

# OptoHiT™ Series, High-Temperature Phototransistor Optocoupler in Half-Pitch Mini-Flat 4-Pin Package

## FODM8801A, FODM8801B, FODM8801C

### Description

In the OptoHiT series, the FODM8801 is a first-of-kind phototransistor, utilizing onsemi's leading-edge proprietary process technology to achieve high operating temperature characteristics, up to 125°C. The opto-coupler consists of an aluminum gallium arsenide (AlGaAs) infrared light-emitting diode (LED) optically coupled to a phototransistor, available in a compact half-pitch, mini-flat, 4-pin package. It delivers high current transfer ratio at very low input current. The input-output isolation voltage,  $V_{ISO}$ , is rated at 3750 VAC<sub>RMS</sub>.

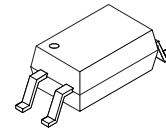
### Features

- Utilizing Proprietary Process Technology to Achieve High Operating Temperature: Up to 125°C
- Guaranteed Current Transfer Ratio (CTR) Specifications Across Full Temperature Range
  - ♦ Excellent CTR Linearity at High-Temperature
  - ♦ CTR at Very Low Input Current,  $I_F$
- High Isolation Voltage Regulated by Safety Agency: C-UL / UL1577, 3750 VAC<sub>RMS</sub> for 1 Minute and DIN EN/IEC60747-5-5
- Compact Half-Pitch, Mini-Flat, 4-Pin Package (1.27 mm Lead Pitch, 2.4 mm Maximum Standoff Height)
- >5 mm Creepage and Clearance Distance
- Applicable to Infrared Ray Reflow, 245°C
- These are Pb-Free Devices

### Applications

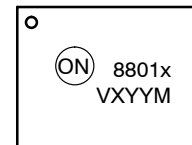
- Primarily Suited for DC-DC Converters
- Ground-Loop Isolation, Signal-Noise Isolation
- Communications – Adapters, Chargers
- Consumer – Appliances, Set-Top Boxes
- Industrial – Power Supplies, Motor Control, Programmable Logic Control

### HALF-PITCH MINI-FLAT



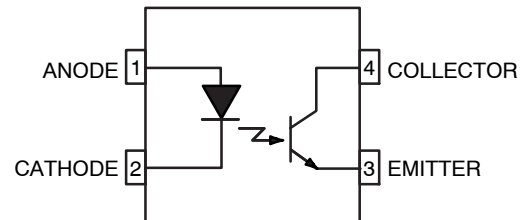
MFP4 2.5 x 4.4, 1.27P  
CASE 100AL

### MARKING DIAGRAM



8801x = Specific Device Code (x = A, B, C)  
V = DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option)  
X = One-Digit Year Code  
YY = Digit Work Week  
M = Assembly Package Code

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# FODM8801A, FODM8801B, FODM8801C

**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-III           |
| Climatic Classification                                                             |                       | 40/125/21       |
| 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  | 848              | 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 | 1060             | V <sub>peak</sub> |
| V <sub>IORM</sub>     | Maximum Working Insulation Voltage                                                                                                                             | 565              | V <sub>peak</sub> |
| V <sub>IOTM</sub>     | Highest Allowable Over-Voltage                                                                                                                                 | 6000             | V <sub>peak</sub> |
|                       | External Creepage                                                                                                                                              | ≥5               | mm                |
|                       | External Clearance                                                                                                                                             | ≥5               | mm                |
| DTI                   | Distance Through Insulation (Insulation Thickness)                                                                                                             | ≥0.5             | mm                |
| T <sub>S</sub>        | Case Temperature (Note 1)                                                                                                                                      | 150              | °C                |
| I <sub>S,INPUT</sub>  | Input Current (Note 1)                                                                                                                                         | 200              | mA                |
| P <sub>S,OUTPUT</sub> | Output Power (Note 1)                                                                                                                                          | 300              | 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 noted)

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

### TOTAL PACKAGE

|                  |                         |              |    |
|------------------|-------------------------|--------------|----|
| T <sub>STG</sub> | Storage Temperature     | -40 to +150  | °C |
| T <sub>OPR</sub> | Operating Temperature   | -40 to +125  | °C |
| T <sub>J</sub>   | Junction Temperature    | -40 to +140  | °C |
| T <sub>SOL</sub> | Lead Solder Temperature | 245 for 10 s | °C |

### EMITTER

|                         |                               |    |    |
|-------------------------|-------------------------------|----|----|
| I <sub>F(average)</sub> | Continuous Forward Current    | 20 | mA |
| V <sub>R</sub>          | Reverse Input Voltage         | 6  | V  |
| P <sub>DLED</sub>       | Power Dissipation (Note 2, 4) | 40 | mW |

### DETECTOR

|                         |                                         |     |    |
|-------------------------|-----------------------------------------|-----|----|
| I <sub>C(average)</sub> | Continuous Collector Current            | 30  | mA |
| V <sub>CEO</sub>        | Collector-Emitter Voltage               | 75  | V  |
| V <sub>ECO</sub>        | Emitter-Collector Voltage               | 7   | V  |
| P <sub>DC</sub>         | Collector Power Dissipation (Note 3, 4) | 150 | mW |

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.

2. Derate linearly from 73°C at a rate of 0.24 mW/°C.

3. Derate linearly from 73°C at a rate of 2.23 mW/°C.

4. Functional operation under these conditions is not implied. Permanent damage may occur if the device is subjected to conditions outside these ratings.

# FODM8801A, FODM8801B, FODM8801C

## RECOMMENDED OPERATING CONDITIONS

| Symbol        | Parameter                  | Value        | Unit |
|---------------|----------------------------|--------------|------|
| $T_A$         | Operating Temperature      | -40 to +125  | °C   |
| $V_{FL(OFF)}$ | Input Low Voltage          | -5.0 to +0.8 | V    |
| $I_{FH}$      | Input High Forward Current | 1 to 10      | mA   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## ISOLATION CHARACTERISTICS

| Symbol    | Parameter                      | Conditions                                                                                | Min       | Typ | Max | Unit               |
|-----------|--------------------------------|-------------------------------------------------------------------------------------------|-----------|-----|-----|--------------------|
| $V_{ISO}$ | Input-Output Isolation Voltage | $f = 60 \text{ Hz}$ , $t = 1 \text{ min.}$ , $I_{I-O} \leq 10 \mu\text{A}$<br>(Note 5, 6) | 3,750     | –   | –   | VAC <sub>RMS</sub> |
| $R_{ISO}$ | Isolation Resistance           | $V_{I-O} = 500 \text{ V}$ (Note 5)                                                        | $10^{12}$ | –   | –   | $\Omega$           |
| $C_{ISO}$ | Isolation Capacitance          | $f = 1 \text{ MHz}$                                                                       | –         | 0.3 | 0.5 | pF                 |

5. Device is considered a two-terminal device: pins 1 and 2 are shorted together and pins 3 and 4 are shorted together.

6. 3,750 VAC<sub>RMS</sub> for 1 minute is equivalent to 4,500 VAC<sub>RMS</sub> for 1 second.

## ELECTRICAL CHARACTERISTICS Apply over all recommended conditions ( $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ unless otherwise specified.)

All typical values are measured at  $T_A = 25^\circ\text{C}$

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------|-----------|------------|-----|-----|-----|------|
|--------|-----------|------------|-----|-----|-----|------|

### EMITTER

|                           |                             |                                         |      |      |      |               |
|---------------------------|-----------------------------|-----------------------------------------|------|------|------|---------------|
| $V_F$                     | Forward Voltage             | $I_F = 1 \text{ mA}$                    | 1.00 | 1.35 | 1.80 | V             |
| $\Delta V_F / \Delta T_A$ | Forward-Voltage Coefficient | $I_F = 1 \text{ mA}$                    | –    | -1.6 | –    | mV/°C         |
| $I_R$                     | Reverse Current             | $V_R = 6 \text{ V}$                     | –    | –    | 10   | $\mu\text{A}$ |
| $C_T$                     | Terminal Capacitance        | $V = 0 \text{ V}$ , $f = 1 \text{ MHz}$ | –    | 30   | –    | pF            |

### DETECTOR

|            |                                     |                                                                           |    |     |     |               |
|------------|-------------------------------------|---------------------------------------------------------------------------|----|-----|-----|---------------|
| $BV_{CEO}$ | Collector-Emitter Breakdown Voltage | $I_C = 0.5 \text{ mA}$ , $I_F = 0 \text{ mA}$                             | 75 | 130 | –   | V             |
| $BV_{ECO}$ | Emitter-Collector Breakdown Voltage | $I_E = 100 \mu\text{A}$ , $I_F = 0 \text{ mA}$                            | 7  | 12  | –   | V             |
| $I_{CEO}$  | Collector Dark Current              | $V_{CE} = 75 \text{ V}$ , $I_F = 0 \text{ mA}$ , $T_A = 25^\circ\text{C}$ | –  | –   | 100 | nA            |
|            |                                     | $V_{CE} = 50 \text{ V}$ , $I_F = 0 \text{ mA}$                            | –  | –   | 50  | $\mu\text{A}$ |
|            |                                     | $V_{CE} = 5 \text{ V}$ , $I_F = 0 \text{ mA}$                             | –  | –   | 30  | $\mu\text{A}$ |
| $C_{CE}$   | Capacitance                         | $V_{CE} = 0 \text{ V}$ , $f = 1 \text{ MHz}$                              | –  | 8   | –   | 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.

# FODM8801A, FODM8801B, FODM8801C

**TRANSFER CHARACTERISTICS** Apply over all recommended conditions ( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  unless otherwise specified.)

All typical values are measured at  $T_A = 25^\circ\text{C}$

| Symbol                 | Parameter                                               | Device    | Conditions                                                            | Min | Typ  | Max  | Unit |
|------------------------|---------------------------------------------------------|-----------|-----------------------------------------------------------------------|-----|------|------|------|
| CTR <sub>CE</sub>      | Current Transfer Ratio<br>(Collector–Emitter)           | FODM8801A | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V} @ T_A = 25^\circ\text{C}$   | 80  | 120  | 160  | %    |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 35  | 120  | 230  |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 5\text{ V}$                            | 40  | 125  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 45  | 138  | –    |      |
|                        |                                                         | FODM8801B | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V} @ T_A = 25^\circ\text{C}$   | 130 | 195  | 260  |      |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 65  | 195  | 360  |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 5\text{ V}$                            | 70  | 202  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 75  | 215  | –    |      |
|                        |                                                         | FODM8801C | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V} @ T_A = 25^\circ\text{C}$   | 200 | 300  | 400  |      |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 100 | 300  | 560  |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 5\text{ V}$                            | 110 | 312  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 5\text{ V}$                            | 115 | 330  | –    |      |
| CTR <sub>CE(SAT)</sub> | Saturated Current Transfer Ratio<br>(Collector–Emitter) | FODM8801A | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V} @ T_A = 25^\circ\text{C}$ | 65  | 108  | 150  | %    |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 30  | 108  | –    |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 25  | 104  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 20  | 92   | –    |      |
|                        |                                                         | FODM8801B | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V} @ T_A = 25^\circ\text{C}$ | 90  | 168  | 245  |      |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 45  | 168  | –    |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 40  | 155  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 35  | 132  | –    |      |
|                        |                                                         | FODM8801C | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V} @ T_A = 25^\circ\text{C}$ | 140 | 238  | 380  |      |
|                        |                                                         |           | $I_F = 1.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 75  | 238  | –    |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 65  | 215  | –    |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, V_{CE} = 0.4\text{ V}$                          | 55  | 177  | –    |      |
| V <sub>CE(SAT)</sub>   | Saturation Voltage                                      | FODM8801A | $I_F = 1.0\text{ mA}, I_C = 0.3\text{ mA}$                            | –   | 0.17 | 0.40 | V    |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, I_C = 0.4\text{ mA}$                            | –   | 0.16 | 0.40 |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, I_C = 0.6\text{ mA}$                            | –   | 0.15 | 0.40 |      |
|                        |                                                         | FODM8801B | $I_F = 1.0\text{ mA}, I_C = 0.45\text{ mA}$                           | –   | 0.17 | 0.40 |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, I_C = 0.6\text{ mA}$                            | –   | 0.16 | 0.40 |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, I_C = 1.0\text{ mA}$                            | –   | 0.16 | 0.40 |      |
|                        |                                                         | FODM8801C | $I_F = 1.0\text{ mA}, I_C = 0.75\text{ mA}$                           | –   | 0.18 | 0.40 |      |
|                        |                                                         |           | $I_F = 1.6\text{ mA}, I_C = 1.0\text{ mA}$                            | –   | 0.17 | 0.40 |      |
|                        |                                                         |           | $I_F = 3.0\text{ mA}, I_C = 1.6\text{ mA}$                            | –   | 0.17 | 0.40 |      |

## FODM8801A, FODM8801B, FODM8801C

**SWITCHING CHARACTERISTICS** Apply over all recommended conditions ( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  unless otherwise specified).

All typical values are measured at  $T_A = 25^\circ\text{C}$

| Symbol    | Parameter                                                              | Device      | Conditions                                                                                                                                                | Min | Typ | Max | Unit                    |
|-----------|------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-------------------------|
| $t_{ON}$  | Turn-On Time                                                           | All Devices | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 0.75\text{ k}\Omega$                                                                               | 1   | 6   | 20  | $\mu\text{s}$           |
|           |                                                                        |             | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 4.7\text{ k}\Omega$                                                                                | –   | 6   | –   |                         |
| $t_{OFF}$ | Turn-Off Time                                                          | All Devices | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 0.75\text{ k}\Omega$                                                                               | 1   | 6   | 20  | $\mu\text{s}$           |
|           |                                                                        |             | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 4.7\text{ k}\Omega$                                                                                | –   | 40  | –   |                         |
| $t_R$     | Output Rise Time<br>(10% to 90%)                                       | All Devices | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 0.75\text{ k}\Omega$                                                                               | –   | 5   | –   | $\mu\text{s}$           |
| $t_F$     | Output Fall Time<br>(90% to 10%)                                       | All Devices | $I_F = 1.6\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $R_L = 0.75\text{ k}\Omega$                                                                               | –   | 5.5 | –   | $\mu\text{s}$           |
| $CM_H$    | Common-Mode Rejection<br>Voltage (Transient Immunity) –<br>Output High | All Devices | $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_O > 2.0\text{ V}$ ,<br>$R_L = 4.7\text{ k}\Omega$ , $V_{CM} = 1000\text{ V}$ (Note 7),<br>Figure 14   | –   | 20  | –   | $\text{kV}/\mu\text{s}$ |
| $CM_L$    | Common-Mode Rejection<br>Voltage (Transient Immunity) –<br>Output Low  | All Devices | $T_A = 25^\circ\text{C}$ , $I_F = 1.6\text{ mA}$ , $V_O < 0.8\text{ V}$ ,<br>$R_L = 4.7\text{ k}\Omega$ , $V_{CM} = 1000\text{ V}$ (Note 7),<br>Figure 14 | –   | 20  | –   | $\text{kV}/\mu\text{s}$ |

7. Common-mode transient immunity at output high is the maximum tolerable positive  $dV_{CM}/dt$  on the leading edge of the common-mode impulse signal,  $V_{CM}$ , to assure that the output remains high.

TYPICAL PERFORMANCE CURVES

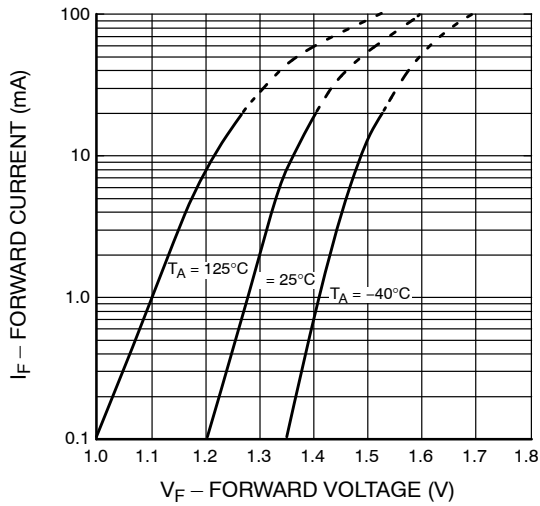


Figure 1. Forward Current vs. Forward Voltage

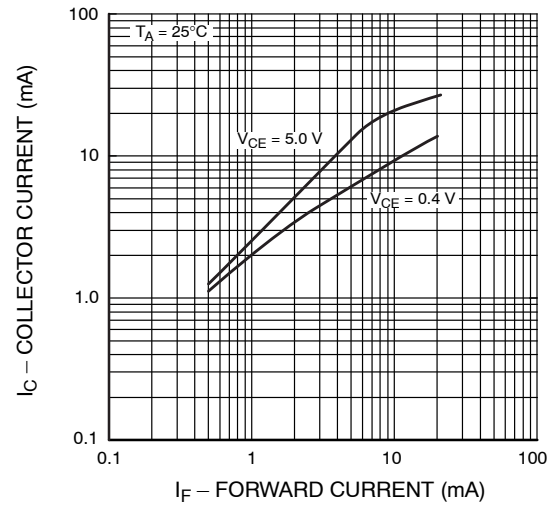


Figure 2. Collector Current vs. Forward Current

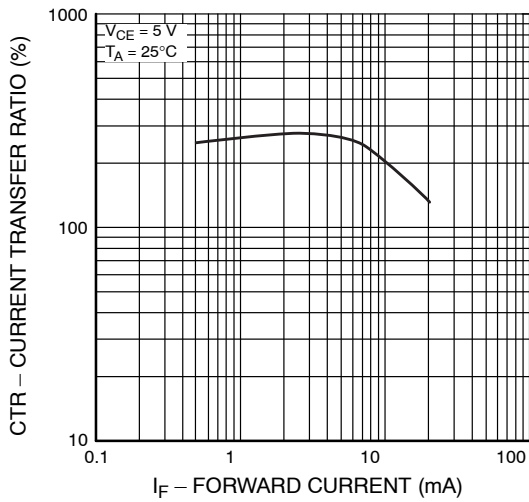


Figure 3. Current Transfer Ratio vs. Forward Current

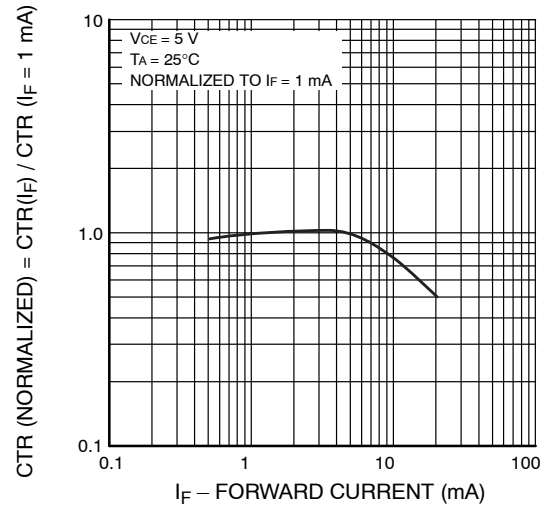


Figure 4. Normalized CTR vs. Forward Current

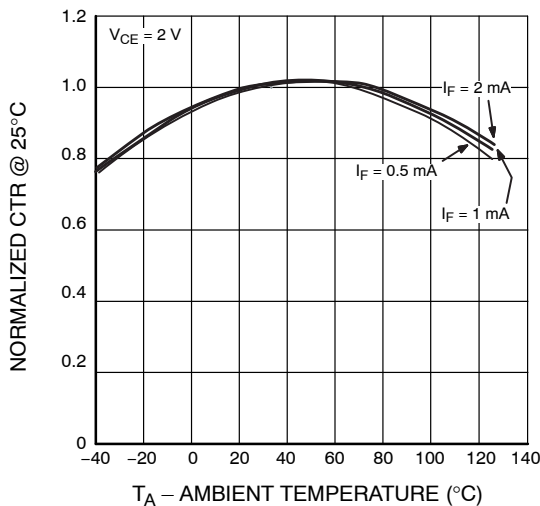


Figure 5. Normalized CTR vs. Ambient Temperature

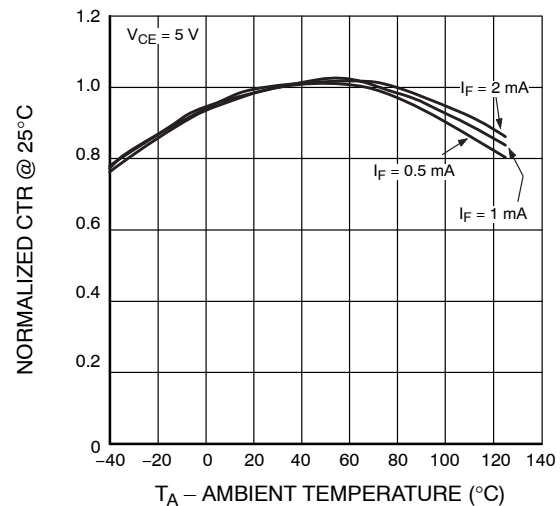


Figure 6. Normalized CTR vs. Ambient Temperature

TYPICAL PERFORMANCE CURVES (continued)

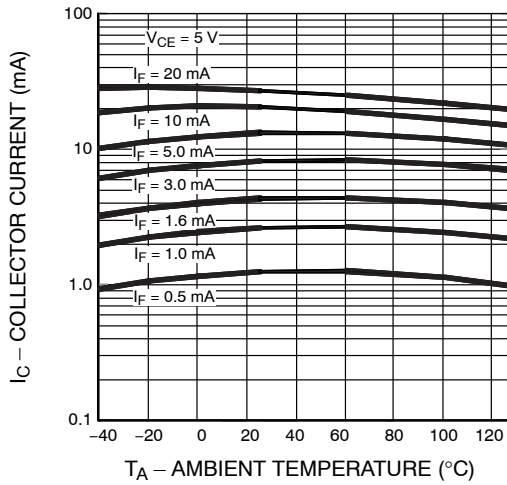


Figure 7. Collector Current vs. Ambient Temperature

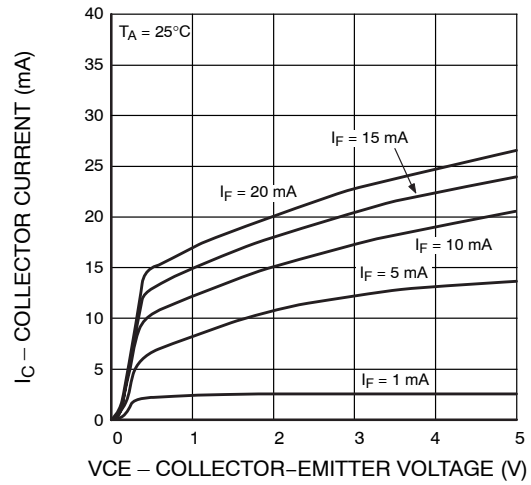


Figure 8. Collector Current vs. Collector-Emitter Voltage

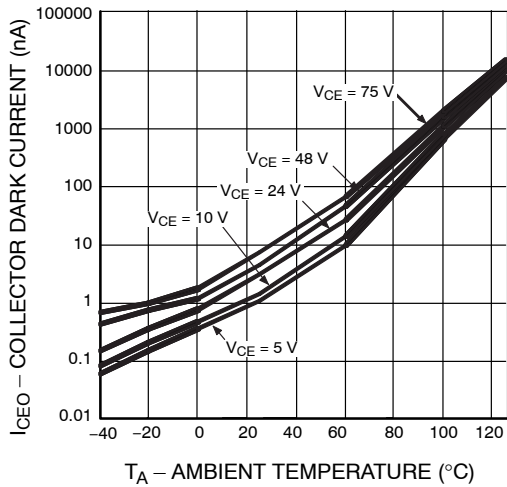


Figure 9. Collector Dark Current vs. Ambient Temperature

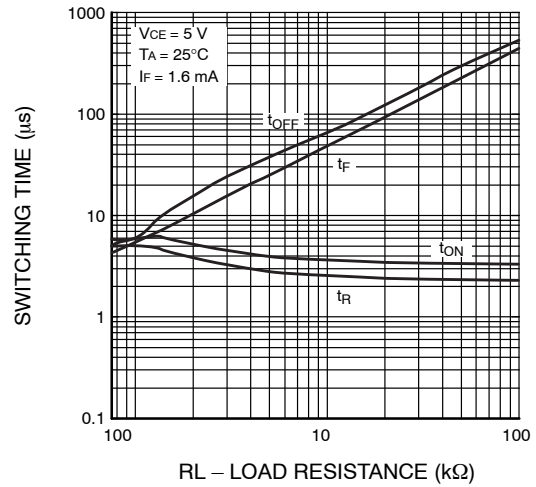


Figure 10. Switching Time vs. Load Resistance

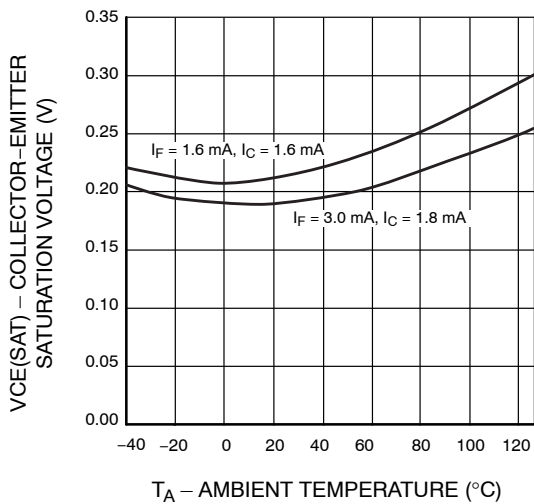


Figure 11. Collector-Emitter Saturation Voltage vs. Ambient Temperature

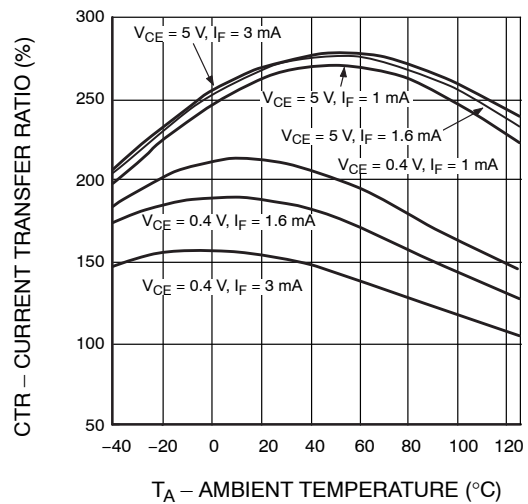


Figure 12. Current Transfer Ratio vs. Ambient Temperature

TEST CIRCUITS

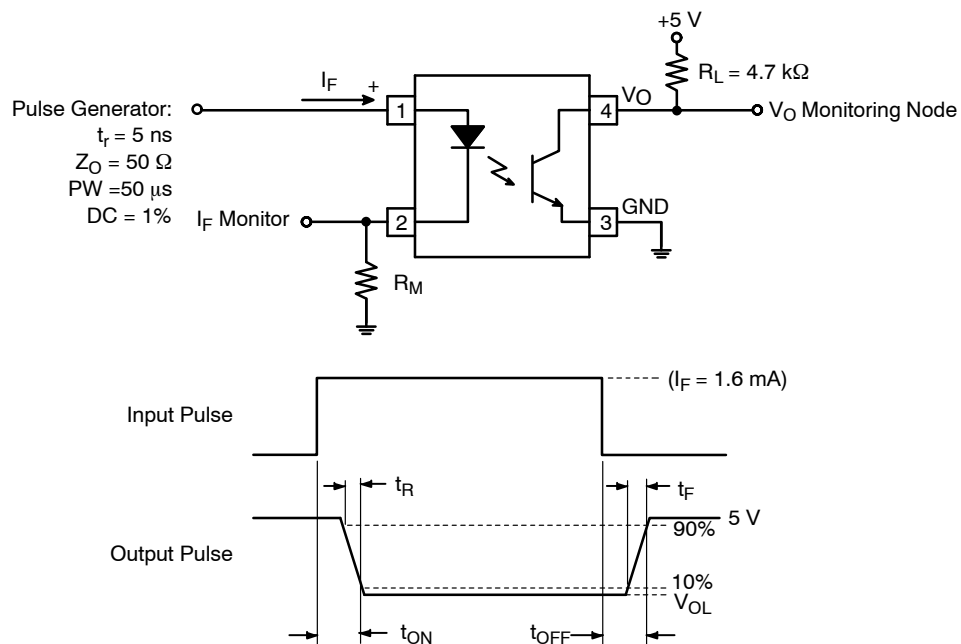


Figure 13. Test Circuit for Propagation Delay, Rise Time, and Fall Time

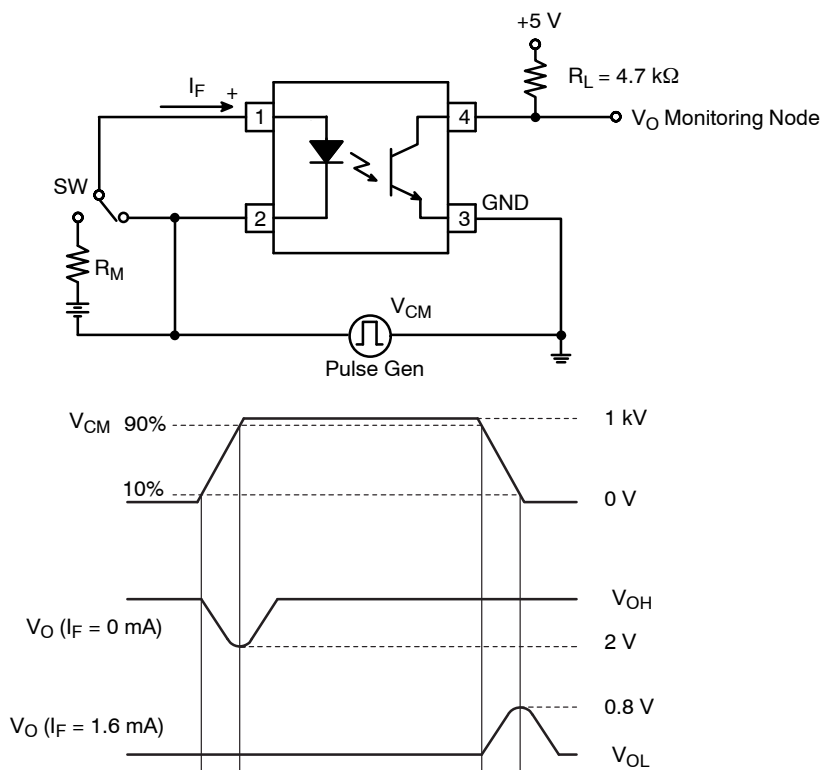


Figure 14. Test Circuit for Instantaneous Common-Mode Rejection Voltage

# FODM8801A, FODM8801B, FODM8801C

## REFLOW PROFILE

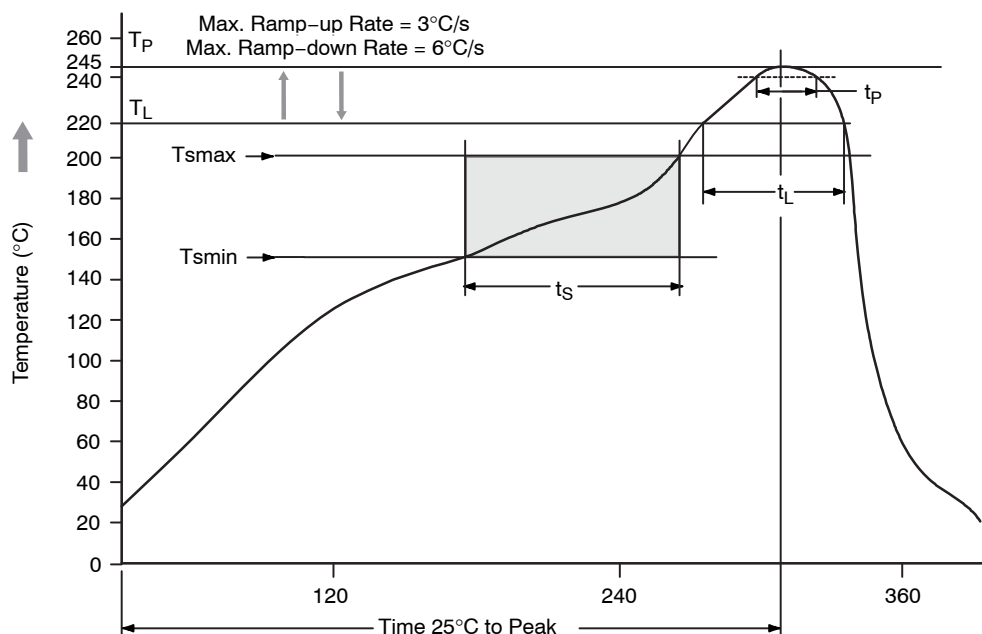


Figure 15. Reflow Profile

Table 1. REFLOW PROFILE

| Profile Feature                 | Pb-Free Assembly Profile |
|---------------------------------|--------------------------|
| Temperature Minimum (Tsm)       | 150°C                    |
| Temperature Maximum (Tsm)       | 200°C                    |
| Time (ts) from (Tsm to Tsm)     | 60 – 120 seconds         |
| Ramp-up Rate (tL to tp)         | 3°C/second maximum       |
| Liquidous Temperature (TL)      | 217°C                    |
| Time (tL) Maintained Above (TL) | 60 – 150 seconds         |
| Peak Body Package Temperature   | 245°C +0°C / -5°C        |
| Time (tp) within 5°C of 245°C   | 30 seconds               |
| Ramp-down Rate (TP to TL)       | 6°C/second maximum       |
| Time 25°C to Peak Temperature   | 8 minutes maximum        |

## ORDERING INFORMATION

| Part Number  | Package                                                | Shipping†          |
|--------------|--------------------------------------------------------|--------------------|
| FODM8801A    | Half Pitch Mini-Flat 4-Pin                             | 150 Units / Tube   |
| FODM8801AR2  | Half Pitch Mini-Flat 4-Pin                             | 2500 / Tape & Reel |
| FODM8801AV   | Half Pitch Mini-Flat 4-Pin, DIN EN/IEC60747-5-5 Option | 150 Units / Tube   |
| FODM8801AR2V | Half Pitch Mini-Flat 4-Pin, DIN EN/IEC60747-5-5 Option | 2500 / Tape & Reel |

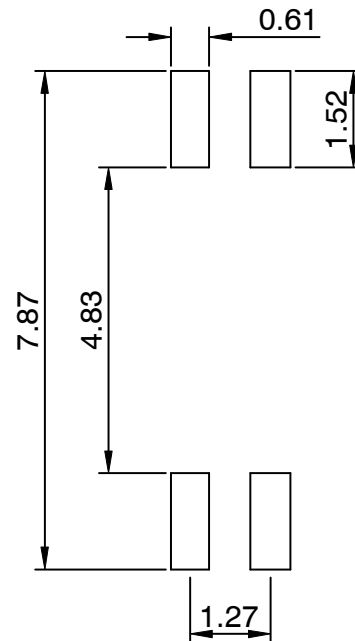
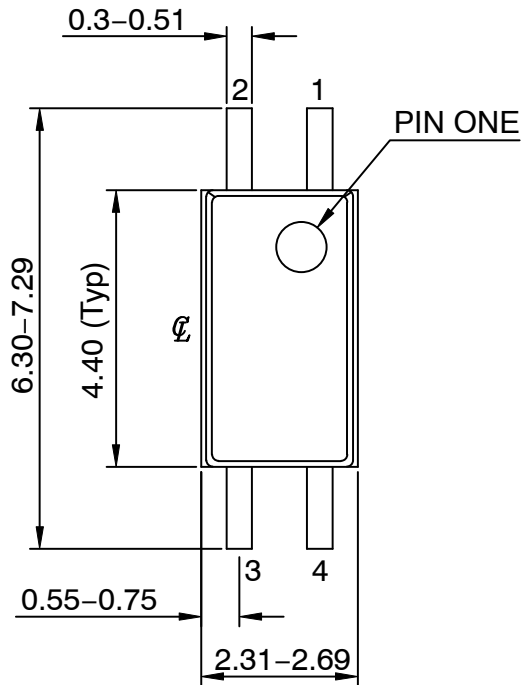
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

8. The product orderable part number system listed in this table also applies to the FODM8801B, FODM8801C products.

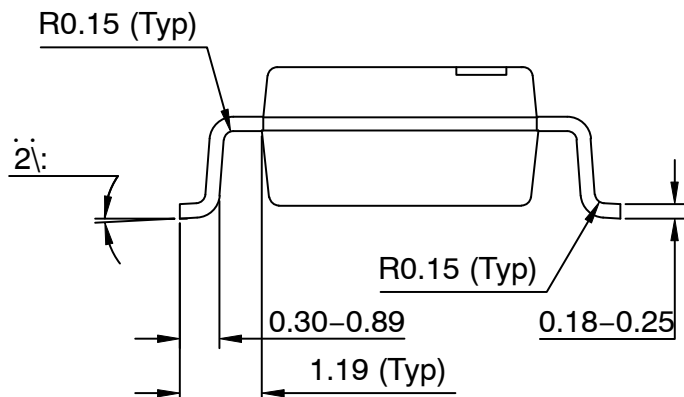
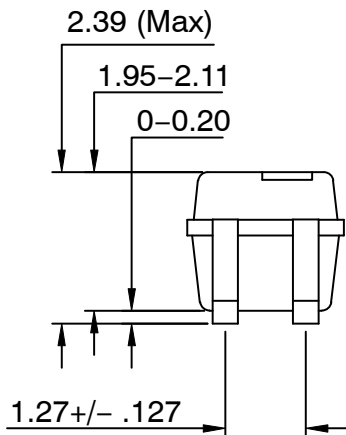
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**MFP4 2.5X4.4, 1.27P**  
CASE 100AL  
ISSUE O

DATE 31 AUG 2016



## LAND PATTERN RECOMMENDATION



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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