



MIC23163/4 Evaluation Board

4MHz PWM 2A Buck Regulator with
HyperLight Load[®] and Power Good

General Description

The MIC23163/4 evaluation board allows the customer to evaluate a fully-integrated 2A, 4MHz synchronous buck regulator that features HyperLight Load[®] mode, a Power Good output indicator, and programmable soft-start. The MIC23163/4 is highly efficient throughout the output current range. The tiny 2mm x 2mm DFN package, in combination with the 4MHz switching frequency, provides a compact sub-1mm height solution that requires few external components. The MIC23163/4 has a maximum 100% duty cycle and incorporates an active discharge feature. It provides accurate output voltage regulation under the most demanding conditions and responds extremely quickly to a load transient with exceptionally small output voltage ripple.

Requirements

The MIC23156 evaluation board requires a single 15W bench power source adjustable from 2.7V to 5.5V. The loads can either be active (electronic load) or passive (resistor), and must be able to dissipate 10W. It is ideal, but not essential, to have an oscilloscope available to view the circuit waveforms. The simplest tests require two voltage meters to measure input and output voltages. Efficiency measurements require two voltage meters and two ammeters to prevent errors caused by measurement inaccuracies.

Precautions

There is no reverse input protection on this board. Be careful when connecting the input source to ensure correct polarity is observed.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

Getting Started

1. Connect an external supply to the V_{IN} (J4) and GND (J3) terminals.

With the output of the power supply disabled, set its voltage to the desired input test voltage ($2.7V \leq V_{IN} \leq 5.5V$). An ammeter may be placed between the input supply and the V_{IN} (J4) terminal. Be sure to monitor the supply voltage at the V_{IN} (J4) terminal, as the ammeter and/or power lead resistance can reduce the voltage supplied to the device.

2. Connect a load to the V_{OUT} (J1) and GND (J2) terminals.

The load can be either passive (resistive) or active (electronic load). An ammeter may be placed between the load and the output terminal. Make sure the output voltage is monitored at the V_{OUT} (J1) terminal.

3. Enable the MIC23163/4.

The MIC23163/4 evaluation board has a pull-up resistor to V_{IN}. By default, the output voltage is enabled when the input supply of >2.7V is applied. To disable the device, apply a voltage below 0.5V to the EN (J6) terminal.

4. Power Good.

A PG test point (J5) is provided to monitor the Power Good feature. The Power Good output will go high (V_{OUT}) approximately 90 μ s after the output voltage reaches 92% of its nominal voltage.

Ordering Information

Part Number	Description
MIC23163YMT EV	MIC23163 Evaluation Board
MIC23164YMT EV	MIC23164 Evaluation Board

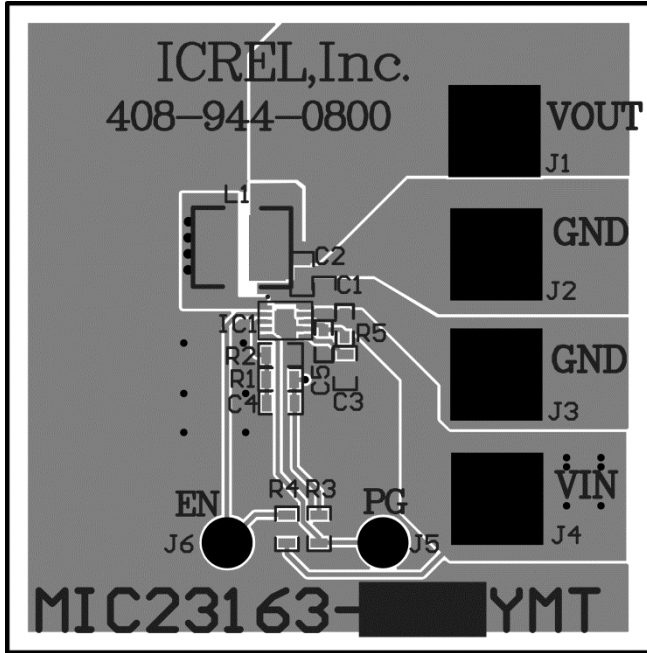
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Evaluation Board



Features

Soft-Start Capacitor (C3)

The soft start (SS) pin is used to control the output voltage ramp-up time. Setting C3 to 1nF sets the start-up time to the minimum. The start-up time can be determined by Equation 1:

$$T_{SS} = 250 \times 10^3 \times \ln(10) \times C_{SS} \quad \text{Eq. 1}$$

The action of the soft-start capacitor is to control the rise time of the internal reference voltage between 0% and 100% of its nominal steady state value.

Feedback Resistors (R1, R2)

The output voltage is set nominally to 1.8V. This output can be changed by adjusting the upper resistor, R1, in the feedback potential divider. Therefore:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R1}{R2} \right)$$

Where $V_{REF} = 0.7V$

Table 1. Example Feedback Resistor Values

V _{OUT}	R1	R2
1.2V	215k	301k
1.5V	301k	261k
1.8V	340k	215k
2.5V	274k	107k
3.3V	383k	102k

The feedforward capacitor, C4, provides essential compensation for the MIC23163/4. A typical value range of 15pF to 68pF is recommended.

Power Good (PG)

The evaluation board has a test point provided for testing the Power Good feature. This is an open-drain connection with an on-board pull-up resistor of 100kΩ to the output voltage. Power Good is asserted high approximately 90μs after the output voltage passes 92% of the nominal set voltage.

HyperLight Load Mode

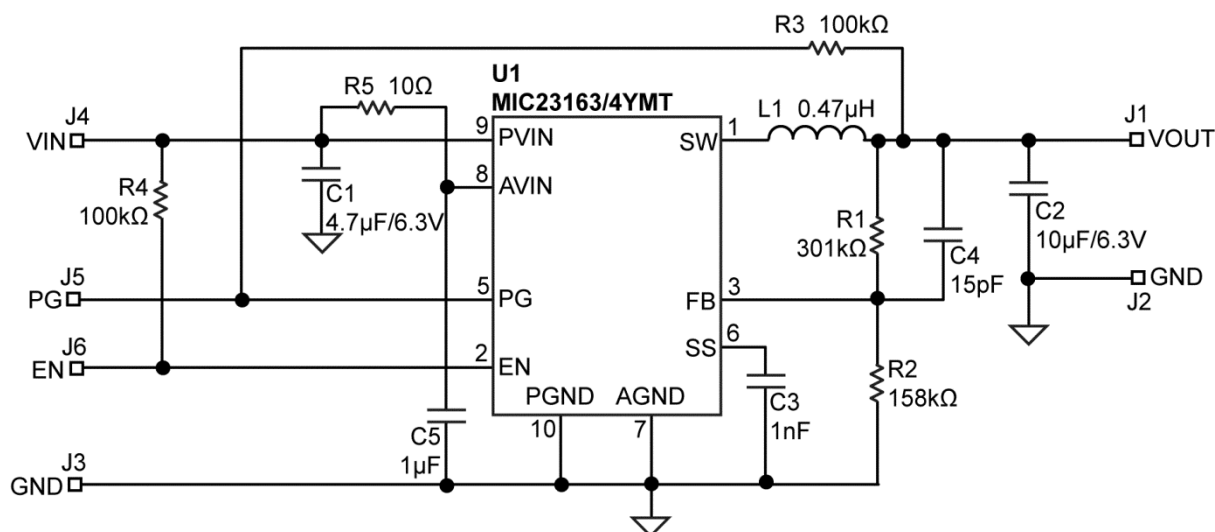
MIC23156 uses a minimum on and off time proprietary control loop (patented by Micrel). When the output voltage falls below the regulation threshold, the error comparator begins a switching cycle that turns the PMOS on and keeps it on for the duration of the minimum-on-time. This increases the output voltage. If the output voltage is more than the regulation threshold, then the error comparator turns the PMOS off for a minimum-off-time until the output drops below the threshold. The NMOS acts as an ideal rectifier that conducts when the PMOS is off. Using an NMOS switch instead of a diode allows for lower voltage drop across the switching device when the NMOS 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, the MIC23163/4 works in pulse frequency modulation (PFM) to regulate the output. As the output current increases, the off-time decreases. This provides more energy to the output. This switching scheme improves the efficiency of MIC231563/4 during light load currents by only switching when it is needed.

As the load current increases, the MIC23163/4 goes into continuous conduction mode (CCM) and switches at a frequency centered at 4MHz. The f to calculate the load when the MIC23163/4 goes into continuous conduction mode is approximated by Equation 2:

$$I_{LOAD} > \left(\frac{(V_{IN} - V_{OUT}) \times D}{2L \times f} \right) \quad \text{Eq. 2}$$

As shown in Equation 2, the load at which MIC23163/4 transitions from HyperLight Load mode to PWM mode is a function of the input voltage (V_{IN}), output voltage (V_{OUT}), duty cycle (D), inductance (L), and frequency (f).

Evaluation Board Schematic



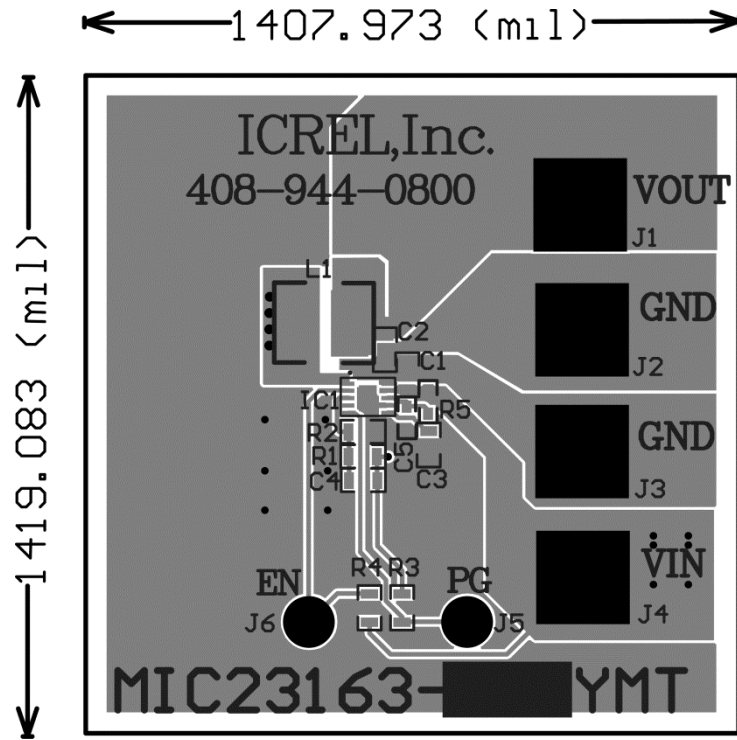
Bill of Materials

Item	Part Name	Manufacturer	Description	Qty.
C1	C1608X5R0J475K	TDK ⁽¹⁾	4.7μF, 6.3V, X5R, Size 0603	1
	GRM188R60J475KE19D	Murata ⁽²⁾		
C2	C1608X5R0J106K080AB	TDK	10μF, 6.3V, X5R, Size 0603	1
	GRM188R60J106ME84D	Murata		
C3	GRM188R71H102MA01D	Murata	1nF/50V, X7R, 0603	1
	06035C102KAT2A	AVX ⁽³⁾		
C4	06035A150KAT2A	AVX	15pF, 50V, 0603	1
	GRM1885C1H150JA01D	Murata		
C5	C1608X7R1A105K	TDK	1μF, 10V, X7R, Size 0603	1
	GRM188R71A105KA61D	Murata		
L1	FLF3215T-R47N	TDK	0.47μH, 2.8A, 21mΩ, L3.2mm x W2.5mm x H1.55mm	1
	LQH32PNNR47NNC	Murata	0.47μH, 2.9A, 24mΩ, L3.2mm x W2.5mm x H1.55mm	
R1	CRCW0603301KFKEA	Vishay ⁽⁴⁾	301kΩ, 1%, 1/10W, Size 0603	1
R2	CRCW0603158KFKEA	Vishay	158kΩ, 1%, 1/10W, Size 0603	1
R3, R4	CRCW0603100KFKEA	Vishay	100kΩ, 1%, 1/10W, Size 0603	1
R5	CRCW060310R0FKEA	Vishay	10Ω, 1%, 1/10W, Size 0603	1
U1	MIC23163YMT	Micrel, Inc. ⁽⁵⁾	4MHz 2A Adjustable Buck Regulator with HyperLight Load Mode	1

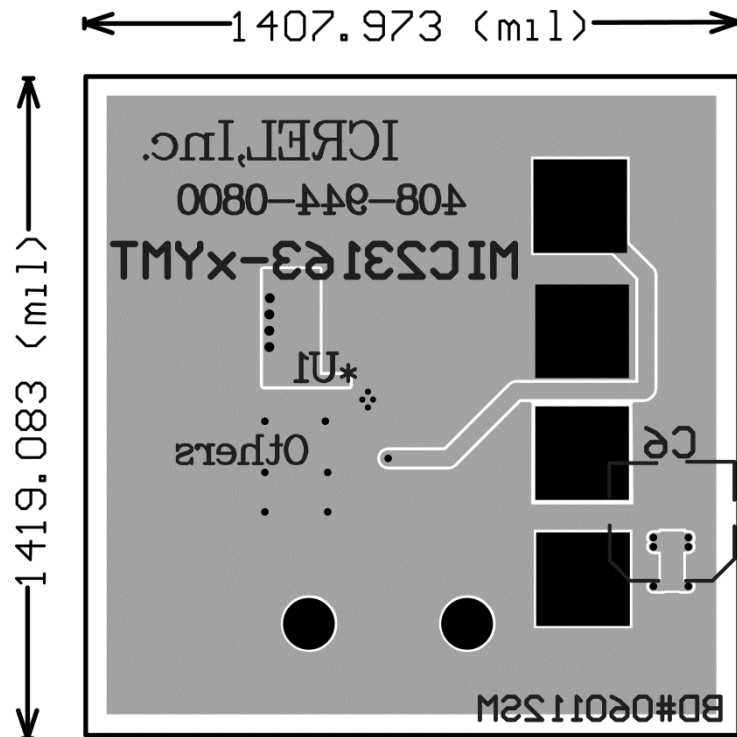
Notes:

1. TDK: www.tdk.com.
2. Murata: www.murata.com.
3. AVX: www.avx.com.
4. Vishay: www.vishay.com.
5. Micrel, Inc.: www.micrel.com.

PCB Layout Recommendations



Top Layer



Bottom Layer

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