



MIC23050 Evaluation Board

4MHz PWM Buck Regulator with HyperLight Load[®]

General Description

Micrel's MIC23050 is a 500mA 4MHz switching regulator with HyperLight Load[®] mode. The MIC23050 is highly efficient throughout the load range and only draws 20 μ A of quiescent current. Sub-1mm solution is easily obtainable using the tiny package (2mm x 2mm x 0.85mm) MIC23050, which only requires four external components. Small and fast, the MIC23050 can respond to a load transient at ultra fast speed while reducing output peak-to-peak voltage.

The MIC23050 has two modes of operation that is automatically selected by the internal circuitry. Under light load conditions from 1mA to 50mA, the MIC23050 goes into HyperLight Load mode. The MIC23050 HyperLight Load uses a Pulse-Frequency Modulation (PFM) control scheme that controls the off time at light load and keeps constant switching frequency in continuous mode. This allows the device to reduce the amount of switching needed at light loads, thus reducing the switching losses. The MIC23050 can attain 85% efficiency at 1mA output load. When the load is more than 50mA, HyperLight Load automatically switches back to Pulse-Width Modulation (PWM) mode to ensure high efficiency at higher loads. The two modes of operation ensure that the MIC23050 maintains the highest efficiency throughout the load range.

The MIC23050 operates from a 2.7V to 5.5V input and features internal power MOSFETs that can supply up to 500mA of output current. It can operate with a maximum duty cycle of 90%.

Requirements

The MIC23050 evaluation board requires an input power source that is able to deliver greater than 650mA at 2.7V. The output load can either be an active or passive source.

Getting Started

1. **Connect an external supply to the V_{IN} (J1) terminal.** Apply desired input voltage to the V_{IN} (J1) and ground (J2 and J4) terminals of the evaluation board, paying careful attention to polarity and supply voltage ($2.7V \leq V_{IN} \leq 5.5V$). An ammeter may be placed between the input supply and the V_{IN} (J1) terminal to the evaluation board. Be sure to monitor that supply voltage at the V_{IN} (J1) terminal. The ammeter and/or power lead resistance can reduce the voltage supplied to the input.
2. **Connect a load to the V_O (J3) output and ground terminal.** The load can be either passive (resistive) or active (electronic load). An ammeter can be placed between the load and the output terminal. Ensure that the output voltage is monitored at the V_O (J3) terminal.
3. **Enable the MIC23050.** Apply a 1.2V or greater voltage source to the enable pin (EN). Be sure that the enable voltage does not exceed the input voltage by more than 0.5V.

Output Voltage

The MIC23050 evaluation board has four fixed voltage options available.

Ordering Information

Part Number	Description
MIC23050-CYML EV	1.0V Output Evaluation Board
MIC23050-4YML EV	1.2V Output Evaluation Board
MIC23050-GYML EV	1.8V Output Evaluation Board
MIC23050-SYML EV	3.3V Output Evaluation Board

HyperLight Load is a registered trademark of Micrel, Inc.

Micrel Inc. • 2180 Fortune Drive • San Jose, CA 95131 • USA • tel +1 (408) 944-0800 • fax + 1 (408) 474-1000 • <http://www.micrel.com>

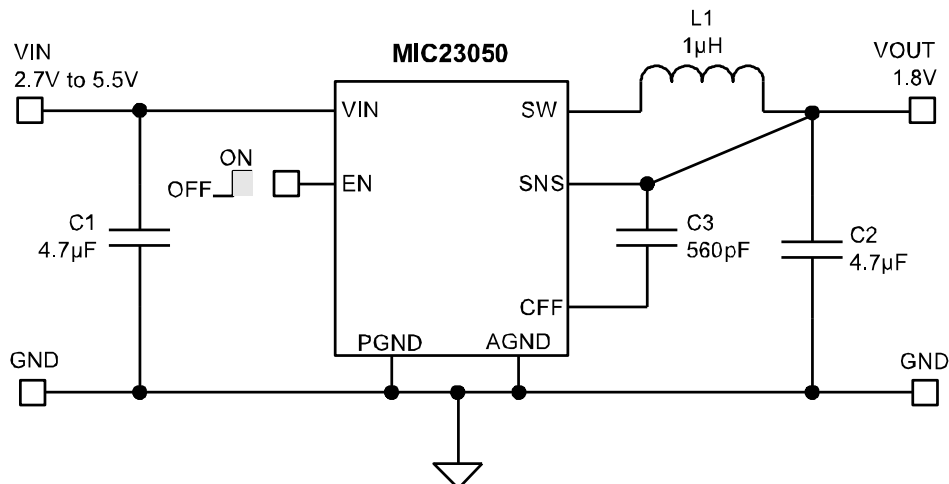
HyperLight Load Mode

MIC23050 uses a minimum on and off time proprietary control loop. When the output voltage falls below the regulation threshold, the error comparator begins a switching cycle that turns the PMOS on and keeps it on for the duration of the minimum-on-time. When the output voltage is over the regulation threshold, the error comparator turns the PMOS off for a minimum-off-time. The NMOS acts as an ideal rectifier that conducts when the PMOS is off. Using a NMOS switch instead of a diode allows for lower voltage drop across the switching device when it is on. The asynchronous switching combination between the PMOS and the NMOS allows the control loop to work in discontinuous mode for light

load operations. In discontinuous mode MIC23050 works in pulse frequency modulation (PFM) to regulate the output. As the output current increases, the switching frequency increases. This improves the efficiency of MIC23050 during light load currents. As the load current increases, the MIC23050 goes into continuous conduction mode (CCM) at a constant frequency of 4MHz. The equation to calculate the load when the MIC23050 goes into continuous conduction mode may be approximated by the following formula:

$$I_{LOAD} = \left(\frac{(V_{IN} - V_{OUT}) \times D}{2L \times f} \right)$$

MIC23050 Typical Circuit (1.8V)



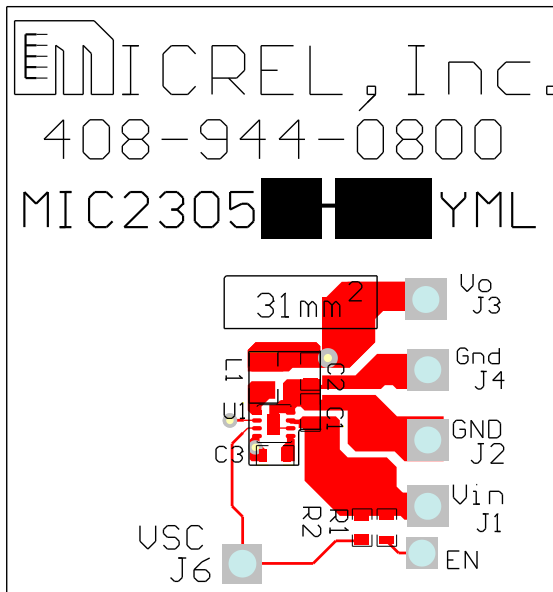
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty
C1, C2	C1608X5R0J476K	TDK ⁽¹⁾	4.7µF Ceramic Capacitor, 6.3V, X5R, Size 0603	2
C3	C1005X5R0J476K	Murata ⁽²⁾	560pF Ceramic Capacitor, 6.3V, X5R, Size 0402	1
L1	LQM21PN1R0M00	Murata ⁽²⁾	1µH, 0.8A, 190mΩ, L2mm x W1.25mm x H0.5mm	1
	LQH32CNR1R0M33	Murata ⁽²⁾	1µH, 1A, 60mΩ, L3.2mm x W2.5mm x H2.0mm	
	LQM31P1R0M00	Murata ⁽²⁾	1µH, 1.2A, 120mΩ, L3.2mm x W1.6mm x H0.95mm	
	GFL251812T	TDK ⁽¹⁾	1µH, 0.8A, 100mΩ, L2.5mm x W1.8mm x H1.35mm	
	LQM31PNR47M00	Murata ⁽²⁾	0.47µH, 1.4A, 80mΩ, L3.2mm x W1.6mm x H0.85mm	
	MIPF2520D1R5	FDK ⁽³⁾	1.5µH, 1.5A, 70mΩ, L2.5mm x W2mm x H1.0mm	
U1	MIC23050-GYML	Micrel, Inc. ⁽⁴⁾	4MHz PWM Buck Regulator with HyperLight Load Mode	1

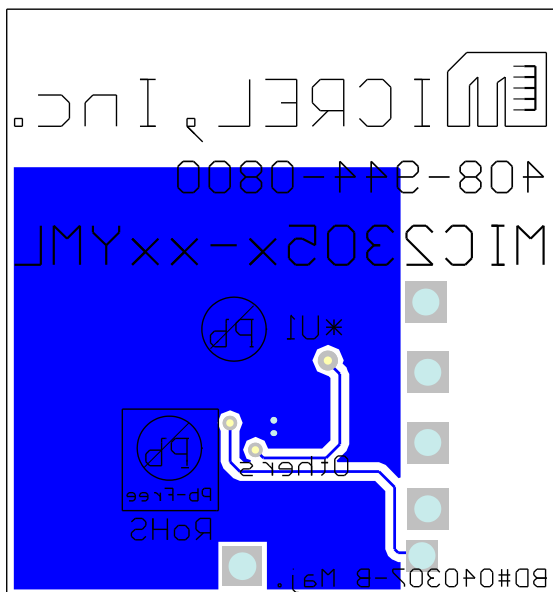
Notes:

1. TDK: www.tdk.com
2. Murata: www.murata.com
3. FDK: www.fdk.co.jp
4. Micrel, Inc: www.micrel.com

PCB Layout Recommendations



Top Layer



Bottom Layer

MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA
TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB <http://www.micrel.com>

The information furnished by Micrel in this data sheet is believed to be accurate and reliable. However, no responsibility is assumed by Micrel for its use. Micrel reserves the right to change circuitry and specifications at any time without notification to the customer.

Micrel Products are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user. A Purchaser's use or sale of Micrel Products for use in life support appliances, devices or systems is a Purchaser's own risk and Purchaser agrees to fully indemnify Micrel for any damages resulting from such use or sale.

© 2014 Micrel, Incorporated.