1 OUTPUT PCIE GEN1/2/3 SYNTHESIZER 5V41234

Typical Applications

One output synthesizer for PCIe Gen1/2/3

Description

The 5V41234 is a PCIe Gen2/3 compliant spread spectrum capable clock generator. The device has 1 differential HCSL output and can be used in communication or embedded systems to substantially reduce electro-magnetic interference (EMI). Spread spectrum can be enabled via a select pin.

Output Features

- 1 - 0.7V current mode differential HCSL output pairs

Features

- 3 x 3 mm 16-QFN package; very small board footprint
- Spread-spectrum capable; reduces EMI
- Outputs can be terminated to LVDS; can drive a wider variety of devices
- Spread enable via pin selection; no software required to configure device
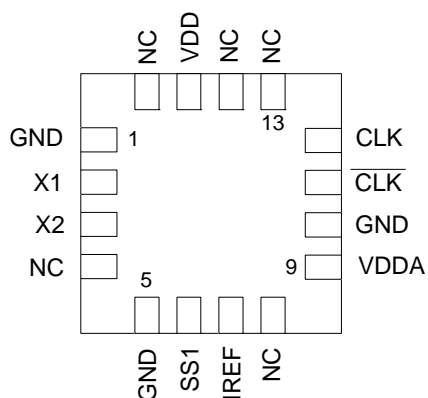- Industrial temperature range available; supports demanding embedded applications

Key Specifications

- Cycle-to-cycle jitter < 100 ps
- PCIe Gen2 phase jitter < 3.0ps RMS
- PCIe Gen3 phase jitter < 1.0ps RMS

Block Diagram
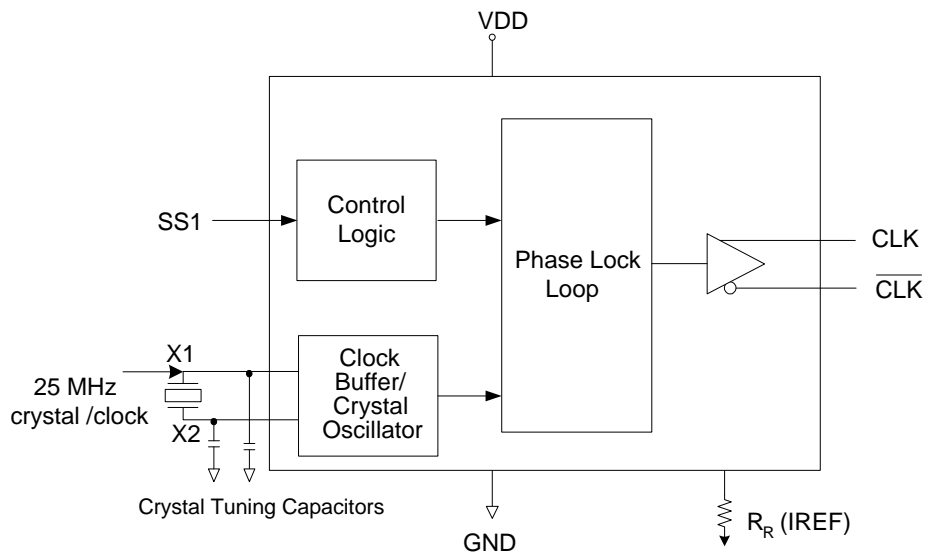
Pin Assignment

16-pin QFN

Spread Spectrum Select Table

SS1	Spread%
0	-0.5% down
1	No spread

Pin Descriptions

Pin Number	Pin Name	Pin Type	Pin Description
1	GND	Power	Connect to ground.
2	X1	XI	Crystal or clock input. Connect to 25MHz crystal or single-ended clock.
3	X2	XO	Crystal connection. Connect to parallel mode crystal. Leave floating if X1 is driven by single-ended clock.
4	NC	–	No connect.
5	GND	Power	Connect to ground.
6	SS1	Input	Spread Select 1. See table above. Internal pull-up resistor.
7	IREF	Output	475Ω precision resistor must be attached to this pin, which is connected to internal current source.
8	NC	–	No connect.
9	VDDA	Power	Connect to 3.3V and filter as analog supply.
10	GND	Power	Connect to ground.
11	$\overline{\text{CLK}}$	Output	HCSL complementary output clock.
12	CLK	Output	HCSL true output clock.
13	NC	–	No connect.
14	NC	–	No connect.
15	VDD	Power	Connect to 3.3V for OSC and digital circuits.
16	NC	–	No connect.

Applications Information

External Components

A minimum number of external components are required for proper operation.

Decoupling Capacitors

Decoupling capacitors of $0.01\mu F$ should be connected between VDD and the ground plane (pin 4) as close to the VDD pin as possible. Do not share ground vias between components. Route power from power source through the capacitor pad and then into IDT pin.

Crystal

A 25 MHz fundamental mode parallel resonant crystal with C_L = 16pF should be used. This crystal must have less than 300 ppm of error across temperature in order for the 5V41234 to meet PCI Express specifications.

Crystal Capacitors

Crystal capacitors are connected from pins X1 to ground and X2 to ground to optimize the accuracy of the output frequency.

C_L= Crystal's load capacitance in pF

Crystal Capacitors (pF) = $(C_L - 8) * 2$

For example, for a crystal with a 16 pF load cap, each external crystal cap would be 16pF. (16-8)*2=16.

Current Source (Iref) Reference Resistor - R_R

If board target trace impedance (Z) is 50Ω, then $R_R = 475\Omega$ (1%), providing IREF of 2.32mA. The output current (I_{OH}) is equal to 6*IREF.

Output Termination

The PCI-Express differential clock outputs of the 5V41234 are open source drivers and require an external series resistor and a resistor to ground. These resistor values and their allowable locations are shown in detail in the **PCI-Express Layout Guidelines** section.

The 5V41234 can also be terminated to LVDS compatible voltage levels. See Layout Guidelines section.

Output Structures
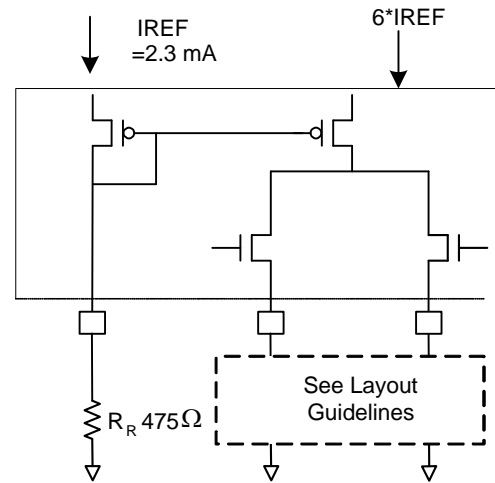
General PCB Layout Recommendations

For optimum device performance and lowest output phase noise, the following guidelines should be observed.

1. Each 0.01µF decoupling capacitor should be mounted on the component side of the board as close to the VDD pin as possible.

2. No vias should be used between decoupling capacitor and VDD pin.

3. The PCB trace to VDD pin should be kept as short as possible, as should the PCB trace to the ground via. Distance of the ferrite bead and bulk decoupling from the device is less critical.

4. An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers (any ferrite beads and bulk decoupling capacitors can be mounted on the back). Other signal traces should be routed away from the 5V41234.This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.

Layout Guidelines for PCI Express

PCIe Reference Clock			
Common Recommendations for Differential Routing	Dimension or Value	Unit	Figure
L1 length, route as non-coupled 50ohm trace	0.5 max	inch	1
L2 length, route as non-coupled 50ohm trace	0.2 max	inch	1
L3 length, route as non-coupled 50ohm trace	0.2 max	inch	1
Rs	33	ohm	1
Rt	49.9	ohm	1

Down Device Differential Routing			
L4 length, route as coupled microstrip 100ohm differential trace	2 min to 16 max	inch	1
L4 length, route as coupled stripline 100ohm differential trace	1.8 min to 14.4 max	inch	1

Differential Routing to PCI Express Connector			
L4 length, route as coupled microstrip 100ohm differential trace	0.25 to 14 max	inch	2
L4 length, route as coupled stripline 100ohm differential trace	0.225 min to 12.6 max	inch	2

Figure 1: Down Device Routing

Figure 2: PCI Express Connector Routing
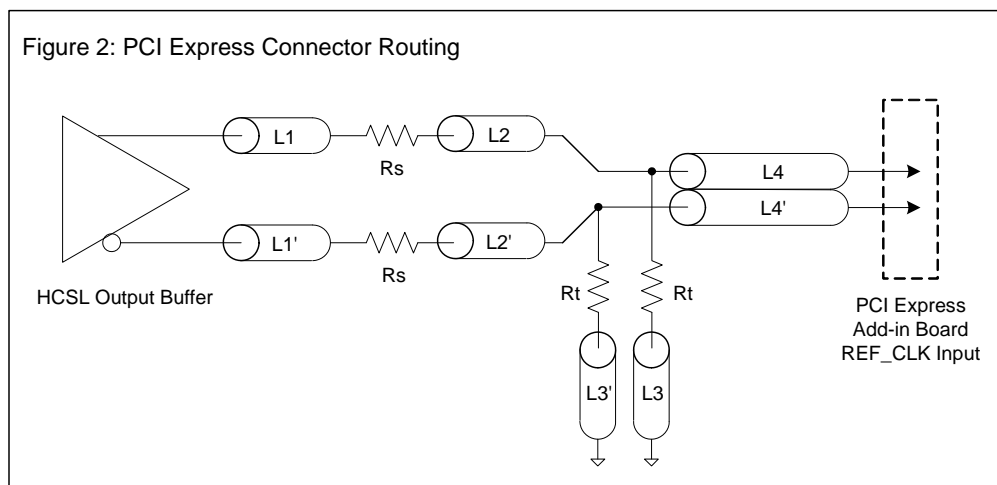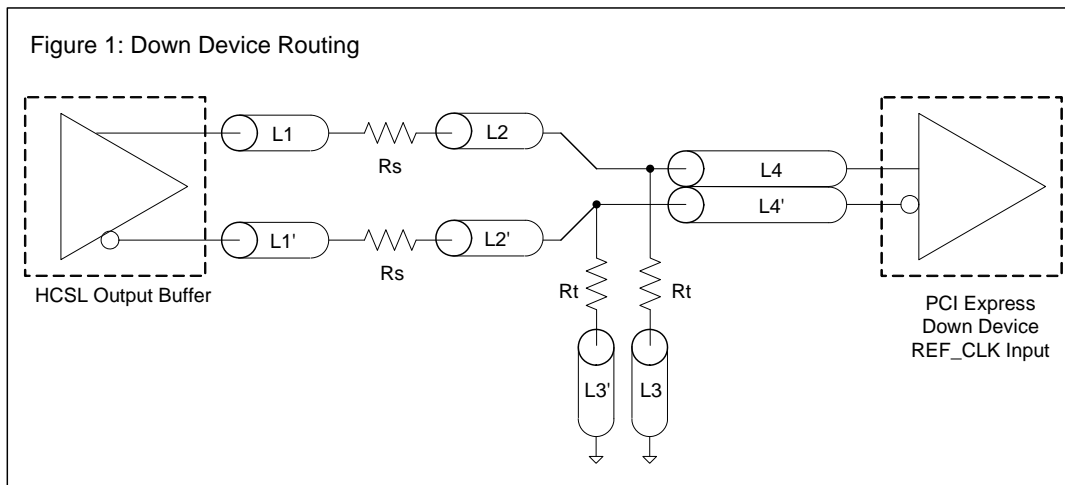
## Layout Guidelines for LVDS and Other Applications

Alternative Termination for LVDS and other Common Differential Signals (figure 3)							
Vdiff	Vp-p	Vcm	R1	R2	R3	R4	Note
0.45v	0.22v	1.08	33	150	100	100	
0.58	0.28	0.6	33	78.7	137	100	
0.80	0.40	0.6	33	78.7	none	100	ICS874003i-02 input compatible
0.60	0.3	1.2	33	174	140	100	Standard LVDS

R1a = R1b = R1

R2a = R2b = R2

Figure 3

HCSL Output Buffer

Down Device REF_CLK Input
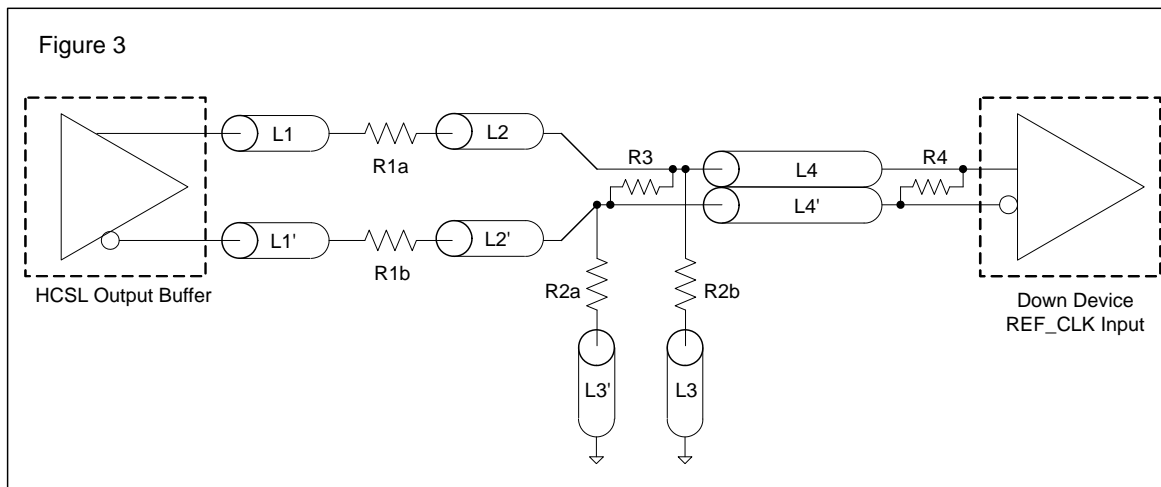
Cable Connected AC Coupled Application (figure 4)		
Component	Value	Note
R5a, R5b	8.2K 5%	
R6a, R6b	1K 5%	
Cc	0.1 µF	
Vcm	0.350 volts	

Figure 4

PCIe Device REF_CLK Input
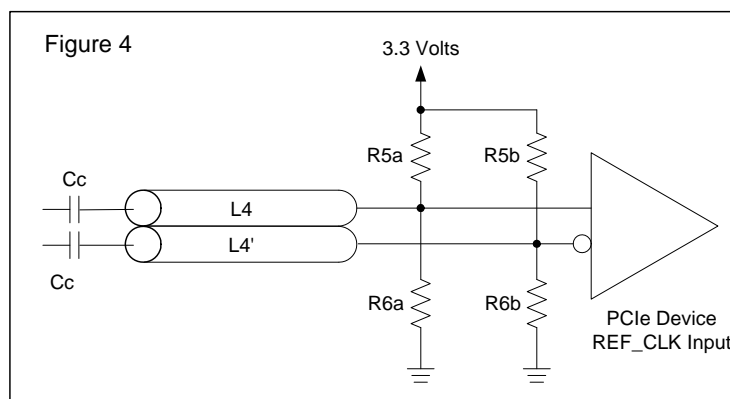
Typical PCI-Express (HCSL) Waveform

700 mV

0

t_{OR} | 500 ps | 500 ps | t_{OF}

0.525 V

0.175 V

0.525 V

0.175 V

Typical LVDS Waveform

1325 mV

1000 mV

t_{OR} | 500 ps | 500 ps | t_{OF}

1250 mV

1150 mV

1250 mV

1150 mV
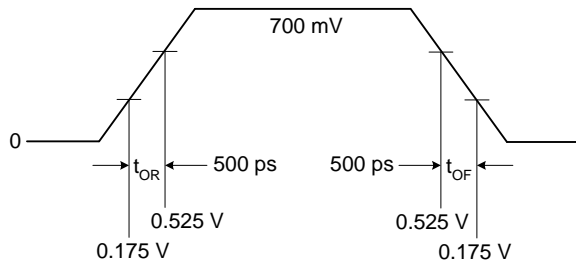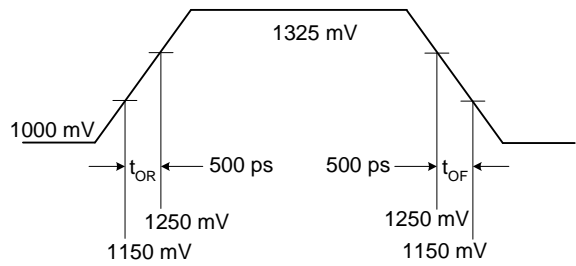
Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the 5V41234. These ratings are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Item	Rating
Supply Voltage, VDD, VDDA	5.5V
All Inputs and Outputs	-0.5V to VDD+0.5V
Ambient Operating Temperature (commercial)	0 to +70°C
Ambient Operating Temperature (industrial)	-40 to +85°C
Storage Temperature	-65 to +150°C
Junction Temperature	125°C
Soldering Temperature	260°C
ESD Protection (Input)	2000V min. (HBM)

DC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3V ±5%**, Ambient Temperature -40 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Supply Voltage	V		3.135		3.465	
Input High Voltage[1]	V_{IH}		2.2		VDD +0.3	V
Input Low Voltage[1]	V_{IL}		VSS-0.3		0.8	V
Input Leakage Current[2]	I_{IL}	0 < Vin < VDD	-5		5	μA
Operating Supply Current	I_{DD}	2pF load			70	mA
Input Capacitance	C_{IN}	Input pin capacitance			7	pF
Output Capacitance	C_{OUT}	Output pin capacitance			6	pF
Pin Inductance	L_{PIN}				5	nH
Output Resistance	Rout	CLK outputs	3.0			kΩ
Pull-up Resistor	R_{PUP}	SS1		100		kΩ

1. Single edge is monotonic when transitioning through region.

2. Inputs with pull-ups/-downs are not included.

AC Electrical Characteristics - CLK/$\overline{\text{CLK}}$

Unless stated otherwise, **VDD=3.3V ±5%**, Ambient Temperature -40 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency				25		MHz
Output Frequency				100		MHz
Output High Voltage[1,2]	V_{OH}		660	700	850	mV
Output Low Voltage[1,2]	V_{OL}		-150	0	27	mV
Crossing Point Voltage[1,2]		Absolute	250	350	550	mV
Crossing Point Voltage[1,2,4]		Variation over all edges		40	140	mV
Jitter, Cycle-to-Cycle[1,3]				25	100	ps
Rise Time[1,2]	t_{OR}	From 0.175V to 0.525V	175	332	700	ps
Fall Time[1,2]	t_{OF}	From 0.525V to 0.175V	175	344	700	ps
Rise/Fall Time Variation[1,2]				75	125	ps
Duty Cycle[1,3]			45	51	55	%
Stabilization Time	t_{STABLE}	From power-up VDD = 3.3V		1.2	3.0	ms
Spread Change Time	t_{SPREAD}	Settling period after spread change		3.0		ms

[1] Test setup is R_S=33 ohms R_P=50 ohms with 2pF, R_R = 475Ω (1%).

[2] Measurement taken from a single-ended waveform.

[3] Measurement taken from a differential waveform.

[4] Measured at the crossing point where instantaneous voltages of both CLK and $\overline{\text{CLK}}$ are equal.

Electrical Characteristics - Differential Phase Jitter

T_A = Commercial and Industrial, Supply Voltage VDD = 3.3 V +/-5%

PARAMETER	Symbol	Conditions	SPEC Min	SPEC Typ	SPEC Max	SPEC Units	SPEC Notes
Jitter, Phase	$t_{jphaseG1}$	PCIe Gen 1		28	86	ps (p-p)	1,2,3
	$t_{jphaseG2Lo}$	PCIe Gen 2 10kHz < f < 1.5MHz		1.1	3	ps (RMS)	1,2,3
	$t_{jphaseG2High}$	PCIe Gen 2 1.5MHz < f < Nyquist (50MHz)		1.8	3.1	ps (RMS)	1,2,3
	$t_{jphaseG3}$	PCIe Gen 3		0.48	1	ps (RMS)	1,2,3

[1] Guaranteed by design and characterization, not 100% tested in production.

[2] See http://www.pcisig.com for complete specs

[3] Applies to 100MHz, spread off and 0.5% down spread only.

Thermal Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		69.4		°C/W
	θ_{JA}	1 m/s air flow		60.7		°C/W
	θ_{JA}	2.5 m/s air flow		54.4		°C/W
Thermal Resistance Junction to Case	θ_{JC}			9.7		°C/W

Marking Diagrams

```
●
  XXX
  YWW$
  234G
```
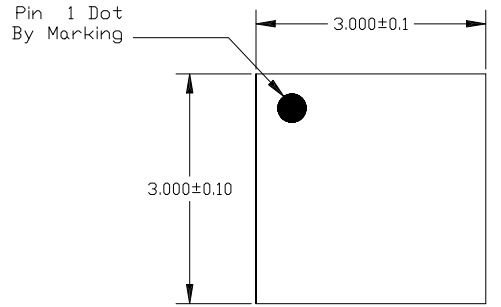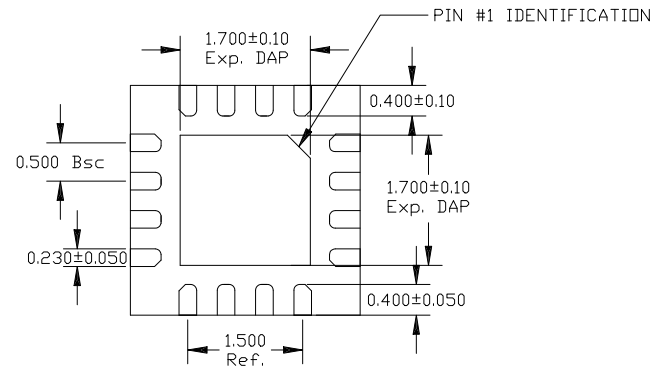
```
●
  XXX
  YWW$
  234GI
```
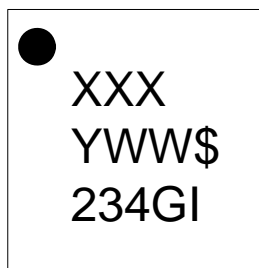
Notes:

1. Line 1: "XXX" is the lot traceability (last numeric character of the assembly lot number).

2. Line 2: "YYW" – date code; "$" – assembly location.

3. Line 3: truncated IDT part number.

4. "G" designates RoHS compliant package.

5. "I" within the part number indicates industrial temperature range.
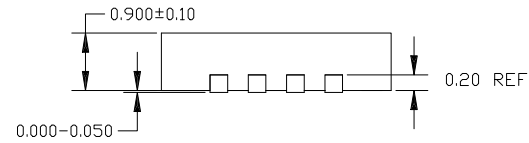
Package Outline and Package Dimensions (3 x 3 mm 16-QFN)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
00	INITIAL RELEASE	10/15/08	RC
01	COMBINE POD & LAND PATTERN	9/17/13	KS

Pin 1 Dot
By Marking

3.000±0.1

3.000±0.10

TOP VIEW

1.700±0.10
Exp. DAP

PIN #1 IDENTIFICATION

0.400±0.10

0.500 Bsc

1.700±0.10
Exp. DAP

0.230±0.050

0.400±0.050

1.500
Ref.

BOTTOM VIEW

0.900±0.10

0.20 REF

0.000-0.050

TOP VIEW

16LD QFN 3X3   (0.5MM PITCH)

TOLERANCES UNLESS SPECIFIED		
DECIMAL	ANGULAR	
XX±	±	
XXX±		
XXXX±		

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APPROVALS	DATE	TITLE NL/NLG16 PACKAGE OUTLINE
DRAWN RdC	10/15/08	3.0 x 3.0 mm BODY
CHECKED		0.5 mm PITCH QFN

SIZE	DRAWING No.	REV
C	PSC-4169	01

DO NOT SCALE DRAWING   SHEET 1 OF 2

5V41234
1 OUTPUT PCIE GEN1/2/3 SYNTHESIZER

Package Outline and Package Dimensions (3 x 3 mm 16-QFN), cont.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
00	INITIAL RELEASE	10/15/08	RC
01	COMBINE POD & LAND PATTERN	9/17/13	KS
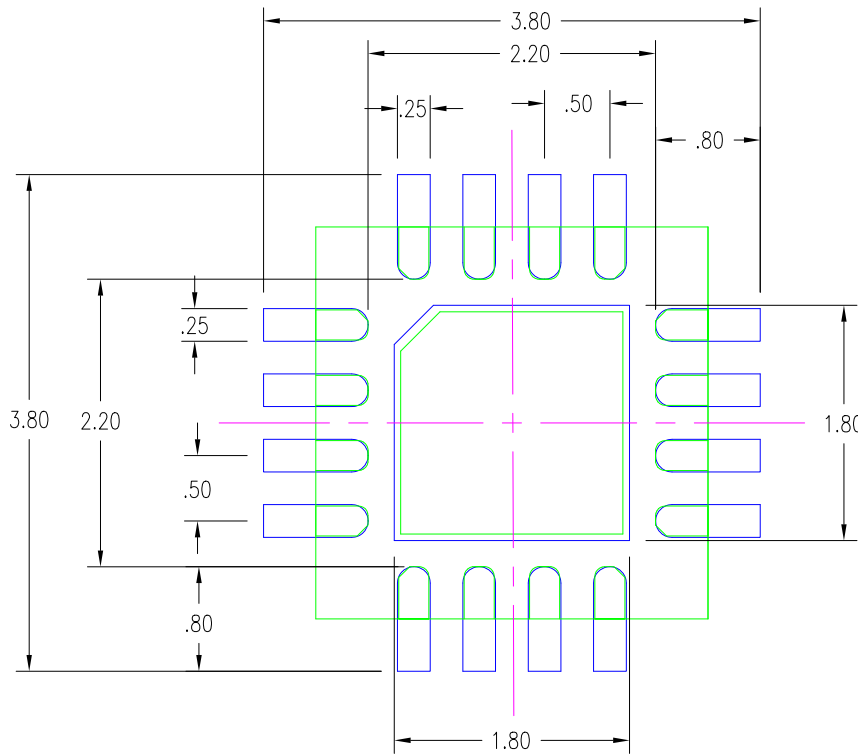
NOTES:
1. ALL DIMENSION ARE IN mm. ANGLES IN DEGREES.
2. TOP DOWN VIEW. AS VIEWED ON PCB.
3. COMPONENT OUTLINE SHOW FOR REFERENCE IN GREEN.
4. LAND PATTERN IN BLUE. NSMD PATTERN ASSUMED.
5. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT
   FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

TOLERANCES
UNLESS SPECIFIED
DECIMAL   ANGULAR
XX±   ±
XXX±
XXXX±

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APPROVALS	DATE	TITLE	NL/NLG16 PACKAGE OUTLINE
DRAWN	R&C 10/15/08		3.0 x 3.0 mm BODY
CHECKED			0.5 mm PITCH QFN

SIZE	DRAWING No.	REV
C	PSC-4169	01

DO NOT SCALE DRAWING   SHEET 2 OF 2

Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
5V41234NLG	See Page 9	Tubes	3 x 3 mm 16-QFN	0 to +70°C
5V41234NLG8		Tape and Reel	3 x 3 mm 16-QFN	0 to +70°C
5V41234NLGI		Tubes	3 x 3 mm 16-QFN	-40 to +85°C
5V41234NLGI8		Tape and Reel	3 x 3 mm 16-QFN	-40 to +85°C

"G" after the two-letter package code are the Pb-Free configuration and are RoHS compliant.

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Revision History

Rev.	Date	Originator	Description of Change
A	09/26/11	RDW	Initial release.
B	11/22/11	RDW	1. Changed title to "1 Output PCIe GEN1/2/3 Synthesizer" 2. Updated Differential Phase Jitter table.
B	03/20/14	S. Lou	Corrected typo in shipping packaging section of Ordering Information table - changed "Trays" to "Tubes".
C	05/05/17	C.P.	1. Updated package drawing to the latest NLG16 version. 2. Updated legal disclaimer.

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