 V_{RMS}	I–IV
Climatic Classification		55/100/21
Pollution Degree (DIN VDE 0110/1.89)		2
Comparative Tracking Index		175

Symbol	Parameter	Value	Unit
V_{PR}	Input-to-Output Test Voltage, Method A, V_{IORM} x 1.6 = V_{PR}, Type and Sample Test with t_m = 10 s, Partial Discharge < 5 pC	1008	V_{peak}
	Input-to-Output Test Voltage, Method B, V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 s, Partial Discharge < 5 pC	1182	V_{peak}
V_{IORM}	Maximum Working Insulation Voltage	630	V_{peak}
V_{IOTM}	Highest Allowable Over-Voltage	6000	V_{peak}
	External Creepage	≥ 7	mm
	External Clearance	≥ 7	mm
DTI	Distance Through Insulation (Insulation Thickness)	≥ 0.4	mm
T_S	Case Temperature[(1)]	150	°C
$I_{S,INPUT}$	Input Current[(1)]	60	mA
$P_{S,OUTPUT}$	Output Power[(1)]	150	mW
R_{IO}	Insulation Resistance at T_S, V_{IO} = 500 V[(1)]	> 10^9	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.

Symbol	Parameter	Value	Unit
T_{STG}	Storage Temperature	-55 to +125	°C
T_{OPR}	Operating Temperature	-40 to +85	°C
T_J	Junction Temperature	-55 to +100	°C
T_{SOL}	Lead Solder Temperature	260 for 10 seconds	°C
P_D	Total Device Power Dissipation @ T_A = 25°C	115	mW
	Derate Above 70°C	4	mW/°C
EMITTER			
	RMS Current	25	mA
	DC Current	±30	mA
$P_{D(EMITTER)}$	LED Power Dissipation @ T_A = 25°C	45	mW
	Derate Above 70°C	2	mW/°C
DETECTOR			
I_{OL}	Low Level Output Current	20	mA
V_{OH}	High Level Output Voltage	7	V
V_{CC}	Supply Voltage	7	V
$P_{D(DETECTOR)}$	Detector Power Dissipation @ T_A = 25°C	70	mW
	Derate Above 70°C	2	mW/°C

Electrical Characteristics

0°C to 70°C Free Air Temperature unless otherwise specified.

Individual Component Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
EMITTER						
V_F	Input Forward Voltage	$I_{IN(DC)}$ = ±30 mA			1.5	V
DETECTOR						
I_{CCL}	Logic Low Output Supply Current	$I_{IN(RMS)}$ = 4.0 mA, V_O = Open, V_{CC} = 5.5V, 24 V ≤ $V_{IN(ON\_RMS)}$ ≤ 240 V			3.0	mA
I_{CCH}	Logic High Output Supply Current	$I_{IN(RMS)}$ = 0.15 mA, V_{CC} = 5.5 V, $V_{IN(OFF\_RMS)}$ ≥ 5.5 V			0.8	mA

Transfer Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
DC CHARACTERISTICS						
V_{OL}	Logic Low Output Current	I_{IN} = $I_{IN(ON\_RMS)}$, I_O = 16 mA, V_{CC} = 4.5 V, 24 V ≤ $V_{IN(ON\_RMS)}$ ≤ 240 V		0.18	0.40	V
I_{OH}	Logic High Output Current	$I_{IN(RMS)}$ = 0.15 mA, V_O = V_{CC} = 5.5 V, $V_{IN(OFF\_RMS)}$ ≥ 5.5 V		0.02	100	µA
$V_{IN(ON\_RMS)}$	On-state RMS Input Voltage	I_O = 16 mA, V_O = 0.4 V, V_{CC} = 4.5 V, R_{IN} = 22 kΩ	90			V
$V_{IN(OFF\_RMS)}$	Off-state RMS Input Voltage	I_O ≤ 100 µA, V_O = V_{CC} = 5.5 V, R_{IN} = 22 kΩ			5.5	V
$I_{IN(ON\_RMS)}$	On-state RMS Input Current	I_O = 16 mA, V_O = 0.4 V, V_{CC} = 4.5 V, 24 V ≤ $V_{IN(ON\_RMS)}$ ≤ 240 V	4.0			mA
$I_{IN(OFF\_RMS)}$	Off-state RMS Input Current	I_O ≤ 100 µA, V_O = V_{CC} = 5.5 V, $V_{IN(OFF\_RMS)}$ ≥ 5.5 V			0.15	mA
AC CHARACTERISTICS						
t_{ON}	Turn-On Time	$I_{IN(RMS)}$ = 4.0 mA, I_O = 16 mA, V_{CC} = 4.5 V, R_{IN} = 22 kΩ (See figure 4)		1.0		ms
t_{OFF}	Turn-Off Time			1.0		ms

Isolation Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{ISO}	Steady State Isolation Voltage	Relative Humidity ≤ 50%, I_{I-O} ≤ 10 µA, 1 Minute, 60 Hz	2,500			VAC_{RMS}
C_{ISO}	Isolation Capacitance	f = 1 MHz			2	pF
R_{ISO}	Isolation Resistance	V_{I-O} = 500 VDC	10^{11}			Ω

Applications Information

The input of the MID400 consists of two back-to-back LED diodes which will accept and convert alternating currents into light energy. An integrated photo diode-detector amplifier forms the output network. Optical coupling between input and output provides 2500 VAC_{RMS} voltage isolation. A very high current transfer ratio (defined as the ratio of the DC output current and the DC input current) is achieved through the use of high gain amplifier. The detector amplifier circuitry operates from a 5V DC supply and drives an open collector transistor output. The switching times are intentionally designed to be slow in order to enable the MID400, when used as an AC line monitor, to respond only to changes in input voltage exceeding many milliseconds. The short period of time during zero-crossing which occurs once every half cycle of the power line is completely ignored. To operate the MID400, always add a resistor, R_{IN}, in series with the input (as shown in figure 3) to limit the current to the required value. The value of the resistor can be determined by the following equation:

$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

Where,

V_{IN} (RMS) is the input voltage.

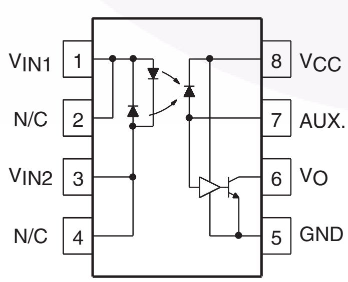
V_F is the forward voltage drop across the LED.

I_{IN} (RMS) is the desired input current required to sustain a logic "O" on the output.

Pin Description

Pin Number	Pin Name	Function
1, 3	V_{IN1}, V_{IN2}	Input terminals
2, 4	N/C	No Connect
8	V_{CC}	Supply voltage, output circuit.
7	AUX	Auxiliary terminal. Programmable capacitor input to adjust AC voltage sensing level and time delay.
6	V_O	Output terminal; open collector.
5	GND	Circuit ground potential.

Schematic Diagram



Glossary

VOLTAGES

$V_{IN\ (ON\_RMS)}$ On-State RMS Input Voltage

The RMS voltage at an input terminal for a specified input current with output conditions applied according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$V_{IN\ (OFF\_RMS)}$ Off-State RMS Input Voltage

The RMS voltage at an input terminal for a specified input current with output conditions applied according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.

V_{OL} Low-Level Output Voltage

The voltage at an output terminal for a specific output current I_{OL}, with input conditions applied according to the product specification will establish a low-level at the output.

V_{OH} High-Level Output Voltage

The voltage at an output terminal for a specific output current I_{OH}, with input conditions applied according to the product specification will establish a high-level at the output.

V_F LED Forward Voltage

The voltage developed across the LED when input current I_F is applied to the anode of the LED.

CURRENTS

$I_{IN\ (ON\_RMS)}$ On-State RMS Input Current

The RMS current flowing into an input with output conditions applied according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.

$I_{IN\ (OFF\_RMS)}$ Off-state RMS Input Current

The RMS current flowing into an input with output conditions applied according to the product specification will cause the output switching element to be sustained in the off-state within one full cycle.

I_{OH} High-Level Output Current

The current flowing into an output with input conditions applied according to the product specification will establish a high-level at the output.

I_{OL} **Low-Level Output Current**

The current flowing into an output with input conditions applied according to the product specification will establish a low-level at the output.

I_{CCL} **Supply Current, Output LOW**

The current flowing into the V_{CC} supply terminal of a circuit when the output is at a low-level voltage.

I_{CCH} **Supply Current, Output HIGH**

The current flowing into the V_{CC} supply terminal of a circuit when the output is at a high-level voltage.

DYNAMIC CHARACTERISTICS

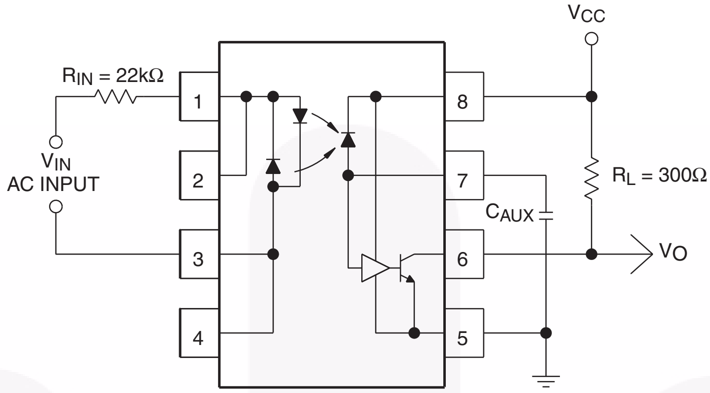
t_{ON} **Turn-On Time**

The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined high-level to the defined low-level.

t_{OFF} **Turn-Off time**

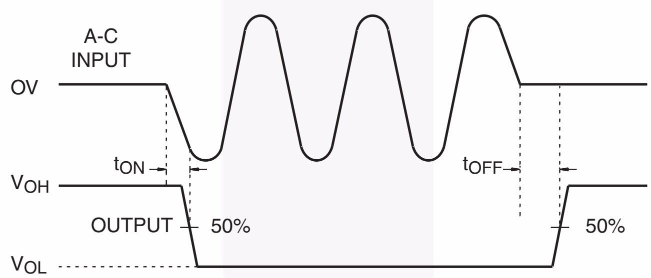
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined low-level to the defined high-level.

Test Circuits

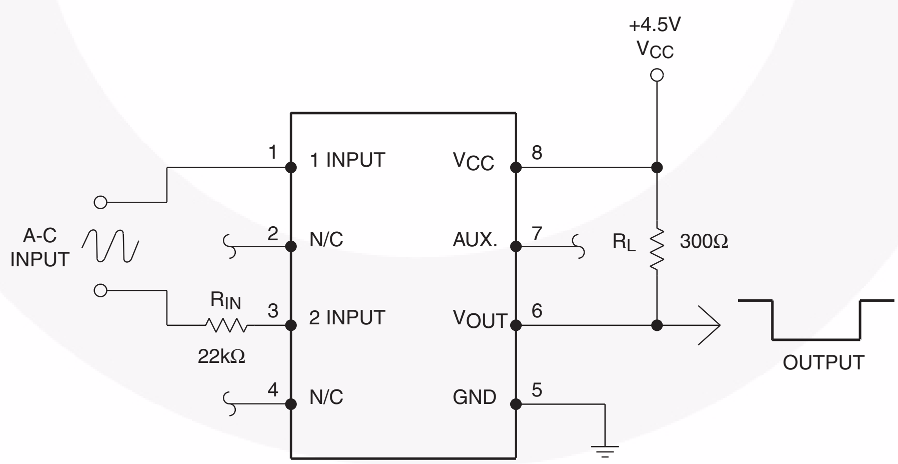


INPUT CURRENT VS. CAPACITANCE, C_{AUX} CIRCUIT

Figure 3. Typical Application Circuit



* INPUT TURNS ON AND OFF AT ZERO CROSSING



TEST CIRCUIT

Figure 4. MID400 Switching Time

Typical Performance Curves

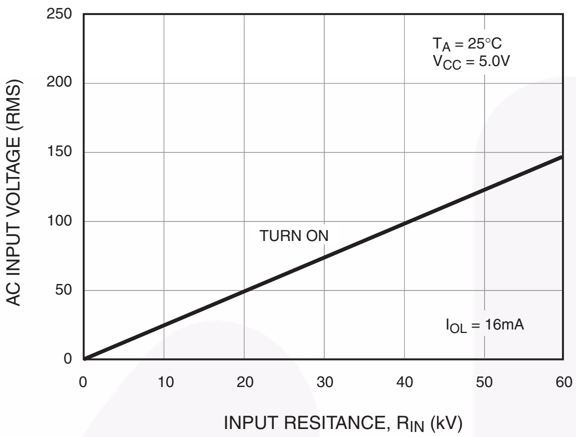


Fig. 5 Input Voltage vs. Input Resistance

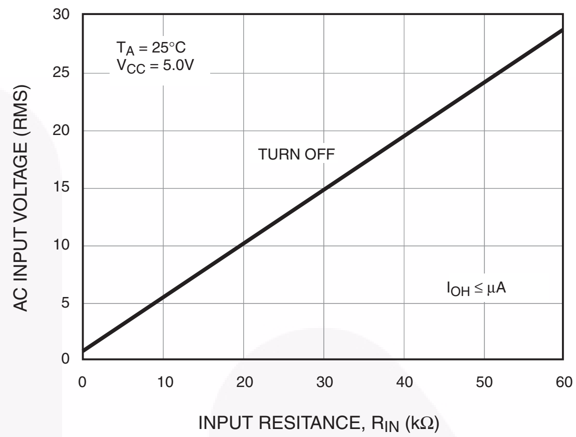


Fig. 6 Input Voltage vs. Input Resistance

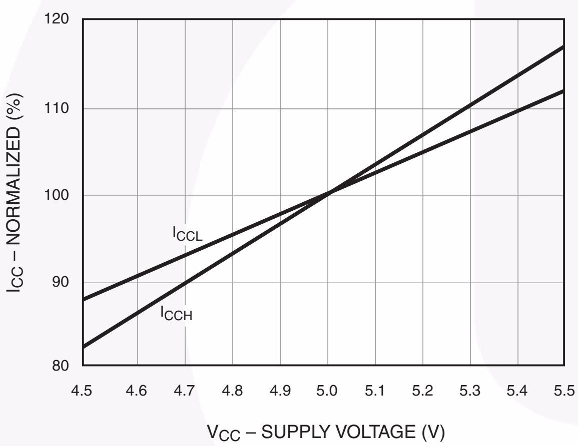


Fig. 7 Supply Current vs. Supply Voltage

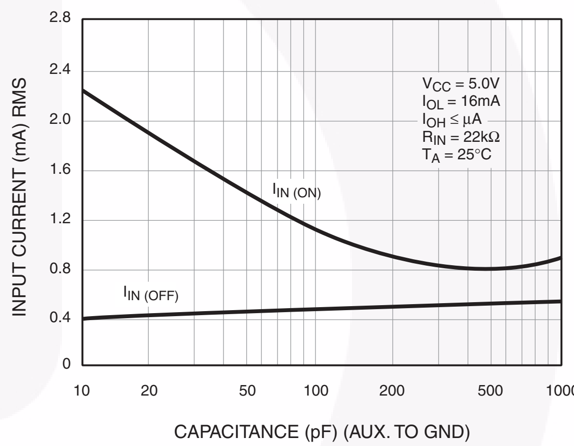


Fig. 8 Input Current vs. Capacitance

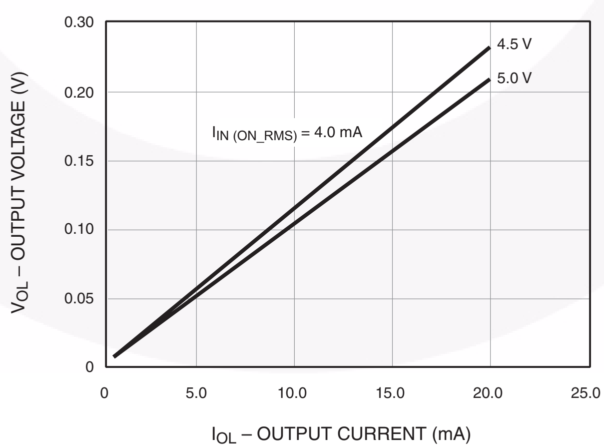


Fig. 9 Output Voltage vs. Output Current

Ordering Information

Part Number	Package	Packing Method
MID400	DIP 8-Pin	Tube (50 units per tube)
MID400S	SMT 8-Pin (Lead Bend)	Tube (50 units per tube)
MID400SD	SMT 8-Pin (Lead Bend)	Tape and Reel (1,000 units per reel)
MID400V	DIP 8-Pin, DIN EN/IEC 60747-5-5 Option	Tube (50 units per tube)
MID400SV	SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 Option	Tube (50 units per tube)
MID400SDV	SMT 8-Pin, DIN EN/IEC 60747-5-5 Option	Tape and Reel (1,000 units per reel)
MID400WV	DIP 8-Pin, 0.4” Lead Spacing, DIN EN/IEC 60747-5-5 Option	Tube (50 units per tube)

Marking Information

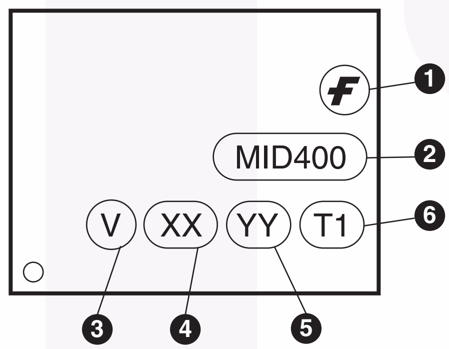
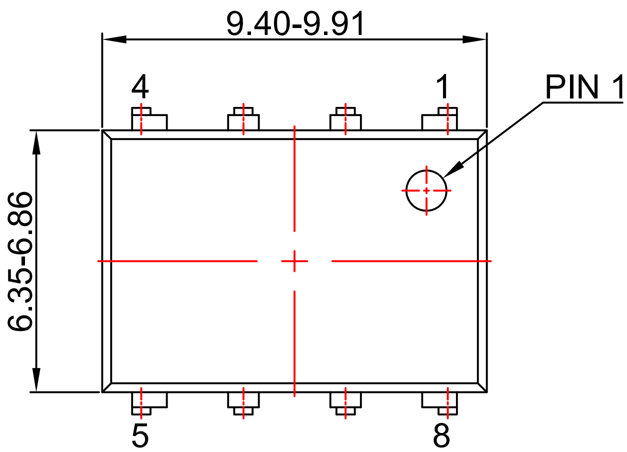
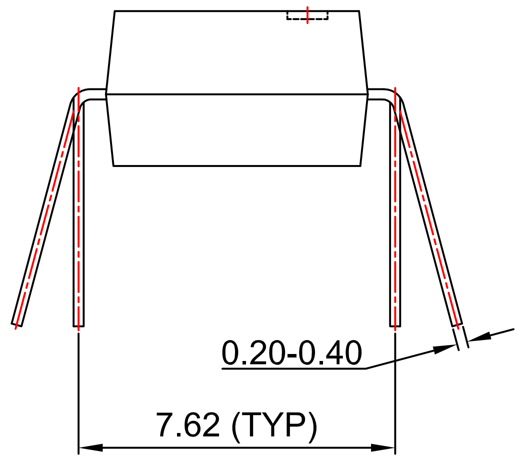


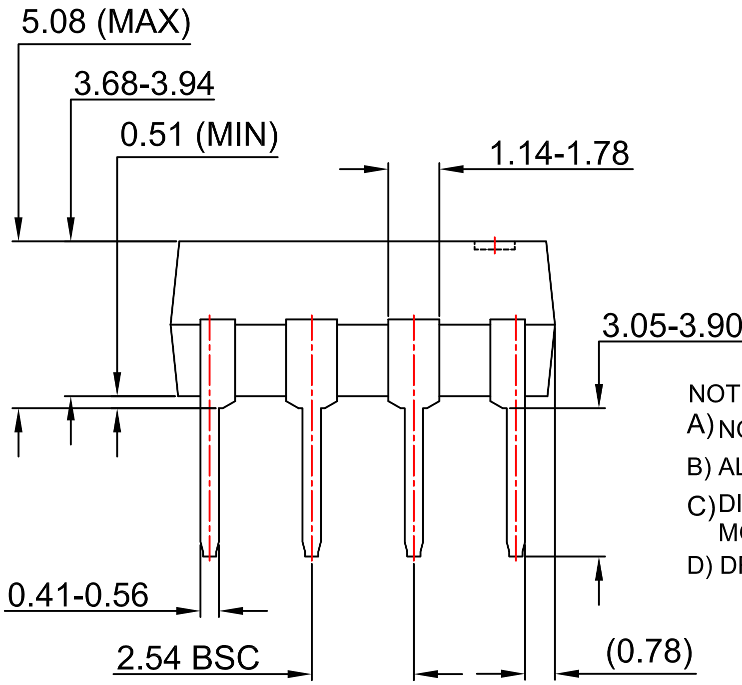
Figure 10. Top Mark

Table 1. Top Mark Definitions

1	Fairchild Logo
2	Device Number
3	DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)
4	Two-Digit Year Code, e.g., “06”
5	Digit Work Week, Ranging from “01” to “53”
6	Assembly Package Code







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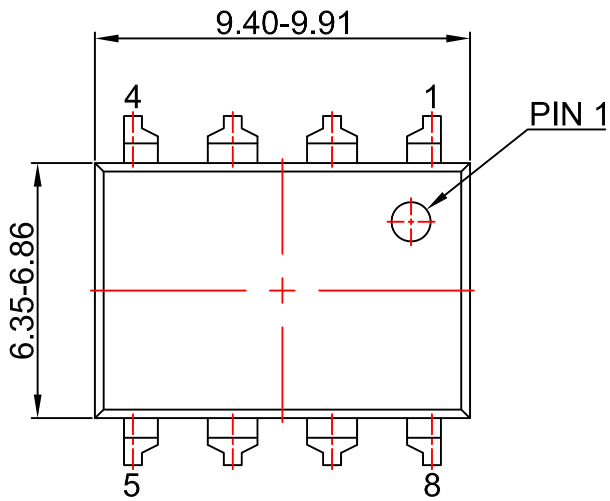
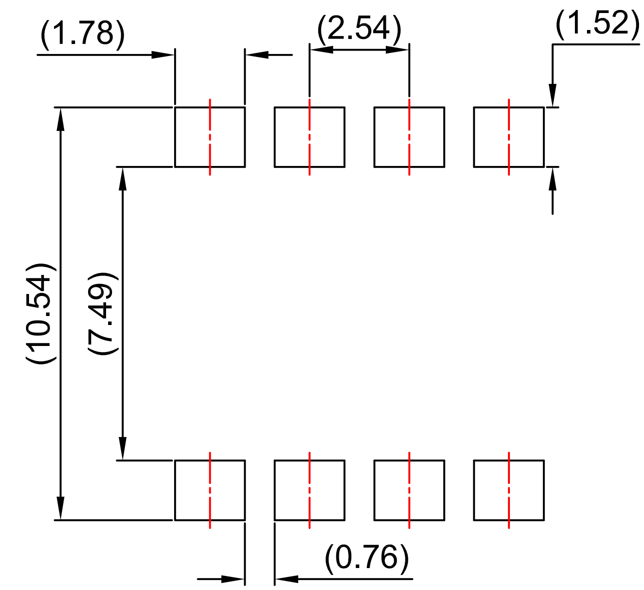
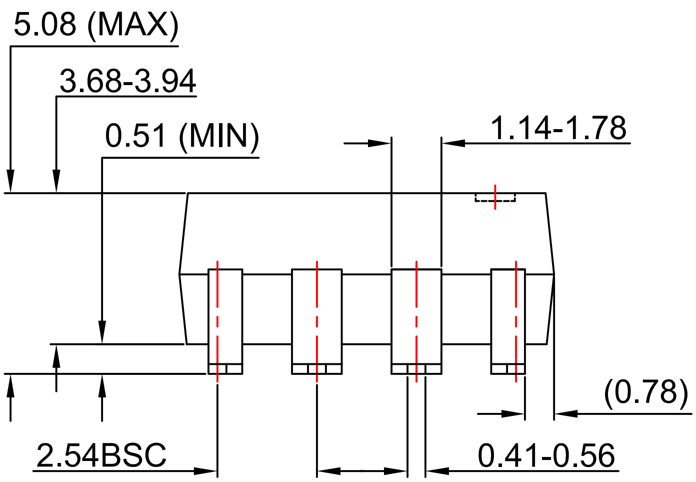
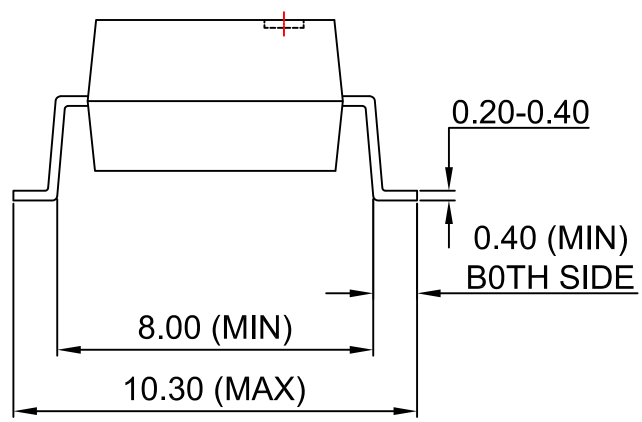




LAND PATTERN RECOMMENDATION





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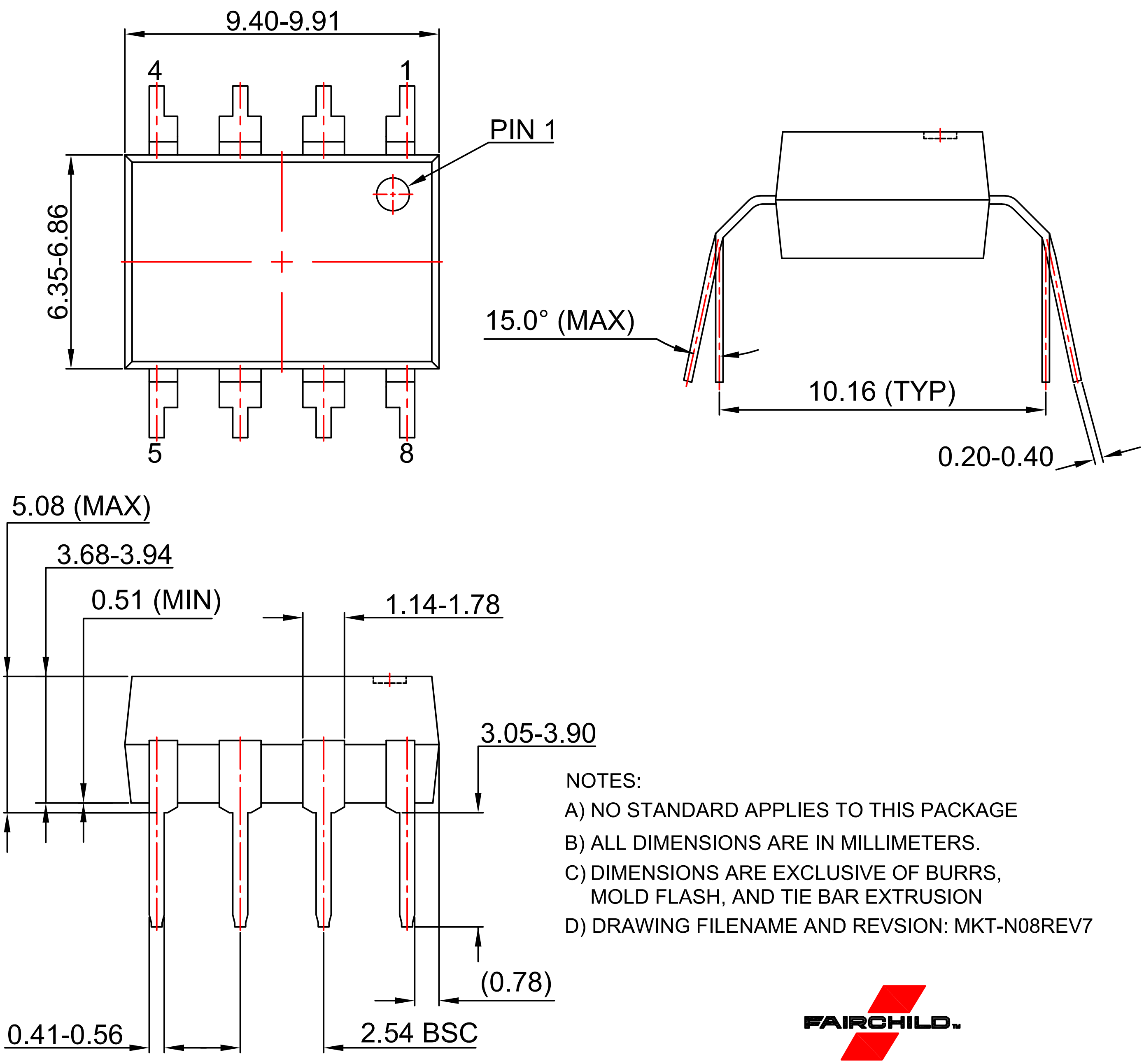

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