FAIRCHILD SEMICONDUCTOR®

April 2010

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
- High voltage isolation between input and output
- Compact plastic DIP package
- Logic level compatibility
- UL recognized (File #E90700)
- VDE recognized (file #102915), – add option V (e.g., MID400V)

Applications

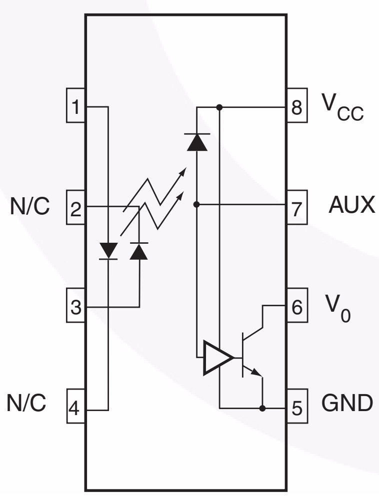
- Monitoring of the AC/DC “line-down” condition
- “Closed-loop” interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

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.

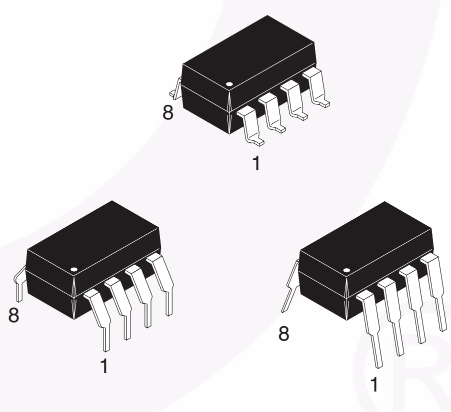
The MID400 has been designed solely for the use as an **AC line monitor**. It is recommended for use in any AC-to-DC control application where excellent optical isolation, solid state reliability, TTL compatibility, small size, low power, and low frequency operations are required.

Schematic



Equivalent Circuit

Package Outlines



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
TOTAL DEVICE			
T_{STG}	Storage Temperature	-55 to +125	°C
T_{OPR}	Operating Temperature	-40 to +85	°C
T_{SOL}	Lead Solder Temperature	260 for 10 sec	°C
P_D	Total Device Power Dissipation @ T_A = 25°C	115	mW
	Derate above 70°C	4.0	mW/°C
	Steady State Isolation	2500	VRMS
EMITTER			
	RMS Current	25	mA
	DC Current	±30	mA
P_D	LED Power Dissipation @ T_A = 25°C	45	mW
	Derate above 70°C	2.0	mW/°C
DETECTOR			
I_{OL}	Low Level Output Current	20	mA
V_{OH}	High Level Output Voltage	7.0	V
V_{CC}	Supply Voltage	7.0	V
P_D	Detector Power Dissipation @ T_A = 25°C	70	mW
	Derate above 70°C	2.0	mW/°C

Electrical Characteristics

(0°C to 70°C Free Air Temperature unless otherwise specified-All typical values are at 25°C)

Individual Component Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
EMITTER						
V_F	Input Forward Voltage	I_F = ±30 mA, DC			1.5	V
DETECTOR						
I_{CCL}	Logic Low Output Supply Current	I_{IN} = 4.0 mA RMS, V_O = Open, V_{CC} = 5.5V, 24V $V_{I\ (ON)}$, RMS ≤ 240V			3.0	mA
I_{CCH}	Logic High Output Supply Current	I_{IN} = 0.15mA RMS, V_{CC} = 5.5V, $V_{I\ (OFF)}$, RMS ≥ 5.5V			0.80	mA

Transfer Characteristics

Symbol	DC Characteristics	Test Conditions	Min.	Typ.	Max.	Units
V_{OL}	Logic Low Output Current	$I_{IN} = I_{I\ (ON)}$ RMS, I_O = 16mA, V_{CC} = 4.5V, 24V ≤ $V_{I\ (ON)}$, RMS ≤ 240V		0.18	0.40	V
I_{OH}	Logic High Output Current	I_{IN} = 0.15mA RMS, $V_O = V_{CC}$ = 5.5V, $V_{I\ (OFF)}$, RMS ≥ 5.5V		0.02	100	µA
$V_{I\ (ON)}$ RMS	On-state RMS Input Voltage	V_O = 0.4V, I_O = 16mA, V_{CC} = 4.5V, R_{IN} = 22kΩ	90			V
$V_{I\ (OFF)}$ RMS	Off-state RMS Input Voltage	$V_O = V_{CC}$ = 5.5 V, I_O ≤ 100µA, R_{IN} = 22kΩ			5.5	V
$I_{I\ (ON)}$ RMS	On-state RMS Input Current	V_O = 0.4V, I_O = 16mA, V_{CC} = 4.5V, 24V ≤ $V_{I\ (ON)}$, RMS ≤ 240V	4.0			mA
$I_{I\ (OFF)}$ RMS	Off-state RMS Input Current	$V_O = V_{CC}$ = 5.5V, I_O ≤ 100µA, $V_{I\ (OFF)}$, RMS ≥ 5.5V			0.15	mA

Transfer Characteristics

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Units
SWITCHING TIME (T_A = 25°C)						
t_{ON}	Turn-On Time	I_{IN} = 4.0mA RMS, I_O = 16mA, V_{CC} = 4.5V, R_{IN} = 22kΩ (See Test Circuit 2)		1.0		ms
t_{OFF}	Turn-Off Time	I_{IN} = 4.0mA RMS, I_O = 16mA, V_{CC} = 4.5V, R_{IN} = 22kΩ (See Test Circuit 2)		1.0		ms

(RMS = True RMS Voltage at 60 Hz, THD ≤ 1%)

Isolation Characteristics (T_A = 25°C)

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Units
V_{ISO}	Steady State Isolation Voltage	Relative Humidity ≤ 50%, I_{I-O} ≤ 10µA, 1 Minute, 60Hz	2500			VRMS
R_{ISO}	Isolation Resistance	V_{I-O} = 500VDC	10^{11}			Ω
C_{ISO}	Isolation Capacitance	f = 1MHz			2	pF

Description/Applications

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 VRMS 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 test circuit 1) 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.

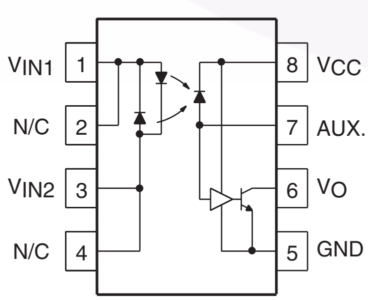
V_F is the forward voltage drop across the LED.

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

$V_{I(ON)}$ RMS — On-State RMS Input Voltage

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

$V_{I(OFF)}$ RMS — Off-State RMS Input Voltage

The RMS voltage at an input terminal for a specified input current with output conditions applied that 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 that 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 that 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

$I_{I(ON)}$ RMS — On-State RMS Input Current

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

$I_{I(OFF)}$ RMS — Off-state RMS Input Current

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

*Current flowing out of a terminal is a negative value.

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

The current flowing into * an output with input conditions applied that 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.

* Current flowing out of a terminal is a negative value.

DYNAMIC CHARACTERISTICS

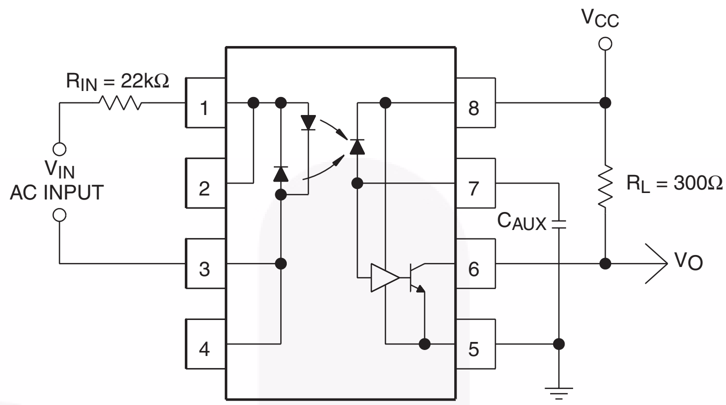
t_{ON} **Turn-On Time**

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**

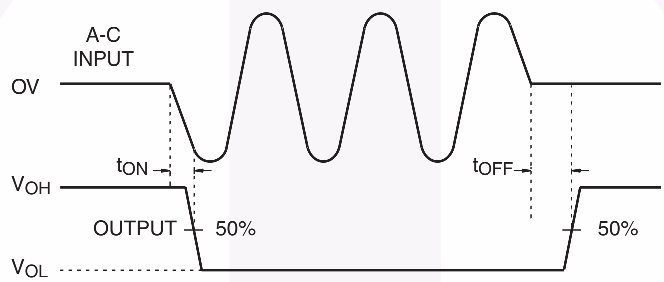
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined low-level to the defined high-level.

Operating Schematics

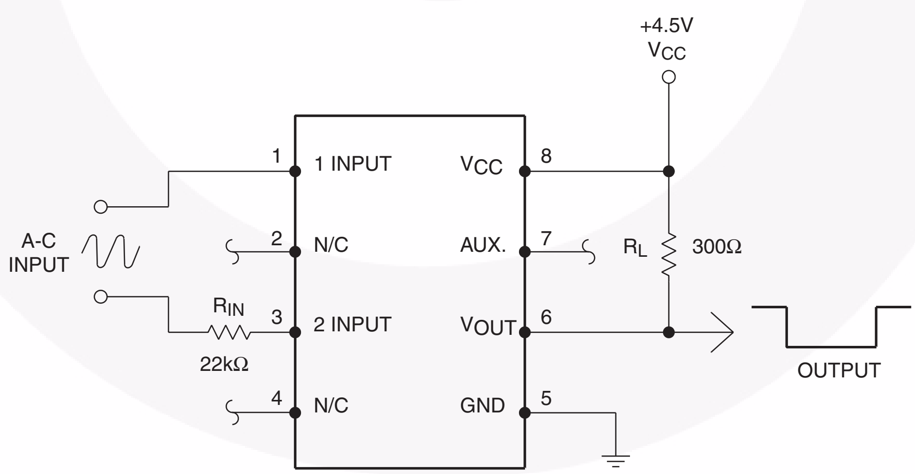


INPUT CURRENT VS. CAPACITANCE, C_{AUX} CIRCUIT

TEST CIRCUIT 1



* INPUT TURNS ON AND OFF AT ZERO CROSSING



TEST CIRCUIT

TEST CIRCUIT 2
MID400 Switching Time

Typical Performance Curves

Fig. 1 Input Voltage vs. Input Resistance

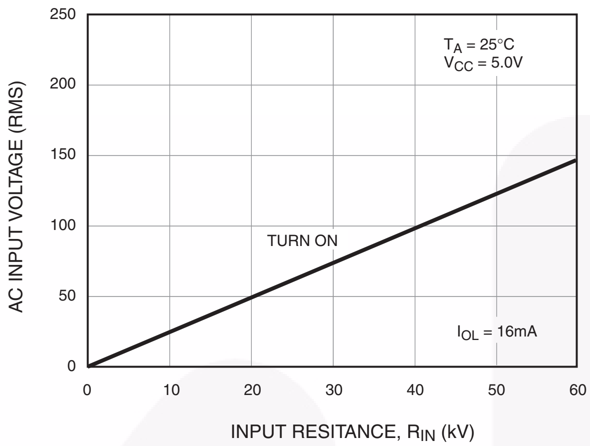


Fig. 2 Input Voltage vs. Input Resistance

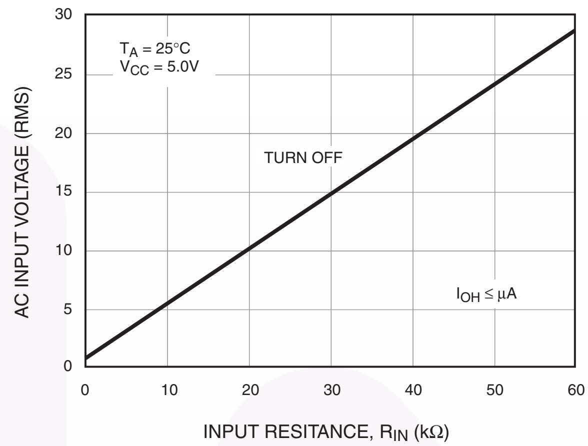


Fig. 3 Supply Current vs. Supply Voltage

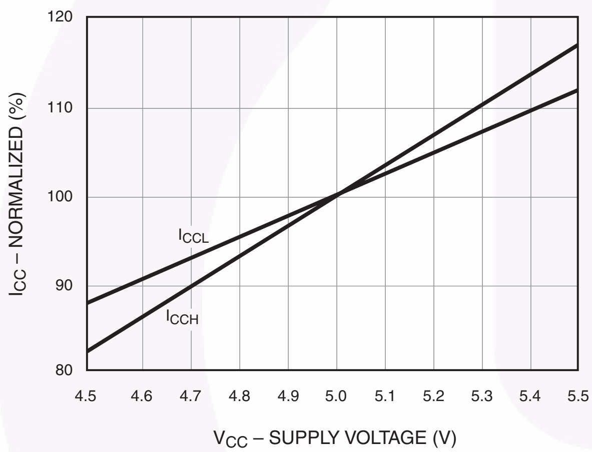


Fig. 4 Input Current vs. Capacitance

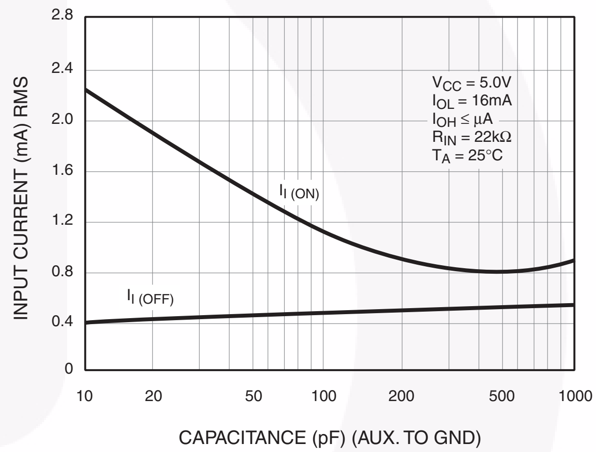
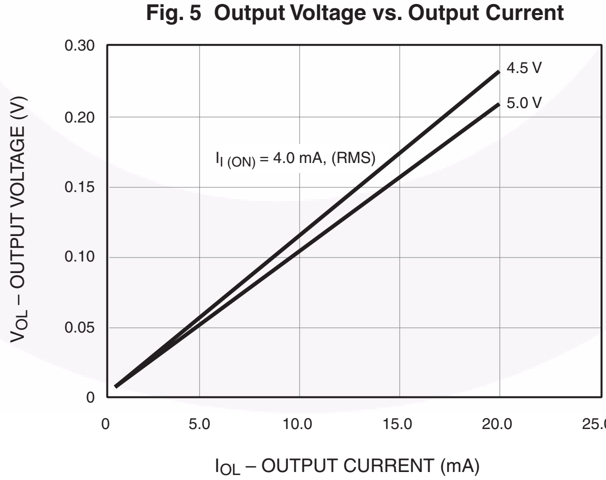


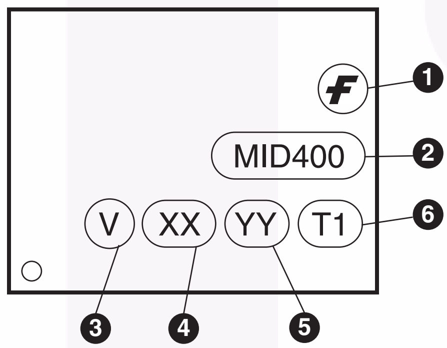
Fig. 5 Output Voltage vs. Output Current



Ordering Information

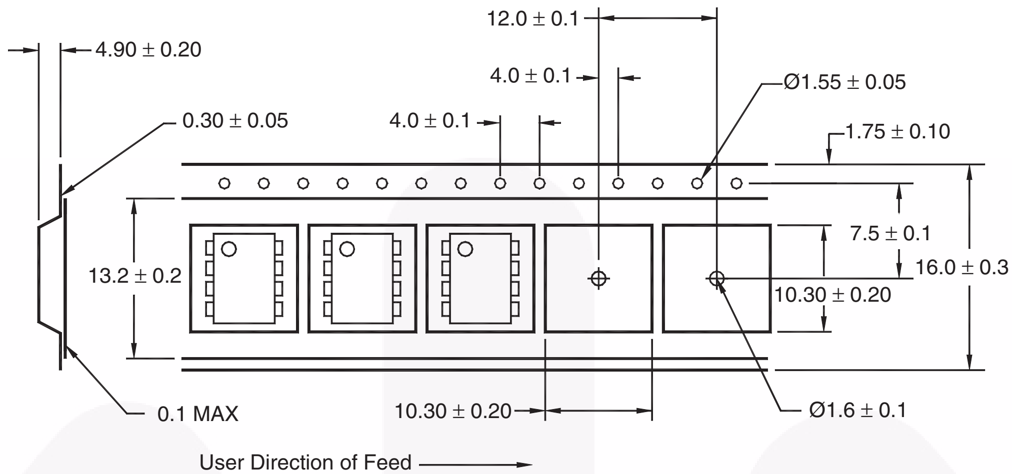
Option	Example Part Number	Description
No Option	MID400	Standard Through Hole
S	MID400S	Surface Mount Lead Bend
SD	MID400SD	Surface Mount; Tape and reel
V	MID400V	VDE0884
WV	MID400WV	VDE0884; 0.4" Lead Spacing
SV	MID400SV	VDE0884; Surface Mount
SDV	MID400SDV	VDE0884; Surface Mount; Tape and Reel

Marking Information



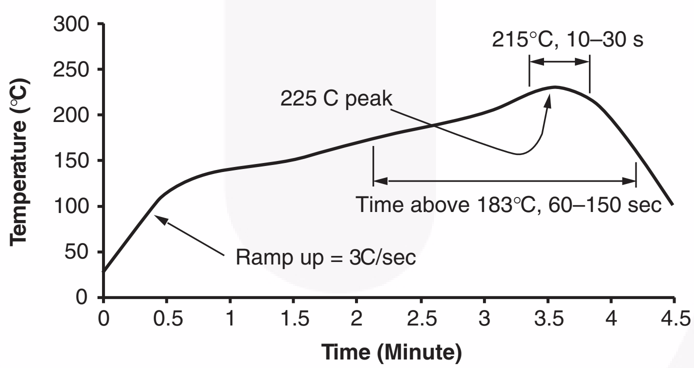
Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

Carrier Tape Specifications ("D" Taping Orientation)

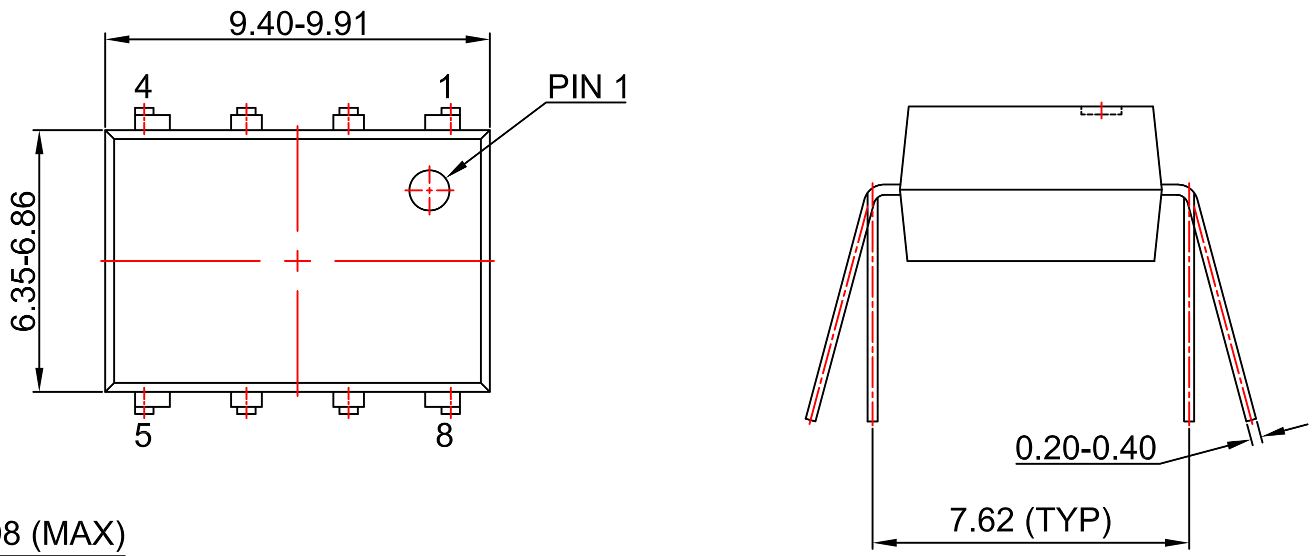


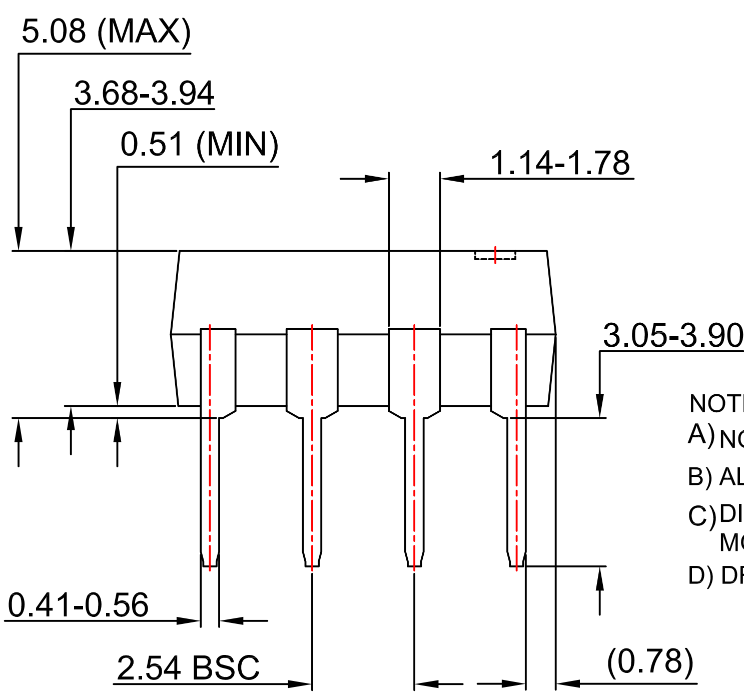
Note:
All dimensions are in inches (millimeters)

Reflow Profile



- Peak reflow temperature: 225°C (package surface temperature)
- Time of temperature higher than 183°C for 60–150 seconds
- One time soldering reflow is recommended





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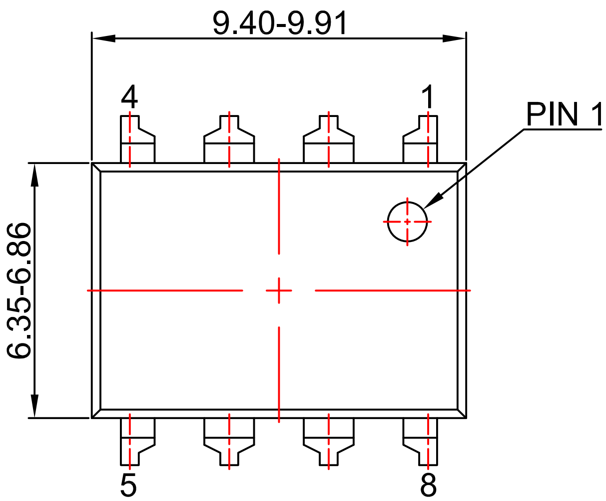
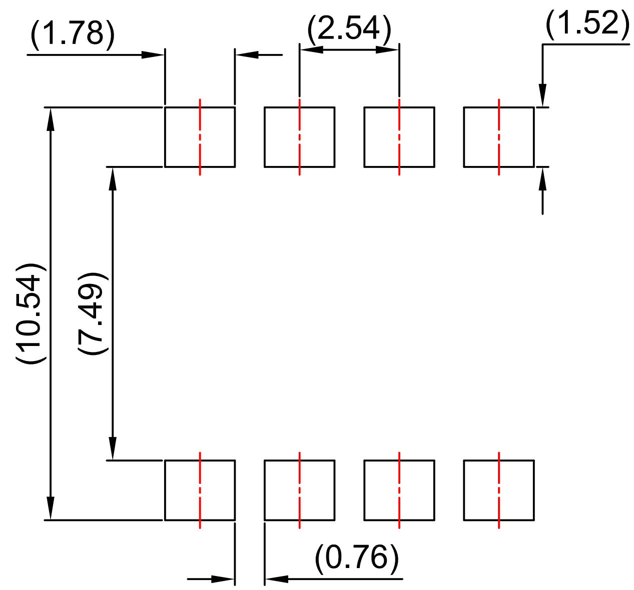
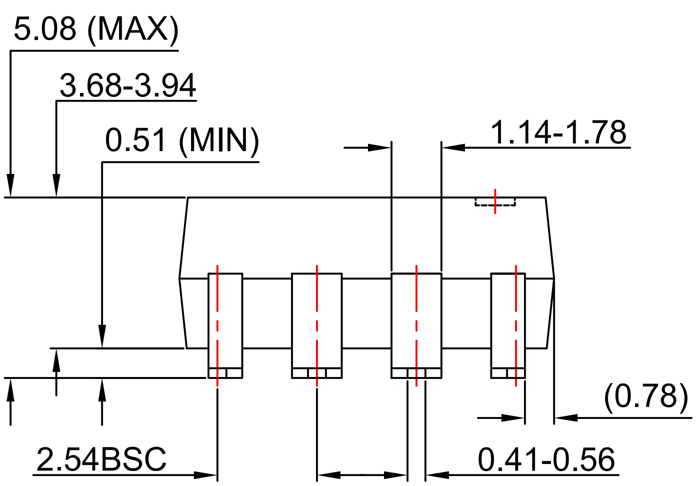
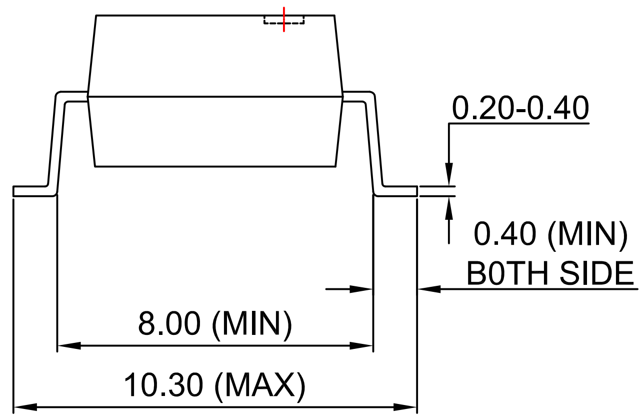




LAND PATTERN RECOMMENDATION





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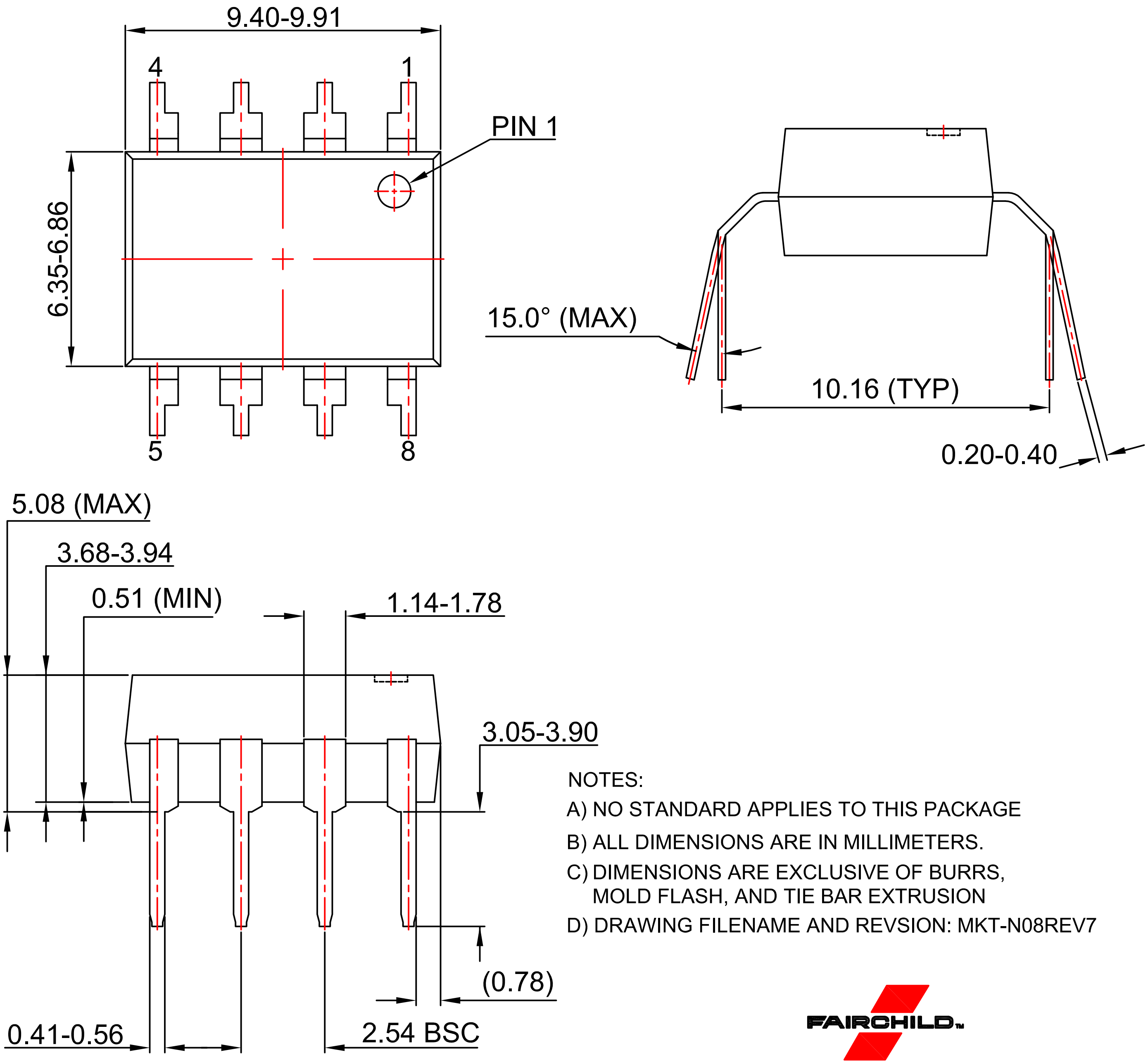

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Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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