MIC33153 Evaluation Board

4MHz 1.2A PWM Buck Regulator with HyperLight Load™ and Power Good

General Description

This board enables the evaluation of the MIC33153, a fully integrated 1.2A, 4MHz switching regulator featuring HyperLight Load™ mode, Power Good (PG) output indicator, and programmable soft start. The MIC33153 is highly efficient throughout the entire output current range, drawing just 22µA of quiescent current in operation. The tiny 3.5mm x 3.0mm x 0.9mm MLF® package, in combination with the 4MHz switching frequency, enables a compact sub 1mm height solution with only two external input and output capacitors. The MIC33153 provides accurate output voltage regulation under the most demanding conditions and responds extremely quickly to a load transient with exceptionally small output voltage ripple.

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

Requirements

This board needs a single 5W bench power source adjustable from 2.7V to 5.5V. The loads can either be active (electronic load) or passive (resistor) with the capability to dissipate 5W. It is ideal to have an oscilloscope available to view the circuit waveforms, but not essential. For the simplest tests two voltage meters are required to measure input and output voltage. For efficiency measurements two voltage meters and two ammeters are required to prevent errors due to measurement inaccuracies.

Precautions

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

Getting Started

1. **Connect an external supply to the V_{IN} (TP4) terminal and GND (TP3)**. With the output of the power supply disabled, set its voltage to the desired input test voltage (2.7V ≤ V_{IN} ≤ 5.5V). An ammeter may be placed between the input supply and the V_{IN} (TP4) terminal. Be sure to monitor the supply voltage at the V_{IN} (TP4) 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} (TP1) and ground (TP 2) terminals**. The load can be either active passive (resistive) or active (electronic load). An ammeter may be placed between the load and the output terminal. Ensure the output voltage is monitored at the V_{OUT} (TP1) terminal.
3. **Enable the MIC33153**. The MIC33153 evaluation board has a pull up resistor (R4) to V_{IN}. By default, the output voltage will be enabled when the input supply of >2.7V is applied. To disable the device, apply a voltage below 0.5V to the EN (TP6) terminal.
4. **Power Good (PG)**. A PG test point (TP5) is provided to monitor the Power Good function. The PG output will go high (V_{OUT}) approximately 70µs after the output voltage reaches 92% of its nominal voltage.

Ordering Information

Part Number	Description
MIC33153-4YHJ	1.2V Fixed Output Evaluation Board
MIC33153YHJ	Adjustable Output Evaluation Board

HyperLight Load is a trademark of Micrel, Inc.
MLF and *Micro*LeadFrame are trademarks of Amkor Technology, Inc.

Soft start Capacitor

The MIC33153 has a nominal 270kΩ resistor charging the capacitor on the SS pin. This enables the output to follow a controlled soft start characteristic. Setting C3 to 100pF sets the startup time to the minimum. The startup time can be determined by:

$$T_{SS} = 270 \times 10^3 \times \ln(10) \times C_{SS}$$

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) for Adjustable Output

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:

$$R1 = R2 \times V_{REF}/(V_O - V_{REF})$$

where V_{REF} = 0.62V.

Some example values are:

V_{OUT}	R1	R2
1.2V	274k	294k
1.5V	316k	221k
1.8V	301k	158k
2.5V	324k	107k
3.3V	309k	71.5k

The feed forward capacitor, C4, is typically not fitted given that transient load regulation is already very good. However, it can be improved slightly by fitting a capacitor at C4 to inject fast output voltage deviations directly into the feedback comparator. This improved load regulation occurs at the expense of slightly increasing the amount of noise on the output at higher loads. Values between 100pF and 1nF are recommended to prevent instability.

Power Good (PG)

The evaluation board has a test point provided to the right of EN for testing PG. This is an open drain connection with an on board pull up resistor of 10k to the output voltage. This is asserted high approximately 70µs after the output voltage passes 92% of the nominal set voltage.

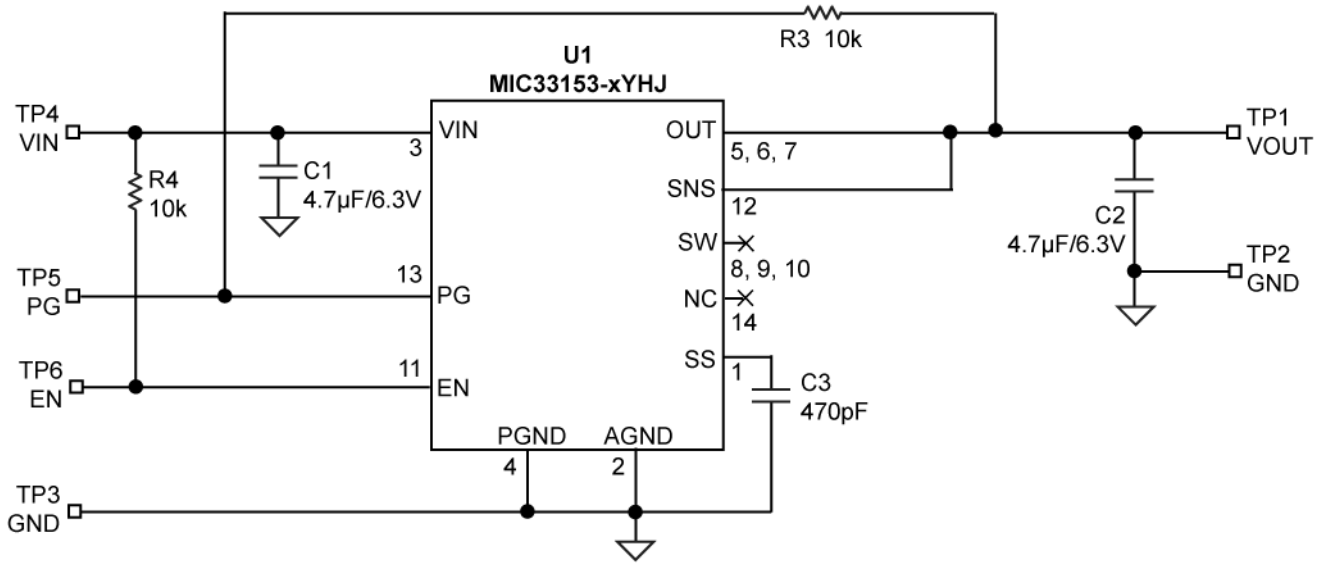
HyperLight Load™ Mode

The MIC33153 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 over 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 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, the MIC33153 works in pulse frequency modulation (PFM) to regulate the output. As the output current increases, the off time decreases, thus provides more energy to the output. This switching scheme improves the efficiency of MIC33153 during light load currents by only switching when it is needed. As the load current increases, the MIC33153 goes into continuous conduction mode (CCM) and switches at a frequency centered at 4MHz. The equation to calculate the load when the MIC33153 goes into continuous conduction mode may be approximated by the following formula:

$$I_{LOAD} > \frac{(V_{IN} \quad V_{OUT}) \times D}{2L \times f}$$

As shown in the above equation, the load at which MIC33153 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). For example, if V_{IN} = 3.6V, V_{OUT} = 1.8V, D = 0.5, f = 4MHz and the internal inductance of MIC33153 is 0.47µH, then the device will enter HyperLight Load™ mode or PWM mode at approximately 200mA.

MIC33153-xYMT Evaluation Board Schematic (Fixed Output)



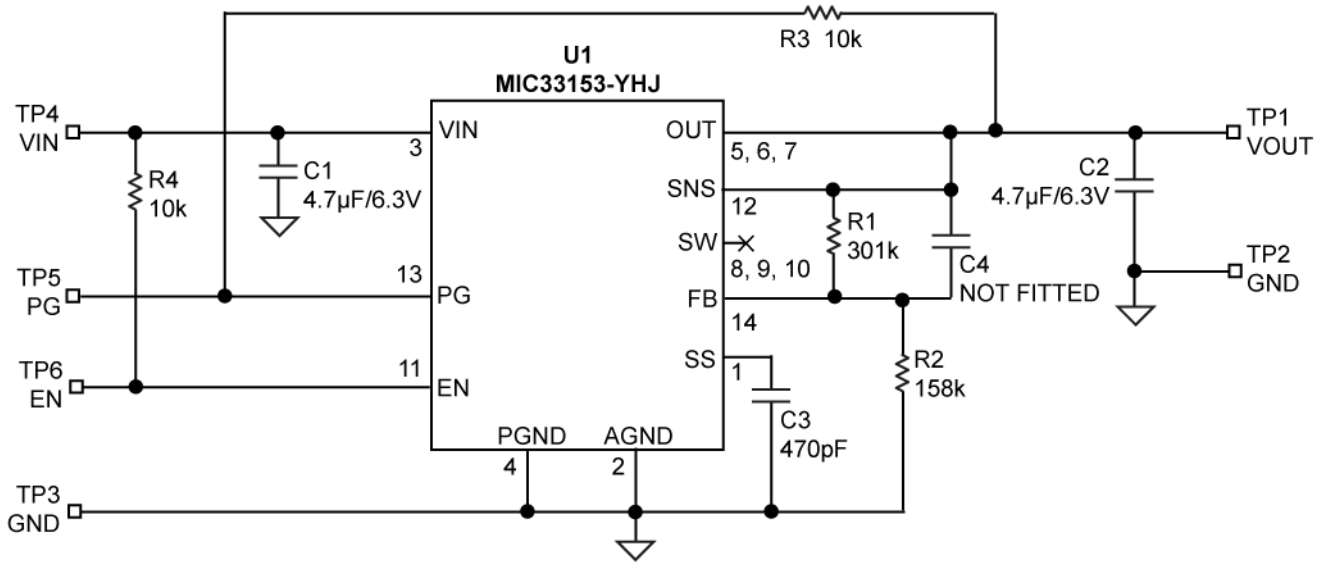
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	C1608X5R0J475K	TDK[1]	Ceramic Capacitor, 4.7µF, 6.3V, X5R, Size 0603	2
	GRM188R60J475KE19D	Murata[2]		
C3	C1608NPO0J471K	TDK[1]	Ceramic Capacitor, 470pF, 6.3V, NPO, Size 0603	1
R3, R4	CRCW06031002FKEA	Vishay[3]	Resistor, 10k, Size 0603	2
U1	**MIC33153-xYHJ**	**Micrel, Inc.[4]**	**4MHz 1.2A Buck Regulator with HyperLight Load™ Mode and Fixed Output Voltage**	1

Notes:

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

MIC33153 Evaluation Board Schematic (Adjustable Output)



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C3	C1608NPO0J471K	TDK[1]	Ceramic Capacitor, 470pF, 6.3V, NPO, Size 0603	1
C4	–	–	Not Fitted (NF)	0
R1	CRCW06033013FKEA	Vishay[3]	Resistor, 301k, Size 0603	1
R2	CRCW06031583FKEA	Vishay[3]	Resistor, 158k, Size 0603	1
R3, R4	CRCW06031002FKEA	Vishay[3]	Resistor, 10k, Size 0603	2
U1	**MIC33153-YHJ**	**Micrel, Inc.[4]**	**4MHz 1.2A Buck Regulator with HyperLight Load™ Mode and Adjustable Output Voltage**	1

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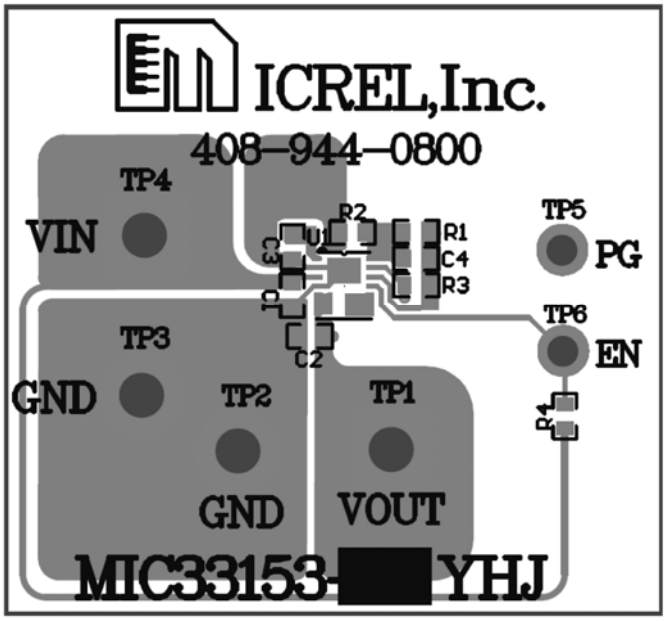
PCB Layout Recommendations



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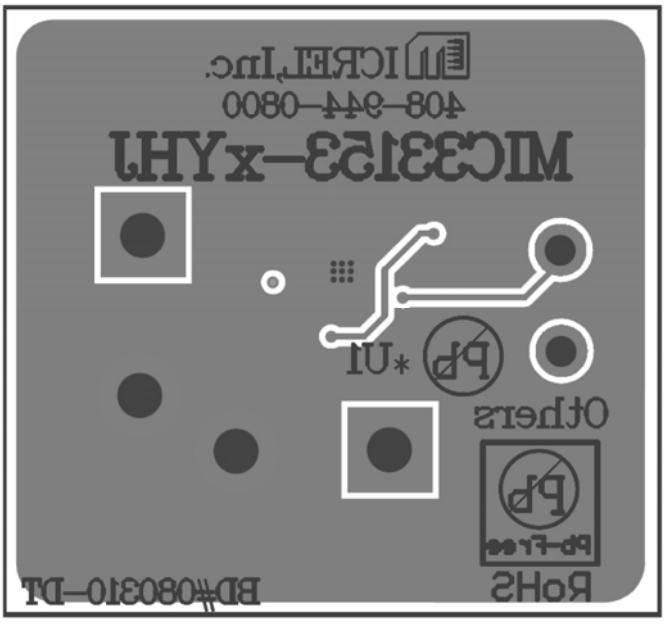

Bottom Layer

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