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December 2014

## 4N38M, H11D1M, H11D3M, MOC8204M 6-Pin DIP High Voltage Phototransistor Optocouplers

### Features

- High Voltage:
  - MOC8204M,  $BV_{CEO} = 400\text{ V}$
  - H11D1M,  $BV_{CEO} = 300\text{ V}$
  - H11D3M,  $BV_{CEO} = 200\text{ V}$
- Safety and Regulatory Approvals:
  - UL1577, 4,170 VAC<sub>RMS</sub> for 1 Minute
- DIN-EN/IEC60747-5-5, 850 V Peak Working Insulation Voltage

### Applications

- Power Supply Regulators
- Digital Logic Inputs
- Microprocessor Inputs
- Appliance Sensor Systems
- Industrial Controls

### Description

The 4N38M, H11D1M, H11D3M, and MOC8204M are phototransistor-type optically coupled optoisolators. A gallium arsenide infrared emitting diode is coupled with a high voltage NPN silicon phototransistor. The device is supplied in a standard plastic six-pin dual-in-line package.

### Schematic

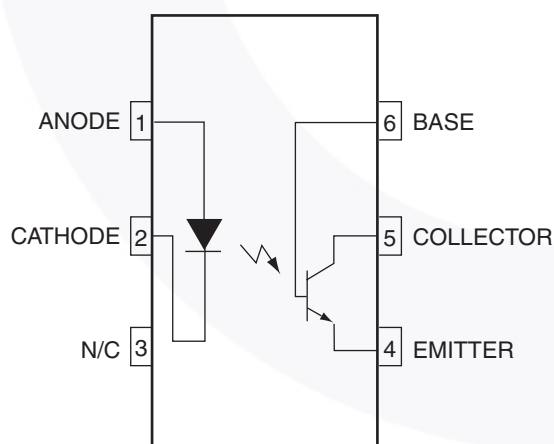


Figure 1. Schematic

### Package Outlines

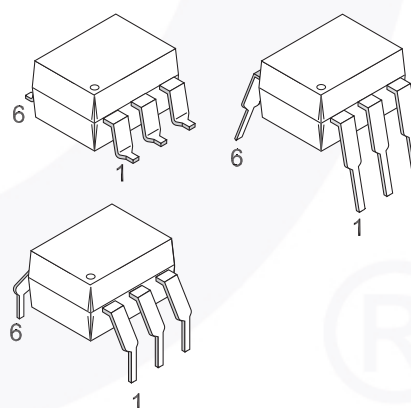


Figure 2. Package Outlines

## Safety and Insulation Ratings

As per DIN EN/IEC 60747-5-5, 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.

| Parameter                                                                           |                        | Characteristics |
|-------------------------------------------------------------------------------------|------------------------|-----------------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 V <sub>RMS</sub> | I–IV            |
|                                                                                     | < 300 V <sub>RMS</sub> | I–IV            |
| Climatic Classification                                                             |                        | 55/100/21       |
| Pollution Degree (DIN VDE 0110/1.89)                                                |                        | 2               |
| Comparative Tracking Index                                                          |                        | 175             |

| Symbol                | Parameter                                                                                                                                                      | Value             | Unit              |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|
| V <sub>PR</sub>       | Input-to-Output Test Voltage, Method A, V <sub>IORM</sub> × 1.6 = V <sub>PR</sub> , Type and Sample Test with t <sub>m</sub> = 10 s, Partial Discharge < 5 pC  | 1360              | V <sub>peak</sub> |
|                       | Input-to-Output Test Voltage, Method B, V <sub>IORM</sub> × 1.875 = V <sub>PR</sub> , 100% Production Test with t <sub>m</sub> = 1 s, Partial Discharge < 5 pC | 1594              | V <sub>peak</sub> |
| V <sub>IORM</sub>     | Maximum Working Insulation Voltage                                                                                                                             | 850               | V <sub>peak</sub> |
| V <sub>IOTM</sub>     | Highest Allowable Over-Voltage                                                                                                                                 | 6000              | V <sub>peak</sub> |
|                       | External Creepage                                                                                                                                              | ≥ 7               | mm                |
|                       | External Clearance                                                                                                                                             | ≥ 7               | mm                |
|                       | External Clearance (for Option TV, 0.4" Lead Spacing)                                                                                                          | ≥ 10              | mm                |
| DTI                   | Distance Through Insulation (Insulation Thickness)                                                                                                             | ≥ 0.5             | mm                |
| T <sub>S</sub>        | Case Temperature <sup>(1)</sup>                                                                                                                                | 175               | °C                |
| I <sub>S,INPUT</sub>  | Input Current <sup>(1)</sup>                                                                                                                                   | 350               | mA                |
| P <sub>S,OUTPUT</sub> | Output Power <sup>(1)</sup>                                                                                                                                    | 800               | mW                |
| R <sub>IO</sub>       | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V <sup>(1)</sup>                                                                               | > 10 <sup>9</sup> | Ω                 |

### Note:

1. Safety limit values – maximum values allowed in the event of a failure.

## 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                                                    | Device                         | Value              | Unit  |
|--------------------|--------------------------------------------------------------|--------------------------------|--------------------|-------|
| TOTAL DEVICE       |                                                              |                                |                    |       |
| T <sub>STG</sub>   | Storage Temperature                                          | All                            | -40 to +125        | °C    |
| T <sub>OPR</sub>   | Operating Temperature                                        | All                            | -40 to +100        | °C    |
| T <sub>J</sub>     | Junction Temperature                                         | All                            | -40 to +125        | °C    |
| T <sub>SOL</sub>   | Lead Solder Temperature                                      | All                            | 260 for 10 seconds | °C    |
| P <sub>D</sub>     | Total Device Power Dissipation @ T <sub>A</sub> = 25°C       | All                            | 420                | mW    |
|                    | Derate Above 25°C                                            |                                | 3.5                | mW/°C |
| EMITTER            |                                                              |                                |                    |       |
| I <sub>F</sub>     | Forward DC Current <sup>(2)</sup>                            | All                            | 80                 | mA    |
| V <sub>R</sub>     | Reverse Input Voltage <sup>(2)</sup>                         | All                            | 6.0                | V     |
| I <sub>F(pk)</sub> | Forward Current – Peak (1 μs pulse, 300pps) <sup>(2)</sup>   | All                            | 3.0                | A     |
| P <sub>D</sub>     | LED Power Dissipation @ T <sub>A</sub> = 25°C <sup>(2)</sup> | All                            | 120                | mW    |
|                    | Derate Above 25°C                                            |                                | 1.41               | mW/°C |
| DETECTOR           |                                                              |                                |                    |       |
| P <sub>D</sub>     | Power Dissipation @ T <sub>A</sub> = 25°C                    | All                            | 300                | mW    |
|                    | Derate linearly above 25°C                                   |                                | 4.0                | mW/°C |
| V <sub>CEO</sub>   | Collector to Emitter Voltage <sup>(2)</sup>                  | MOC8204M                       | 400                | V     |
|                    |                                                              | H11D1M                         | 300                | V     |
|                    |                                                              | H11D3M                         | 200                | V     |
|                    |                                                              | 4N38M                          | 80                 | V     |
| V <sub>CBO</sub>   | Collector Base Voltage <sup>(2)</sup>                        | MOC8204M                       | 400                | V     |
|                    |                                                              | H11D1M                         | 300                | V     |
|                    |                                                              | H11D3M                         | 200                | V     |
|                    |                                                              | 4N38M                          | 80                 | V     |
| V <sub>ECO</sub>   | Emitter to Collector Voltage <sup>(2)</sup>                  | H11D1M,<br>H11D3M,<br>MOC8204M | 7                  | V     |
| I <sub>C</sub>     | Collector Current (Continuous)                               | All                            | 100                | mA    |

### Note:

2. Parameters meet or exceed JEDEC registered data (for 4N38M only).

## Electrical Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified.

### Individual Component Characteristics

| Symbol                          | Characteristic                                                                         | Test Conditions                                                             | Device   | Min. | Typ. | Max. | Unit          |
|---------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------|------|------|------|---------------|
| <b>EMITTER</b>                  |                                                                                        |                                                                             |          |      |      |      |               |
| $V_F$                           | Forward Voltage <sup>(3)</sup>                                                         | $I_F = 10\text{ mA}$                                                        | All      |      | 1.15 | 1.50 | V             |
| $\frac{\Delta V_F}{\Delta T_A}$ | Forward Voltage Temperature Coefficient                                                |                                                                             | All      |      | -1.8 |      | mV/°C         |
| $BV_R$                          | Reverse Breakdown Voltage                                                              | $I_R = 10\text{ }\mu\text{A}$                                               | All      | 6    | 25   |      | V             |
| $C_J$                           | Junction Capacitance                                                                   | $V_F = 0\text{ V}, f = 1\text{ MHz}$                                        | All      |      | 50   |      | pF            |
|                                 |                                                                                        | $V_F = 1\text{ V}, f = 1\text{ MHz}$                                        |          |      | 65   |      | pF            |
| $I_R$                           | Reverse Leakage Current <sup>(3)</sup>                                                 | $V_R = 6\text{ V}$                                                          | All      |      | 0.05 | 10   | $\mu\text{A}$ |
| <b>DETECTOR</b>                 |                                                                                        |                                                                             |          |      |      |      |               |
| $BV_{CEO}$                      | Breakdown Voltage Collector-to-Emitter <sup>(3)</sup>                                  | $R_{BE} = 1\text{ M}\Omega$ ,<br>$I_C = 1.0\text{ mA}, I_F = 0$             | MOC8204M | 400  |      |      | V             |
|                                 |                                                                                        |                                                                             | H11D1M   | 300  |      |      | V             |
|                                 |                                                                                        |                                                                             | H11D3M   | 200  |      |      | V             |
|                                 |                                                                                        | No RBE, $I_C = 1.0\text{ mA}$                                               | 4N38M    | 80   |      |      | V             |
| $BV_{CBO}$                      | Collector to Base <sup>(3)</sup>                                                       | $I_C = 100\text{ }\mu\text{A}, I_F = 0$                                     | MOC8204M | 400  |      |      | V             |
|                                 |                                                                                        |                                                                             | H11D1M   | 300  |      |      | V             |
|                                 |                                                                                        |                                                                             | H11D3M   | 200  |      |      | V             |
|                                 |                                                                                        |                                                                             | 4N38M    | 80   |      |      | V             |
| $BV_{EBO}$                      | Emitter to Base                                                                        | $I_E = 100\text{ }\mu\text{A}, I_F = 0$                                     | 4N38M    | 7    |      |      | V             |
| $BV_{ECO}$                      | Emitter to Collector                                                                   | $I_E = 100\text{ }\mu\text{A}, I_F = 0$                                     | All      | 7    | 10   |      | V             |
| $I_{CEO}$                       | Leakage Current Collector to Emitter <sup>(3)</sup><br>( $R_{BE} = 1\text{ M}\Omega$ ) | $V_{CE} = 300\text{ V}, I_F = 0$ ,<br>$T_A = 25^\circ\text{C}$              | MOC8204M |      |      | 100  | nA            |
|                                 |                                                                                        | $V_{CE} = 300\text{ V}, I_F = 0$ ,<br>$T_A = 100^\circ\text{C}$             |          |      |      | 250  | $\mu\text{A}$ |
|                                 |                                                                                        | $V_{CE} = 200\text{ V}, I_F = 0$ ,<br>$T_A = 25^\circ\text{C}$              | H11D1M   |      |      | 100  | nA            |
|                                 |                                                                                        | $V_{CE} = 200\text{ V}, I_F = 0$ ,<br>$T_A = 100^\circ\text{C}$             |          |      |      | 250  | $\mu\text{A}$ |
|                                 |                                                                                        | $V_{CE} = 100\text{ V}, I_F = 0$ ,<br>$T_A = 25^\circ\text{C}$              | H11D3M   |      |      | 100  | nA            |
|                                 |                                                                                        | $V_{CE} = 100\text{ V}, I_F = 0$ ,<br>$T_A = 100^\circ\text{C}$             |          |      |      | 250  | $\mu\text{A}$ |
|                                 |                                                                                        | No $R_{BE}$ , $V_{CE} = 60\text{ V}$ ,<br>$I_F = 0, T_A = 25^\circ\text{C}$ | 4N38M    |      |      | 50   | nA            |

#### Note:

3. Parameters meet or exceed JEDEC registered data (for 4N38M only).

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

| Symbol          | Characteristics                              | Test Conditions                                                             | Device                   | Min.   | Typ. | Max. | Unit          |
|-----------------|----------------------------------------------|-----------------------------------------------------------------------------|--------------------------|--------|------|------|---------------|
| EMITTER         |                                              |                                                                             |                          |        |      |      |               |
| CTR             | Current Transfer Ratio, Collector-to-Emitter | $I_F = 10\text{ mA}$ , $V_{CE} = 10\text{ V}$ , $R_{BE} = 1\text{ M}\Omega$ | H11D1M, H11D3M, MOC8204M | 2 (20) |      |      | mA (%)        |
|                 |                                              | $I_F = 10\text{ mA}$ , $V_{CE} = 10\text{ V}$                               | 4N38M                    | 2 (20) |      |      | mA (%)        |
| $V_{CE(SAT)}$   | Saturation Voltage <sup>(4)</sup>            | $I_F = 10\text{ mA}$ , $I_C = 0.5\text{ mA}$ , $R_{BE} = 1\text{ M}\Omega$  | H11D1M, H11D3M, MOC8204M |        | 0.1  | 0.4  | V             |
|                 |                                              | $I_F = 20\text{ mA}$ , $I_C = 4\text{ mA}$                                  | 4N38M                    |        |      | 1.0  | V             |
| SWITCHING TIMES |                                              |                                                                             |                          |        |      |      |               |
| $t_{ON}$        | Non-Saturated Turn-on Time                   | $V_{CE} = 10\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\text{ }\Omega$    | All                      |        | 5    |      | $\mu\text{s}$ |
| $t_{OFF}$       | Turn-off Time                                |                                                                             | All                      |        | 5    |      | $\mu\text{s}$ |

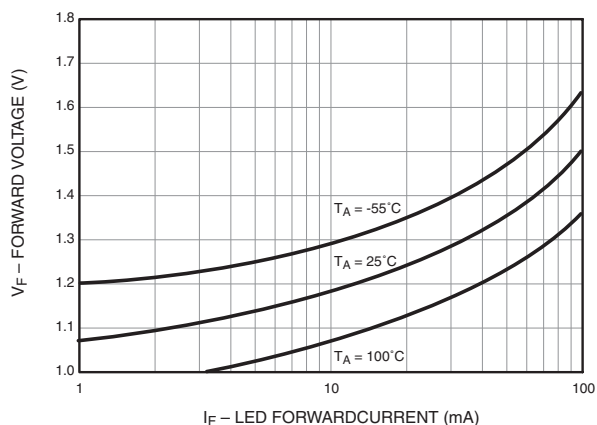
**Note:**

4. Parameters meet or exceed JEDEC registered data (for 4N38M only).

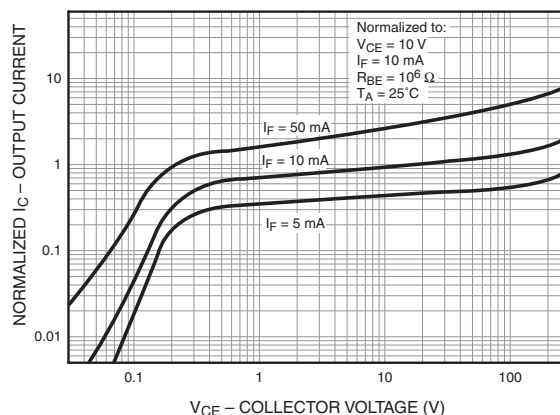
**Isolation Characteristics**

| Symbol    | Characteristic                 | Test Conditions                                           | Min.      | Typ. | Max. | Unit          |
|-----------|--------------------------------|-----------------------------------------------------------|-----------|------|------|---------------|
| $V_{ISO}$ | Input-Output Isolation Voltage | $t = 1\text{ Minute}$                                     | 4170      |      |      | $V_{AC(RMS)}$ |
| $C_{ISO}$ | Isolation Capacitance          | $V_{I-O} = 0\text{ V}$ , $f = 1\text{ MHz}$               |           | 0.2  |      | pF            |
| $R_{ISO}$ | Isolation Resistance           | $V_{I-O} = \pm 500\text{ VDC}$ , $T_A = 25^\circ\text{C}$ | $10^{11}$ |      |      | $\Omega$      |

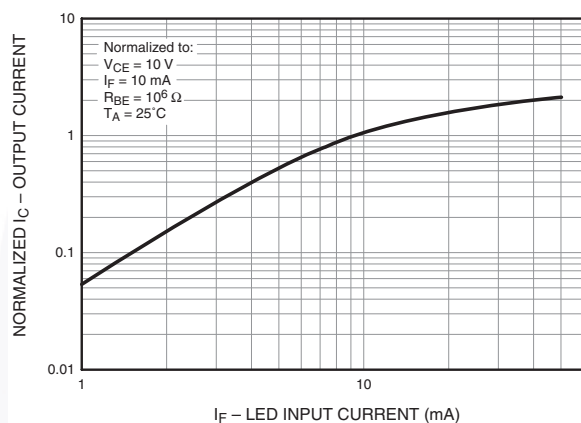
## Typical Performance Curves



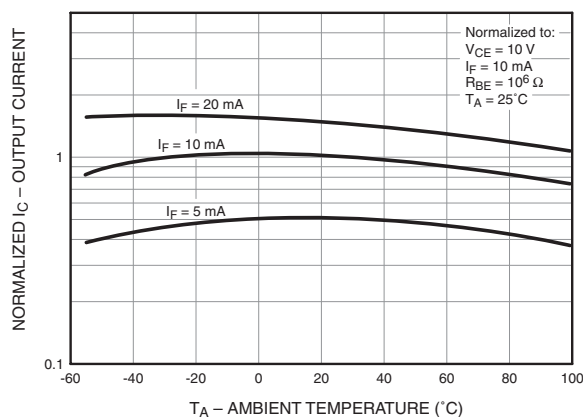
**Figure 3. LED Forward Voltage vs. Forward Current**



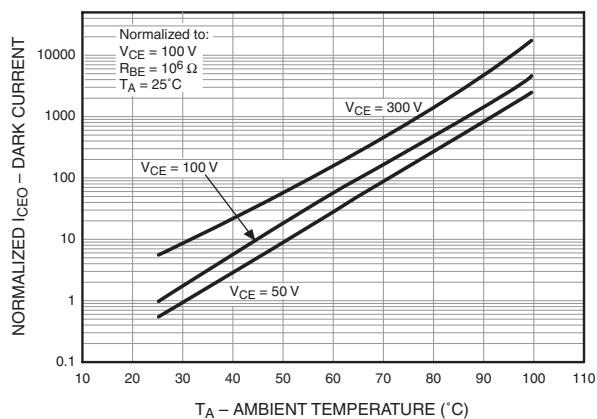
**Figure 4. Normalized Output Characteristics**



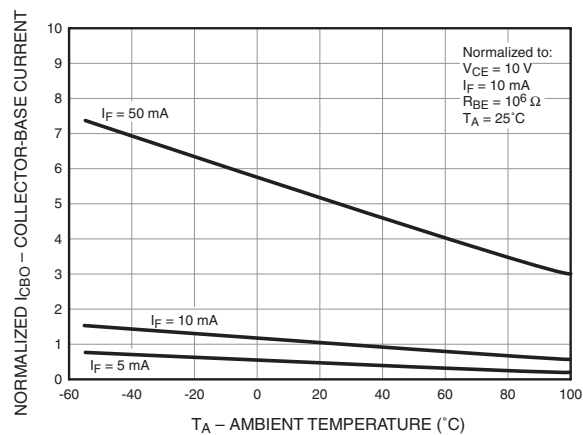
**Figure 5. Normalized Output Current vs. LED Input Current**



**Figure 6. Normalized Output Current vs. Temperature**



**Figure 7. Normalized Dark Current vs. Ambient Temperature**



**Figure 8. Normalized Collector-Base Current vs. Temperature**

## Reflow Profile

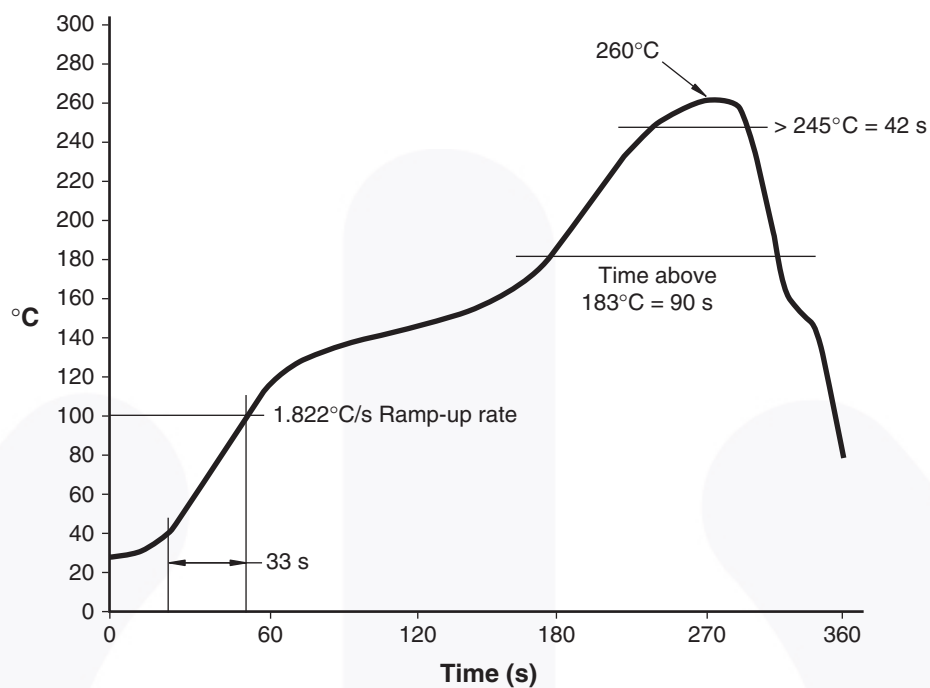


Figure 9. Reflow Profile



## Ordering Information

| Part Number | Package                                                  | Packing Method             |
|-------------|----------------------------------------------------------|----------------------------|
| H11D1M      | DIP 6-Pin                                                | Tube (50 Units)            |
| H11D1SM     | SMT 6-Pin (Lead Bend)                                    | Tube (50 Units)            |
| H11D1SR2M   | SMT 6-Pin (Lead Bend)                                    | Tape and Reel (1000 Units) |
| H11D1VM     | DIP 6-Pin, DIN EN/IEC60747-5-5 Option                    | Tube (50 Units)            |
| H11D1SVM    | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tube (50 Units)            |
| H11D1SR2VM  | SMT 6-Pin (Lead Bend), DIN EN/IEC60747-5-5 Option        | Tape and Reel (1000 Units) |
| H11D1TVM    | DIP 6-Pin, 0.4" Lead Spacing, DIN EN/IEC60747-5-5 Option | Tube (50 Units)            |

### Note:

- The product orderable part number system listed in this table also applies to the 4N38M, H11D3M, and MOC8204M devices.

## Marking Information

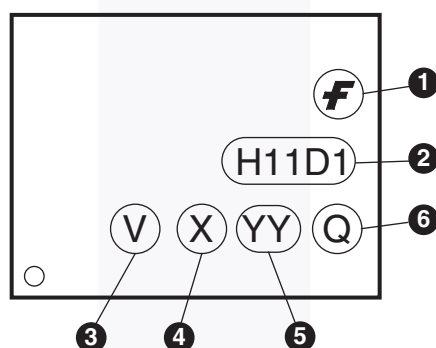
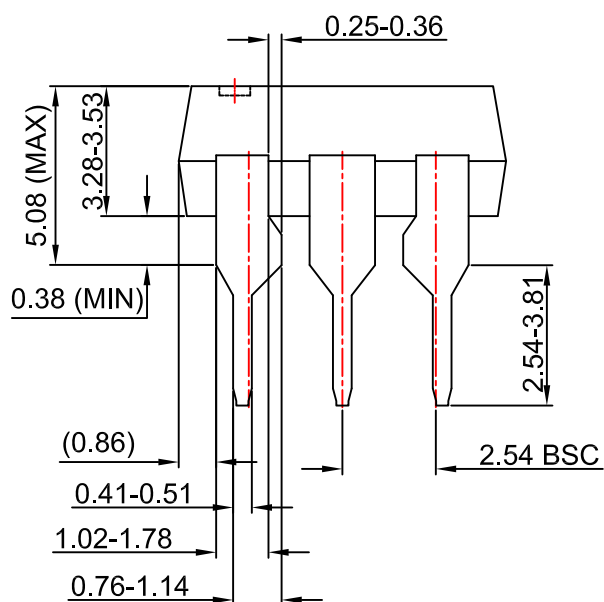
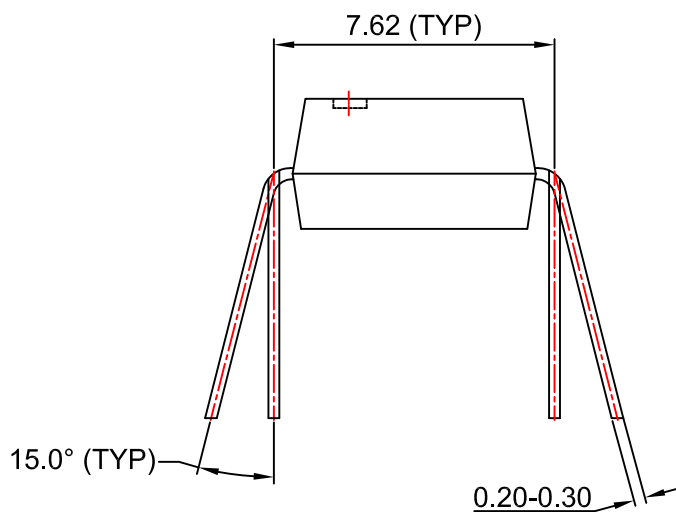
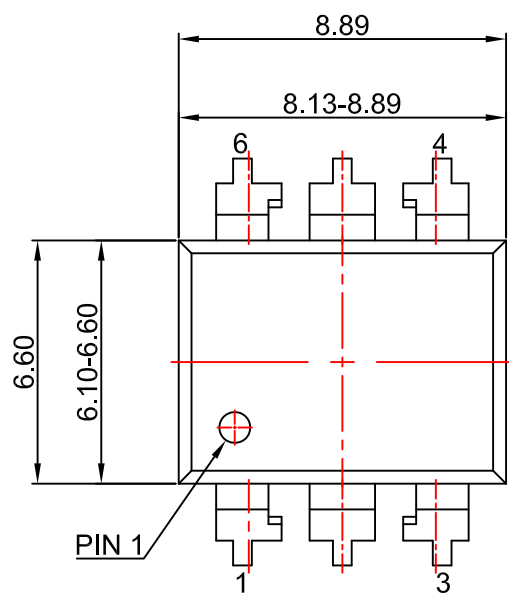


Figure 10. 12. Top Mark

Table 1. Top Mark Definitions

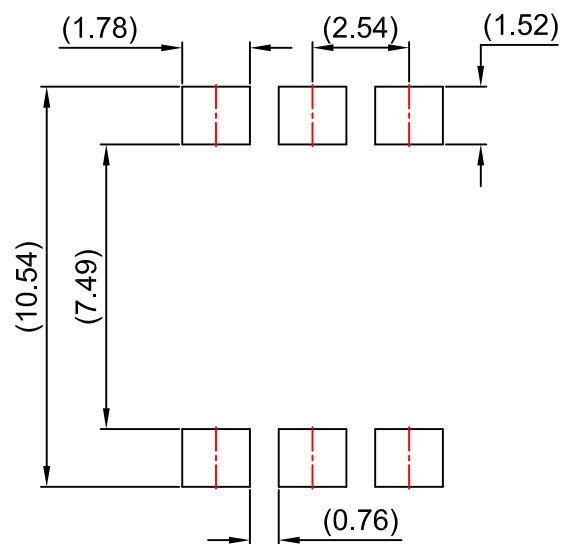
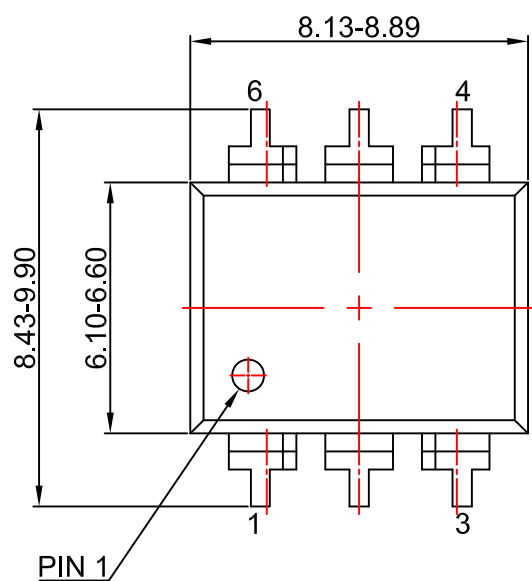
|   |                                                                                 |
|---|---------------------------------------------------------------------------------|
| 1 | Fairchild Logo                                                                  |
| 2 | Device Number                                                                   |
| 3 | DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4 | One-Digit Year Code, e.g., "4"                                                  |
| 5 | Digit Work Week, Ranging from "01" to "53"                                      |
| 6 | Assembly Package Code                                                           |



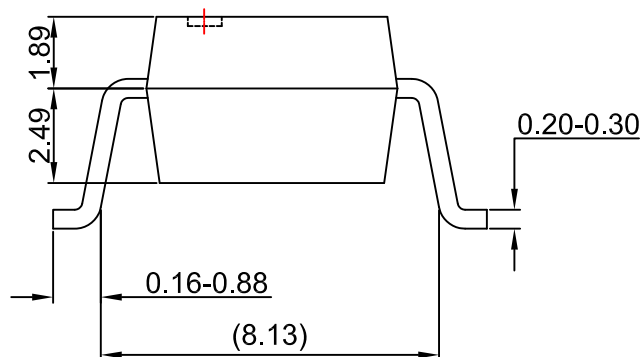
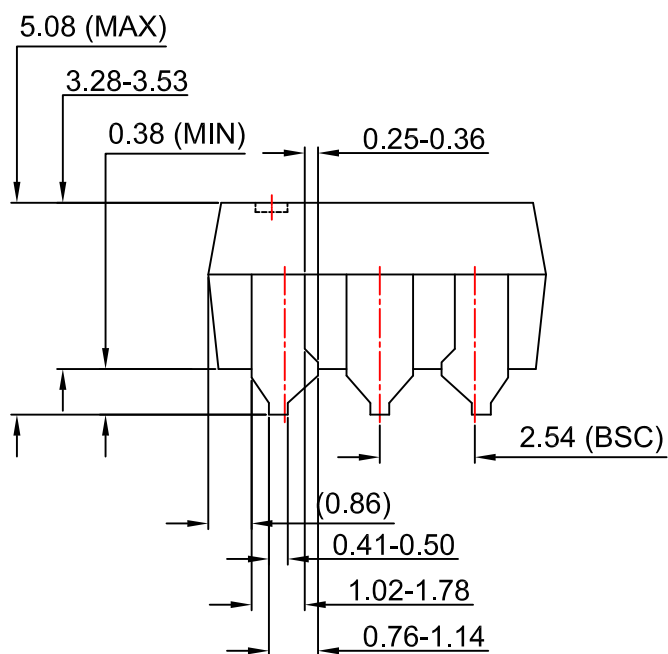
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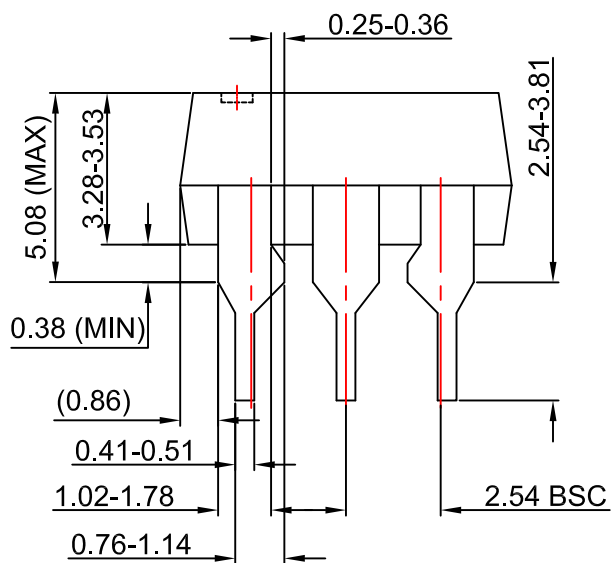
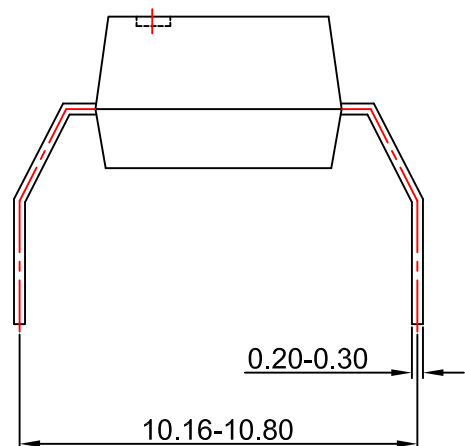
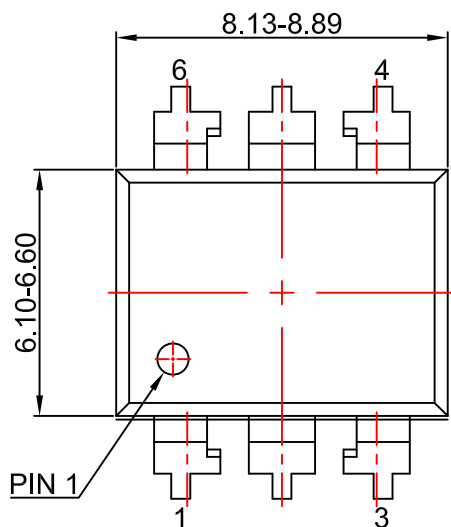
LAND PATTERN RECOMMENDATION



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