



MIC22602YML Evaluation Board

Integrated 6A Synchronous Buck Regulator

General Description

The Micrel MIC22602 is a high efficiency 6A Integrated synchronous buck (step-down) regulator. The MIC22602 is optimized for highest power density and achieves over 90% efficiency while switching at 1MHz. The MIC22602 features integrated 6A MOSFETs, flexible sequencing and tracking abilities.

This board enables the evaluation of the MIC22602. The board is optimized for ease of testing, with all the components on a single side. The voltage-mode feedback loop is designed to allow high bandwidth with just 2 external compensation components. The high-side MOSFET is a P-Channel device, allowing duty cycle control up to 100%. 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. The MIC22602 offers a full range of sequencing and tracking options. The EN/DLY pin combined with the POR/PG pin allows multiple outputs to be sequenced in any way on turn-on and turn-off using EN/DLY pin. The RC (Ramp Control™) pin allows the device to be connected to another MIC22602 to keep the output voltages within a certain voltage margin on start up.

Requirements

This board needs a single bench power source adjustable over the input voltage of $2.6V < V_{IN} < 5.5V$ that can provide at least 6A of current. The loads can either be active (electronic load) or passive (resistor) with the ability to dissipate the maximum load power while keeping accessible surfaces ideally $< 70^{\circ}C$.

Precautions

There is no reverse input protection on this board. When connecting the input sources, ensure that the correct polarity is observed.

Under extreme load conditions, such as short circuit testing, input transients can be quite large if long test leads are used. In such cases a $470\mu F$, 10V electrolytic capacitor is installed at the V_{IN} terminals to prevent over voltage damage to the IC.

Getting Started

1. **Connect V_{IN} supply to the input terminals PV_{IN} and $PGND$.** With the output of this supply disabled, set its voltage to the desired input test voltage ($2.6V < V_{IN} < 5.5V$). 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.
2. **Connect the loads to the output terminals between V_{OUT} and $PGND$.** Again, this output voltage should be monitored by connecting the voltmeter at the V_{OUT} and $PGND$ terminals. An ammeter can be added inline with the $+V_O$ terminal of the evaluation board to accurately measure the output current.

The Output voltage has been set to 1.8V. Output voltage can be changed by selecting the resistor R2.

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 an input supply of $> 2.6V$ is applied. When this threshold is crossed, the EN pin capacitor (1nF) begins to charge at $1V/\mu s$ until it reaches 1.25V, where switching begins. To test the Enable functions of the MIC22602, a test point is provided.

Ordering Information

| Part Number | Description |
|----------------|---|
| MIC22602YML EV | Evaluation board with the Integrated 6A MIC22602 device |

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Other Features

EN/DLY Input

C6 creates a delay set by an internal 1µA source charging to a 1.25V threshold. A switch (Q1) is used from EN pin-to-ground as shutdown 'SHDN' control. There is 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 MIC22602 has a nominal 1µA current source/sink to the RC pin. The startup output voltage waveform tracks the voltage on RC pin. The 100% output voltage is represented by 0.7V on RC pin. The default value of C7 connected to the RC pin is 470pF. This sets the output ramp up time to approximately 190µs.

Feedback resistors

The output voltage 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 select R1<10k.

The resistor divider network for a desired V_{OUT} is given by:

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

where V_{REF} is 0.7V and V_{OUT} is the desired output voltage.

DELAY Time Input

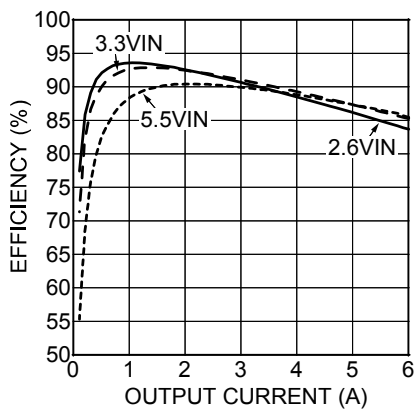
Adding an external capacitor to this DELAY pin allows the Power Good delay to be adjusted to perform as a Power-On Reset (POR). As with the RC pin, this pin has an internal 1µA current source and sink. After EN pin voltage is driven high, the V_{OUT} will start to rise (rate determined by RC pin capacitor). As the FB pin voltage goes above 90% of its nominal set voltage, DELAY pin voltage begins to rise as the 1µA source charges the external capacitor. When the threshold of 1.24V is crossed, the POR/PG pin is asserted high and DELAY pin continues to charge to a voltage SV_{IN}. When FB pin voltage falls below 90% of nominal, POR/PG is asserted low immediately. However, if EN pin is driven low, the POR/PG pin voltage will fall immediately to the low state and DELAY pin voltage will begin to fall as the external capacitor is discharged by the 1µA current sink. When the threshold of ((V_{TP}+1.24V)-1.24V) is crossed (V_{TP} is the internal voltage clamp, V_{TP}=0.9V), the V_{OUT} will begin to fall at a rate determined by the RC pin capacitor. As the voltage change in both cases is 1.24V, both rising and falling delays are matched.

POR (Power-On Reset) Output

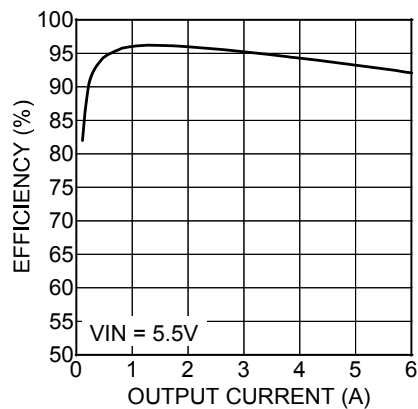
This is an open drain connection with an on board pull-up resistor (R3) to SV_{IN}. This is only asserted high when the FB pin reaches >90% of its nominal set voltage. This can be used as part of the tracking and sequencing function described in the data sheet.

Evaluation Board Performances

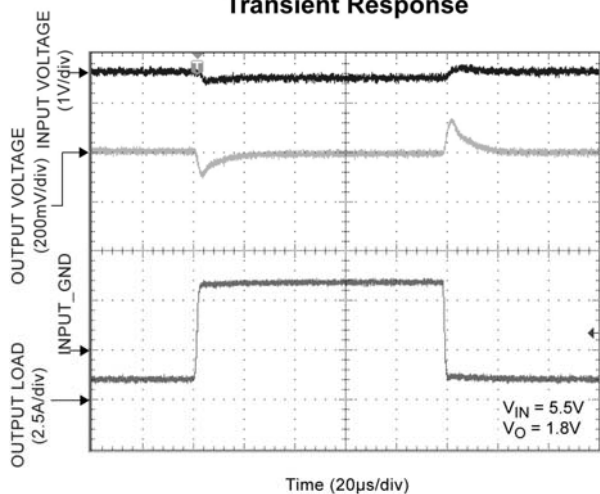
Efficiency @ 1.8V_{OUT}



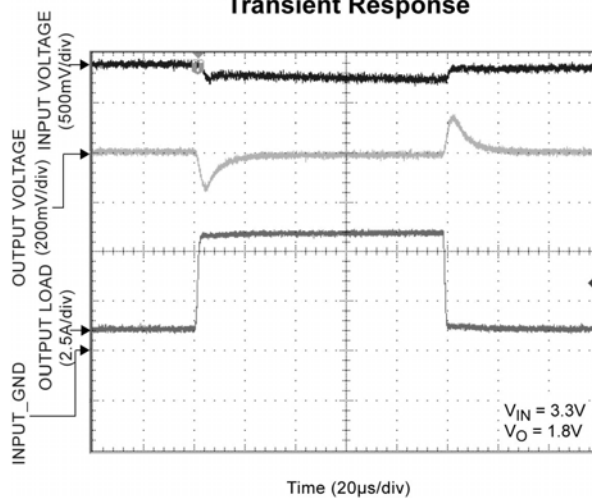
Efficiency @ 3.3V_{OUT}



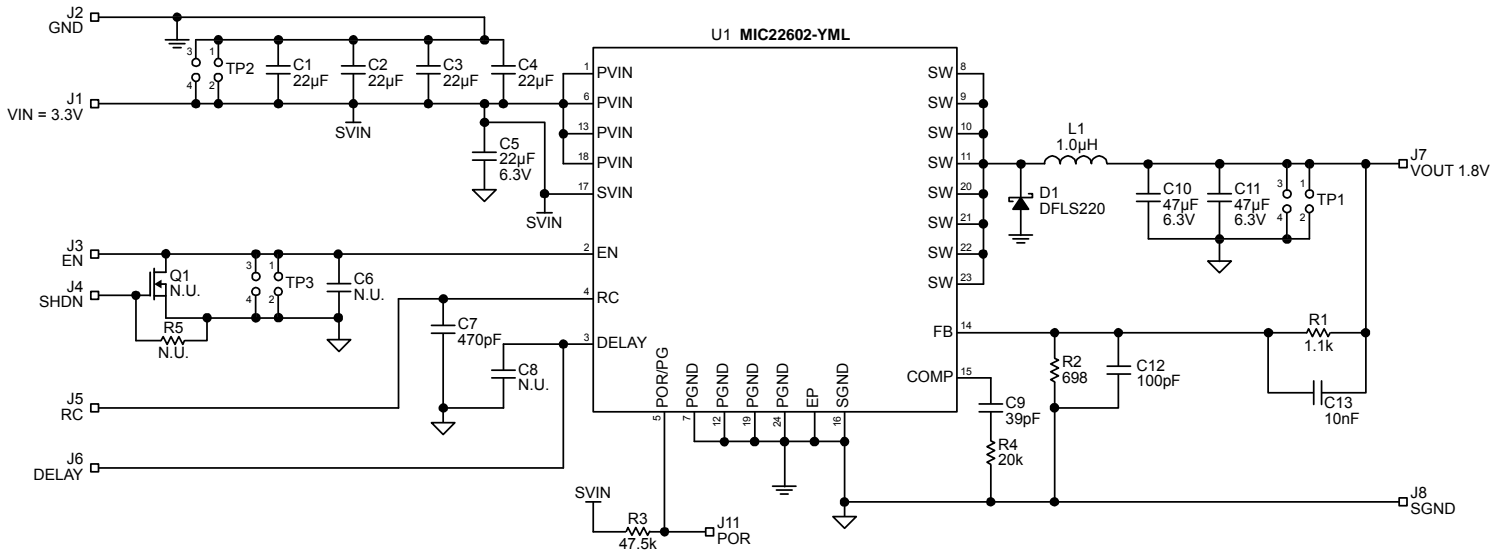
Transient Response



Transient Response



Evaluation Board Schematic



Notes:

1. If buck capacitor on input rail is away (4 inches or more) from the MIC22602, install the 470µF buck capacitor near VIN.
2. Source impedance should be as low as 10mΩ.

Bill of Materials

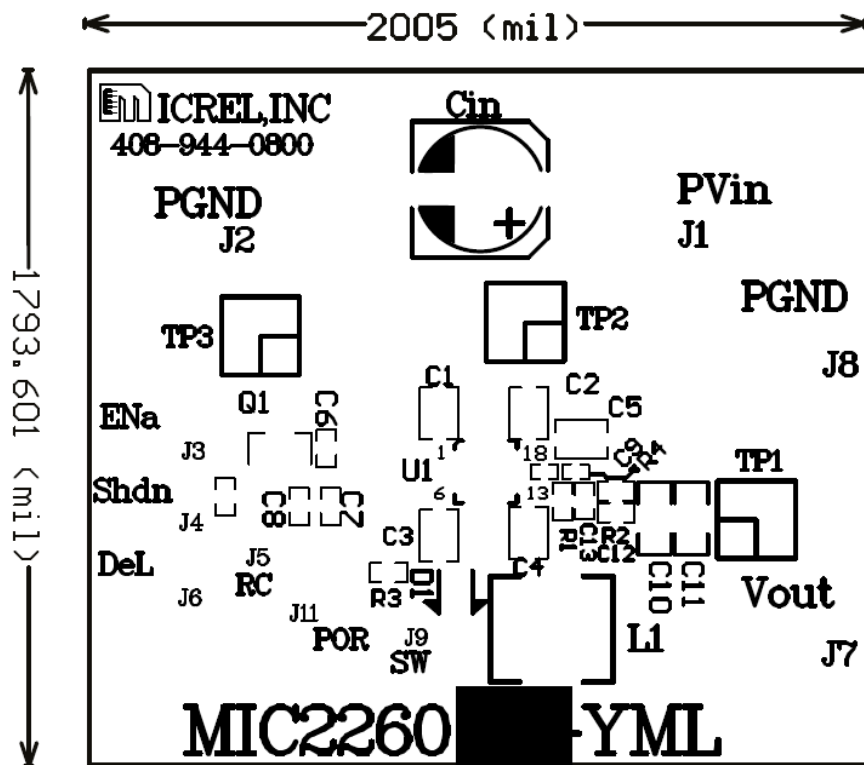
| Item | Part Number | Manufacturer | Description | Qty |
|--------------------|--------------------------|------------------------------|---|-----|
| C1, C2, C3, C4, C5 | C2012X5R0J226M | TDK ⁽¹⁾ | 22µF/6.3V, X5R, 0805, Ceramic Capacitor | 5 |
| | 08056D226MAT | AVX ⁽²⁾ | | |
| | GRM21BR60J226ME39L | Murata ⁽³⁾ | | |
| C6 | Open(VJ0603Y102KXQCW1BC) | Vishay ⁽⁴⁾ | 1nF, 0603, Ceramic Capacitor | 1 |
| | Open(GRM188R71H102KA01D) | Murata ⁽³⁾ | | |
| | Open(C1608C0G1H102J) | TDK ⁽¹⁾ | | |
| C7 | VJ0603Y471KXACW1BC | Vishay ⁽⁴⁾ | 470pF, 0603, Ceramic Capacitor | 1 |
| | C1608X7R1H471M | TDK ⁽¹⁾ | | |
| C8 | Open(VJ0603Y102KXQCW1BC) | Vishay ⁽⁴⁾ | 1nF, 0603, Ceramic Capacitor, | 1 |
| | Open(GRM188R71H102KA01D) | Murata ⁽³⁾ | | |
| | Open(C1608C0G1H102J) | TDK ⁽¹⁾ | | |
| C9 | GRM1555C1H390JZ01D | Murata ⁽³⁾ | 39pF/50V, COG, 0402, Ceramic Capacitor | 1 |
| | VJ0402A390KXQCW1BC | BC components ⁽⁵⁾ | | |
| C10, C11 | C3216X5R0J476M | TDK ⁽¹⁾ | 47µF/6.3V, X5R, 1206, Ceramic Capacitor | 2 |
| | GRM31CR60J476ME19 | Murata ⁽³⁾ | | |
| | GRM31CC80G476ME19L | Murata ⁽³⁾ | | |
| C12 | VJ0402A101KXQCW1BC | Vishay ⁽⁴⁾ | 100pF, 0603, Ceramic Capacitor | 1 |
| | GRM1555C1H101JZ01D | Murata ⁽³⁾ | | |
| C13 | GRM188R71H103KA01D | Murata ⁽³⁾ | 10nF, 0603, Ceramic Capacitor | 1 |

| | | | | |
|-----|------------------------|--------------------------------------|---|---|
| Cin | B41125A3477M000 | EPCOS ⁽¹⁰⁾ | 470 μ F/10V, Electrolytic, SMD, 8x10-Case | 1 |
| D1 | SS2P2L | Vishay ⁽⁴⁾ | Schottky Diode, 2A, 20V | 1 |
| | DFLS220 | Diodes, Inc. ⁽⁶⁾ | | |
| L1 | SPM6530T-1R0M120 | TDK ⁽¹⁾ | 1 μ H, 12A, size 7x6.5x3mm | 1 |
| | HCP0704-1R0-R | Coiltronics ⁽⁷⁾ | 1 μ H, 12A, size 6.8x6.8x4.2mm | |
| R1 | CRCW06031101FKEYE3 | Vishay ⁽⁴⁾ | Resistor, 1.1k, 0603, 1% | 1 |
| R2 | CRCW04026980FKEYE3 | Vishay ⁽⁴⁾ | Resistor, 698 Ω , 0603, 1% | 1 |
| R3 | CRCW06034752FKEYE3 | Vishay ⁽⁴⁾ | Resistor, 47.5k, 0603, 1% | 1 |
| R4 | CRCW04022002FKEYE3 | Vishay ⁽⁴⁾ | Resistor, 20k, 0402, 1% | 1 |
| R5 | Open(CRCW06031003FRT1) | Vishay ⁽⁴⁾ | Resistor, 100k, 0603, 1% | 1 |
| Q1 | Open(2N7002E) | Vishay ⁽⁴⁾ | Signal MOSFET, SOT-23-6 | 1 |
| | Open(CMDPM7002A) | Central Semiconductor ⁽⁸⁾ | | |
| U1 | MIC22602YML | Micrel ⁽⁹⁾ | Integrated 6A Synchronous Buck Regulator | 1 |

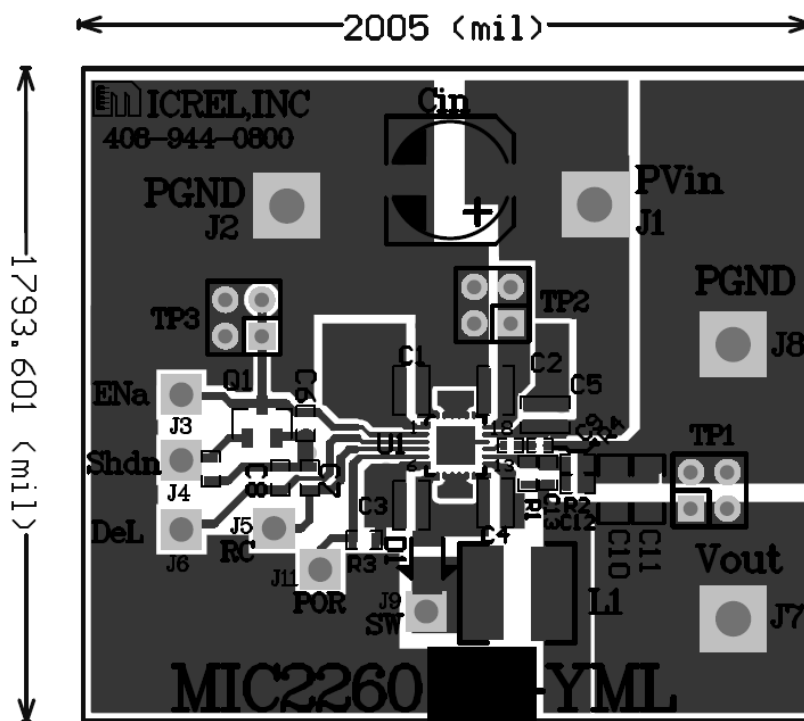
Notes:

1. TDK: www.tdk.com
2. AVX: www.avx.com
3. Murata: www.murata.com
4. Vishay: www.vishay.com
5. BC Components: www.bccomponents.com
6. Diodes, Inc.: www.diodes.com
7. Coiltronics: coiltronics.com
8. Central Semiconductor: www.centrasemi.com
9. **Micrel, Inc.:** www.micrel.com
10. EPCOS Inc. : www.epcos.com

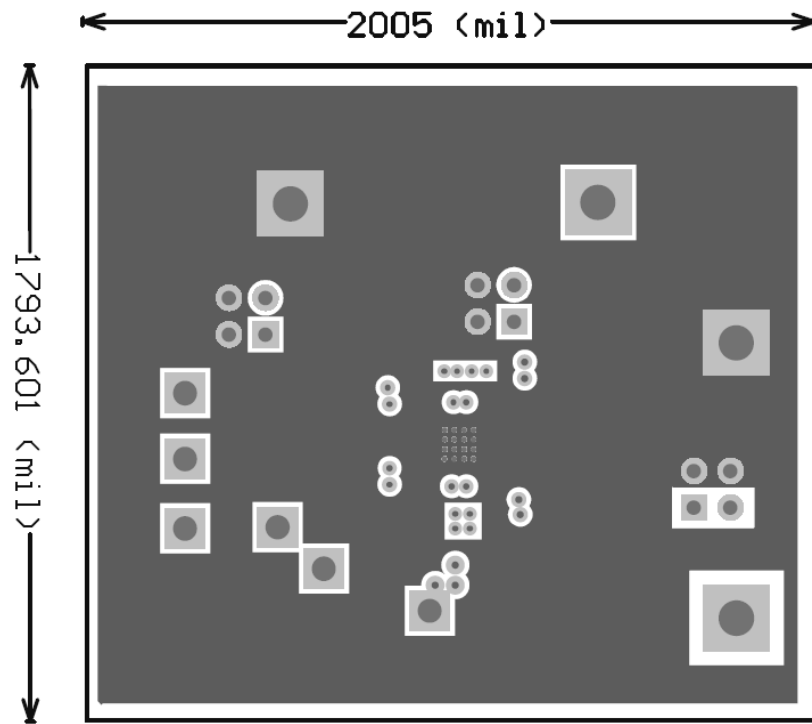
PCB Layout Recommendations



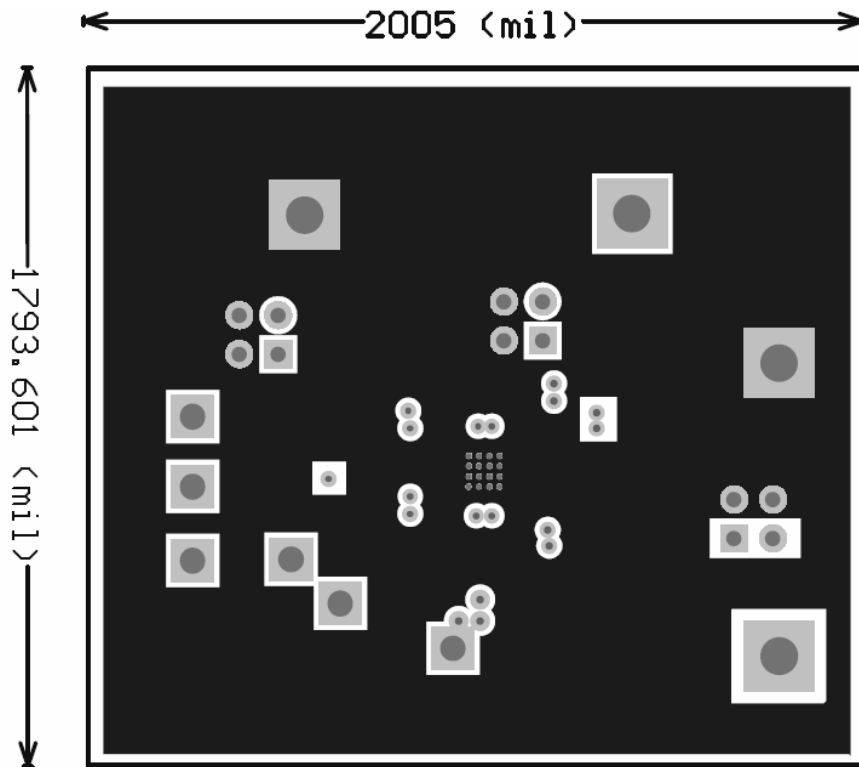
Top Silk



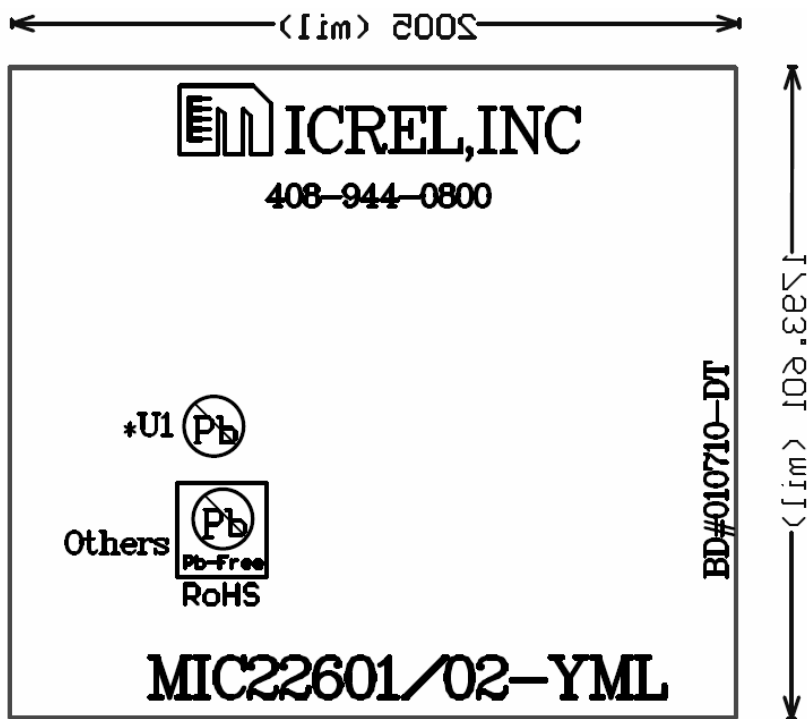
Top Layer



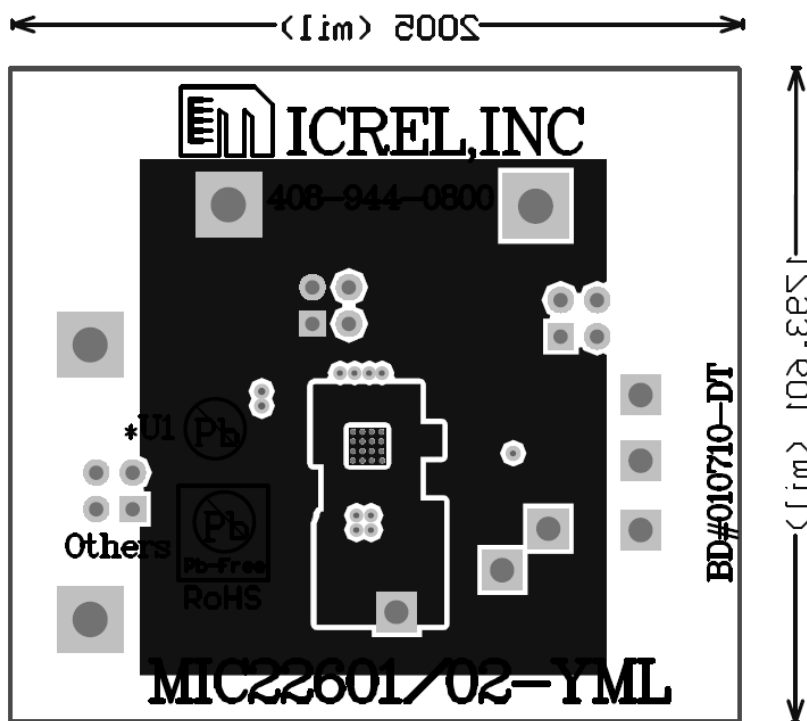
Mid Layer 1



Mid Layer 2



Bottom Silk



Bottom Layer

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