

Description

The XR46083 is a Three Terminal Current Controller (TTCC) for regulating the current flowing through an LED string.

The application of the XR46083 is configured in parallel with an LED string. The XR46083 can work as voltage controlled current source, current regulator, or cut-off. It is suitable for the applications adopting periodical AC voltage source.

The layout is very flexible allowing for PCB designs in any conceivable shape. Whether high bay, downlights, or unique architectural shapes the XR46083 can provide an excellent LED lighting solution.

Typical Application

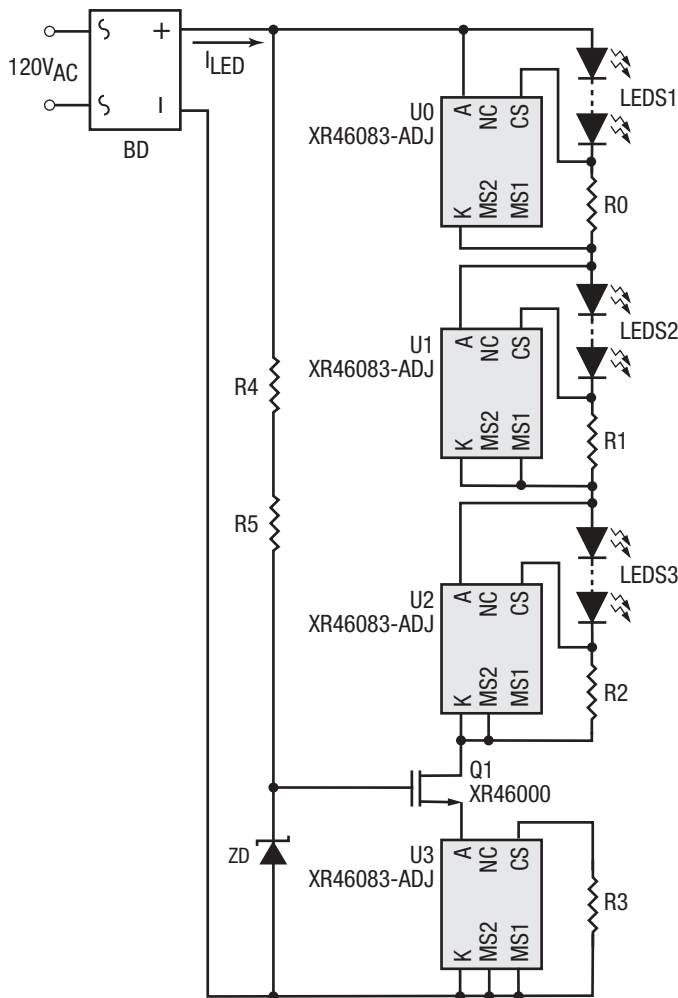


Figure 1. Typical Application

FEATURES

- System
 - All solid state components
 - No electrolytic capacitor required
 - Compact size to minimize mechanical cost
 - Driver-on-board and chip-on-board available which minimize process flow and assembly cost
 - High PF and low THD performance
 - High efficiency achieved
 - Flexible PCB layout style
 - Wide range of LED forward voltage selection
 - Distributed heat to several chips
 - TRIAC dimmable
- Chip
 - 88V input sustaining voltage
 - < 3V dropout voltage for up to 150mA regulating current

APPLICATIONS

- LED Lighting Applications
 - Downlight
 - High bay
 - Specialty
 - Architectural

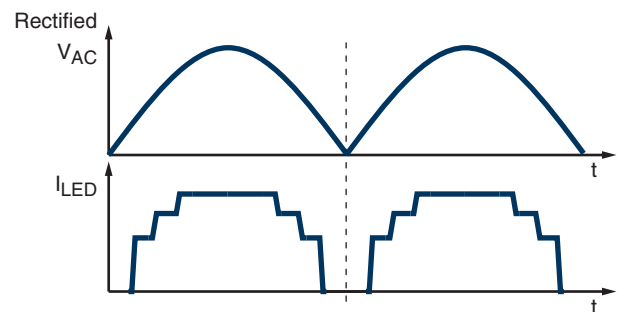


Figure 2. Typical Performance

Absolute Maximum Ratings

Stresses beyond the limits listed below may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

| | |
|---|----------------|
| Sustaining voltage A to K | -0.3V to 88V |
| Sustaining voltage CS, MS1, MS2 to K..... | -0.3V to 1V |
| Regulating current | 150mA |
| Maximum operating junction temperature, T_J | 165°C |
| Storage temperature range | -55°C to 150°C |
| Lead temperature (soldering, 10 seconds)..... | 260°C |

NOTE:

1. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.
2. All parameters having Min/Max specifications are guaranteed. Typical values are for reference purpose only.
3. Unless otherwise noted, all tests are pulsed tests at the specified temperature, therefore: $T_J = T_C = T_A$.

Operating Conditions

| | |
|--|----------------|
| Regulating current (with adequate heat sinking) ⁽¹⁾ , I_{AK} | 130mA |
| Input voltage ⁽¹⁾ , V_{AK} | 3V to 80V |
| Maximum junction temperature, T_J | 150°C |
| Operating free-air temperature range, T_A | -40°C to 100°C |

NOTE:

1. Due to thermal dissipation consideration, the maximum LED Vf in parallel should decrease with the regulating current.

Electrical Characteristics

Unless otherwise noted, typical values are at $T_A = 25^\circ\text{C}$.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units | |
|---|--|--|--|-------|---------|---------|------------------|
| I_{PEAK0} | Peak regulating current ⁽¹⁾⁽²⁾ | $V_{AK} = 5V$, Mode 0 (MS1/MS2 connected to K) | Option C1 | 38.4 | 40 | 41.6 | mA |
| | | | Option C2 | 63.4 | 66 | 68.6 | |
| | | | Option C3 | 49.9 | 52 | 54.1 | |
| | | | Option D1 | 76.8 | 80 | 83.2 | |
| | | | Option D2 | 124.8 | 130 | 135.2 | |
| | | | Option D3 | 99.8 | 104 | 108.2 | |
| I_{PEAK0}/I_{PEAK0} | Current ratio of mode selection ⁽¹⁾ | All Options (C1/C2/C3/D1/D2/D3) $V_{AK} = 5V$ | Mode 0 (MS1/MS2 connected to K) | | 100 | | % |
| I_{PEAK1}/I_{PEAK0} | | | Mode 1 (MS1 open, MS2 connected to K) | 75 | 80 | 85 | |
| I_{PEAK2}/I_{PEAK0} | | | Mode 2 (MS2 open, MS1 connected to K) | 50 | 55 | 60 | |
| I_{PEAK3}/I_{PEAK0} | | | Mode 3 (MS1/ MS2 open) | 32 | 35 | 38 | |
| $\Delta I_{LR}/I_{PEAKx}$ (x = 0 to 3) | Regulating current line regulation ⁽³⁾ | Option C1/C2/C3/D1/D2/D3, Mode 1 to 3, $V_{AK} = 5V$ and 40V | | | ± 1 | ± 2 | % |
| | | Option C1/C2/C3/D1/D2/D3, Mode 0, $V_{AK} = 5V$ and 40V | | -4 | -8 | -15 | |
| V_{CS} | CS pin voltage | Option ADJ, Mode 0, $V_{AK} = 5V$, with 1K Ω external resistor between CS and K | | 0.26 | 0.27 | 0.28 | V |
| $\Delta V_{LR}/V_{CS}$ | CS pin voltage line regulation ⁽⁴⁾ | Option ADJ, Mode 1 to 3, $V_{AK} = 5V$ and 40V with 1K Ω external resistor between CS and K | | | ± 1 | ± 2 | % |
| | | Option ADJ, Mode 0, $V_{AK} = 5V$ and 40V with 1K Ω external resistor between CS and K | | -4 | -8 | -15 | |
| V_{DROP} | Dropout voltage ⁽⁵⁾ | Mode 0 (MS1/ MS2 connected to K) | | | 2.8 | 3.8 | V |
| T_{TP} | Thermal protection trip temperature ⁽⁶⁾ | When T_J is higher than T_{TP} , the peak regulating current decreases to I_{TP} linearly. | | 120 | 130 | | $^\circ\text{C}$ |
| I_{TP}/I_{PEAKx} (x = 0 to 3) | Thermal protection mode regulating current | $T_J = 175^\circ\text{C}$ | | | 50 | | % |

NOTES:

1. For ADJ option, the regulating current is determined by an external resistor, R_{EXT} , connected between the CS pin and the K pin. The mode selection function will not change the current ratio of option ADJ. To activate the line regulation function, the chip (U3) connected in series with the LED string should be set in Mode 0 (MS1 and MS2 connected to pin K). The regulating current will be: $I_{PEAK} = 0.27/R_{EXT}$

And the maximum regulating current of second step (ex: U2 in Mode 1) should not exceed 80% of the top level (ex: U3 in Mode 0), otherwise the circuit operation might become abnormal when OTP function is activated. It is strongly recommended to set at 75%.

Electrical Characteristics (Continued)

NOTES: (Continued)

2. The user can add an external resistor R_{EXT} between the CS pin and the K pin of U3 (Mode 0, serial connected to the LED string) to increase the regulating current of option C1, C2, C3, D1, D2 and D3, as shown in below. For U1 ~ U2 (Mode 1 ~ Mode 3, parallel connected to the LED string), adding an external resistor R_{EXT} between the CS pin and the K pin may cause abnormal operation and chip damage.

For option C1/ C2/ C3, the regulating current variation $\Delta I_{PEAK}/I_{PEAK} = 6.25/R_{EXT}$.

For option D1/ D2/ D3, the regulating current variation $\Delta I_{PEAK}/I_{PEAK} = 3.13/R_{EXT}$.

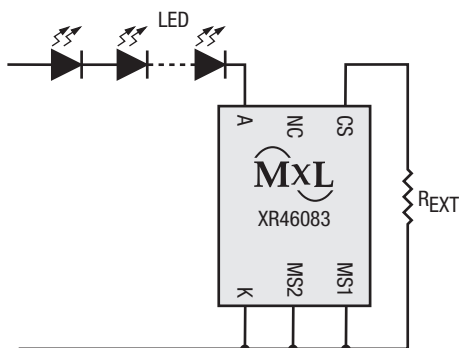


Table 1. U3 (Mode 0) Regulating Current

| | Without External Resistor | With 100Ω External Resistor |
|-----------|---------------------------|-----------------------------|
| Option C1 | 40 | 42.5 |
| Option C2 | 66 | 70.1 |
| Option C3 | 52 | 55.3 |
| Option D1 | 80 | 82.5 |
| Option D2 | 132 | 136.1 |
| Option D3 | 104 | 107.3 |

Figure 3. External Resistor to Increase Regulating Current

3. The Regulating Current Line Regulation is defined as:

$$\text{For Mode 1~3: } \Delta I_{LR}/I_{PEAKx} = \frac{I_{AK}(V_{AK} = 40V) - I_{AK}(V_{AK} = 5V)}{I_{AK}(V_{AK} = 5V)}, x = 1\sim3$$

$$\text{For Mode 0: } \Delta I_{LR}/I_{PEAK0} = \frac{I_{AK}(V_{AK} = 40V) - I_{AK}(V_{AK} = 5V)}{I_{AK}(V_{AK} = 5V)}$$

4. The CS Pin Voltage Line Regulation is defined as:

$$\text{For Mode 1~3: } \Delta V_{LR}/V_{CS} = \frac{V_{CS}(V_{AK} = 40V) - V_{CS}(V_{AK} = 5V)}{V_{CS}(V_{AK} = 5V)}$$

$$\text{For Mode 0: } \Delta V_{LR}/V_{CS} = \frac{V_{CS}(V_{AK} = 40V) - V_{CS}(V_{AK} = 5V)}{V_{CS}(V_{AK} = 5V)}$$

5. Dropout voltage = $V_{AK} @ 90\% \times (I_{PEAK0} @ V_{AK} = 5V)$

6. When $T_J > T_{TP}$, the peak regulating current decreases linearly to around 50% at 175°C.

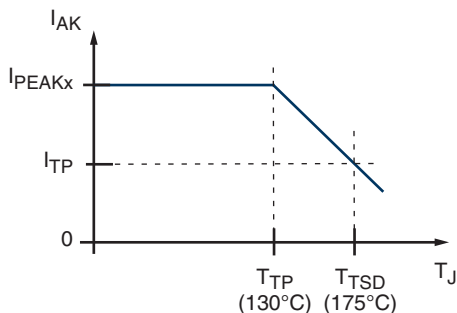
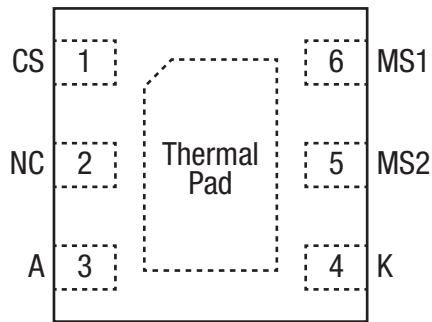
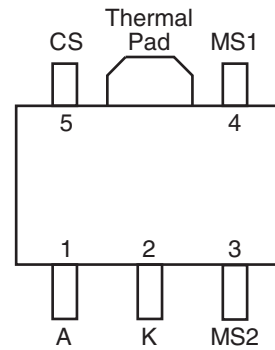


Figure 4. Peak Regulating Current vs. T_J

Pin Configuration



2mm x 2mm TDFN-6



SOT-89-5

Pin Functions

| Pin Number | | Pin Name | Description |
|---------------------|----------|----------|--|
| TDFN-6 | SOT-89-5 | | |
| 1 | 5 | CS | Current sense pin. Connected to negative end of LED string. |
| 3 | 1 | A | Regulating current input pin. Connected to positive end of LED string. |
| 4 | 2 | K | Regulating current output pin. This is effectively a ground pin. |
| 5 | 3 | MS2 | Mode selection pin 2. Floating or connecting to pin K only. |
| 6 | 4 | MS1 | Mode selection pin 1. Floating or connecting to pin K only. |
| 2 | - | NC | No Connection |
| Exposed Thermal Pad | | | Exposed thermal pad of the chip. Use this pin to enhance the power dissipation ability. The thermal conductivity will be improved if a copper foil on PCB is soldered with the thermal pad. It is recommended to connect the thermal pad to pin K. |

Functional Block Diagram

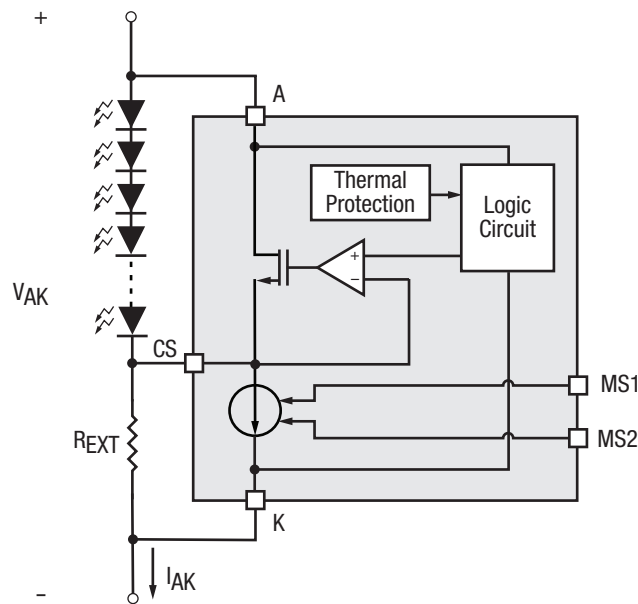


Figure 5. Functional Block Diagram

I-V Curve

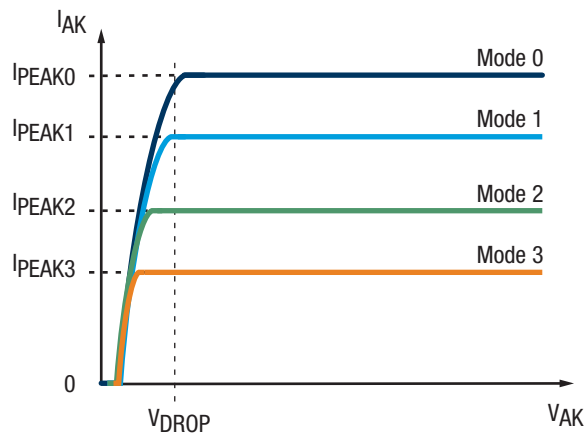


Figure 6. Cx/Dx Options

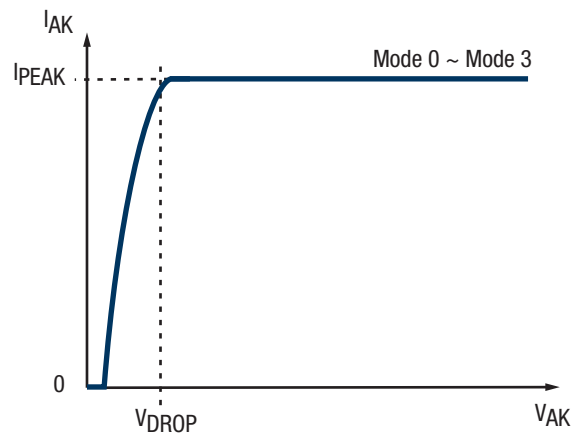


Figure 7. ADJ Option

Applications Information

220V_{AC}/10W LED Light Engine

- 3 steps, PF = 0.98, THD = 16%
- To pass 1KV surge test, Q1 can be changed to 800V NMOS

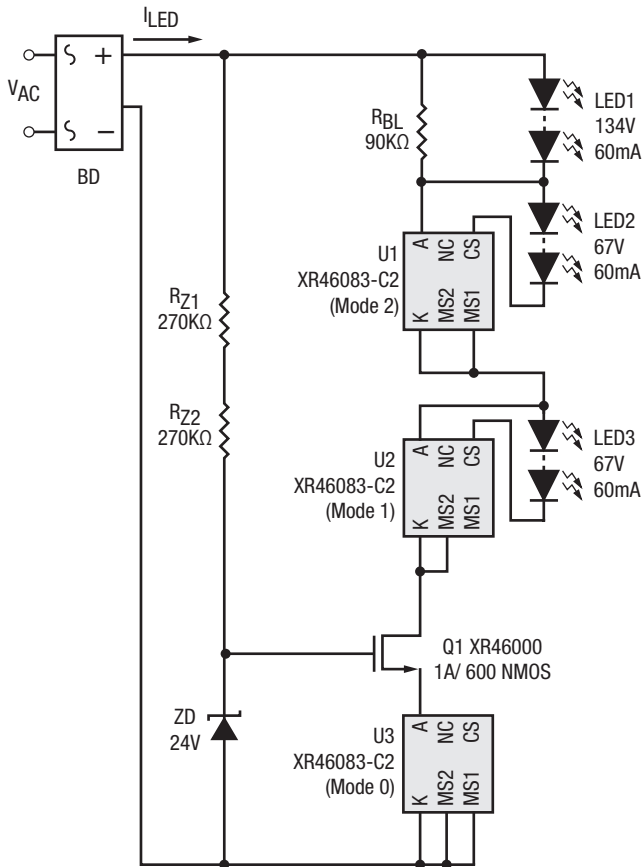


Figure 8. C2 Option

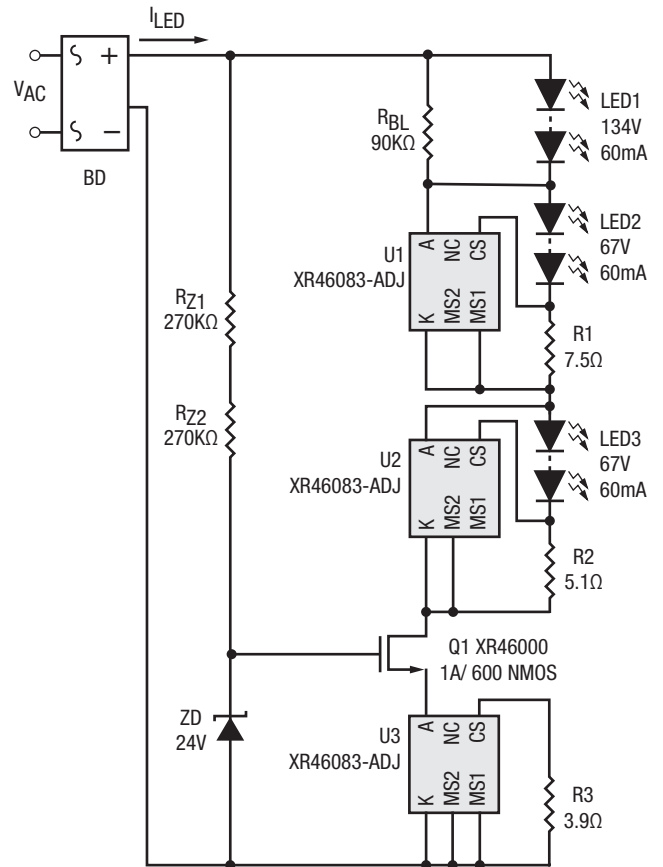


Figure 9. ADJ Option

Applications Information (Continued)

7W Low Cost LED Light Engine

- 2 steps, PF = 0.95, THD = 28%

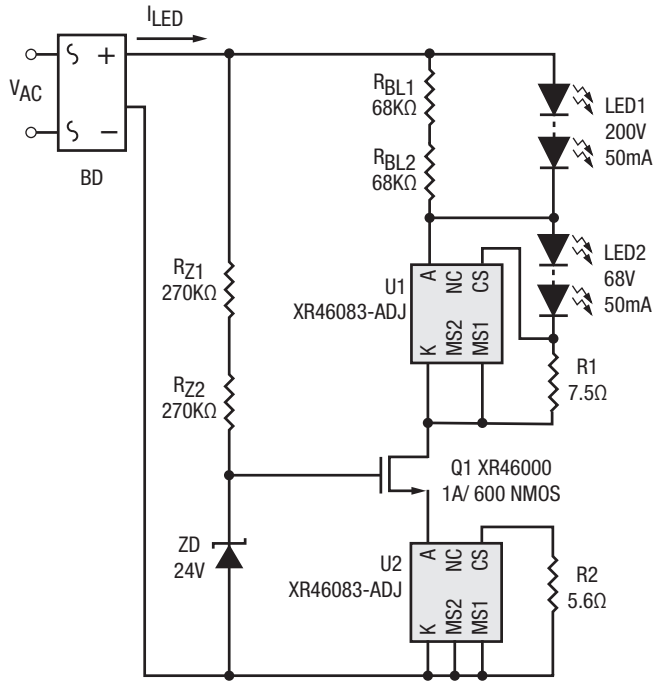


Figure 12. 220V_{AC}, ADJ Option

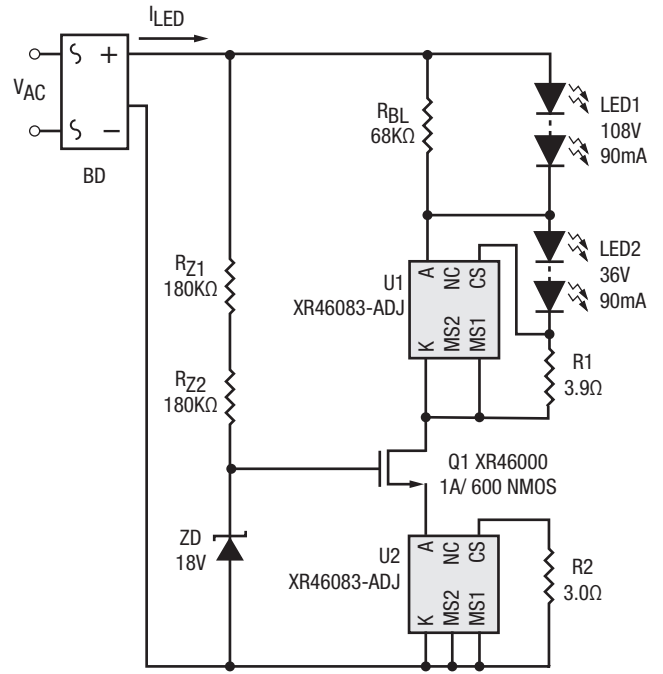


Figure 13. 120V_{AC}, ADJ Option

Applications Information (Continued)

Low Flicker Solutions

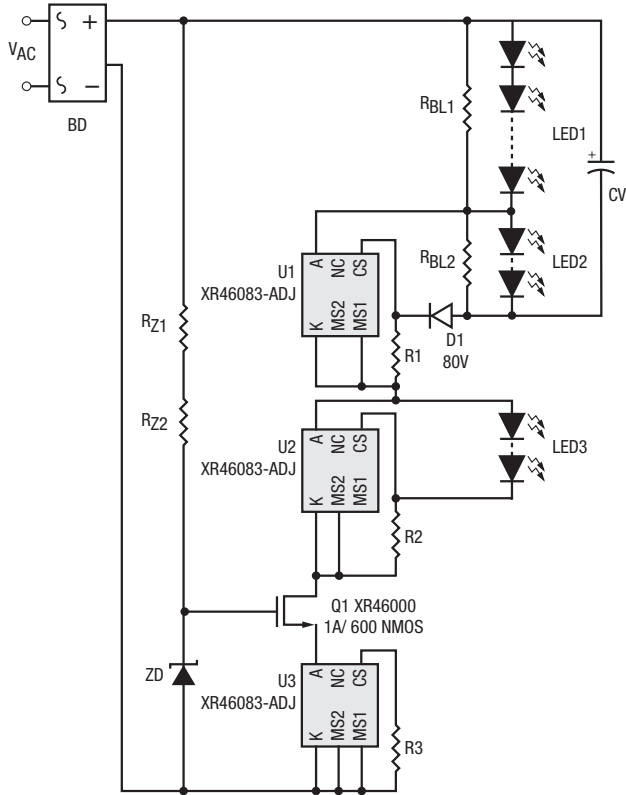


Figure 14. 3-Step, ADJ Option

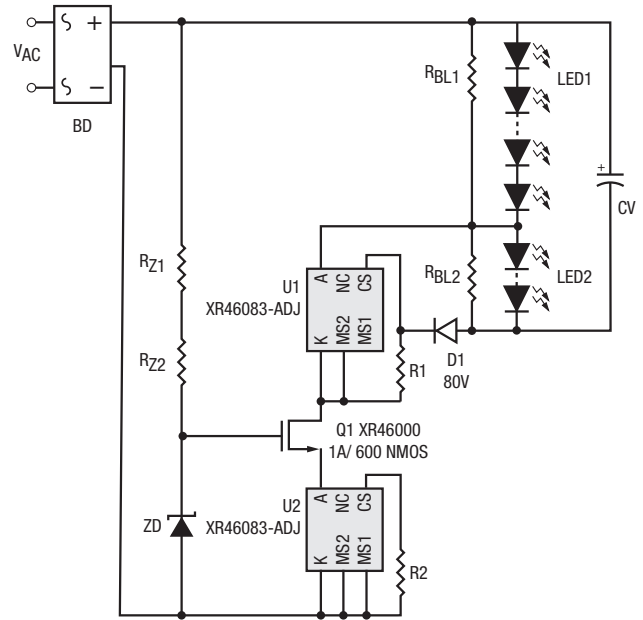
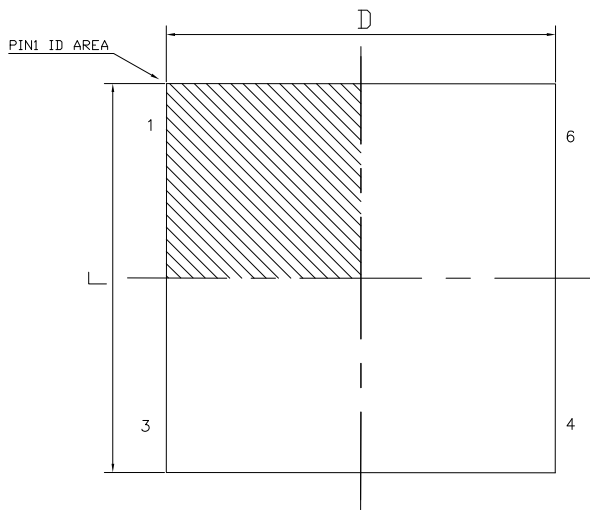


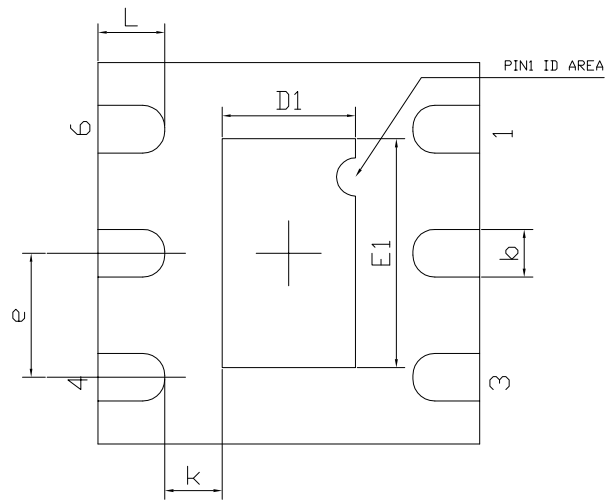
Figure 15. 2-Step, ADJ Option

Mechanical Dimensions

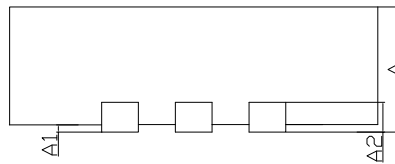
TDFN6 2x2



TOP VIEW



BOTTOM VIEW



SIDE VIEW

| DIM SYMBOL | MIN | NOM | MAX |
|------------|-----------|-------|-------|
| A | 0.700 | 0.750 | 0.800 |
| A1 | 0.000 | - | 0.050 |
| A2 | 0.203Ref | | |
| b | 0.200 | 0.250 | 0.300 |
| D | 2.00 BSC | | |
| E | 2.00 BSC | | |
| e | 0.650 BSC | | |
| D1 | 0.600 | 0.700 | 0.800 |
| E1 | 1.100 | 1.200 | 1.300 |
| L | 0.274 | 0.350 | 0.426 |
| K | 0.200 | - | - |
| N | 6 | | |

TERMINAL DETAILS

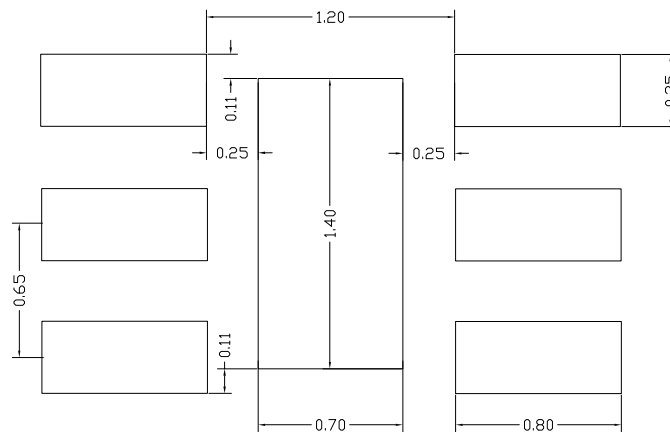
- ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
- DIMENSIONS AND TOLERANCE PER JEDEC MO-229.

Drawing No.: POD-00000072

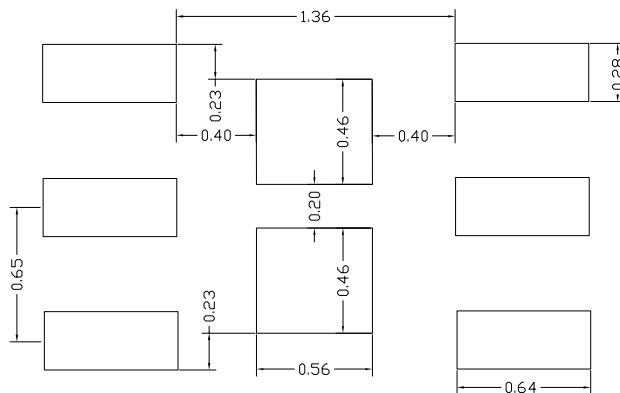
Revision: B

Recommended Land Pattern and Stencil

TDFN6 2x2



TYPICAL RECOMMENDED LAND PATTERN



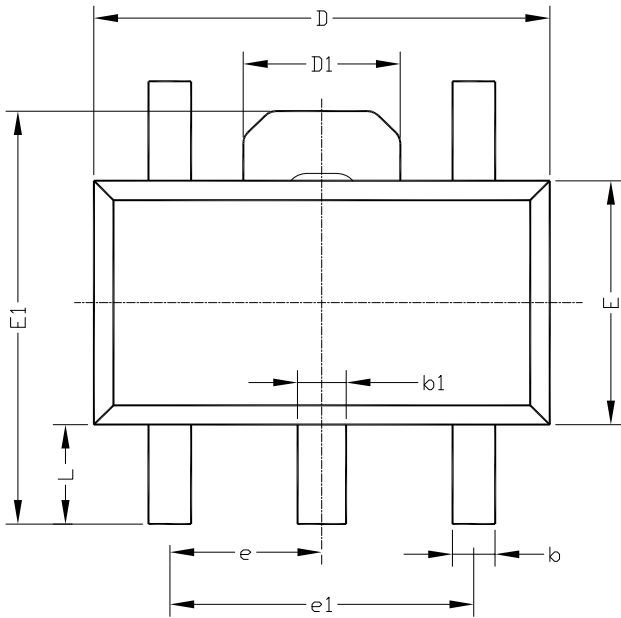
TYPICAL RECOMMENDED STENCIL

Drawing No.: POD-00000072

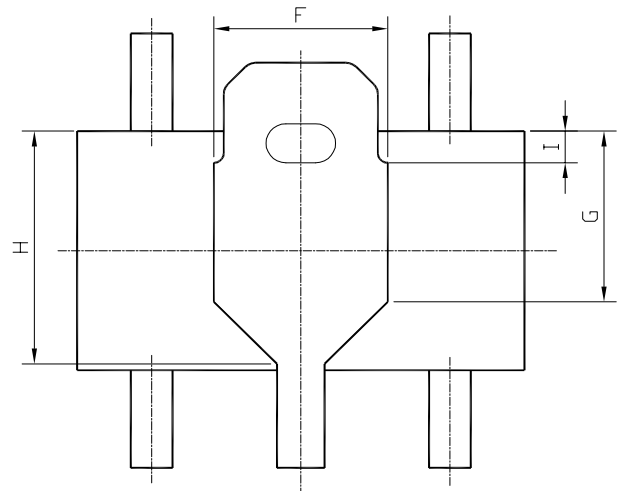
Revision: B

Mechanical Dimensions (Continued)

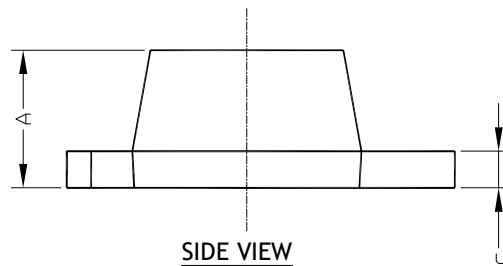
SOT-89-5



TOP VIEW



BOTTOM VIEW



SIDE VIEW

| DIM SYMBOL | MIN. | NOM. | MAX. |
|------------|---------|------|------|
| A | 1.40 | 1.50 | 1.60 |
| b | 0.32 | 0.42 | 0.52 |
| b1 | 0.36 | 0.46 | 0.56 |
| c | 0.35 | 0.40 | 0.44 |
| D | 4.40 | 4.50 | 4.60 |
| E | 2.30 | 2.45 | 2.60 |
| D1 | 1.55REF | | |
| E1 | 3.94 | 4.15 | 4.25 |
| e | 1.50TYP | | |
| e1 | 2.90 | 3.00 | 3.10 |
| L | 0.90 | 1.00 | 1.20 |
| F | 1.75REF | | |
| H | 2.38REF | | |
| G | 1.75REF | | |
| I | 0.32REF | | |

TERMINAL DETAILS

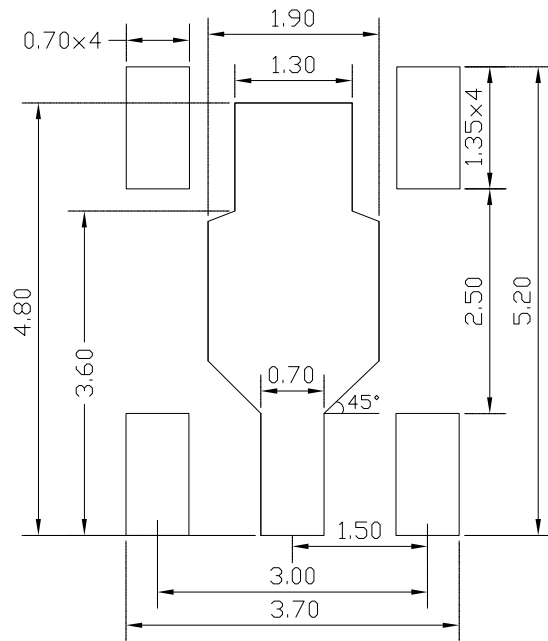
NOTE : ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No.: POD-00000097

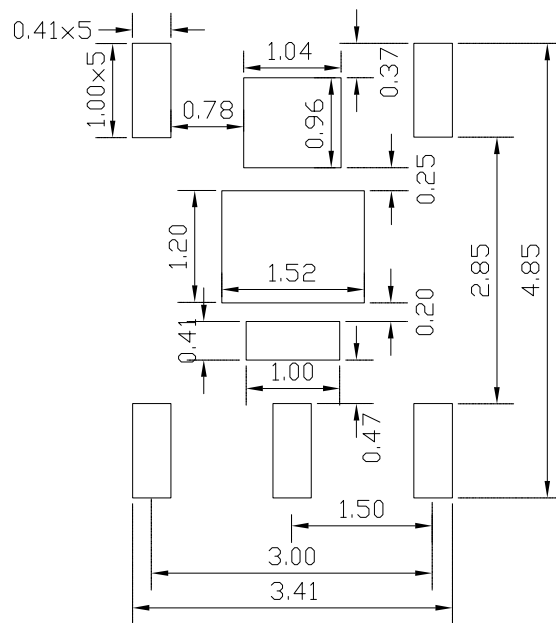
Revision: B

Recommended Land Pattern and Stencil

SOT-89-5



TYPICAL RECOMMENDED LAND PATTERN



TYPICAL RECOMMENDED STENCIL

NOTE : ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No.: POD-0000097

Revision: B

Ordering Information⁽¹⁾

| Part Number | Operating Temperature Range | Lead-Free | Package | Package Method |
|------------------|---|--------------------|-----------|----------------|
| XR46083EHTR-ADJ | $-40^{\circ}\text{C} \leq T_J \leq 150^{\circ}\text{C}$ | Yes ⁽²⁾ | TDFN6 2x2 | Reel |
| XR46083ESFTR-ADJ | $-40^{\circ}\text{C} \leq T_J \leq 150^{\circ}\text{C}$ | Yes ⁽²⁾ | SOT-89-5 | Reel |

NOTE:

1. Refer to www.exar.com/XR46083 for most up-to-date Ordering Information.
2. Visit www.exar.com for more information on Environmental Rating.

Revision History

| Revision | Date | Description |
|----------|----------|---|
| 1A | Aug 2016 | Initial release |
| 1B | Oct 2016 | Update Typical Application, Package Descriptions, and Ordering Information table. |
| 1C | Aug 2018 | Update to MaxLinear logo. Update format and Ordering Information. |



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