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# H11F1M, H11F2M, H11F3M Photo FET Optocouplers

## Features

As a remote variable resistor:

- $\leq 100\Omega$  to  $\geq 300M\Omega$
- $\leq 15pF$  shunt capacitance
- $\geq 100G\Omega$  I/O isolation resistance

As an analog switch:

- Extremely low offset voltage
- 60 V<sub>pk-pk</sub> signal capability
- No charge injection or latch-up
- UL recognized (File #E90700)

## Applications

As a remote variable resistor:

- Isolated variable attenuator
- Automatic gain control
- Active filter fine tuning/band switching

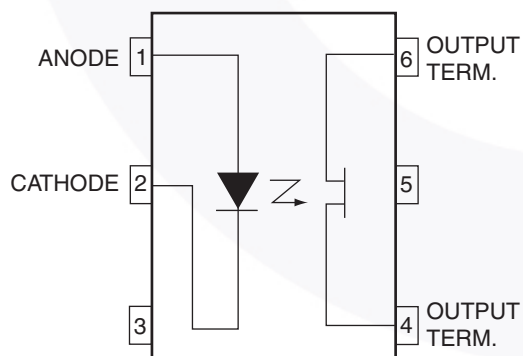
As an analog switch:

- Isolated sample and hold circuit
- Multiplexed, optically isolated A/D conversion

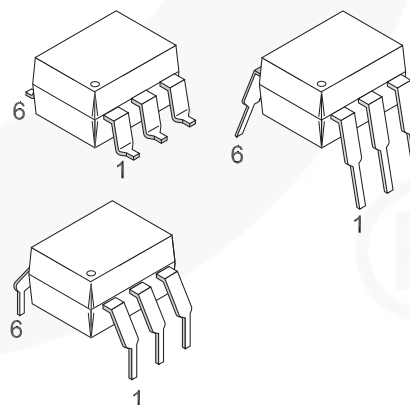
## General Description

The H11FXM series consists of a Gallium-Aluminum-Arsenide IRED emitting diode coupled to a symmetrical bilateral silicon photo-detector. The detector is electrically isolated from the input and performs like an ideal isolated FET designed for distortion-free control of low level AC and DC analog signals. The H11FXM series devices are mounted in dual in-line packages.

## Schematic



## Package Outlines



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

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                                          | Device         | Value          | Units |
|--------------------|----------------------------------------------------|----------------|----------------|-------|
| TOTAL DEVICE       |                                                    |                |                |       |
| T <sub>STG</sub>   | Storage Temperature                                | All            | -40 to +150    | °C    |
| T <sub>OPR</sub>   | Operating Temperature                              | All            | -40 to +100    | °C    |
| T <sub>SOL</sub>   | Lead Solder Temperature                            | All            | 260 for 10 sec | °C    |
| EMITTER            |                                                    |                |                |       |
| I <sub>F</sub>     | Continuous Forward Current                         | All            | 60             | mA    |
| V <sub>R</sub>     | Reverse Voltage                                    | All            | 5              | V     |
| I <sub>F(pk)</sub> | Forward Current – Peak (10μs pulse, 1% duty cycle) | All            | 1              | A     |
| P <sub>D</sub>     | LED Power Dissipation 25°C Ambient                 | All            | 100            | mW    |
|                    | Derate Linearly from 25°C                          |                | 1.33           | mW/°C |
| DETECTOR           |                                                    |                |                |       |
| P <sub>D</sub>     | Detector Power Dissipation @ 25°C                  | All            | 300            | mW    |
|                    | Derate linearly from 25°C                          |                | 4.0            | mW/°C |
| BV <sub>4-6</sub>  | Breakdown Voltage (either polarity)                | H11F1M, H11F2M | ±30            | V     |
|                    |                                                    | H11F3M         | ±15            | V     |
| I <sub>4-6</sub>   | Continuous Detector Current (either polarity)      | All            | ±100           | mA    |

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise specified.)**Individual Component Characteristics**

| Symbol                 | Parameter                            | Test Conditions                                               | Device         | Min. | Typ.* | Max. | Unit          |
|------------------------|--------------------------------------|---------------------------------------------------------------|----------------|------|-------|------|---------------|
| <b>EMITTER</b>         |                                      |                                                               |                |      |       |      |               |
| $V_F$                  | Input Forward Voltage                | $I_F = 16\text{mA}$                                           | All            |      | 1.3   | 1.75 | V             |
| $I_R$                  | Reverse Leakage Current              | $V_R = 5\text{V}$                                             | All            |      |       | 10   | $\mu\text{A}$ |
| $C_J$                  | Capacitance                          | $V = 0\text{V}, f = 1.0\text{MHz}$                            | All            |      | 50    |      | pF            |
| <b>OUTPUT DETECTOR</b> |                                      |                                                               |                |      |       |      |               |
| $BV_{4-6}$             | Breakdown Voltage<br>Either Polarity | $I_{4-6} = 10\mu\text{A}, I_F = 0$                            | H11F1M, H11F2M | 30   |       |      | V             |
|                        |                                      |                                                               | H11F3M         | 15   |       |      |               |
| $I_{4-6}$              | Off-State Dark Current               | $V_{4-6} = 15\text{V}, I_F = 0$                               | All            |      |       | 50   | nA            |
|                        |                                      | $V_{4-6} = 15\text{V}, I_F = 0,$<br>$T_A = 100^\circ\text{C}$ | All            |      |       | 50   | $\mu\text{A}$ |
| $R_{4-6}$              | Off-State Resistance                 | $V_{4-6} = 15\text{V}, I_F = 0$                               | All            | 300  |       |      | M $\Omega$    |
| $C_{4-6}$              | Capacitance                          | $V_{4-6} = 15\text{V}, I_F = 0,$<br>$f = 1\text{MHz}$         | All            |      |       | 15   | pF            |

**Transfer Characteristics**

| Symbol                    | Characteristics                            | Test Conditions                                                             | Device | Min | Typ* | Max | Units         |
|---------------------------|--------------------------------------------|-----------------------------------------------------------------------------|--------|-----|------|-----|---------------|
| <b>DC CHARACTERISTICS</b> |                                            |                                                                             |        |     |      |     |               |
| $R_{4-6}$                 | On-State Resistance                        | $I_F = 16\text{mA},$<br>$I_{4-6} = 100\mu\text{A}$                          | H11F1M |     |      | 200 | $\Omega$      |
|                           |                                            |                                                                             | H11F2M |     |      | 330 |               |
|                           |                                            |                                                                             | H11F3M |     |      | 470 |               |
| $R_{6-4}$                 | On-State Resistance                        | $I_F = 16\text{mA},$<br>$I_{6-4} = 100\mu\text{A}$                          | H11F1M |     |      | 200 | $\Omega$      |
|                           |                                            |                                                                             | H11F2M |     |      | 330 |               |
|                           |                                            |                                                                             | H11F3M |     |      | 470 |               |
|                           | Resistance, non-linearity<br>and assymetry | $I_F = 16\text{mA},$<br>$I_{4-6} = 25\mu\text{A RMS},$<br>$f = 1\text{kHz}$ | All    |     | 2    |     | %             |
| <b>AC CHARACTERISTICS</b> |                                            |                                                                             |        |     |      |     |               |
| $t_{on}$                  | Turn-On Time                               | $R_L = 50\Omega, I_F = 16\text{mA},$<br>$V_{4-6} = 5\text{V}$               | All    |     |      | 45  | $\mu\text{s}$ |
| $t_{off}$                 | Turn-Off Time                              | $R_L = 50\Omega, I_F = 16\text{mA},$<br>$V_{4-6} = 5\text{V}$               | All    |     |      | 45  | $\mu\text{s}$ |

**Isolation Characteristics**

| Symbol    | Characteristic        | Test Conditions                      | Device | Min.      | Typ.* | Max. | Units               |
|-----------|-----------------------|--------------------------------------|--------|-----------|-------|------|---------------------|
| $V_{ISO}$ | Isolation Voltage     | $f = 60\text{Hz}, t = 1\text{ sec.}$ | All    | 7500      |       |      | $V_{AC\text{PEAK}}$ |
| $R_{ISO}$ | Isolation Resistance  | $V_{I-O} = 500\text{VDC}$            | All    | $10^{11}$ |       |      | $\Omega$            |
| $C_{ISO}$ | Isolation Capacitance | $f = 1\text{MHz}$                    | All    |           | 0.2   |      | pF                  |

\*All Typical values at  $T_A = 25^\circ\text{C}$

## Safety and Insulation Ratings

As per IEC 60747-5-2, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.

| Symbol     | Parameter                                                                                                                                   | Min.   | Typ.      | Max. | Unit       |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------|------|------------|
|            | Installation Classifications per DIN VDE 0110/1.89 Table 1                                                                                  |        |           |      |            |
|            | For Rated Main Voltage < 150Vrms                                                                                                            |        | I-IV      |      |            |
|            | For Rated Main voltage < 300Vrms                                                                                                            |        | I-IV      |      |            |
|            | Climatic Classification                                                                                                                     |        | 55/100/21 |      |            |
|            | Pollution Degree (DIN VDE 0110/1.89)                                                                                                        |        | 2         |      |            |
| CTI        | Comparative Tracking Index                                                                                                                  | 175    |           |      |            |
| $V_{PR}$   | Input to Output Test Voltage, Method b, $V_{IORM} \times 1.875 = V_{PR}$ , 100% Production Test with $t_m = 1$ sec, Partial Discharge < 5pC | 1594   |           |      | $V_{peak}$ |
|            | Input to Output Test Voltage, Method a, $V_{IORM} \times 1.5 = V_{PR}$ , Type and Sample Test with $t_m = 60$ sec, Partial Discharge < 5pC  | 1275   |           |      | $V_{peak}$ |
| $V_{IORM}$ | Max. Working Insulation Voltage                                                                                                             | 850    |           |      | $V_{peak}$ |
| $V_{IOTM}$ | Highest Allowable Over Voltage                                                                                                              | 6000   |           |      | $V_{peak}$ |
|            | External Creepage                                                                                                                           | 7      |           |      | mm         |
|            | External Clearance                                                                                                                          | 7      |           |      | mm         |
|            | Insulation Thickness                                                                                                                        | 0.5    |           |      | mm         |
| RIO        | Insulation Resistance at $T_s$ , $V_{IO} = 500V$                                                                                            | $10^9$ |           |      | $\Omega$   |

## Typical Performance Curves

Figure 1. Resistance vs. Input Current

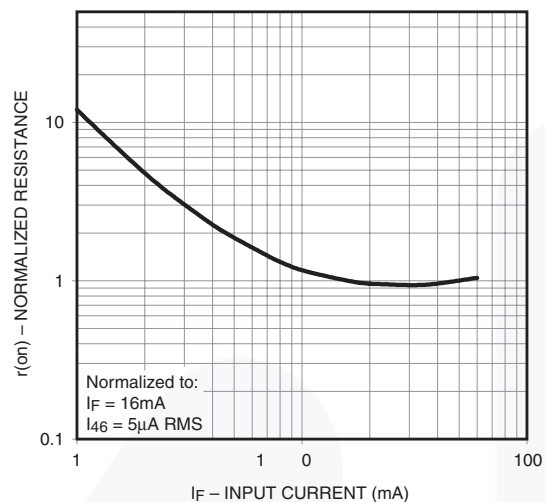


Figure 2. Output Characteristics

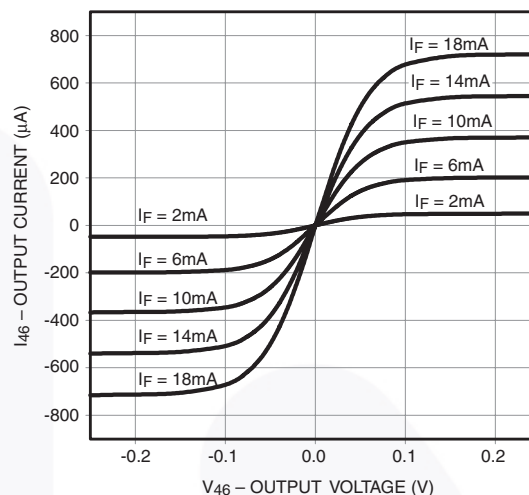


Figure 3. LED Forward Voltage vs. Forward Current

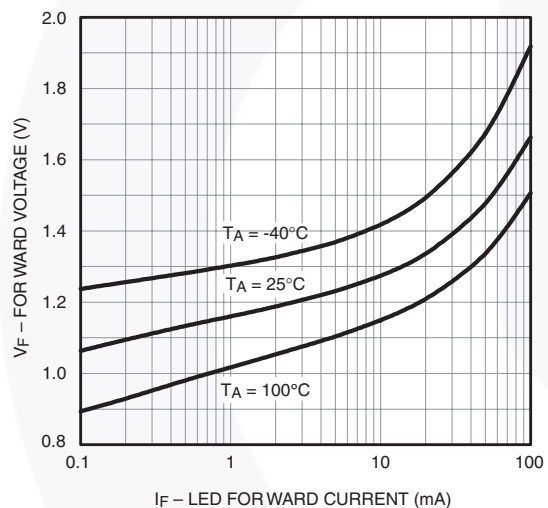


Figure 4. Off-state Current vs. Ambient Temperature

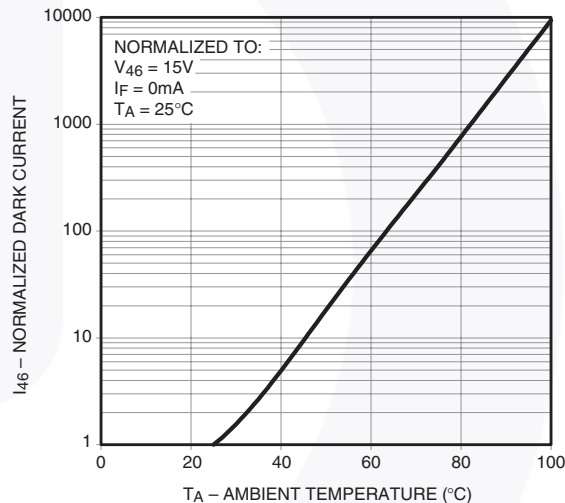
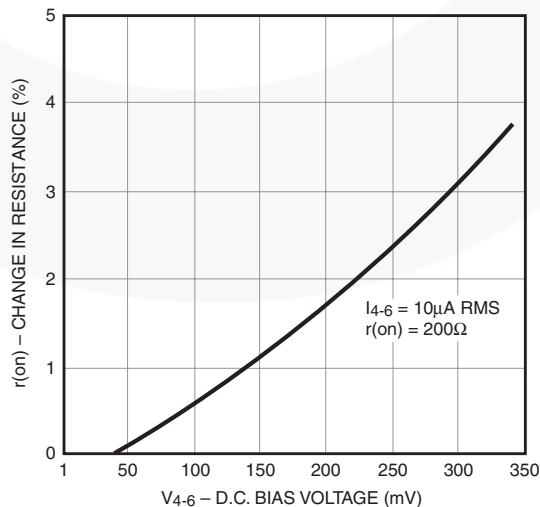


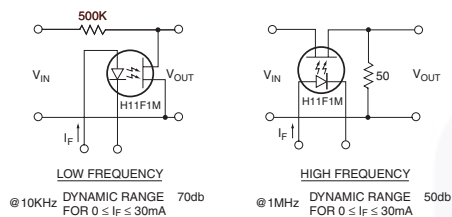
Figure 5. Resistive Non-Linearity vs. D.C. Bias



## Typical Applications

### As a Variable Resistor

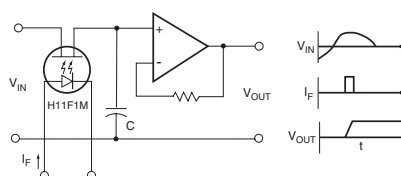
#### ISOLATED VARIABLE ATTENUATORS



Distortion free attenuation of low level A.C. signals is accomplished by varying the IRED current,  $I_F$ . Note the wide dynamic range and absence of coupling capacitors; D.C. level shifting or parasitic feedback to the controlling function.

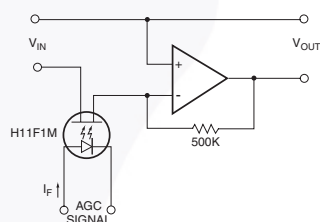
### As an Analog Signal Switch

#### ISOLATED SAMPLE AND HOLD CIRCUIT



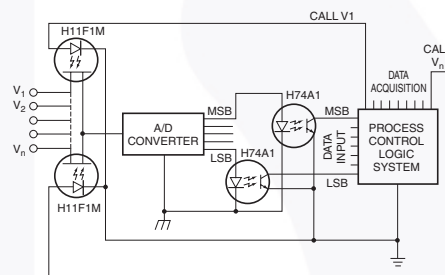
Accuracy and range are improved over conventional FET switches because the H11FXM has no charge injection from the control signal. The H11FXM also provides switching of either polarity input signal up to 30V magnitude.

### AUTOMATIC GAIN CONTROL



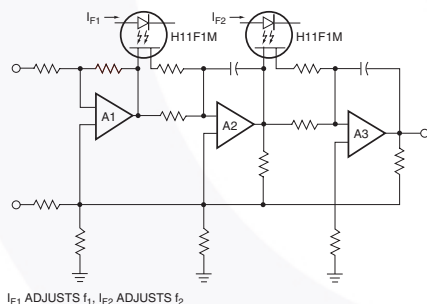
This simple circuit provides over 70db of stable gain control for an AGC signal range of from 0 to 30mA. This basic circuit can be used to provide programmable fade and attack for electronic music.

### MULTIPLEXED, OPTICALLY-ISOLATED A/D CONVERSION



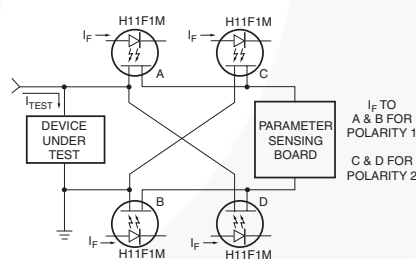
The optical isolation, linearity and low offset voltage of the H11FXM allows the remote multiplexing of low level analog signals from such transducers as thermocouples, Hall effect devices, strain gauges, etc. to a single A/D converter.

### ACTIVE FILTER FINE TUNING/BAND SWITCHING



The linearity of resistance and the low offset voltage of the H11FXM allows the remote tuning or band-switching of active filters without switching glitches or distortion. This schematic illustrates the concept, with current to the H11F1M IRED's controlling the filter's transfer characteristic.

### TEST EQUIPMENT - KELVIN CONTACT POLARITY

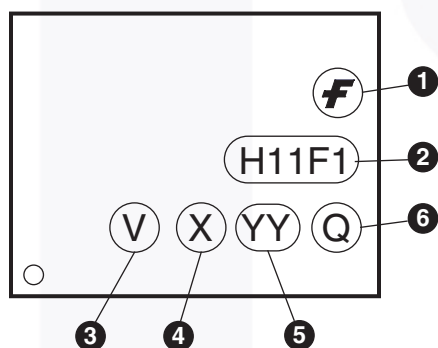


In many test equipment designs the auto polarity function uses reed relay contacts to switch the Kelvin Contact polarity. These reeds are normally one of the highest maintenance cost items due to sticking contacts and mechanical problems. The totally solid-State H11FXM eliminates these troubles while providing faster switching.

## Ordering Information

| Option    | Order Entry Identifier<br>(Example) | Description                                         |
|-----------|-------------------------------------|-----------------------------------------------------|
| No option | H11F1M                              | Standard Through Hole Device                        |
| S         | H11F1SM                             | Surface Mount Lead Bend                             |
| SR2       | H11F1SR2M                           | Surface Mount; Tape and Reel                        |
| V         | H11F1VM                             | IEC60747-5-2 approval                               |
| TV        | H11F1TVM                            | IEC60747-5-2 approval, 0.4" Lead Spacing            |
| SV        | H11F1SVM                            | IEC60747-5-2 approval, Surface Mount                |
| SR2V      | H11F1SR2VM                          | IEC60747-5-2 approval, Surface Mount, Tape and Reel |

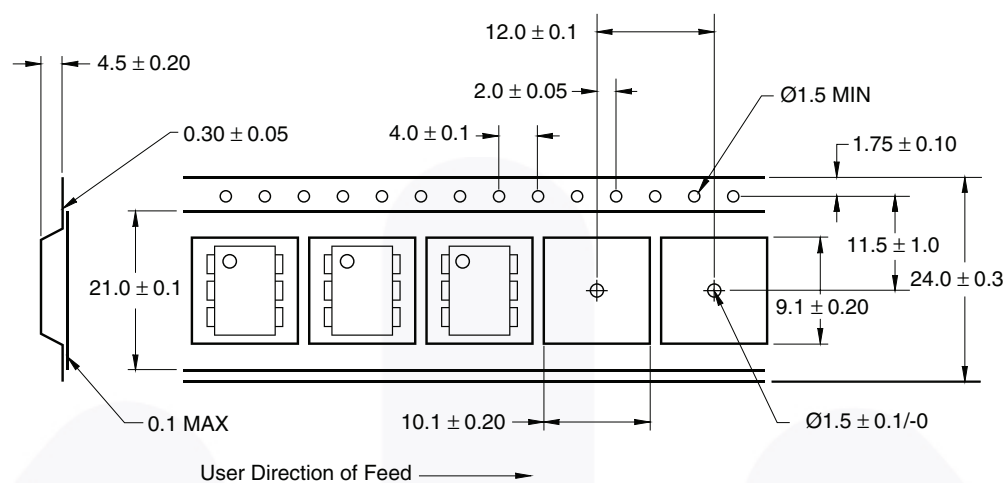
## Marking Information



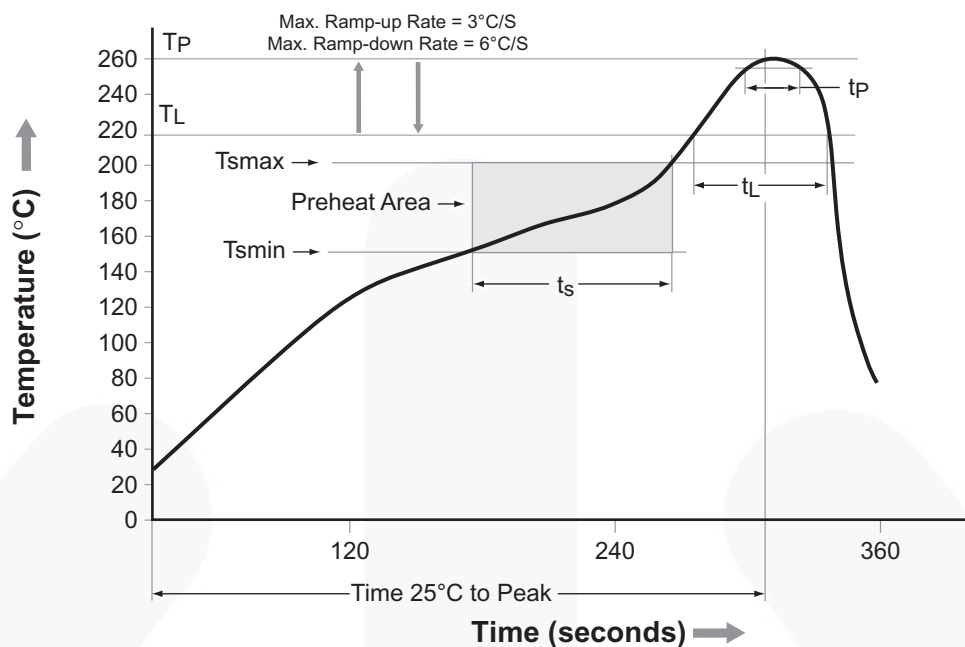
| Definitions |                                                                                        |
|-------------|----------------------------------------------------------------------------------------|
| 1           | Fairchild logo                                                                         |
| 2           | Device number                                                                          |
| 3           | VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table) |
| 4           | One digit year code, e.g., '7'                                                         |
| 5           | Two digit work week ranging from '01' to '53'                                          |
| 6           | Assembly package code                                                                  |



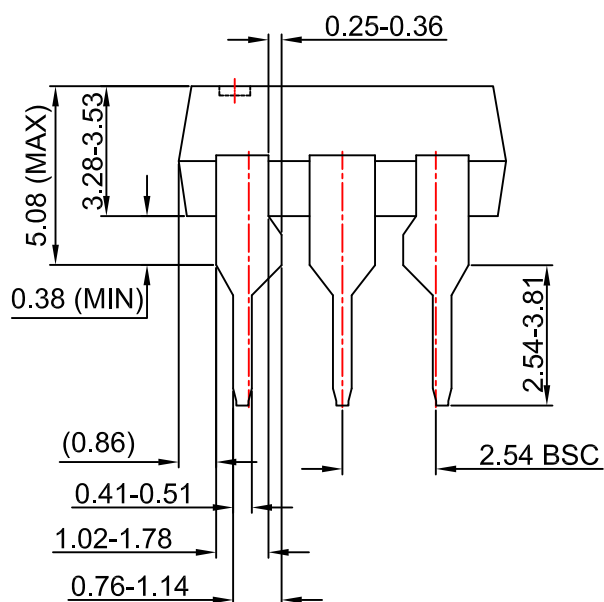
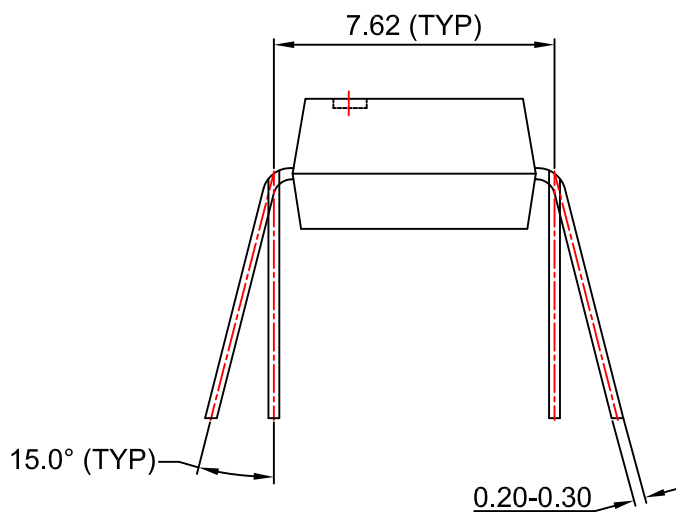
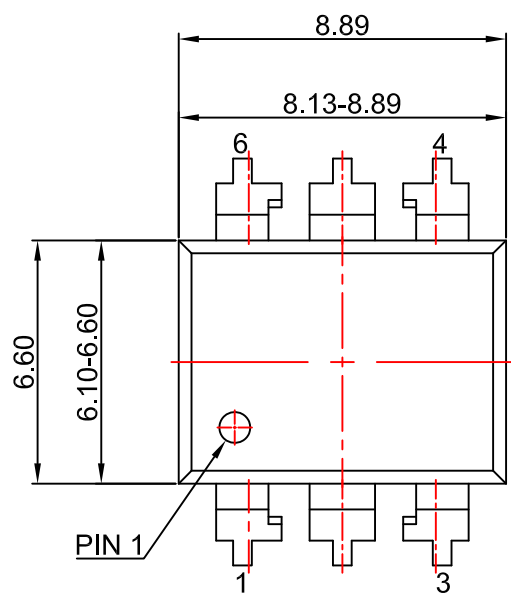
## Carrier Tape Specification



## Reflow Profile



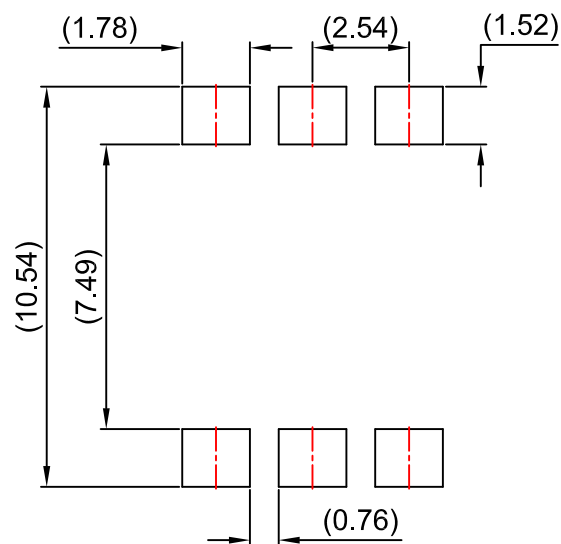
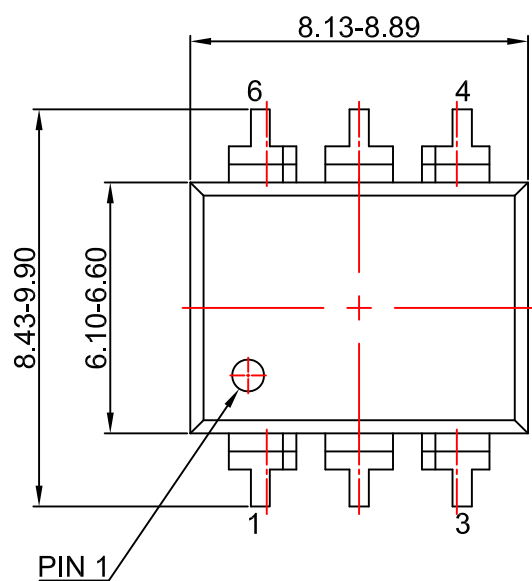
| Profile Feature                                                       | Pb-Free Assembly Profile |
|-----------------------------------------------------------------------|--------------------------|
| Temperature Min. (T <sub>smin</sub> )                                 | 150°C                    |
| Temperature Max. (T <sub>smax</sub> )                                 | 200°C                    |
| Time (t <sub>s</sub> ) from (T <sub>smin</sub> to T <sub>smax</sub> ) | 60–120 seconds           |
| Ramp-up Rate (t <sub>L</sub> to t <sub>p</sub> )                      | 3°C/second max.          |
| Liquidous Temperature (T <sub>L</sub> )                               | 217°C                    |
| Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )             | 60–150 seconds           |
| Peak Body Package Temperature                                         | 260°C +0°C / -5°C        |
| Time (t <sub>p</sub> ) within 5°C of 260°C                            | 30 seconds               |
| Ramp-down Rate (T <sub>p</sub> to T <sub>L</sub> )                    | 6°C/second max.          |
| Time 25°C to Peak Temperature                                         | 8 minutes max.           |



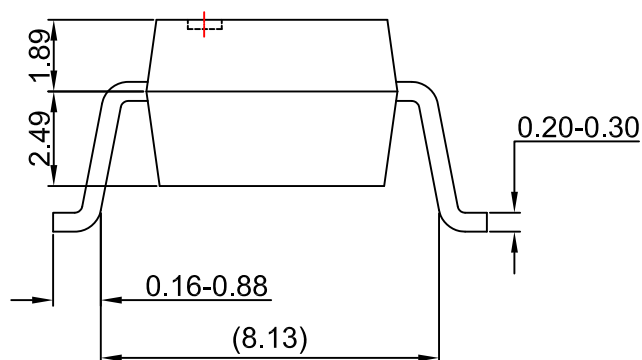
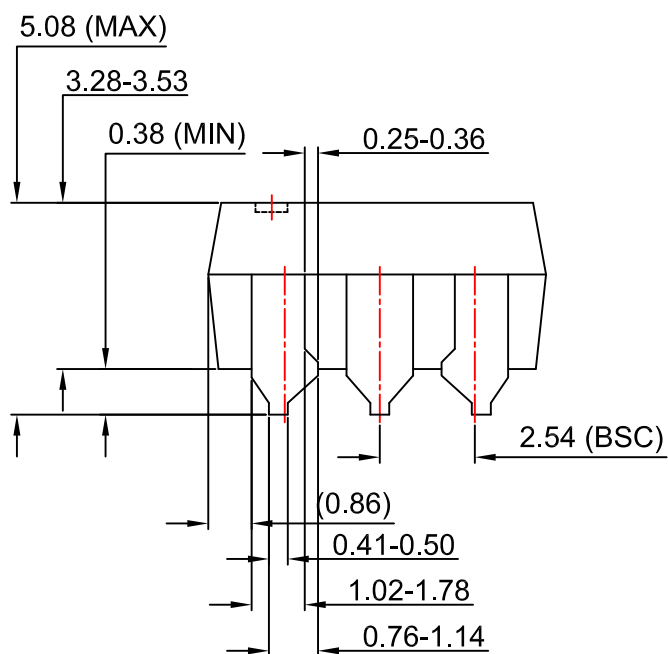
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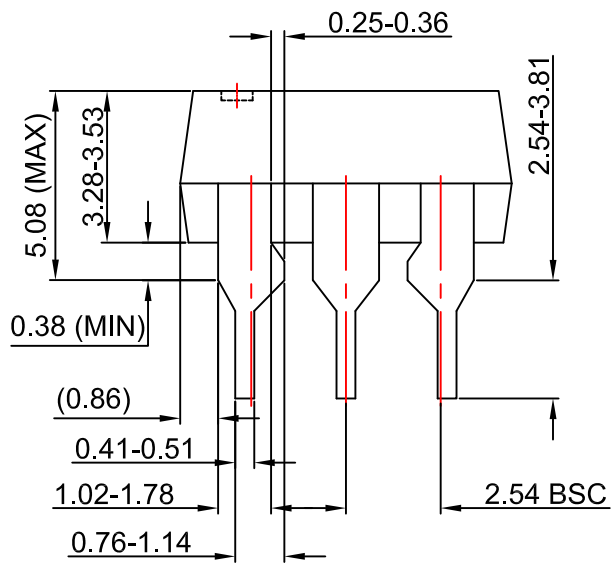
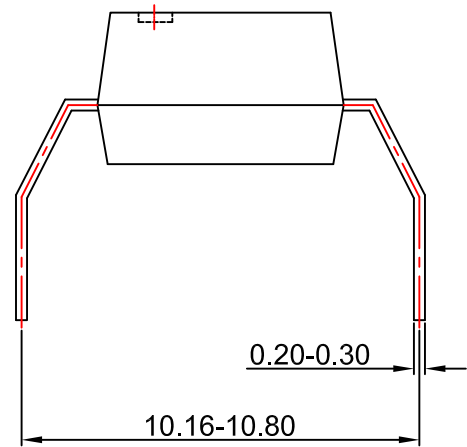
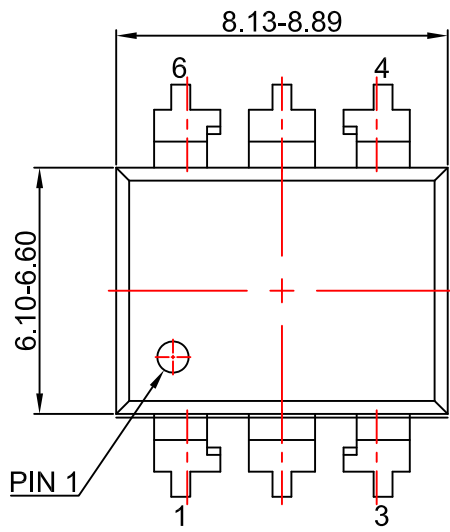
LAND PATTERN RECOMMENDATION



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