MIC22400YML Evaluation Board

Integrated 4A Synchronous Buck Regulator

General Description

This board enables the evaluation of the MIC22400; a high-power density, frequency-adjustable synchronous buck regulator. The MIC22400 features, integrated 4A MOSFETs, integrated frequency compensation, flexible sequencing and tracking abilities. The board is optimized for ease of testing, so all major components are on a single side. The voltage mode feedback loop is designed to allow high bandwidth with just two external compensation components. The high-side MOSFET is P-Channel allowing duty cycle control up to 100%.

The Micrel MIC22400 is a high-efficiency 4A integrated synchronous buck (step-down) regulator. The MIC22400 is optimized for highest power density and achieves over 85% efficiency whilst switching at 4MHz with only 1uH inductor and down to 22µF output capacitor. The ultra-high speed control loop keeps the output voltage within regulation even under extreme transient load swings commonly found in FPGAs and low voltage ASICs. The output voltage can be adjusted down to 0.7V to address all low-voltage power needs. A full range of sequence options are available with the MIC22400. The EN/DLY pin combined with the power POR pin allows multiple outputs to be sequenced in any way on turn on and turn off. The RC (Ramp Control™) pin allows the device to be connected to another MIC2240x family of products to keep the output voltages within a certain delta V on start-up.

Requirements

This board needs a single 30W bench power source adjustable over the input voltage of interest. The loads can either be active (electronic load) or passive (resistor) with the capability to dissipate the maximum load power while keeping accessible surfaces ideally <70°C. It is ideal to have an oscilloscope to view the circuit waveforms, but not essential. For the simplest tests, two voltage meters are required to measure input and output voltages. For efficiency measurements, two voltage and two current meters 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.

Under extreme loading conditions such as short circuit testing, input transients can be quite large if long test leads are used. In such cases, place a 22µF or 47µF, 6.3V Tantalum capacitor at the V_{IN} terminals to prevent over voltage damage to the IC.

Getting Started

1. **Connect V_{IN} supply to the input terminals $+V_{IN}$ and GND**. With the output of this supply disabled, set its voltage to the desired input test voltage. This supply voltage should be monitored at the test boards input terminals to allow voltage drops in the test cables (and ammeter if used) to be accounted for. An ammeter can be added inline with the $+V_{IN}$ input terminal to accurately measure input current as some power sources current and voltage displays can be misleading.

2. **Connect the loads to the output terminals between $+V_O$ and GND**. Again, this output voltage should be monitored by connecting the voltmeter at the $+V_O$ and GND terminals. An ammeter can be added inline with the $+V_O$ terminal of the evaluation board to accurately measure the output current.

   Initially, set the output load to 0A to check that the output is regulating properly prior to loaded tests.

3. **Enable the input supply**. By default, the output voltage is enabled when the input supply of >2.5V is applied. When this threshold is crossed, the enable pin capacitor (1nF) begins to charge at 1V/µs until it reaches 1.25V where switching begins. To test the Enable functions of the MIC22400, a test point is provided.

Ordering Information

Part Number	Description
MIC22400YML EV	Evaluation board with the Integrated 4A MIC22400 device

Ramp Control is a trademark of Micrel, Inc.

Other Features

EN/DLY

C6 creates a delay set by an internal 1µA source charging to a 1.25V threshold. Using a switch-to-ground (Q1) using "SHDN" to enable the part will exhibit approximately 1.3µs enable delay from "SHDN" going low to the start of switching. Using a pulse generator with a low-impedance output connected to the EN terminal will remove this delay as it defeats the internal 1µA source.

RC (Ramp Control™) Capacitor

The MIC22400 has a nominal 1µA current source/sink to the RC pin. The startup output voltage waveform tracks the voltage on RC. 100% output voltage is represented by 0.7V on RC. The default capacitor on RC (C7) of 10nF therefore sets the ramp up time to approximately 700µs.

Feedback resistors

The output is set nominally at 1.8V. This can be changed by adjusting the upper or lower resistor in the FB potential dividers. It is recommended that R1 or R2 value should be kept <10k to reduce noise susceptibility and offset currents from creating voltage errors. Therefore, choosing R1<10k:

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

Where V_{REF} = 0.7V

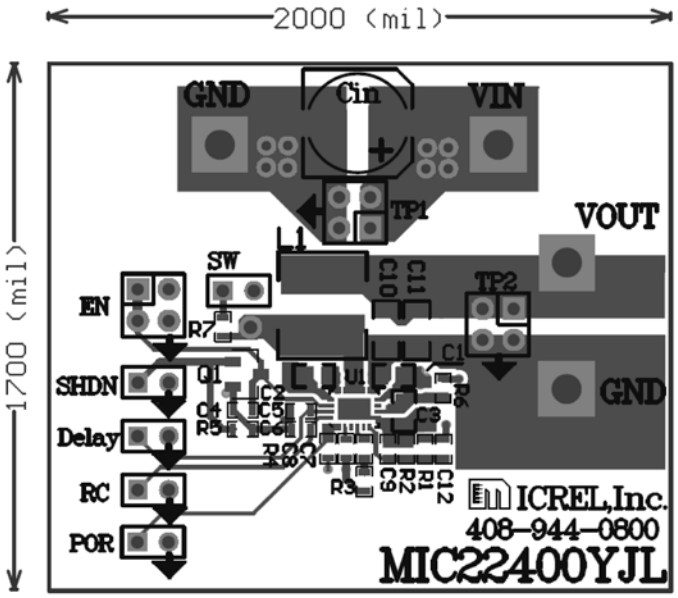
DELAY

Adding an external capacitor to this pin allows the Power Good delay to be adjusted to perform as a Power-on Reset (POR). As with the RC pin, this pin has an internal 1µA current source and sink. When V_{FB} reaches 90% of its nominal voltage (~ 630mV) the internal 1µA current source charges the capacitor on this pin (C8) to the rising threshold of 1.25V, at this point, PG is asserted high. When the enable pin is set low, POR is asserted low immediately. However, the internal "DELAY" current sink discharges the capacitor (C8) to 1.25V lower than its starting point, at which point, it enables the RC pin 1µA current sink to begin discharging C7.

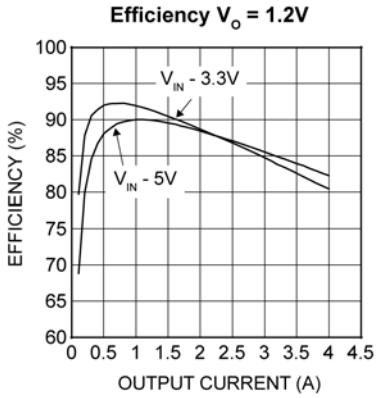
Power-on-Reset (POR)

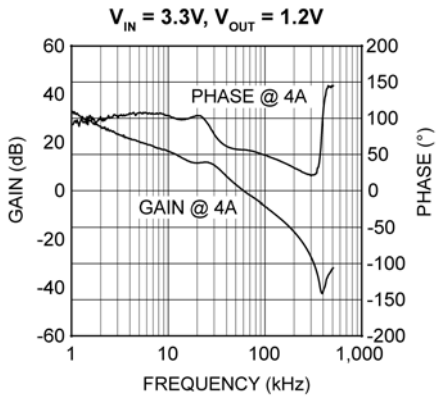
This is an open-drain connection with an on board pull-up resistor (R3) to V_{IN}. This is only asserted high when the FB pin reaches >90% of its nominal set voltage. This can be used as part of the tracking and sequencing function described in the data sheet.

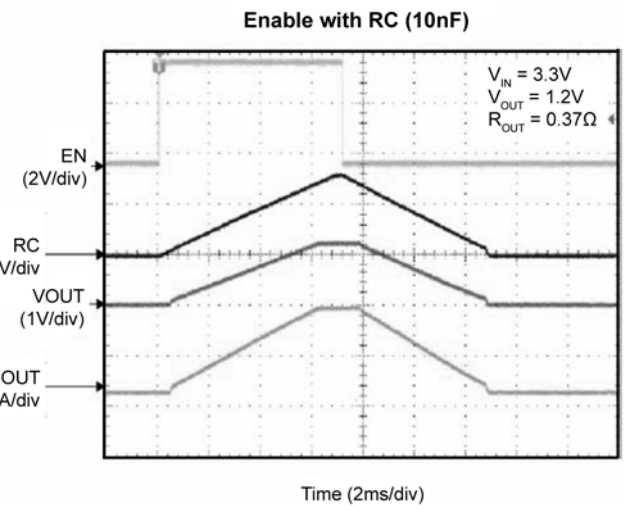
Evaluation Board

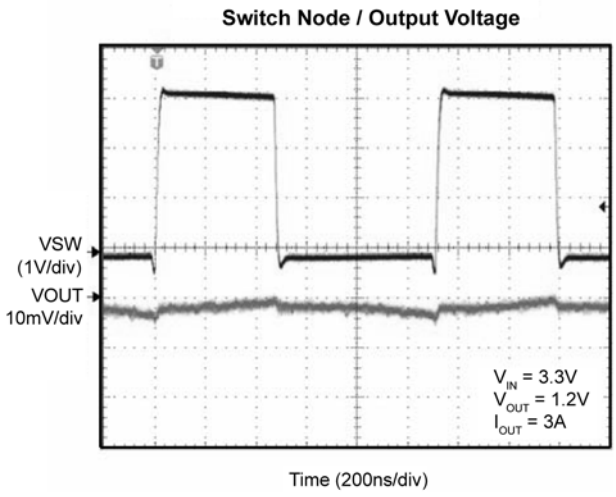


Evaluation Board Performances

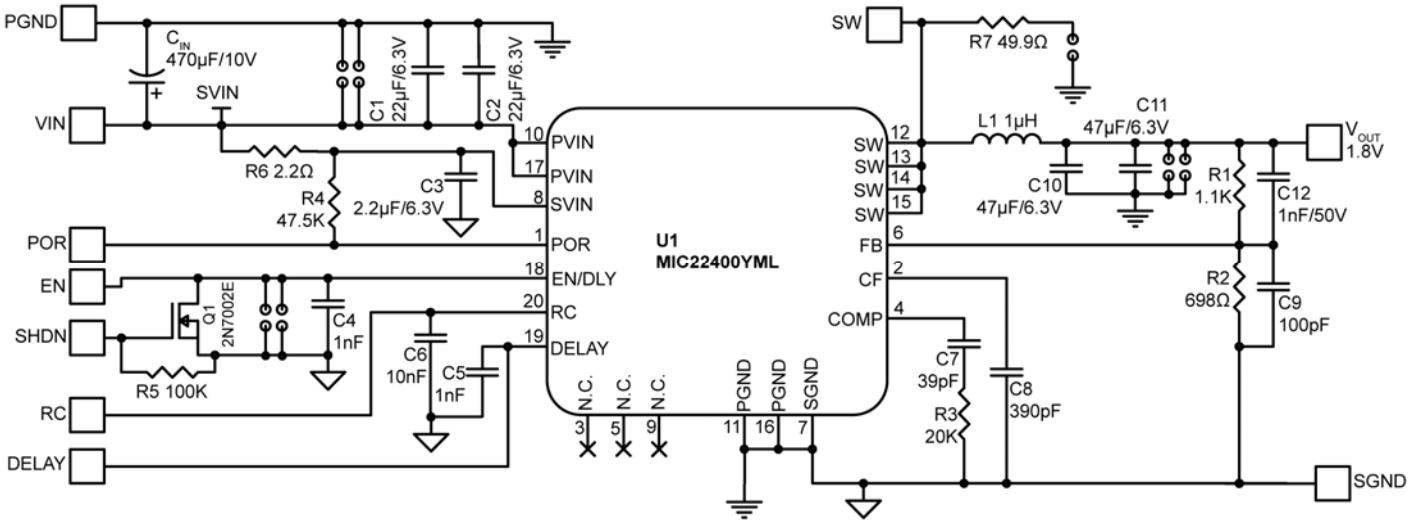








Evaluation Board Schematic



Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	08056D226MAT	AVX[1]	Capacitor, 22µF, 6.3V, X5R, Size 0805	2
	C2012X5R0J226M	TDK[2]		
	GRM21BR60J226ME39L	Murata[3]		
C3	06036D225TAAT2A	AVX[1]	Capacitor, 2.2µF, 6.3V, X5R, Size 0805	1
	GRM188R7160J225M	Murata[3]	Capacitor, 2.2µF, 6.3V, X7R, Size 0805	
	C1608X5R0J225M	TDK[2]	Capacitor, 2.2µF, 6.3V, X5R, Size 0805	
C4, C5, C12	GRM188R71H102KA01D	Murata[3]	Capacitor, 1nF, 50V, X7R, Size 0603	2
	C1608C0G1H102J	TDK[2]	Capacitor, 1nF, 50V, COG, Size 0603	
	06035C102KAT2A	AVX[1]		
C6	GRM188R71H103KA01D	Murata[3]	Capacitor, 10nF, 50V, X7R, Size 0603	1
	C1608X7R1H103K	TDK[2]		
	06035C103KAT2A	AVX[1]		
C7	GRM188R71H390JA01	Murata[3]	Capacitor, 39pF, 50V, Size 0603	1
	C1608COG1H390J	TDK[2]		
	06035A390JAT2A	AVX[1]		
C8	GRM188R71H391JA01	Murata[3]	Capacitor, 390pF, 50V, Size 0603	1
	1608COG1H391J	TDK[2]		
	06035A391JAT2A	AVX[1]		
C9	GRM188R71H101JA01	Murata[3]	Capacitor, 100pF, 50V, Size 0603	1
	C1608COG1H101J	TDK[2]		
	06035A101JT2A	AVX[1]		

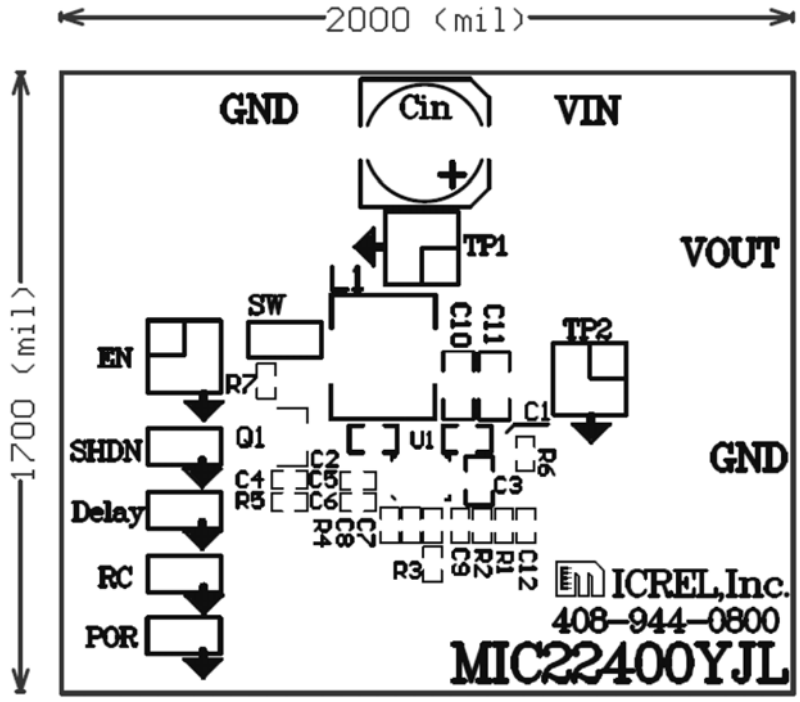
Bill of Materials (Continued)

Item	Part Number	Manufacturer	Description	Qty.
C10, C11	GRM31CR60J476ME19	Murata[3]	Capacitor, 47µF, 6.3V, X5R, Size 1206	2
	C3216X5R0J476M	TDK[2]		
	12066D476MAT2A	AVX[1]		
C_{IN}	B41125A3477M	Epcos	470µF, 10V, Electrolytic, 8x10-case	
L1	FP3-1R0-R(7.2x6.7x3mm)	Cooper[5]	Inductor, 1µH, 6.26A	1
	CDRH8D28NP-1R0NC (8x6x3mm)	Sumida[6]	Inductor, 1µH, 8A	1
	SPM6530T-1R0M120 (7x6.5x3mm)	TDK[2]	Inductor, 1µH, 12A	1
R1	CRCW06031101FKEYE3	Vishay[4]	Resistor, 1.1k, 1%, Size 0603	1
R2	CRCW06036980FKEYE3	Vishay[4]	Resistor, 698, 1%, Size 0603	1
R3	CRCW06032002FKEYE3	Vishay[4]	Resistor, 20k, 1%, Size 0603	1
R4	CRCW06034752FKEYE3	Vishay[4]	Resistor, 47.5k, 1%, Size 0603	1
R5	CRCW06031003FKEYE3	Vishay[4]	Resistor, 100k, 1%, Size 0603	1
R6	CRCW06032R20FKEA	Vishay[4]	Resistor, 2.2Ω, 1%, Size 0603	1
R7	CRCW060349R9FKEA	Vishay[4]	Resistor, 49.9Ω, 1%, Size 0603	1
Q1	2N7002E	Vishay[4]	Open	1
U1	**MIC22400YML**	**Micrel[7]**	**Integrated 4A Synchronous Buck Regulator**	**1**

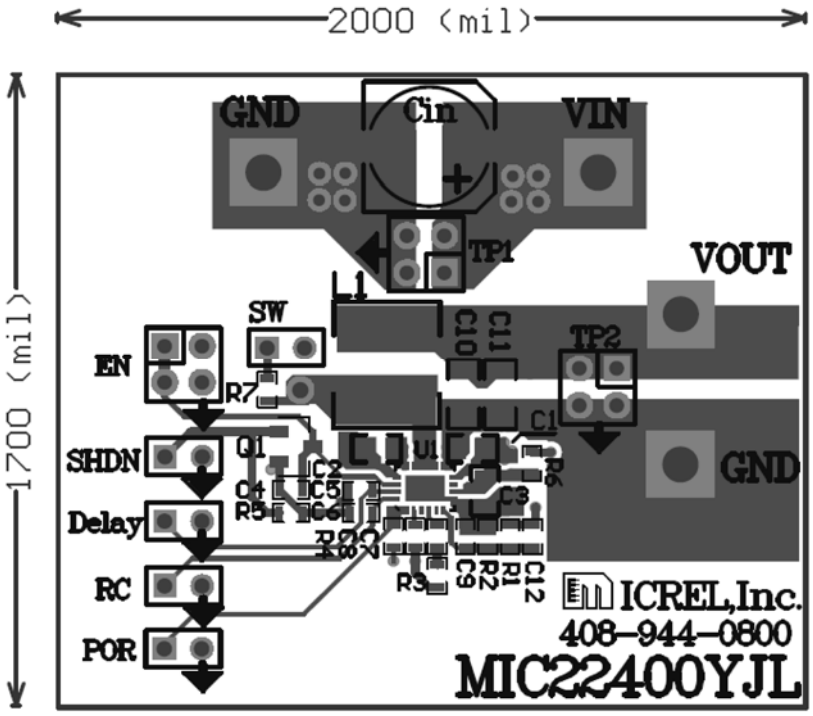
Notes:

1. AVX: www.avx.com.
2. TDK: www.tdk.com.
3. Murata: www.murata.com.
4. Vishay: www.vishay.com.
5. Cooper Bussmann: www.cooperet.com.
6. Sumida: www.sumida.com.
1. **Micrel, Inc.: www.micrel.com.**

PCB Layout Recommendations

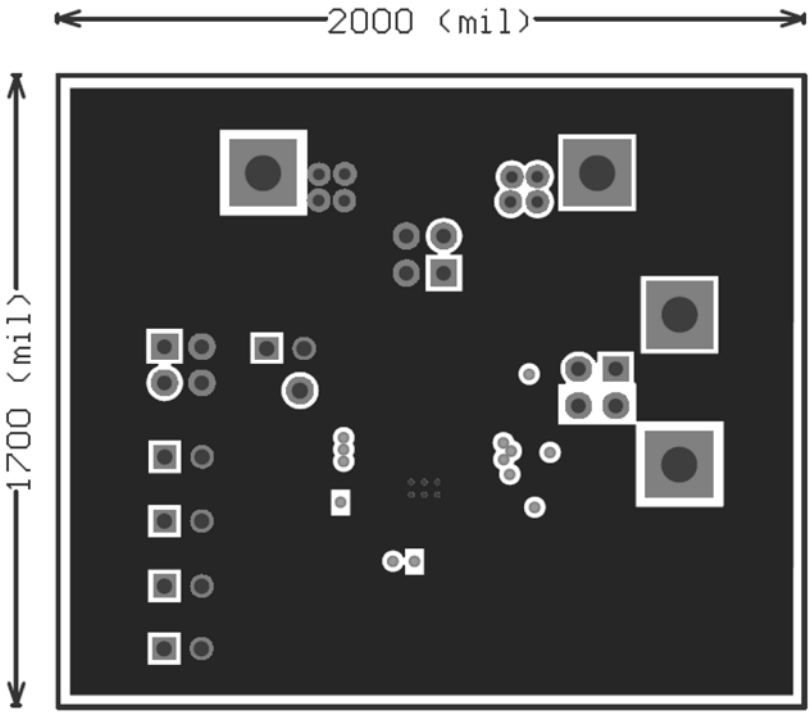


Top Silk

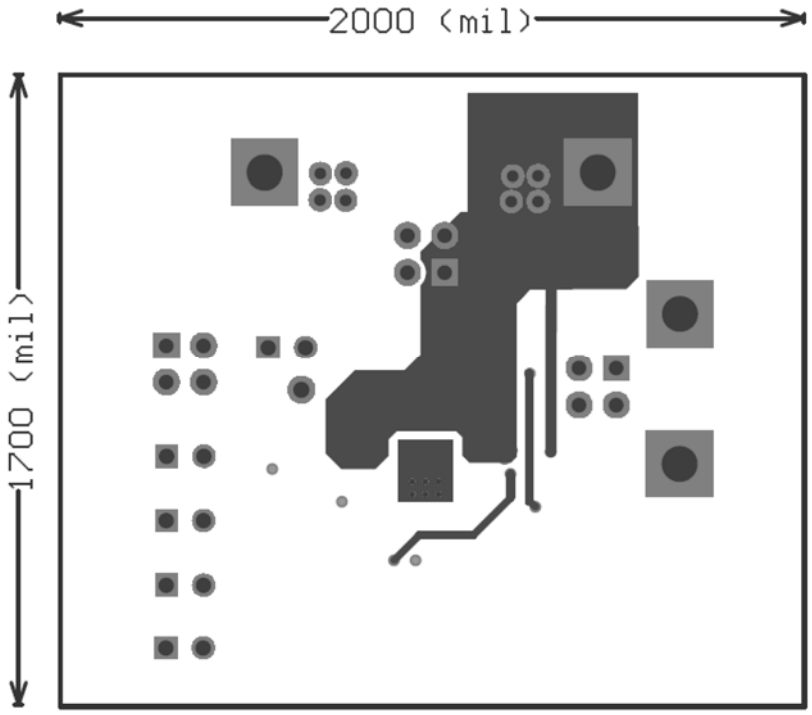


Top Layer

PCB Layout Recommendations (Continued)

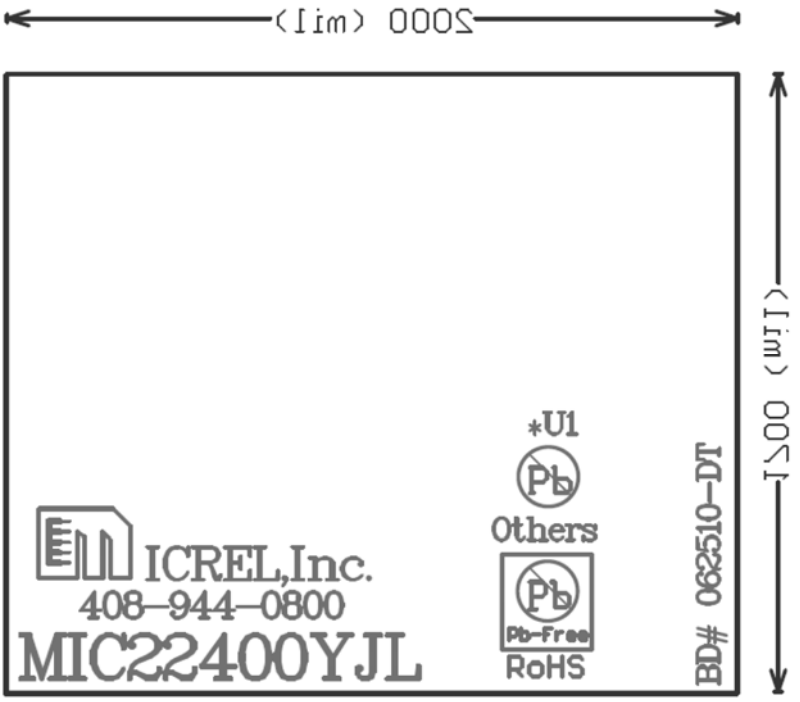


Mid Layer 1

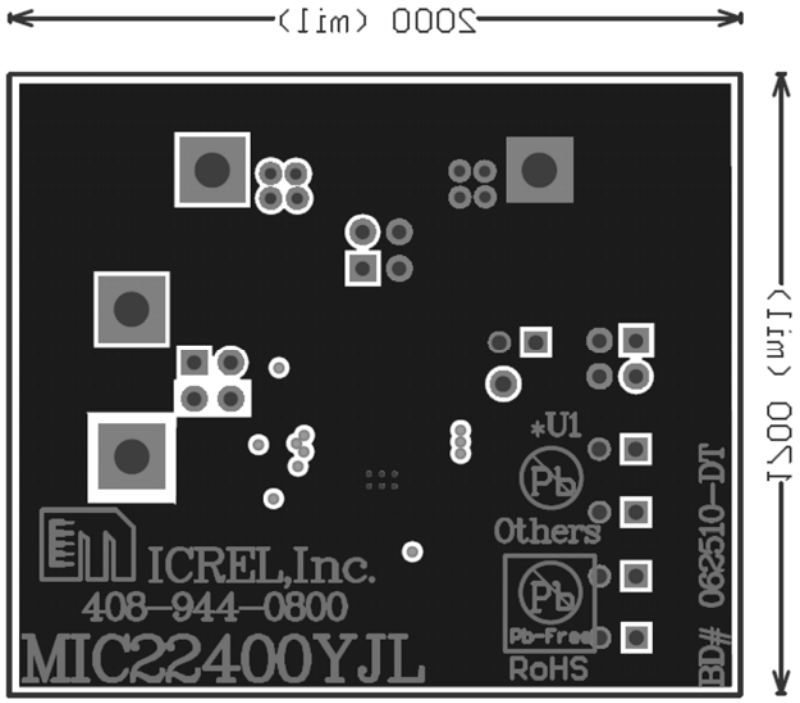


Mid Layer 2

PCB Layout Recommendations (Continued)



Bottom Silk



Bottom Layer

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