

**MID400**

**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.

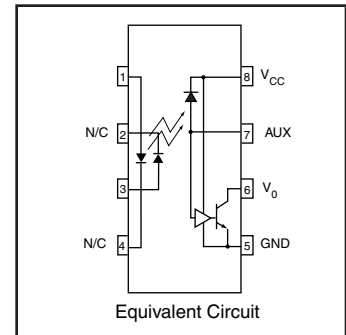
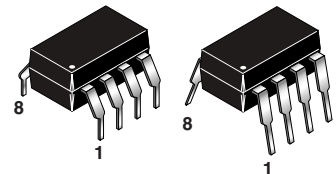
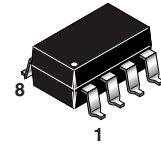
The MID400 has been designed solely for the use as an **AC line monitor**. It is recommended for use in any AC-to-DC control application where excellent optical isolation, solid state reliability, TTL compatibility, small size, low power, and low frequency operations are required.

**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



**ABSOLUTE MAXIMUM RATINGS**

| Rating  | Value          | Unit                 |
|---|----------------|----------------------|
| <b>EMITTER</b>  |                |                      |
| RMS Current   | 25             | mA                   |
| DC Current  | ±30            | mA                   |
| LED Power Dissipation @ $T_A = 25^\circ\text{C}$ ( $P_D$ )          | 45             | mW                   |
| Derate above $70^\circ\text{C}$                                     | 2.0            | mW/ $^\circ\text{C}$ |
| <b>DETECTOR</b>   |                |                      |
| Low Level Output Current ( $I_{OL}$ )                               | 20             | mA                   |
| High Level Output Voltage ( $V_{OH}$ )                              | 7.0            | V                    |
| Supply Voltage ( $V_{CC}$ )   | 7.0            | V                    |
| Detector Power Dissipation @ $T_A = 25^\circ\text{C}$ ( $P_D$ )     | 70             | mW                   |
| Derate above $70^\circ\text{C}$                                     | 2.0            | mW/ $^\circ\text{C}$ |
| <b>TOTAL DEVICE</b>   |                |                      |
| Storage Temperature   | -55 to +125    | $^\circ\text{C}$     |
| Operating Temperature   | -40 to +85     | $^\circ\text{C}$     |
| Lead Solder Temperature   | 260 for 10 sec | $^\circ\text{C}$     |
| Total Device Power Dissipation @ $T_A = 25^\circ\text{C}$ ( $P_D$ ) | 115            | mW                   |
| Derate above $70^\circ\text{C}$                                     | 4.0            | mW/ $^\circ\text{C}$ |
| Steady State Isolation  | 2500           | VRMS                 |

**ELECTRICAL CHARACTERISTICS**

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

**INDIVIDUAL COMPONENT CHARACTERISTICS**

| Parameter                        | Test Conditions  | Symbol    | Min | Typ | Max  | Unit |
|----------------------------------|--|-----------|-----|-----|------|------|
| <b>EMITTER</b>                   |  |           |     |     |      |      |
| Input Forward Voltage            | ( $I_F = \pm 30$ mA, DC)   | $V_F$     |     |     | 1.5  | V    |
| <b>DETECTOR</b>                  |  |           |     |     |      |      |
| Logic Low Output Supply Current  | ( $I_{IN} = 4.0$ mA RMS,<br>$V_O = \text{Open}$ , $V_{CC} = 5.5$ V,<br>$24$ V [ $V_{I(ON)}$ ], RMS $\leq 240$ V) | $I_{CCL}$ |     |     | 3.0  | mA   |
| Logic High Output Supply Current | ( $I_{IN} = 0.15$ mA RMS, $V_{CC} = 5.5$ V,<br>$V_{I(OFF)}$ , RMS $\geq 5.5$ V)                                  | $I_{CCH}$ |     |     | 0.80 | mA   |

**TRANSFER CHARACTERISTICS**

| DC Characteristics          | Test Conditions   | Symbol           | Min | Typ  | Max  | Units   |
|-----------------------------|---|------------------|-----|------|------|---------|
| Logic Low Output Current    | ( $I_{IN} = I_{I(ON)}$ RMS, $I_O = 16$ mA, $V_{CC} = 4.5$ V,<br>$24$ V $\leq V_{I(ON)}$ , RMS $\leq 240$ V) | $V_{OL}$         |     | 0.18 | 0.40 | V       |
| Logic High Output Current   | ( $I_{IN} = 0.15$ mA RMS, $V_O = V_{CC} = 5.5$ V,<br>$V_{I(OFF)}$ , RMS $\geq 5.5$ V)                       | $I_{OH}$         |     | 0.02 | 100  | $\mu$ A |
| On-state RMS Input Voltage  | ( $V_O = 0.4$ V, $I_O = 16$ mA<br>$V_{CC} = 4.5$ V, $R_{IN} = 22$ K $\Omega$ )                              | $V_{I(ON)}$ RMS  | 90  |      |      | V       |
| Off-state RMS Input Voltage | ( $V_O = V_{CC} = 5.5$ V,<br>$I_O \leq 100$ $\mu$ A, $R_{IN} = 22$ K $\Omega$ )                             | $V_{I(OFF)}$ RMS |     |      | 5.5  | V       |
| On-state RMS Input Current  | ( $V_O = 0.4$ V, $I_O = 16$ mA, $V_{CC} = 4.5$ V,<br>$24$ V $\leq V_{I(ON)}$ , RMS $\leq 240$ V)            | $I_{I(ON)}$ RMS  | 4.0 |      |      | mA      |
| Off-state RMS Input Current | ( $V_O = V_{CC} = 5.5$ V, $I_O \leq 100$ $\mu$ A,<br>$V_{I(OFF)}$ , RMS $\geq 5.5$ V)                       | $I_{I(OFF)}$ RMS |     |      | 0.15 | mA      |

**TRANSFER CHARACTERISTICS**

| Characteristics   | Test Conditions   | Symbol    | Min | Typ | Max | Units |
|---|---|-----------|-----|-----|-----|-------|
| <b>SWITCHING TIME (<math>T_A = 25^\circ\text{C}</math>)</b> |   |           |     |     |     |       |
| Turn-On Time  | ( $I_{IN} = 4.0$ mA RMS,<br>$I_O = 16$ mA, $V_{CC} = 4.5$ V,<br>$R_{IN} = 22$ K $\Omega$ ) (See Test Circuit 2) | $t_{ON}$  |     | 1.0 |     | ms    |
| Turn-Off Time   | ( $I_{IN} = 4.0$ mA RMS,<br>$I_O = 16$ mA, $V_{CC} = 4.5$ V,<br>$R_{IN} = 22$ K $\Omega$ ) (See Test Circuit 2) | $t_{OFF}$ |     | 1.0 |     | ms    |

(RMS = True RMS Voltage at 60 Hz, THD  $\leq 1\%$ )

**MID400**

| ISOLATION CHARACTERISTICS (T <sub>A</sub> = 25°C) |   |                  |                  |     |     |       |
|---|---|------------------|------------------|-----|-----|-------|
| Characteristics                                   | Test Conditions   | Symbol           | Min              | Typ | Max | Units |
| Steady State Isolation Voltage                    | Relative Humidity ≤ 50%, I <sub>I-O</sub> ≤ 10 μA,<br>1 Minute, 60 Hz | V <sub>ISO</sub> | 2500             |     |     | VRMS  |
| Isolation Resistance                              | (V <sub>I-O</sub> = 500 VDC)  | R <sub>ISO</sub> | 10 <sup>11</sup> |     |     | Ω     |
| Isolation Capacitance                             | (f = 1 MHz)   | C <sub>ISO</sub> |                  |     | 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 5 V 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<sub>IN</sub>, 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:

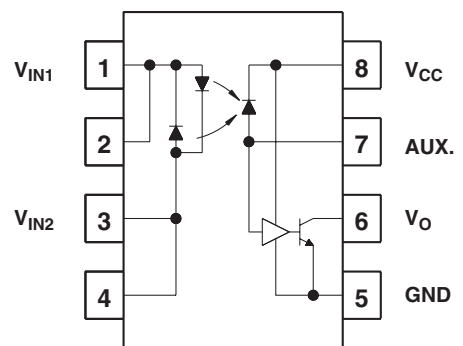
$$R_{IN} = \frac{V_{IN} - V_F}{I_{IN}}$$

Where V<sub>IN</sub> (RMS) is the input voltage.  
V<sub>F</sub> is the forward voltage drop across the LED.  
I<sub>IN</sub> (RMS) is the desired input current required to sustain a logic "O" on the output.

**PIN DESCRIPTION**

| DESIGNATION                         | PIN # | FUNCTION  |
|-------------------------------------|-------|---|
| V <sub>IN1</sub> , V <sub>IN2</sub> | 1,3   | Input terminals   |
| V <sub>CC</sub>                     | 8     | Supply voltage, output circuit.   |
| AUX.                                | 7     | Auxiliary terminal.   |
|                                     |       | Programmable capacitor input to adjust AC voltage sensing level and time delay. |
| V <sub>O</sub>                      | 6     | Output terminal; open collector.  |
| GND                                 | 5     | Circuit ground potential.   |

**SCHEMATIC DIAGRAM**



NOTE: DO NOT CONNECT PINS 2 AND 4

**GLOSSARY**

**VOLTAGES**

|                  |  |
|------------------|--|
| $V_{I(ON)}$ RMS  | On-state RMS input voltage<br>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<br>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<br>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<br>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<br>The voltage developed across the LED when input current $I_F$ is applied to the anode of the LED.   |

**CURRENTS**

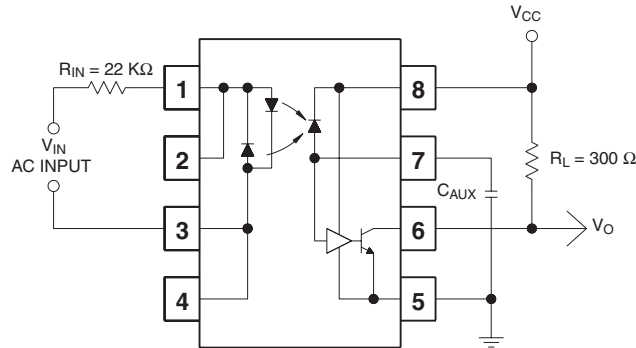
|                  |   |
|------------------|---|
| $I_{I(ON)}$ RMS  | On-state RMS input current<br>The RMS current flowing into an input with output conditions applied that according to the product specification will cause the output switching element to be sustained in the on-state within one full cycle.   |
| $I_{I(OFF)}$ RMS | Off-state RMS input current<br>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<br>The current flowing into * an output with input conditions applied that according to the product specification will establish a high-level at the output.  |
| $I_{OL}$         | Low-level output current<br>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<br>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<br>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<br>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<br>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. |

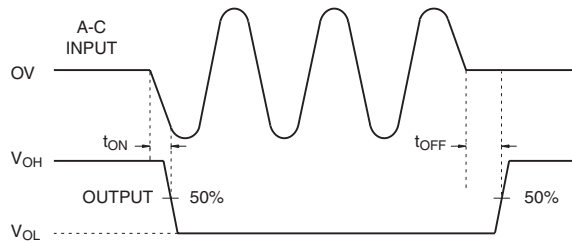
\* Current flowing out of a terminal is a negative value.

**OPERATING SCHEMATICS**

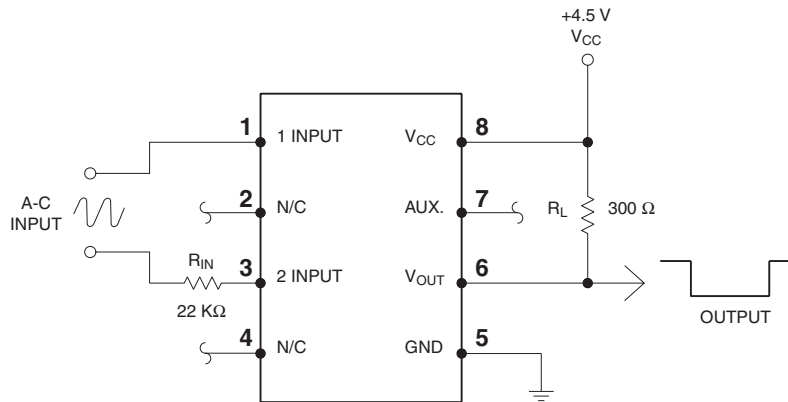


INPUT CURRENT VS. CAPACITANCE, C<sub>AUX</sub> CIRCUIT

**TEST CIRCUIT 1**



\* INPUT TURNS ON AND OFF AT ZERO CROSSING

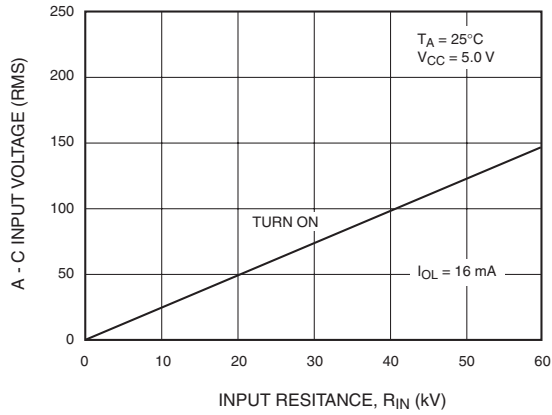


TEST CIRCUIT

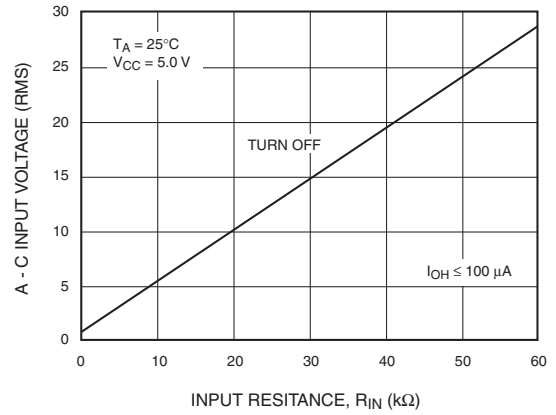
**TEST CIRCUIT 2  
MID400 Switching Time**

**TYPICAL CURVES**

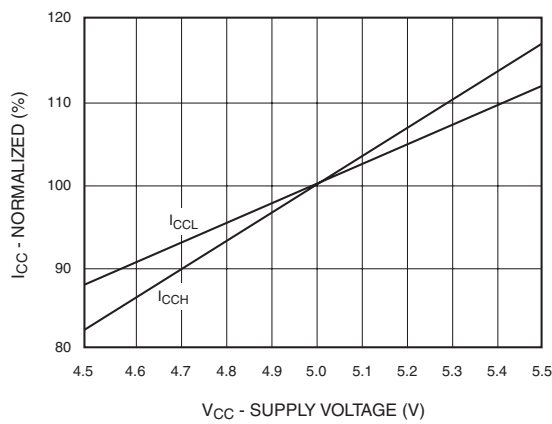
**Fig. 1 Input Voltage vs. Input Resistance**



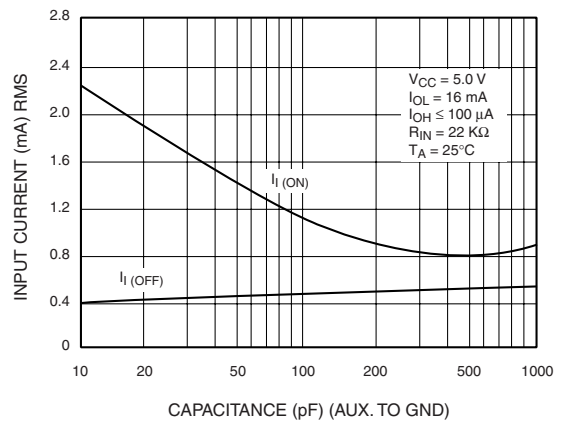
**Fig. 2 Input Voltage vs. Input Resistance**



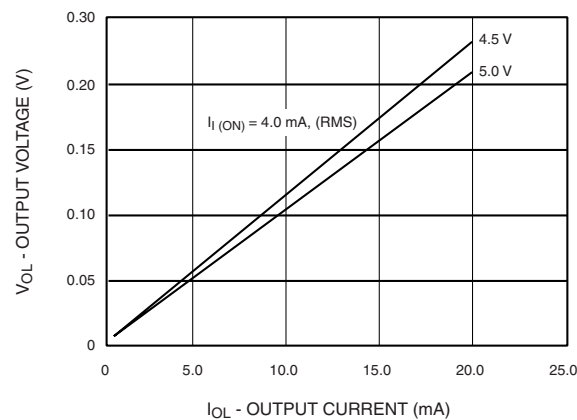
**Fig. 3 Supply Current vs. Supply Voltage**



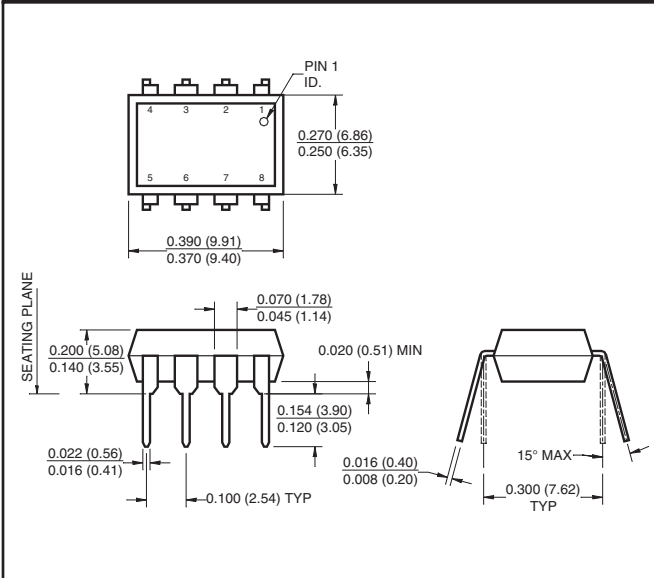
**Fig. 4 Input Current vs. Capacitance**



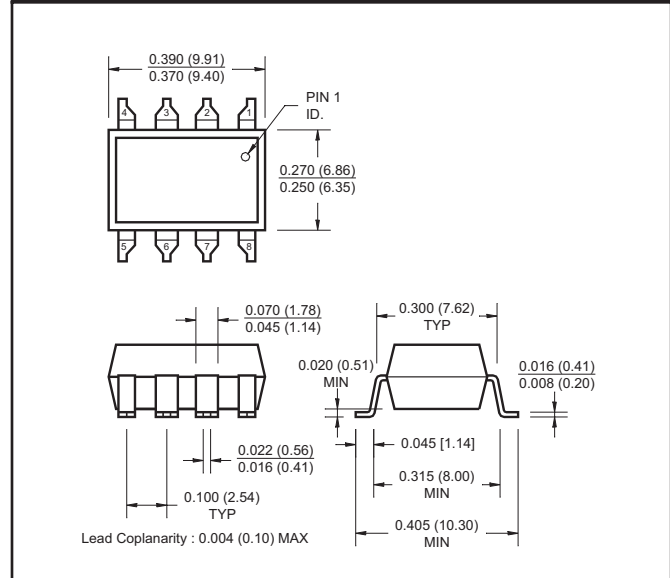
**Fig. 5 Output Voltage vs. Output Current**



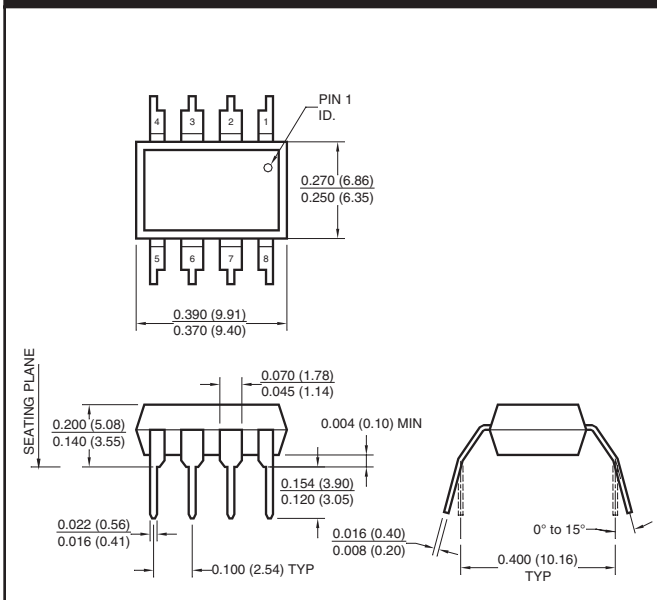
**Package Dimensions (Through Hole)**



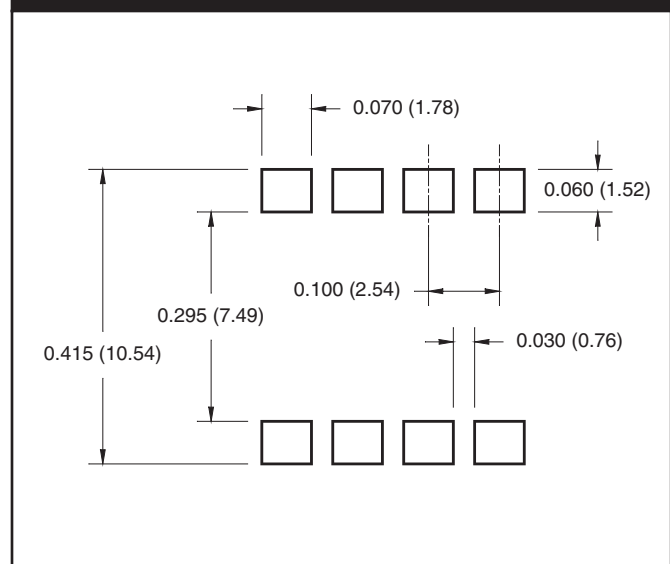
**Package Dimensions (Surface Mount)**



**Package Dimensions (0.4" Lead Spacing)**



**Recommended Pad Layout for  
Surface Mount Leadform**



**NOTE**

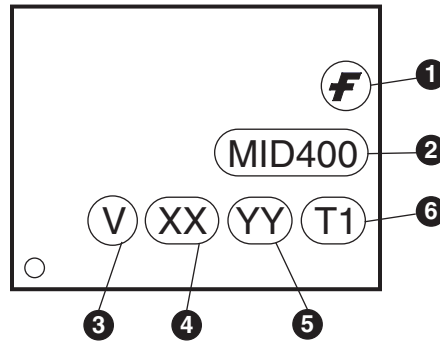
All dimensions are in inches (millimeters)



**ORDERING INFORMATION**

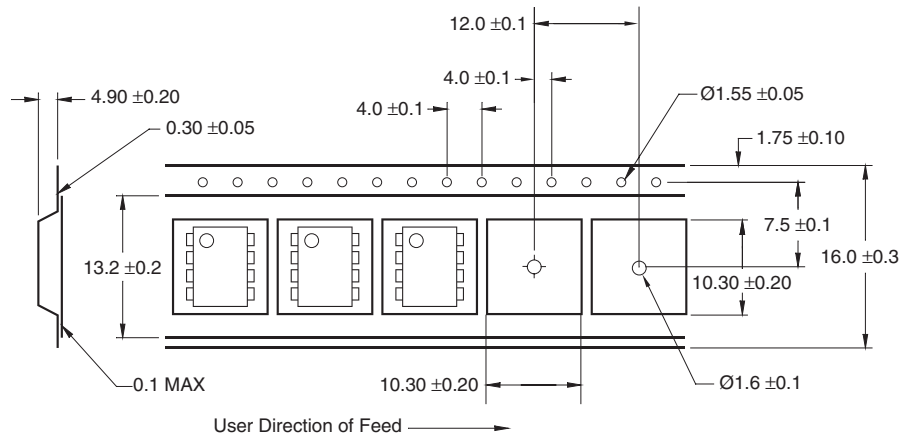
| Option | Description                            |
|--------|--|
| S      | Surface Mount Lead Bend                |
| SD     | Surface Mount; Tape and Reel           |
| SDV    | Surface Mount; Tape and Reel, VDE 0884 |
| SV     | Surface Mount, VDE 0884                |
| V      | VDE 0884                               |
| W      | 0.4" Lead Spacing                      |
| WV     | 0.4" Lead Spacing; VDE 0884            |

**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  |

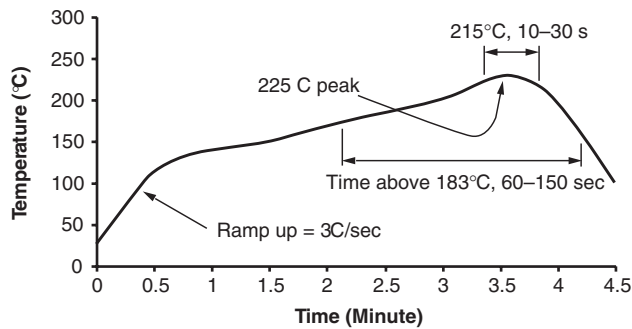
**Carrier Tape Specifications (“D” Taping Orientation)**



**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

**DISCLAIMER**

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

**LIFE SUPPORT POLICY**

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.