

# 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

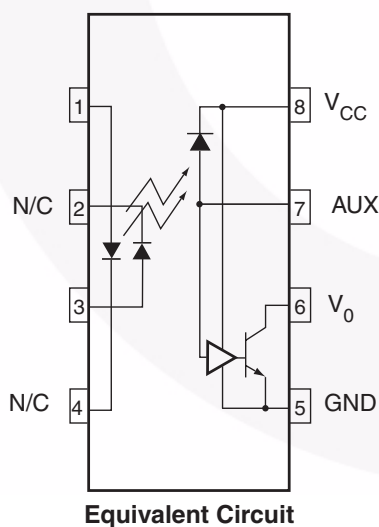
- Monitoring of the AC/DC “line-down” condition
- “Closed-loop” interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

### Description

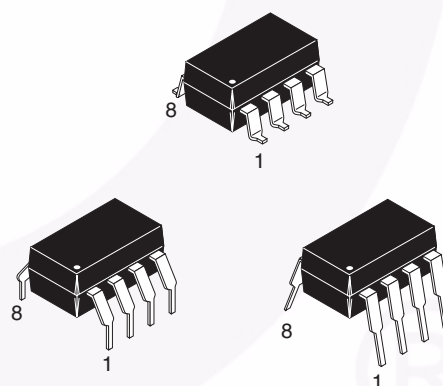
The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a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



### 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
<b>TOTAL DEVICE</b>			
$T_{STG}$	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 @ $T_A = 25^{\circ}\text{C}$	115	mW
	Derate above $70^{\circ}\text{C}$	4.0	mW/°C
	Steady State Isolation	2500	VRMS
<b>EMITTER</b>			
	RMS Current	25	mA
	DC Current	±30	mA
$P_D$	LED Power Dissipation @ $T_A = 25^{\circ}\text{C}$	45	mW
	Derate above $70^{\circ}\text{C}$	2.0	mW/°C
<b>DETECTOR</b>			
$I_{OL}$	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 @ $T_A = 25^{\circ}\text{C}$	70	mW
	Derate above $70^{\circ}\text{C}$	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
<b>EMITTER</b>						
$V_F$	Input Forward Voltage	$I_F = \pm 30 \text{ mA, DC}$			1.5	V
<b>DETECTOR</b>						
$I_{CCL}$	Logic Low Output Supply Current	$I_{IN} = 4.0 \text{ mA RMS, } V_O = \text{Open, } V_{CC} = 5.5\text{V, } 24\text{V } V_{I(ON)}, \text{RMS} \leq 240\text{V}$			3.0	mA
$I_{CCH}$	Logic High Output Supply Current	$I_{IN} = 0.15\text{mA RMS, } V_{CC} = 5.5\text{V, } V_{I(OFF)}, \text{RMS} \geq 5.5\text{V}$			0.80	mA

### Transfer Characteristics

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

### Transfer Characteristics

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

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

### Isolation Characteristics ( $T_A = 25^\circ\text{C}$ )

Symbol	Characteristics	Test Conditions	Min.	Typ.	Max.	Units
$V_{ISO}$	Steady State Isolation Voltage	Relative Humidity $\leq 50\%$ , $I_{I-O} \leq 10\mu\text{A, } 1 \text{ Minute, } 60\text{Hz}$	2500			VRMS
$R_{ISO}$	Isolation Resistance	$V_{I-O} = 500\text{VDC}$	$10^{11}$			$\Omega$
$C_{ISO}$	Isolation Capacitance	$f = 1\text{MHz}$			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.

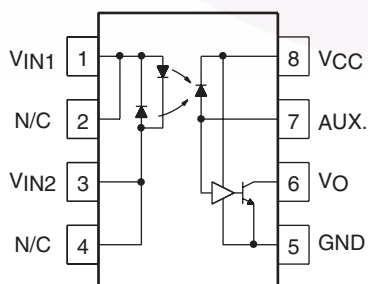
$V_F$  is the forward voltage drop across the LED.

$I_{IN}$  (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<sub>OL</sub>****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<sub>CCL</sub>****Supply Current, Output LOW**

The current flowing into \* the V<sub>CC</sub> supply terminal of a circuit when the output is at a low-level voltage.

**I<sub>CCH</sub>****Supply Current, Output HIGH**

The current flowing into \* the V<sub>CC</sub> supply terminal of a circuit when the output is at a high-level voltage.

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

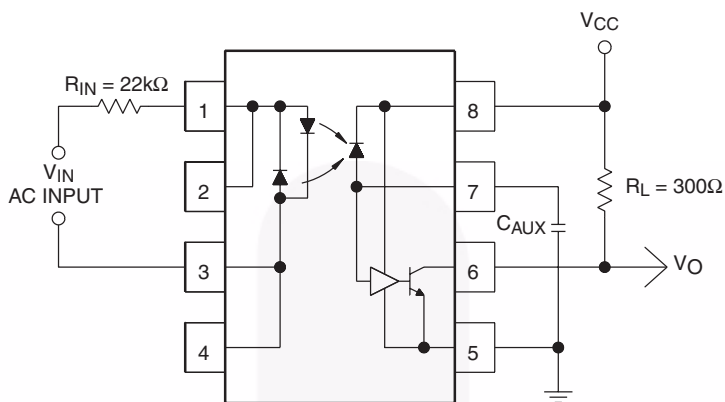
**DYNAMIC CHARACTERISTICS****t<sub>ON</sub>****Turn-On Time**

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<sub>OFF</sub>****Turn-Off time**

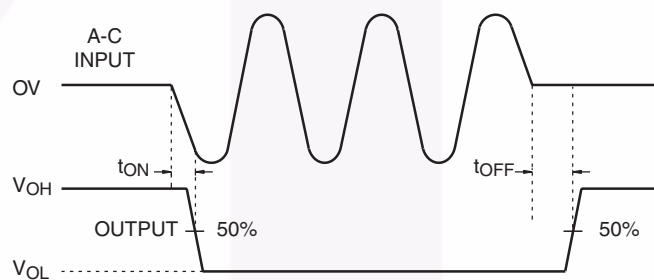
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined low-level to the defined high-level.

## Operating Schematics

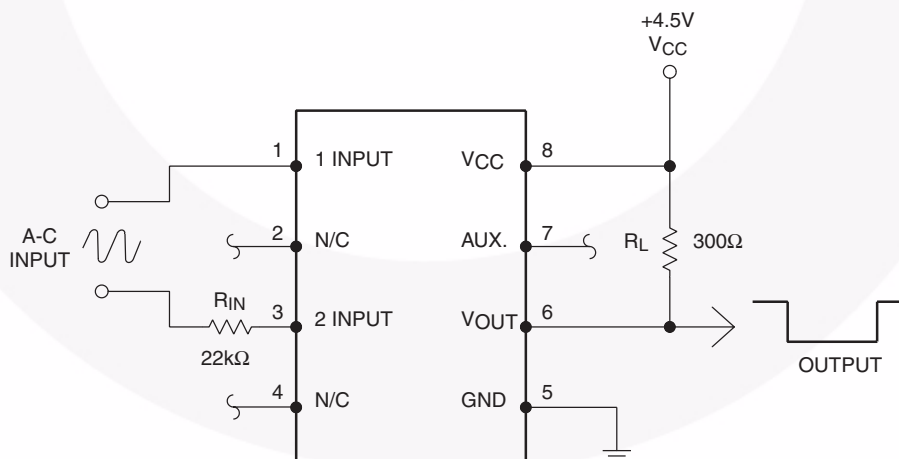


INPUT CURRENT VS. CAPACITANCE,  $C_{AUX}$  CIRCUIT

### 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

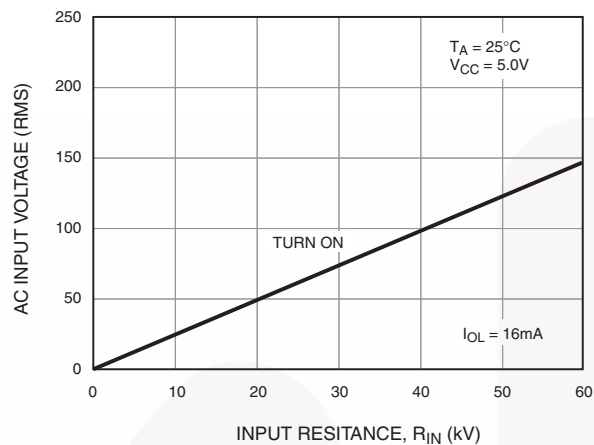


Fig. 2 Input Voltage vs. Input Resistance

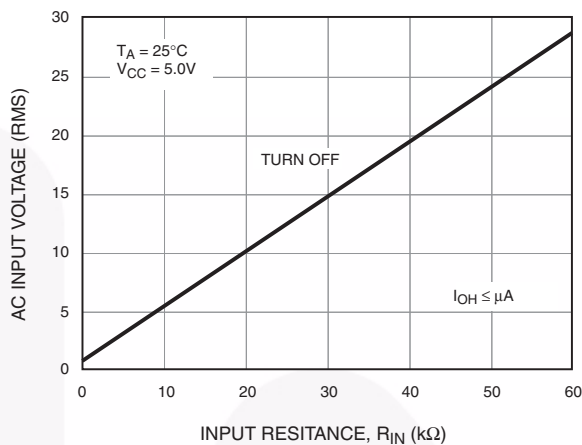


Fig. 3 Supply Current vs. Supply Voltage

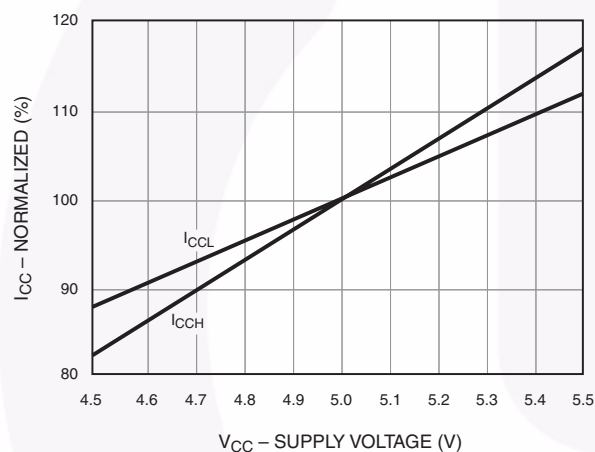


Fig. 4 Input Current vs. Capacitance

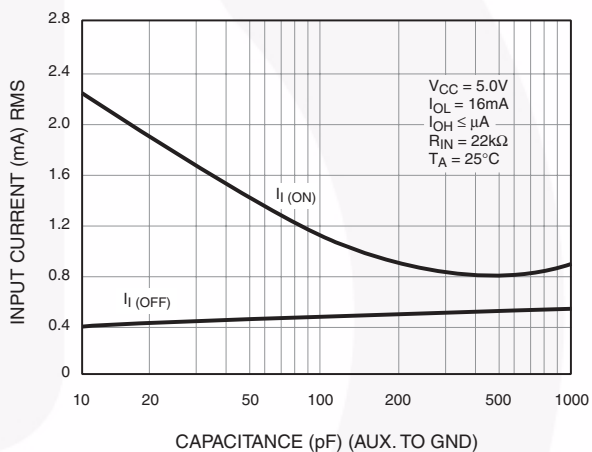
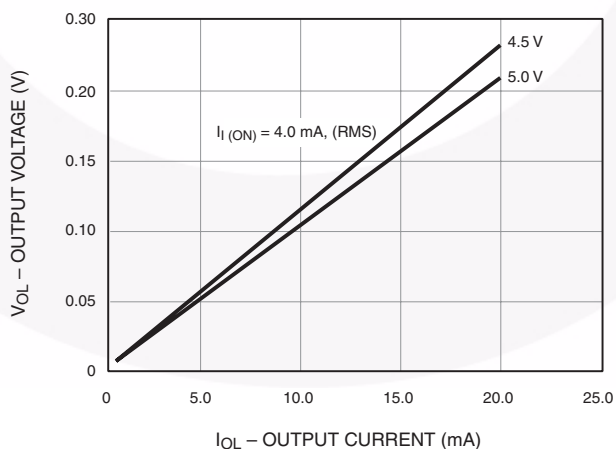
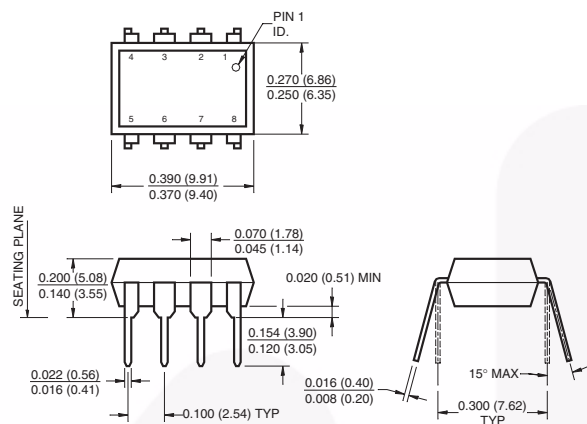


Fig. 5 Output Voltage vs. Output Current

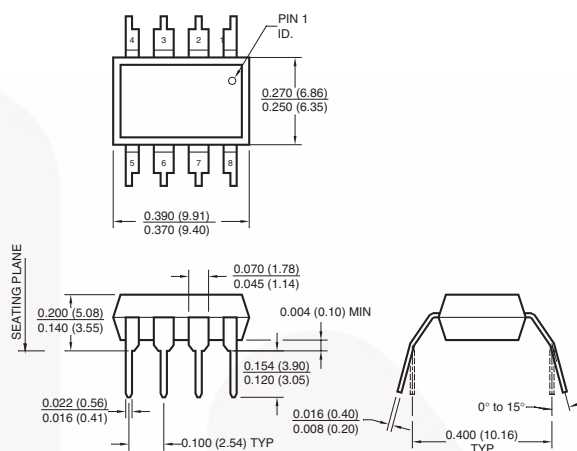


## Package Dimensions

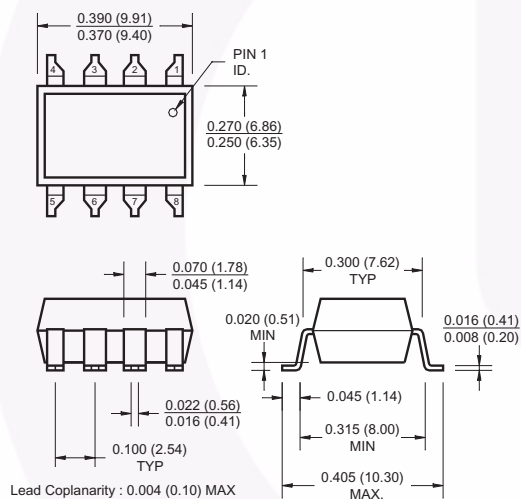
### Through Hole



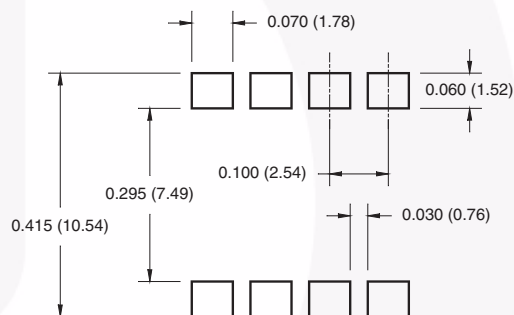
### 0.4" Lead Spacing



### Surface Mount



### 8-Pin DIP – Land Pattern



#### Note:

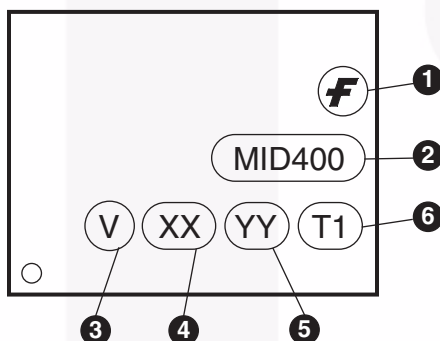
All dimensions are in inches (millimeters)



## Ordering Information

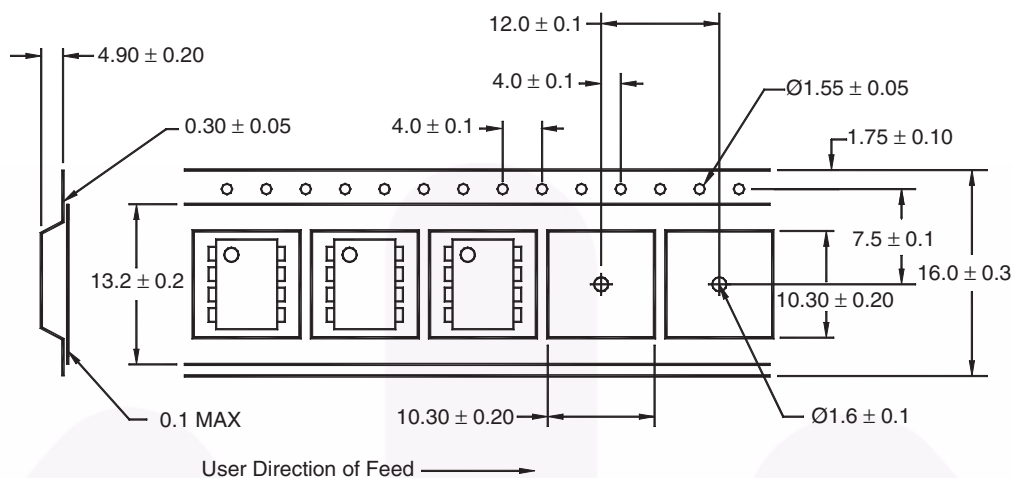
Option	Example Part Number	Description
No Option	MID400	Standard Through Hole
S	MID400S	Surface Mount Lead Bend
SD	MID400SD	Surface Mount; Tape and reel
V	MID400V	VDE0884
WV	MID400WV	VDE0884; 0.4" Lead Spacing
SV	MID400SV	VDE0884; Surface Mount
SDV	MID400SDV	VDE0884; Surface Mount; Tape and Reel

## 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

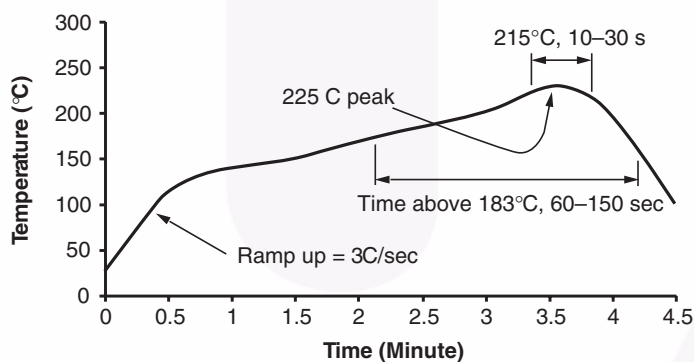
## Carrier Tape Specifications (“D” Taping Orientation)



### Note:

All dimensions are in inches (millimeters)

## Reflow Profile








- Peak reflow temperature:  $225^\circ\text{C}$  (package surface temperature)
- Time of temperature higher than  $183^\circ\text{C}$  for 60–150 seconds
- One time soldering reflow is recommended



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Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
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.
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Rev. 147

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