

# 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

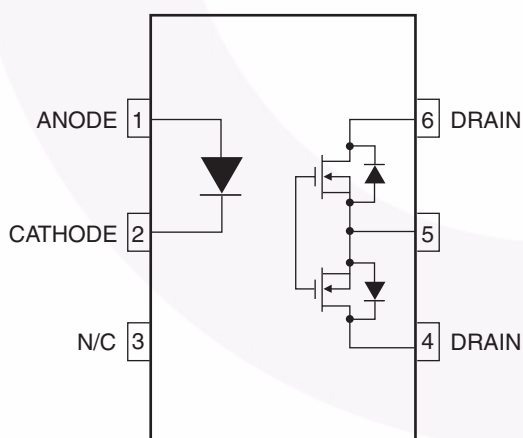
## Applications

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

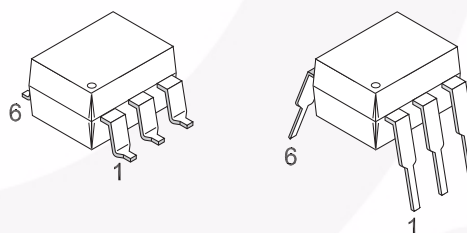
## Description

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<sub>A</sub> = -40°C to +85°C unless otherwise specified)

### Input Characteristics

| Symbol              | Parameters/<br>Test Conditions                                   | Connection         | Limit | HSR312 | HSR312L | HSR412 | HSR412L | Units |
|---------------------|------------------------------------------------------------------|--------------------|-------|--------|---------|--------|---------|-------|
| I <sub>F(ON)</sub>  | Control Current                                                  | Series or Parallel | Max.  | 2.0    | 2.0     | 3.0    | 3.0     | mA    |
| I <sub>F(OFF)</sub> | Control Current for Off-State Resistance (T <sub>A</sub> = 25°C) | Series or Parallel | Min.  | 0.4    | 0.4     | 0.4    | 0.4     | mA    |
| I <sub>F</sub>      | Control Current Range                                            | Series or Parallel | Min.  | 2.0    | 2.0     | 3.0    | 3.0     | mA    |
|                     |                                                                  |                    | Max.  | 25     | 25      | 25     | 25      |       |
| V <sub>R</sub>      | Reverse Voltage                                                  | Series or Parallel | Min.  | 7      | 7       | 7      | 7       | V     |
| V <sub>F</sub>      | Forward Voltage (I <sub>F</sub> = 10mA)                          | 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 <sub>OPR</sub> | Operating Voltage Range                                                                    | Series or Parallel | Max.  | 250    | 250     | 400    | 400     | V <sub>DC</sub> or V <sub>AC(PEAK)</sub> |
| I <sub>L</sub>   | Load Current<br>T <sub>A</sub> = +40°C, 5mA control (see Fig. 1 & 2)                       | Series             | Max.  | 190    | 170     | 140    | 120     | mA                                       |
|                  |                                                                                            | Parallel           | Max.  | 320    | 300     | 210    | 200     |                                          |
| R <sub>ON</sub>  | On-State Resistance<br>T <sub>A</sub> = 25°C, 50mA pulsed load, 5mA control                | Series             | Max.  | 10     | 15      | 27     | 35      | Ω                                        |
|                  |                                                                                            | Parallel           | Max.  | 3      | 4.25    | 7      | 9       |                                          |
|                  | Off-State Leakage Current<br>T <sub>A</sub> = 25°C, ±250V for HSR312/L, ±400V for HSR412/L | Series or Parallel | Max.  | 1.0    | 1.0     | 1.0    | 1.0     | μA                                       |
| I <sub>LMT</sub> | Current Limit<br>T <sub>A</sub> = +25°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 <sub>ON</sub>  | Turn-On Time<br>T <sub>A</sub> = +25°C for 50mA, 100VDC load, 5mA control                  | Series or Parallel | Max.  | 3.0    | 3.0     | 2.0    | 2.0     | mS                                       |
| T <sub>OFF</sub> | Turn-Off Time T <sub>A</sub> = +25°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 <sub>O</sub>   | Output Capacitance 50V <sub>DC</sub>                                                       | Series             | Max.  | 50     | 50      | 12     | 12      | pF                                       |

### Isolation Characteristics

| Symbol           | Characteristics                | Test Conditions         | Limit | HSR312 | HSR312L | HSR412 | HSR412L | Units |
|------------------|--------------------------------|-------------------------|-------|--------|---------|--------|---------|-------|
| V <sub>ISO</sub> | Input-Output Isolation Voltage | I <sub>I-O</sub> ≤ 2 μA | Max   | 4000   | 4000    | 4000   | 4000    | V     |

## Typical Performance Curves

Figure 1. Forward Current vs. Forward Voltage

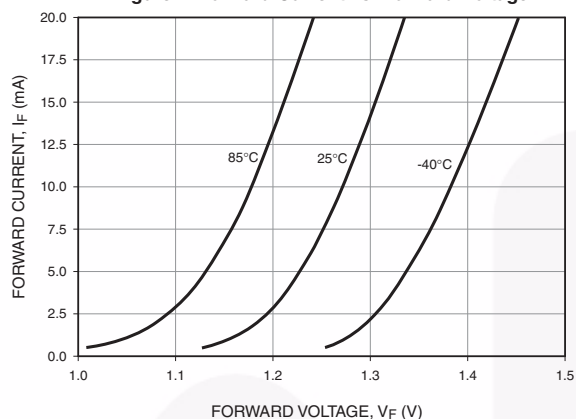


Figure 2. Normalized on Resistance vs. Ambient Temperature

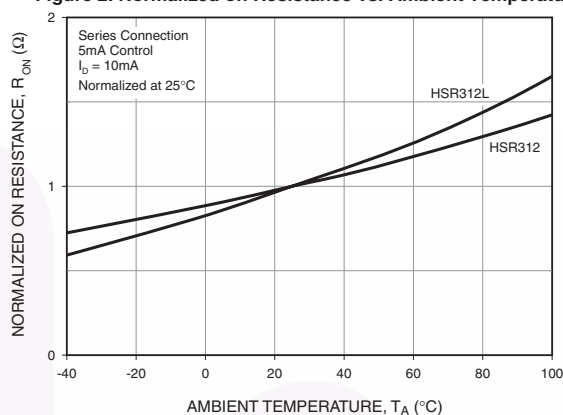


Figure 3. Normalized on Resistance vs. Ambient Temperature

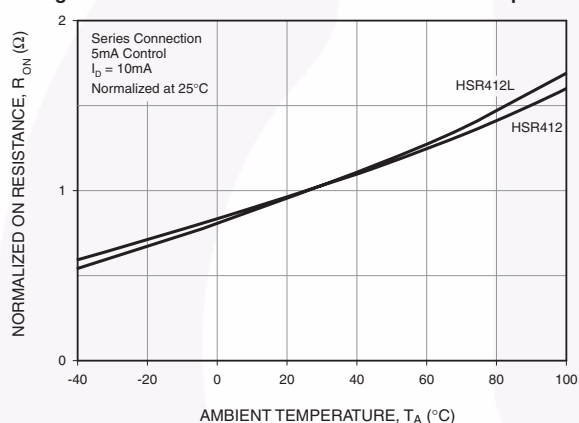


Figure 4. Load Current vs. Voltage Drop

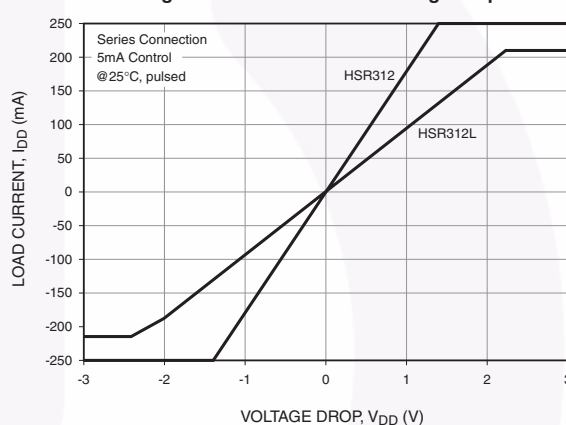


Figure 5. Load Current vs. Voltage Drop

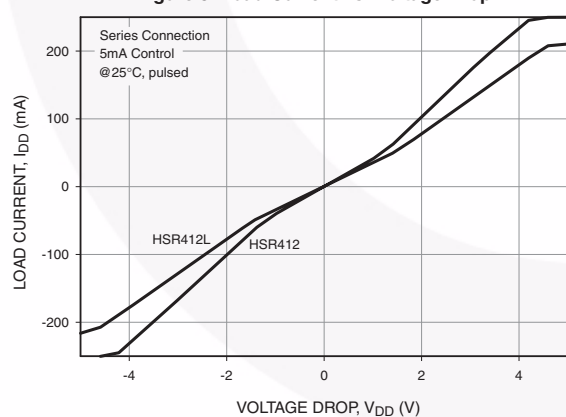
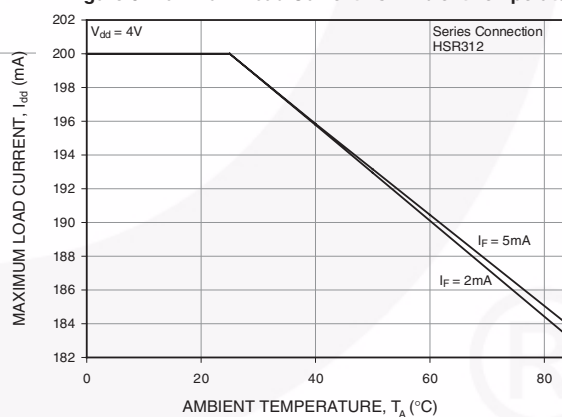


Figure 6. Maximum Load Current Vs Ambient Temperature



## Typical Performance Curves (Continued)

Figure 7. Maximum Load Current Vs Ambient Temperature

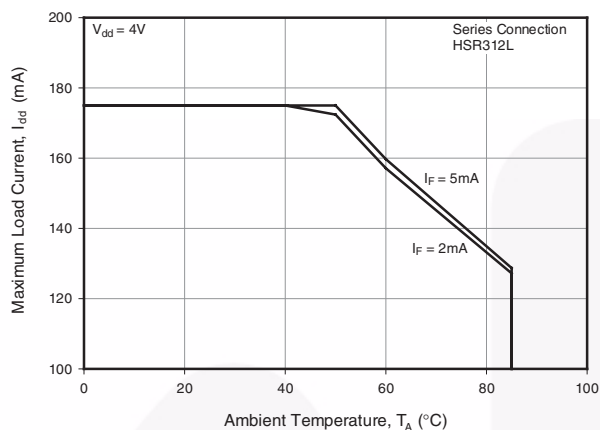


Figure 8. Maximum Load Current Vs Ambient Temperature

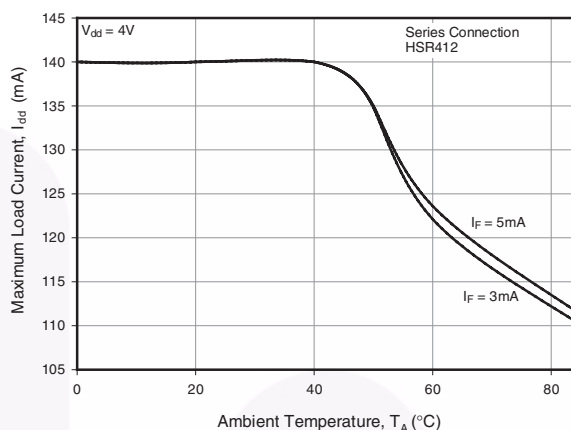


Figure 9. Maximum Load Current Vs Ambient Temperature

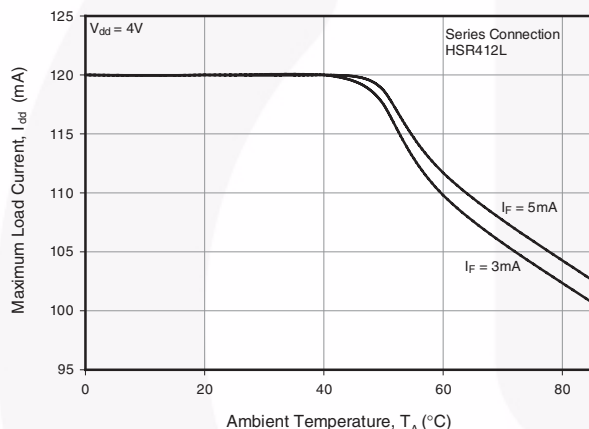


Figure 10. Off State Current vs. Ambient Temperature

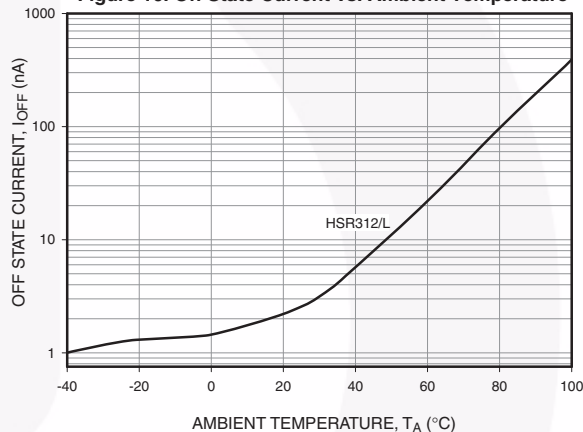


Figure 11. Off State Current vs. Ambient Temperature

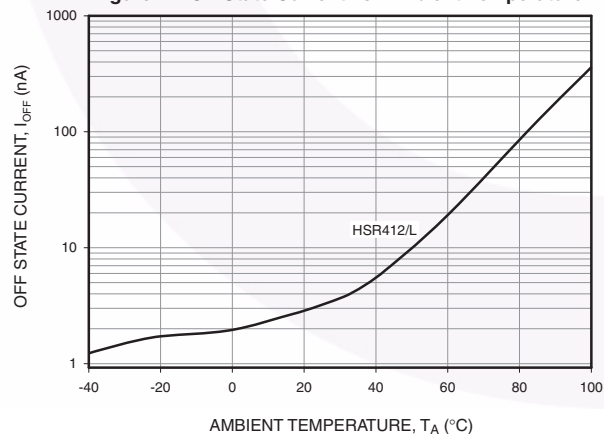
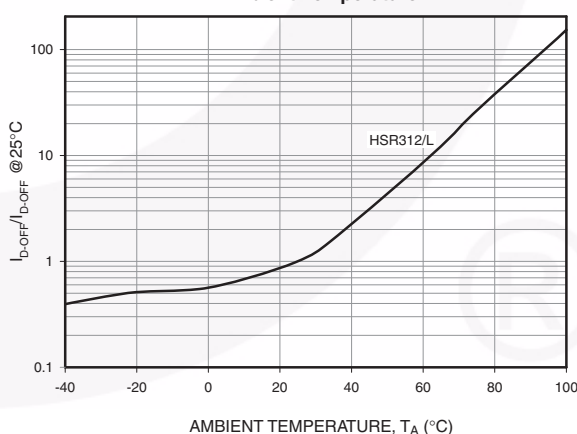
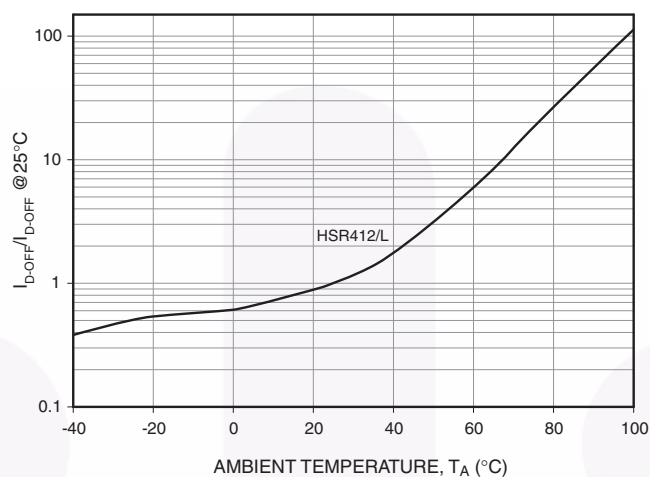


Figure 12. Normalized Off State Leakage vs. Ambient Temperature

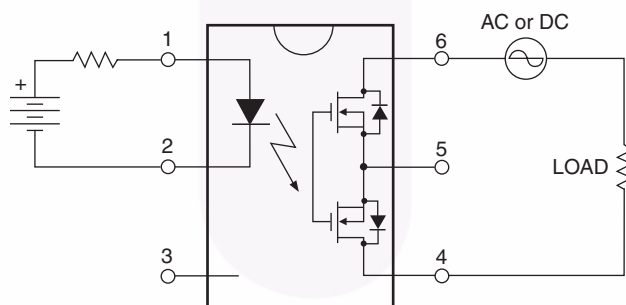


## Typical Performance Curves (Continued)

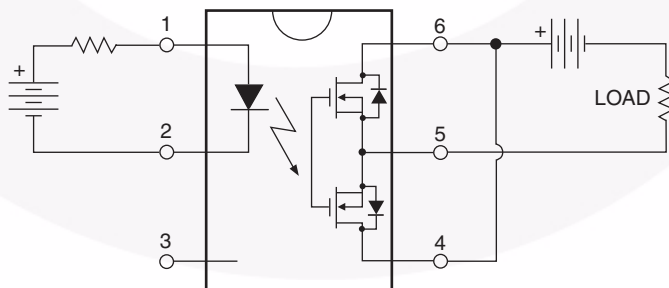
Figure 13. Normalized Off State Leakage vs. Ambient Temperature



### Series Connection

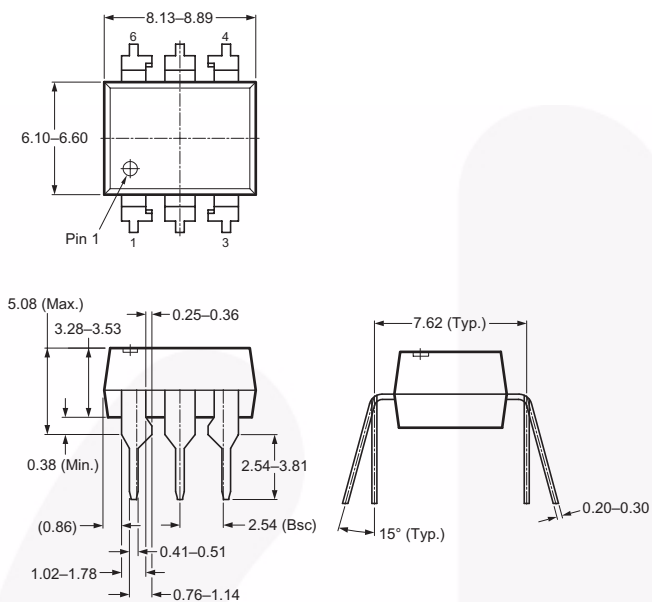


### Parallel Connection

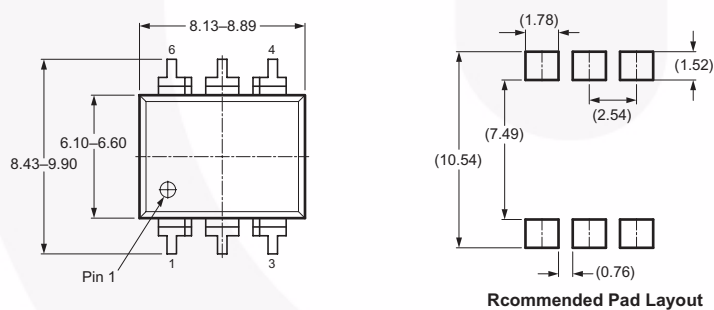


## Package Dimensions

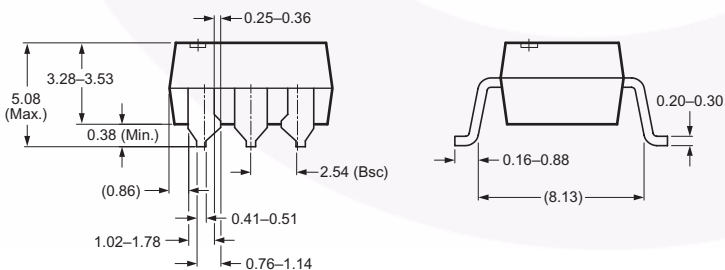
### Through Hole



### Surface Mount



Recommended Pad Layout

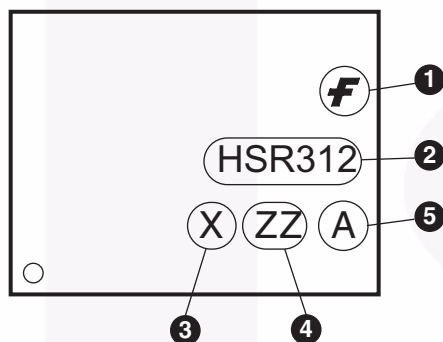


**Note:**  
All dimensions in mm.

## Ordering Information

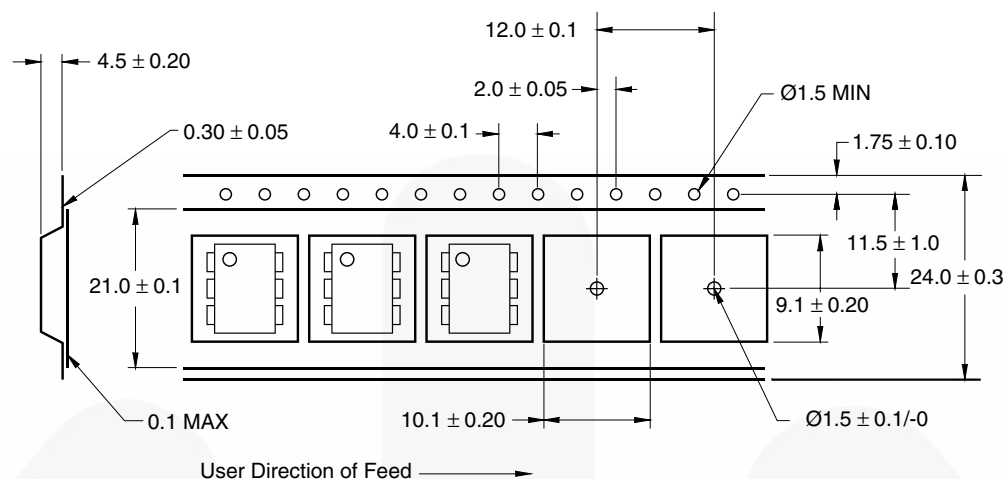
| Option    | Order Entry Identifier<br>(Example) | Description                  |
|-----------|-------------------------------------|------------------------------|
| No option | HSR312                              | Standard Through Hole Device |
| S         | HSR312S                             |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

## Marking Information

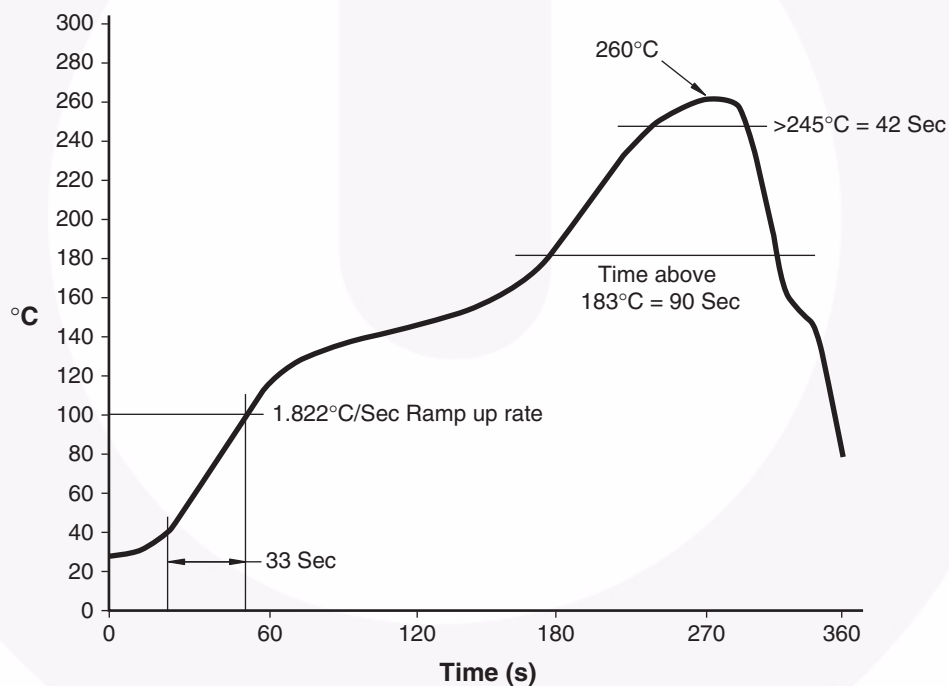


| Definitions |                                               |
|-------------|-----------------------------------------------|
| 1           | Fairchild logo                                |
| 2           | Device number                                 |
| 3           | One digit year code, e.g., '3'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

## Carrier Tape Specification



## Reflow Profile





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