MIC2155YML Evaluation Board

MIC2155 Two-Phase, Single-Output, 1.8V/40A Synchronous Buck Converter

General Description

The MIC2155 is part of a family of two-phase synchronous buck controllers. This evaluation board converts a 12V input to a 1.8V output at 40A.

Please refer to the MIC2155 datasheet for a detailed explanation of the control IC. Datasheets and support documentation can be found on Micrel's web site at: www.micrel.com.

Evaluation Board Description

Control IC MIC2155
Topology.. Two-Phase, Single-Output Synchronous Buck
V_{IN1} Input Voltage Range .... 10.8V to 14.5V
V_{IN2} Input Voltage Range .... 3.3V to 14.5V
Maximum Input Voltage.. 14.5V
Output Voltage 1.8V
Maximum Output Current 40A
Switching Frequency (each phase)...................... 500kHz
Line Regulation (10V ≤ V_{IN} ≤ 14.5V)...................... 0.10%
Load Regulation (0A ≤ I_{OUT} ≤ 40A) 0.18%
Output Ripple/Noise Voltage.................................. 20mV
Maximum Sync Pin "LOW" Voltage.......................... 0.5V
Minimum Sync Pin "HIGH" Voltage............................. 3V
Sync Frequency Range..................... 860kHz to 1200kHz
Maximum Enable Pin "LOW" Voltage 0.6V
Minimum Enable Pin "HIGH" Voltage........................ 1.6V

Requirements

The MIC2155 evaluation board requires:

- An input power supply able to provide greater than 8A for an input voltage of 10.8V.
- A load (resistive or electronic) capable of supporting 40A at 1.8V.

Features

- V_{OUT} = 1.8V
- I_{OUT} = 40A
- 500kHz-per-phase switching frequency
- Dual input voltage capable
- Sync Input
- Independent enable pins for each phase
- Tight line/load regulation

Related Documentation

- MIC2155 Datasheet

Precautions

The evaluation board does not have reverse polarity protection. Applying a negative voltage to the V_{IN1} or V_{IN2} terminals may damage the device.

The maximum output voltage for the MIC2155 is 3.6V.

Ordering Information

Part Number	Description	Package
MIC2155YML	IC	32-Pin MLF®
MIC2155YML EV	Evaluation Board	Board

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Getting Started

1. V_{IN} Supply Options

Single-Input Voltage Source

Make sure jumper J2 is connected. Use a 16AWG or 18AWG solid wire to make the connection. Apply an input voltage between the V_{IN1} and ground terminals of the evaluation board. Pay careful attention to polarity and supply voltage (10.8V < V_{IN} < 14.5V). An ammeter can be placed between the input supply and the V_{IN1} terminal of the evaluation board. Ensure the supply voltage is monitored at the V_{IN} terminal. The ammeter and/or power-lead resistance can reduce the voltage supplied to the input. When performing transient testing the ammeter should be removed to minimize input lead resistance and inductance.

Dual-Input Voltage Source

Remove jumper J2. Apply an input voltage of 10.8V < V_{IN} < 14.5V between V_{IN1} and ground. Using a second voltage source, apply an input voltage of 3.3V < V_{IN} < 14.5V between V_{IN2} and ground. When V_{IN2} is less than 5V, a second high-side MOSFET should be added to location Q2_1 and MOSFET Q4_1 should be removed. Refer to the MIC2155 datasheet for additional information on selecting MOSFETs and calculating MOSFET power dissipation.

Operation at V_{IN1} < 6V

V_{IN1} and V_{DD} must be connected together when operating with V_{IN1} less than 6V. This connection is made by placing a 5Ω resistor in location R32. This resistor and the V_{DD} capacitor filter switching frequency ripple and noise from the V_{DD} supply. This resistor should not be used if V_{IN1} can rise above 6V since the maximum V_{DD} voltage is 6V. This connection is not necessary when V_{IN2} is less than 6V.

2. Connect the Load to the V_{OUT} and Ground Terminals

The load can be either passive (resistive) or active (as in an electronic load). An ammeter may be placed between the load and the V_{OUT} terminal. Ensure the output voltage is monitored at the V_{OUT} terminal. An 8AWG wire (or its equivalent in paralleled wire) is recommended for connections between the board and load. The wire should be crimped or soldered to an appropriately sized ring terminal. Use a #12 or 1/4" bolt, nut, and washer to secure the ring terminal to the board.

3. Turn-On

Turn on the input voltage and monitor the output voltage. Pull-up resistors between the enable pins and V_{IN} enable the controller as V_{IN} is turned on.

Output Voltage

The output voltage on the MIC2155 evaluation board may be changed by adjusting the voltage feedback resistor divider ratio. The output voltage is controlled by the feedback resistors (R8 and R16) and can be calculated as follows:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R8}{R16}\right)$$

where V_{REF} = 0.7V.

The evaluation board is preset at 1.8V output, but can easily be modified by removing R16 and replacing it with the value that yields the desired output voltage.

$$R16 = \frac{R8}{\frac{V_{OUT}}{V_{REF}} - 1}$$

NOTE: Changing the output voltage will change (among other things) the duty cycle, input and inductor ripple current, output ripple voltage and power dissipation in the high- and low-side MOSFETs. Please consult the MIC2155 datasheet for details on re-calculating these parameters and possible changes to components and values on the board.

Remote Sense (J1)

The positive and negative remote sense connections are made through J1. Connect the "+" terminal to the output voltage remote sense point and the "–" terminal to ground at the remote-sense location.

Monitoring Board Operation

Terminals and headers are provided to assist with the monitoring of signals and waveforms as well as inputting signals.

Enable (EN1, EN2)

Both enable pins are pulled up to V_{IN1} with 50k resistors. Pulling EN1 to ground turns off both phases. Pulling EN2 to ground turns off Phase 2 and allows phase 1 to operate. Turning off Phase 2 improves efficiency at lower output currents.

Switch Nodes (SW1, SW2), V_{DD}, Soft Start (SS)

These terminals allow easy access to the switching nodes of Phases 1 and 2, the V_{DD} supply voltage, and the soft-start pin voltage.

Network Analyzer Connections (N.A.-A, N.A.-B)

These terminals connect across a 22Ω resistor (see schematic) and can be used to easily connect a network analyzer to the feedback path. A typical setup is to inject the signal between the two terminals (across the 22Ω resistor) using a transformer to isolate the signal from ground. Probes are connected to Terminals A and B to measure the ratio of the signals and generate a gain/phase Bode plot. The 22Ω resistor is not necessary for normal circuit operation and can be shorted when loop-gain measurements are not being made.

SYNC

A square wave or pulse applied to this input synchronizes the switching frequency of the converter with the input signal's frequency. The synchronizing frequency must be between 860kHz and 1200kHz for proper operation.

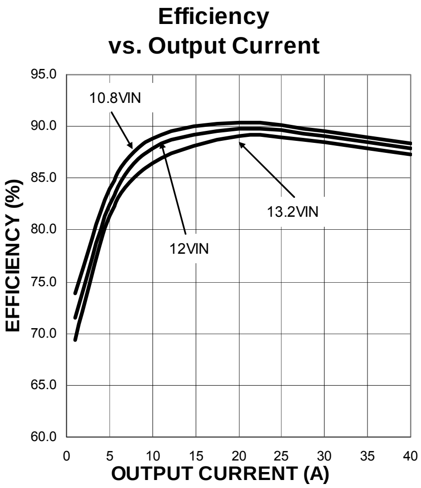
Power Good (PG)

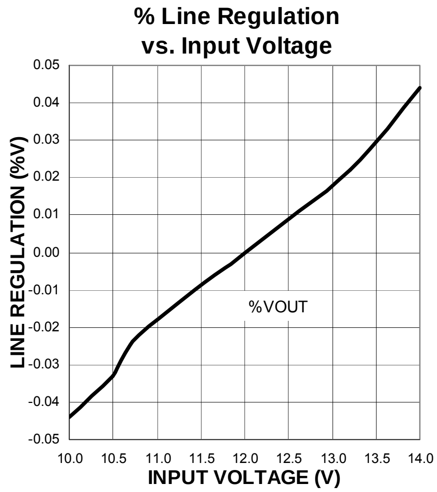
This signal asserts HIGH when V_{OUT} rises to the regulated voltage. This signal in pulled up to A_{VDD} through a 10K resistor on the board.

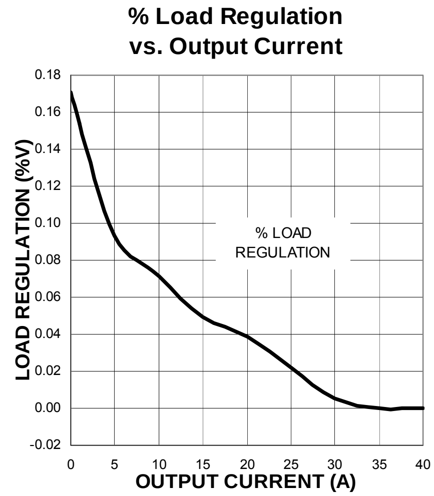
AGND

These terminals connect to the analog ground plane of the board.

Typical Characteristics

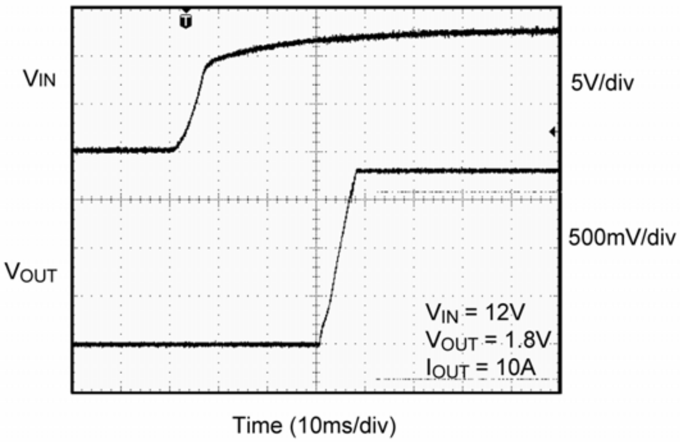




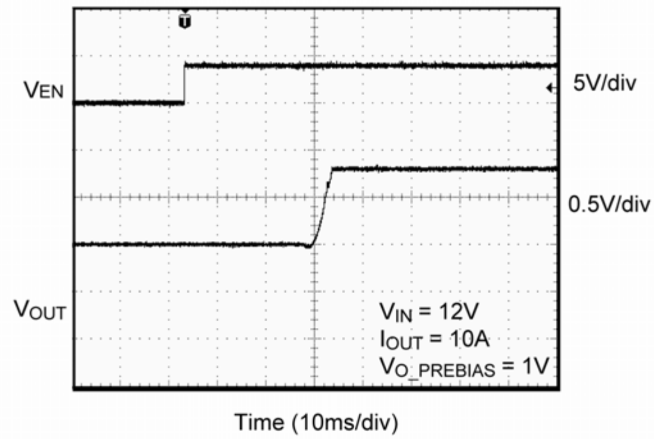


Functional Characteristics

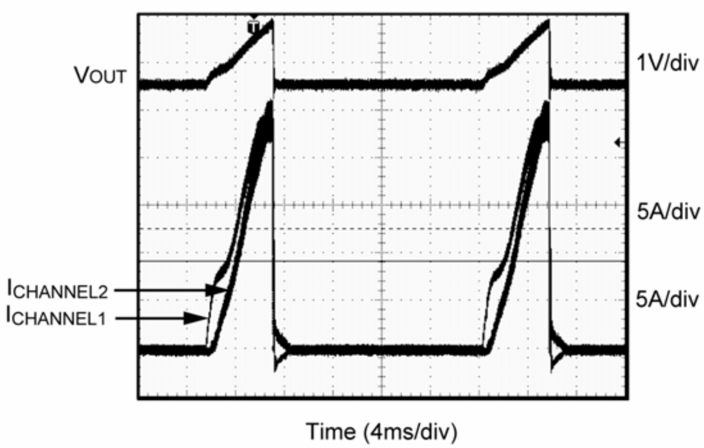
Turn-On



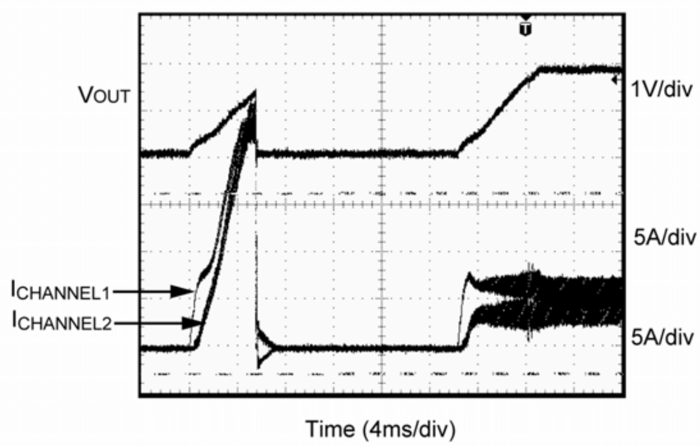
Pre-Biased Output Turn-On



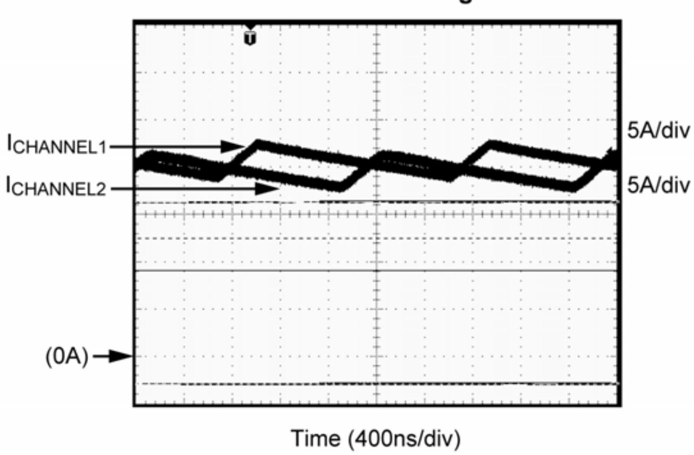
Current Limit (VIN = 12V)



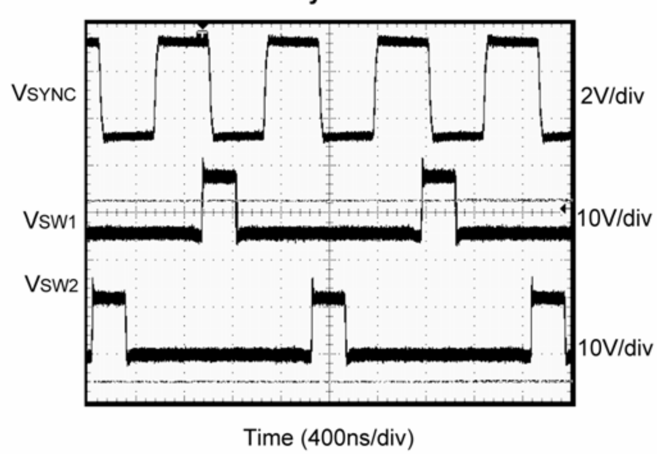
Output Recovery from Current Limit



Current Sharing

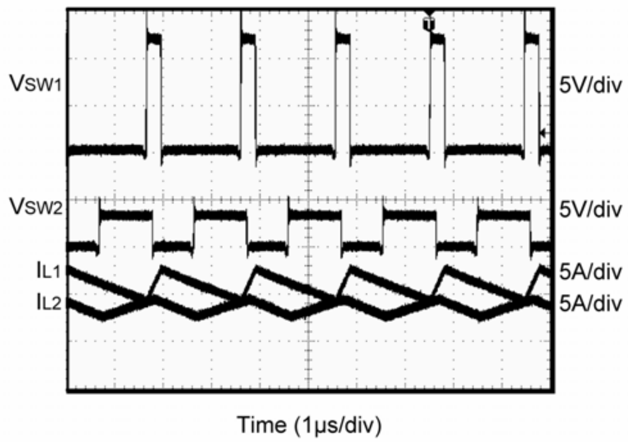


Synch

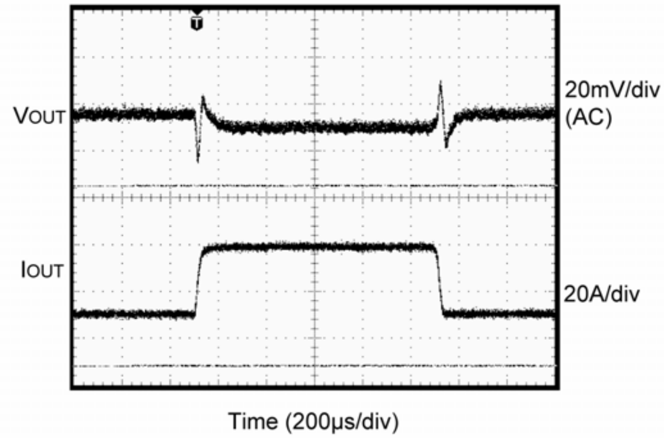


Functional Characteristics (Continued)

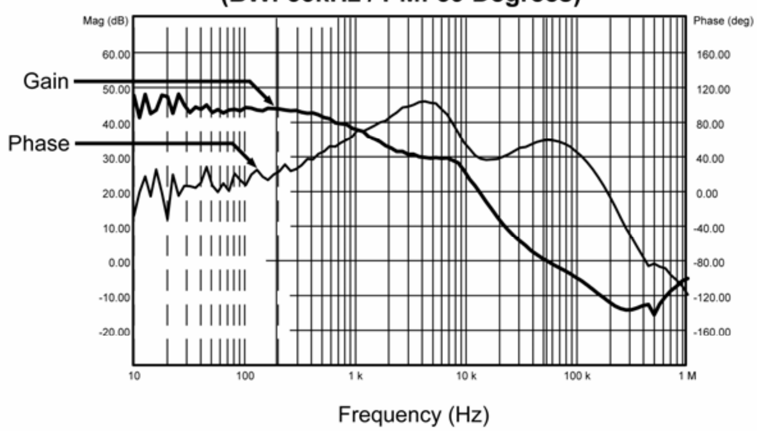
Two-Input Supply Voltages



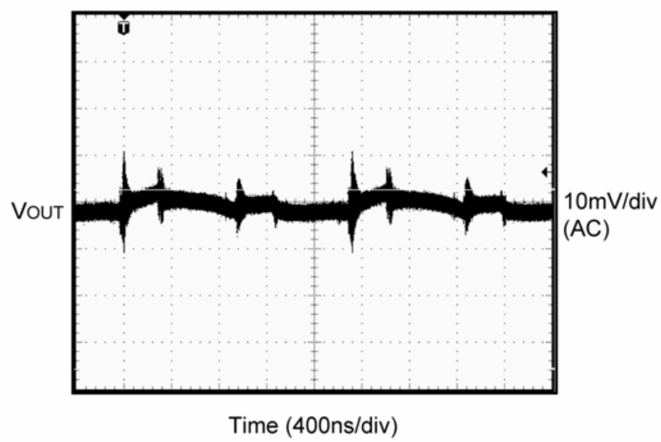
Transient Response



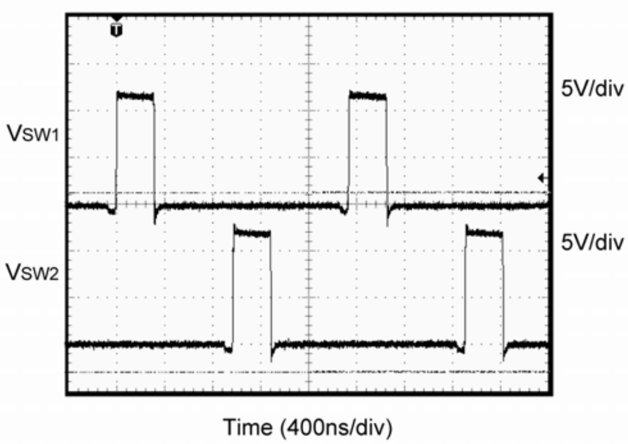
Open Loop Bode Plot (BW: 53kHz / PM: 59 Degrees)



Output Ripple



Switch Node Waveform



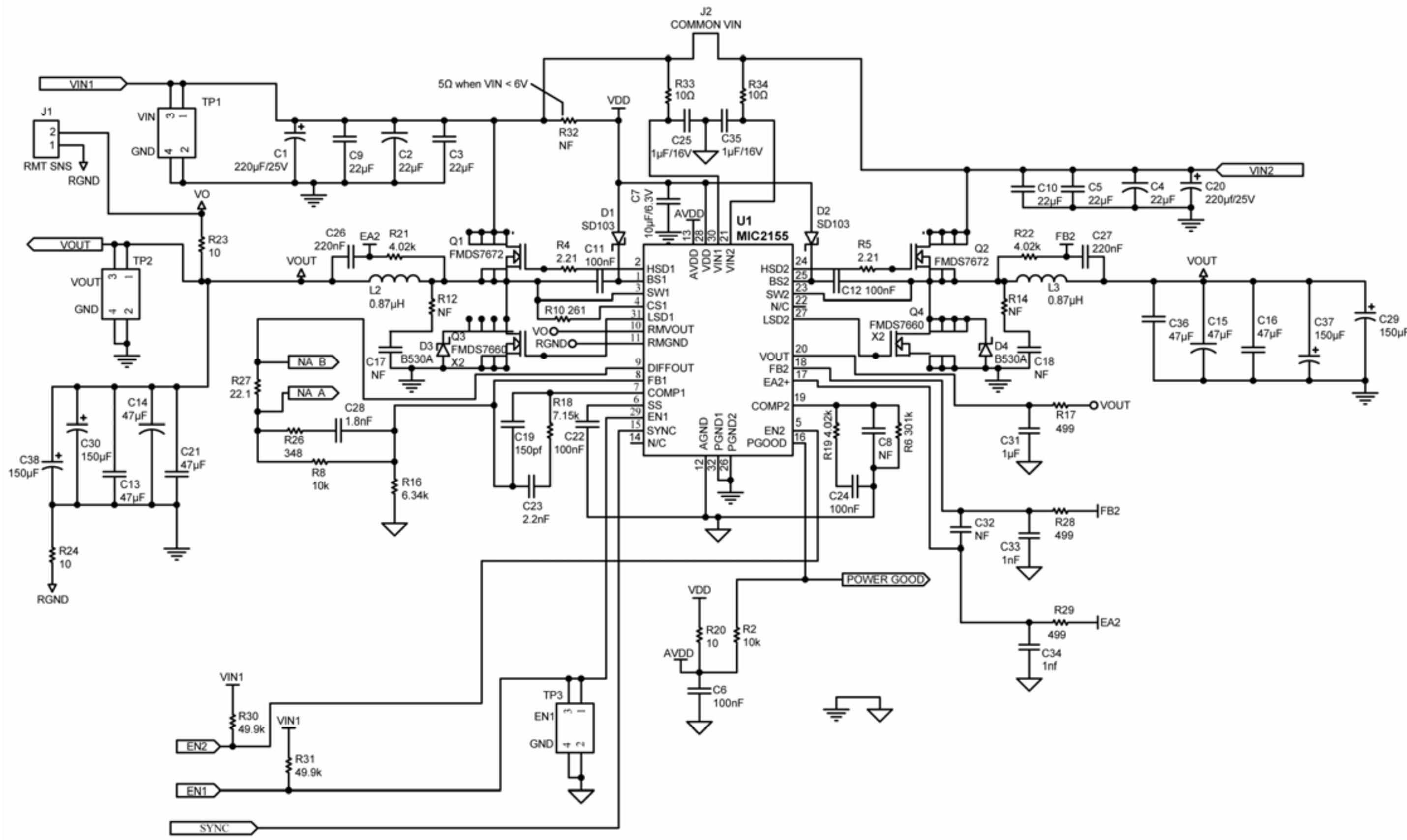
Evaluation Board Layout

The evaluation board is constructed of four layers with separate ground sections planes for the analog and high-power grounds.

Layer Section	Description
L1	Power, Signal, and PGND
L2	AGND and PGND
L3	PGND and Gate Drive
L4	PGND, AGND, and Power

Table 1. Layer Stack

Evaluation Board Schematic



Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C20	B41125A5227M000	Epcos[1]	220µF, 25V Al. El.	2
	222215095612	Vishay[2]		
C29, C30, C37, C38	A700D157M004ATE018	Kemet[3]	150µF, 4V Al. Polymer ESR = 18mΩ	4
	10TPF150ML	Sanyo[4]		
C19	06035C151MAT2A	AVX[5]	150pF, 50V, X7R	1
C33, C34	06035C102MAT2A	AVX[5]	1000pF, 50V, X7R	2
C28	06035C182MAT2A	AVX[5]	1800pF, 50V, X7R	1
C2, C3, C4, C5, C9, C10	1206YD226MAT2A	AVX[5]	22µF, 16V, X5R	6
C23	06035C222MAT2A	AVX[5]	2.2nF, 50V, X7R	1
C25, C31, C35	0603YD105MAT2A	AVX[5]	1µF, 16V, X5R	3
C26, C27	06033C224KAT	AVX[5]	220nF, 50V, X7R	2
	VJ0603Y224KXXAT	Vishay[2]		
C13, C14, C15, C16, C21, C36	12106D476MAT2	AVX[5]	47µF, 6.3V, X5R	6
C7	08056D106MAT2A	AVX[5]	10µF, 6.3V, X5R	1
C6, C11, C12, C22, C24	06033C104KAT	AVX[5]	0.1µF, 25V, X7R	5
C8, C32, C17, C18	0603 size capacitor	AVX[5]	No Fill	4
D1, D2	SD103BWS	MCC[6]	30V, 200mA Schottky Diode	2
	SD103BWS-7	Diodes Inc. [7]		
D3, D4	SK53L	MCC[6]	30V, 5A Schottky Diode	2
	B530C	Diodes Inc. [7]		
	SSC53L	Vishay[2]		
L2, L3	HC1-R87-R	Cooper Magnetics[8]	0.87µH, 28A	
Q1_1, Q2	FDMS7672	Fairchild[9]	N-Channel MOSFET	2
Q4_1, Q4, Q3_1, Q3	FDMS7660	Fairchild[9]	N-Channel MOSFET	4
R2, R8	CRCW06031002FRT1	Vishay[2]	10k, 1%, 1/10W, 0603	2
R10	CRCW06032610FRT1	Vishay[2]	261Ω, 1%, 1/10W, 0603	1
R16	CRCW06036341FRT1	Vishay[2]	6.34k, 1%, 1/10W, 0603	1
R19, R21, R22	CRCW06034021FRT1	Vishay[2]	4.02k, 1%, 1/10W, 0603	3
R18	CRCW06037151FRT1	Vishay[2]	7.15k, 1%, 1/10W, 0603	1

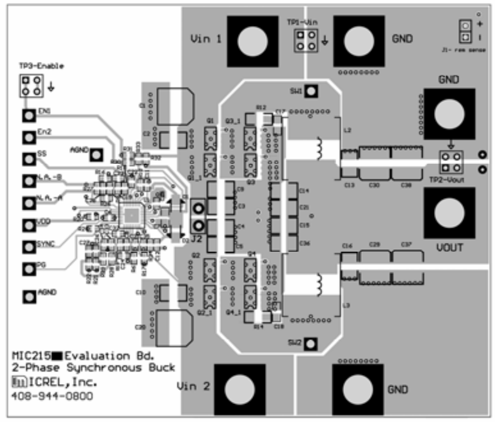
Bill of Materials (Continued)

Item	Part Number	Manufacturer	Description	Qty.
R20, R23, R24, R33, R34	CRCW060310R0FRT1	Vishay[(2)]	10Ω, 1%, 1/10W, 0603	5
R32, R14,R12	No Fill	Vishay[(2)]	Open Resistor Locations	3
R4, R5	CRCW06032R21FRT1	Vishay[(2)]	2.21Ω, 1%, 1/10W, 0603	2
R26	CRCW06033480FRT1	Vishay[(2)]	348Ω, 1%, 1/10W, 0603	1
R17, R28, R29	CRCW06034990FRT1	Vishay[(2)]	499Ω, 1%, 1/10W, 0603	3
R30, R31	CRCW06034992FRT1	Vishay[(2)]	49.9k, 1%, 1/10W, 0603	2
R27	CRCW060322R1FRT1	Vishay[(2)]	22.1Ω, 1%, 1/10W, 0603	1
R6	CRCW06033013FRT1	Vishay[(2)]	301k, 1%, 1/10W, 0603	1
J2		Vishay[(2)]	16AWG Wire Jumper	1
U1	**MIC2155YML**	**Micrel, Inc.[(10)]**	**Two-Phase, Single-Output, PWM Synchronous Buck Control IC**	1

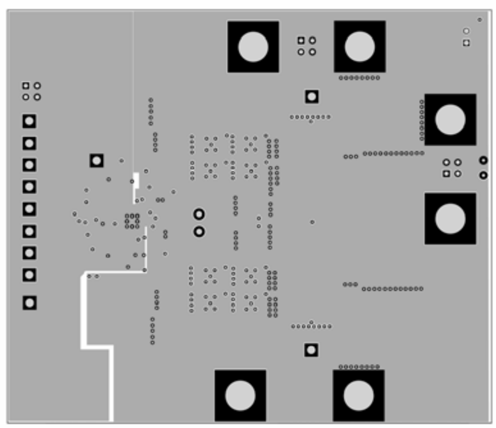
Notes:

1. Epcos: www.epcos.com
2. Vishay: www.vishay.com
3. Kemet: www.kemet.com
4. Sanyo: www.sanyo.com
5. AVX: www.avx.com
6. MCC: www.mccsemi.com
7. Diodes Inc.: www.diodes.com
8. Cooper Magnetics: www.cooperet.com
9. Fairchild: www.fairchildsemi.com
10. **Micrel, Inc.: www.micrel.com**

Evaluation Board Layers

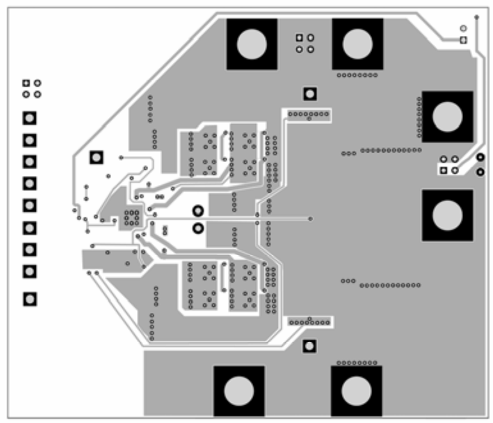


Top Layer (L1)

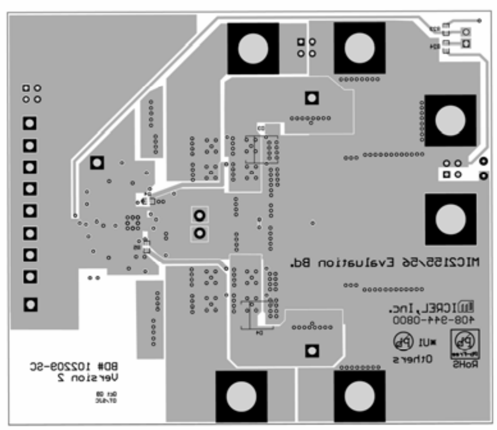


Mid-Layer 1 (L2)

Evaluation Board Layers (Continued)



Mid-Layer 2 (L3)



Bottom Layer (L4)