



# SM802117

## ClockWorks™ GbE (125MHz) Ultra-Low Jitter, LVPECL Frequency Synthesizer

### General Description

The SM802117 is a member of the ClockWorks™ family of devices from Micrel and provides an extremely low-noise timing solution for GbE Ethernet clock signals. It is based upon a unique patented RotaryWave® architecture that provides very low phase noise.

The device operates from a 3.3V or 2.5V power supply and synthesizes LVPECL output clocks at 125MHz. There are two differential clock outputs each with it's own OE pin allowing them to be disabled independently. The SM802117 accepts a 25 MHz crystal or LVCMOS reference clock.

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

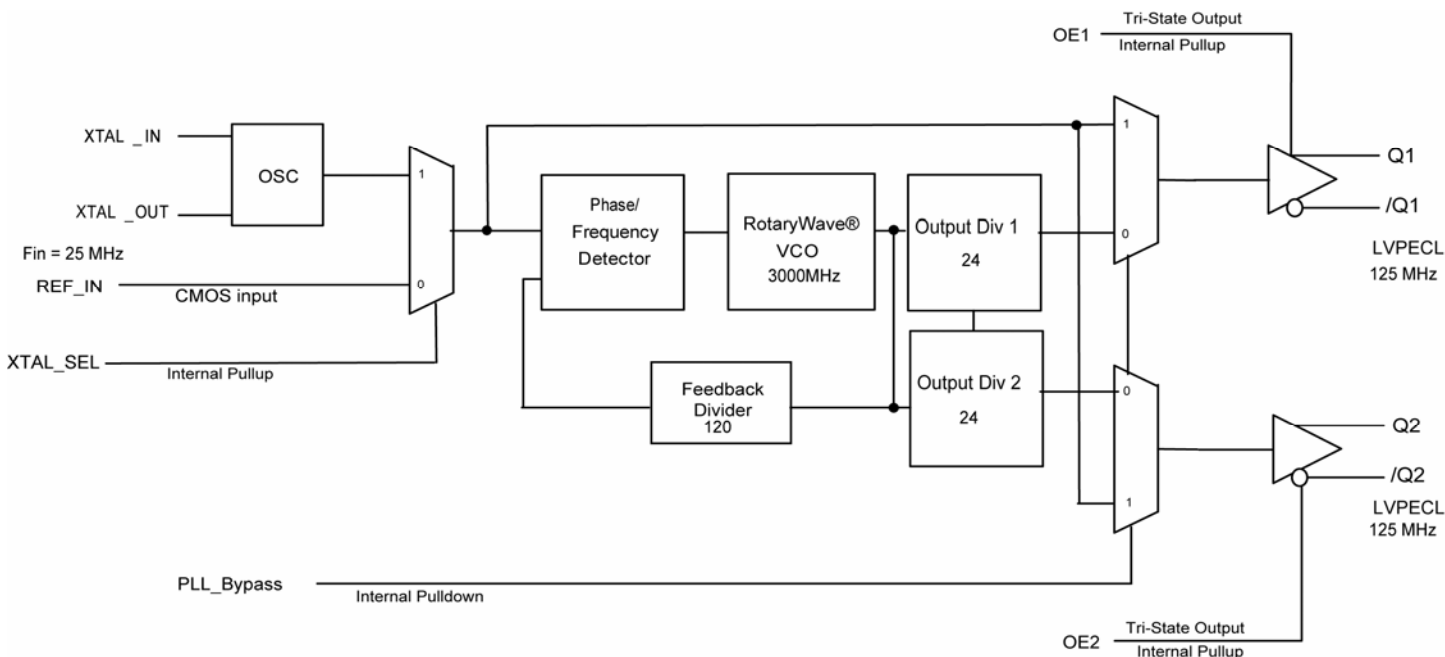
### Features

- Generates one or two LVPECL clock outputs at 125MHz
- 2.5V or 3.3V operating range
- Typical phase jitter @ 125MHz (1.875MHz to 20MHz): 115fs
- Industrial temperature range (-40°C to +85°C)
- Green, RoHS, and PFOS compliant
- Available in 24-pin 4mm × 4mm QFN package

### Applications

- Gigabit Ethernet - PHY

### Block Diagram



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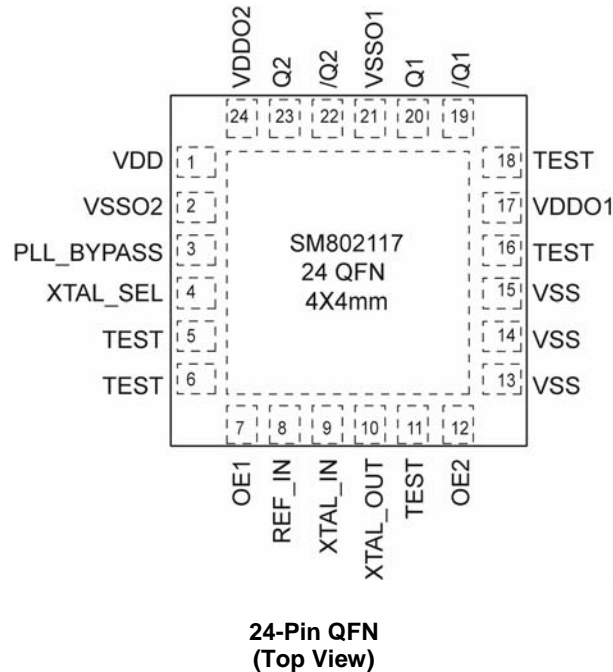
## Ordering Information

Part Number	Marking	Shipping	Temperature Range	Package
SM802117UMG	802117	Tube	-40°C to +85°C	24-Pin QFN
SM802117UMGTR	802117	Tape and Reel	-40°C to +85°C	24-Pin QFN

### Note:

1. Devices are Green, RoHS, and PFOS compliant.

## Pin Configuration



## Pin Description

Pin Number	Pin Name	Pin Type	Pin Level	Pin Function
19, 20	/Q1, Q1	O, (DIF)	LVPECL	Differential Clock Output from Bank 1 125MHz
22, 23	/Q2, Q2	O, (DIF)	LVPECL	Differential Clock Output from Bank 2 125MHz
24	VDDO2	PWR		Power Supply for Output Bank 2
2	VSSO2	PWR		Power Supply Ground for Output Bank 2
3	PLL_BYPASS	I, (SE)	LVC MOS	PLL Bypass, Selects Output Source 0 = Normal PLL Operation 1 = Output from Input Reference Clock or Crystal 45KΩ pull-down
4	XTAL_SEL	I, (SE)	LVC MOS	Selects PLL Input Reference Source 0 = REF_IN, 1 = XTAL, 45KΩ pull-up

## Pin Description (Continued)

Pin Number	Pin Name	Pin Type	Pin Level	Pin Function
5, 6, 11, 16, 18	TEST			Factory Test pins, Do not connect anything to these pins.
1	VDD	PWR		Core Power Supply
13, 14, 15	VSS	PWR		Core Power Supply Ground
17	VDDO1	PWR		Power Supply for Output Bank 1
21	VSSO1	PWR		Power Supply Ground for Output Bank 1
8	REF_IN	I, (SE)	LVC MOS	Reference Clock Input
9	XTAL_IN	I, (SE)	crystal	Crystal Reference Input, no load caps needed. See Fig. 5.
10	XTAL_OUT	O, (SE)	crystal	Crystal Reference Output, no load caps needed. See Fig. 5.
7	OE1	I, (SE)	LVC MOS	Output Enable, Q1 disables to tri-state, 0 = Disabled, 1 = Enabled, 45K $\Omega$ pull-up
12	OE2	I, (SE)	LVC MOS	Output Enable, Q2 disables to tri-state, 0 = Disabled, 1 = Enabled, 45K $\Omega$ pull-up

## Application Information

### Input Reference

When operating with a crystal input reference, do not apply a switching signal to REF\_IN.

### Crystal Layout

Keep the layers under the crystal as open as possible and do not place switching signals or noisy supplies under the crystal.

Crystal load capacitance is built inside the die so no external capacitance is needed. See the *Selecting a Quartz crystal for the Clockworks Flex I Family of Precision Synthesizers* application note for further details.

Contact Micrel's HBW applications group if you need assistance on selecting a suitable crystal for your application at [hbwhelp@micrel.com](mailto:hbwhelp@micrel.com).

## Truth Table

PLL_BYPASS	XTAL_SEL	INPUT	OUTPUT
0	–	–	PLL
1	–	–	XTAL/REF_IN
–	0	REF_IN	–
–	1	XTAL	–

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

Supply Voltage ( $V_{DD}$ , $V_{DDO1/2}$ )	+4.6V
Input Voltage ( $V_{IN}$ )	-0.50V to $V_{DD} + 0.5V$
Lead Temperature (soldering, 20sec.)	260°C
Case Temperature	115°C
Storage Temperature ( $T_s$ )	-65°C to +150°C

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

Supply Voltage ( $V_{DD}$ , $V_{DDO1/2}$ )	+2.375V to +3.465V
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Junction Thermal Resistance <sup>(3)</sup>	
QFN ( $\theta_{JA}$ )	
Still-Air	50°C/W
QFN ( $\psi_{JB}$ )	
Junction-to-Board	30°C/W

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

$$V_{DD} = V_{DDO1/2} = 3.3V \pm 5\% \text{ or } 2.5V \pm 5\%$$

$$V_{DD} = 3.3V \pm 5\%, V_{DDO1/2} = 2.5V \pm 5\%$$

$$T_A = -40^\circ\text{C to } +85^\circ\text{C.}$$

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{DD}$ , $V_{DDO1/2}$	2.5V Operating Voltage		2.375	2.5	2.625	V
$V_{DD}$ , $V_{DDO1/2}$	3.3V Operating Voltage		3.135	3.3	3.465	V
$I_{DD}$ REF_IN	Supply current $V_{DD} + V_{DDO}$ XTAL_SEL = 0 Outputs open	125MHz - 1 output		97	125	mA
		125MHz - 2 outputs		114	148	mA
$I_{DD}$ XTAL	Supply current $V_{DD} + V_{DDO}$ XTAL_SEL = 1 Outputs open	125MHz - 1 output		87	113	mA
		125MHz - 2 outputs		104	135	mA

**LVPECL OUTPUT DC Electrical Characteristics<sup>(4)</sup>**

$$V_{DD} = V_{DDO1/2} = 3.3V \pm 5\% \text{ or } 2.5V \pm 5\%$$

$$V_{DD} = 3.3V \pm 5\%, V_{DDO1/2} = 2.5V \pm 5\%$$

$$T_A = -40^\circ\text{C to } +85^\circ\text{C. } R_L = 50\Omega \text{ to } V_{DDO} - 2V$$

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{OH}$	Output High Voltage		$V_{DDO} - 1.145$	$V_{DDO} - 0.97$	$V_{DDO} - 0.845$	V
$V_{OL}$	Output Low Voltage		$V_{DDO} - 1.945$	$V_{DDO} - 1.77$	$V_{DDO} - 1.645$	V
$V_{SWING}$	Output Voltage Swing		0.6	0.8	1.0	V

**Note:**

1. Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB.
4. The circuit is designed to meet the AC and DC specifications shown in the above table(s) after thermal equilibrium has been established.

**LVCMOS (PLL\_BYPASS, XTAL\_SEL, OE1/2) DC Electrical Characteristics<sup>(4)</sup>**

$V_{DD} = 3.3V \pm 5\%$ , or  $2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ .

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{IH}$	Input High Voltage		2		$V_{DD} + 0.3$	V
$V_{IN}$	Input Low Voltage		-0.3		0.8	V
$I_{IH}$	Input High Current	$V_{DD} = V_{IN} = 3.465V$			150	$\mu A$
$I_{IL}$	Input Low Current	$V_{DD} = 3.465V, V_{IN} = 0V$	-150			$\mu A$

**REF\_IN DC Electrical Characteristics<sup>(4)</sup>**

$V_{DD} = 3.3V \pm 5\%$ , or  $2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ .

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
$V_{IH}$	Input High Voltage		1.1		$V_{DD} + 0.3$	V
$V_{IL}$	Input Low Voltage		-0.3		0.6	V
$I_{IN}$	Input Current	$XTAL\_SEL = V_{IL}, V_{IN} = 0V$ to $V_{DD}$	-5		5	$\mu A$
		$XTAL\_SEL = V_{IH}, V_{IN} = V_{DD}$		20		$\mu A$

**Crystal Characteristics**

Parameter	Condition	Min.	Typ.	Max.	Units
Mode of Oscillation	10 to 12pF Load	Fundamental, Parallel Resonant			
Frequency			25		MHz
Equivalent Series Resistance (ESR)				50	$\Omega$
Shunt Capacitor, C0			1	5	pF
Correlation Drive Level			10	100	$\mu W$

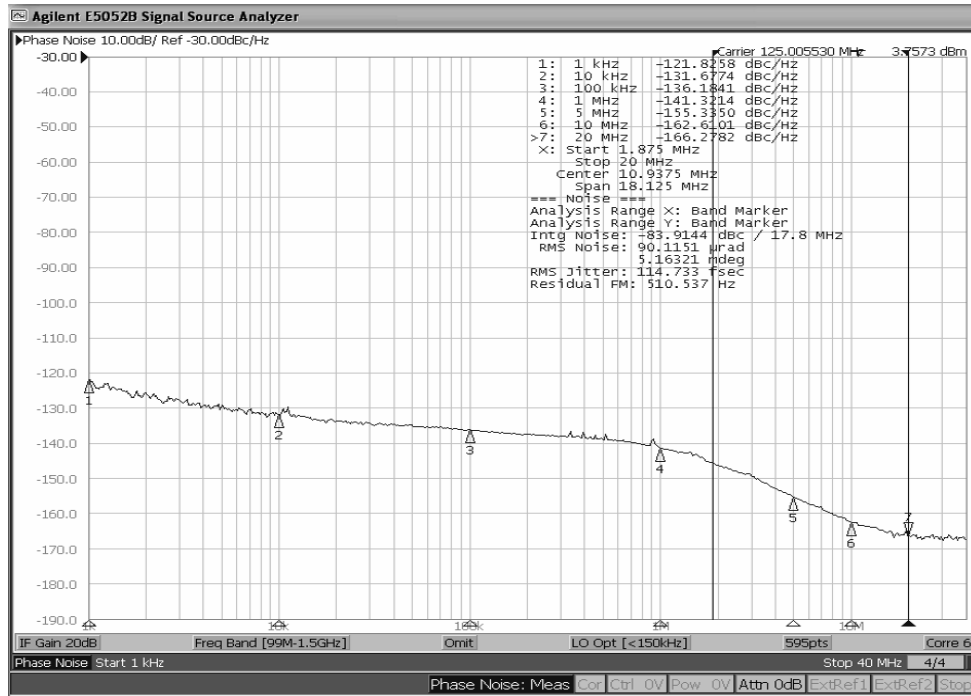
**AC Electrical Characteristics**<sup>(4, 5)</sup>
 $V_{DD} = V_{DDO1/2} = 3.3V \pm 5\% \text{ or } 2.5V \pm 5\%$ 
 $V_{DD} = 3.3V \pm 5\%, V_{DDO1/2} = 2.5V \pm 5\%$ 
 $T_A = -40^\circ\text{C to } +85^\circ\text{C. } R_L = 50\Omega \text{ to } V_{DDO} - 2V$ 

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
F <sub>OUT</sub>	Output Frequency			125		MHz
F <sub>REF</sub>	Reference Input Frequency			25		MHz
T <sub>R</sub> /T <sub>F</sub>	LVPECL Output Rise/Fall Time	20% – 80%	80	175	350	ps
ODC	Output Duty Cycle		48	50	52	%
T <sub>SKEW</sub>	Output-to-Output Skew	Within bank. Note <sup>6</sup>			45	ps
T <sub>LOCK</sub>	PLL Lock Time				20	ms
T <sub>jitter</sub> (∅)	RMS Phase Jitter <sup>(7)</sup>	125MHz Integration Range (1.875MHz – 20MHz) Integration Range (12kHz – 20MHz)		115 254		fs
	Spurious Noise Components	25MHz		-85		dBc

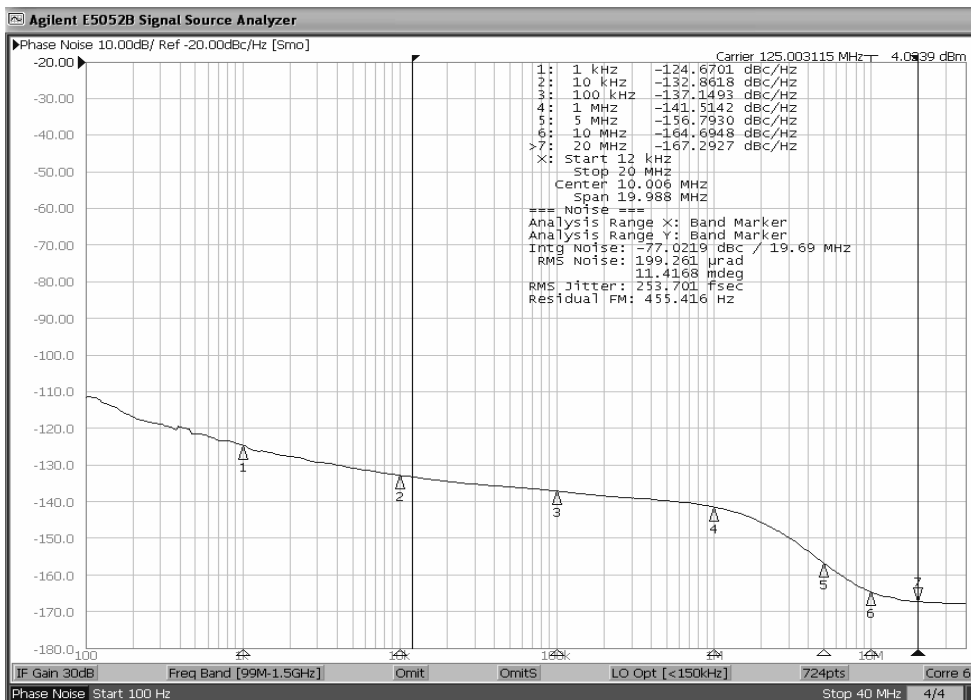
**Notes:**

- All phase noise measurements were taken with an Agilent 5052B phase noise system.
- Defined as skew between outputs at the same supply voltage and with equal load conditions and same frequency; Measured at the output differential crossing points.
- Measured using 25MHz crystal as the input reference source. If using an external reference input, use a low phase noise source. With an external reference, the phase noise will follow the input source phase noise up to about 1MHz.

# Phase Noise Plots



Phase Noise Plot: 125MHz, 1.875MHz – 20MHz 115fS



Phase Noise Plot: 125MHz, 12kHz – 20MHz 254fS

## Timing Diagrams

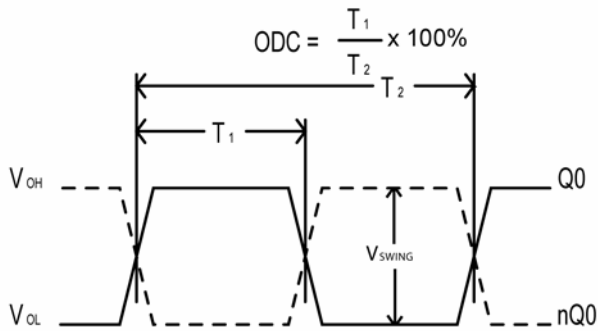


Figure 1. Duty Cycle Timing

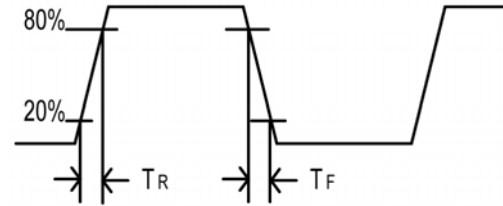


Figure 2. All Outputs Rise/Fall Time

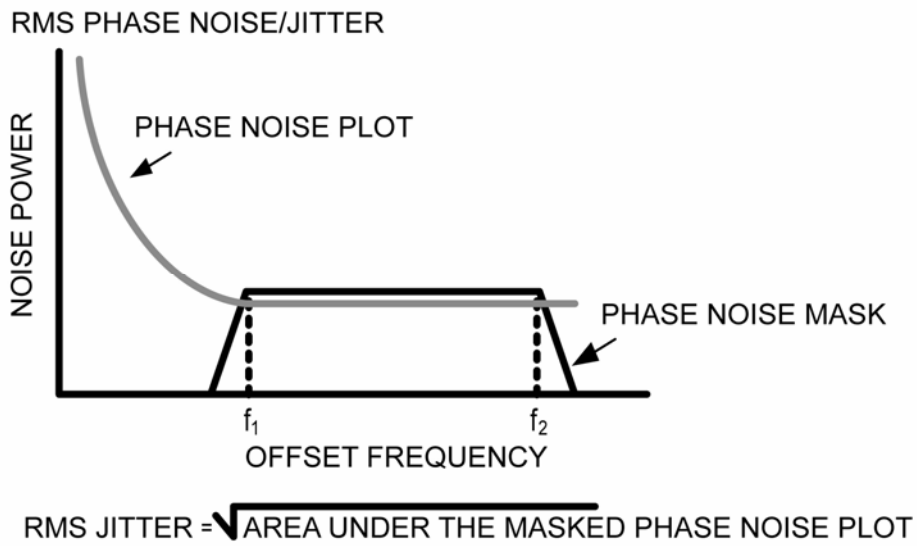


Figure 3. RMS Phase/Noise/Jitter



## Input and Output Stage

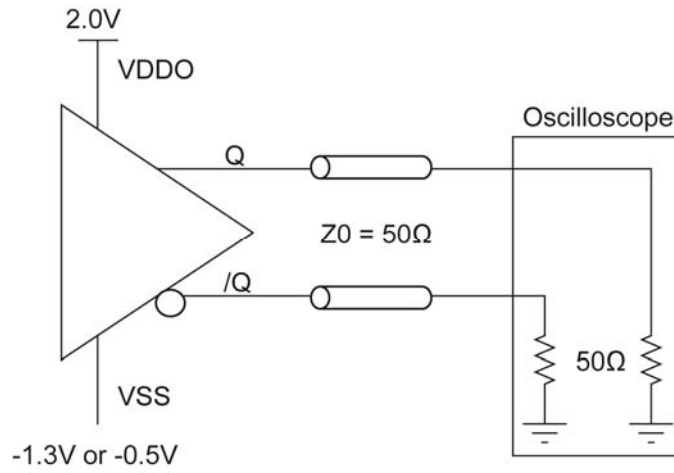


Figure 4. LVPECL Output Load and Test Circuit

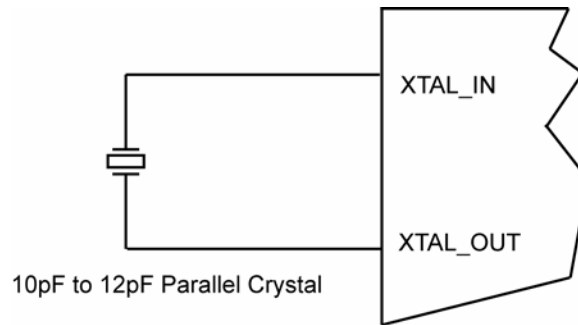
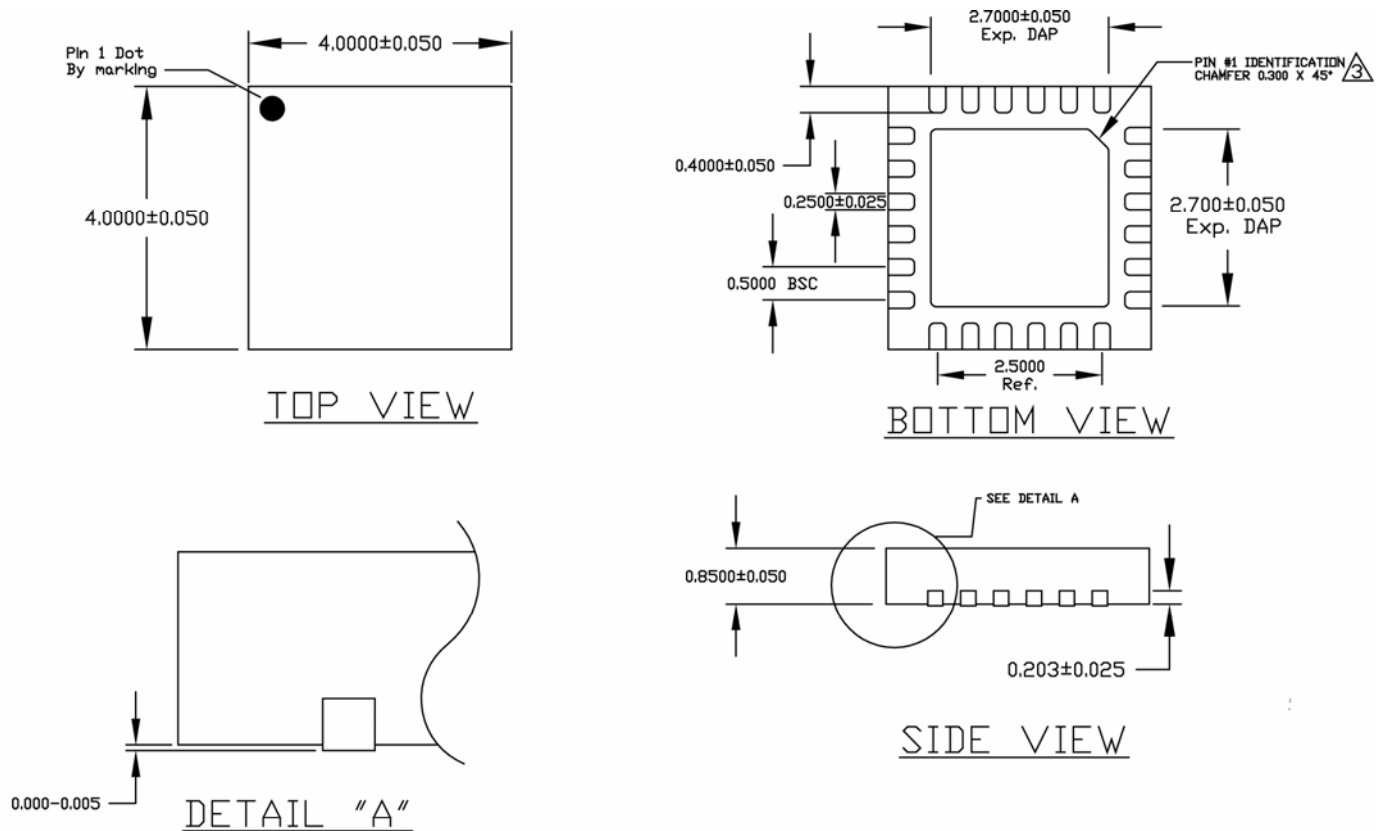


Figure 5. Crystal Input Interface

## Package Information



### NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS (mm).
2. THE PIN#1 IDENTIFIER MUST EXIST ON THE TOP SURFACE OF PACKAGE BY USING IDENTIFICATION MARK OR OTHER FEATURE OF PACKAGE BODY.

③ CHAMFER STYLE PIN 1 IDENTIFIER ON BOTTOM SIDE

### 24-Pin QFN

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