MIC3205 Evaluation Board

High-Brightness LED Driver Controller with Fixed-Frequency Hysteretic Control

General Description

The MIC3205 is a hysteretic, step-down, high-brightness LED (HB LED) driver with a patent pending frequency regulation scheme that maintains a constant operating frequency over input voltage range. It provides an ideal solution for interior/exterior lighting, architectural and ambient lighting, LED bulbs, and other general illumination applications.

The board is optimized for ease of testing, with all of the components on a single side. The device operates from a 4.5V to 40V input voltage range, and controls an external power MOSFET to drive high-current LEDs. On-board components are set up to evaluate one 1A current rating LED, at a switching frequency of approximately 400 kHz. To evaluate a different number of LEDs or different current rating LEDs, component values must be changed as explained in the Application Information section of the MIC3205 data sheet.

Requirements

This board needs a single bench power source adjustable over the input voltage of 4.5V < V_{IN} < 40V that can provide at least 1A of current. The loads can either be active (electronic load) or passive (LEDs) with the ability to dissipate the maximum load power while keeping accessible surfaces ideally < 70°C.

Precautions

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

Under extreme load conditions, input transients can be quite large if long test leads are used. In such cases, a 100µF, 63V electrolytic capacitor is needed at the V_{IN} terminals to prevent overvoltage damage to the IC.

Datasheets and support documentation can be found on Micrel's web site at: www.micrel.com.

Getting Started

1. **Connect V_{IN} supply to the input terminals VIN and GND**.

   Connect a supply between the VIN terminal (J1) and the GND terminal (J2), paying careful attention to polarity and supply range (4.5V < V_{IN} < 40V). Monitor I_{IN} with a current meter and V_{IN} at the VIN and GND terminals with a voltmeter. Don't apply power until step 4.

2. **Connect the load to the output terminals, LED+ and LED–.**

   Connect a load between the LED+ (J5) and LED– (J6) terminals. The load can be either one 1A rated LED or an active, electronic load. Make sure to connect the anode of the 1A LED to the LED+ terminal and the cathode to the LED– terminal.

3. **Enable input.**

   The MIC3205YML EV board comes with a 100kΩ pull-up resistor to VIN. A jumper (JP6) is provided on board for users to easily access the enable feature. Applying an external logic signal on the EN pin to pull it low or using a jumper to short the EN pin to GND shuts off the output of the evaluation board.

4. **Turn ON the input supply.**

   By default, the controller is enabled when the input voltage approaches the UVLO threshold and crosses 5V, the internal 5V V_{CC} is regulated, and the external MOSFET is turned ON if the EN pin and the DIM pin are high. To use the EN and DIM functions of the MIC3205, a test point is provided for each of them.

Ordering Information

Part Number	Description
MIC3205YML EV	Evaluation board with MIC3205YML device

Evaluation Board Features

EN Input

The EN pin provides a logic level control of the output. The voltage must 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 into an off state and the supply current of the device is reduced to 1µA. A logic low pulls down the DRV pin, turning off the external MOSFET. Do not drive the EN pin above the supply voltage. Do not leave floating. R8 is provided for default "ON."

DIM Input

The DIM pin provides logic level control for the brightness of the LED. The DIM pin can turn the LEDs on and off if EN is in an active-high state. The MIC3205YML EV board comes with a 100kΩ pull-up resistor installed (R5). R5 provides default 100% brightness. LED brightness can be controlled by varying the duty cycle, on the DIM input, from 1% to 99%. Do not leave floating.

LED Current and R_{CS}

The CS and VINS pins provide the high-side current sense to set the LED current with an external sense resistor R_{CS}. The MIC3205YML EV board comes with a 200mΩ R_{CS} resistor installed as the default value, which corresponds to an LED current rating of 1A. The following equation gives the R_{CS} value for required LED current:

$$R_{CS} = \frac{200mV}{I_{LED}} \qquad \text{Eq. 1}$$

For more information, please see the LED Current and R_{CS} subsection in the Application Information section of the MIC3205 data sheet.

Operating Frequency

The operating switching frequency can be programmed by installing an external capacitor from the CTIMER pin to AGND.

$$F_{SW} = \frac{2.22 \times 10^{-4}}{C_T} \qquad \text{Eq. 2}$$

The MIC3205YML EV board comes with a 470pF C_T capacitor (C10) installed for default 400kHz frequency. For more information, please see the Frequency of Operation subsection in the Application Information section of the MIC3205 datasheet.

Inductor

The inductor value can be calculated after average LED current, operating frequency, and an appropriate hysteresis ΔV_{HYS} value have been chosen. The MIC3205YML EV board comes with a 22µH inductor installed.

Inductor L is given by:

$$L = \frac{(V_{IN} - I_{LED} \times R_{CS} - V_{LED}) \times (V_D + I_{LED} \times R_{CS} + V_{LED}) \times R_{CS}}{(V_{IN} + V_D) \times \Delta V_{HYS} \times F_{SW}} \qquad \text{Eq. 3}$$

where:

V_{LED} is the total voltage drop of the LED string

V_{IN} is the input voltage

R_{CS} is the current sense resistor

I_{LED} is the average LED current

V_D is the freewheeling diode forward drop

F_{SW} is the operating switching frequency

ΔV_{HYS} is the hysteresis on the CS pin

L is the inductor value

Tables 1, 2, and 3 give reference inductor values for an operating frequency of 400 kHz, for a given LED current, freewheeling diode forward drop, and number of LEDs. By selecting ΔV_{HYS} in the 55mV to 75mV range, we get the following inductor values:

R_{CS} (Ω)	I_{LED} (A)	V_{IN} (V)	L (µH)	ΔV_{HYS} (mV)
0.56	0.35	5	22	64.1
0.56	0.35	12	68	57.7
0.28	0.7	5	10	70.5
0.28	0.7	12	33	59.4
0.2	1.0	5	6.8	72.6
0.2	1.0	12	22	62.4
0.1	2.0	5	3.6	68.5
0.1	2.0	12	10	68.6

Table 1. Inductor for F_{SW} = 400 kHz, V_D = 0.4V, 1 LED

R_{CS} (Ω)	I_{LED} (A)	V_{IN} (V)	L (µH)	ΔV_{HYS} (mV)
0.56	0.35	24	150	55.8
0.56	0.35	36	220	56.8
0.28	0.7	24	68	61.6
0.28	0.7	36	100	62.5
0.2	1.0	24	47	62.4
0.2	1.0	36	68	64.3
0.1	2.0	24	22	66.6
0.1	2.0	36	33	66.2

Table 2. Inductor for F_{SW} = 400 kHz, V_D = 0.4V, 4 LEDs

R_{CS} (Ω)	I_{LED} (A)	V_{IN} (V)	L (µH)	ΔV_{HYS} (mV)
0.56	0.35	36	150	58.4
0.56	0.35	40	220	54.3
0.28	0.7	36	68	64.4
0.28	0.7	40	100	59.6
0.2	1.0	36	47	65.2
0.2	1.0	40	68	61.4
0.1	2.0	36	22	69.6
0.1	2.0	40	33	63.3

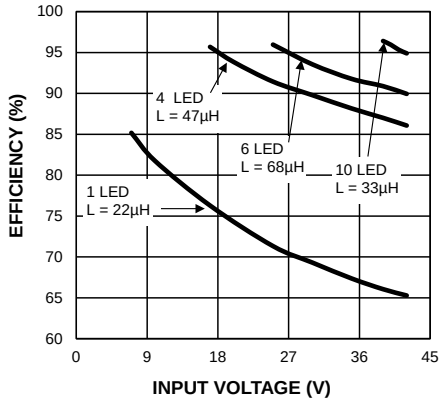
Table 3. Inductor for F_{SW} = 400 kHz, V_D = 0.4V, 8 LEDs

The MIC3205YML EV board is set up for evaluation for one 1A LED. If more LEDs are required, the inductor value must be recalculated. If a different operating switching frequency is desired, the C_T capacitor value must be recalculated. If LEDs with a current rating other than 1A need to be evaluated, the R_{CS} value must be recalculated.

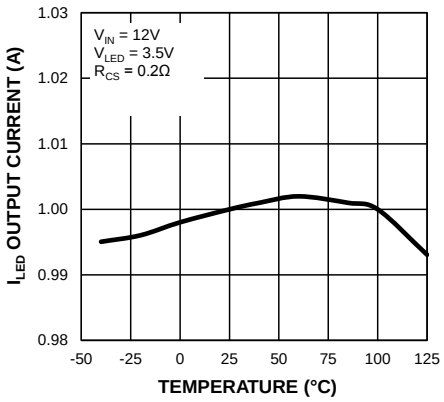
The LED voltage drop depends on the manufacturer tolerance and number of LEDs. The LED current can be measured using an ammeter or current probe. The 4.7µF ceramic capacitor between the LED+ and LED– terminals is highly recommended, as it helps to reduce the current ripple through the LED.

Evaluation Board Performance (Typical Characteristics)

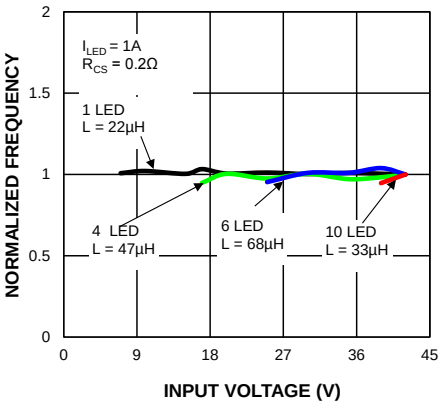
Efficiency (I_{LED} = 1A) vs. Input Voltage



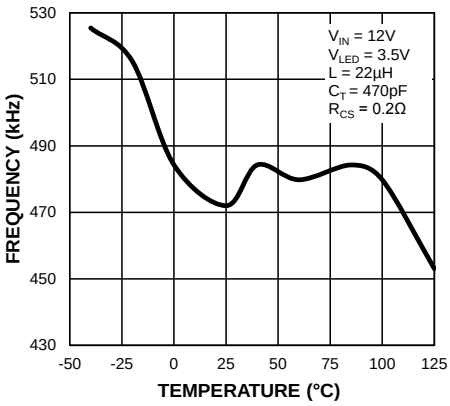
I_{LED} Output Current vs. Temperature



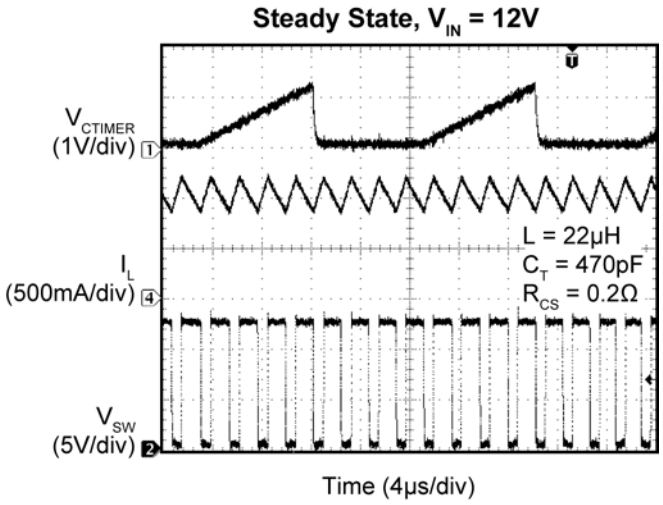
Normalized Switching Frequency vs. Input Voltage

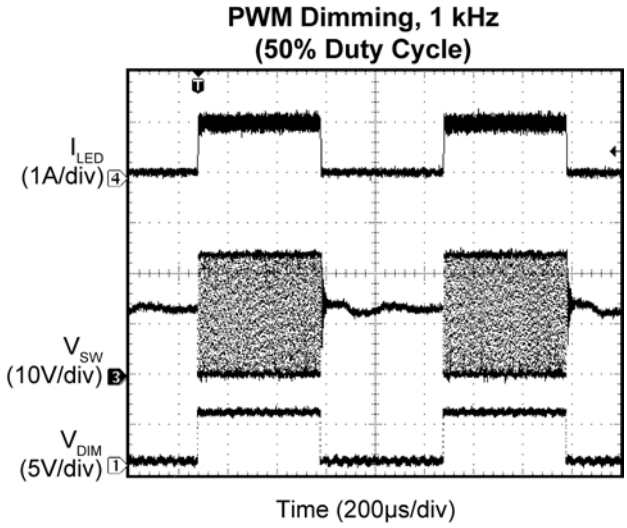


Switching Frequency vs. Temperature

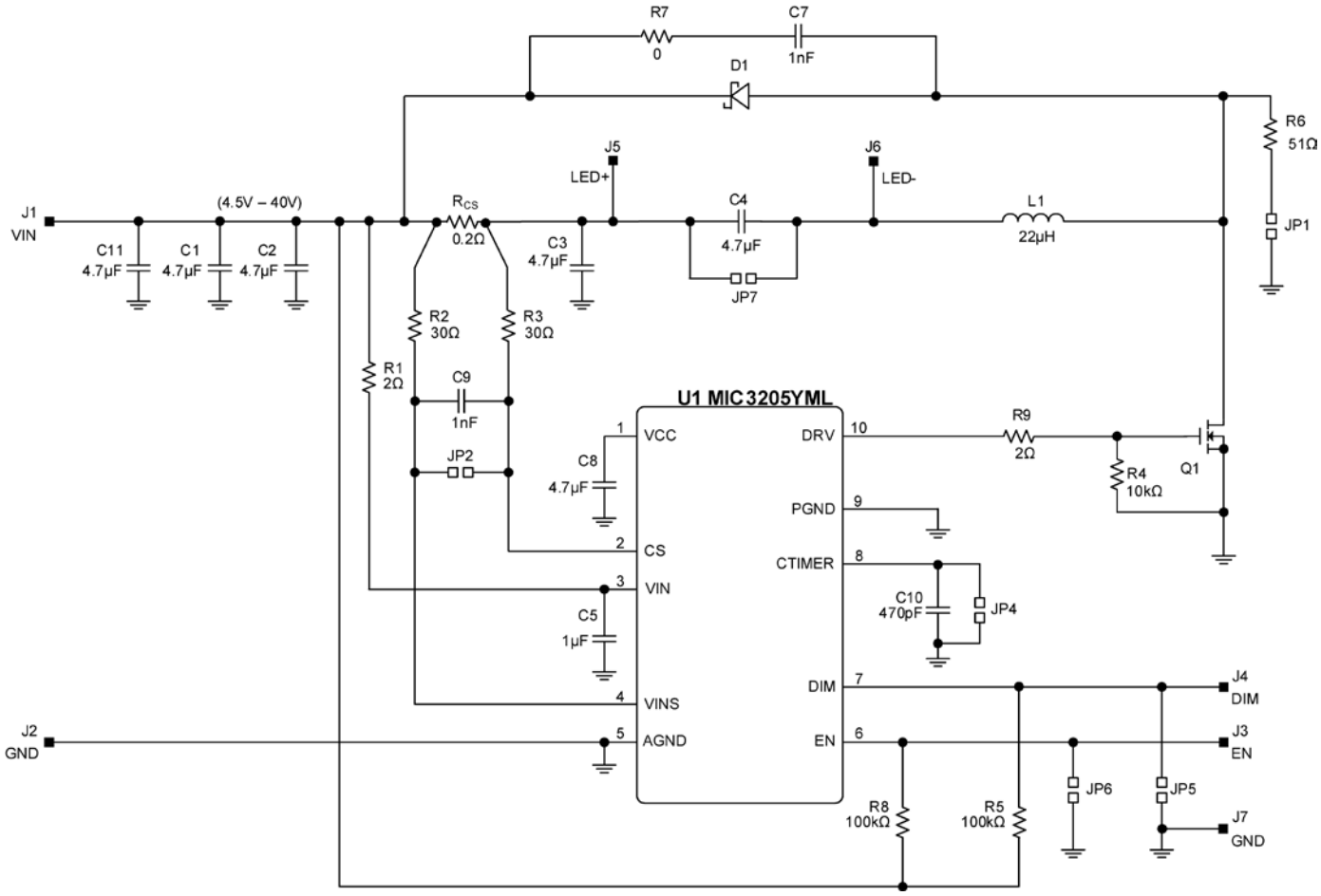


Evaluation Board Performance (Functional Characteristics)





Evaluation Board Schematic



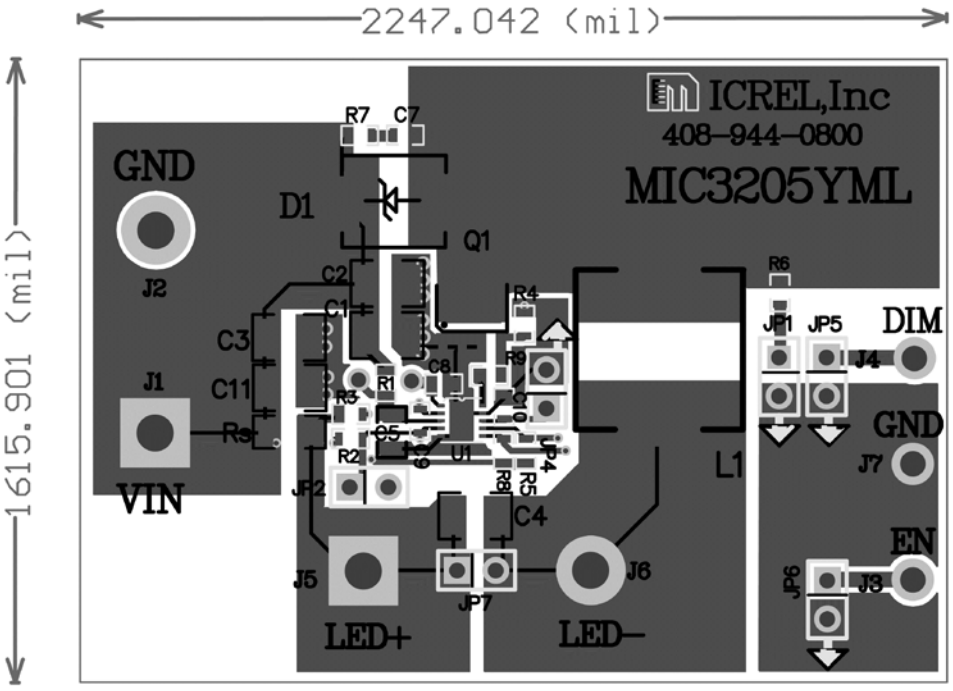
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2,C3,C4,C11	12105C475KAZ2A	AVX[1]	4.7µF/50V, Ceramic Capacitor, X7R, Size 1210	5
	GRM32ER71H475KA88L	Murata[2]		
	CGA6P3X7R1H475K	TDK[3]		
C5	GRM21BR71H105KA12L	Murata	1µF/50V, Ceramic Capacitor, X7R, Size 0805	1
	CGA4J3X7R1H105K	TDK		
C10	06035C471K4T2A	AVX	470pF/50V, Ceramic Capacitor, X7R, Size 0603	1
	GRM188R71H471KA01D	Murata		
	C1608X7R1H471K	TDK		
C8	06036D475KAT2A	AVX	4.7µF/6.3V, Ceramic Capacitor, X5R, Size 0603	1
	GRM188R60J475KE19J	Murata		
	CGA3E1X5R0J475K	TDK		
C7,C9	06035C102KAT2A	AVX	1nF/50V, Ceramic Capacitor, X7R, Size 0603	2
	GRM188R71H102KA01D	Murata		
	C1608X7R1H102K	TDK		
D1	SK36-TP	MCC[4]	60V, 3A, SMC, Schottky Diode	1
	SK36	Fairchild[5]		
	SK36-7-F	Diodes, Inc.[6]		
L1	SLF10145T-220M1R9-PF	TDK	22µH, 2.1A, 0.0591Ω, SMT, Power Inductor	1
M1	FDS5672	Fairchild	MOSFET, N-CH, 60V, 12A, SO-8	1
R_{CS}	CSR1206FKR200	Stackpole Electronics, Inc.[7]	0.2Ω Resistor, 1/2W, 1%, Size 1206	1
R5, R8	CRCW0603100KFKEA	Vishay Dale[8]	100kΩ Resistor, 1%, Size 0603	2
R2, R3	CRCW060330R0FKEA	Vishay Dale	30Ω Resistor, 1%, Size 0603	2
R1, R9	CRCW06032R00FKEA	Vishay Dale	2Ω Resistor, 1%, Size 0603	2
R4	CRCW060310K0FKEA	Vishay Dale	10kΩ Resistor, 1%, Size 0603	1
R6	CRCW060351R0FKEA	Vishay Dale	51Ω Resistor, 1%, Size 0603	1
R7	CRCW06030000Z0EA	Vishay Dale	0Ω Resistor, Size 0603	1
U1	**MIC3205YML**	**Micrel, Inc.[9]**	**High-Brightness LED Driver Controller with Fixed-Frequency Hysteretic Control**	1

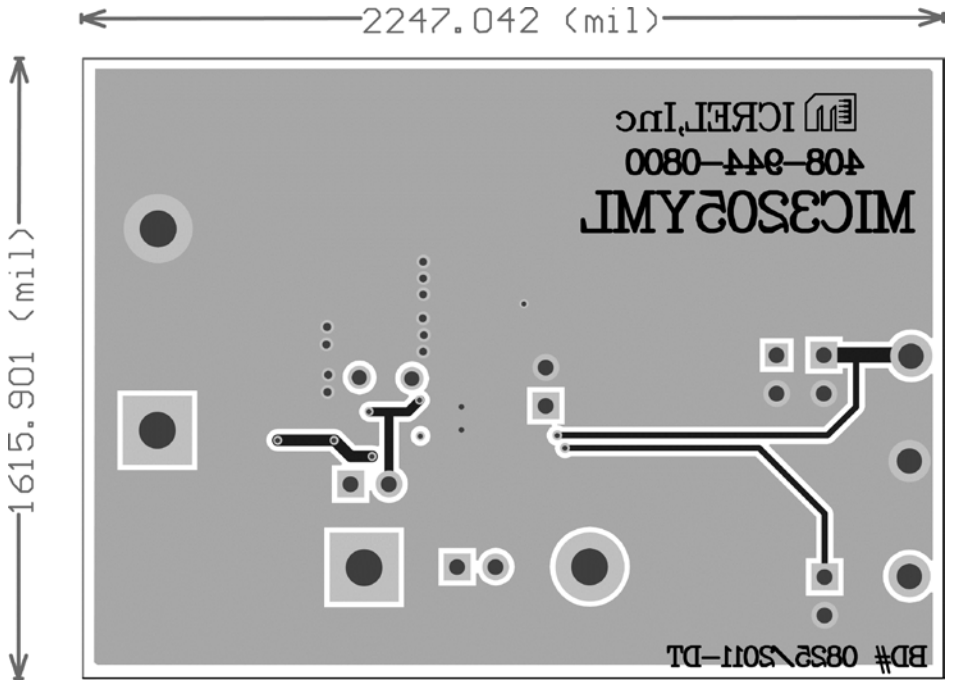
Notes:

1. AVX: www.avx.com.
2. Murata: www.murata.com.
3. TDK: www.tdk.com.
4. MCC: www.mccsemi.com.
5. Fairchild: www.fairchildsemi.com.
6. Diodes Inc.: www.diodes.com.
7. Stackpole Electronics: www.seielect.com.
8. Vishay Dale: www.vishay.com.
9. **Micrel, Inc.: www.micrel.com.**

PCB Layout Recommendations



Top Layer



Bottom Layer

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