



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

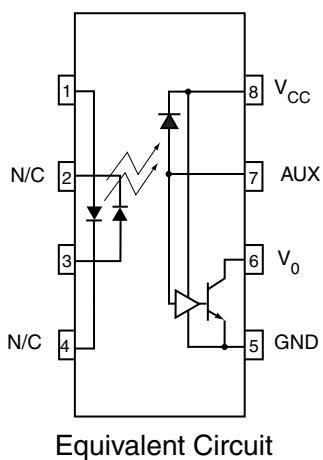
- Monitoring of the AC/DC “line-down” condition
- “Closed-loop” interface between electromechanical elements such as solenoids, relay contacts, small motors, and microprocessors
- Time delay isolation switch

Description

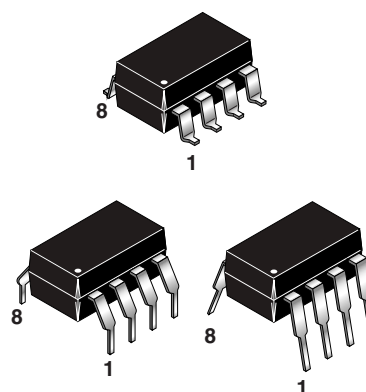
The MID400 is an optically isolated AC line-to-logic interface device. It is packaged in an 8-lead plastic DIP. The AC line voltage is monitored by two back-to-back GaAs LED diodes in series with an external resistor. A high gain detector circuit senses the LED current and drives the output gate to a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



Absolute Maximum Ratings

Rating	Value	Unit
EMITTER		
RMS Current	25	mA
DC Current	±30	mA
LED Power Dissipation @ $T_A = 25^{\circ}\text{C}$ (P_D) Derate above 70°C	45 2.0	mW mW/ $^{\circ}\text{C}$
DETECTOR		
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) Derate above 70°C	70 2.0	mW mW/ $^{\circ}\text{C}$
TOTAL DEVICE		
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) Derate above 70°C	115	mW
	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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
EMITTER						
V_F	Input Forward Voltage	$I_F = \pm 30 \text{ mA}$, DC			1.5	V
DETECTOR						
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	μA
$V_{I(ON)} \text{ RMS}$	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
SWITCHING TIME ($T_A = 25^\circ\text{C}$)						
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 Minute, 60Hz	2500			VRMS
R_{ISO}	Isolation Resistance	$V_{I-O} = 500\text{VDC}$	10^{11}			Ω
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.

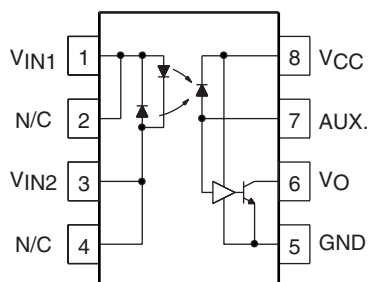
V_F is the forward voltage drop across the LED.

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.

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.

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

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**

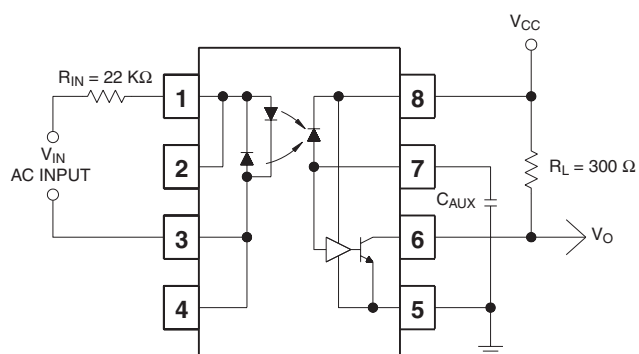
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined high-level to the defined low-level.

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

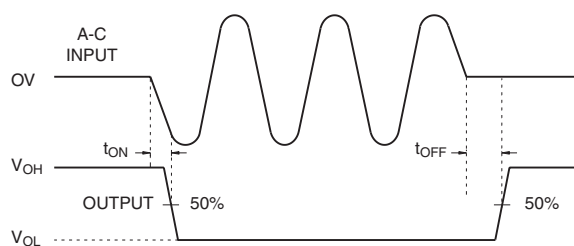
The time between the specified reference points on the input and the output voltage waveforms with the output changing from the defined low-level to the defined high-level.

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

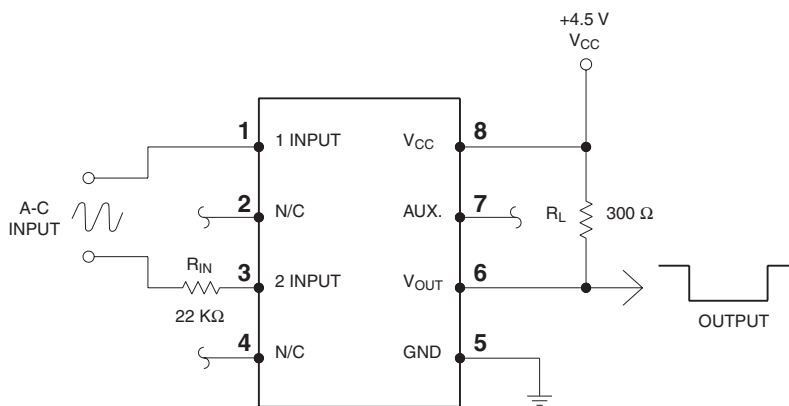
Operating Schematics

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

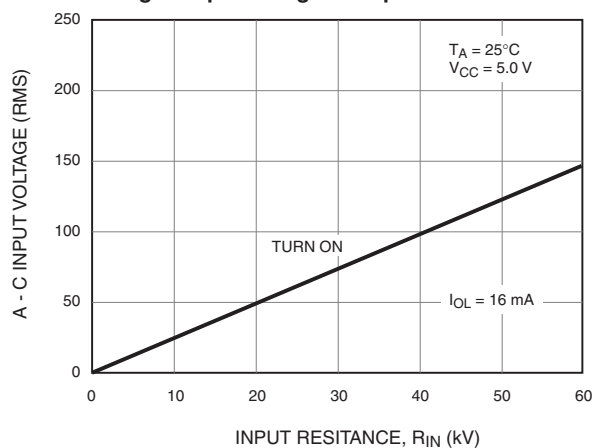


Fig. 2 Input Voltage vs. Input Resistance

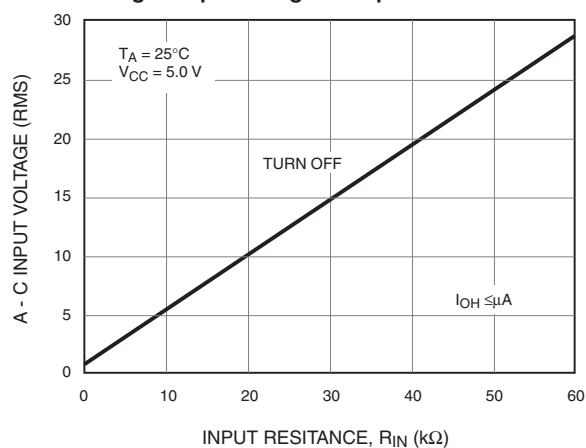


Fig. 3 Supply Current vs. Supply Voltage

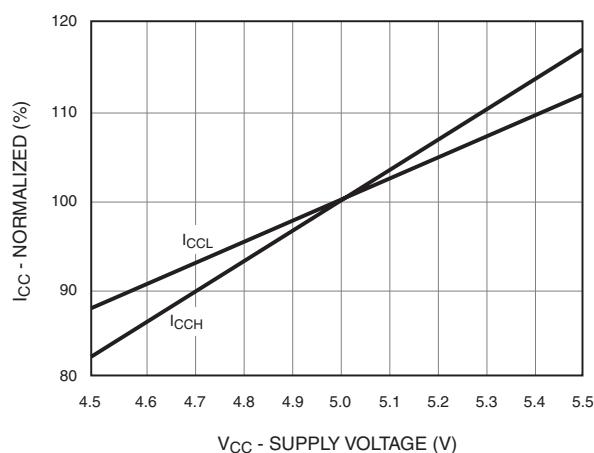


Fig. 4 Input Current vs. Capacitance

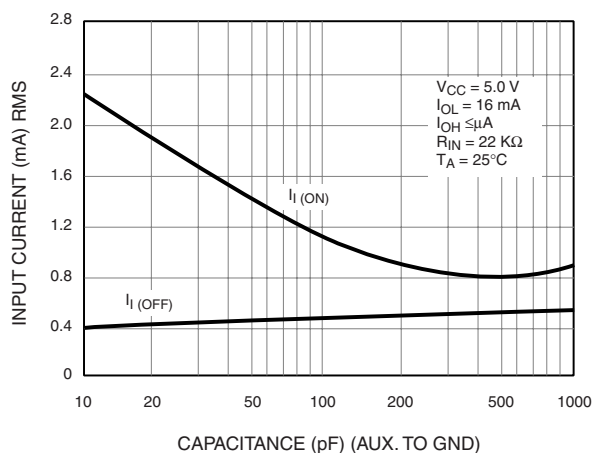
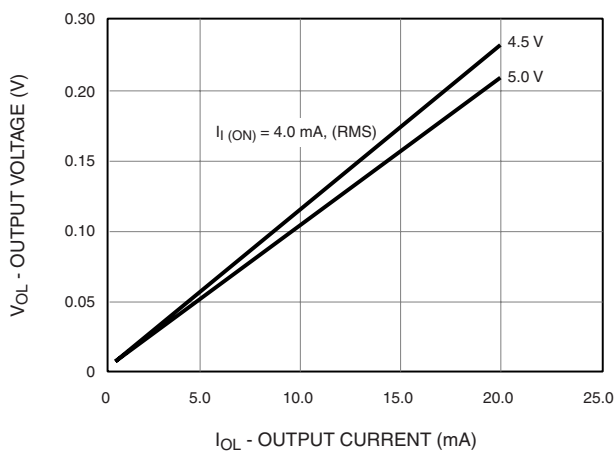
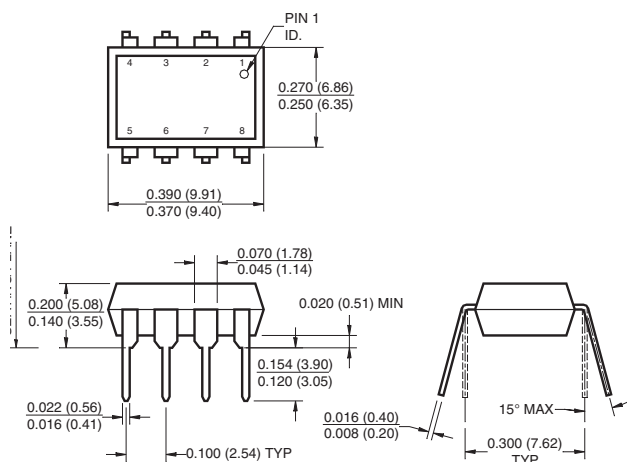


Fig. 5 Output Voltage vs. Output Current

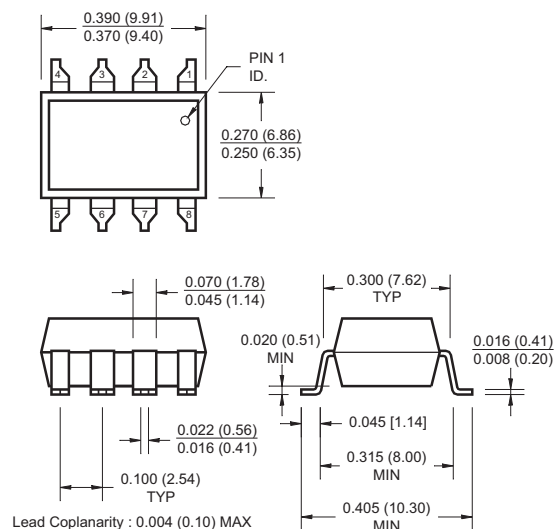


Package Dimensions

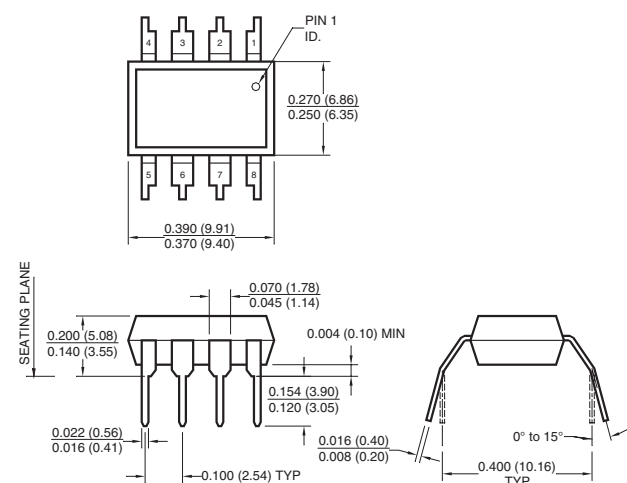
Through Hole



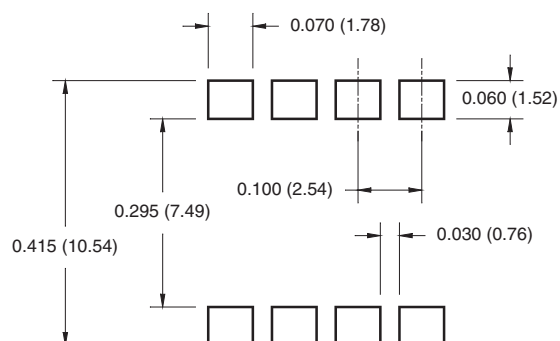
Surface Mount



0.4" Lead Spacing



Recommended Pad Layout for Surface Mount Leadform



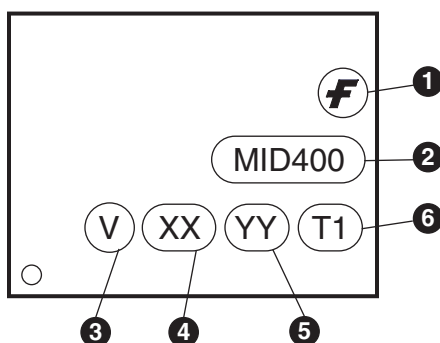
Note:

All dimensions are in inches (millimeters)

Ordering Information

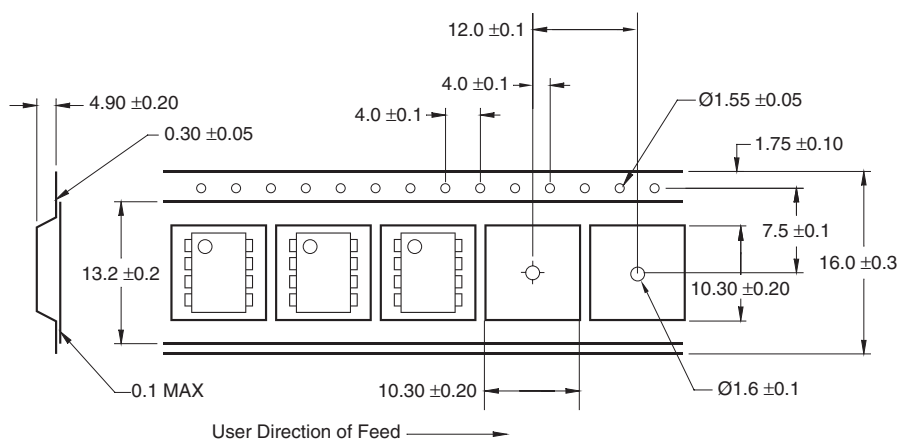
Option	Example Part Number	Description
	MID400	No Option
S	MID400S	Surface Mount Lead Bend
SD	MID400SD	Surface Mount; Tape and reel
W	MID400W	0.4" Lead Spacing
V	MID400V	VDE0884
TV	MID400TV	VDE0884; 0.4" lead spacing
SV	MID400SV	VDE0884; surface mount
SDV	MID400SDV	VDE0884; surface mount; tape and reel

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

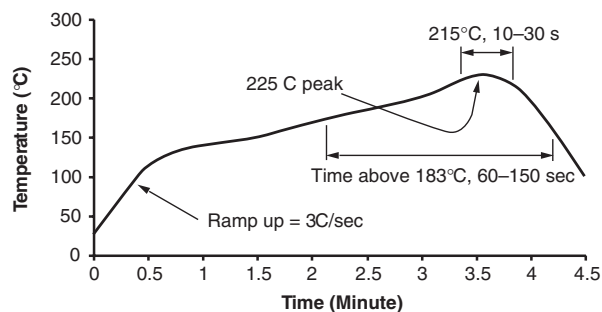
Carrier Tape Specifications (“D” Taping Orientation)



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

FAIRCHILD SEMICONDUCTOR TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACE [™]	FACT Quiet Series [™]	OCX [™]	SILENT SWITCHER [®]	UniFET [™]
ActiveArray [™]	GlobalOptoisolator [™]	OCXPro [™]	SMART START [™]	UltraFET [®]
Bottomless [™]	GTO [™]	OPTOLOGIC [®]	SPM [™]	VCX [™]
Build it Now [™]	HiSeC [™]	OPTOPLANAR [™]	Stealth [™]	Wire [™]
CoolFET [™]	I ² C [™]	PACMAN [™]	SuperFET [™]	
CROSSVOLT [™]	i-Lo [™]	POP [™]	SuperSOT [™] -3	
DOME [™]	ImpliedDisconnect [™]	Power247 [™]	SuperSOT [™] -6	
EcoSPARK [™]	IntelliMAX [™]	PowerEdge [™]	SuperSOT [™] -8	
E ² CMOS [™]	ISOPPLANAR [™]	PowerSaver [™]	SyncFET [™]	
EnSigna [™]	LittleFET [™]	PowerTrench [®]	TCM [™]	
FACT [®]	MICROCOUPLER [™]	QFET [®]	TinyBoost [™]	
FAST [®]	MicroFET [™]	QS [™]	TinyBuck [™]	
FASTr [™]	MicroPak [™]	QT Optoelectronics [™]	TinyPWM [™]	
FPS [™]	MICROWIRE [™]	Quiet Series [™]	TinyPower [™]	
FRFET [™]	MSX [™]	RapidConfigure [™]	TinyLogic [®]	
	MSXPro [™]	RapidConnect [™]	TINYOPTO [™]	
Across the board. Around the world. [™]		μSerDes [™]	TruTranslation [™]	
The Power Franchise [®]		ScalarPump [™]	UHC [®]	
Programmable Active Droop [™]				

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. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

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 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, or (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 significant injury to the user.

2. A critical component is 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.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and 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	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Rev. I21