

## HSR312, HSR312L, HSR412, HSR412L Photovoltaic Solid-State Relay Optocouplers

### Features

- 4,000 VRMS Isolation
- Wide operating voltage range
- 250V (HSR312, HSR312L)
- 400V (HSR412, HSR412L)
- Solid-State Reliability
- Bounce-Free Operation
- 4000V ESD Rating (HBM)
- UL and CSA approved

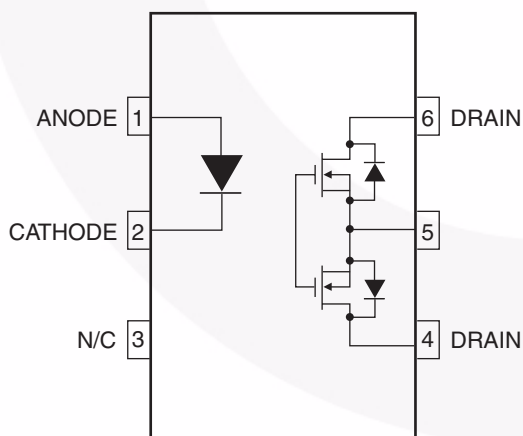
### Applications

- On/Off Hook Switch
- Replacement for Mechanical Relays
- Dial Out Relay
- Ring Injection Relay
- General Switching
- Ground Start

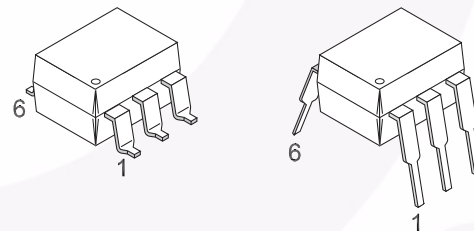
### Description

The HSR312 and HSR412 devices consist of a AlGaAs infrared emitting diode optically coupled to a power MOSFET detector which is driven by a photovoltaic generator. The devices are housed in a 6-pin dual-in-line package. The HSR312L and HSR412L employ an active current limit circuitry enabling the device to withstand current surge transients.

### Schematic



### Package Outlines



**Absolute Maximum Ratings** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

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              | Parameters                       | Device | Value          | Units            |
|---------------------|----------------------------------|--------|----------------|------------------|
| <b>TOTAL DEVICE</b> |                                  |        |                |                  |
| $T_{\text{STG}}$    | Storage Temperature              | All    | -40 to +100    | $^\circ\text{C}$ |
| $T_{\text{OPR}}$    | Operating Temperature            | All    | -40 to +85     | $^\circ\text{C}$ |
| $T_{\text{SOL}}$    | Lead Solder Temperature          | All    | 260 for 10 sec | $^\circ\text{C}$ |
| $V_{\text{ISO}}$    | Isolation Surge Voltage          | All    | 4000           | Vac(RMS)         |
| $C_{\text{IO}}$     | Maximum Input/Output Capacitance | All    | 1.0            | pF               |
| $R_{\text{IO}}$     | Maximum Input/Output Resistance  | All    | $10^{12}$      | $\Omega$         |

**Electrical Characteristics** ( $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  unless otherwise specified)**Input Characteristics**

| Symbol       | Parameters/<br>Test Conditions  | Connection         | Limit | HSR312 | HSR312L | HSR412 | HSR412L | Units |
|--------------|---|--------------------|-------|--------|---------|--------|---------|-------|
| $I_{F(ON)}$  | Control Current   | Series or Parallel | Max.  | 2.0    | 2.0     | 3.0    | 3.0     | mA    |
| $I_{F(OFF)}$ | Control Current for Off-State Resistance ( $T_A = 25^{\circ}\text{C}$ ) | Series or Parallel | Min.  | 0.4    | 0.4     | 0.4    | 0.4     | mA    |
| $I_F$        | Control Current Range   | Series or Parallel | Min.  | 2.0    | 2.0     | 3.0    | 3.0     | mA    |
|              |   |                    | Max.  | 25     | 25      | 25     | 25      |       |
| $V_R$        | Reverse Voltage   | Series or Parallel | Min.  | 7      | 7       | 7      | 7       | V     |
| $V_F$        | Forward Voltage ( $I_F = 10\text{mA}$ )                                 | Series or Parallel | Max.  | 1.6    | 1.6     | 1.6    | 1.6     | V     |

**Output Characteristics**

| Symbol    | Parameters/<br>Test Conditions   | Connection         | Limit | HSR312 | HSR312L | HSR412 | HSR412L | Units                      |
|-----------|--|--------------------|-------|--------|---------|--------|---------|----------------------------|
| $V_{OPR}$ | Operating Voltage Range  | Series or Parallel | Max.  | 250    | 250     | 400    | 400     | $V_{DC}$ or $V_{AC(PEAK)}$ |
| $I_L$     | Load Current<br>$T_A = +40^{\circ}\text{C}$ , 5mA control (see Fig. 1 & 2)   | Series             | Max.  | 190    | 170     | 140    | 120     | mA                         |
|           |  | Parallel           | Max.  | 320    | 300     | 210    | 200     |                            |
| $R_{ON}$  | On-State Resistance<br>$T_A = 25^{\circ}\text{C}$ , 50mA pulsed load, 5mA control  | Series             | Max.  | 10     | 15      | 27     | 35      | $\Omega$                   |
|           |  | Parallel           | Max.  | 3      | 4.25    | 7      | 9       |                            |
|           | Off-State Leakage Current<br>$T_A = 25^{\circ}\text{C}$ , $\pm 250\text{V}$ for HSR312/L, $\pm 400\text{V}$ for HSR412/L | Series or Parallel | Max.  | 1.0    | 1.0     | 1.0    | 1.0     | $\mu\text{A}$              |
| $I_{LMT}$ | Current Limit<br>$T_A = +25^{\circ}\text{C}$ , 5mA control   | Series             | Min.  | N/A    | 190     | N/A    | 130     | mA                         |
|           |  |                    | Max.  | N/A    | 300     | N/A    | 220     |                            |
|           |  | Parallel           | Min.  | N/A    | 330     | N/A    | 260     |                            |
|           |  |                    | Max.  | N/A    | 560     | N/A    | 440     |                            |
| $T_{ON}$  | Turn-On Time<br>$T_A = +25^{\circ}\text{C}$ for 50mA, 100VDC load, 5mA control   | Series or Parallel | Max.  | 3.0    | 3.0     | 2.0    | 2.0     | mS                         |
| $T_{OFF}$ | Turn-Off Time $T_A = +25^{\circ}\text{C}$ for 50mA, 100VDC load, 5mA control   | Series or Parallel | Max.  | 0.5    | 0.5     | 0.5    | 0.5     | mS                         |
|           | Thermal Offset Voltage 5mA control   | Series or Parallel | Max.  | N/A    | N/A     | 0.5    | 0.5     | mV                         |
| $C_O$     | Output Capacitance $50V_{DC}$  | Series             | Max.  | 50     | 50      | 12     | 12      | pF                         |

**Isolation Characteristics**

| Symbol    | Characteristics                | Test Conditions              | Limit | HSR312 | HSR312L | HSR412 | HSR412L | Units |
|-----------|--------------------------------|------------------------------|-------|--------|---------|--------|---------|-------|
| $V_{ISO}$ | Input-Output Isolation Voltage | $I_{I-O} \leq 2 \mu\text{A}$ | Max   | 4000   | 4000    | 4000   | 4000    | V     |

## Typical Performance Curves

Figure 1. Forward Current vs. Forward Voltage

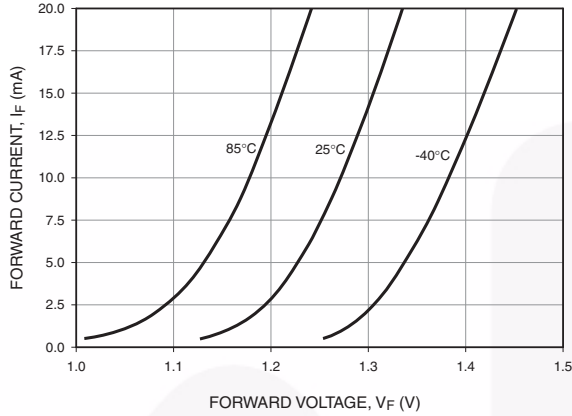


Figure 2. Normalized on Resistance vs. Ambient Temperature

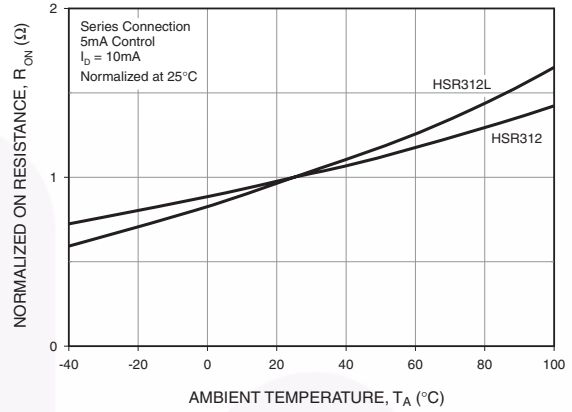


Figure 3. Normalized on Resistance vs. Ambient Temperature

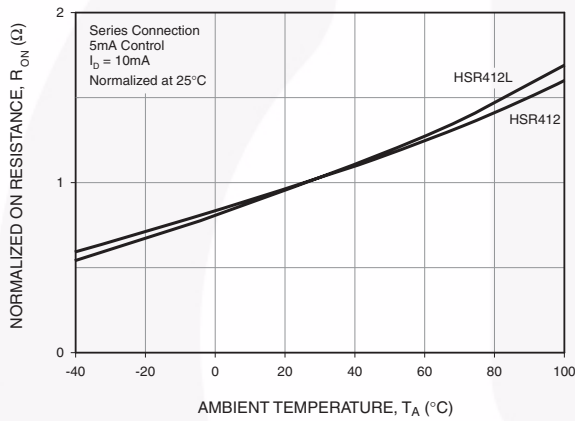


Figure 4. Load Current vs. Voltage Drop

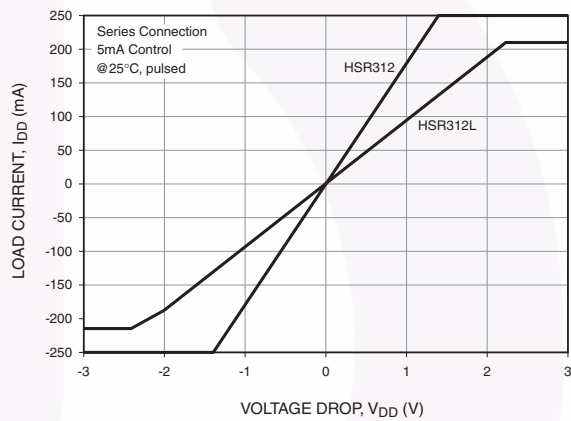


Figure 5. Load Current vs. Voltage Drop

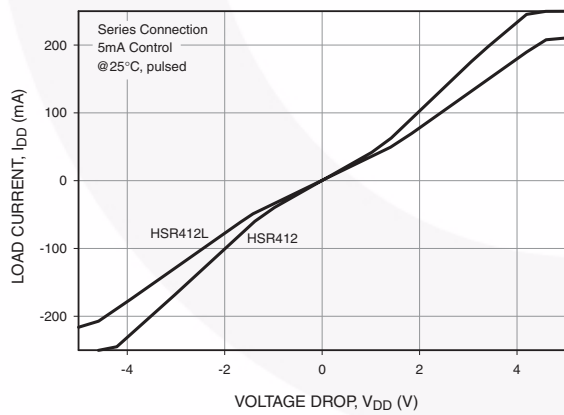
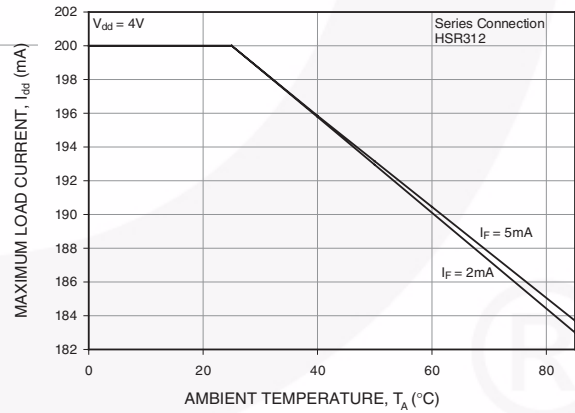
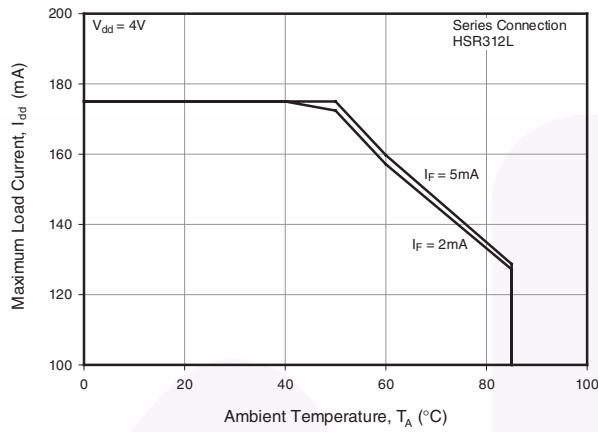


Figure 6. Maximum Load Current Vs Ambient Temperature

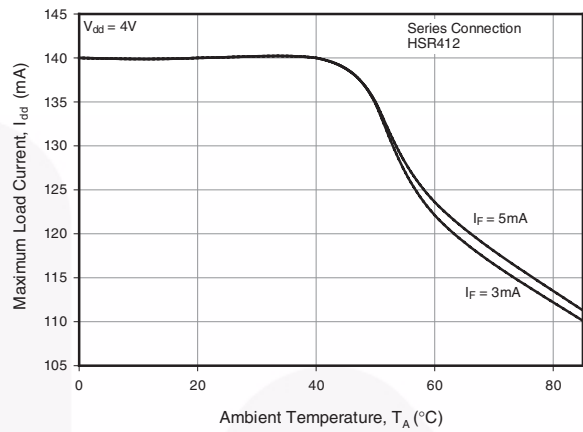


## Typical Performance Curves (Continued)

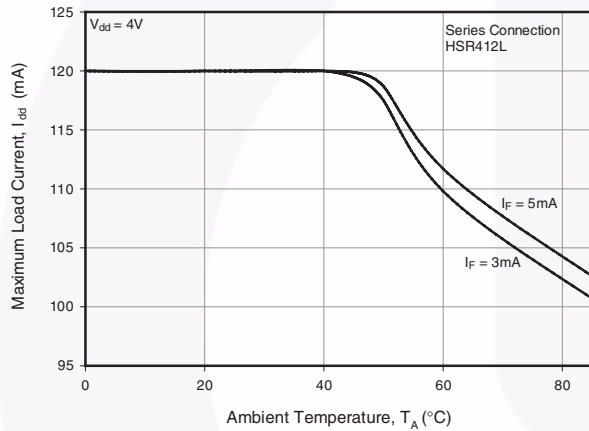
**Figure 7. Maximum Load Current Vs Ambient Temperature**



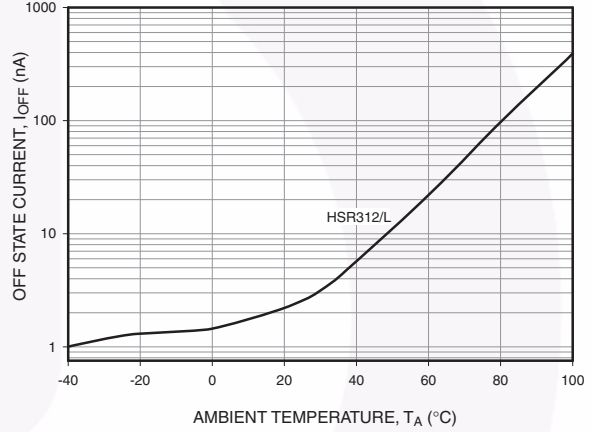
**Figure 8. Maximum Load Current Vs Ambient Temperature**



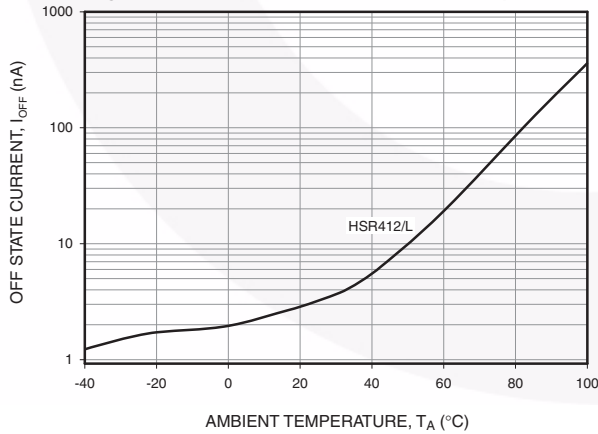
**Figure 9. Maximum Load Current Vs Ambient Temperature**



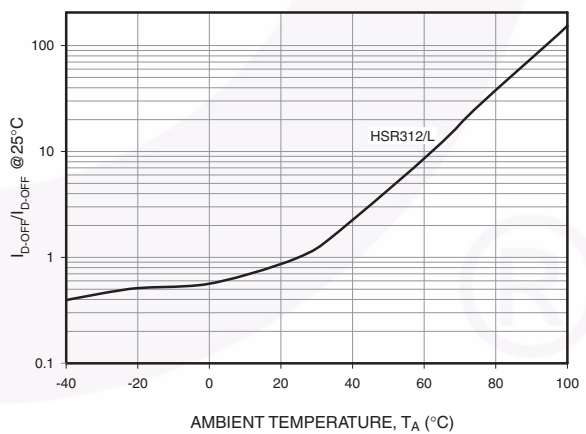
**Figure 10. Off State Current vs. Ambient Temperature**



**Figure 11. Off State Current vs. Ambient Temperature**

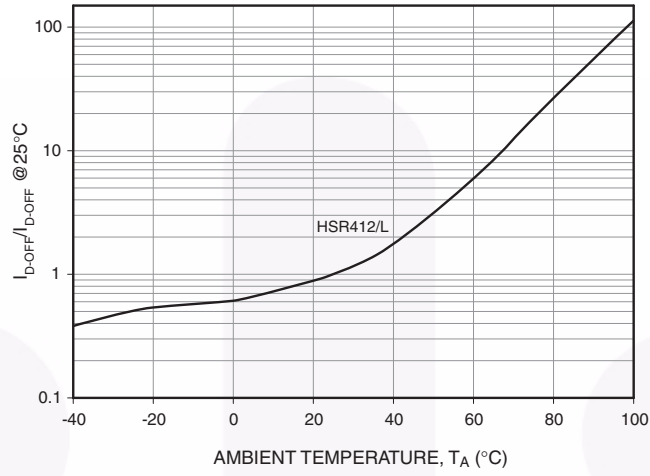


**Figure 12. Normalized Off State Leakage vs. Ambient Temperature**

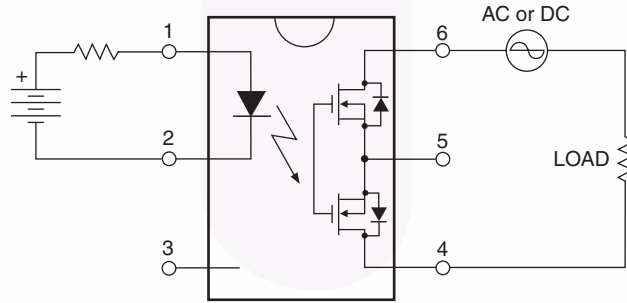


Typical Performance Curves (Continued)

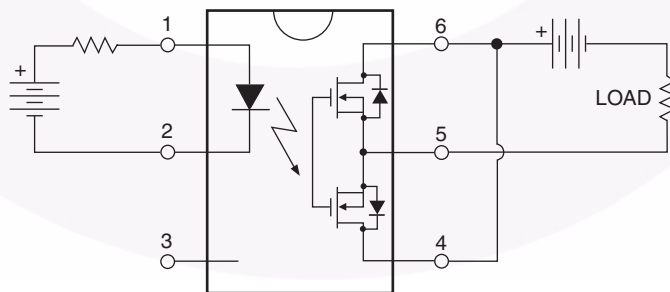
Figure 13. Normalized Off State Leakage vs. Ambient Temperature



Series Connection

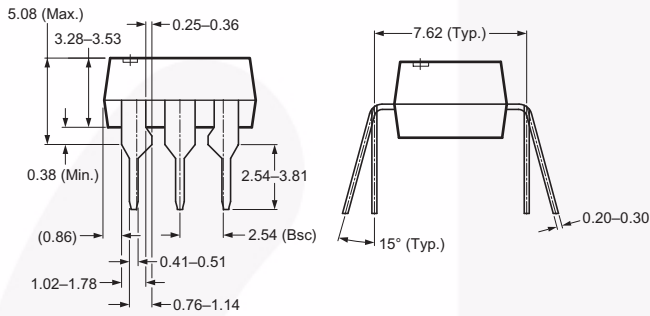
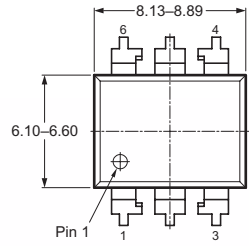


Parallel Connection

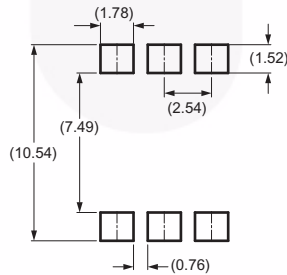
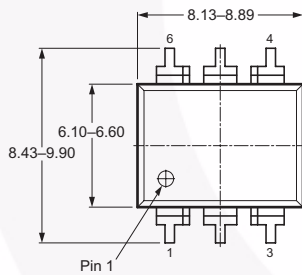


## Package Dimensions

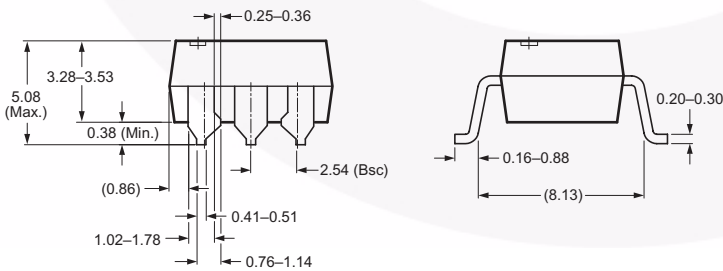
### Through Hole



### Surface Mount



Recommended Pad Layout

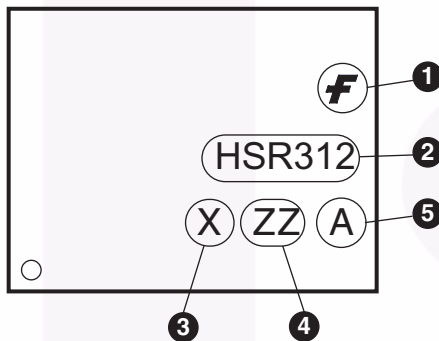


**Note:**  
All dimensions in mm.

### Ordering Information

| Option    | Order Entry Identifier (Example) | Description                  |
|-----------|----------------------------------|------------------------------|
| No option | HSR312                           | Standard Through Hole Device |
| S         | HSR312S                          | Surface Mount Lead Bend      |
| SR2       | HSR312SR2                        | Surface Mount; Tape and Reel |

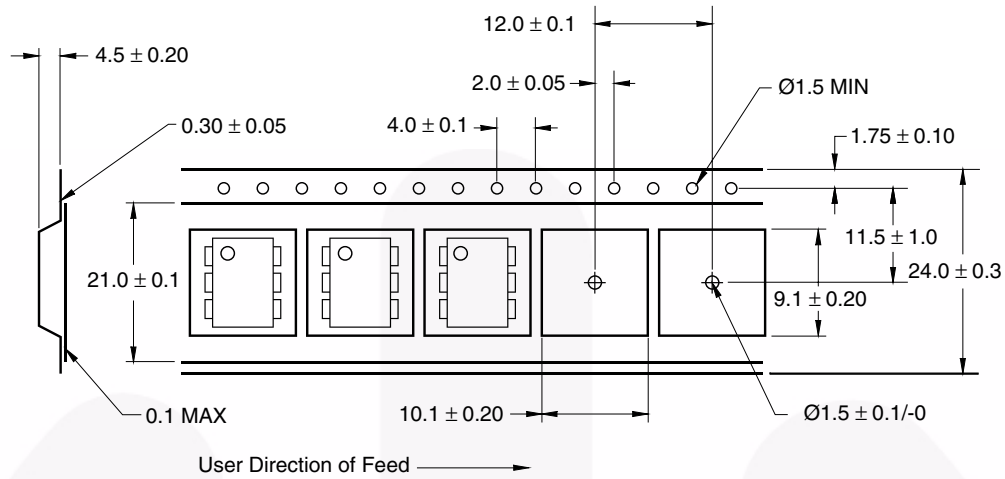
### Marking Information



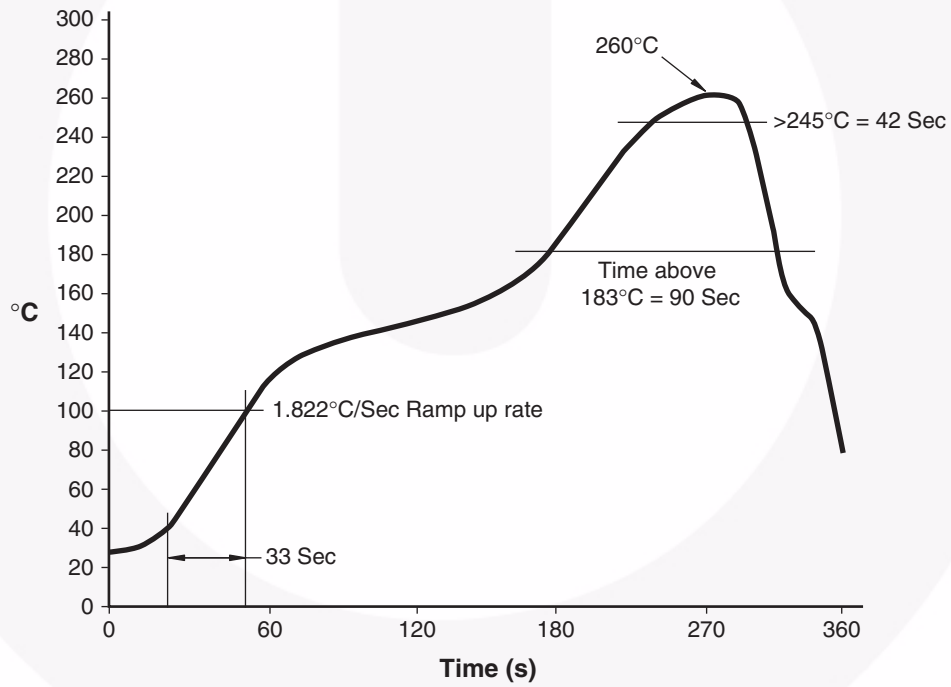
| Definitions |   |
|-------------|---|
| 1           | Fairchild logo                                |
| 2           | Device number                                 |
| 3           | One digit year code, e.g., '3'                |
| 4           | Two digit work week ranging from '01' to '53' |
| 5           | Assembly package code                         |



### Carrier Tape Specification





### Reflow Profile






**TRADEMARKS**

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

AccuPower™  
Auto-SPM™  
Build it Now™  
CorePLUS™  
CorePOWER™  
CROSSVOLT™  
CTL™  
Current Transfer Logic™  
DEUXPEED®  
EcoSPARK®  
EfficientMax™  
EZSWITCH™\*  
™\*  
™  
Fairchild®  
Fairchild Semiconductor®  
FACT Quiet Series™  
FACT®  
FAST®  
FastvCore™  
FETBench™

FlashWriter®\*  
FPS™  
F-PFS™  
FRFET®  
Global Power Resource<sup>SM</sup>  
Green FPS™  
Green FPS™ e-Series™  
Gmax™  
GTO™  
IntelliMAX™  
ISOPLANAR™  
MegaBuck™  
MICROCOUPLER™  
MicroFET™  
MicroPak™  
MillerDrive™  
MotionMax™  
Motion-SPM™  
OPTOLOGIC®  
OPTOPLANAR®  
®  
PDP SPM™

Power-SPM™  
PowerTrench®  
PowerXS™  
Programmable Active Droop™  
QFET®  
QS™  
Quiet Series™  
RapidConfigure™  
™  
Saving our world, 1mW/W/kW at a time™  
SignalWise™  
SmartMax™  
SMART START™  
SPM®  
STEALTH™  
SuperFET™  
SuperSOT™-3  
SuperSOT™-6  
SuperSOT™-8  
SupreMOS™  
SyncFET™  
Sync-Lock™

 SYSTEM<sup>®</sup> GENERAL  
The Power Franchise®  
the **power** franchise  
TinyBoost™  
TinyBuck™  
TinyCalc™  
TinyLogic®  
TINYOPTO™  
TinyPower™  
TinyPWM™  
TinyWire™  
TriFault Detect™  
TRUECURRENT™\*  
µSerDes™  
 SerDes™  
UHC®  
Ultra FRFET™  
UniFET™  
VCX™  
VisualMax™  
XS™

\* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

**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, 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.

**ANTI-COUNTERFEITING POLICY**

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, [www.fairchildsemi.com](http://www.fairchildsemi.com), under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

| 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.   |
| Obsolete                 | Not In Production     | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.  |

Rev. I44