MIC3809 Evaluation Board

Push-Pull Evaluation Board

General Description

The MIC3808 and MIC3809 are part of a family of complimentary gate drive Push-Pull controllers. The parts can be used to control any dual-ended switching converter topology such as Push-Pull, Half-Bridge or Full-Bridge. The MIC3808 has a 12.5V turn-on threshold while the MIC3809 has a lower turn-on threshold of 4.3V.

This evaluation board provides a platform for evaluating the MIC3809 power supply controller IC in a Push-Pull converter topology. The evaluation board schematic is shown in Figure 1. Please refer to the MIC3808/9 data sheet for a detailed explanation of the control IC.

Specifications

Control IC MIC3809
Power Supply Topology .... Push-Pull
Recommended Operating Input Voltage ..36V to 72V
Maximum Input Voltage 80V
Output Voltage 12V
Maximum Output Current 8A
Output Switching Frequency............180kHz (typical)

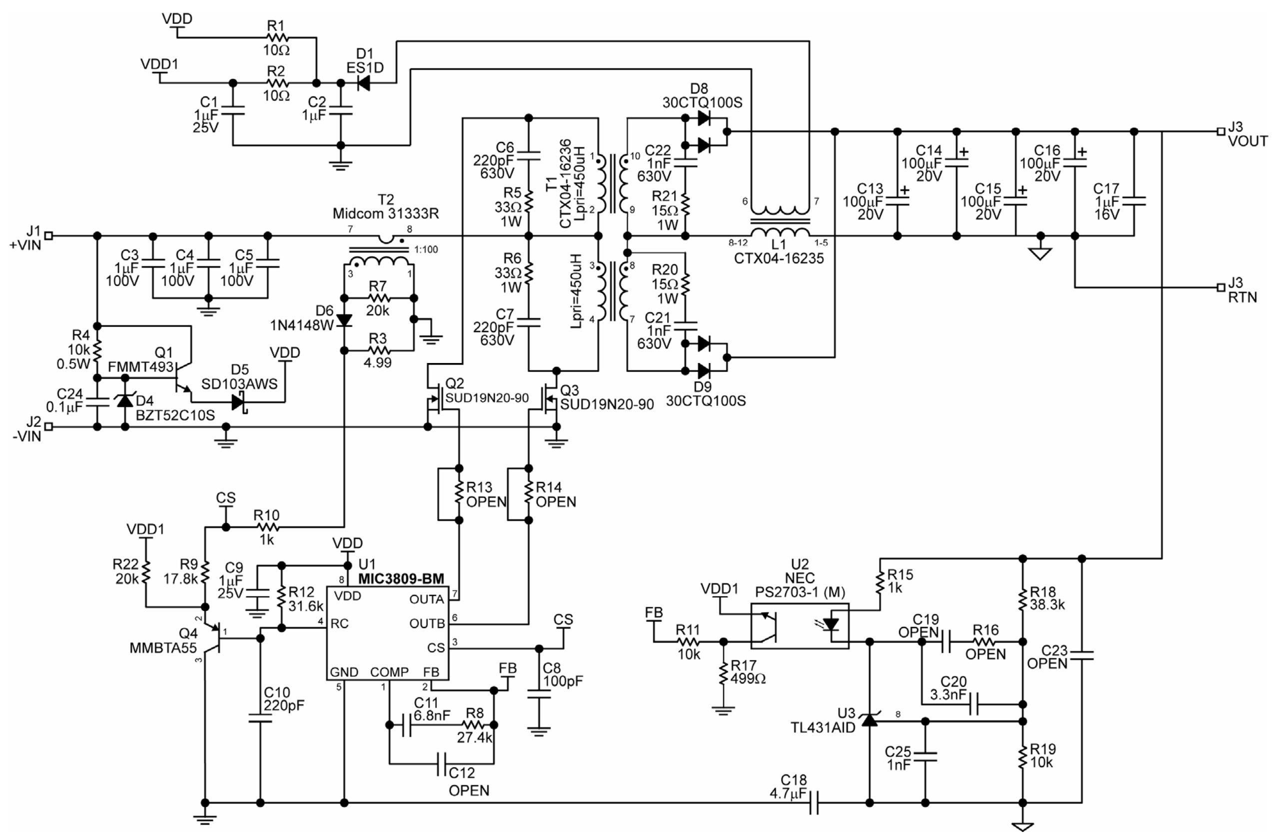


Figure 1. MIC3809 Evaluation Board Schematic

Requirements

The evaluation board requires a DC input power source capable of supplying at least 3.5A at 36V to obtain maximum power at the output. The output may be loaded with a resistive or active load. The active load may be set for constant current or constant resistance mode.

Precautions

The evaluation board does not have input reverse polarity protection. Applying a negative voltage at the +VIN terminal (with respect to the -VIN terminal) may permanently damage the components on the board.

The maximum input voltage should be limited to 80 volts to prevent overvoltage stress on the components.

Getting Started

1) Connect an input voltage source to the +VIN and -VIN terminals. An ammeter may be placed between the source and VIN terminals to monitor input current.
2) Connect a load to the 12V output and GND terminals. An ammeter may be used in series with the output.
3) Apply 48 volts at the input. The output voltage should be 12V.

Startup and Bootstrap Operation

At startup, Q1 and D4 regulate the initial supply voltage to the MIC3809. The voltage on the base of Q1 is regulated at one V_{BE} drop lower than the 10V zener voltage of D4. Including the voltage drop of D5, V_{DD} at startup is approximately 9V.

A flyback winding on the output inductor provides the primary side bias voltages. Once the power supply has started up, this voltage is set higher than the 9V startup voltage and reverse bias D5 under normal operation. This improves efficiency by eliminating power loss in Q1.

$V_{DD}1$ is filtered to isolate the noise sensitive sections of the controller from V_{DD}, which supplies power to the MOSFET gate drive circuit.

Power Stage

The Push-Pull transformer has split primary and secondary windings that operate out of phase with each other. Figures 2 and 3 illustrate the MOSFET drain-source voltages and drain currents. When one of the primary MOSFETs is on, driving current through one of the primary windings, the other MOSFET is off, thereby preventing current from flowing through the other. V_{DS} across the off MOSFET is equal to twice the input voltage. The voltage across the secondary winding is stepped down from the primary by the turns ratio of the transformer. The output inductor and capacitors filter this voltage. RC snubbers across the primary and secondary windings dampen high frequency noise spikes caused by component and circuit parasitics.

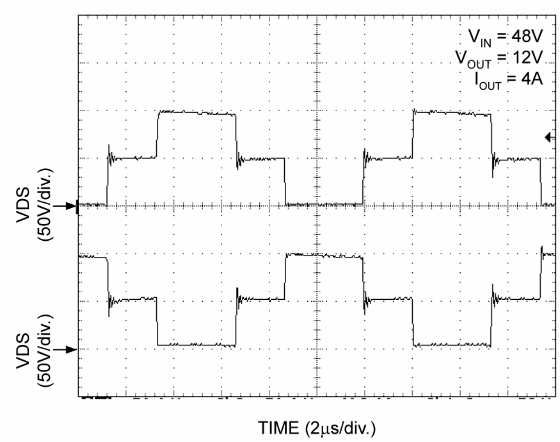


Figure 2

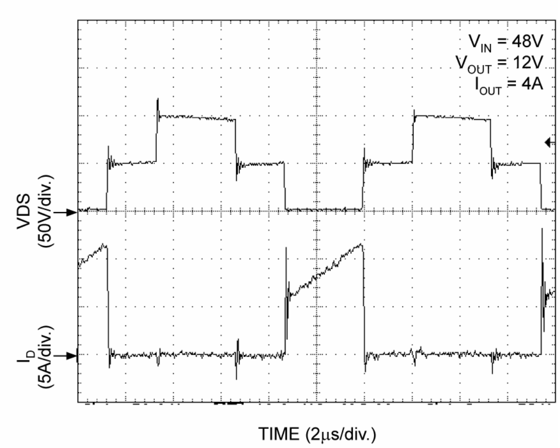


Figure 3

Current Sense and Slope Compensation

The MIC3809 uses current mode control. A current sense transformer senses the primary side current from both halves of the power transformer which improves efficiency over using a resistor for current sensing. A slope compensation ramp must be added to the current signal since the duty cycle at the output is greater than 50%. Emitter follower, Q4, buffers the clock signal ramp and R9/R10 divides the signal down and mixes the ramp with the current sense resistor. The voltage across current sense resistor R3 is shown in the top waveform of Figure 4. This represents the current through the current sense transformer. The bottom waveform shows the voltage as the MIC3809's ISNS pin, which is the sum of the slope compensation signal and the voltage across the current sense resistor. For reference, Figure 5 shows the block diagram of the MIC3809.

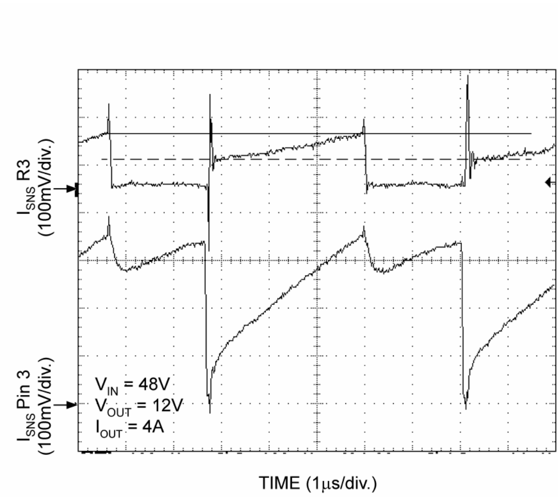


Figure 4

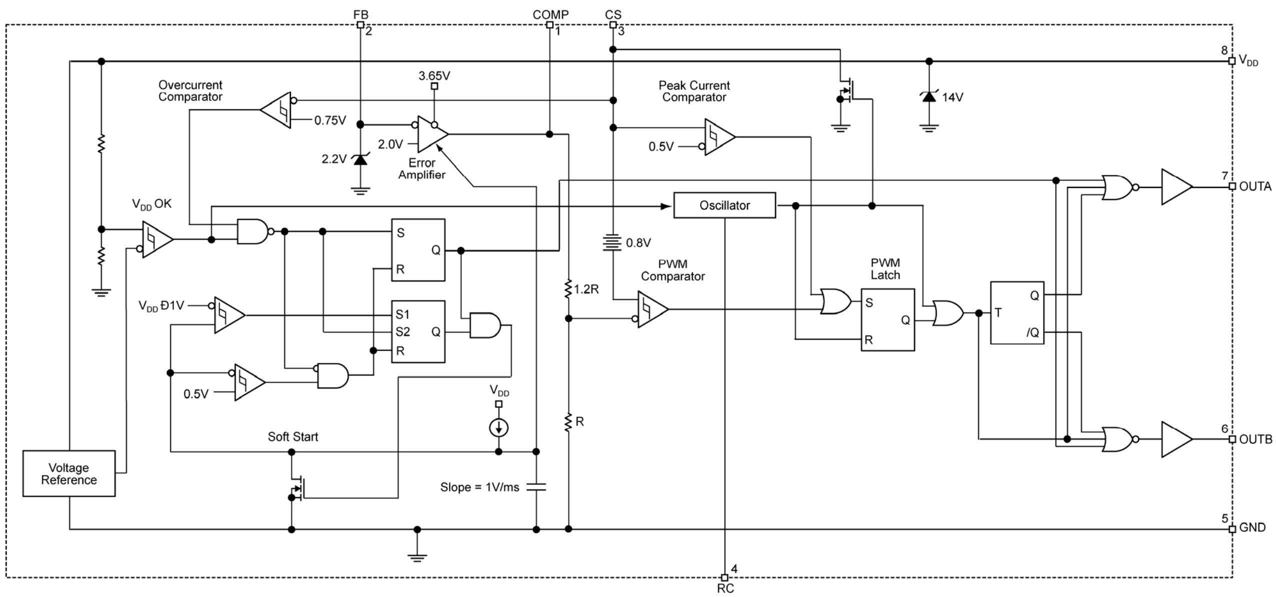


Figure 5

Voltage Sensing and Isolation

The power supply provides safety isolation between the input and output. A TL431 senses the output voltage and compares it to an internal 2.5V reference. An opto-isolator sends the control signal, generated by the TL431 output, across the isolation barrier. This signal is used by the MIC3809 to control the pulse width of the gate drive signal, which regulates the output voltage.

Voltage divider resistors R18/R19 and the internal 2.5V reference set the output voltage. V_{OUT} is calculated using the formula below:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R18}{R19}\right)$$

Where V_{REF}=2.5V

Power Supply Performance

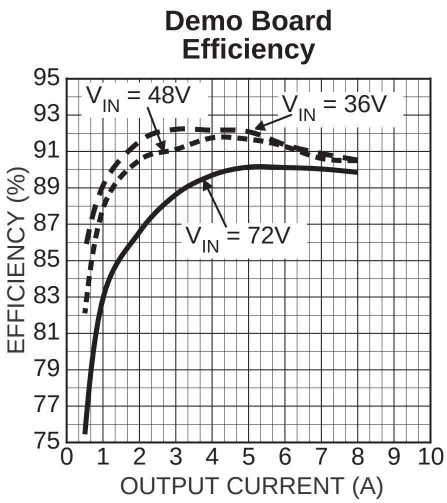


Figure 6

The line and load regulation are shown in Figures 7 and 8.

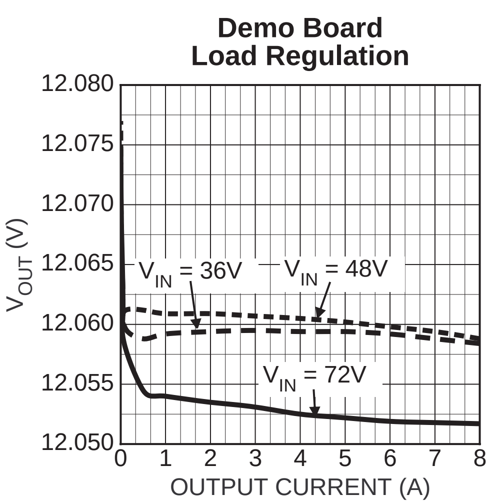


Figure 7

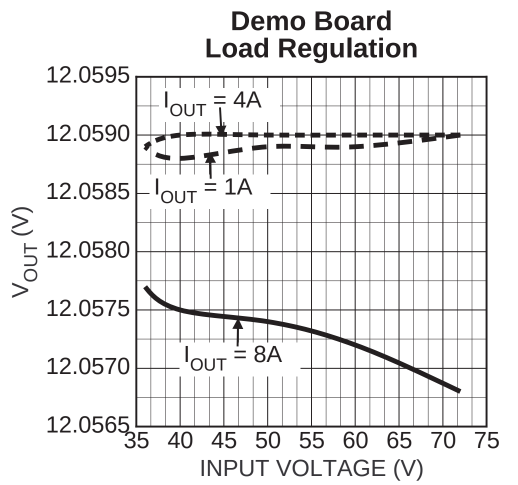


Figure 8

The power supply transient response and bode plots are shown in figures 9 through 11. The output voltage ripple is shown in figure 12.

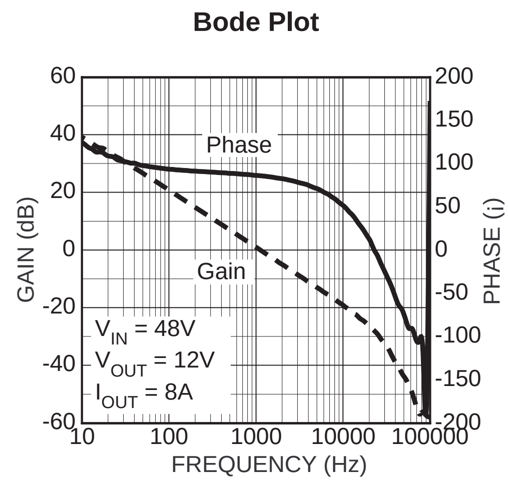


Figure 9

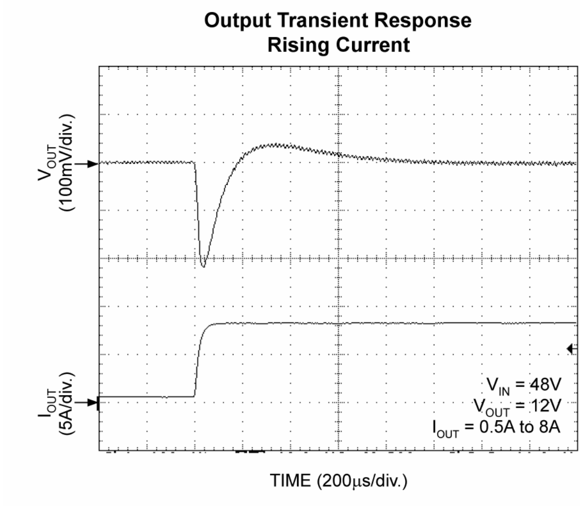


Figure 10

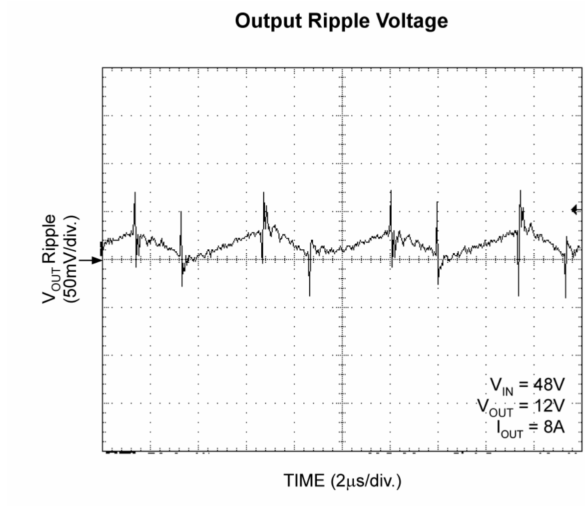


Figure 11

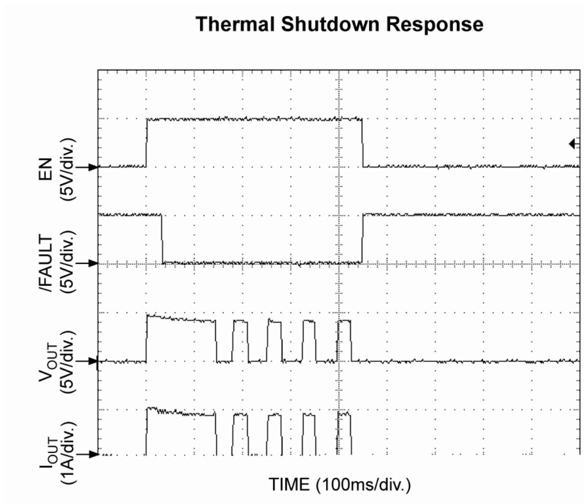


Figure 12

Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
U1	MIC3809BM	**Micrel[(1)]**	MIC3809 push-pull controller	1
U2	PS2703-1(M)	NEC[(2)]	Opto-Isolator	1
U3	TL431AIDBVR	TI[(3)]	Voltage Reference	1
C1, C2, C9, C17	C3216X7R1E105K	TDK[(4)]	1µF, 25V, X7R size 1206	4
or	GRM21BR71E105KA99L	muRata[(5)]	1µF, 25V, X7R, 0805	4
C3, C4, C5	C4532X7R2A105M	TDK[(4)]	1µF, 100V, X7R, 1210	3
or	GRM31CR72A105K***L	muRata[(5)]	1µF,100V , X7R, 1206	0
or	GRM32ER72A105KA01L	muRata[(5)]	1µF, 100V, X7R, 1210	0
or	12101C105KAZ1A	AVX[(6)]	1uF, 100V, X7R, 1210	0
C6, C7	GRM31BR32J221CKY01L	muRata[(5)]	220pF, 630V, X7R, 1206	2
C8	VJ0805A101KXAAT	Vishay Vitramon[(6)]	100pF, 50V, 0805, NPO	1
C10	VJ0805A221KXAAT	Vishay Vitramon[(6)]	220pF, 50V, 0805,NPO, 5%	1
C11	VJ0805Y682KXAAT	Vishay Vitramon[(6)]	6.8nF, 50V, X7R, 0805, 5%	1
C13, C14, C15, C16	594D107X0020D2T	Vishay Sprague[(6)]	100µF, 20V, tantalum D case.	4
C18	GA355DR7GC472K	muRata[(5)]	4.7nF/250AC, X7R, 2220	1
C12, C19, C23			open, Size 0805	3
C20	VJ0805Y332KXAAT	Vishay Vitramon[(6)]	3.3nF, 50V, X7R,0805, 5%	1
C21, C22	GRM31BR32J102CKY01L	muRata[(5)]	1nF, 250V, X7R, 1206.	2
C24	VJ0805Y104KXAAT	Vishay Vitramon[(6)]	0.1µF, 50V, X5R, 0805	1
C25	VJ0805Y102KXAAT	Vishay Vitramon[(6)]	1nF, 50V, X7R, 5%, 0805	1
D1	ES1D	Diodes Inc.[(7)]	200V, 1A ultrafast	1
or	ES1D	Vishay[(6)]		0
D4	BZT52C10S	Diodes Inc.[(7)]	10V zener	1
or	BZX384C10	Vishay[(6)]		0
D5	SD103AWS	Diodes Inc.[(7)]	Signal Schottky, 40V	1
or	SD103AWS	Vishay[(6)]		0
D6	1N4148W	Diodes Inc.[(7)]	Signal diode	1
or	1N4148W	Vishay[(6)]		0

Bill of Materials (cont.)

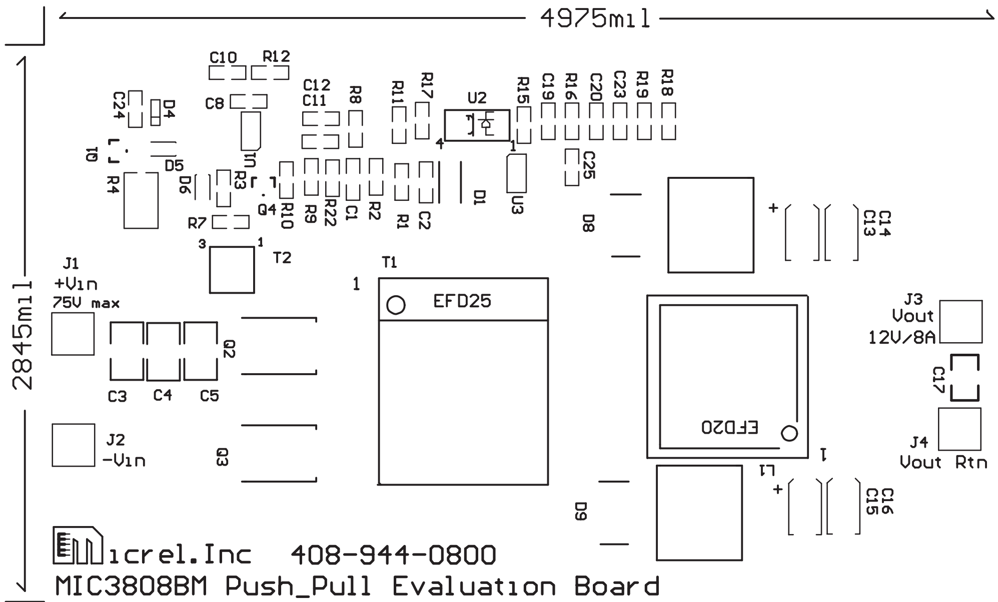
Item	Part Number	Manufacturer	Description	Qty.
D8, D9	30CTQ100S	IR(8)	Power Schottky, 30A, 100V	2
or	MBRB30H100CT	Vishay(6)		0
Q1	FMMT493	Zetex(10)	FMMT493 NPN transistor	1
Q2, Q3	SUD19N20-90	Vishay(6)	MOSFET, Nch 200V, 90mohm	2
Q4	MMBTA55	Diodes Inc.(7)	PNP, MMBTA55	1
or	MMBTA56	Vishay(6)		0
T1	CTX04-16236-X2	Cooper Electronics(9)	Push-Pull Transformer	1
T2	31333R	Midcom(10)	100:1 Current sense x-fmr	1
L1	CTX04-16235-X1	Cooper Electronics(9)	12µH inductor with bias winding	1
R1, R2	CRCW080510R0FRT1	Vishay Dale(6)	10Ω	2
R3	CRCW08054R99FRT1	Vishay dale(6)	4.99Ω 1%	1
R4	CRCW25121002FRT1	Vishay dale(6)	10kΩ, 1/2W, 5%	1
R5, R6	CRCW251233R0FRT1	Vishay dale(6)	33Ω, 1W, 5%	2
R7, R22	CRCW08052002FRT1	Vishay dale(6)	20kΩ	2
R8	CRCW08052742FRT1	Vishay dale(6)	27.4kΩ	1
R9	CRCW08051782FRT1	Vishay dale(6)	17.8kΩ	1
R10, R15	CRCW08051001FRT1	Vishay dale(6)	1kΩ	2
R11, R19	CRCW08051002FRT1	Vishay dale(6)	10kΩ	2
R12	CRCW08053162FRT1	Vishay dale(6)	31.6kΩ	1
R13, R14, R16		Vishay dale(6)	open	3
R17	CRCW08054990FRT1	Vishay dale(6)	499Ω	1
R18	CRCW08053832FRT1	Vishay dale(6)	38.3kΩ	1
R20, R21	CRCW251215R0FRT1	Vishay dale(6)	15Ω, 1W	2

Notes:
Micrel Inc.: 408-944-0800

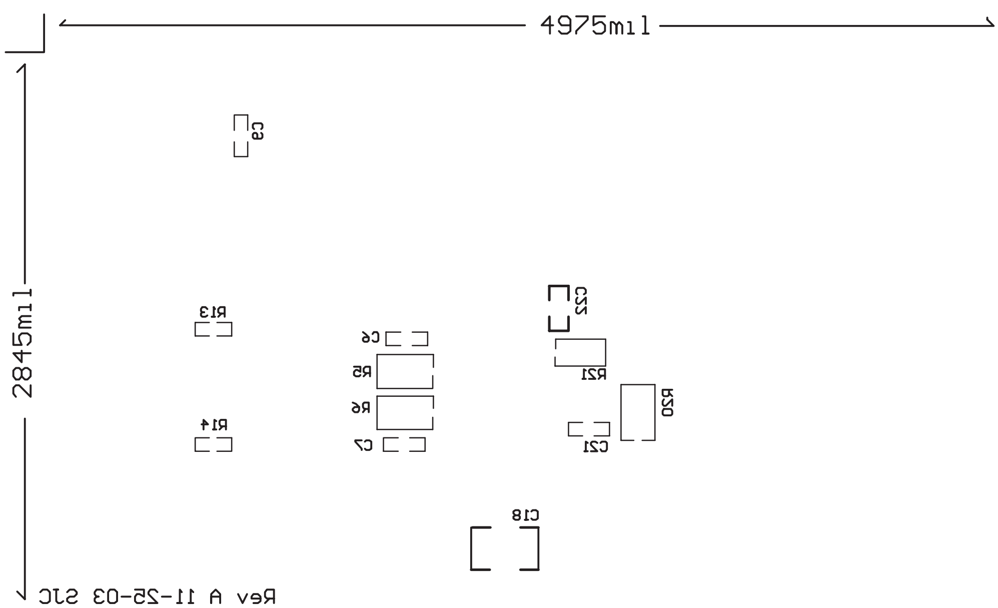
NEC: 408-588-2247
TDK: 847-803-6100
muRata: 800-831-9172
AVX: 843-448-9411

Vishay Corporation: 206-452-5664
Diodes Inc.: 805-466-4800
IR: 310-252-7105
Cooper Electronics: 888-414-2645
Midcom: 800-643-2661

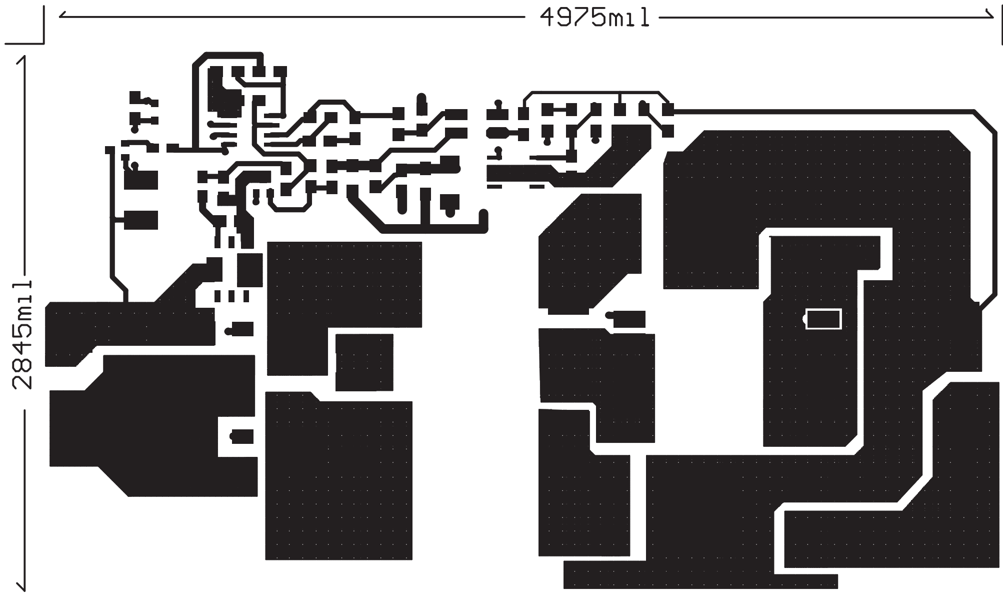
Printed Circuit Boards



Top Silkscreen Overlay



Bottom Silkscreen Overlay



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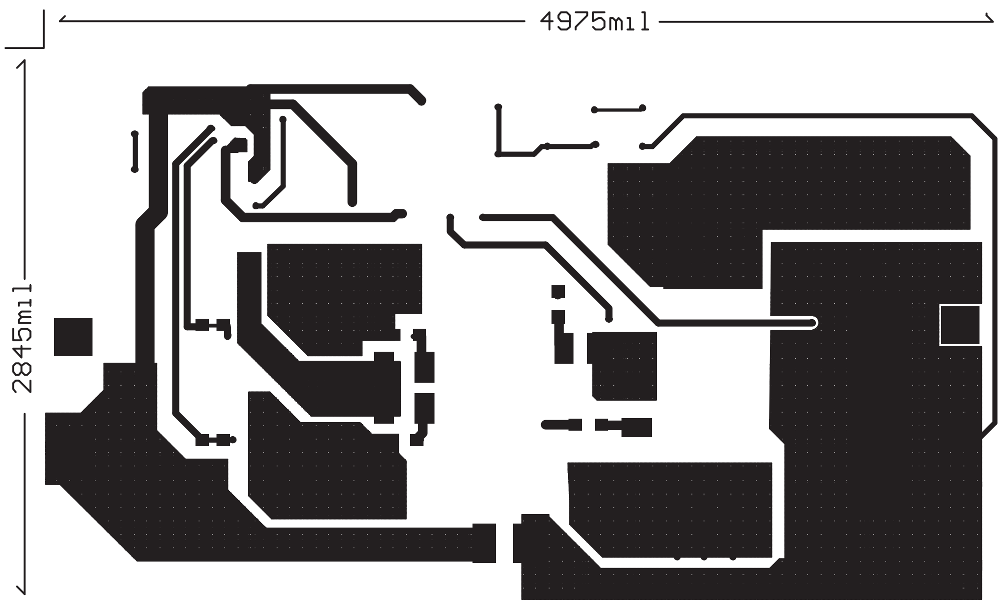

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