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## 8 or 12 Output Ultra-Low Additive Jitter PCIe 1/2/3/4/5/6 Clock Buffer

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### Features

- Eight (SY75608) and Twelve (SY75612) PCIe 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0 Compliant Outputs
- Ultra-Low Additive Jitter: 10 fs (PCIe Gen5)
- Supports Frequencies of Up to 250 MHz
- Transparent for Spread Spectrum
- Supports 1.8V  $\pm$ 10%, 2.5V  $\pm$ 10%, and 3.3V  $\pm$ 10% Power Supplies
- Outputs Low Power HCSL with Embedded Termination Resistors
- Selectable Pin or I<sup>2</sup>C Bus Control
- Individual Glitch Free Output Enable (OExb) Control Pins
- Accepts DC-Coupled HCSL Input Signal and AC-Coupled PECL, LVDS, and CML Input Signals
- Extended Temperature Range:  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
- 6 mm x 6 mm VQFN (SY75608) and 8 mm x 8 mm VQFN (SY75612) package

### Applications

- Cloud and High-Performance Computing
- PCIe-Based SSD Drives
- PCIe Switches
- Servers

### General Description

The SY75608 and SY75612 are industry-leading PCIe clock buffers with ultra-low additive jitter:

- 6 fs (PCIe 6.0)
- 10 fs (PCIe 5.0)
- 20 fs (PCIe 3.0/4.0)
- 52 fs in the 12 kHz to 20 MHz band

They can be used in all PCIe 1/2/3/4/5/6 common clock and SRIS applications.

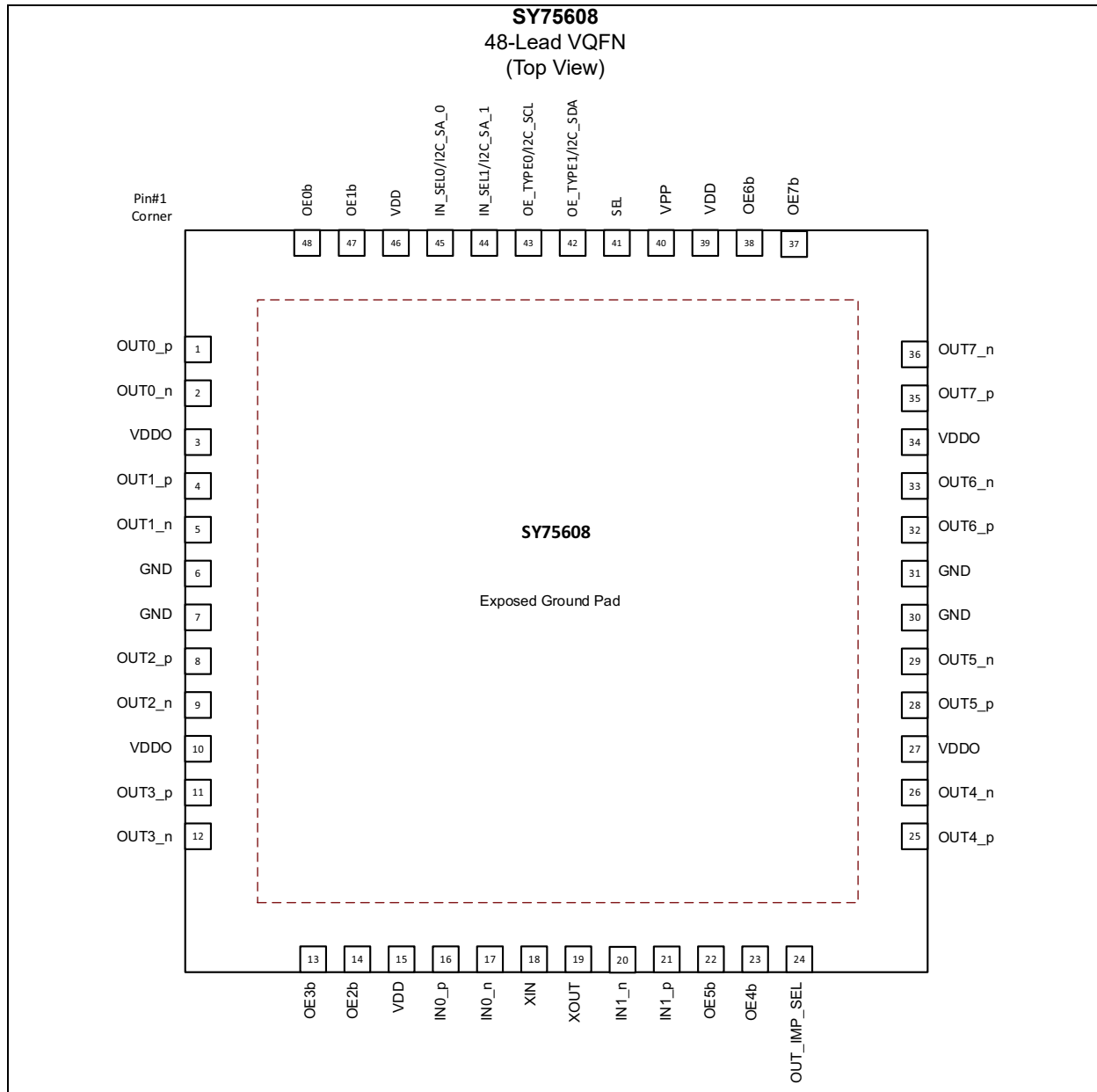
SY75608 and SY75612 are, respectively, eight and twelve output PCIe clock buffers with glitch free per-output enable/disable control hardware pins. Devices are packaged in 6 mm x 6 mm VQFN (SY75608) and 8 mm x 8 mm VQFN (SY75612).

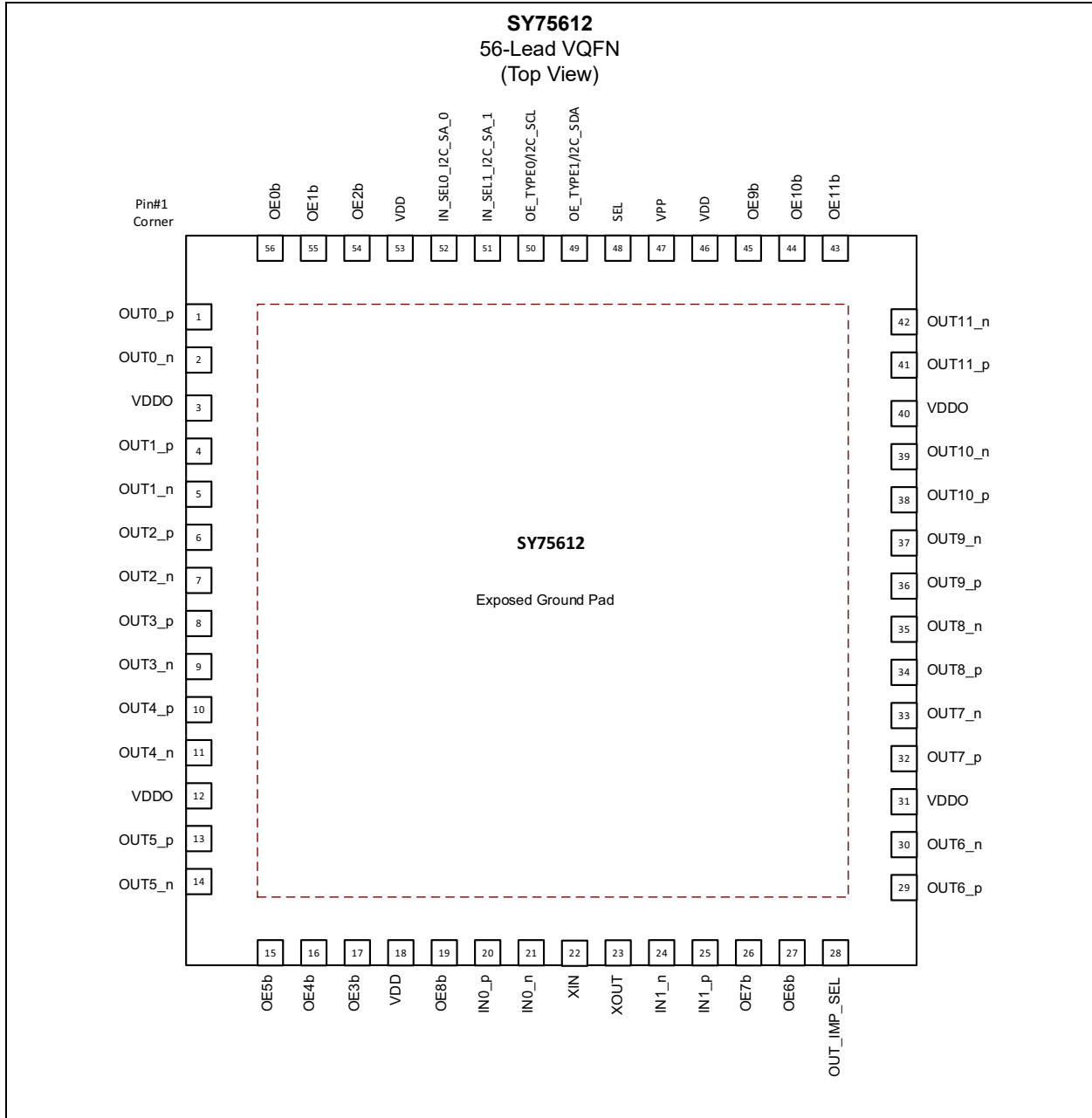
The SY75608/612 each have an embedded low-dropout regulator (LDO) for superior power noise supply rejection. They support 1.8V, 2.5V, and 3.3V supplies with a tolerance of  $\pm$ 10%, which exceeds the  $\pm$ 9% required by the PCIe Card Electro Mechanical Specification.

Both parts are available in the extended temperature range of  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ . Both parts are also available with customized configurations to meet the customer's needs. Please visit the [ClockWorks Configurator](#) to design your particular specifications.

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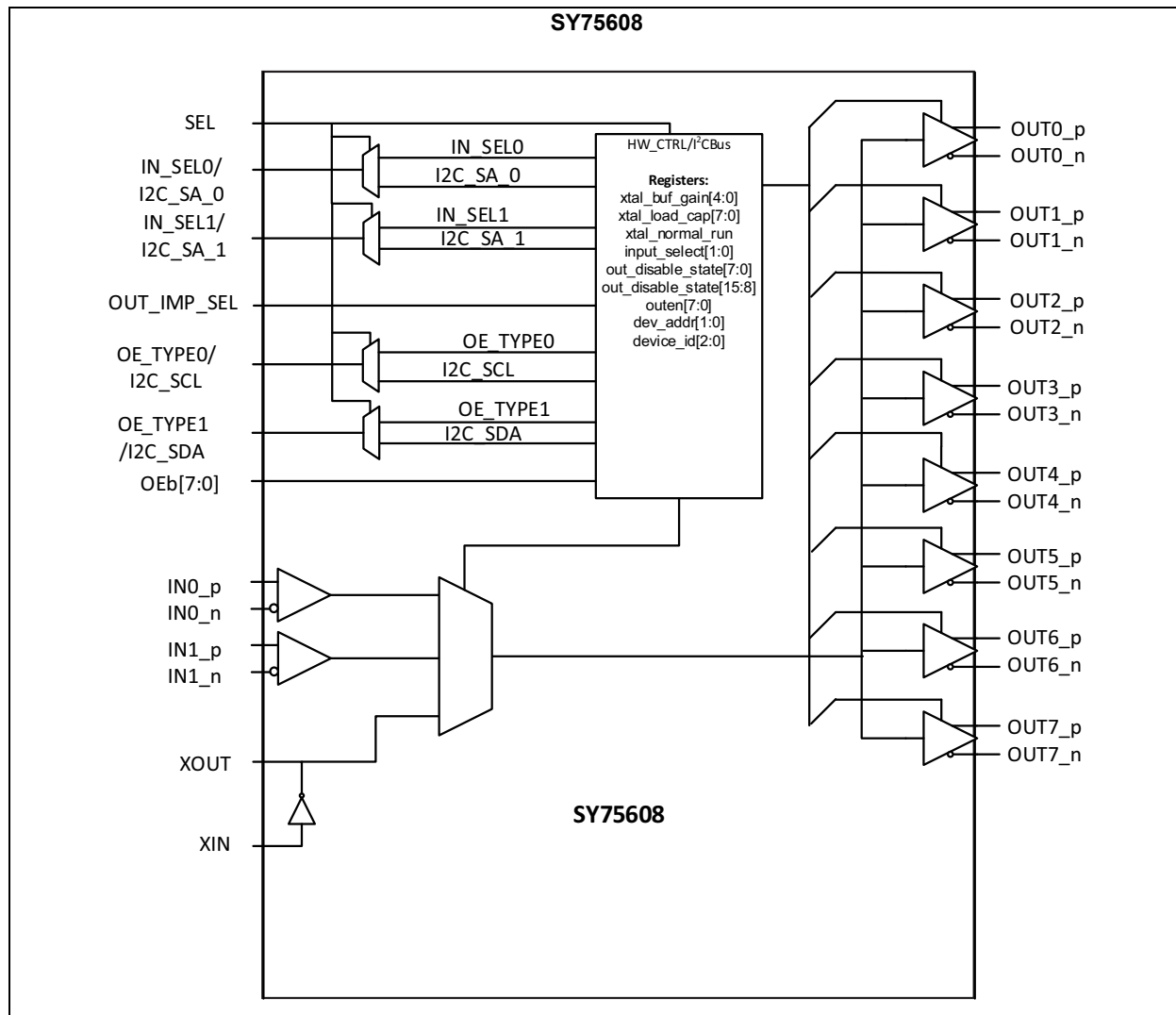
## Package Types

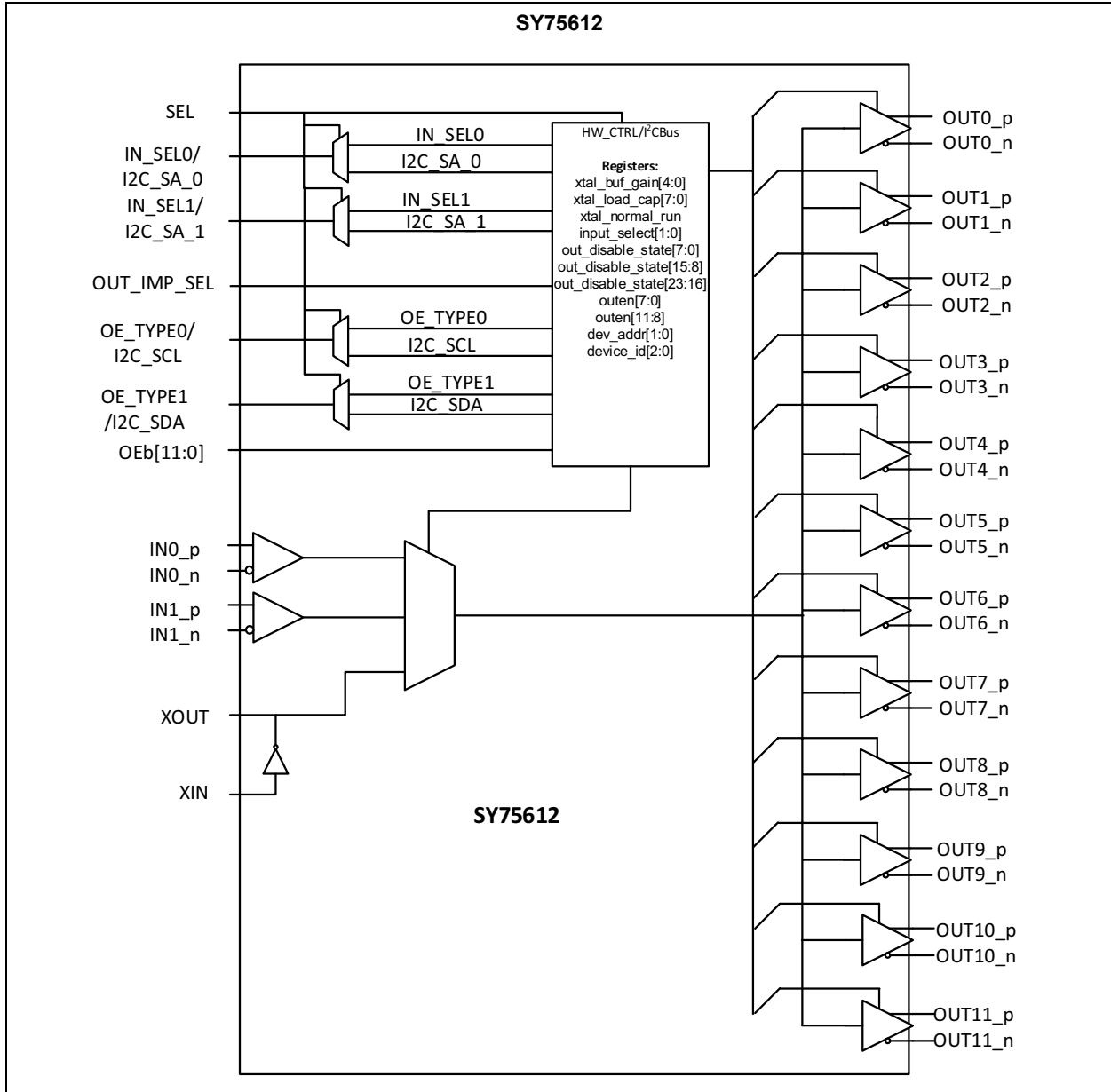




# SY75608/612

## Block Diagrams





# SY75608/612

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage ( $V_{DD}$ )	-0.5V to +4.6V
Input Voltage ( $V_{IN}$ )	-0.5V to $V_{DD} + 0.5V$
Input ESD Protection (HBM)	2 kV

### Operating Ratings ‡

1.8V Operating Voltage ( $V_{DD}$ )	+1.62V to +1.98V
2.5V Operating Voltage ( $V_{DD}$ )	+2.25V to +2.75V
3.3V Operating Voltage ( $V_{DD}$ )	+2.97V to +3.63V

† **Notice:** 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 ratings conditions may affect device reliability.

‡ **Notice:** The data sheet limits are not guaranteed if the device is operated beyond the recommended operating conditions.

## ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $V_{DD} = 3.3V \pm 10\%$ , $V_{DD} = 2.5V \pm 10\%$ , $V_{DD} = 1.8V \pm 10\%$ , $T_A = -40^\circ C$ to $+105^\circ C$ .						
Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>Current Consumption</b>						
Core Device Current	$I_{DD}$	—	13	15	mA	All outputs and XTAL disabled. Both reference inputs fed with 100 MHz differential clock.
Core Device Current	$I_{DD\_XTAL}$	—	13	15	mA	All outputs disabled; XTAL circuit enabled with 25 MHz Crystal connected between XIN and XOUT
Current Dissipation per LPHCSL Output (100 $\Omega$ )	$I_{DD\_HCSL\_100\Omega}$	—	3.5	3.9	mA	Note 1
Current Dissipation per LPHCSL Output (85 $\Omega$ )	$I_{DD\_HCSL\_85\Omega}$	—	4.0	4.4	mA	Note 1
<b>Power Supply Noise Rejection Ratio</b>						
Power Supply Noise Rejection Ratio	$PSNRR_{HCSL}$	—	70	—	dB	100 mV <sub>PP</sub> , 100 kHz noise injected to $V_{DD}$ . Clock Frequency 100 MHz, $V_{DD} = 3.3V$
<b>Input</b>						
Input Slew Rate	$SR_{IN}$	0.6	—	—	V/ns	—
Differential Input High Voltage	$V_{IH}$	0.15	—	—	V	—
Differential Input Low Voltage	$V_{IL}$	—	—	-0.15	V	—
Input Voltage Swing	$V_{ASWING}$	0.15	—	—	V	—
Absolute Crossing Point Voltage	$V_{CROSS}$	0.25	—	0.55	V	—
Variation of $V_{CROSS}$ Over All Edges	$V_{CROSS\Delta}$	—	—	0.14	V	—
Voltage High for Control Inputs	$V_{IH\_OE}$	$0.7 \cdot V_{DD}$	—	—	V	—
Voltage Low for Control Inputs	$V_{IL\_OE}$	—	—	$0.3 \cdot V_{DD}$	V	—

## ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: $V_{DD} = 3.3V \pm 10\%$ , $V_{DD} = 2.5V \pm 10\%$ , $V_{DD} = 1.8V \pm 10\%$ , $T_A = -40^\circ\text{C}$ to $+105^\circ\text{C}$ .						
Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Leakage Current	$I_{IL\_IN}$	-5	—	5	$\mu\text{A}$	$V_{IN} = V_{DD}$ , $V_{IN} = \text{GND}$
Input Capacitance	$C_{IN}$	—	—	5	pF	—
Input Leakage Current for OE Inputs	$I_{IL\_OE}$	-5	—	70	$\mu\text{A}$	$V_{IN} = V_{INMAX}$ , $V_{IN} = \text{GND}$ ; includes current due to pull down resistors
Single-Ended Input Common Mode Voltage (IN_p)	$V_{SIC}$	0.25	—	0.55	V	HCSL common mode
Single-Ended Input Voltage Swing for IN_p	$V_{SID}$	0.3	—	1.45		—
Maximum Input Voltage	$V_{IN(MAX)}$	—	—	1.15	V	—
Minimum Input Voltage	$V_{IN(MIN)}$	-0.3	—	—	V	—
Differential Input Frequency	$f_{IN}$	0	—	250	MHz	Note 2
Single-Ended Input Frequency	$f_{IN\_SE}$	0	—	250	MHz	Note 2
Input Duty Cycle	DC	35	—	65	%	—
Input Multiplexer Isolation IN0_p/n to IN1_p/n and Vice Versa	$I_{SO}$	—	-84	—	dBc	$f_{IN} = 100$ MHz, Note 2, Power on both inputs 0 dBm, $f_{OFFSET} > 50$ kHz
		—	-82	—		$f_{IN} = 250$ MHz, Note 2, Power on both inputs 0 dBm, $f_{OFFSET} > 50$ kHz

- Note 1:** Tested with 100 MHz clock with outputs driving 4" long trace terminated with 2 pF Capacitors to ground.
- 2:** Output Enable control (pin or register) is synchronous with the input clock and it takes four rising edges before output gets enabled or disabled. Hence the minimum input frequency is greater than 0 Hz. Once the outputs are enabled the input clock frequency can be reduced to 0 Hz.

## CRYSTAL OSCILLATOR CHARACTERISTICS

Electrical Characteristics: $V_{DD}/V_{DDO} = 3.3V \pm 10\%$ , $V_{DD}/V_{DDO} = 2.5V \pm 10\%$ , $V_{DD}/V_{DDO} = 1.8V \pm 10\%$ , $T_A = -40^\circ\text{C}$ to $+105^\circ\text{C}$ .						
Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Mode of Oscillation	—	—	—	—	—	Fundamental
Frequency	f	8	—	160	MHz	High frequency crystal needs lower motion resistance. For example, the motion resistance for 156.25 MHz needs to be lower than $25\Omega$
On-Chip Load Capacitance in I <sup>2</sup> C Bus Controlled Mode	$C_L$	0	—	21.75	pF	The values are programmable. On the top of this, there are intrinsic pin capacitances and the capacitance of PCB trace connecting to the crystal.
On-Chip Load Capacitance in Pin Controlled Mode	—	—	4	—	pF	Fixed
On-Chip Series Resistor in Pin Controlled Mode	—	—	150	—	$\Omega$	Fixed
On-Chip Shunt Resistor	R	—	500	—	k $\Omega$	—

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## CRYSTAL OSCILLATOR CHARACTERISTICS (CONTINUED)

**Electrical Characteristics:**  $V_{DD}/V_{DDO} = 3.3V \pm 10\%$ ,  $V_{DD}/V_{DDO} = 2.5V \pm 10\%$ ,  $V_{DD}/V_{DDO} = 1.8V \pm 10\%$ ,  $T_A = -40^\circ\text{C}$  to  $+105^\circ\text{C}$ .

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Frequency in Overdrive Mode (Note 1)	$f_{OV}$	8	—	160	MHz	Functional, but may not meet AC parameters. Minimum depends on AC coupling Capacitor (0.1 $\mu\text{F}$ assumed)
Frequency in Bypass Mode (Note 2)	$f_{BP}$	0	—	250	MHz	Functional, but may not meet AC parameters

**Note 1:** Maximum input level is 2V.

**2:** Maximum output level is  $V_{DD}$ .

## OUTPUT ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:**  $V_{DD} = 3.3V \pm 10\%$ ,  $V_{DD} = 2.5V \pm 10\%$ ,  $V_{DD} = 1.8V \pm 10\%$ ,  $T_A = -40^\circ\text{C}$  to  $+105^\circ\text{C}$ , unless noted.  $C_{LOAD} = 2 \text{ pF}$ .

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Rising Edge Rate	—	1	2.5	4	V/ns	Note 1, Note 2
Falling Edge Rate	—	1	2.5	4	V/ns	Note 1, Note 2
Differential Output High Voltage	$V_{OH}$	0.6	—	0.9	V	Note 1
Differential Output Low Voltage	$V_{OL}$	-0.9	—	-0.6	V	Note 1
Absolute Crossing Voltage	$V_{CROSS}$	0.25	—	0.55	V	Note 3, Note 4, Note 5
Variation of $V_{CROSS}$ Over All Rising Clock Edges	$V_{CROSS\_DELTA}$	—	—	0.14	V	Note 3, Note 4, Note 6
Ring Back Voltage Margin	$V_{RB}$	-0.1	—	0.1	V	Note 1, Note 7
Time before $V_{RB}$ is Allowed	$t_{STABLE}$	500	—	—	ps	Note 1, Note 7
Cycle-to-Cycle Additive Jitter	$t_{OCJITTER}$	—	6.5	8.1	ps <sub>PP</sub>	Note 1
Absolute Maximum Output Voltage	$V_{MAX}$	—	—	1.15	V	Note 3, Note 8
Absolute Minimum Output Voltage	$V_{MIN}$	-0.3	—	—	V	Note 3, Note 9
Output Duty Cycle	ODC	48	50	52	%	When input has 50% duty cycle and $V_{IN} \geq 200 \text{ mV}$ , Note 1
Rising-to-Falling Edge Matching	—	—	—	15	%	Note 3, Note 10
Clock Source DC Impedance (OUT <sub>x_p</sub> )	$Z_{C-DC\_OUT\_p}$	—	50/42.5	—	$\Omega$	OUT_IMP_SEL = low/high, Note 3, Note 11
Clock Source DC Impedance (OUT <sub>x_n</sub> )	$Z_{C-DC\_OUT\_n}$	—	50/42.5	—	$\Omega$	OUT_IMP_SEL = low/high, Note 3, Note 11
Output Frequency	$f_{MAX}$	0	—	250	MHz	—
Output-to-Output Skew	$t_{OOSK}$	—	14	30	ps	—



## OUTPUT ELECTRICAL CHARACTERISTICS (CONTINUED)

**Electrical Characteristics:**  $V_{DD} = 3.3V \pm 10\%$ ,  $V_{DD} = 2.5V \pm 10\%$ ,  $V_{DD} = 1.8V \pm 10\%$ ,  $T_A = -40^\circ C$  to  $+105^\circ C$ , unless noted.  $C_{LOAD} = 2$  pF.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Device-to-Device Output Skew	$t_{DOOSK}$	—	—	0.6	ps	—
Input-to-Output Delay	$t_{IOD}$	1	1.4	2	ns	—
Output Enable Time	$t_{EN}$	—	—	5	cycles	Note 12
Output Disable Time	$t_{DIS}$	—	—	6	cycles	Note 12

- Note 1:** Measurement taken from differential waveform.
- 2:** Measured from  $-150$  mV to  $+150$  mV on the differential waveform (derived from  $OUTx\_p$  to  $OUTx\_n$ ). The signal must be monotonic through the measurement region for rise and fall time. The 300 mV measurement window is centered on the differential zero crossing. See Figure 1-5.
- 3:** Measurement taken from single ended waveform.
- 4:** Measured at crossing point where the instantaneous voltage value of the rising edge of  $OUTx\_p$  equals the falling edge of  $OUTx\_n$ . See Figure 1-1.
- 5:** Refers to the total variation from the lowest crossing point to the highest, regardless of which edge is crossing. Refers to all crossing points for this measurement. See Figure 1-1.
- 6:** Defined as the total variation of all crossing voltages of Rising  $OUTx\_p$  and Falling  $OUTx\_n$ . This is the maximum allowed variance in  $V_{CROSS}$  for any particular system. See Figure 1-2.
- 7:**  $t_{STABLE}$  is the time the differential clock must maintain a minimum  $\pm 150$  mV differential voltage after rising/falling edges before it is allowed to droop back into the  $V_{RB} \pm 100$  mV differential range. See Figure 1-6.
- 8:** Defined as the maximum instantaneous voltage including overshoot. See Figure 1-1.
- 9:** Defined as the minimum instantaneous voltage including undershoot. See Figure 1-1.
- 10:** Matching applies to rising edge rate for  $OUTx\_p$  and falling edge rate for  $OUTx\_n$ . It is measured using a  $\pm 75$  mV window centered on the median cross point where  $OUTx\_p$  rising meets  $OUTx\_n$  falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations. The Rise Edge Rate of  $OUTx\_p$  should be compared to the Fall Edge Rate of  $OUTx\_n$ ; the maximum allowed difference should not exceed 20% of the slowest edge rate. See Figure 1-3.
- 11:** System board compliance measurements must use the test load card described in Figure 1-7.  $OUTx\_p$  and  $OUTx\_n$  are to be measured at the load capacitors  $C_{LOAD}$ . Single-ended probes must be used for measurements requiring single-ended measurements. Either single-ended probes with math or differential probe can be used for differential measurements. Test load  $C_{LOAD} = 2$  pF.
- 12:** Output Enable control (pin or register) is synchronous with the input clock and it takes four rising edges before output gets enabled or disabled. Hence the minimum input frequency is greater than 0 Hz. Once the outputs are enabled the input clock frequency can be reduced to 0 Hz.

## JITTER AND PHASE NOISE

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Peak-to-Peak Additive Jitter	$A_{JRMS\_PP}$	—	4	5.1	ps	Note 1, Note 2
Additive Jitter per PCIe 1.0 (1.5 MHz to 22 MHz)	$t_{jPCIe\_1.0}$	—	0.7	0.9	ps <sub>RMS</sub>	Note 1, Note 2
Additive Jitter per PCIe 2.0 High Band (1.5 MHz to 50 MHz)	$t_{jPCIe\_2.0\_high}$	—	79	100	fs <sub>RMS</sub>	Note 1, Note 2
Additive Jitter per PCIe 2.0 Low Band (10 kHz to 1.5 MHz)	$t_{jPCIe\_2.0\_low}$	—	16	21	fs <sub>RMS</sub>	Note 1, Note 2
Additive Jitter per PCIe 2.0 Mid Band (5 MHz to 16 MHz)	$t_{jPCIe\_2.0\_mid}$	—	62	79	fs <sub>RMS</sub>	Note 1, Note 2

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## JITTER AND PHASE NOISE (CONTINUED)

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Additive Jitter per PCIe 3.0 (PLL_BW = 2 MHz to 5 MHz, CDR = 10 MHz)	$t_{jPCle\_3.0}$	—	20	25	$f_{SRMS}$	Note 1, Note 2
Additive Jitter per PCIe 4.0 (PLL_BW = 2 MHz to 5 MHz, CDR = 10 MHz)	$t_{jPCle\_4.0}$	—	20	25	$f_{SRMS}$	Note 1, Note 2
Additive Jitter per PCIe 5.0 (PLL_BW = 0.5 MHz to 1.8 MHz, CDR for 32 GT/s CC)	$t_{jPCle\_5.0}$	—	8.2	10	$f_{SRMS}$	Note 2, Note 3
Additive Jitter per PCIe 6.0 (PLL_BW = 0.5 MHz to 1.0 MHz, CDR for 64 GT/s CC)	$t_{jPCle\_6.0}$	—	5.2	6.2	$f_{SRMS}$	Note 2, Note 3
Additive jitter per Intel QPI 9.6 Gbps	$t_{jQPI}$	—	35	45	$f_{SRMS}$	Note 1, Note 2
Additive RMS Jitter in 1 MHz to 20 MHz Band	$t_{j\_1M\_20M}$	—	53	67	$f_{SRMS}$	Note 1, Note 2, 100 MHz Clock
		—	41	56	$f_{SRMS}$	Note 1, Note 2, 133 MHz Clock
Additive RMS Jitter in 12 kHz to 20 MHz Band	$t_{j\_12k\_20M}$	—	51	64	$f_{SRMS}$	Note 1, Note 2, 100 MHz Clock
		—	39	54	$f_{SRMS}$	Note 1, Note 2, 133 MHz Clock
Noise Floor	$N_F$	—	-165	-163	dBc/Hz	Note 1, Note 2, 100 MHz Clock
		—	-165	-162	dBc/Hz	Note 1, Note 2, 133 MHz Clock

**Note 1:** Measured into AC test load as per Figure 1-7.

**Note 2:** Measured from differential crossing point to differential crossing point.

**Note 3:** Measured with 50Ω termination in instrument without a test load.

## I<sup>2</sup>C BUS ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Nominal Bus Voltage	$V_{DD\_I2C}$	1.62	—	5.5	V	Note 1
Input Low Voltage	$V_{IL}$	—	—	0.6	V	—
Input High Voltage	$V_{IH}$	1.5	—	$V_{DD\_I2C}$	V	—
Output Low Voltage	$V_{OL}$	—	—	0.4	V	At $I_{PULLUP,MAX}$
Input Leakage Current	$I_{LEAK}$	—	—	±10	μA	—
Current Sinking at $V_{OL,MAX}$	$I_{PULLUP}$	4	—	—	mA	—
Pin Capacitive Load	$C_L$	—	—	1	pF	—
Signal Noise Immunity from 10 MHz to 100 MHz	$V_{NOISE}$	300	—	—	mV <sub>PP</sub>	—
Noise Spike Suppression Time	$t_{SPIKE}$	0	—	50	ns	Note 3
I <sup>2</sup> C Bus Operating Frequency	$f_{I2C}$	0	—	400	kHz	—
Bus Free Time Between Stop and Start Condition	$t_{BUF}$	1.3	—	—	μs	—
Hold Time After (Repeated) Start Condition	$t_{HD:STA}$	0.6	—	—	μs	After this period, the first clock is generated.

**I<sup>2</sup>C BUS ELECTRICAL CHARACTERISTICS (CONTINUED)**

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Repeated Start Condition Setup Time	$t_{SU:STA}$	0.6	—	—	$\mu s$	—
Stop Condition Setup Time	$t_{SU:STO}$	0.6	—	—	$\mu s$	—
Data Hold Time	$t_{HD:DAT}$	0	—	0.9	$\mu s$	Note 4
Data Setup Time	$t_{SU:DAT}$	100	—	—	ns	—
Clock Low Period	$t_{LOW}$	1.3	—	—	$\mu s$	—
Clock High Period	$t_{HIGH}$	0.6	—	—	$\mu s$	—
Clock/Data Fall Time	$t_F$	20 + 0.1*Cb	—	250	ns	Note 2
Clock/Data Rise Time	$t_R$	20 + 0.1*Cb	—	250	ns	Note 2

**Note 1:** 3V to 5V  $\pm 10\%$ .

**2:** Rise and fall time is defined as follows:  $t_R = (V_{IL,MAX} - 0.15)$  to  $(V_{IH,MIN} + 0.15)$ ;  $t_F = (V_{IH,MIN} - 0.15)$  to  $(V_{IL,MAX} + 0.15)$

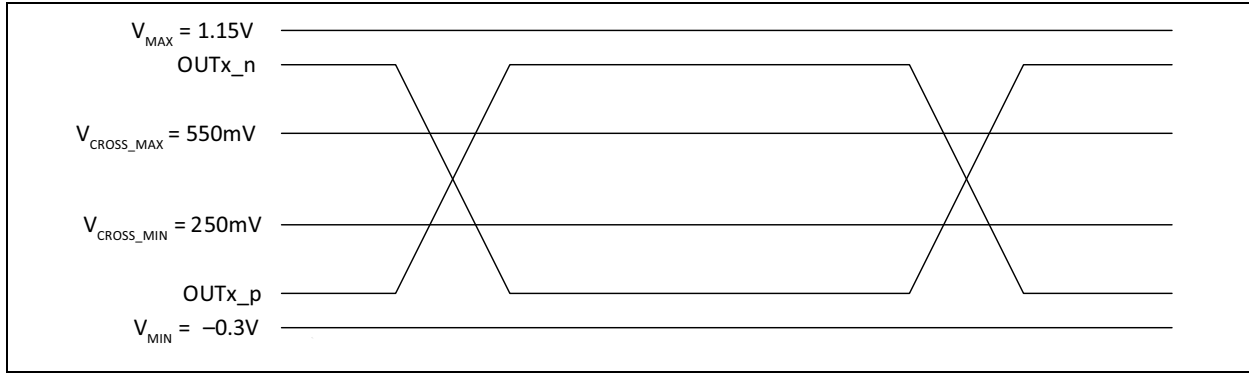
**3:** Devices must provide a means to reject noise spikes of a duration up to the maximum specified value.

**4:** The maximum hold time has to be less than the maximum data valid or data valid acknowledge time as per Table 10, note [4] of I<sup>2</sup>C bus Rev. 6 specification.

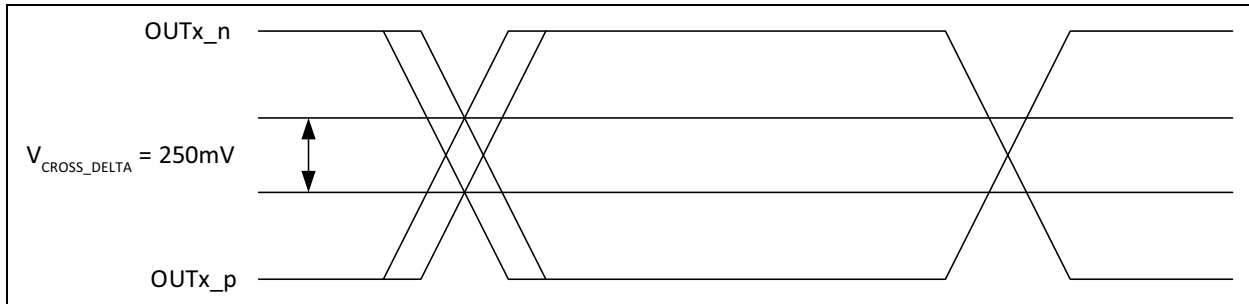
**TEMPERATURE SPECIFICATIONS**

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
<b>Temperature Ranges</b>						
Ambient Operating Temperature Range	$T_A$	-40	—	+105	$^{\circ}C$	—
Storage Temperature Range	$T_S$	-65	—	+150	$^{\circ}C$	—
<b>Package Thermal Resistances</b>						
Junction to Ambient Thermal Resistance 6x6 VQFN-48Ld	$\Theta_{JA}$	—	29	—	$^{\circ}C/W$	Still-Air
		—	24	—	$^{\circ}C/W$	1 m/s airflow
		—	22	—	$^{\circ}C/W$	2.5 m/s airflow
Junction to Board Thermal Resistance 6x6 VQFN-48Ld	$\Theta_{JB}$	—	8	—	$^{\circ}C/W$	—
Junction to Case Thermal Resistance 6x6 VQFN-48Ld	$\Theta_{JC}$	—	18	—	$^{\circ}C/W$	—
Thermal Characterization, Junction to Top of Package 6x6 VQFN-48Ld	$\Psi_{JB}$	—	1	—	$^{\circ}C/W$	Still-Air
Junction to Ambient Thermal Resistance 8x8 VQFN-56Ld	$\Theta_{JA}$	—	28	—	$^{\circ}C/W$	Still-Air
		—	23	—	$^{\circ}C/W$	1 m/s airflow
		—	22	—	$^{\circ}C/W$	2.5 m/s airflow
Junction to Board Thermal Resistance 8x8 VQFN-56Ld	$\Theta_{JB}$	—	8	—	$^{\circ}C/W$	—
Junction to Case Thermal Resistance 8x8 VQFN-56Ld	$\Theta_{JC}$	—	14	—	$^{\circ}C/W$	—
Thermal Characterization, Junction to Top of Package 8x8 VQFN-56Ld	$\Psi_{JB}$	—	1	—	$^{\circ}C/W$	Still-Air

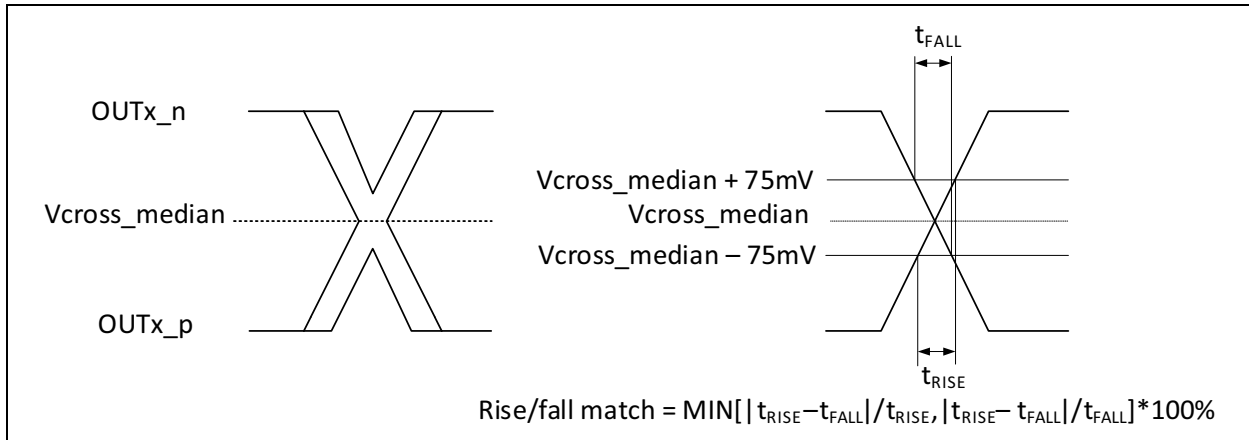
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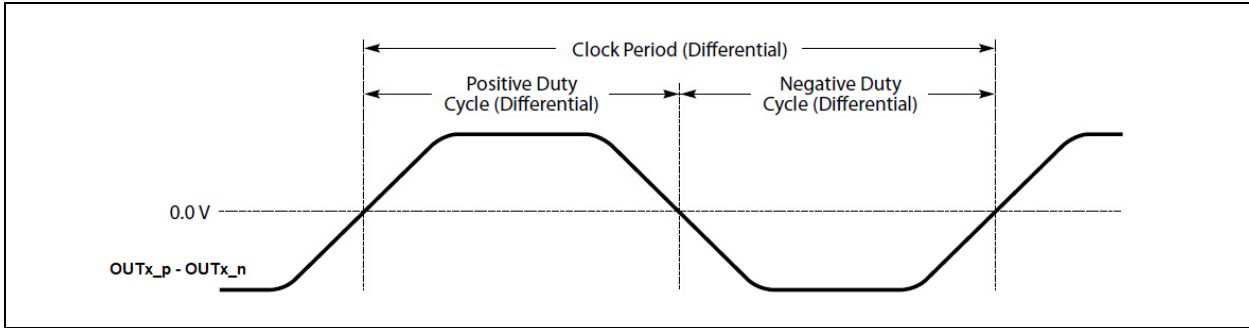
**FIGURE 1-1:** Single-Ended Measurement Points for Absolute Cross Point and Swing.



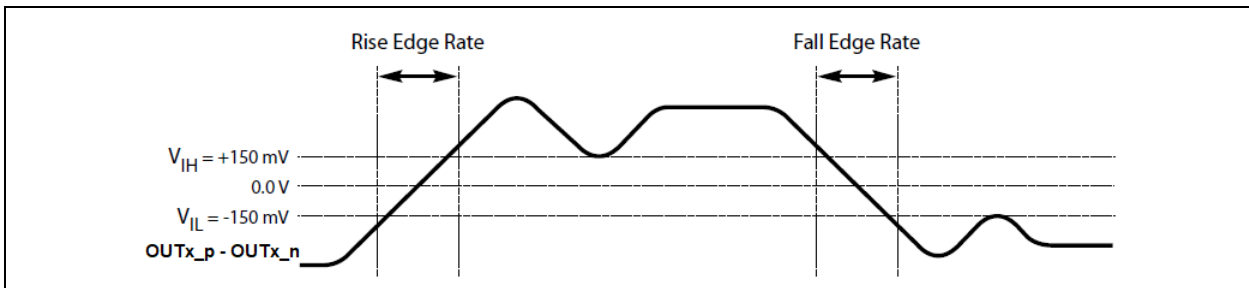
**FIGURE 1-2:** Single-Ended Measurement Points for Delta Cross Point.



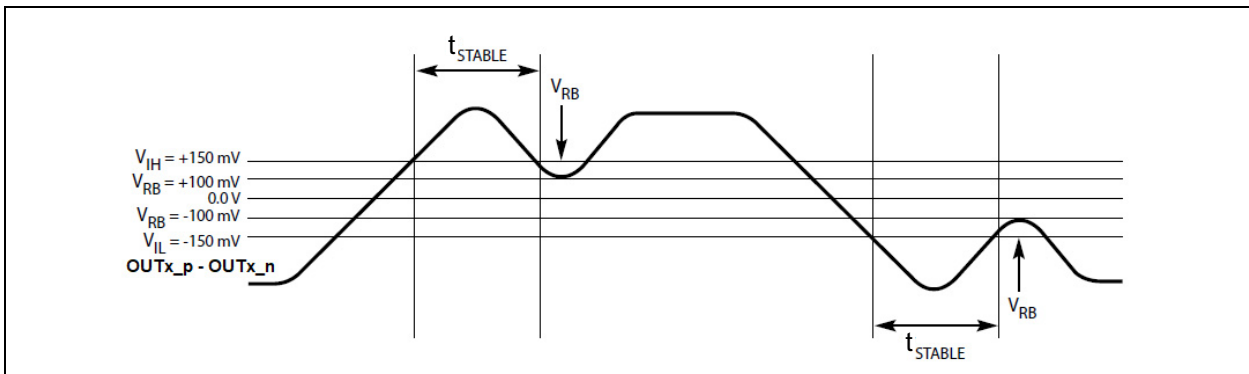
**FIGURE 1-3:** Single-Ended Measurement Points for Rise and Fall Time Matching.



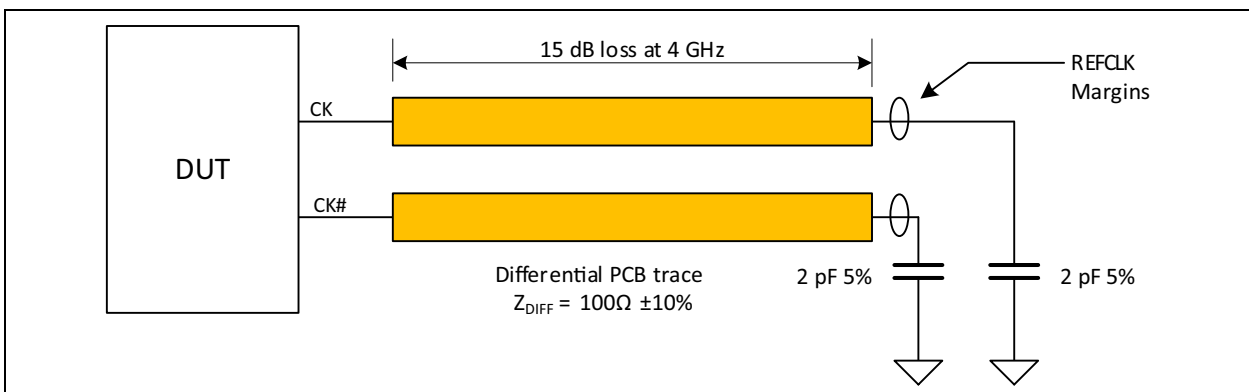
**FIGURE 1-4:** Differential Measurement Points for Duty Cycle and Period.



**FIGURE 1-5:** Differential Measurement Points for Rise and Fall Time.



**FIGURE 1-6:** Differential Measurement Points for Ringback.



**FIGURE 1-7:** PCIe Test Load.

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## 2.0 TYPICAL OPERATING CHARACTERISTICS

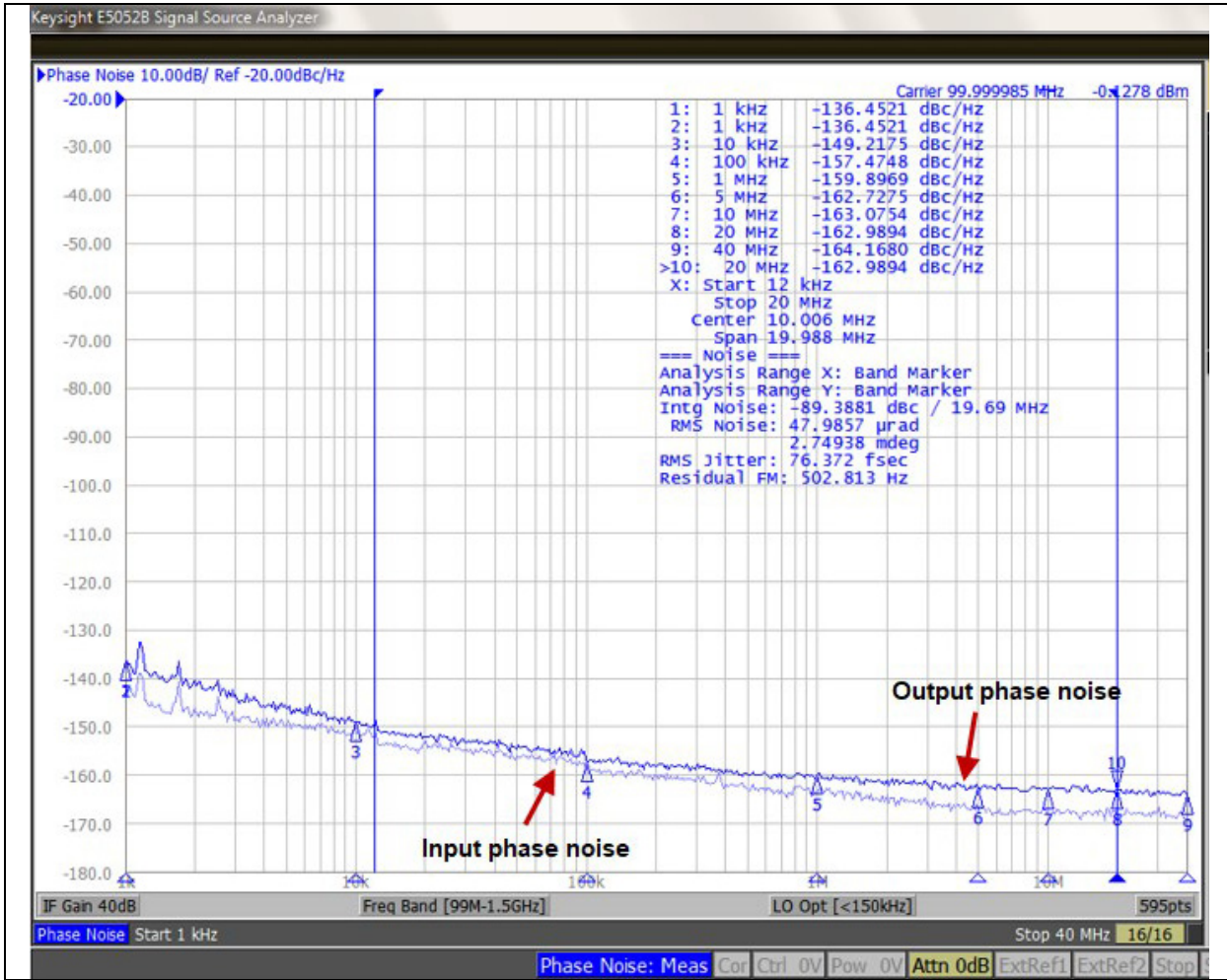


FIGURE 2-1: Typical Expected Phase Noise.

## 3.0 PIN DESCRIPTIONS

All device inputs and outputs are LPHCSL unless described otherwise. The Type column uses the following symbols:

- I: Input
- IPU: Input with 100 kΩ internal pull-up resistor
- IPD: Input with 100 kΩ internal pull-down resistor
- O: Output
- I/OOD: Input/Open-Drain Output
- NC: No Connect
- P: Power Supply

The descriptions of the pins are listed in [Table 3-1](#) and [Table 3-2](#).

**TABLE 3-1: SY75608 PIN FUNCTION TABLE**

Pin Number	Pin Name	Pin Type	Description															
16	IN0_p	I	<b>Differential/Single Ended References 0 and 1</b> Input frequency range >0 Hz to 250 MHz  <b>Note:</b> >0 Hz means frequency higher than DC. Output Enable control pins (OEnb) need four clock cycles before the corresponding output get enabled/disable. This feature ensures glitch free transition of the outputs.															
17	IN0_n																	
21	IN1_p																	
20	IN1_n																	
1	OUT0_p	O	<b>Ultra-Low Additive Jitter Differential LPHCSL Outputs 0 to 7</b> Output frequency range >0 Hz to 250 MHz  In I <sup>2</sup> C bus controlled mode (SEL pin pulled high) output enable is controlled via internal registers  In Hardware control mode (SEL pin pulled low) output enable is controlled by OE_n pins.															
2	OUT0_n																	
4	OUT1_p																	
5	OUT1_n																	
8	OUT2_p																	
9	OUT2_n																	
11	OUT3_p																	
12	OUT3_n																	
25	OUT4_p																	
26	OUT4_n																	
28	OUT5_p																	
29	OUT5_n																	
32	OUT6_p																	
33	OUT6_n																	
35	OUT7_p																	
36	OUT7_n																	
45	IN_SEL0 /I2C_SA_0	IPD	<b>Input Select 0 or I<sup>2</sup>C Address</b> When SEL pin is low, this pin is Input Select 0 hardware control input. When SEL pin is high, this pin together with pin 44 provides address for I <sup>2</sup> C Bus. This pin is pulled down with 100 kΩ resistor.															
			<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>IN_SEL1</th> <th>IN_SEL0</th> <th>OUTN</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Input 0 (IN0)</td> </tr> <tr> <td>0</td> <td>1</td> <td>Input 1 (IN1)</td> </tr> <tr> <td>1</td> <td>0</td> <td>Crystal Oscillator or Overdrive</td> </tr> <tr> <td>1</td> <td>1</td> <td>Crystal Bypass</td> </tr> </tbody> </table>	IN_SEL1	IN_SEL0	OUTN	0	0	Input 0 (IN0)	0	1	Input 1 (IN1)	1	0	Crystal Oscillator or Overdrive	1	1	Crystal Bypass
			IN_SEL1	IN_SEL0	OUTN													
			0	0	Input 0 (IN0)													
			0	1	Input 1 (IN1)													
1	0	Crystal Oscillator or Overdrive																
1	1	Crystal Bypass																
0	0	Input 0 (IN0)																
0	1	Input 1 (IN1)																
1	0	Crystal Oscillator or Overdrive																
1	1	Crystal Bypass																
44	IN_SEL1 /I2C_SA_1	IPD	<b>Input Select 1 or Serial Interface Input</b> When SEL pin is low, this pin is Input Select 1 hardware control pin. When SEL pin is high, this pin together with pin 45 provides address for I <sup>2</sup> C Bus. This pin is pulled down with 100 kΩ resistor.															

# SY75608/612

**TABLE 3-1: SY75608 PIN FUNCTION TABLE (CONTINUED)**

Pin Number	Pin Name	Pin Type	Description		
43	OE_TYPE0 /I2C_SCL	IPD/O	<b>Output Signal Type or I<sup>2</sup>C Bus Clock</b> When SEL pin is low this pin and pin 42 selects output type.		
			<b>OE_TYPE1</b>	<b>OE_TYPE0</b>	<b>Output [7:0] state when OE_n is high</b>
			0	0	Both p and n are pulled low via internal output termination resistors per standard HCSL (PCIe)
			0	1	Drive Differential Low: p is pulled low and n is pulled high via output termination resistors
			1	0	Reserved
			1	1	High-Z (disabled)
			When SEL pin is high this pin is I <sup>2</sup> C Bus Clock. This pin is pulled down with 100 kΩ resistor when SEL is low.		
42	OE_TYPE1/ I2C_SDA	IPD/OOD	<b>Output Signal Type or I<sup>2</sup>C Bus I/O Data</b> When SEL pin is low, this pin and pin 43 selects output type. When SEL pin is high, this pin is an I/O pin (Input/Open-Drain) for I <sup>2</sup> C Bus. This pin is pulled down with 100 kΩ resistor when SEL is low.		
48	OE0b	IPD	<b>Output Enable Control</b> When the SEL pin is low and OE <sub>n</sub> is low, the output n where n = {0,...,7} is active. When the SEL pin is low and OE <sub>n</sub> is high, the output is dependent on OE_TYPE0/1 pins OE <sub>n</sub> is synchronous and it need four clock cycles before the corresponding output gets enabled/disabled.  OE <sub>n</sub> pins are pulled-down with 100 kΩ resistor.		
47	OE1b				
14	OE2b				
13	OE3b				
23	OE4b				
22	OE5b				
38	OE6b				
37	OE7b				
18	XIN	I	<b>Crystal Oscillator Input or Crystal Bypass Mode or Crystal Overdrive Mode</b> If crystal circuit is not used, pull-down this pin or connect it to ground.		
19	XOUT	O	<b>Crystal Oscillator Output</b>		
41	SEL	IPD	<b>Select Control</b> When this pin is low, the device is controlled via hardware pins, IN_SEL0/1 and OE_TYPE0/1. When this pin is high, the device is controlled via I <sup>2</sup> C Bus port.  Any change of SEL pin value requires power cycle. Hence, SEL pin cannot be changed on the fly. This pin is pulled down with 100 kΩ resistor.		
24	OUT_IMP_SEL	IPD	<b>Output Impedance Select</b> When this pin is low, the output differential impedance is 100Ω When this pin is high, the output differential impedance is 85Ω This pin is pulled down with 100 kΩ resistor.		
15	VDD	P	<b>Positive Supply Voltage</b> Connect to 3.3V, 2.5V, or 1.8V supply.		
39					
46					



**TABLE 3-1: SY75608 PIN FUNCTION TABLE (CONTINUED)**

Pin Number	Pin Name	Pin Type	Description
3	VDDO	P	<b>Positive Supply Voltage for Differential Outputs</b> Connect to 3.3V, 2.5V or 1.8V supply. These pins power up differential outputs OUT[7:0]_p/n.
10			
27			
34			
40	VPP	P	<b>Positive Supply Voltage for Programming OTP Memory</b> This pin is used for generating custom configurations on ATE. Connect to ground for normal operation.
6	GND	P	<b>Ground</b> Connect to ground.
7			
30			
31			
ePAD			

**TABLE 3-2: SY75612 PIN FUNCTION TABLE**

Pin Number	Pin Name	Pin Type	Description
20	IN0_p	I	<b>Differential/Single-Ended References 0 and 1</b>  Input frequency range >0 Hz to 250 MHz  Note: >0 Hz means frequency higher than DC. Output Enable control pins (OEnb) need four clock cycles before the corresponding output get enabled/disable. This feature ensures glitch free transition of the outputs.
21	IN0_n		
25	IN1_p		
24	IN1_n		
1	OUT0_p	O	<b>Ultra-Low Additive Jitter Differential LPHCSL Outputs 0 to 11</b>  Output frequency range >0 Hz to 250 MHz  In I <sup>2</sup> C bus controlled mode (SEL pin pulled high) output enable is controlled via internal registers  In Hardware control mode (SEL pin pulled low) output enable is controlled by OE_n pins.
2	OUT0_n		
4	OUT1_p		
5	OUT1_n		
6	OUT2_p		
7	OUT2_n		
8	OUT3_p		
9	OUT3_n		
10	OUT4_p		
11	OUT4_n		
13	OUT5_p		
14	OUT5_n		
29	OUT6_p		
30	OUT6_n		
32	OUT7_p		
33	OUT7_n		
34	OUT8_p		
35	OUT8_n		
36	OUT9_p		
37	OUT9_n		
38	OUT10_p		
39	OUT10_n		
41	OUT11_p		
42	OUT11_n		

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**TABLE 3-2: SY75612 PIN FUNCTION TABLE (CONTINUED)**

Pin Number	Pin Name	Pin Type	Description		
52	IN_SEL0 /I2C_SA_0	IPD	<b>Input Select 0 or I<sup>2</sup>C Address</b> When SEL pin is low, this pin is Input Select 0 hardware control input. When SEL pin is high, this pin together with pin 51 provides address for I <sup>2</sup> C Bus. This pin is pulled down with 100 kΩ resistor when SEL is low.		
			<b>IN_SEL1</b>	<b>IN_SEL0</b>	<b>OUTN</b>
			0	0	Input 0 (IN0)
			0	1	Input 1 (IN1)
			1	0	Crystal Oscillator or Overdrive
1	1	Crystal Bypass			
51	IN_SEL1 /I2C_SA_1	IPD	<b>Input Select 1 or Serial Interface Input</b> When SEL pin is low, this pin is Input Select 1 hardware control pin. When SEL pin is high, this pin together with pin 52 provides address for I <sup>2</sup> C Bus. This pin is pulled-down with 100 kΩ resistor when SEL is low.		
50	OE_TYPE0 /I2C_SCL	IPD/O	<b>Output Signal Type or I<sup>2</sup>C Bus Clock</b> When SEL pin is low this pin and pin 49 selects output type.		
			<b>OE_TYPE1</b>	<b>OE_TYPE0</b>	<b>Output [11:0] state when OE_n is high</b>
			0	0	Both p and n are pulled low via internal output termination resistors per standard HCSL (PCIe)
			0	1	Drive Differential Low: p is pulled low and n is pulled high via output termination resistors
			1	0	Reserved
			1	1	High-Z (Disabled)
			When SEL pin is high this pin is I <sup>2</sup> C Bus Clock. This pin is pulled-down with 100 kΩ resistor.		
49	OE_TYPE1 /I2C_SDA	IPD/OOD	<b>Output Signal Type or I<sup>2</sup>C Bus I/O Data</b> When SEL pin is low, this pin and pin 50 selects output type. When SEL pin is high, this pin is an I/O pin (Input/Open-Drain) for I <sup>2</sup> C Bus. This pin is pulled down with 100 kΩ resistor.		
56	OE0b	IPD	<b>Output Enable Control</b> When the SEL pin is low and OE <sub>n</sub> b is low the output n where n = {0,...,11} is active When the SEL pin is low and OE <sub>n</sub> b is high the output is dependent on OE_TYPE0/1 pins  OE <sub>n</sub> b is synchronous and it need four clock cycles before the corresponding output gets enabled/disabled.  OE <sub>n</sub> b pins are pulled-down with 100 kΩ resistor.		
55	OE1b				
54	OE2b				
17	OE3b				
16	OE4b				
15	OE5b				
27	OE6b				
26	OE7b				
19	OE8b				
45	OE9b				
44	OE10b				
43	OE11b				
22	XIN	I	<b>Crystal Oscillator Input or Crystal Bypass Mode or Crystal Overdrive Mode</b> If crystal circuit is not used pull-down this pin or connect it to the ground.		
23	XOUT	O	<b>Crystal Oscillator Output</b>		

**TABLE 3-2: SY75612 PIN FUNCTION TABLE (CONTINUED)**

Pin Number	Pin Name	Pin Type	Description
48	SEL	IPD	<p><b>Select control</b>            When this pin is low, the device is controlled via hardware pins, IN_SEL0/1 and OE_TYPE0/1.            When this pin is high, the device is controlled via I<sup>2</sup>C Bus port.</p> <p>Any change of SEL pin value requires power cycle. Hence, SEL pin cannot be changed on the fly.            This pin is pulled down with 100 kΩ resistor.</p>
28	OUT_IMP_SEL	IPD	<p><b>Output Impedance Select</b>            When this pin is low, the output differential impedance is 100Ω            When this pin is high, the output differential impedance is 85Ω            This pin is pulled down with 100 kΩ resistor.</p>
18	VDD	P	<p><b>Positive Supply Voltage</b>            Connect to 3.3V, 2.5V, or 1.8V supply.</p>
46			
53			
3	VDDO	P	<p><b>Positive Supply Voltage for Differential Outputs</b>            Connect to 3.3V, 2.5V, or 1.8V power supply. These pins power up differential outputs OUT[11:0]_p/n.</p>
12			
31			
40			
47	VPP	P	<p><b>Positive Supply Voltage for Programming OTP Memory</b>            This pin is used for generating custom configurations on ATE. Connect to ground for normal operation.</p>
ePAD	GND	P	<p><b>Ground</b>            Connect to ground</p>

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## 4.0 FUNCTIONAL DESCRIPTION

The SY75608 and SY75612, respectively, are 2-to-8 and 2-to-12 PCIe clock buffers with ultra-low additive jitter. They can be used in all PCIe 1/2/3/4/5/6 common clock and SRIS applications.

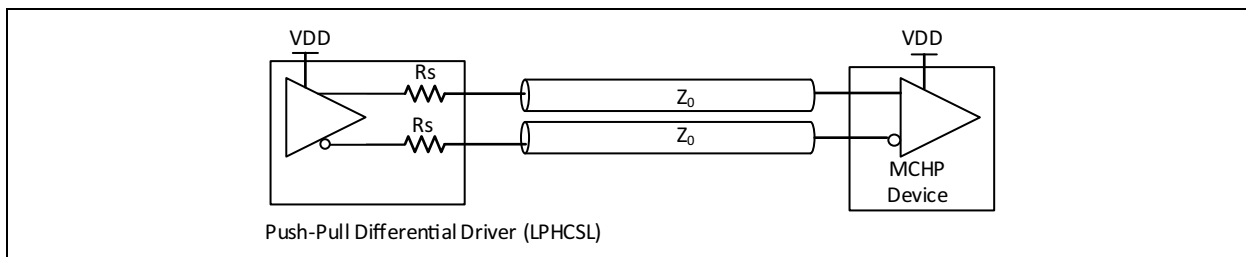
Each output can be enabled/disabled glitch-free via dedicated OE pins or via I<sup>2</sup>C bus.

The SY75608/612 each have an embedded low-dropout regulator (LDO) for superior power noise supply rejection. They support 1.8V, 2.5V, and 3.3V supplies with tolerance of  $\pm 10\%$ , which exceeds the  $\pm 9\%$  required by PCIe Card Electro Mechanical Specification.

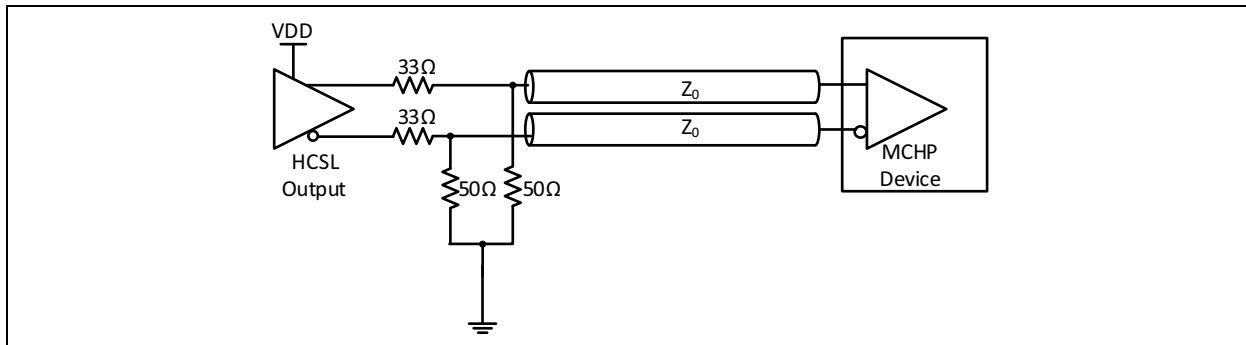
Besides operating as fanout buffers, these devices can work as fixed frequency clock generators with external crystal. Supported crystal frequencies are 8 MHz to 160 MHz.

## 4.1 Clock Input

The following figures show how to terminate input of the device in most common cases: Low Power HCSL (LPHCSL), HCSL, and single-ended LVCMOS.



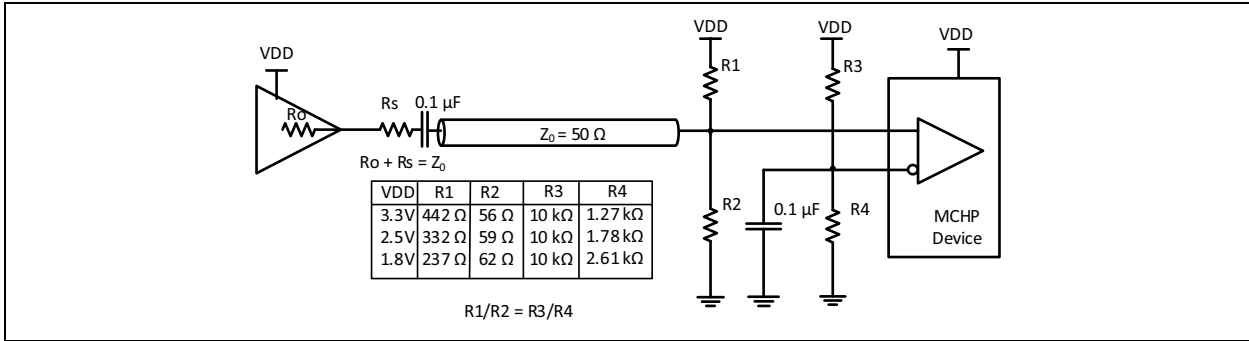
**FIGURE 4-1:** Input Driven by LPHCSL Driver.



**FIGURE 4-2:** Input Driven by HCSL Driver.

Figure 4-3 shows how to terminate a single-ended output, such as LVCMOS. This example assumes 50Ω transmission line, which is the most common for single-ended CMOS signaling. Ideally, resistors R1 and R2 should be 100Ω each and  $R_O + R_S$  should be 50Ω so that the transmission line is terminated at both ends with characteristic impedance. If the driving strength of the output driver is not sufficient to drive low impedance, the value of series resistor  $R_S$  should be increased. This will reduce the voltage swing at the input, but this should be fine as long as the input voltage swing requirement is not violated (Figure 1-3). The source resistors of  $R_S = 270\Omega$  could be used for a standard LVCMOS driver. This will provide 516 mV of voltage swing for 3.3V LVCMOS driver with load current of  $(3.3V/2) * (1/(270\Omega + 50\Omega)) = 5.16 \text{ mA}$ .

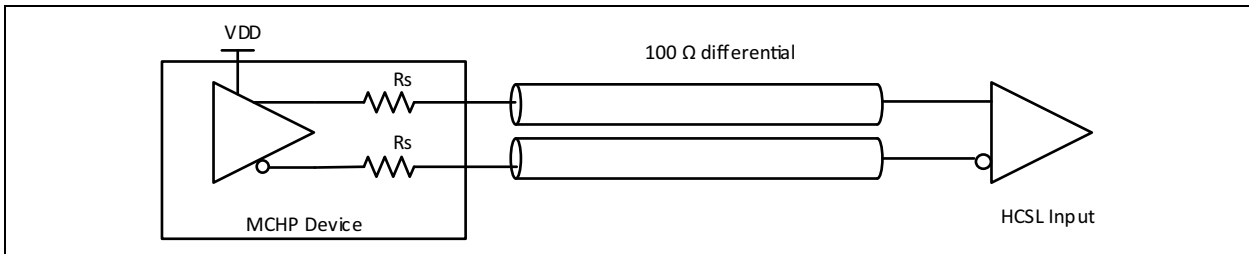
For optimum performance both differential input pins ( $\_p$  and  $\_n$ ) need to be DC-biased to the same voltage. Hence, the ratio  $R1/R2$  should be equal to the ratio  $R3/R4$ .



**FIGURE 4-3:** Input Driven from a Single-Ended CMOS Output.

## 4.2 Clock Outputs

Differential outputs have embedded termination resistors as shown in Figure 4-4. This provides significant saving relative to traditional current-based HCSL outputs that require four resistors per differential output.

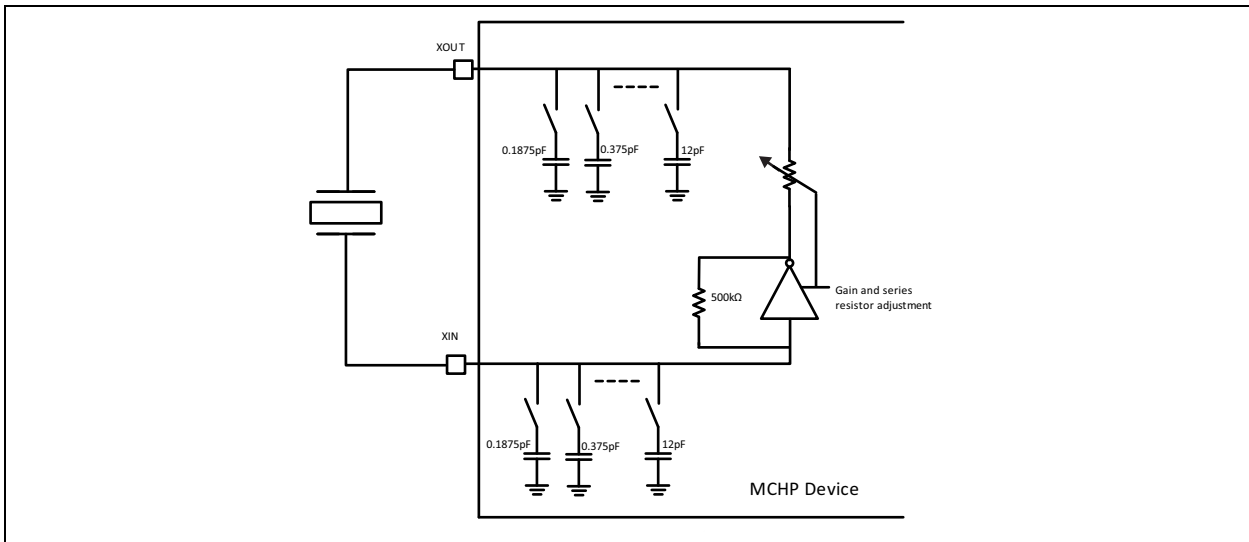


**FIGURE 4-4:** Terminating Differential Outputs.

Embedded termination resistors in SY75608/612 are matched for 85Ω or 100Ω differential transmission lines.

## 4.3 Crystal Oscillator Circuit

The crystal oscillator circuit can work with crystal resonators from 8 MHz to 160 MHz. As can be seen in Figure 4-5, only a crystal resonator is required and all the other components are built into the device. To be able support crystal resonators with different characteristics all internal components are programmable in I<sup>2</sup>C Controlled mode.

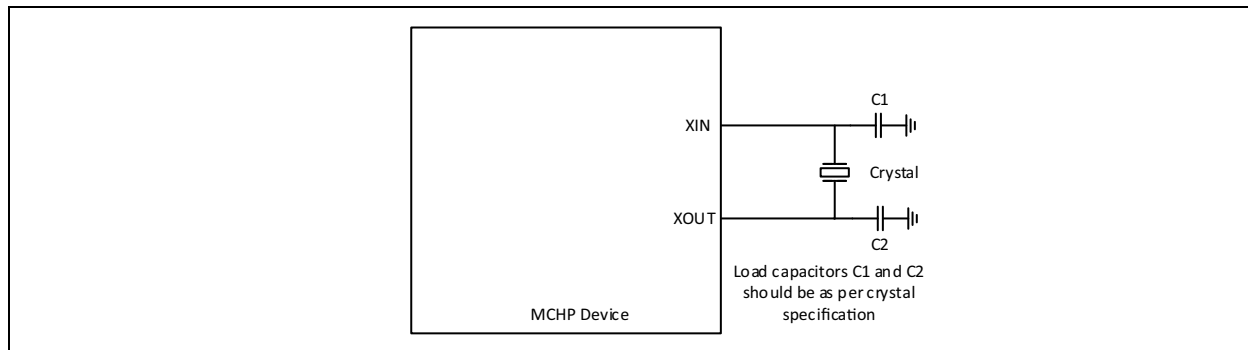


**FIGURE 4-5:** Crystal Oscillator Circuit in SPI Controlled Mode.

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Load capacitors can be programmed from 0 pF to 23.8 pF with a resolution of 0.1875 pF that not only meets load requirement for most crystal resonator, but also allows for fine tuning of the crystal resonator frequency. The amplifier gain can be adjusted by selecting one of seven gain values. The series resistor is adjusted based on the selected gain. Shunt resistor has fixed value of 500 k $\Omega$ .

In Hardware Controlled mode, the capacitive load is set at 8 pF and cannot be changed. For crystals that require higher load, additional capacitance can be added externally as shown in [Figure 4-6](#).



**FIGURE 4-6:** Crystal Oscillator Circuit in Hardware Controlled Mode.

## 5.0 HOST INTERFACE

SY75608 and SY75612 can be controlled via hardware pins (SEL pin tied low) or via I<sup>2</sup>C Bus (SEL pin tied high). The mode shall be selected during power up and it cannot be changed on the fly.

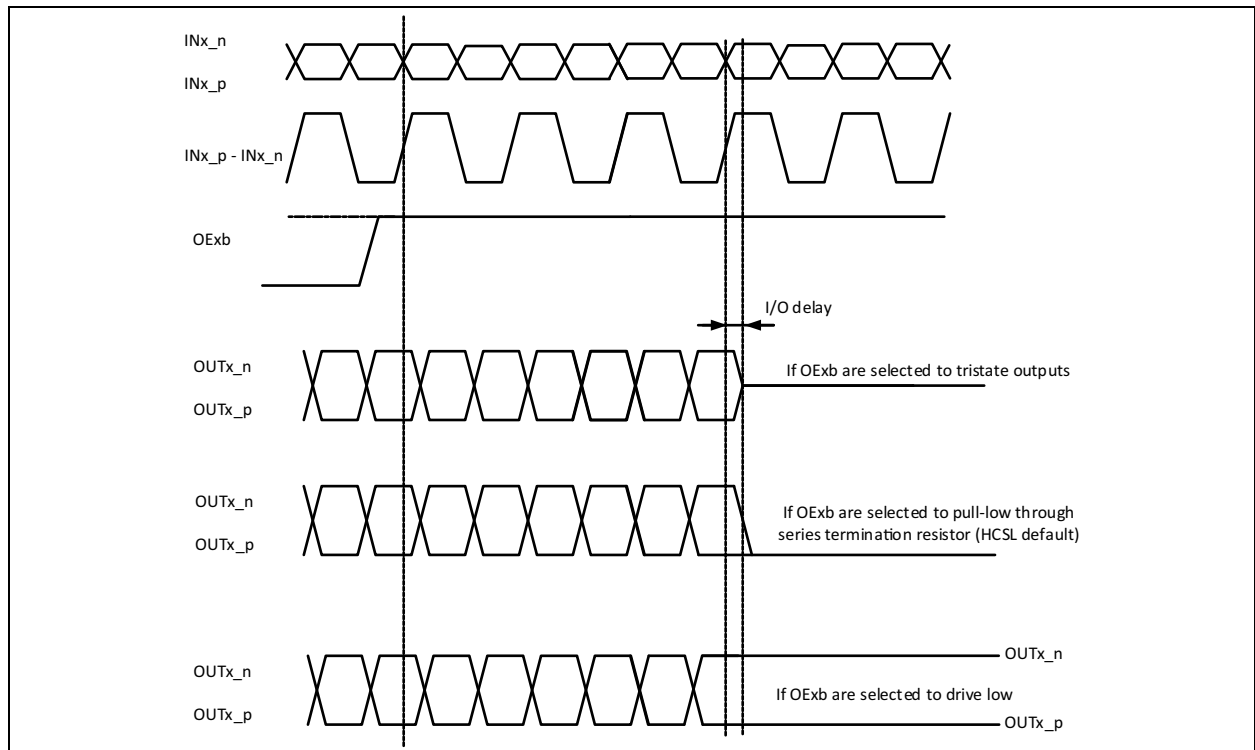
### 5.1 Hardware Controlled Mode

In this mode, SY75608/612 is controlled via Input Select pins (IN\_SEL[1:0]) that select which one of three inputs is fed to outputs (as shown in Table 5-1), output enable pins (OE\_b) for each output (as shown in Figure 5-1), and Output Impedance Select pin.

**TABLE 5-1: INPUT CLOCK SELECTION**

IN_SEL1	IN_SEL0	Selected Input
0	0	IN0_p, IN0_n
0	1	IN1_p, IN1_n
1	X	XIN (crystal input pin)

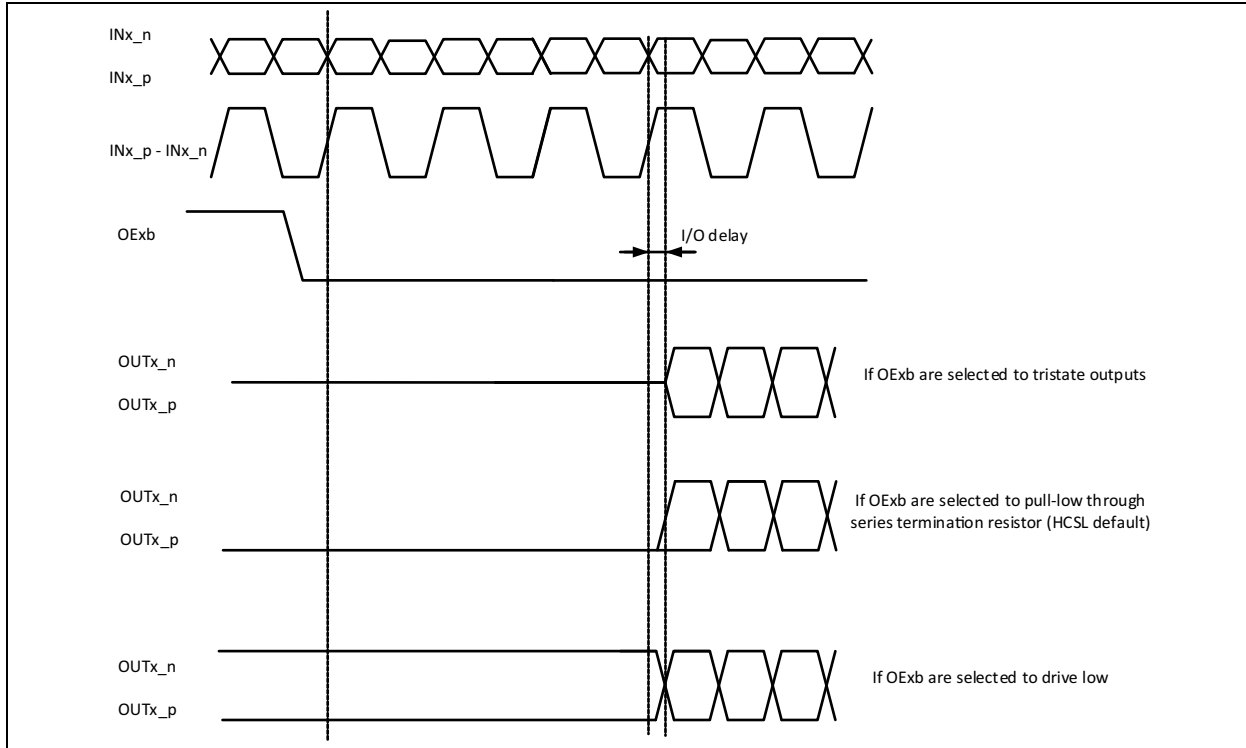
Any outputs can be disabled by pulling the corresponding OE<sub>b</sub> pin high. The OE<sub>b</sub> is sampled on the falling edge of the differential input clock (or falling edge of IN<sub>x\_p</sub>). It takes 4.5 clock cycles before the output goes from the active state to the state defined by OE\_TYPE0/1 pins (SEL = 0) or defined by DRVSTATE0/1/2 register (SEL = 1) as shown in Figure 5-1.



**FIGURE 5-1:** Output Disable.

Any outputs can be enabled by pulling the corresponding OE<sub>b</sub> pin low. The OE<sub>b</sub> is sampled on the falling edge of the differential input (or falling edge of IN<sub>x\_p</sub> signal). It takes 3.5 clock cycles of the input clock before the output goes from the state defined by OE\_TYPE0/1 pins (SEL pin pulled low) or defined by DRVSTATE0/1/2 registers (SEL pin pulled high) to the active state as shown in Figure 5-2.

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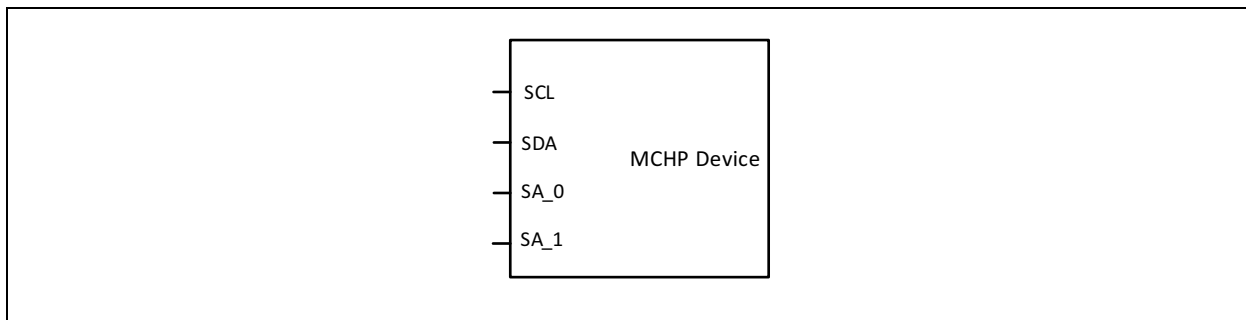


**FIGURE 5-2:** Output Enable.

The Output Impedance Select pin is an asynchronous control input that selects between 100Ω (OUT\_IMP\_SEL tied low) and 85Ω (OUT\_IMP\_SEL tied high).

## 5.2 I<sup>2</sup>C Bus Control Mode

The SY75608 and SY75612 are controlled via four pin I<sup>2</sup>C Bus client interface as shown in Figure 5-3.



**FIGURE 5-3:** I<sup>2</sup>C Bus Client Interface.

The address selection is done via SA\_0 and SA\_1 hardware pins that select the appropriate address for the device.

**TABLE 5-2: I<sup>2</sup>C BUS ADDRESS**

SA_1	SA_0	I <sup>2</sup> C Bus Address
0	0	0x34
0	1	0x35
1	0	0x36
1	1	0x37

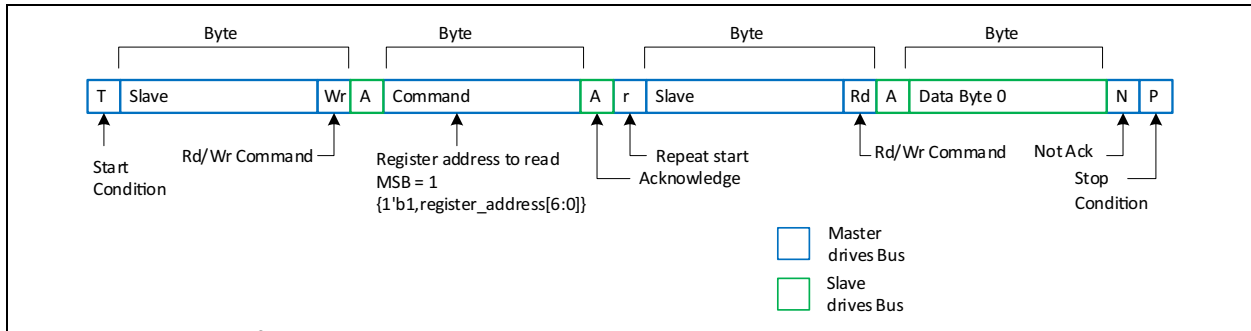


## 5.2.1 I<sup>2</sup>C BUS READ/WRITE

Reading or writing a register or registers in a I<sup>2</sup>C Bus client device is MSB first and LBS last in one-byte blocks.

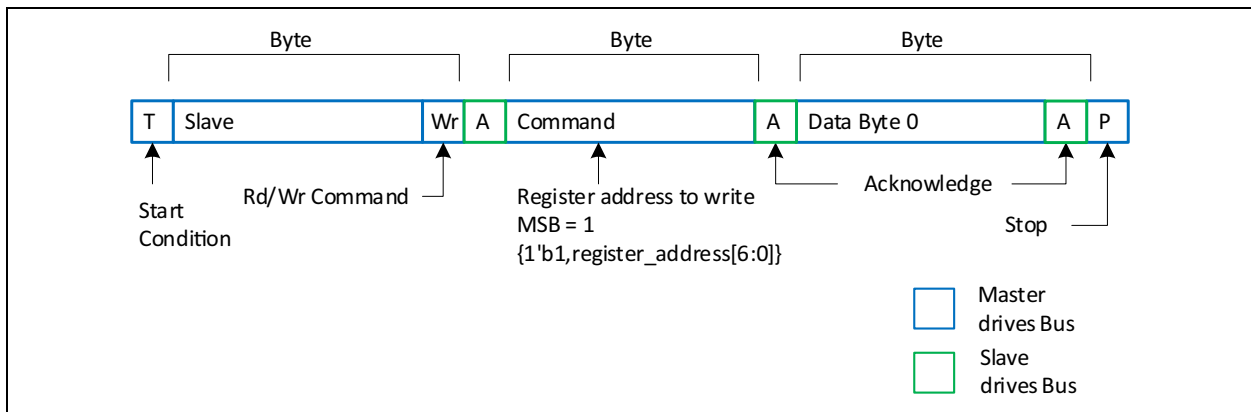
The access from I<sup>2</sup>C server starts with the start condition followed by the client address and the write indicator bit. This is then followed by the command byte which in bits [6:0] contains the address of the register to be accessed for byte mode or the first register to be accessed in the burst mode. The most significant bit in the command byte must be set to 1.

**Byte Read.** The standard byte read is as shown in Figure 5-4. The command byte is followed the client address and read indication bit. The device (client) will respond by sending the requested byte.



**FIGURE 5-4:** I<sup>2</sup>C Bus Byte Read.

**Write.** Figure 5-5 illustrates the standard byte write. After the written byte has been acknowledged by the device, the server will assert the stop signal.



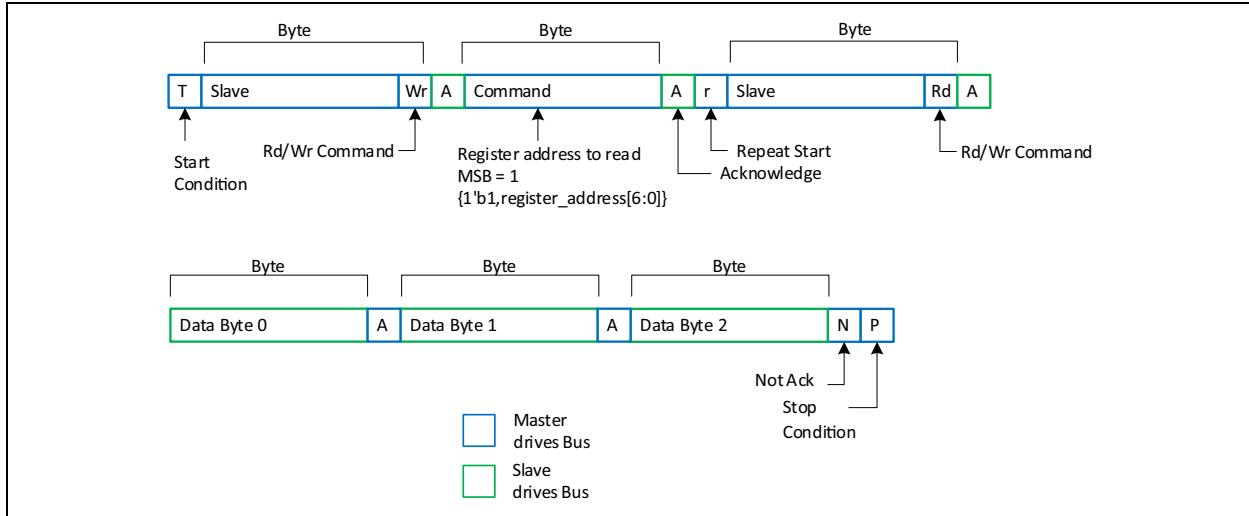
**FIGURE 5-5:** I<sup>2</sup>C Bus Byte Write.

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## 5.2.2 I<sup>2</sup>C BURST READ/WRITE

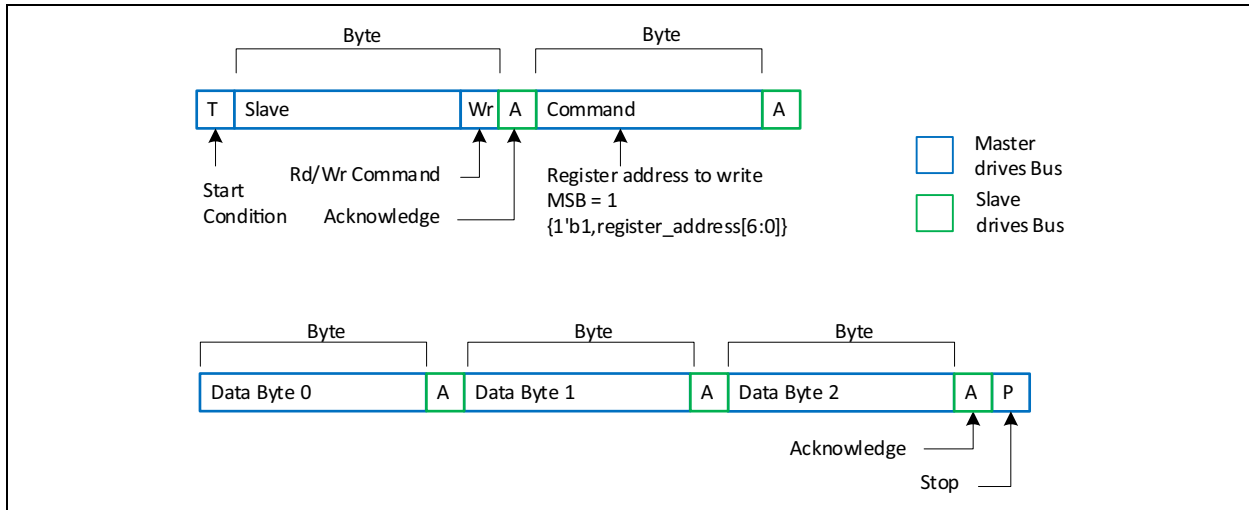
Burst Read and Write are very similar to Byte Read and Write.

**Burst Read.** Figure 5-6 illustrates the Burst Read. The I<sup>2</sup>C server acknowledges after each received byte and finally sends a Not Acknowledge (NACK) followed with Stop Condition.



**FIGURE 5-6:** I<sup>2</sup>C Bus Burst Read.

**Burst Write.** Figure 5-7 illustrates Burst Write operation. The I<sup>2</sup>C server will send the Stop Condition after the last data byte.



**FIGURE 5-7:** I<sup>2</sup>C Bus Burst Write.

## 6.0 REGISTER MAP

The device is controlled by accessing registers through the serial interface. The following table provides a summary of the registers available for the configuration of the device. The default settings can be modified via factory programmable OTP memory (64 bit in total).

**TABLE 6-1: REGISTER MAP**

Address I <sup>2</sup> C A[6:0] Hex (0x)	Name	Data D[7:0]
00	XTALBG	xtal_buf_gain[4:0]
01	Reserved	Leave as default
02	XTALLC	xtal_load_cap[7:0]
03	XTALNR	xtal_normal_run
04	INSEL	input_select[1:0]
05	OUTDSTATE0	out_disable_state[7:0] (differential output OUT3, OUT2, OUT1, OUT0)
06	OUTDSTATE1	out_disable_state[15:8] (differential output OUT7, OUT6, OUT5, OUT4)
07	OUTDSTATE2	out_disable_state[23:16] (differential output OUT11, OUT10, OUT9, OUT8), SY75612 Only
08	OUTEN0	outen[7:0]
09	OUTEN1	outen[15:8], SY75612 Only
0A	DEVADDR	dev_addr[2:0]
0B	DEVICEID	Device Identification
0D	IN1_BUFF_CTRL	Differential Input 1 Control

**TABLE 6-2: DETAILED REGISTER MAP**

Bit	Name	Description	Type	Reset																											
<b>XTAL Buffer Gain - XTALBG (0x00)</b>																															
7:5	Unused	Leave as default	R/W	000																											
4:0	xtal_buf_gain[4:0]	Programs crystal buffer (inverting amplifier) gain by selecting number of parallel gain elements: Each gain value has associated series resistor as shown below:	R/W	00100 Note 1																											
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">xtal_buf_gain[4:0]</th> <th style="width: 25%;">Number of Parallel XO Amplifiers</th> <th style="width: 25%;">Series Resistance</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Open circuit</td> </tr> <tr> <td>1</td> <td>1</td> <td>550Ω</td> </tr> <tr> <td>2</td> <td>2</td> <td>550Ω</td> </tr> <tr> <td>3</td> <td>3</td> <td>550Ω</td> </tr> <tr> <td>4</td> <td>4</td> <td>150Ω</td> </tr> <tr> <td>8</td> <td>4</td> <td>0Ω</td> </tr> <tr> <td>16</td> <td>8</td> <td>0Ω</td> </tr> <tr> <td>24</td> <td>12</td> <td>0Ω</td> </tr> </tbody> </table>			xtal_buf_gain[4:0]	Number of Parallel XO Amplifiers	Series Resistance	0	0	Open circuit	1	1	550Ω	2	2	550Ω	3	3	550Ω	4	4	150Ω	8	4	0Ω	16	8	0Ω	24	12	0Ω
		xtal_buf_gain[4:0]			Number of Parallel XO Amplifiers	Series Resistance																									
		0			0	Open circuit																									
		1			1	550Ω																									
		2			2	550Ω																									
		3			3	550Ω																									
		4			4	150Ω																									
		8			4	0Ω																									
		16			8	0Ω																									
24	12	0Ω																													
Only values 0, 1, 2, 3, 4, 8, 16 and 24 are allowed values to be written to xtal_buf_gain[4:0]. All the other values are reserved.																															

# SY75608/612

**TABLE 6-2: DETAILED REGISTER MAP (CONTINUED)**

Bit	Name	Description	Type	Reset
<b>XTAL Load Capacitance - XTALLC (0x02)</b>				
7:0	xtal_load_cap[7:0]	<p>Internal load capacitance of crystal circuit (0 pF to 23.8 pF with the resolution of 0.1875 pF). XIN and XOUT have each capacitor connected to GND.</p> <p>Multiple bit combinations available between 7 capacitors.</p> <p>8'b0000_0000 = Disable all xtal load capacitors            8'b0000_0001 = Enable capacitor 0.1875 pF            8'b0000_0010 = Enable capacitor 0.375 pF            8'b0000_0100 = Enable capacitor 0.75 pF            8'b0000_1000 = Enable capacitor 1.5 pF            8'b0001_0000 = Enable capacitor 3 pF            8'b0010_0000 = Enable capacitor 6 pF            8'b0100_0000 = Enable capacitor 12 pF            8'b1000_0000 = Reserved</p>	R/W	40 Note 1
<b>XTAL Normal Run - XTALNR (0x03)</b>				
7:1	Unused	Unused	R	0000000
0	xtal_normal_run	<p>When this bit is set high crystal oscillator circuit is running only if input_select[1:0] register at address 0x05 selects crystal mode (2'b10). This value is recommended because it provides best jitter performance—XO circuit is running only when it is needed.</p> <p>When this bit is set low the crystal oscillator will keep running even if crystal oscillator is not selected in input_select[1:0] register at address 0x05. This mode should only be used when fast switching between input references and crystal oscillator is required.</p>	R/W	1 Note 1
<b>Input Select - INSEL (0x04)</b>				
7:2	Unused	Unused	R	000000
1:0	input_select[1:0]	<p>Input reference clock selection. Proper external coupling and termination are required.</p> <p>2'b00 = Differential input from IN0_p and IN0_n            2'b01 = Differential input from IN1_p and IN1_n            2'b10 = Fundamental XTAL mode with XIN and XOUT (Use internal crystal oscillator circuits) or XTAL overdrive mode (single-ended clock signal fed to XIN)            2'b11 = XTAL bypass mode (single-ended clock signal with XIN and disabled internal crystal buffer circuit in the analog block)</p>	R/W	00 Note 1
<b>State of Outputs when Disabled (Outputs 0 to 3) - OUTDSTATE0 (0x05)</b>				
7:6	out_disable_state[7:6]	<p>State of OUT3 driver when the corresponding bit in OUTEN register is set low.            The same bit configuration with OUT0.</p>	R/W	00
5:4	out_disable_state[5:4]	<p>State of OUT2 driver when the corresponding bit in OUTEN register is set low.            The same bit configuration with OUT0.</p>	R/W	00

**TABLE 6-2: DETAILED REGISTER MAP (CONTINUED)**

Bit	Name	Description	Type	Reset
3:2	out_disable_state[3:2]	State of OUT1 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
1:0	out_disable_state[1:0]	State of OUT0 driver when the corresponding bit in OUTEN register is set low. These bits should be set first before the corresponding bit in OUTEN register is toggled.  2'b00 = Both low (p output low, n output low) 2'b01 = Drive Low (p output low, n output high) 2'b10 = Outputs High-Z 2'b11 = Outputs High-Z	R/W	00
<b>State of Outputs when Disabled (Outputs 4 to 7) - OUTDSTATE1 (0x06)</b>				
7:6	out_disable_state[15:14]	State of OUT7 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
5:4	out_disable_state[13:12]	State of OUT6 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
3:2	out_disable_state[11:10]	State of OUT5 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
1:0	out_disable_state[9:8]	State of OUT4 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
<b>State of Outputs when Disabled (Outputs 8 to 11) - OUTDSTATE2 (0x07) (Applies only to SY75612)</b>				
7:6	out_disable_state[23:22]	State of OUT11 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
5:4	out_disable_state[21:20]	State of OUT10 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
3:2	out_disable_state[19:18]	State of OUT9 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
1:0	out_disable_state[17:16]	State of OUT8 driver when the corresponding bit in OUTEN register is set low. The same bit configuration with OUT0.	R/W	00
<b>Output Enable (Outputs 0 to 7) - OUTEN0 (0x08)</b>				
7	outen7	Enable/Disable output 7. The same bit configuration with OUT0.	RW	0
6	outen6	Enable/Disable output 6. The same bit configuration with OUT0.	RW	0
5	outen5	Enable/Disable output 5. The same bit configuration with OUT0.	RW	0
4	outen4	Enable/Disable output 4. The same bit configuration with OUT0.	RW	0
3	outen3	Enable/Disable output 3. The same bit configuration with OUT0.	RW	0
2	outen2	Enable/Disable output 2. The same bit configuration with OUT0.	RW	0

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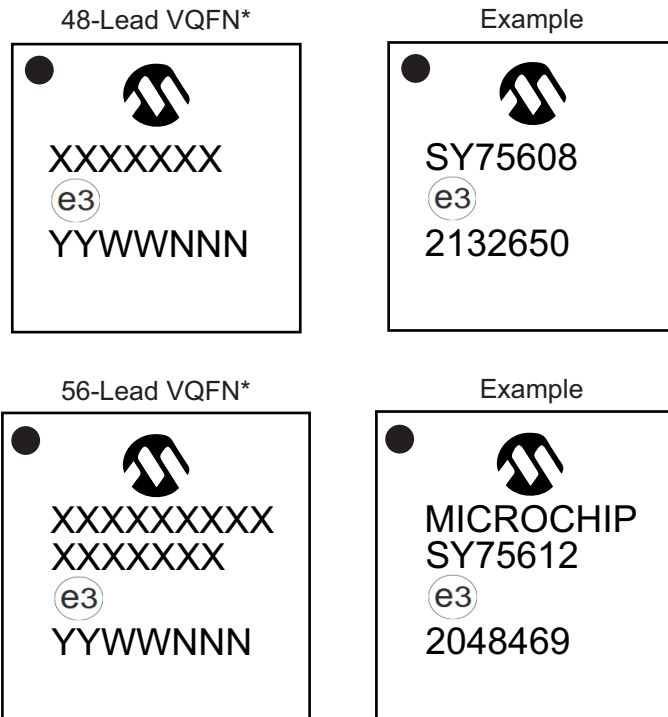
**TABLE 6-2: DETAILED REGISTER MAP (CONTINUED)**

Bit	Name	Description	Type	Reset
1	outen1	Enable/Disable output 1. The same bit configuration with OUT0.	RW	0
0	outen0	Enable/Disable output 0. When this bit is set low the OUT 0 is disabled. The type of the disable mode is specified in the corresponding bit of the OUTDSTATE register. When this bit is set high the OUT0 is in LPHCSL active mode.	RW	0
<b>Output Enable (Outputs 11 to 8) - OUTEN1 (0x09) (Applies only to SY75612)</b>				
7:4	Reserved	Leave as default	RW	0000
3	outen11	Enable/Disable output 11. The same bit configuration with OUT0.	RW	0
2	outen10	Enable/Disable output 10. The same bit configuration with OUT0.	RW	0
1	outen9	Enable/Disable output 9. The same bit configuration with OUT0.	RW	0
0	outen8	Enable/Disable output 8. The same bit configuration with OUT0.	RW	0
<b>I<sup>2</sup>C Bus Client Device Address - DEVADDR (0x0A)</b>				
7:2	Unused	Unused	R	000000
1:0	dev_addr[1:0]	These three bits contributes as the following to the 7 bits of the I <sup>2</sup> C Bus client address {2'b011, dev_addr[1:0], SA1, SA0}, where SA0 and SA1 are from pins IN_SEL0_I2C_SA_0 and IN_SEL0_I2C_SA_0 respectively	RW	01 Note 1
<b>Device Identification - DEVID (0x0B)</b>				
7	Unused	Unused	R	0
6:3	Revision Number	Silicon Revision Number	RO	0001
2:0	dev_id[2:0]	Device ID 3'b001 = SY75608 3'b002 = SY75612	RO	001(Note 1) or 010(Note 1)
<b>Differential Input 1 Control - IN1_BUFF_CTRL (0x0D)</b>				
7:6	Unused	Unused	R	0
5:2	in1_buff_ctrl	Bias current control from low (4'b0000) to high (4'b1111)	RW	1010 Note 1
1	in1_buff_powdown	1'b0 = Input buffer is enabled 1'b1 = Input buffer is powered down	RW	0
0	in1_buff_ac_coupl	This bit selects either internal DC or AC coupling of the differential input 1 signal. 1'b0 = Input is DC-coupled 1'b1 = Input is AC-coupled	RW	0

**Note 1:** The default value is OTP programmable.

## 7.0 PACKAGING INFORMATION

### 7.1 Package Marking Information



**Note:** For customers ordering these parts with a customized configuration, the characters “GXXX” will appear on the marking to the right of the JEDEC designator in which “XXX” represents a numerical code. Please visit the [ClockWorks Configurator](#) to design your particular specifications.

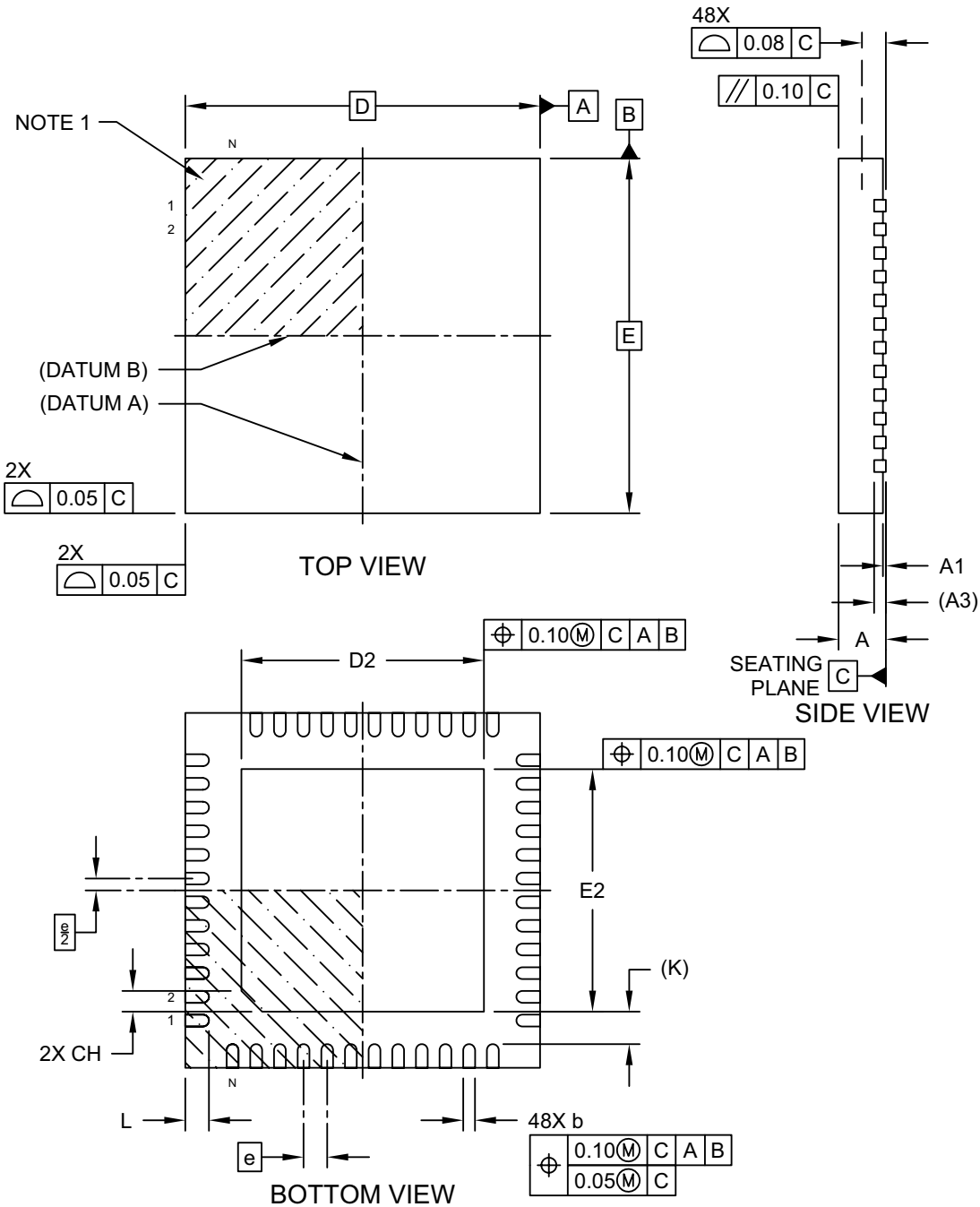
<b>Legend:</b>	XX...X	Product code
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
		Pb-free JEDEC® designator for Matte Tin (Sn)
	(e3)	This package is Pb-free. The Pb-free JEDEC designator ( ) can be found on the outer packaging for this package. (e3)
	•, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
<b>Note:</b>	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.	
	Underbar ( ) and/or Overbar ( ) symbol may not be to scale.	

# SY75608/612

## 48-Lead VQFN 6 mm x 6 mm Package Outline and Recommended Land Pattern

### 48-Lead Very Thin Plastic Quad Flat, No Lead Package (6LX) - 6x6 mm Body [VQFN] With 4.1x4.1 mm Exposed Pad

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

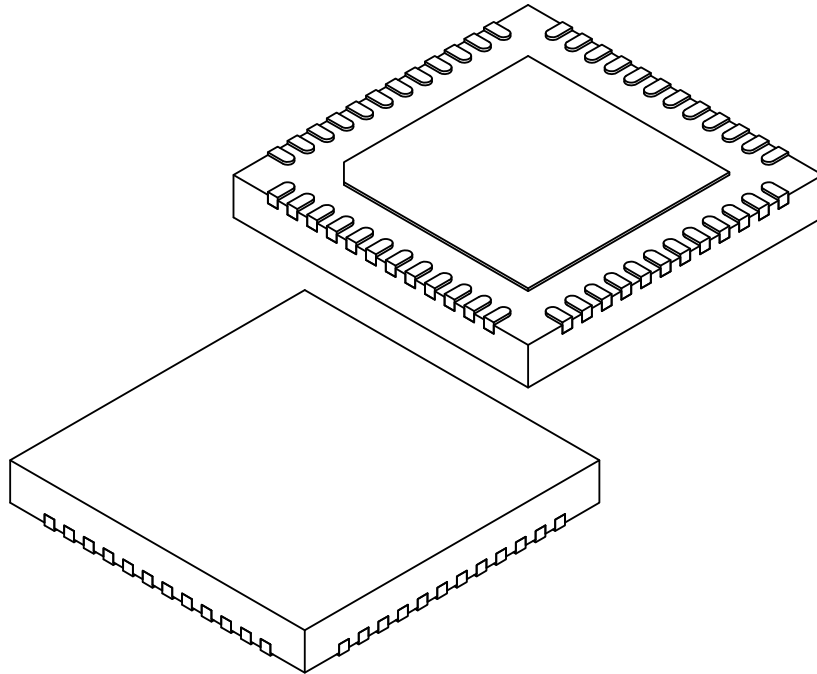


Microchip Technology Drawing C04-494 Rev A Sheet 1 of 2



## 48-Lead Very Thin Plastic Quad Flat, No Lead Package (6LX) - 6x6 mm Body [VQFN] With 4.1x4.1 mm Exposed Pad

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Units		MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	N	48		
Pitch	e	0.40 BSC		
Overall Height	A	0.80	0.85	0.90
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3	0.20 REF		
Overall Length	D	6.00 BSC		
Exposed Pad Length	D2	4.00	4.10	4.20
Overall Width	E	6.00 BSC		
Exposed Pad Width	E2	4.00	4.10	4.20
Exposed Pad Corner Chamfer	CH	0.35 REF		
Terminal Width	b	0.15	0.20	0.25
Terminal Length	L	0.30	0.40	0.50
Terminal-to-Exposed-Pad	K	0.55 REF		

**Notes:**

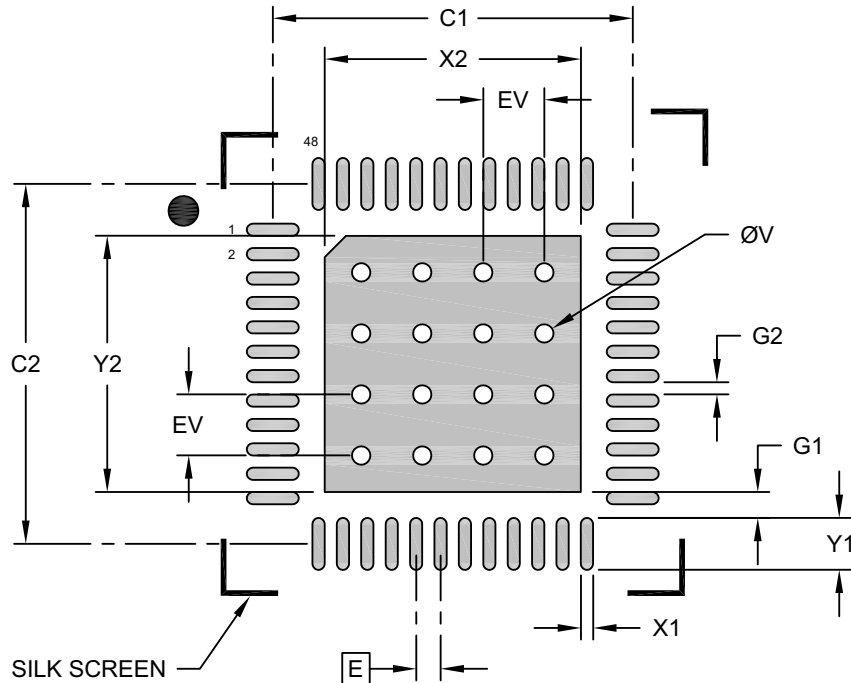
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
  - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-494 Rev A Sheet 1 of 2

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## 48-Lead Very Thin Plastic Quad Flat, No Lead (6LX) - 6x6 mm Body [VQFN] With 4.1x4.1 mm Exposed Pad

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



### RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.40 BSC		
Optional Center Pad Width	X2			4.20
Optional Center Pad Length	Y2			4.20
Contact Pad Spacing	C1		5.90	
Contact Pad Spacing	C2		5.90	
Contact Pad Width (X48)	X1			0.20
Contact Pad Length (X48)	Y1			0.85
Contact Pad to Center Pad (X48)	G1	0.20		
Contact Pad to Contact Pad (X44)	G2	0.20		
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

**Notes:**

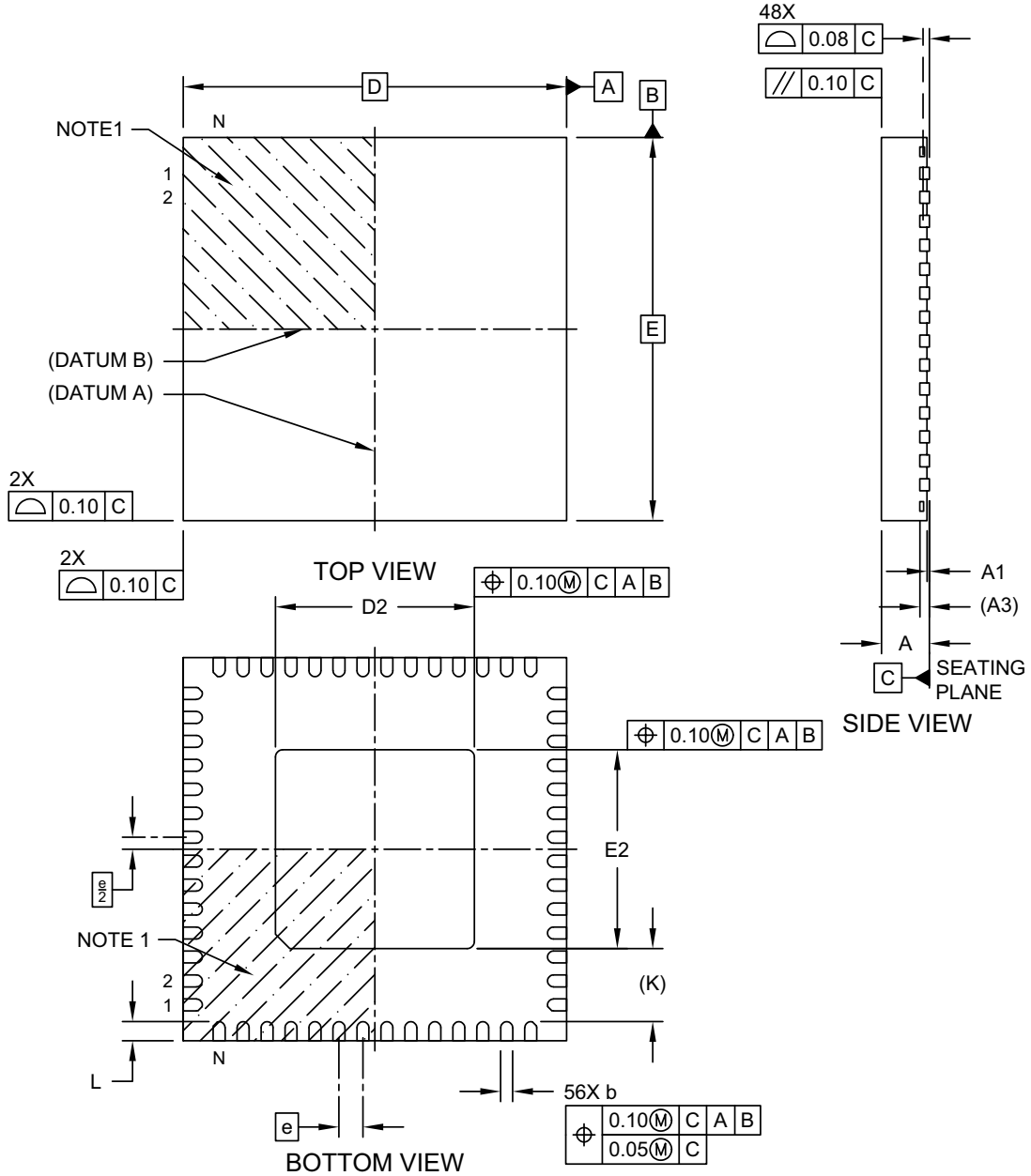
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2494 Rev A

## 56-Lead VQFN 8 mm x 8 mm Package Outline and Recommended Land Pattern

### 56-Lead Very Thin Plastic Quad Flat, No Lead Package (K3C) - 8x8x1.0 mm Body [VQFN] With 4.15 mm Exposed Pad

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

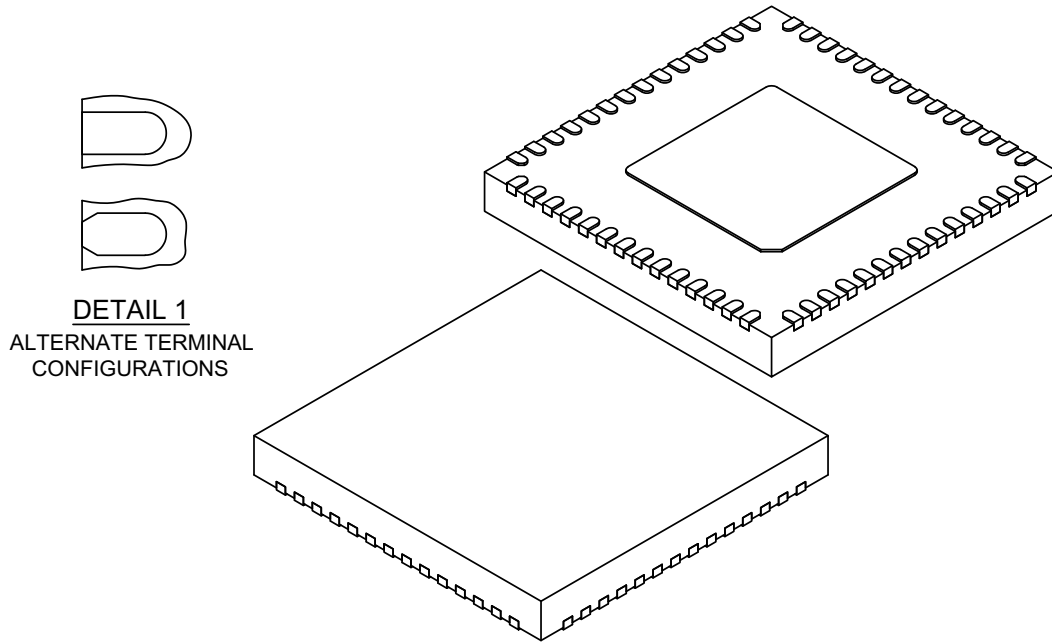


Microchip Technology Drawing C04-25665 Rev A Sheet 1 of 2

# SY75608/612

## 56-Lead Very Thin Plastic Quad Flat, No Lead Package (K3C) - 8x8x1.0 mm Body [VQFN] With 4.15 mm Exposed Pad

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



**DETAIL 1**  
ALTERNATE TERMINAL CONFIGURATIONS

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	N	56		
Pitch	e	0.50 BSC		
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3	0.20 REF		
Overall Length	D	8.00 BSC		
Exposed Pad Length	D2	4.05	4.15	4.25
Overall Width	E	8.00 BSC		
Exposed Pad Width	E2	4.05	4.15	4.25
Terminal Width	b	0.18	0.25	0.30
Terminal Length	L	0.35	0.40	0.45
Terminal-to-Exposed-Pad	K	1.53 REF		

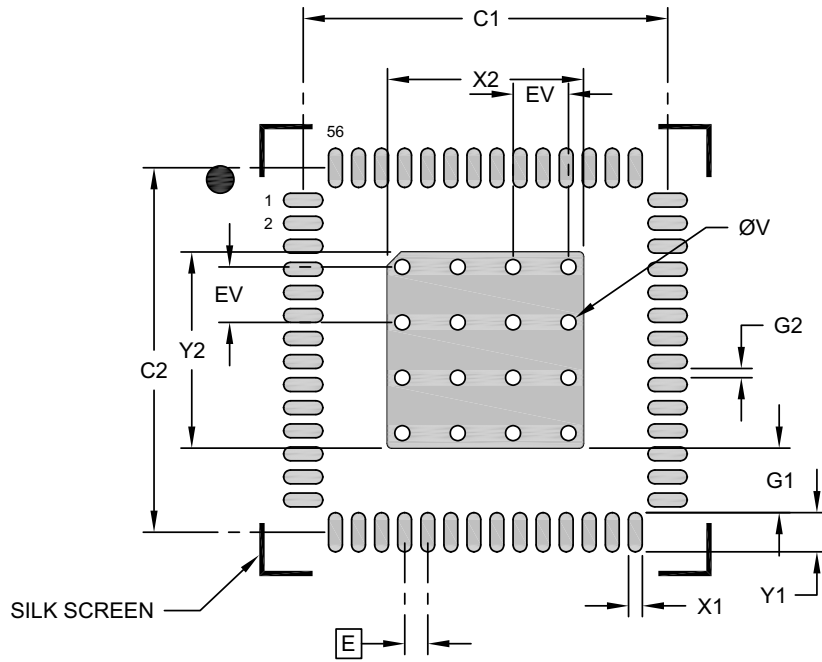
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Package is saw singulated
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-25665 Rev A Sheet 2 of 2

**56-Lead Very Thin Plastic Quad Flat, No Lead Package (K3C) - 8x8x1.0 mm Body [VQFN]  
With 4.15 mm Exposed Pad**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



**RECOMMENDED LAND PATTERN**

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Optional Center Pad Width	X2			4.25
Optional Center Pad Length	Y2			4.25
Contact Pad Spacing	C1		7.90	
Contact Pad Spacing	C2		7.90	
Contact Pad Width (X56)	X1			0.30
Contact Pad Length (X56)	Y1			0.85
Contact Pad to Center Pad (X56)	G1	0.85		
Contact Pad to Contact Pad (X52)	G2	0.20		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-27665 Rev A

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NOTES:

## APPENDIX A: REVISION HISTORY

### Revision A (February 2021)

- Initial release of SY75608/612 as Microchip data sheet DS20006363A.

### Revision B (August 2022)

- Replaced 48-lead VQFN (6MX) package outline drawing with 48-lead VQFN (6LX) package outline drawing.
- Replaced 56-lead VQFN (MEC) package outline drawing with 56-lead VQFN (K3C) package outline drawing.
- Updated the Product Identification System section to remove Wettable Flank from both package options.
- Updated the [Package Marking Information](#) drawing.
- Updated values for Output Enable and Disable Time in the [Output Electrical Characteristics](#) table.
- Updated max value for Input Leakage Current for OE Inputs in the [Electrical Characteristics](#) table.

### Revision C (January 2023)

- Update values in the [Electrical Characteristics](#), [Crystal Oscillator Characteristics](#), [Output Electrical Characteristics](#), and [Jitter and Phase Noise](#) tables.
- Added [I2C Bus Electrical Characteristics](#) table.
- Removed Preliminary from the footer.
- Added content relevant to PCIe Gen 6.0 throughout document.

# SY75608/612

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NOTES:



## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

<u>PART No.</u>	<u>XXX</u>	<u>[-XX]</u>	<b>Examples:</b>
Device	Package	Media Type	
<b>Device:</b>	SY75608:	8 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer	a) SY75608TWL: 8 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer, 48-Lead 6 mm x 6 mm VQFN, 490/Tray
	SY75612:	12 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer	b) SY75608TWL-TR: 8 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer, 48-Lead 6 mm x 6 mm VQFN, 3,300/Reel
<b>Package:</b>	TWL =	48-Lead 6 mm x 6 mm VQFN	c) SY75612TWL: 12 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer, 56-Lead 8 mm x 8 mm VQFN, 260/Tray
	TWL =	56-Lead 8 mm x 8 mm VQFN	d) SY75612TWL-TR: 12 Output Ultra-Low Additive Jitter PCIe Gen1/2/3/4/5/6 Clock Buffer, 56-Lead 8 mm x 8 mm VQFN, 3,000/Reel
<b>Media Type:</b>	<blank>=	490/Tray (SY75608 Only)	<b>Note 1:</b> Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.
	<blank>=	260/Tray (SY75612 Only)	
	TR =	3,000/Reel (SY75612 Only)	
	TR =	3,300/Reel (SY75608 Only)	

**Note:** For customers ordering a customized configuration from the [ClockWorks Configurator](#), the part number examples shown above will be appended by "GXXX" in which the "XXX" represents a numerical code assigned by Microchip (e.g., SY75608TWL-TRG0001).

# SY75608/612

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**Note the following details of the code protection feature on Microchip products:**

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