



# MIC3202/MIC3202-1 Evaluation Board

High-Brightness LED Driver with Integrated  
MOSFET and High-Side Current Sense

## General Description

The MIC3202/MIC3202-1 is a hysteretic step-down, constant-current, High-Brightness LED (HB LED) driver. It provides an ideal solution for interior/exterior lighting, architectural and ambient lighting, LED bulbs, and other general illumination applications.

This board enables the evaluation of the MIC3202/MIC3202-1 for 1A LED current. The board is optimized for ease of testing, with all the components on a single side. The device operates from a 6V to 37V input voltage range, and includes an integrated 1.0A MOSFET. When the input voltage approaches and crosses UVLO threshold, the internal 5V  $V_{CC}$  is regulated and the integrated MOSFET is turned on if EN pin and DIM pin are high. The inductor current builds up linearly. When the CS pin voltage hits the  $V_{CS(MAX)}$  with respect to  $V_{IN}$ , the internal MOSFET is turned off and the Schottky diode takes over and returns the current to  $V_{IN}$ . Then the current through inductor and LEDs starts decreasing. When CS pin hits  $V_{CS(MIN)}$ , the internal MOSFET is turned on and the cycle repeats.

Since the control scheme does not need loop compensation, it makes for a very simple design and avoids problems of instability.

Datasheets and support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

## Requirements

This board needs a single-bench power source adjustable over the input voltage of  $6V < V_{IN} < 37V$  that can provide at least 1A of current. The loads can either be active (electronic load in CV mode) or passive (LEDs) with the ability to dissipate the maximum load power while keeping accessible surfaces ideally  $<70^{\circ}C$ .

## Precautions

There is no reverse input protection on this board. When connecting the input sources, ensure that the correct polarity is observed.

In the line transient condition, such as hot plug-in, an electrolytic capacitor may be required at the VIN and GND terminals in order to prevent IC damage from a surge voltage.

## Getting Started

1. **Connect  $V_{IN}$  supply to the input VIN and GND terminals.** With the output of this supply disabled, set the supply voltage to the desired input test voltage ( $6V < V_{IN} < 37V$ ). This supply voltage should be monitored at the test boards input terminals to allow voltage drops in the test cables (and ammeter if used) to be accounted for. An ammeter can be added inline with the +VIN input terminal to accurately measure input current.
2. **Connect the LEDs to the output terminals between LED+ and LED-.** This LED voltage drop depends on manufacturer tolerance and number of LEDs. The LED current can be measured using an ammeter or current probe. A 4.7 $\mu$ F ceramic capacitor helps to reduce the current ripple through the LED. The LED current is set to 1A by a 200m $\Omega$  current-sense resistor ( $R_{CS}$ ).
3. **Enable the input supply.** By default, the IC is enabled when the input voltage crosses the VIN threshold (4V) and the internal VCC regulator and internal MOSFET are turned on with the EN and DIM pins are high. To use the EN and DIM functions of the MIC3202/MIC3202-1, a test point is provided for each of them.

## Ordering Information

Part Number	Description
MIC3202YME EV	MIC3202YME Evaluation Board

## Other Features

### EN Input

The EN pin provides a logic level control of the output and the voltage has to be 2.0V or higher to enable the current regulator. The output stage is gated by the DIM pin. When the EN pin is pulled low, the regulator goes to off-state and the supply current of the device is reduced to below 1µA. Do not drive the EN pin above the supply voltage.

### DIM Input

The DIM pin provides a logic level control for brightness of the LED. A PWM input can be used to control the brightness of LED. DIM high enables the output and its voltage has to be 2.0V or higher. DIM low disables the output, regardless of EN high-state.

### Current-Sense Input

The CS pin provides the high-side current sense to set the LED current with an external sense resistor.

A sense resistor  $R_{CS}$  is placed between  $V_{IN}$  and LED+ terminals.

The current through LED is sensed by the sense resistor ( $R_{CS}$ ). The sensed voltage is fed back to the MIC3202 to regulate the LED current

$R_{CS}$  is given by:

$$R_{CS} = \frac{1}{2} \times \left( \frac{V_{CS(MAX)} + V_{CS(MIN)}}{I_{LED}} \right) \quad \text{Error!}$$

**Bookmark not defined.**

$I_{LED}$  is LED current required to set.

$R_{CS}$ (Ω)	$I_{LED}$ (A)	$I^2R$ (W)	Size (SMD)
1.33	0.15	0.03	0603
0.56	0.35	0.07	0805
0.4	0.5	0.1	0805
0.28	0.7	0.137	0805
0.2	1.0	0.2	1206

For  $V_{CS(MAX)}$  and  $V_{CS(MIN)}$  refers to the Electrical Characteristics table.

### Frequency of Operation

To calculate the frequency spread across input supply:

$$F_{SW} = \frac{(V_D + I_{LED} \times R_{CS} + V_{LED}) \times (V_{IN} - I_{LED} \times R_{CS} - V_{LED})}{L \times \Delta I_L \times (V_D + V_{IN})}$$

$$\Delta I_L = \frac{V_{CS(MAX)} - V_{CS(MIN)}}{R_{CS}}$$

where:

$V_D$  is Schottky diode forward drop

$V_{LED}$  is total LEDs voltage drop

$V_{IN}$  is input voltage

$I_{LED}$  is average LED current

According to the above equation, choose the inductor to make the operating frequency no higher than 1MHz.

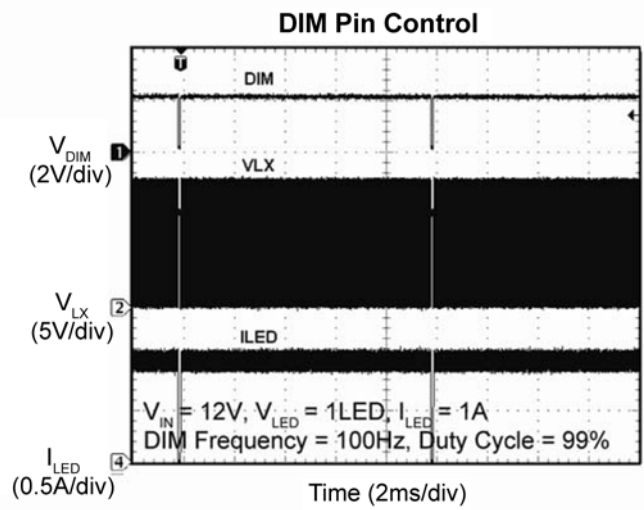
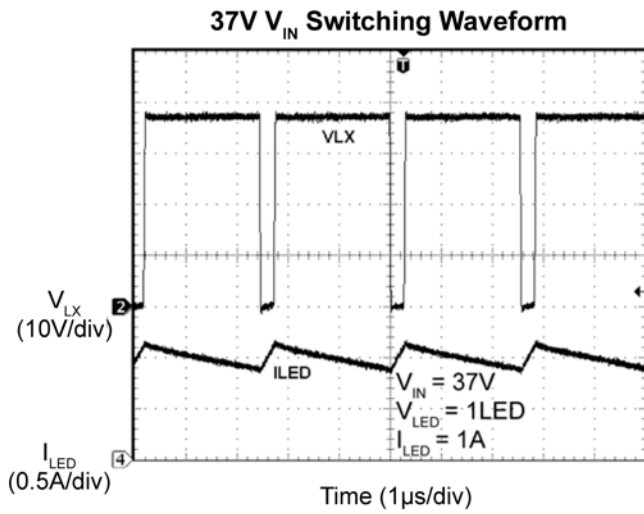
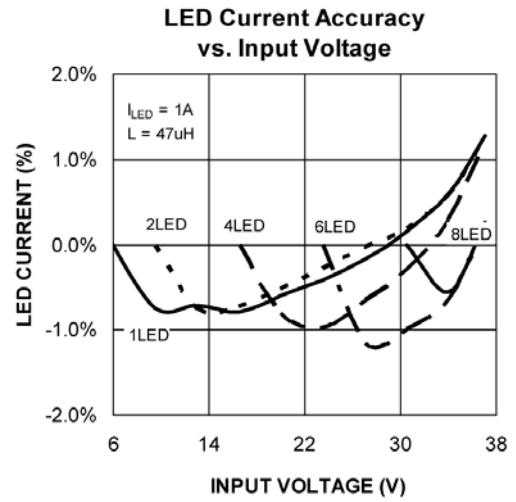
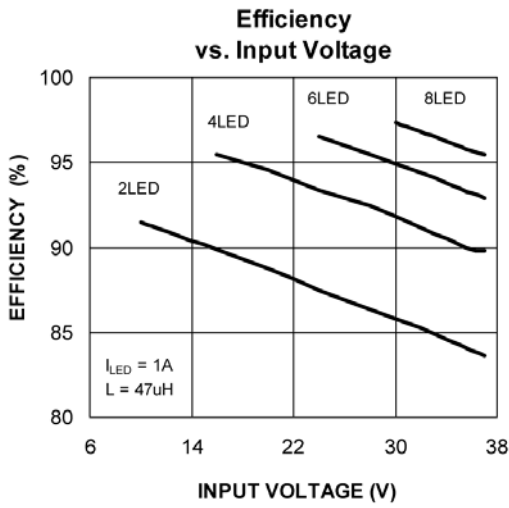
Refer to the datasheet *Application Information* for more information on components selection guidelines.

### Frequency Dithering

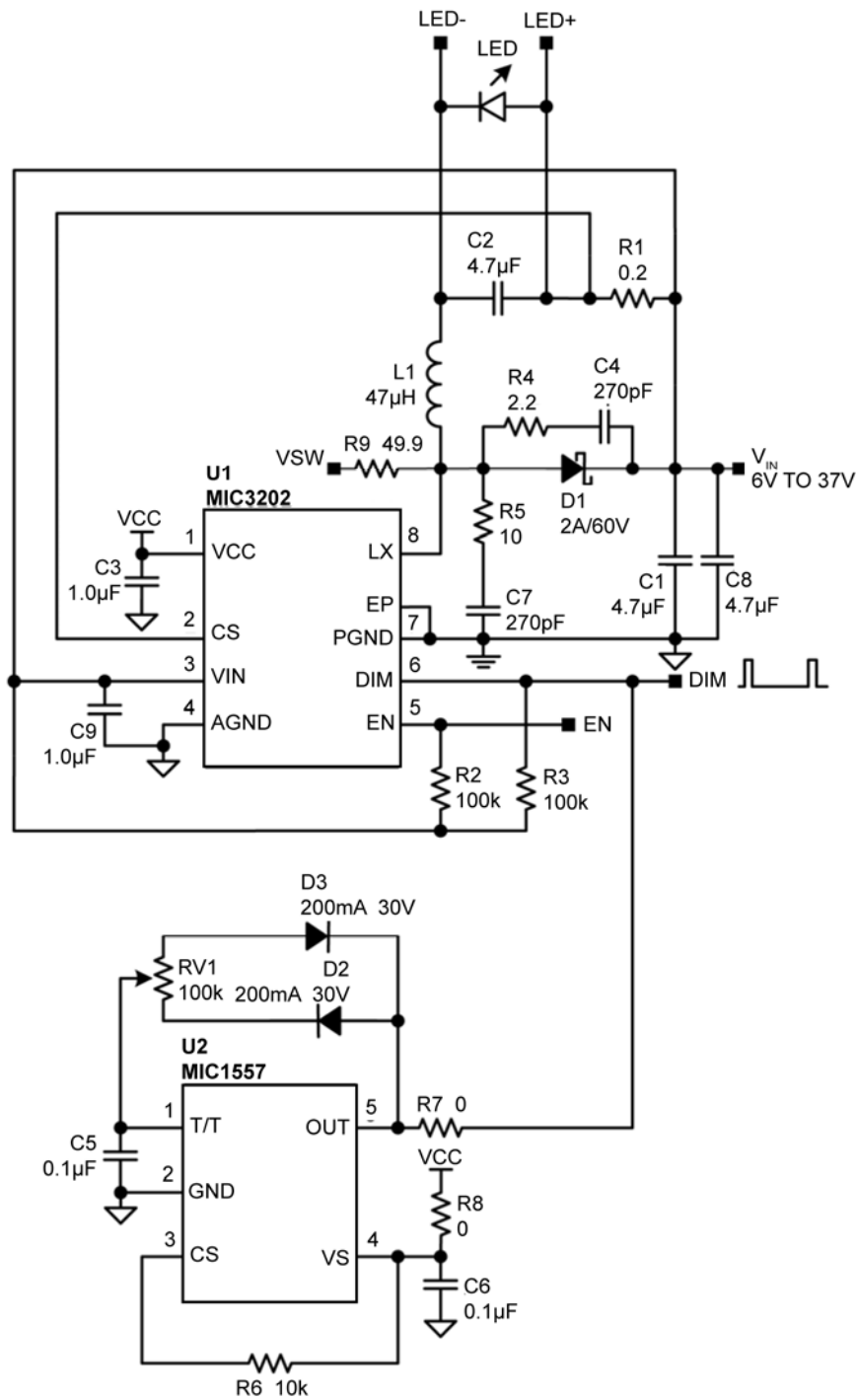
The MIC3202 is designed to modulate the  $V_{CS(MAX)}$  with amplitude  $\pm 6mV$  by a pseudo random generator to generate the  $\pm 12\%$  of the switching frequency dithering. This spreads the frequency spectrum over a wider range and reduce the EMI noise peaks.

The MIC3202-1 is non-dithering version of the MIC3202.

### Evaluation Board Performance



### Evaluation Board Schematic



**Notes:**

1. If bulk capacitor on input rail is away (4 inches or more) from the MIC3202/MIC3202-1, install the 100µF bulk capacitor near VIN.
2. Source impedance should be as low as 10mΩ.

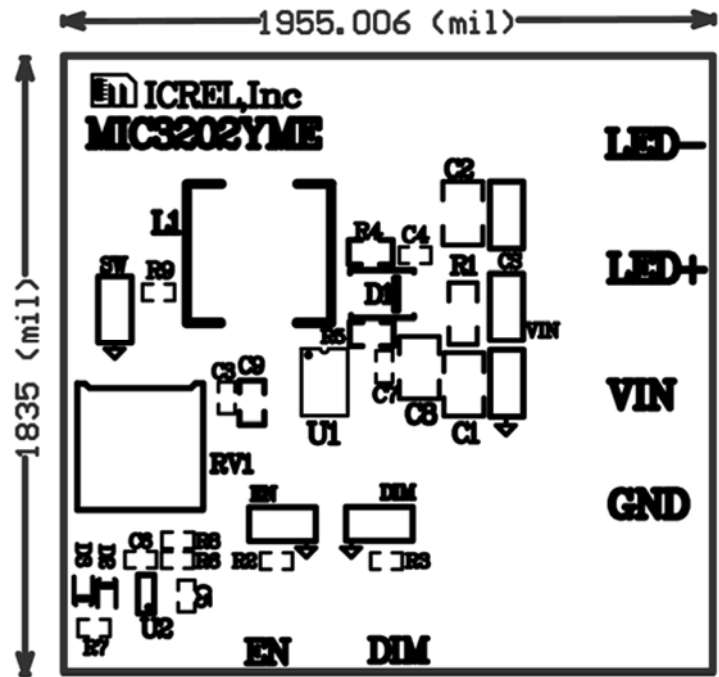
## Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2, C8	12105C475KAZ2A	AVX <sup>(1)</sup>	4.7μF/50V, Ceramic Capacitor, X7R, Size 1210	2
	GRM32ER71H475KA88L	Murata <sup>(2)</sup>		
C3, C9	08053D105KAT2A	AVX <sup>(1)</sup>	1μF/25V, Ceramic Capacitor, X5R, Size 0805	1
	GRM21BR71E105KA99L	Murata <sup>(2)</sup>	1μF/25V, Ceramic Capacitor, X7R, Size 0805	1
	C2012X7R1E105K	TDK <sup>(3)</sup>		
C4, C7	06035C271KAT2A	AVX <sup>(1)</sup>	270pF/50V, Ceramic Capacitor NPO, Size 0603	2
	GRM188R71H271KA01D	Murata <sup>(2)</sup>		
C5, C6	06035C104MAT	AVX <sup>(1)</sup>	0.1μF/50V, Ceramic Capacitor, X7R, Size 0603	2
	GRM188R71H104KA93D	Murata <sup>(2)</sup>		
	C1608X7R1H104K	TDK <sup>(3)</sup>		
D1	SS24-TP	MCC <sup>(4)</sup>	60V, 2A, SMA, Schottky Diode	1
	SS24	Fairchild <sup>(5)</sup>		
D2, D3	B0530WS-TP	MCC <sup>(4)</sup>	30V, 200mA, Schottky diode, SOD-323	2
L1	SLF10145T-470M1R4	TDK <sup>(3)</sup>	47μH, 1.4A, SMT, Power Inductor	1
R1	CSR 1/2 0.2 1% I	Stackpole Electronics, Inc <sup>(7)</sup>	0.2Ω Resistor, 1/2W, 1%, Size 1206	1
R2, R3	CRCW06031003FKEA	Vishay <sup>(8)</sup>	100kΩ Resistor, 1%, Size 0603	2
R4	CRCW08052R20FKEA	Vishay <sup>(8)</sup>	2.2Ω Resistor, 1%, Size 0805	1
R5	CRCW080510R0FKEA	Vishay <sup>(8)</sup>	10Ω Resistor, 1%, Size 0805	1
R6	CRCW060310K0FKEA	Vishay <sup>(8)</sup>	10kΩ Resistor, 1%, Size 0603	1
R7, R8	CRCW06030000FKEA	Vishay <sup>(8)</sup>	0Ω Resistor, 1%, Size 0603	2
R9	CRCW060349R9FKEA	Vishay <sup>(8)</sup>	49.9Ω Resistor, 1%, Size 0603	1
RV1	3386P-1-104TLF	Bourns <sup>(9)</sup>	POT 100kΩ 3/8" SQ CERM SL ST	1
U1	MIC3202YME	Micrel, Inc. <sup>(10)</sup>	High Brightness LED Driver with High-Side Current Sense	1
U2	MIC1557YM5	Micrel, Inc. <sup>(10)</sup>	RC Time/Oscillator (SOT-23-5)	1

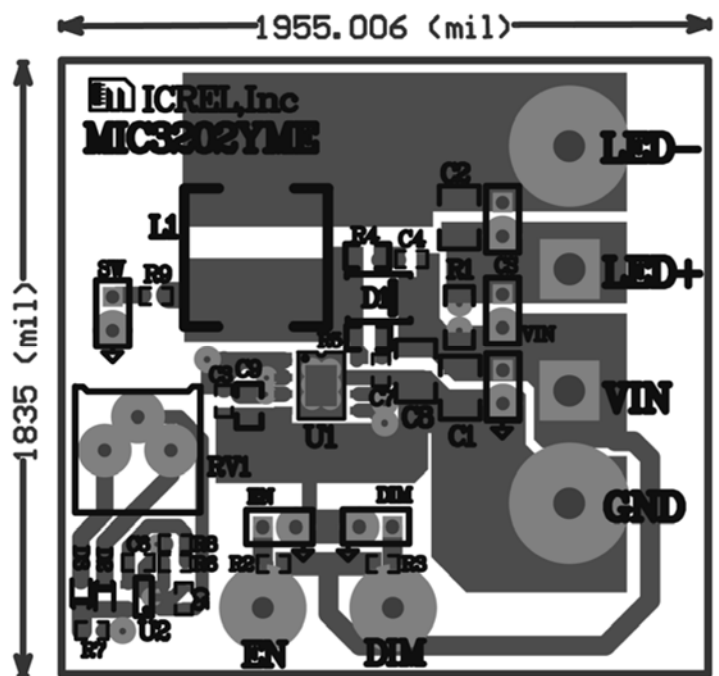
### Notes:

1. AVX: [www.avx.com](http://www.avx.com).
2. Murata: [www.murata.com](http://www.murata.com).
3. TDK: [www.tdk.com](http://www.tdk.com).
4. MCC: [www.mccsemi.com](http://www.mccsemi.com).
5. Fairchild: [www.fairchildsemi.com](http://www.fairchildsemi.com).
6. Diodes Inc. : [www.diodes.com](http://www.diodes.com).
7. Stackpole Electronics: [www.seielect.com](http://www.seielect.com).
8. Vishay: [www.vishay.com](http://www.vishay.com).
9. Bourns Inc : [www.bourns.com](http://www.bourns.com).
10. Micrel, Inc.: [www.micrel.com](http://www.micrel.com).

### PCB Layout Recommendations

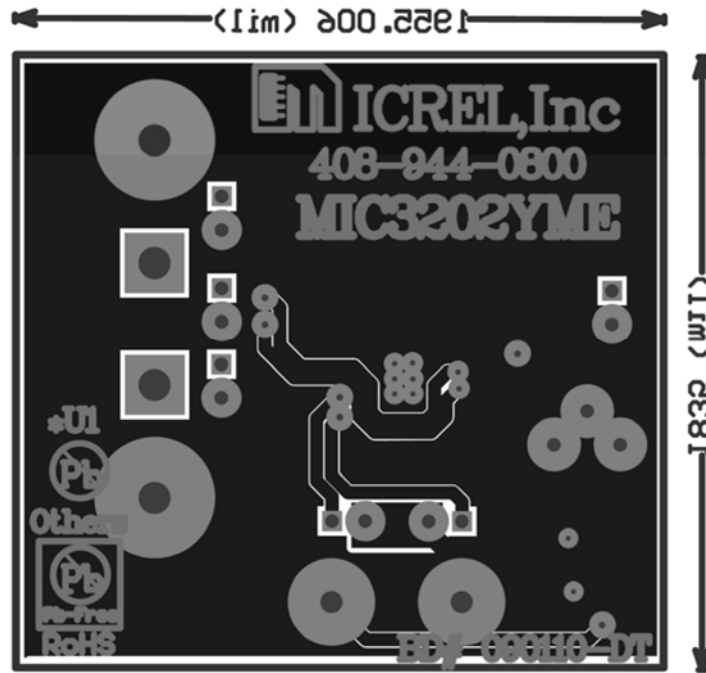


Top Assembly



Top Layer

**PCB Layout Recommendations (Continued)**



**Bottom Layer**

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