

# Photo FET Optocouplers

## H11F1M, H11F2M, H11F3M

### General Description

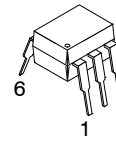
The H11FXM series consists of a Gallium–Aluminum–Arsenide IRED emitting diode coupled to a symmetrical bilateral silicon photo–detector. The detector is electrically isolated from the input and performs like an ideal isolated FET designed for distortion–free control of low level AC and DC analog signals.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

### Features

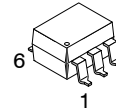
- As a Remote Variable Resistor:
  - ◆  $\leq 100\ \Omega$  to  $\geq 300\ M\Omega$
  - ◆  $\leq 15\ pF$  Shunt Capacitance
  - ◆  $\geq 100\ G\Omega$  I/O Isolation Resistance
- As an Analog Switch:
  - ◆ Extremely Low Offset Voltage
  - ◆ 60 V<sub>pk-pk</sub> Signal Capability
  - ◆ No Charge Injection or Latch–Up
  - ◆ UL Recognized (File #E90700)
- These are Pb–Free Devices

### Application

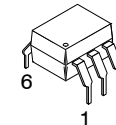
- As a Remote Variable Resistor:
  - ◆ Isolated Variable Attenuator
  - ◆ Automatic Gain Control
  - ◆ Active Filter Fine Tuning/Band Switching
- As an Analog Switch:
  - ◆ Isolated Sample and Hold Circuit
  - ◆ Multiplexed, Optically Isolated A/D Conversion



PDIP6 8.51x6.35, 2.54P  
CASE 646BX

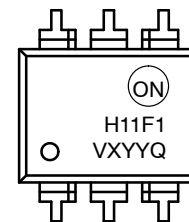


PDIP6 8.51x6.35, 2.54P  
CASE 646BY



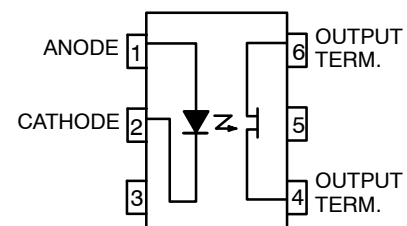
PDIP6 8.51x6.35, 2.54P  
CASE 646BZ

### MARKING DIAGRAM



H11F1 = Specific Device Code  
 V = VDE Mark (Only appears on parts ordered with VDE option – See order entry table)  
 X = One–Digit Year Code, e.g., “7”  
 YY = Two Digit Work Week Ranging from “01” to “53”  
 Q = Assembly Package Code

### SCHEMATIC



### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# H11F1M, H11F2M, H11F3M

## 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 | < 150 Vrms | I–IV            |
|                                                            | < 300 Vrms | 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                                                                                                                                 | 6,000            | 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 (Note 1)                                                                                                                                      | 175              | °C                |
| I <sub>S,INPUT</sub>  | Input Current (Note 1)                                                                                                                                         | 350              | mA                |
| P <sub>S,OUTPUT</sub> | Output Power (Note 1)                                                                                                                                          | 800              | mW                |
| R <sub>IO</sub>       | Insulation Resistance at T <sub>S</sub> , V <sub>IO</sub> = 500 V (Note 1)                                                                                     | >10 <sup>9</sup> | Ω                 |

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

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise specified)

| Symbol | Parameter | Value | Unit |
|--------|-----------|-------|------|
|--------|-----------|-------|------|

### TOTAL DEVICE

|                  |                         |                    |    |
|------------------|-------------------------|--------------------|----|
| T <sub>STG</sub> | Storage Temperature     | –40 to +125        | °C |
| T <sub>OPR</sub> | Operating Temperature   | –40 to +100        | °C |
| T <sub>SOL</sub> | Lead Solder Temperature | 260 for 10 seconds | °C |

### EMITTER

|                    |                                                     |      |       |
|--------------------|-----------------------------------------------------|------|-------|
| I <sub>F</sub>     | Continuous Forward Current                          | 60   | mA    |
| V <sub>R</sub>     | Reverse Voltage                                     | 5    | V     |
| I <sub>F(pk)</sub> | Forward Current – Peak (10 μs Pulse, 1% Duty Cycle) | 1    | A     |
| P <sub>D</sub>     | LED Power Dissipation Ambient 25°C Ambient          | 100  | mW    |
|                    | Derate Linearly from 25°C                           | 1.33 | mW/°C |

### DETECTOR

|                   |                                               |                |      |       |
|-------------------|-----------------------------------------------|----------------|------|-------|
| P <sub>D</sub>    | Detector Power Dissipation at 25°C            |                | 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) |                | ±100 | mA    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

# H11F1M, H11F2M, H11F3M

## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

### INDIVIDUAL COMPONENT CHARACTERISTICS

| Symbol         | Parameter               | Test Conditions                      | Min | Typ* | Max  | Unit          |
|----------------|-------------------------|--------------------------------------|-----|------|------|---------------|
| <b>EMITTER</b> |                         |                                      |     |      |      |               |
| $V_F$          | Input Forward Voltage   | $I_F = 16\text{ mA}$                 | –   | 1.3  | 1.75 | V             |
| $I_R$          | Reverse Leakage Current | $V_R = 5\text{ V}$                   | –   | –    | 10   | $\mu\text{A}$ |
| $C_J$          | Capacitance             | $V = 0\text{ V}, f = 1.0\text{ MHz}$ | –   | 50   | –    | pF            |

### OUTPUT DETECTOR

|            |                                      |                   |                                                                |     |   |    |                  |
|------------|--------------------------------------|-------------------|----------------------------------------------------------------|-----|---|----|------------------|
| $BV_{4-6}$ | Breakdown Voltage<br>Either Polarity | H11F1M,<br>H11F2M | $I_{4-6} = 10\text{ }\mu\text{A}, I_F = 0$                     | 30  | – | –  | V                |
|            |                                      | H11F3M            |                                                                | 15  | – | –  |                  |
| $I_{4-6}$  | Off-State Dark Current               |                   | $V_{4-6} = 15\text{ V}, I_F = 0$                               | –   | – | 50 | nA               |
|            |                                      |                   | $V_{4-6} = 15\text{ V}, I_F = 0,$<br>$T_A = 100^\circ\text{C}$ | –   | – | 50 | $\mu\text{A}$    |
| $R_{4-6}$  | Off-State Resistance                 |                   | $V_{4-6} = 15\text{ V}, I_F = 0$                               | 300 | – | –  | $\text{M}\Omega$ |
| $C_{4-6}$  | Capacitance                          |                   | $V_{4-6} = 15\text{ V}, I_F = 0,$<br>$f = 1\text{ MHz}$        | –   | – | 15 | pF               |

### TRANSFER CHARACTERISTICS

| Symbol | Characteristics | Test Conditions | Min | Typ* | Max | Unit |
|--------|-----------------|-----------------|-----|------|-----|------|
|--------|-----------------|-----------------|-----|------|-----|------|

#### DC CHARACTERISTICS

|           |                                         |        |                                                                                  |   |   |     |          |
|-----------|-----------------------------------------|--------|----------------------------------------------------------------------------------|---|---|-----|----------|
| $R_{4-6}$ | On-State Resistance                     | H11F1M | $I_F = 16\text{ mA}, I_{4-6} = 100\text{ }\mu\text{A}$                           | – | – | 200 | $\Omega$ |
|           |                                         | H11F2M |                                                                                  | – | – | 330 |          |
|           |                                         | H11F3M |                                                                                  | – | – | 470 |          |
| $R_{6-4}$ | On-State Resistance                     | H11F1M | $I_F = 16\text{ mA}, I_{6-4} = 100\text{ }\mu\text{A}$                           | – | – | 200 | $\Omega$ |
|           |                                         | H11F2M |                                                                                  | – | – | 330 |          |
|           |                                         | H11F3M |                                                                                  | – | – | 470 |          |
|           | Resistance, Non-Linearity and Assymetry |        | $I_F = 16\text{ mA}, I_{4-6} = 25\text{ }\mu\text{A RMS},$<br>$f = 1\text{ kHz}$ | – | 2 | –   | %        |

#### AC CHARACTERISTICS

|           |               |                                                                         |   |   |    |               |
|-----------|---------------|-------------------------------------------------------------------------|---|---|----|---------------|
| $t_{on}$  | Turn-On Time  | $R_L = 50\text{ }\Omega, I_F = 16\text{ mA},$<br>$V_{4-6} = 5\text{ V}$ | – | – | 45 | $\mu\text{s}$ |
| $t_{off}$ | Turn-Off Time | $R_L = 50\text{ }\Omega, I_F = 16\text{ mA},$<br>$V_{4-6} = 5\text{ V}$ | – | – | 45 | $\mu\text{s}$ |

### ISOLATION CHARACTERISTICS

| Symbol    | Characteristics                | Test Conditions            | Min       | Typ* | Max | Unit        |
|-----------|--------------------------------|----------------------------|-----------|------|-----|-------------|
| $V_{ISO}$ | Input-Output Isolation Voltage | $t = 1\text{ Minute}$      | 4170      | –    | –   | $V_{ACRMS}$ |
| $R_{ISO}$ | Isolation Resistance           | $V_{I-O} = 500\text{ VDC}$ | $10^{11}$ | –    | –   | $\Omega$    |
| $C_{ISO}$ | Isolation Capacitance          | $f = 1\text{ MHz}$         | –         | 0.2  | –   | pF          |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

# H11F1M, H11F2M, H11F3M

## TYPICAL PERFORMANCE CURVES

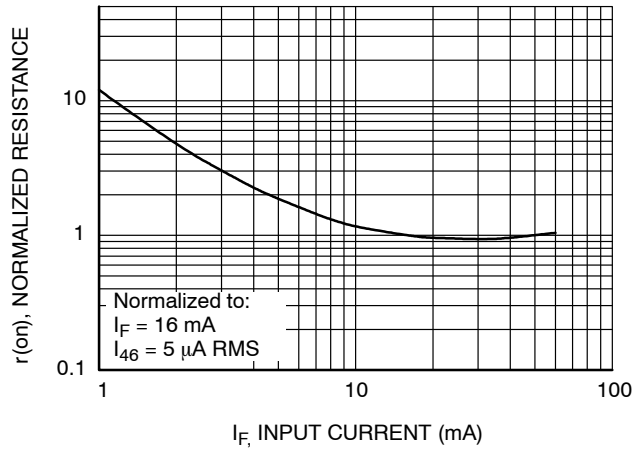


Figure 1. Resistance vs. Input Current

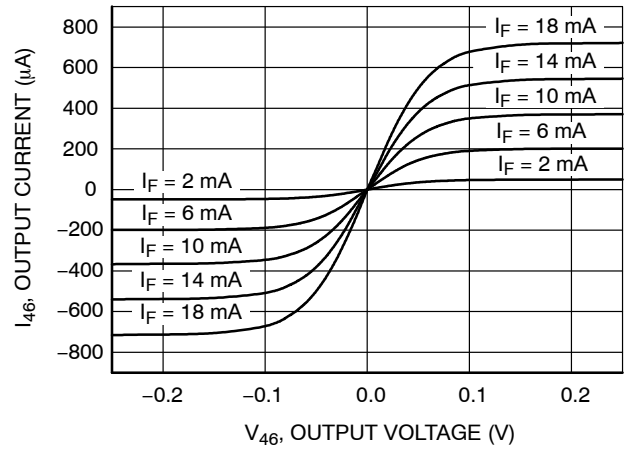


Figure 2. Output Characteristics

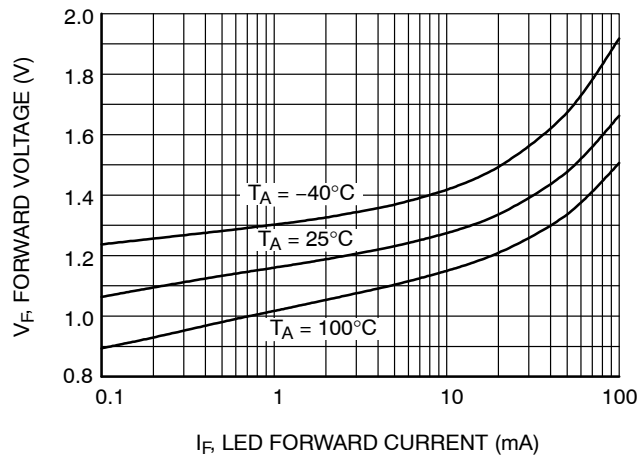


Figure 3. LED Forward Voltage vs. Forward Current

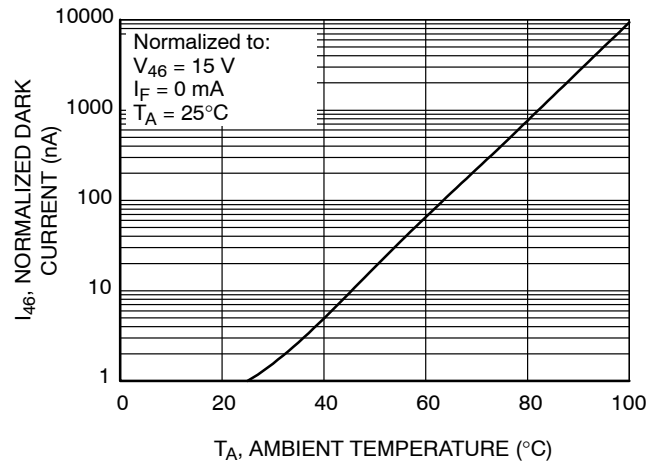


Figure 4. Off-State Current vs. Ambient Temperature

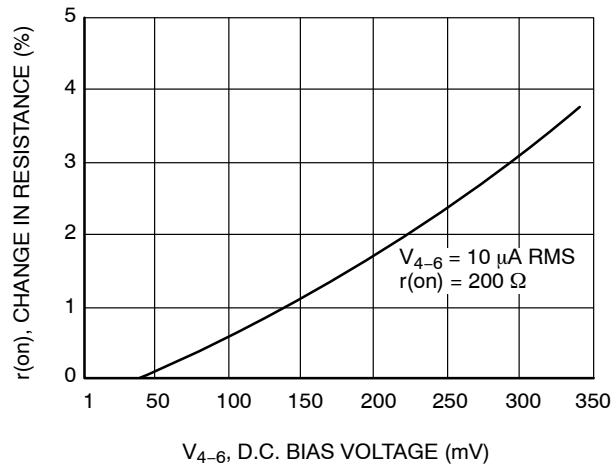


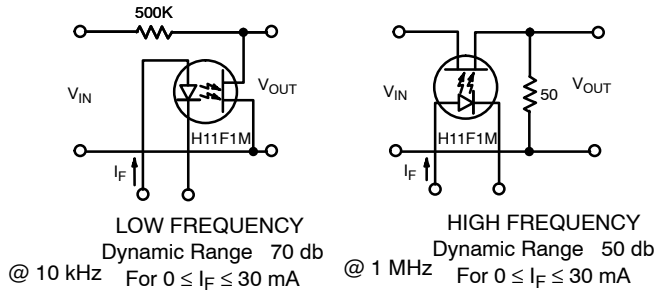
Figure 5. Resistive Non-Linearity vs. D.C. Bias

# H11F1M, H11F2M, H11F3M

## TYPICAL APPLICATIONS

### As a Variable Resistor

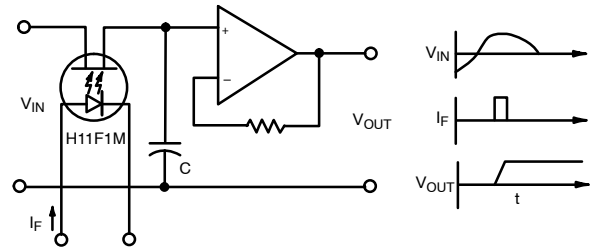
#### ISOLATED VARIABLE ATTENUATORS



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.

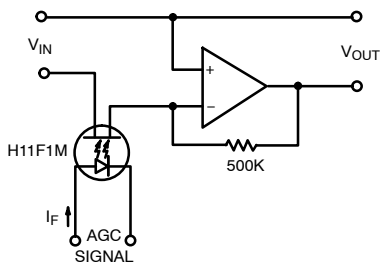
### As an Analog Signal Switch

#### ISOLATED VARIABLE ATTENUATORS



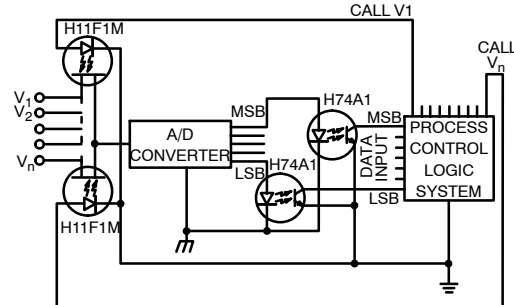
Accuracy and range are improved over conventional FET switches because the H11FXM has no charge injection from the control signal. The H11FXM also provides switching of either polarity input signal up to 30V magnitude.

### AUTOMATIC GAIN CONTROL



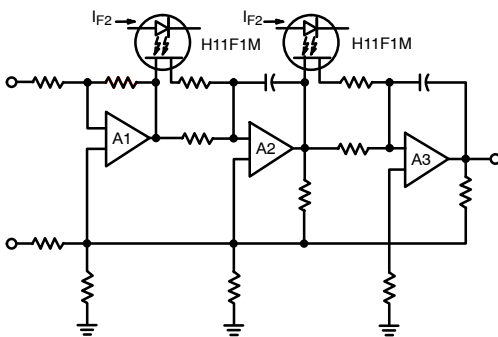
This simple circuit provides over 70db of stable gain control for an AGC signal range of from 0 to 30mA. This basic circuit can be used to provide programmable fade and attack for electronic music.

### MULTIPLEXED, OPTICALLY-ISOATED 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.

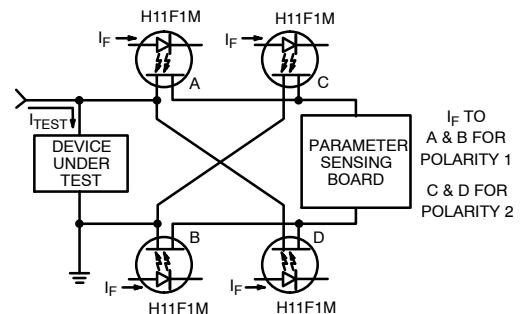
### ACTIVE FILTER FINE TUNING/BAND SWITCHING



$I_{F2}$  ADJUSTS  $f_1$ ,  $I_{F2}$  ADJUSTS  $f_2$

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.

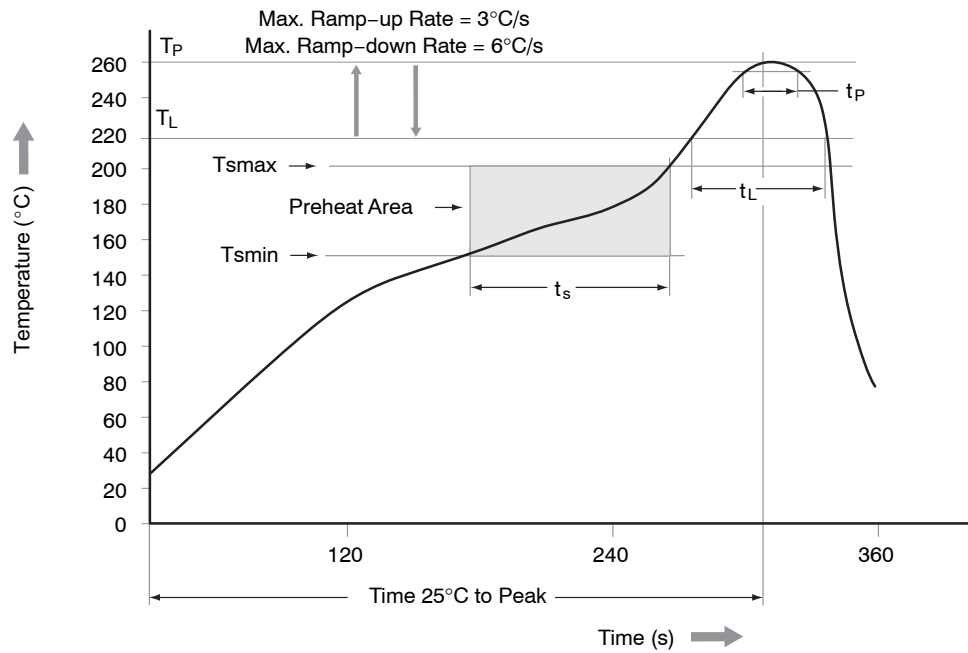
### TEST EQUIPMENT - KELVIN CONTACT POLARITY



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.

# H11F1M, H11F2M, H11F3M

## REFLOW PROFILE



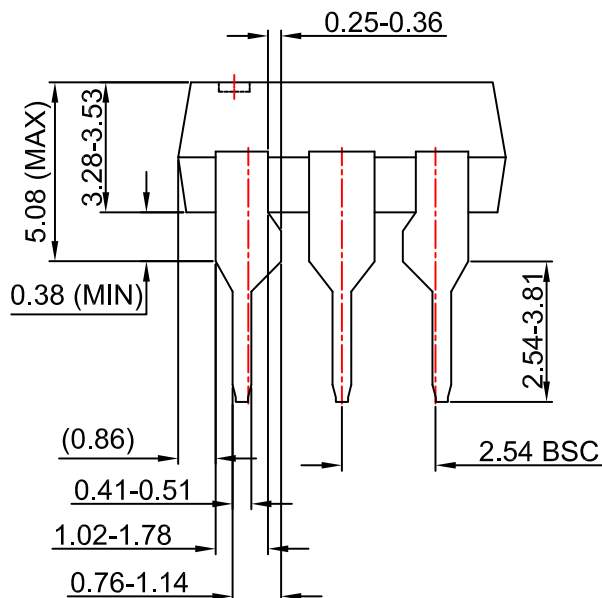
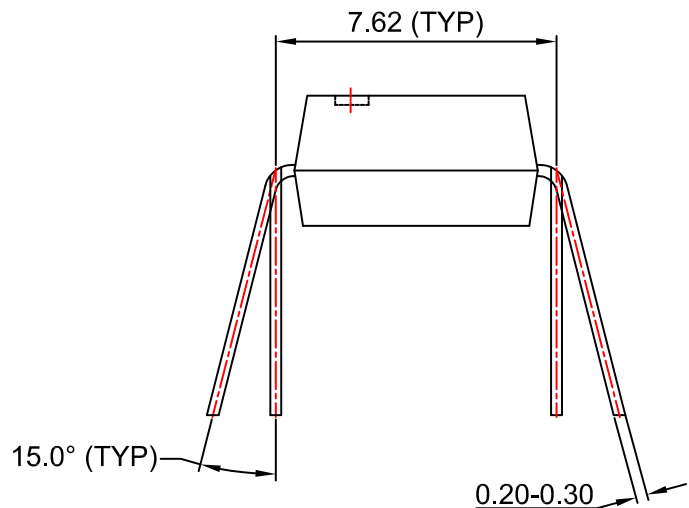
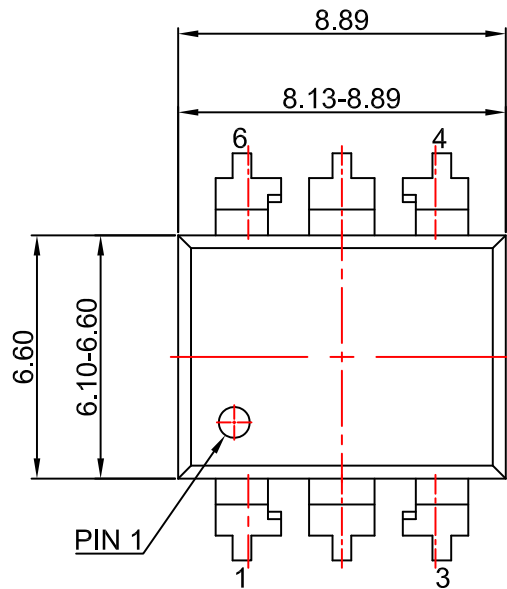
| Profile Feature                                                       | Pb-Free Assembly Profile |
|-----------------------------------------------------------------------|--------------------------|
| Temperature Min. (T <sub>smin</sub> )                                 | 150°C                    |
| 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/seconds 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/seconds max.         |
| Time 25°C to Peak Temperature                                         | 8 minutes max.           |

## ORDERING INFORMATION

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

**PDIP6 8.51x6.35, 2.54P**  
CASE 646BX  
ISSUE O

DATE 31 JUL 2016



**NOTES:**

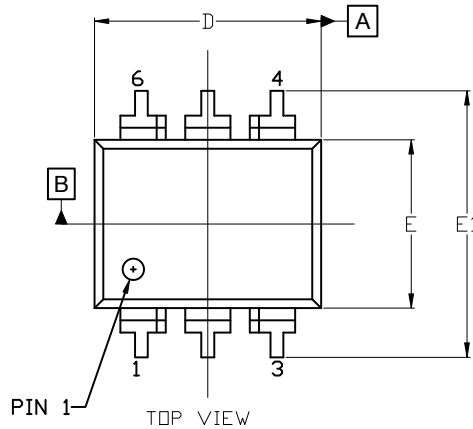
- A) NO STANDARD APPLIES TO THIS PACKAGE.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSION

|                         |                               |                                                                                                                                                                                     |
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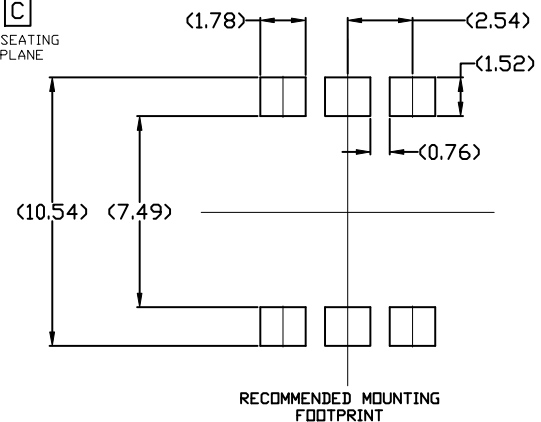
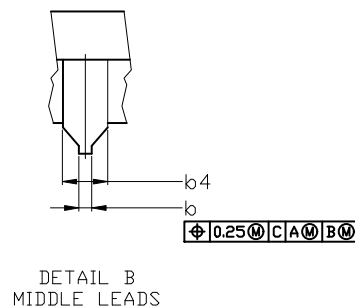
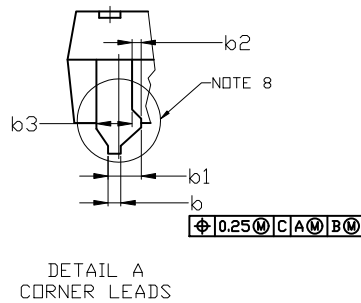
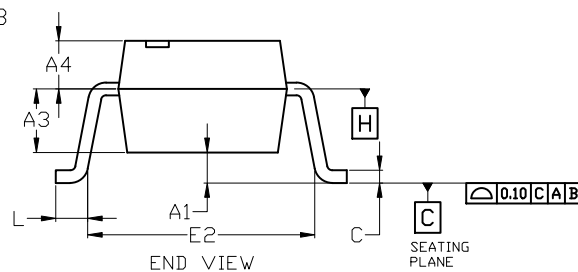
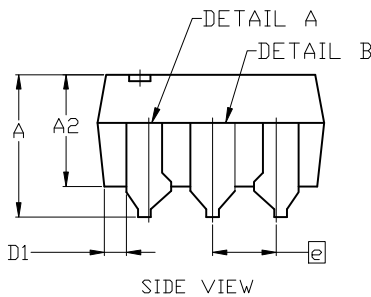
**PDIP6 8.51x6.35, 2.54P**  
**CASE 646BY**  
**ISSUE A**

DATE 15 JUL 2019


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS A, A1, AND L ARE MEASURED WITH THE PACKAGE SEATED.
4. DIMENSIONS D, D1, AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 2.54mm.
5. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).
6. CENTER LINE OF CORNER LEADS IS LOCATED BY LOCATING THE CENTER OF FEATURE b2 AND b3.

| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | ---         | ---  | 4.80 |
| A1  | 0.38        | ---  | ---  |
| A2  | 3.28        | 3.40 | 3.53 |
| A3  | 2.49 REF    |      |      |
| A4  | 1.89 REF    |      |      |
| b   | 0.41        | 0.46 | 0.51 |
| b1  | 0.76        | 0.92 | 1.14 |
| b2  | 0.25        | 0.28 | 0.36 |
| b3  | 1.02        | 1.40 | 1.78 |
| b4  | 1.778 REF   |      |      |
| c   | 0.20        | 0.25 | 0.30 |
| D   | 8.13        | 8.51 | 8.89 |
| D1  | 0.86 REF    |      |      |
| E   | 6.10        | 6.35 | 6.60 |
| E1  | 8.43        | 9.17 | 9.90 |
| E2  | 8.13 REF    |      |      |
| e   | 2.54 BSC    |      |      |
| L   | 0.16        | 0.52 | 0.88 |



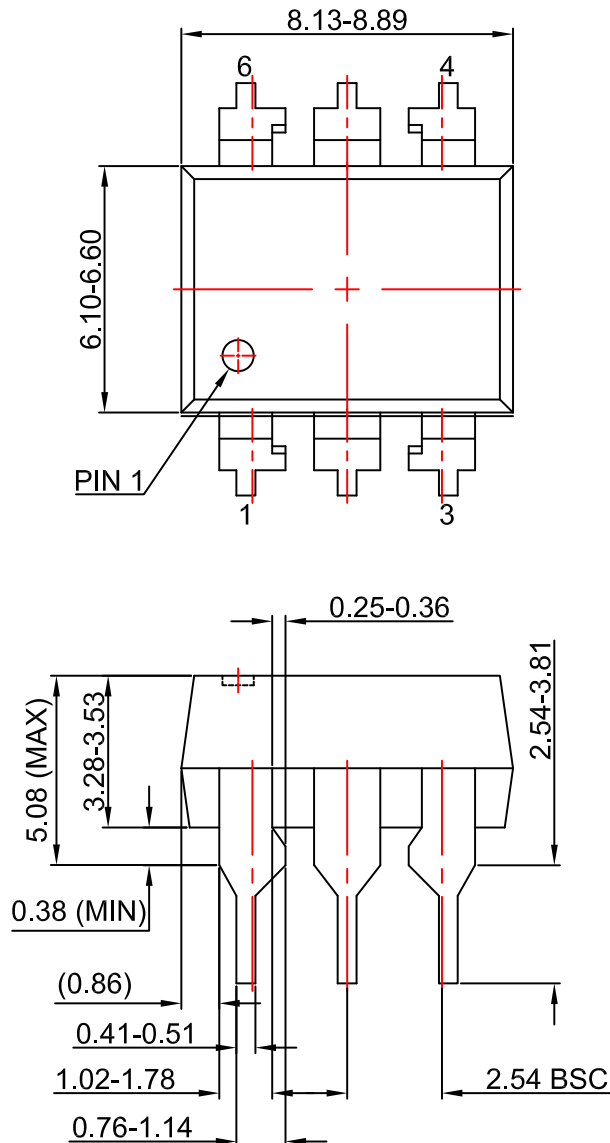
For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

|                         |                               |                                                                                                                                                                                     |
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