

### General Description

The MIC2788/MIC2789 are low-current, ultra-small, push-button reset supervisors with long set-up delays. The devices feature two manual reset inputs and two reset outputs. The devices initiate a reset for the reset timeout period when the /MR0 and /MR1 inputs are asserted low for a period longer than the set-up delay. The two manual reset inputs and long set-up period help to avoid unintended system resets. Both manual reset inputs can be tied together if a single push-button reset is desired.

The MIC2788 features integrated pull-up resistors on the /MR0 and /MR1 inputs, while the MIC2789 requires external pull-up resistors. The PDY input pin selects between a 2s, 4s or 6s set-up period. Factory-programmed reset timeout periods of 140ms (min.) and 240ms (min.) are available. An active-low, open-drain reset output (/RST) and an active-high, push-pull reset output (RSTP) provide flexibility when interfacing to various microcontrollers, PMICs, or load switches.

The MIC2788/MIC2789 consume a quiescent current of only 2.9µA and are offered in a tiny, space-saving 8-pin thin MLF<sup>®</sup> (2mm x 2mm x 0.55mm) package.

Data sheets and support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

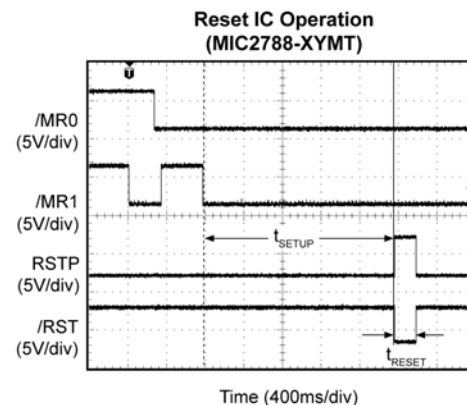
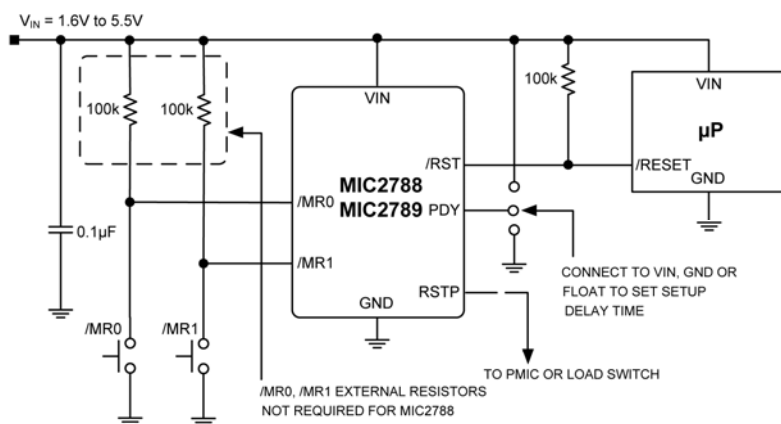
### Features

- 1.6V to 5.5V operating voltage
- 2.9µA supply current when /MR0, /MR1 are not asserted
- Asserting /MR0 and /MR1 for longer than set-up delay asserts reset output for the reset timeout period
- Programmable delay (PDY) input selects 2.0s, 4.0s or 6.0s set-up delay
- Factory-programmed 140ms (min.) or 240ms (min.) reset timeout period
- Integrated /MR0, /MR1 pull-up resistors (MIC2788)
- Dual Reset Outputs:
  - Open-drain active-low reset (/RST) output
  - Push-pull active-high reset (RSTP) output
- -40°C to 85°C ambient operating temperature range
- 8-pin 2mm x 2mm x 0.55mm thin MLF<sup>®</sup> package

### Applications

- Smart phones
- MP3 players
- Portable navigation devices
- Set-top boxes (STBs)
- Tablets/pads

### Typical Application



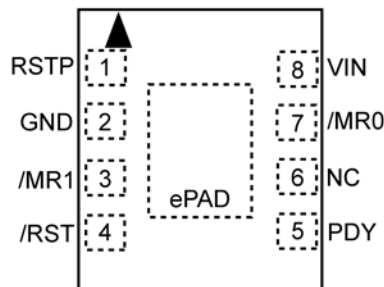
## Ordering Information <sup>(1)</sup>

Part Number	Marking	Minimum $t_{\text{RESET}}$ (ms)	Package <sup>(3,4)</sup>	Integrated Pull-Up Resistors
MIC2788-XYMT	8XA	140	8-Pin (2mm × 2mm) Thin MLF <sup>®</sup>	Yes
MIC2788-YYMT <sup>(2)</sup>	8YA	240	8-Pin (2mm × 2mm) Thin MLF <sup>®</sup>	Yes
MIC2789-XYMT	9XA	140	8-Pin (2mm × 2mm) Thin MLF <sup>®</sup>	No
MIC2789-YYMT <sup>(2)</sup>	9YA	240	8-Pin (2mm × 2mm) Thin MLF <sup>®</sup>	No

### Notes:

- All devices available in Tape and Reel only.
- Contact factory for availability.
- Thin MLF<sup>®</sup> ▲ = Pin 1 identifier.
- Thin MLF<sup>®</sup> is a Green RoHS compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

## Pin Configuration



**MIC2788/89**  
**8-Pin (2mm × 2mm) Thin MLF<sup>®</sup>**  
**Top View**

## Pin Description

Pin Number	Pin Name	Pin Function
1	RSTP	Active-High Push-Pull Reset Output. This output changes from low-to-high when both manual reset pins are pulled low for the setup delay period. RSTP remains high for the reset timeout delay duration after the setup delay period has elapsed.
2	GND	Supply Ground.
3	/MR1	Active-Low Manual Reset Input. The MIC2788 has an internal 65kΩ pull-up resistor to VIN while the MIC2789 requires an external pull-up resistor to VIN if used with a push-button. Pull this pin low to assert and force a reset. Pulling both manual reset inputs low for the setup delay time causes one reset output pulse for the reset timeout delay period. Connect to VIN if unused, do not leave floating.
4	/RST	Active-Low Open Drain Reset Output. This output changes from high to low when both manual reset pins are pulled low for the setup delay period. /RST remains low for the reset timeout delay after the setup delay has elapsed and it requires an external pull-up resistor.
5	PDY	Programmable Delay Input with Tri-State Connection. When left open, set-up delay is 2s, when connected to GND, set-up delay is 4s and when connected to VIN, set-up delay is 6s.

**Pin Description (Continued)**

Pin Number	Pin Name	Pin Function
6	NC	No Connect. Leave pin floating.
7	/MRO	Active-Low Manual Reset Input. The MIC2788 has an internal 65k $\Omega$ pull-up resistor to VIN while the MIC2789 requires an external pull-up resistor to VIN if used with a push-button. Pull this pin low to assert and force a reset. Pulling both manual reset inputs low for the setup delay time causes one reset output pulse for the reset timeout delay period. If unused, connect to VIN; do not leave floating.
8	VIN	Positive Supply Voltage. A minimum 0.1 $\mu$ F decoupling ceramic capacitor must be connected between VIN and GND close to the pins.
EPAD	EPAD	Exposed Pad. Connect to GND.

**Absolute Maximum Ratings<sup>(1)</sup>**

Supply Voltage ( $V_{IN}$ )	-0.3V to +6.0V
Reset Input Voltage (/MR0, /MR1)	-0.3V to $V_{IN} + 0.3V$
Open Drain Reset Output (/RST)	-0.3V to +6.0V
Push-Pull Reset Output (RSTP)	-0.3V to $V_{IN} + 0.3V$
Tri-State Programmable Delay (PDY)	-0.3V to $V_{IN} + 0.3V$
Lead Temperature (soldering, 10sec.)	260°C
Junction Temperature ( $T_J$ )	-40°C to +150°C
Storage Temperature ( $T_s$ )	-55°C to +150°C
ESD Rating (Human Body Model) <sup>(3)</sup>	2kV
ESD Rating (Machine Model) <sup>(3)</sup>	300V

**Operating Ratings<sup>(2)</sup>**

Supply Voltage ( $V_{IN}$ )	+1.6V to +5.5V
Reset Input Voltage (/MR0, /MR1)	0V to $V_{IN}$
Open Drain Reset Output (/RST)	0V to +5.5V
Push-Pull Reset Output (/RSTP)	0V to $V_{IN}$
Tri-State Programmable Delay (PDY)	0V to $V_{IN}$
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Junction Thermal Resistance	
2mm × 2mm Thin MLF <sup>®</sup> ( $\theta_{JA}$ )	90°C/W

**Electrical Characteristics<sup>(4)</sup>**

$V_{IN} = 3.0V$ ,  $T_A = 25^\circ C$ , **Bold** values indicate  $-40^\circ C \leq T_A \leq +85^\circ C$ ; unless noted otherwise.

Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Power Supply Input</b>					
Supply Voltage ( $V_{IN}$ )		<b>1.6</b>		<b>5.5</b>	V
Supply Current ( $I_{IN}$ )	$V_{IN} = 5V$ ; /MR0, /MR1, /RST, RSTP, and PDY open		3.4	<b>7.5</b>	$\mu A$
	$V_{IN} = 3V$ ; /MR0, /MR1, /RST, RSTP, and PDY open		2.9		
<b>Reset Time</b>					
Set-Up Delay ( $t_{SETUP}$ )	PDY = Open	<b>1.6</b>	2.0	<b>2.4</b>	s
	PDY = 0V	<b>3.2</b>	4.0	<b>4.8</b>	
	PDY = $V_{IN}$	<b>4.8</b>	6.0	<b>7.2</b>	
Reset Timeout Delay ( $t_{RESET}$ )	Option X	<b>140</b>	220	<b>280</b>	ms
	Option Y	<b>240</b>	350	<b>480</b>	
<b>Reset Outputs (/RST, RSTP)</b>					
Reset Output Voltage Low (/RST Output and RSTP Output) ( $V_{OL}$ )	$V_{IN} = 4.5V$ , $I_{SINK} = 3.2mA$			<b>0.3</b>	V
	$V_{IN} = 3.3V$ , $I_{SINK} = 2.5mA$			<b>0.3</b>	
	$V_{IN} = 1.6V$ , $I_{SINK} = 1.0mA$			<b>0.3</b>	
Reset Output Voltage High (RSTP Output) ( $V_{OH}$ )	$V_{IN} = 4.5V$ , $I_{SOURCE} = 0.8mA$	<b><math>0.8 \times V_{IN}</math></b>			V
	$V_{IN} = 2.7V$ , $I_{SOURCE} = 0.5mA$	<b><math>0.8 \times V_{IN}</math></b>			
	$V_{IN} = 1.6V$ , $I_{SOURCE} = 250\mu A$	<b><math>0.8 \times V_{IN}</math></b>			
/RST Output Leakage ( $I_{LO}$ )	$V_{/RST} = 5.5V$			<b>0.3</b>	$\mu A$

**Notes:**

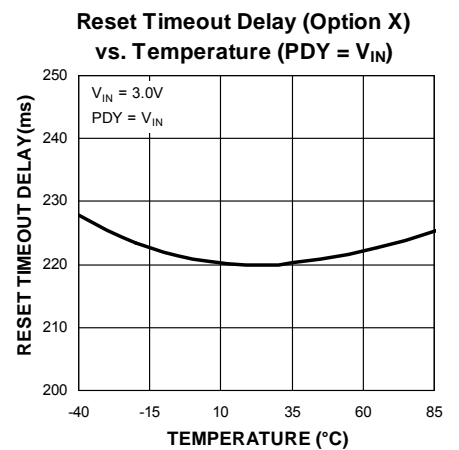
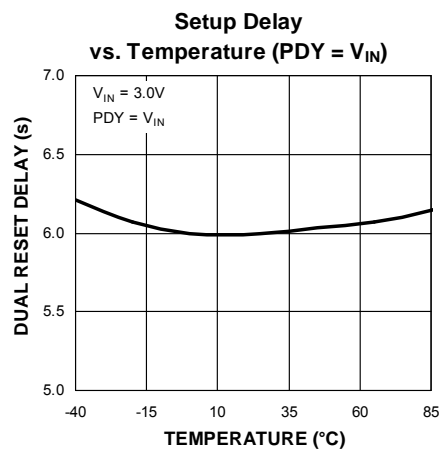
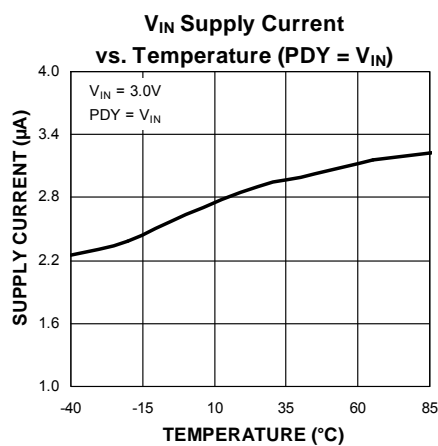
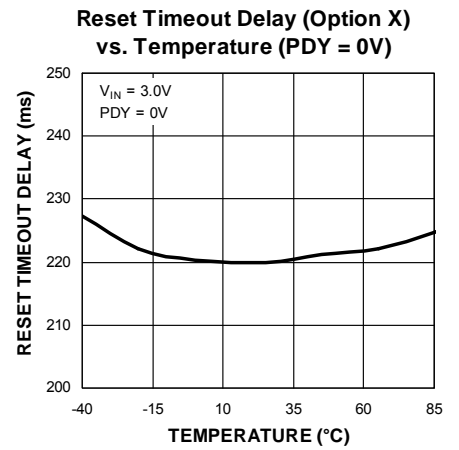
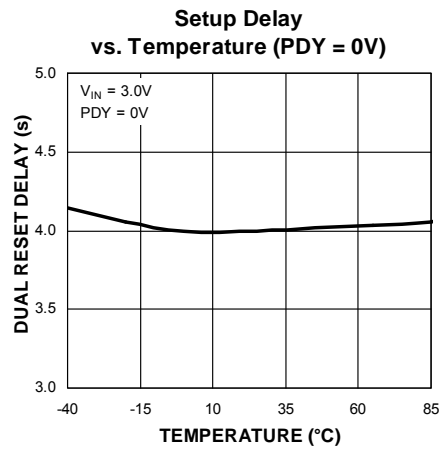
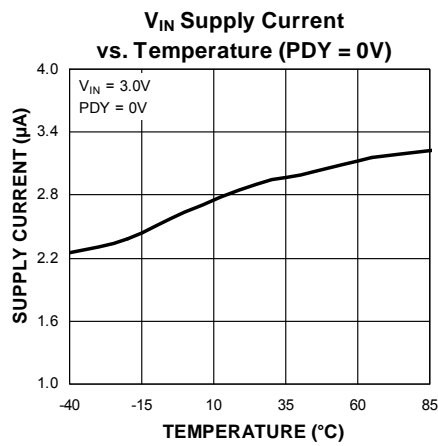
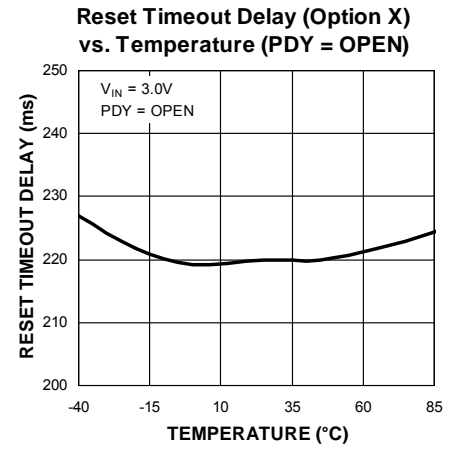
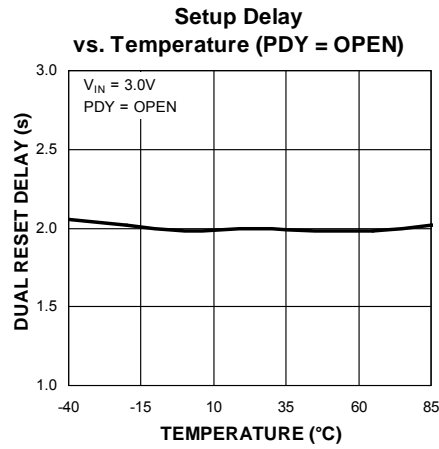
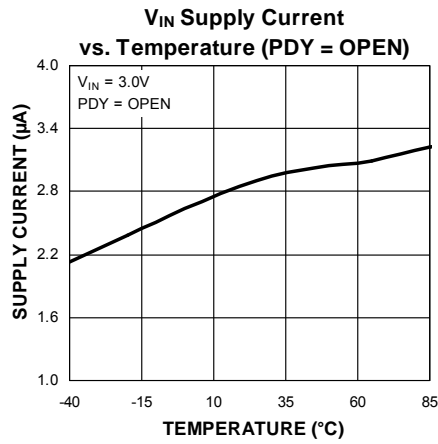
- Exceeding the absolute maximum rating may damage the device.
- The device is not guaranteed to function outside its operating rating.
- Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k $\Omega$  in series with 100pF.
- Specification for packaged product only.

## Electrical Characteristics <sup>(4)</sup> (Continued)

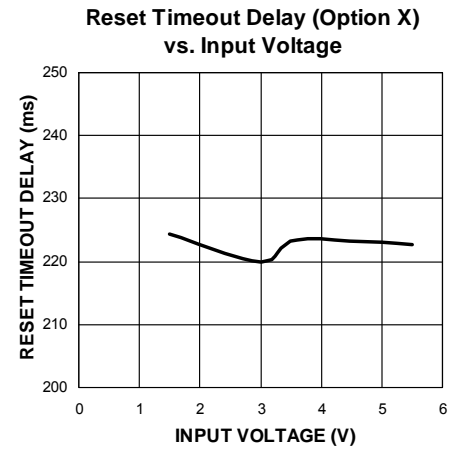
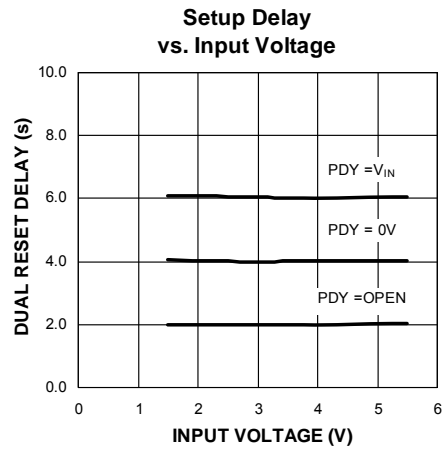
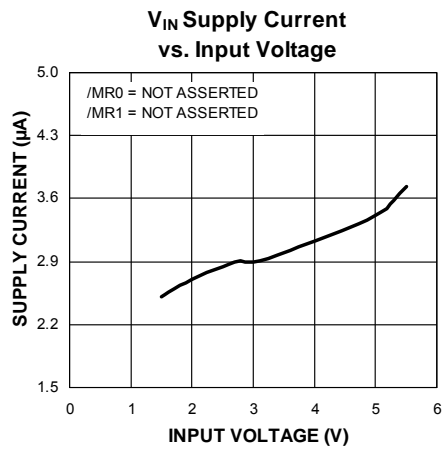
$V_{IN} = 3.0V$ ,  $T_A = 25^\circ C$ , **Bold** values indicate  $-40^\circ C \leq T_A \leq +85^\circ C$ ; unless noted otherwise.

Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Manual Reset Inputs (/MR0, /MR1)</b>					
Input High Voltage ( $V_{IH}$ )		<b>1.2</b>			V
Input Low Voltage ( $V_{IL}$ )				<b>0.3</b>	V
Internal Pull-Up Resistor ( $R_{PU}$ )	MIC2788 only		65		k $\Omega$
Leakage Current /MR0, /MR1 pin ( $I_{MR}$ )	/MR0, /MR1 inputs; MIC2789 only	<b>-1.0</b>		<b>1.0</b>	$\mu A$
<b>Programmable Setup Delay Input (PDY)</b>					
Input Bias Current PDY Pin ( $I_{PDY}$ )	PDY = $V_{IN}$ , /MR0 = /MR1 = 0V		+60		$\mu A$
	PDY = $V_{IN}$ , /MR0 = $V_{IN}$ or /MR1 = $V_{IN}$		100		nA
	PDY = 0V, /MR0 = /MR1 = 0V		-60		$\mu A$
	PDY = 0V, /MR0 = $V_{IN}$ or /MR1 = $V_{IN}$		100		nA

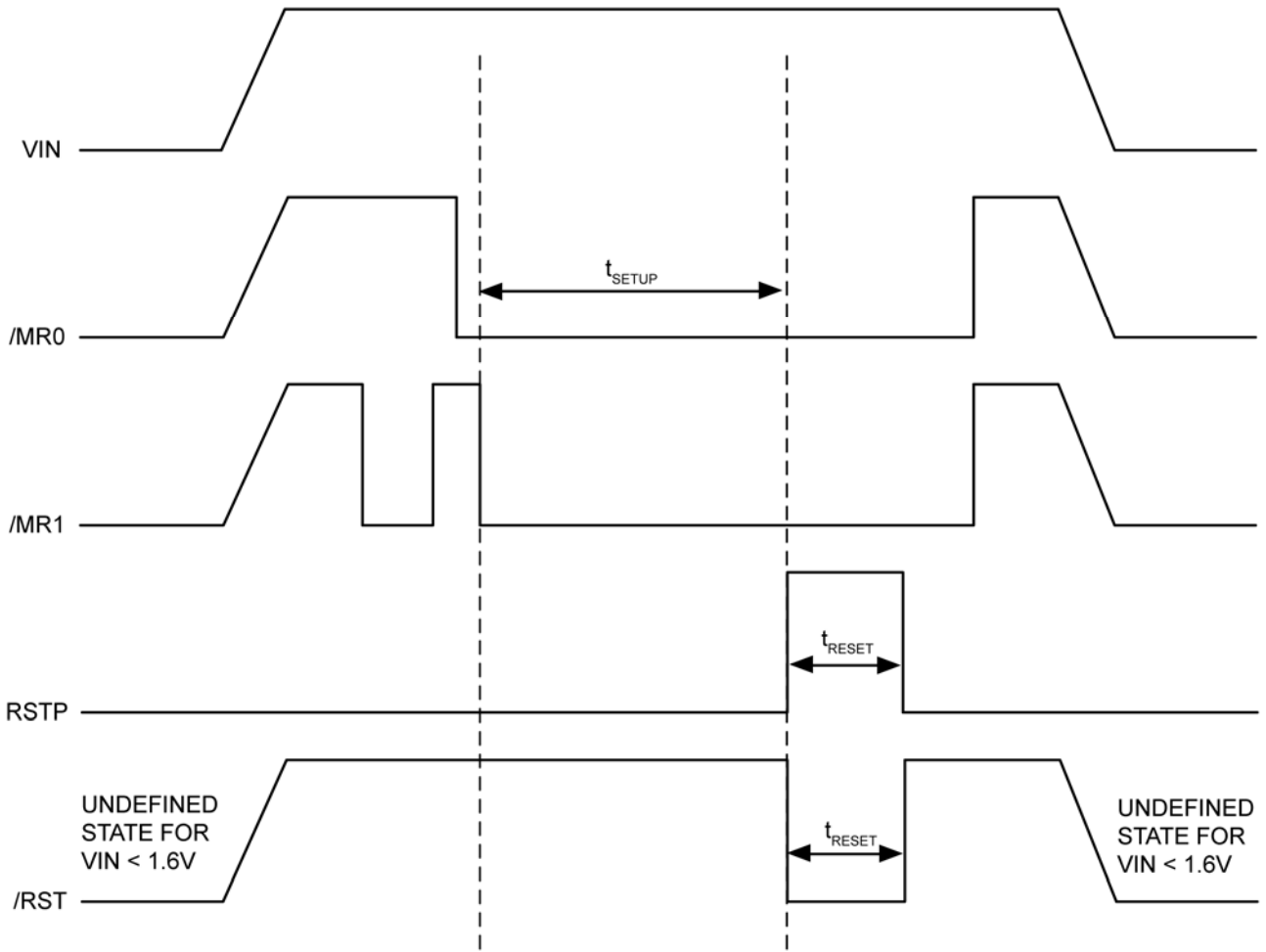
# Typical Characteristics



## Typical Characteristics (Continued)

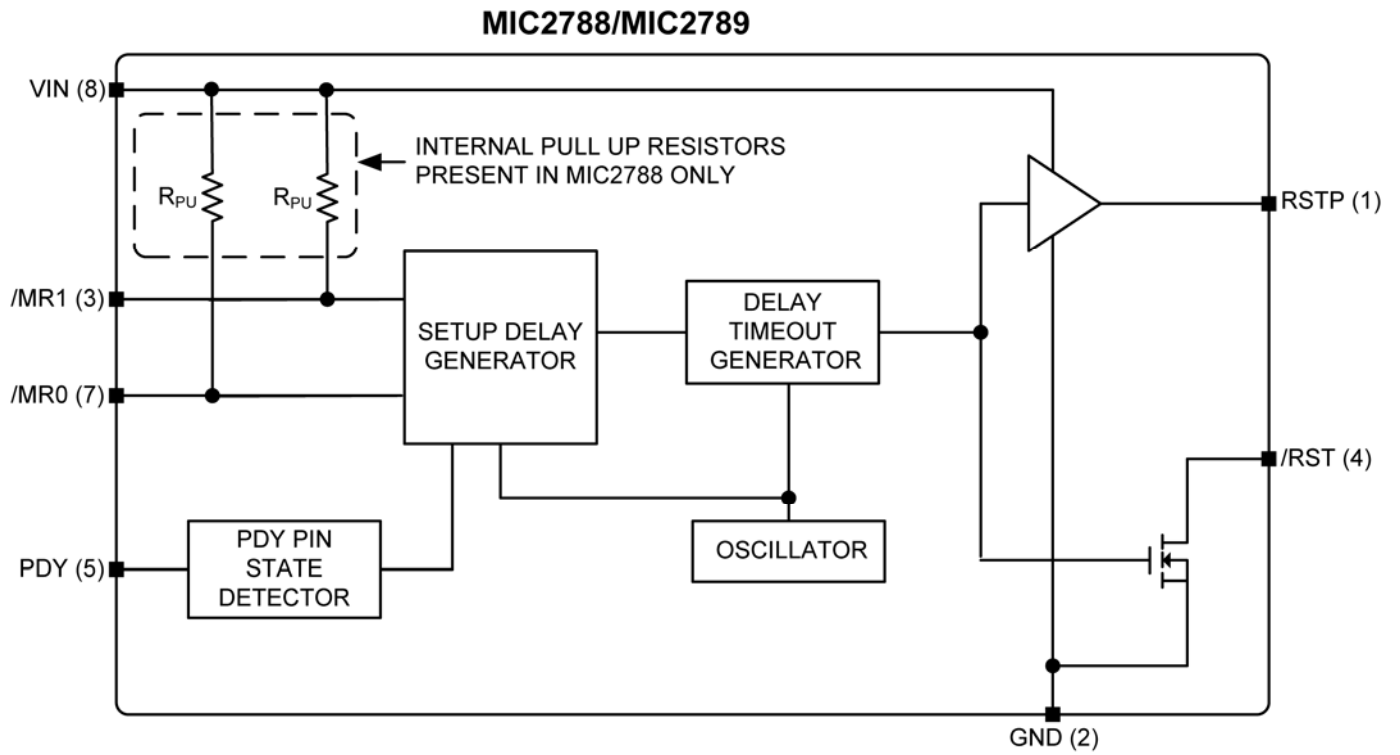


# Timing Diagram





# Functional Diagram



## Application Information

### Design and Product Advantages

The dual reset programmability of the MIC2788/MIC2789 allows for already existing manual push buttons to be used to generate a hardware reset based on pre-programmed timing requirements. This ability to increase the functionality of already existing buttons, allows for cost reduction and more robust phone designs. The dual reset delay time allows for significant protection against accidental resets due to its long time duration and dual push button requirement. The fixed reset timeout delay allows for more predictable phone operation during hardware resets. The tri-state option provides an easy to use way to select between three reset delay time options with no additional external components required.

### Supply Bypass Capacitor

A 0.1µF input bypass capacitor must be placed from  $V_{IN}$  (Pin 8) to GND (Pin 2).

### Programmable Delay Pin (PDY)

The MIC2788/MIC2789 has a programmable dual reset delay time,  $t_{SETUP}$ , that is set via a tri-state logic configuration. The PDY pin is intended to be connected to the  $V_{IN}$  supply voltage, ground or left floating.

PDY Configuration	$t_{SETUP}$
OPEN	2s
GND	4s
$V_{IN}$	6s

### Dual Manual Reset Inputs (/MR0, /MR1)

The /MR0, /MR1 input pins have integrated pull-up resistors for the MIC2788 but require external pull-up resistors for the MIC2789. A recommended value is 100kΩ to keep the current consumption low when the push-button switches are pressed. The behavior of the reset outputs is independent of the order in which the /MR0, /MR1 inputs are driven low. If both inputs are low for a setup delay time, only one reset pulse, of width  $t_{RESET}$ , is generated. Keeping both inputs low for a longer time does not generate additional reset output pulses.

### Reset Outputs (/RST and RSTP)

The /RST output is a simple open-drain N-channel MOSFET structure that requires a pull-up resistor. For most applications, the pull-up voltage will be the same as the power supply that supplies  $V_{IN}$  to the MIC2788/MIC2789. As shown in Figure 1, it is possible

to tie this resistor to some other voltage, other than  $V_{IN}$ , thus enabling level-shifting of the /RST output. The pull-up voltage must be limited to 5.5V or less to avoid damage to the MIC2788/MIC2789. The pull-up resistor must be small enough to supply current to the inputs and leakage paths that are driven by the /RST output. A recommended value is 100kΩ. Leave floating if the /RST pin is unused.

The RSTP pin is a push-pull output that is driven to  $V_{IN}$ . It cannot be level-shifted to another voltage. It is an inverted signal of /RST.

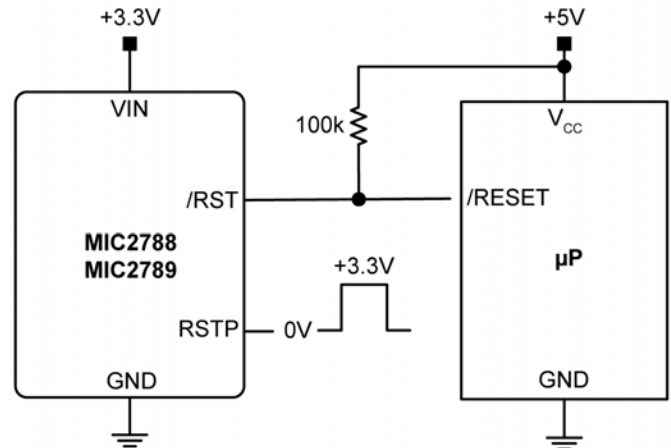


Figure 1. MIC2788/MIC2789 Used in Multiple Supply System

The reset outputs /RST and RSTP are asserted when the dual reset delay time,  $t_{SETUP}$ , is exceeded while the /MR0, /MR1 pins are driven low. Both the reset outputs remain asserted for a factory-programmed reset timeout delay time  $t_{RESET}$ . Two options are available with 140ms or 240ms minimum  $t_{RESET}$  duration. The /RST pin is driven active low while the RSTP pin is driven active high for the  $t_{RESET}$  duration. The reset outputs are de-asserted for  $V_{IN} < 1.6V$ .

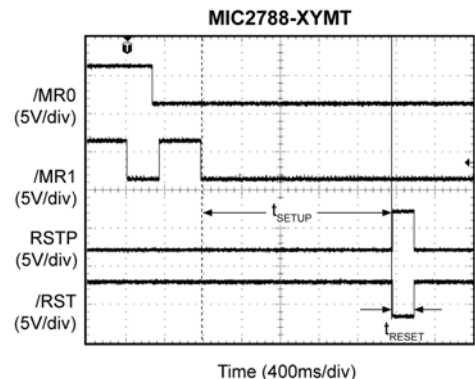


Figure 2. Manual Reset Function

### Typical Applications

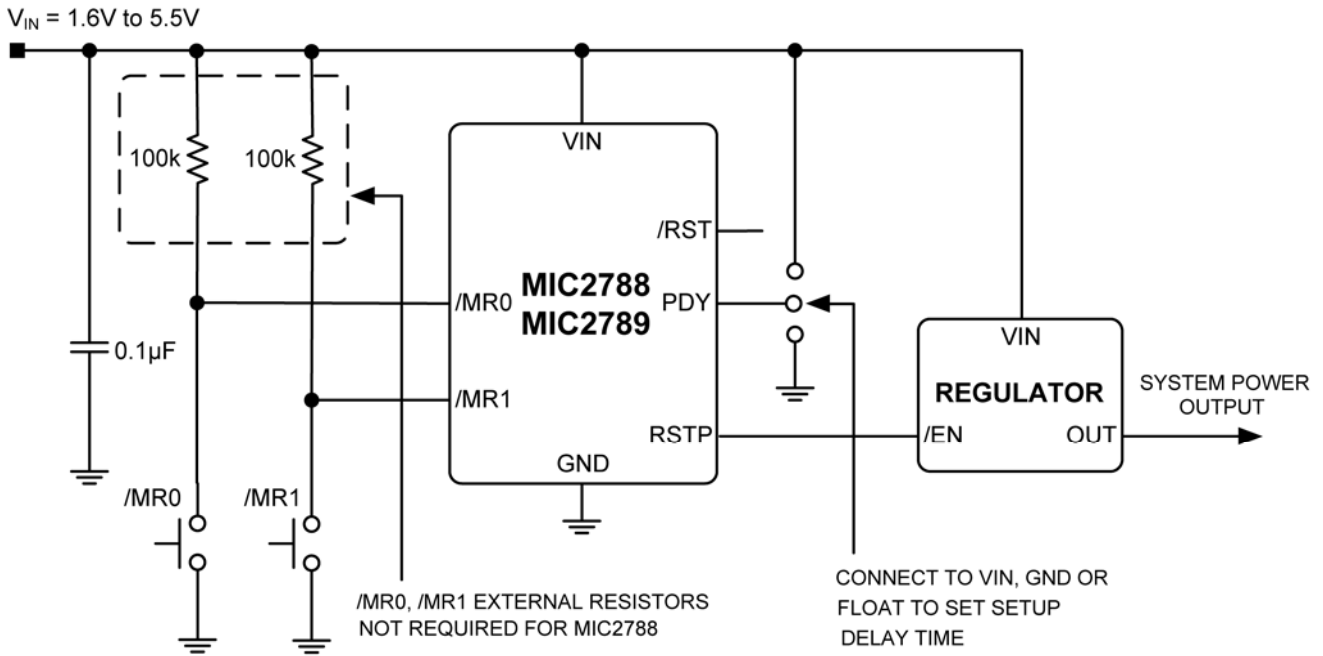


Figure 3. MIC2788/89 Used for Interrupting System Power

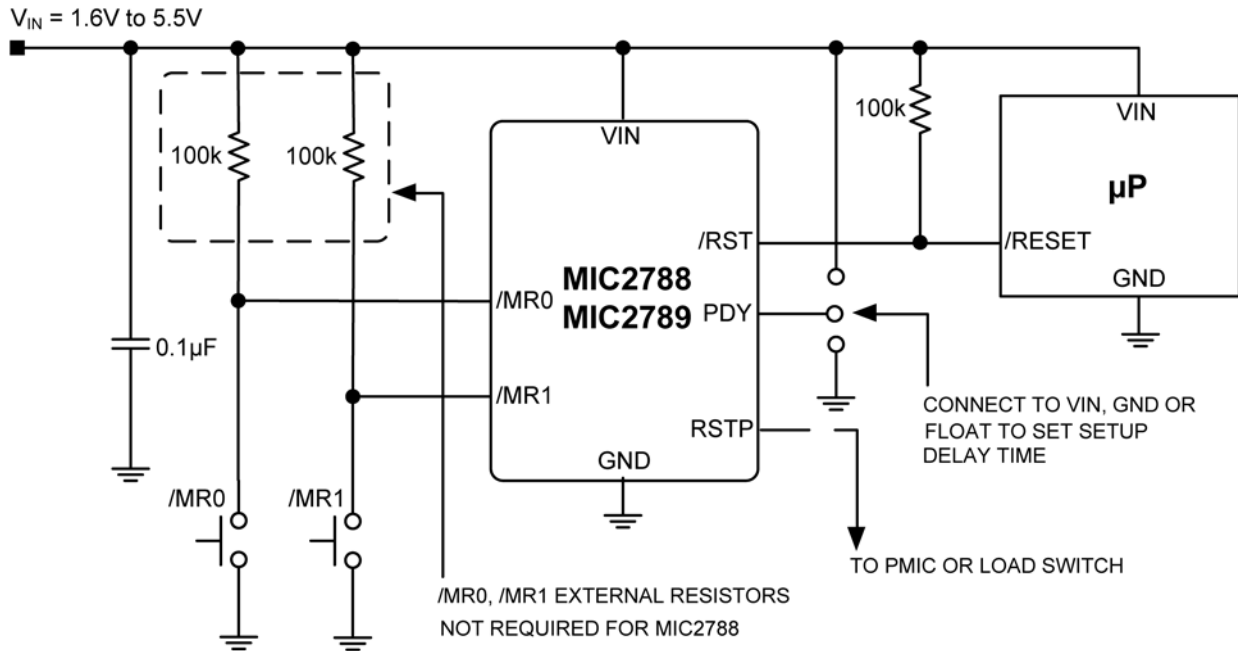
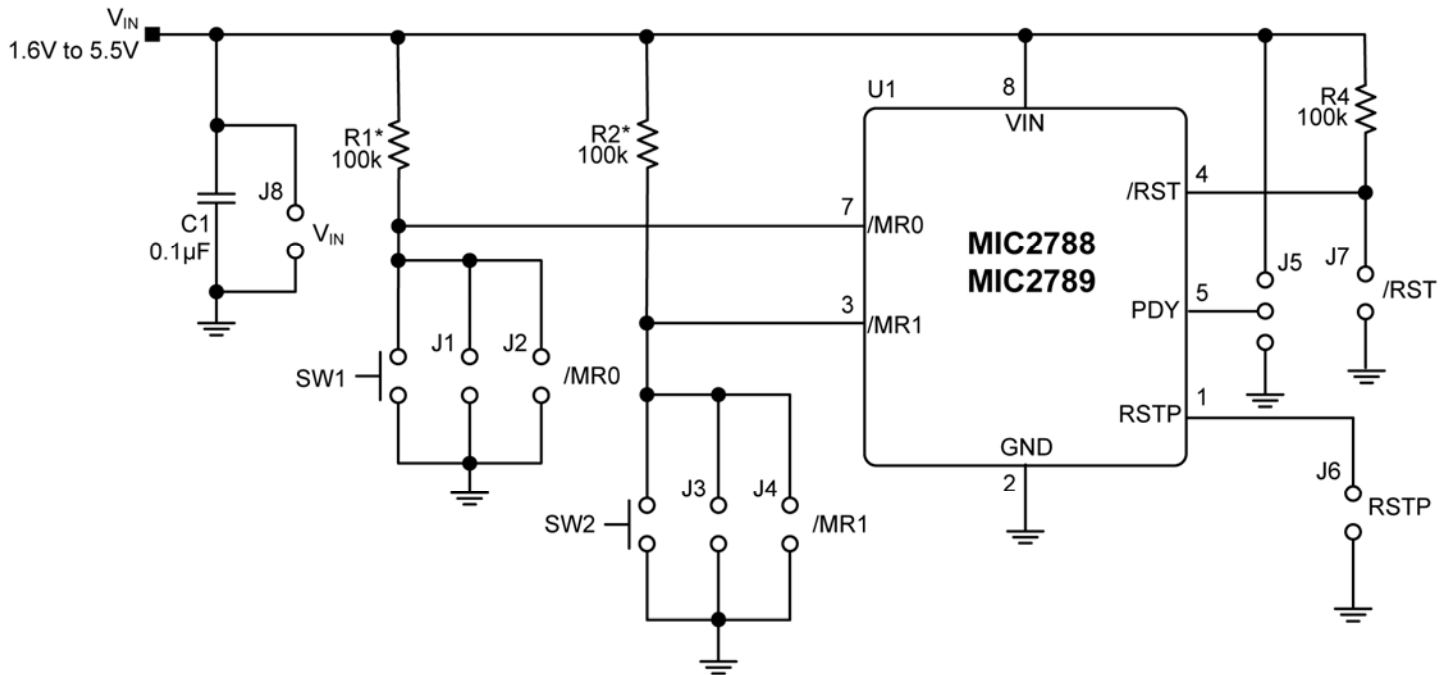


Figure 4. MIC2788/89 Used for Microcontroller Reset

### Evaluation Board Schematic



\*RESISTORS R1 AND R2 ARE FOR MIC2789. R1 AND R2 ARE NOT REQUIRED FOR MIC2788.

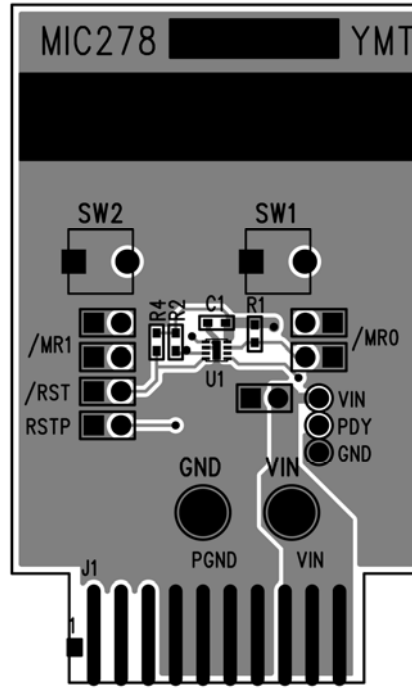
### Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1	GRM188R71C104KA01D	Murata <sup>(1)</sup>	0.1µF, 16V capacitor, X7R, 0603	1
R1, R2, R4	CRCW0603100KJNEA	Vishay <sup>(2)</sup>	100k, 5% resistor, 0603	3
U1	MIC2788-XYMT	Micrel, Inc. <sup>(3)</sup>	Push-Button Supervisor Reset ICs	1
	MIC2789-XYMT			

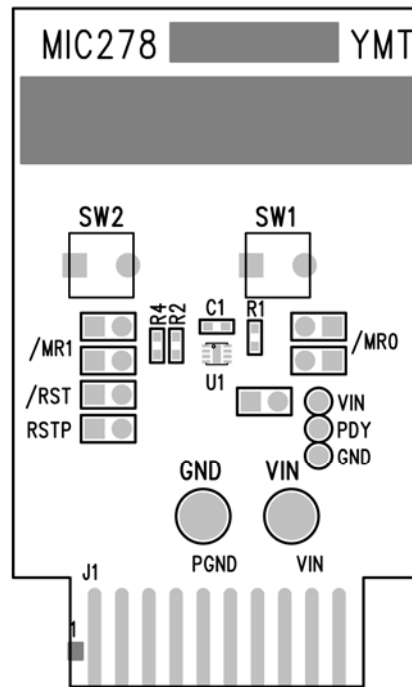
**Notes:**

1. Murata Tel: [www.murata.com](http://www.murata.com).
2. Vishay Tel: [www.vishay.com](http://www.vishay.com).
3. Micrel, Inc.: [www.micrel.com](http://www.micrel.com).

# PCB Layout Recommendations

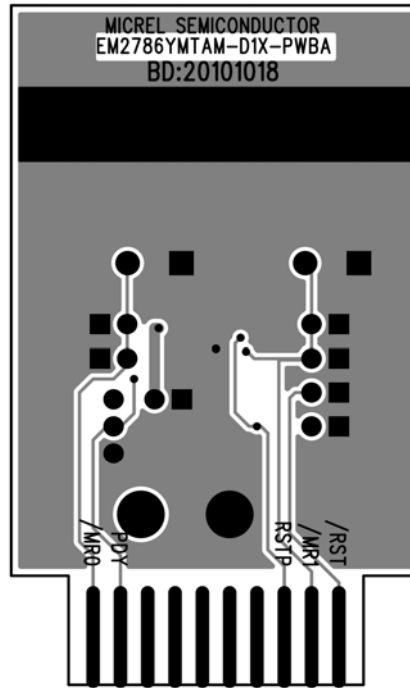


Top Layer

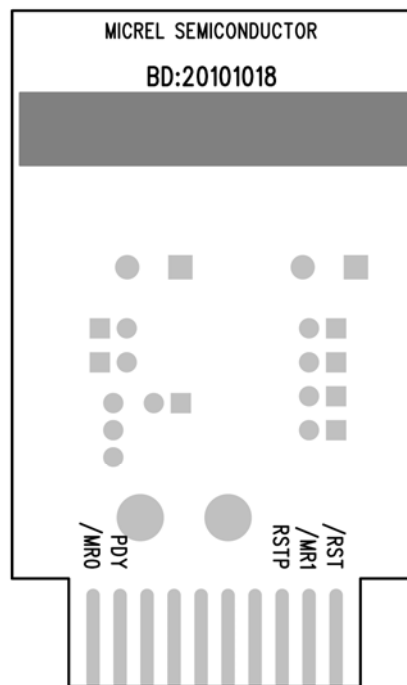


Top Silkscreen

## PCB Layout Recommendations (Continued)

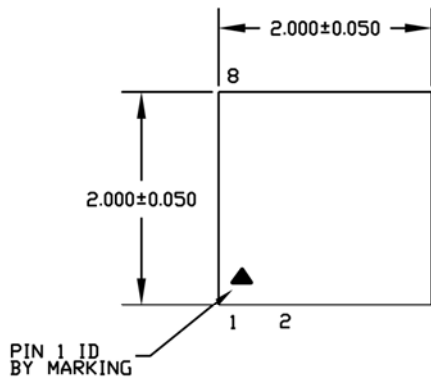


Copper Layer

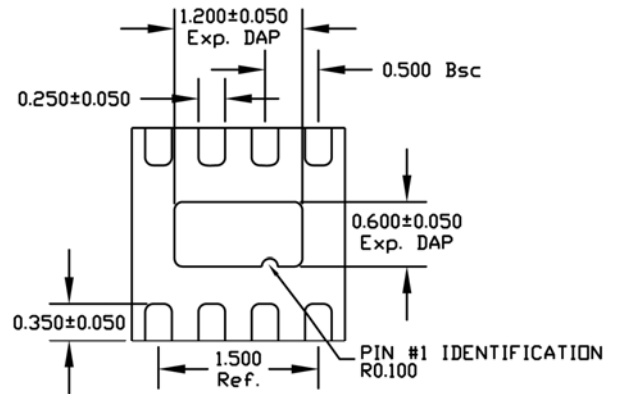


Bottom Silkscreen

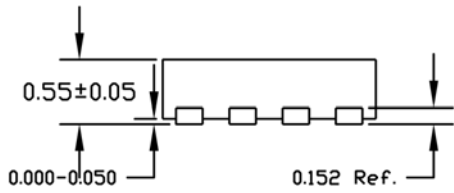
**Package Information**



TOP VIEW



BOTTOM VIEW



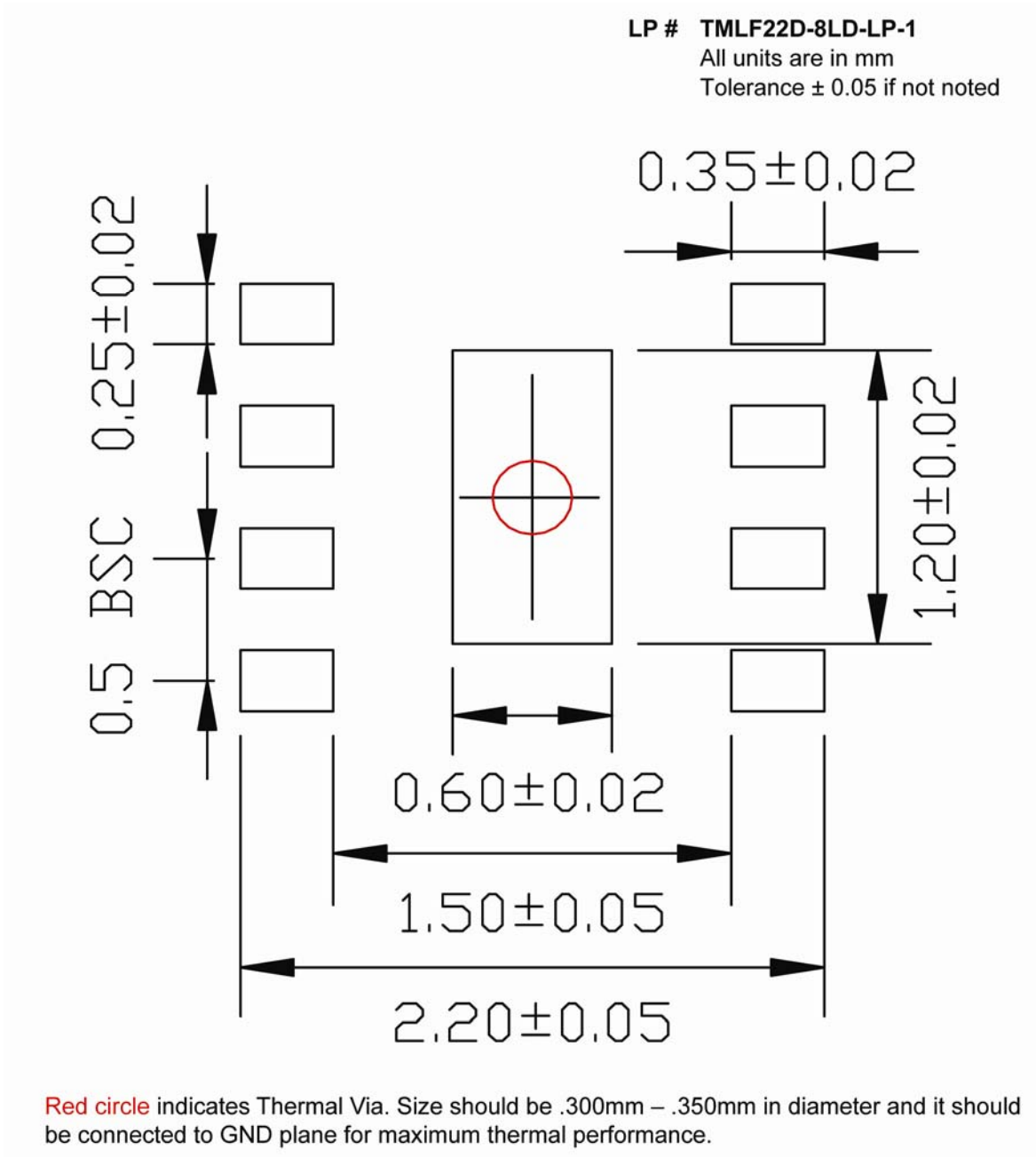
SIDE VIEW

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. MAX. PACKAGE WARPAGE IS 0.08 mm.
3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
4. PIN #1 ID WILL BE LASER MARKED.

**8-Pin 2mm x 2mm Thin MLF<sup>®</sup>**

### Recommended Landing Pattern



8-Pin 2mm x 2mm Thin MLF<sup>®</sup>



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