



SKYWORKS®

# Si53313

## DUAL 1:5 LOW-JITTER, ANY-FORMAT BUFFER/ LEVEL TRANSLATOR (<1.25 GHz)

### Features

- 2 independent banks of 5x differential outputs
- Ultra-low additive jitter: 45 fs rms
- Wide frequency range: dc to 1.25 GHz
- Any-format input with pin selectable output formats: LVPECL, Low Power LVPECL, LVDS, CML, HCSL, LVCMOS
- Asynchronous output enable
- Low output-output skew: <70 ps
- Output clock division: /1, /2, /4 (dc to 725 MHz for /2 and /4)
- Independent  $V_{DD}$  and  $V_{DDO}$ : 1.8/2.5/3.3 V
- Excellent power supply noise rejection (PSRR)
- Small size: 44-QFN (7 mm x 7 mm)
- RoHS compliant, Pb-free
- Industrial temperature range: -40 to +85 °C

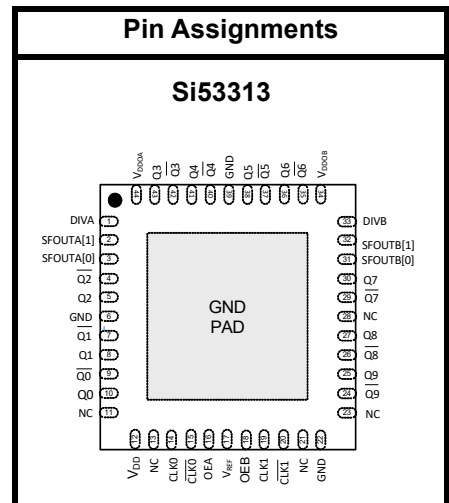
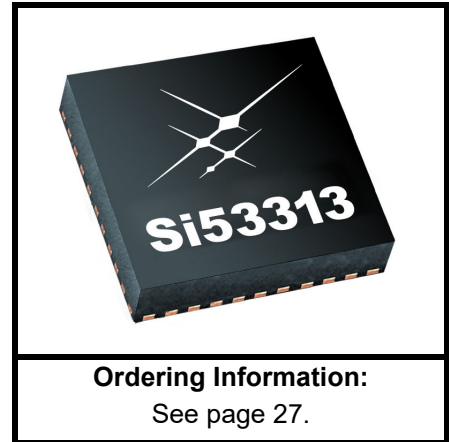
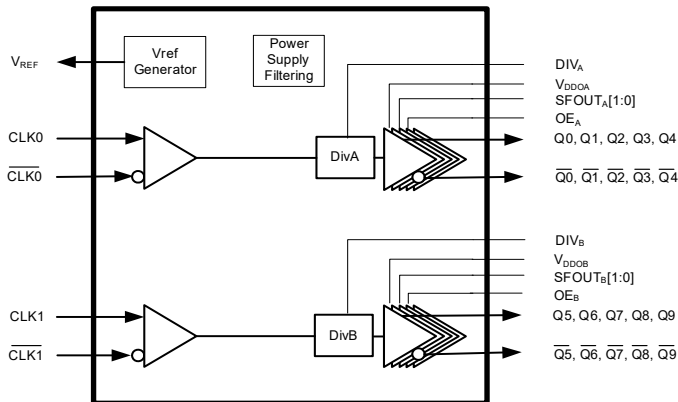
### Applications

- High-speed clock distribution
- Ethernet switch/router
- Optical Transport Network (OTN)
- SONET/SDH
- PCI Express Gen 1/2/3
- Storage
- Telecom
- Industrial
- Servers
- Backplane clock distribution

### Description

The Si53313 is an ultra low jitter dual 1:5 differential buffer with pin-selectable output clock signal format and divider selection. The Si53313 utilizes Skyworks Solutions' advanced CMOS technology to fanout clocks from dc to 1.25 GHz with guaranteed low additive jitter, low skew, and low propagation delay variability. The Si53313 features minimal cross-talk and provides superior supply noise rejection, simplifying low jitter clock distribution in noisy environments. Independent core and output bank supply pins provide integrated level translation without the need for external circuitry.

### Functional Block Diagram



Patents pending

## TABLE OF CONTENTS

Section	Page
<b>1. Electrical Specifications</b>	<b>3</b>
<b>2. Functional Description</b>	<b>11</b>
2.1. Universal, Any-Format Input	11
2.2. Input Bias Resistors	13
2.3. Voltage Reference (VREF)	13
2.4. Universal, Any-Format Output Buffer	14
2.5. Flexible Output Divider	15
2.6. Output Enable Logic	15
2.7. Power Supply (VDD and VDDOX)	15
2.8. Output Clock Termination Options	16
2.9. AC Timing Waveforms	19
2.10. Typical Phase Noise Performance	20
2.11. Input Mux Noise Isolation	23
2.12. Power Supply Noise Rejection	23
<b>3. Pin Description: 44-Pin QFN</b>	<b>24</b>
<b>4. Ordering Guide</b>	<b>27</b>
<b>5. Package Outline</b>	<b>28</b>
5.1. 7x7 mm 44-QFN Package Diagram	28
<b>6. PCB Land Pattern</b>	<b>30</b>
6.1. 7x7 mm 44-QFN Package Land Pattern	30
<b>7. Top Marking</b>	<b>31</b>
7.1. Si53313 Top Marking	31
7.2. Top Marking Explanation	31
<b>Document Change List</b>	<b>32</b>
<b>Contact Information</b>	<b>33</b>

## 1. Electrical Specifications

**Table 1. Recommended Operating Conditions**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Ambient Operating Temperature	$T_A$		-40	—	85	°C
Supply Voltage Range*	$V_{DD}$	LVDS, CML	1.71	1.8	1.89	V
			2.38	2.5	2.63	V
			2.97	3.3	3.63	V
		LVPECL, low power LVPECL, LVCMOS	2.38	2.5	2.63	V
			2.97	3.3	3.63	V
		HCSL	2.97	3.3	3.63	V
Output Buffer Supply Voltage*	$V_{DDOX}$	LVDS, CML, LVCMOS	1.71	1.8	1.89	V
			2.38	2.5	2.63	V
			2.97	3.3	3.63	V
		LVPECL, low power LVPECL	2.38	2.5	2.63	V
			2.97	3.3	3.63	V
		HCSL	2.97	3.3	3.63	V

**\*Note:** Core supply  $V_{DD}$  and output buffer supplies  $V_{DDOX}$  are independent. LVCMOS clock input is not supported for  $V_{DD} = 1.8V$  but is supported for LVCMOS clock output for  $V_{DDOX} = 1.8V$ . LVCMOS outputs at 1.5V and 1.2V can be supported via a simple resistor divider network. See “2.8.1. LVCMOS Output Termination To Support 1.5 V and 1.2 V”

**Table 2. Input Clock Specifications**

( $V_{DD} = 1.8V \pm 5\%$ ,  $2.5V \pm 5\%$ , or  $3.3V \pm 10\%$ ,  $T_A = -40$  to  $85$  °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Differential Input Common Mode Voltage	$V_{CM}$	$V_{DD} = 2.5V \pm 5\%$ , $3.3V \pm 10\%$	0.05	—	—	V
Differential Input Swing (peak-to-peak)	$V_{IN}$		0.2	—	2.2	V
LVCMOS Input High Voltage	$V_{IH}$	$V_{DD} = 2.5V \pm 5\%$ , $3.3V \pm 10\%$	$V_{DD} \times 0.7$	—	—	V
LVCMOS Input Low Voltage	$V_{IL}$	$V_{DD} = 2.5V \pm 5\%$ , $3.3V \pm 10\%$	—	—	$V_{DD} \times 0.3$	V
Input Capacitance	$C_{IN}$	CLK0 and CLK1 pins with respect to GND	—	5	—	pF

**Table 3. DC Common Characteristics**

( $V_{DD} = 1.8\text{ V} \pm 5\%$ ,  $2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40\text{ to }85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply Current	$I_{DD}$		—	65	100	mA
Output Buffer Supply Current (Per Clock Output) @100 MHz	$I_{DDOX}$	LVPECL (3.3 V)	—	35	—	mA
		Low Power LVPECL (3.3 V)	—	35	—	mA
		LVDS (3.3 V)	—	20	—	mA
		CML (3.3 V)	—	30	—	mA
		HCSL, 100 MHz, 2 pF load (3.3 V)	—	35	—	mA
		CMOS (1.8 V, SFOUT = Open/0), per output, $C_L = 5\text{ pF}$ , 200 MHz	—	5	—	mA
		CMOS (2.5 V, SFOUT = Open/0), per output, $C_L = 5\text{ pF}$ , 200 MHz	—	8	—	mA
CMOS (3.3 V, SFOUT = 0/1), per output, $C_L = 5\text{ pF}$ , 200 MHz	—	15	—	mA		
Voltage Reference	$V_{REF}$	$V_{REF}$ pin ( $-500\text{ }\mu\text{A} < I_{REF} < 500\text{ }\mu\text{A}$ )	—	$V_{DD}/2$	—	V
Input High Voltage	$V_{IH}$	SFOUTx, DIVx, CLK_SEL, OEx	$0.8 \times V_{DD}$	—	—	V
Input Mid Voltage	$V_{IM}$	SFOUTx, DIVx 3-level input pins	$0.45 \times V_{DD}$	$0.5 \times V_{DD}$	$0.55 \times V_{DD}$	V
Input Low Voltage	$V_{IL}$	SFOUTx, DIVx, CLK_SEL, OEx	—	—	$0.2 \times V_{DD}$	V
Internal Pull-down Resistor	$R_{DOWN}$	CLK_SEL, DIVx, SFOUTx,	—	25	—	k $\Omega$
Internal Pull-up Resistor	$R_{UP}$	OEx, DIVx, SFOUTx	—	25	—	k $\Omega$

**Table 4. Output Characteristics (LVPECL)**

( $V_{DDOX} = 2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40\text{ to }85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output DC Common Mode Voltage	$V_{COM}$		$V_{DDOX} - 1.595$	—	$V_{DDOX} - 1.245$	V
Single-Ended Output Swing	$V_{SE}$		0.40	0.80	1.050	V

**\*Note:** Unused outputs can be left floating. Do not short unused outputs to ground.

**Table 5. Output Characteristics (Low Power LVPECL)** $(V_{DDOX} = 2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40$  to  $85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output DC Common Mode Voltage	$V_{COM}$	$R_L = 100\ \Omega$ across $Q_n$ and $\overline{Q_n}$	$V_{DDOX} - 1.895$		$V_{DDOX} - 1.275$	V
Single-Ended Output Swing	$V_{SE}$	$R_L = 100\ \Omega$ across $Q_n$ and $\overline{Q_n}$	0.20	0.60	0.85	V

**Table 6. Output Characteristics—CML** $(V_{DDOX} = 1.8\text{ V} \pm 5\%$ ,  $2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40$  to  $85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Single-Ended Output Swing	$V_{SE}$	Terminated as shown in Figure 9 (CML termination).	200	400	550	mV

**Table 7. Output Characteristics—LVDS** $(V_{DDOX} = 1.8\text{ V} \pm 5\%$ ,  $2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40$  to  $85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Single-Ended Output Swing	$V_{SE}$	$R_L = 100\ \Omega$ across $Q_N$ and $\overline{Q_N}$	200	—	490	mV
Output Common Mode Voltage ( $V_{DDO} = 2.5\text{ V}$ or $3.3\text{ V}$ )	$V_{COM1}$	$V_{DDOX} = 2.38$ to $2.63\text{ V}$ , $2.97$ to $3.63\text{ V}$ , $R_L = 100\ \Omega$ across $Q_N$ and $\overline{Q_N}$	1.10	1.25	1.35	V
Output Common Mode Voltage ( $V_{DDO} = 1.8\text{ V}$ )	$V_{COM2}$	$V_{DDOX} = 1.71$ to $1.89\text{ V}$ , $R_L = 100\ \Omega$ across $Q_N$ and $\overline{Q_N}$	0.85	0.97	1.25	V

**Table 8. Output Characteristics—LVCMOS** $(V_{DDOX} = 1.8\text{ V} \pm 5\%$ ,  $2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40$  to  $85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output Voltage High	$V_{OH}$		$0.75 \times V_{DDOX}$	—	—	V
Output Voltage Low	$V_{OL}$		—	—	$0.25 \times V_{DDOX}$	V

**\*Note:**  $I_{OH}$  and  $I_{OL}$  per the Output Signal Format Table for specific  $V_{DDOX}$  and SFOUTx settings.

**Table 9. Output Characteristics—HCSL**

( $V_{DDOX} = 3.3\text{ V} \pm 10\%$ ,  $T_A = -40\text{ to }85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output Voltage High	$V_{OH}$	$R_L = 50\ \Omega$ to GND	550	700	900	mV
Output Voltage Low	$V_{OL}$	$R_L = 50\ \Omega$ to GND	-150	0	150	mV
Single-Ended Output Swing	$V_{SE}$	$R_L = 50\ \Omega$ to GND	450	700	850	mV
Crossing Voltage	$V_C$	$R_L = 50\ \Omega$ to GND	250	350	550	mV

**Table 10. AC Characteristics**

( $V_{DD} = V_{DDOX} = 1.8\text{ V} \pm 5\%$ ,  $2.5\text{ V} \pm 5\%$ , or  $3.3\text{ V} \pm 10\%$ ,  $T_A = -40\text{ to }85\text{ }^\circ\text{C}$ )

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Frequency <sup>1</sup>	F	LVPECL, low power LVPECL, LVDS, CML, HCSL	dc	—	1.25	GHz
		LVC MOS	dc	—	200	MHz
Duty Cycle <sup>2</sup>	$D_C$	200 MHz, 20/80% $T_R/T_F < 10\%$ of period (LVC MOS) (12 mA drive)	40	50	60	%
		20/80% $T_R/T_F < 10\%$ of period (Differential)	47	50	53	%
Minimum Input Clock Slew Rate <sup>3</sup>	SR	Required to meet prop delay and additive jitter specifications (20–80%)	0.75	—	—	V/ns
Output Rise/Fall Time	$T_R/T_F$	LVDS, 20/80%	—	—	325	ps
		LVPECL, 20/80%	—	—	350	ps
		HCSL <sup>4</sup> , 20/80%	—	—	280	ps
		CML, 20/80%	—	—	350	ps
		Low-Power LVPECL, 20/80%	—	—	325	ps
		LVC MOS 200 MHz, 20/80%, 2 pF load	—	—	750	ps

**Notes:**

1. Slew rate should be  $\geq 30\text{ mV/ns}$ .
2. 50% input duty cycle.
3. When using the on-chip clock divider, a minimum input clock slew rate of  $30\text{ mV/ns}$  is required.
4. HCSL measurements were made with receiver termination. See Figure 9 on page 17.
5. Output to Output skew specified for outputs with an identical configuration.
6. Defined as skew between any output on different devices operating at the same supply voltage, temperature, and equal load condition. Using the same type of inputs on each device, the outputs are measured at the differential cross points.
7. Measured for 156.25 MHz carrier frequency. Sine-wave noise added to  $V_{DDOX}$  ( $3.3\text{ V} = 100\text{ mV}_{PP}$ ) and noise spur amplitude measured. See "AN491: Power Supply Rejection for Low-Jitter Clocks" for further details.

**Table 10. AC Characteristics (Continued)** $(V_{DD} = V_{DDOX} = 1.8\text{ V} \pm 5\%, 2.5\text{ V} \pm 5\%, \text{ or } 3.3\text{ V} \pm 10\%, T_A = -40\text{ to } 85\text{ }^\circ\text{C})$ 

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Minimum Input Pulse Width	$T_W$		360	—	—	ps
Propagation Delay	$T_{PLH}, T_{PHL}$	LVC MOS (12mA drive with no load)	1250	2000	2750	ps
		LVPECL	600	800	1000	ps
		LVDS	600	800	1000	ps
Output Enable Time	$T_{EN}$	F = 1 MHz	—	2500	—	ns
		F = 100 MHz	—	30	—	ns
		F = 725 MHz	—	5	—	ns
Output Disable Time	$T_{DIS}$	F = 1 MHz	—	2000	—	ns
		F = 100 MHz	—	30	—	ns
		F = 725 MHz	—	5	—	ns
Output to Output Skew <sup>5</sup>	$T_{SK}$	LVC MOS (12 mA drive to no load)	—	50	120	ps
		LVPECL	—	35	70	ps
		LVDS	—	35	70	ps
Part to Part Skew <sup>6</sup>	$T_{PS}$	Differential	—	—	150	ps
Power Supply Noise Rejection <sup>7</sup>	PSRR	10 kHz sinusoidal noise	—	-63	—	dBc
		100 kHz sinusoidal noise	—	-62	—	dBc
		500 kHz sinusoidal noise	—	-58	—	dBc
		1 MHz sinusoidal noise	—	-55	—	dBc

**Notes:**

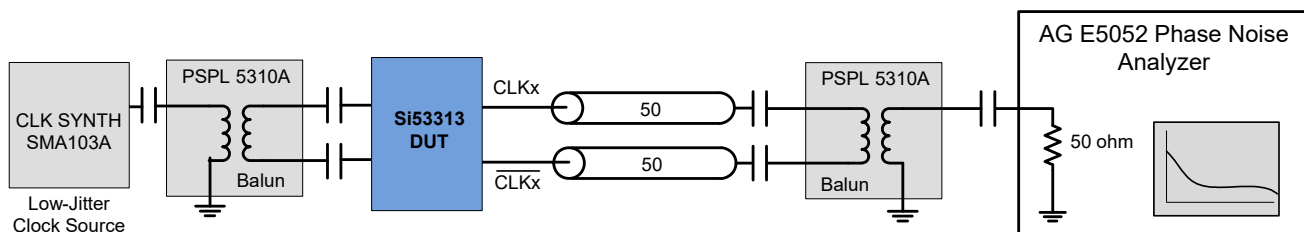
1. Slew rate should be  $\geq 30$  mV/ns.
2. 50% input duty cycle.
3. When using the on-chip clock divider, a minimum input clock slew rate of 30 mV/ns is required.
4. HCSL measurements were made with receiver termination. See Figure 9 on page 17.
5. Output to Output skew specified for outputs with an identical configuration.
6. Defined as skew between any output on different devices operating at the same supply voltage, temperature, and equal load condition. Using the same type of inputs on each device, the outputs are measured at the differential cross points.
7. Measured for 156.25 MHz carrier frequency. Sine-wave noise added to  $V_{DDOX}$  ( $3.3\text{ V} = 100\text{ mV}_{PP}$ ) and noise spur amplitude measured. See "AN491: Power Supply Rejection for Low-Jitter Clocks" for further details.

**Table 11. Additive Jitter, Differential Clock Input**

V <sub>DD</sub>	Input <sup>1,2</sup>				Output	Additive Jitter (fs rms, 12 kHz to 20 MHz) <sup>3</sup>	
	Freq (MHz)	Clock Format	Amplitude V <sub>IN</sub> (Single-Ended, Peak-to-Peak)	Differential 20%-80% Slew Rate (V/ns)		Clock Format	Typ
3.3	725	Differential	0.15	0.637	LVPECL	45	65
3.3	725	Differential	0.15	0.637	LVDS	50	65
3.3	156.25	Differential	0.5	0.458	LVPECL	160	185
3.3	156.25	Differential	0.5	0.458	LVDS	150	200
2.5	725	Differential	0.15	0.637	LVPECL	45	65
2.5	725	Differential	0.15	0.637	LVDS	50	65
2.5	156.25	Differential	0.5	0.458	LVPECL	145	185
2.5	156.25	Differential	0.5	0.458	LVDS	145	195

**Notes:**

1. For best additive jitter results, use the fastest slew rate possible. See “AN766: Understanding and Optimizing Clock Buffer’s Additive Jitter Performance” for more information.
2. AC-coupled differential inputs.
3. Measured differentially using a balun at the phase noise analyzer input. See Figure 2.



**Figure 1. Differential Measurement Method Using a Balun**

**Important:** See AN925 for additional information on the dependence of measured additive jitter on the input source jitter.



Table 12. Additive Jitter, Single-Ended Clock Input

V <sub>DD</sub>	Input <sup>1,2</sup>				Output	Additive Jitter (fs rms, 12 kHz to 20 MHz) <sup>3</sup>	
	Freq (MHz)	Clock Format	Amplitude V <sub>IN</sub> (single-ended, peak to peak)	SE 20%-80% Slew Rate (V/ns)		Clock Format	Typ
3.3	200	Single-ended	1.70	1	LVC MOS <sup>4</sup>	120	160
3.3	156.25	Single-ended	2.18	1	LVPECL	160	185
3.3	156.25	Single-ended	2.18	1	LVDS	150	200
3.3	156.25	Single-ended	2.18	1	LVC MOS <sup>4</sup>	130	180
2.5	200	Single-ended	1.70	1	LVC MOS <sup>5</sup>	120	160
2.5	156.25	Single-ended	2.18	1	LVPECL	145	185
2.5	156.25	Single-ended	2.18	1	LVDS	145	195
2.5	156.25	Single-ended	2.18	1	LVC MOS <sup>5</sup>	140	180

**Notes:**

- For best additive jitter results, use the fastest slew rate possible. See “AN766: Understanding and Optimizing Clock Buffer’s Additive Jitter Performance” for more information.
- DC-coupled single-ended inputs.
- Measured differentially using a balun at the phase noise analyzer input. See Figure 2.
- Drive Strength: 12 mA, 3.3 V (SFOUT = 11). LVC MOS jitter is measured single-ended.
- Drive Strength: 9 mA, 2.5 V (SFOUT = 11). LVC MOS jitter is measured single-ended.

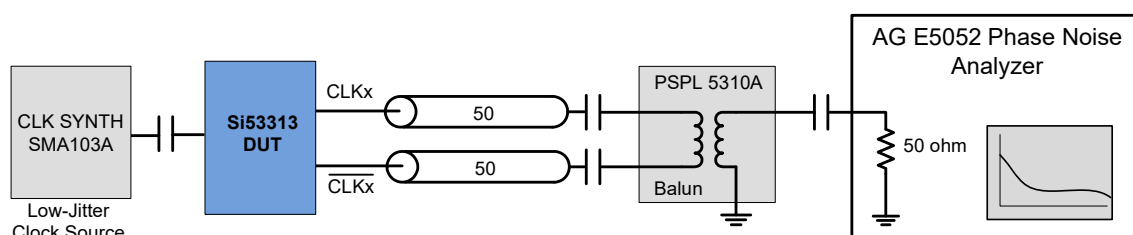


Figure 2. Single-Ended Measurement Method Using a Balun

**Important:** See AN925 for additional information on the dependence of measured additive jitter on the input source jitter.

**Table 13. Thermal Conditions**

Parameter	Symbol	Test Condition	Value	Unit
Thermal Resistance, Junction to Ambient	$\theta_{JA}$	Still air	49.6	°C/W
Thermal Resistance, Junction to Case	$\theta_{JC}$	Still air	32.3	°C/W

**Table 14. Absolute Maximum Ratings**

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Storage Temperature	$T_S$		-55	—	150	°C
Supply Voltage	$V_{DD}$		-0.5	—	3.8	V
Input Voltage	$V_{IN}$		-0.5	—	$V_{DD} + 0.3$	V
Output Voltage	$V_{OUT}$		—	—	$V_{DD} + 0.3$	V
ESD Sensitivity	HBM	HBM, 100 pF, 1.5 k $\Omega$	—	—	2000	V
ESD Sensitivity	CDM		—	—	500	V
Peak Soldering Reflow Temperature	$T_{PEAK}$	Pb-Free; Solder reflow profile per JEDEC J-STD-020	—	—	260	°C
Maximum Junction Temperature	$T_J$		—	—	125	°C

**Note:** Stresses beyond those listed in this table may cause permanent damage to the device. Functional operation specification compliance is not implied at these conditions. Exposure to maximum rating conditions for extended periods may affect device reliability.

## 2. Functional Description

The Si53313 is a low-jitter, low-skew dual 1:5 differential output buffer with an independent input for each bank. The device has an any-format input that accepts most common differential or LVCMOS input signals. Each output bank features control pins to select signal format, output enable, output divider setting and LVCMOS drive strength.

### 2.1. Universal, Any-Format Input

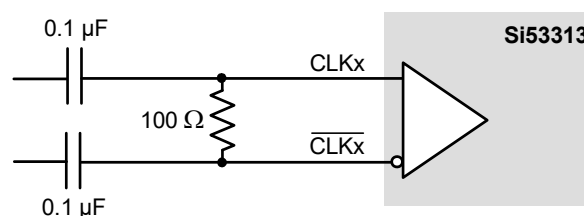
The Si53313 has a universal input stage that enables simple interfacing to a wide variety of clock formats, including LVPECL, LVCMOS, LVDS, HCSL, and CML. Tables 15 and 16 summarize the various input ac- and dc-coupling options supported by the device. Figures 3, 4, and 5 show the recommended input clock termination options.

**Table 15. LVPECL, LVCMOS, and LVDS**

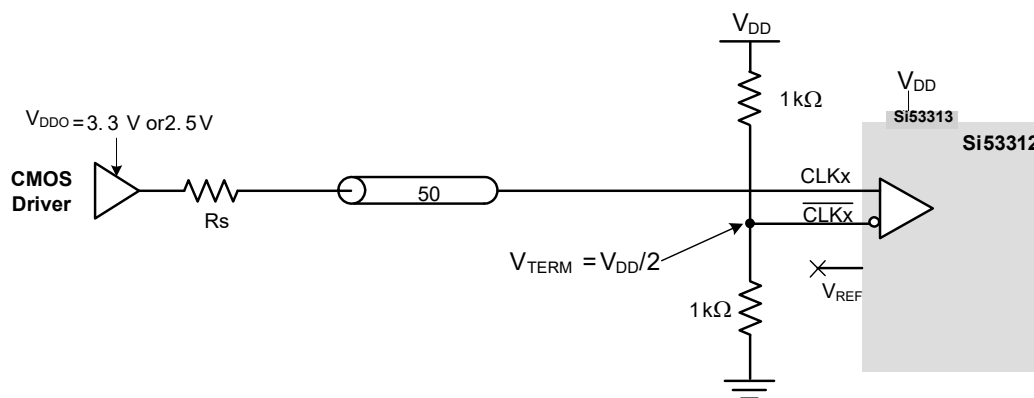
	LVPECL		LVCMOS		LVDS	
	AC-Couple	DC-Couple	AC-Couple	DC-Couple	AC-Couple	DC-Couple
1.8 V	N/A	N/A	No	No	Yes	No
2.5/3.3 V	Yes	Yes	No	Yes	Yes	Yes

**Table 16. HCSL and CML**

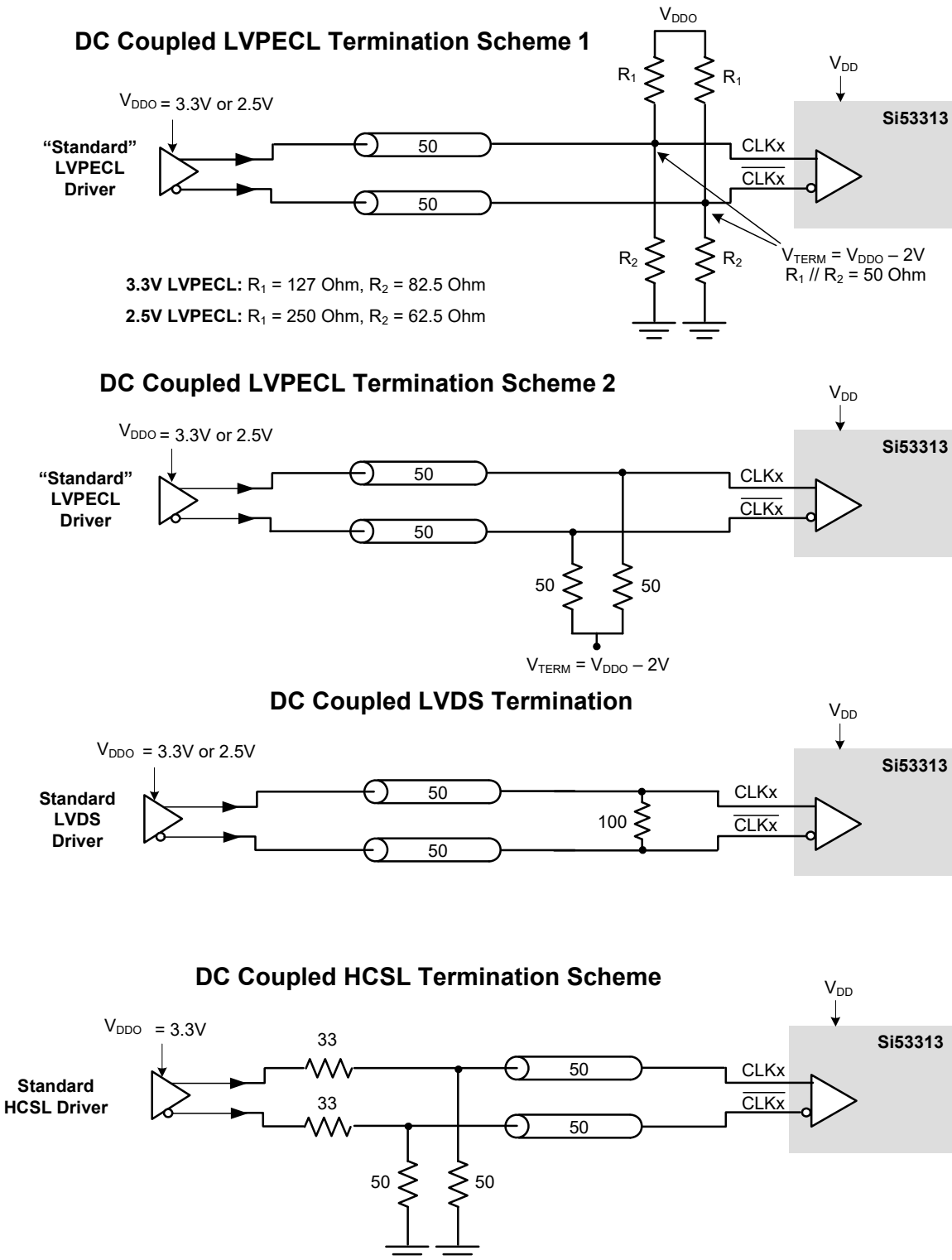
	HCSL		CML	
	AC-Couple	DC-Couple	AC-Couple	DC-Couple
1.8 V	No	No	Yes	No
2.5/3.3 V	Yes	Yes	Yes	No



**Figure 3. Differential LVPECL, LVDS, CML AC-Coupled Input Termination**



**Figure 4. LVCMOS DC-Coupled Input Termination**

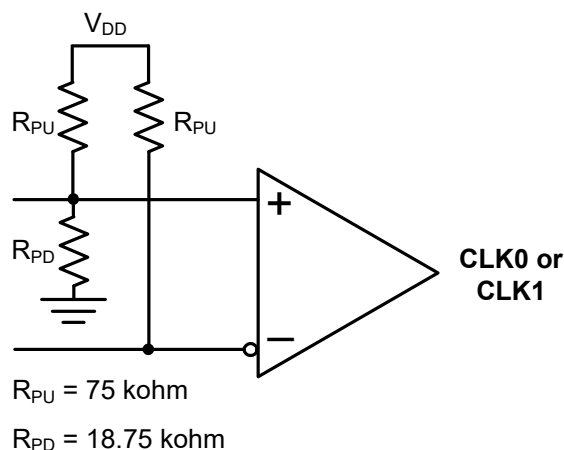


Note: 33 Ohm series termination is optional depending on the location of the receiver.

**Figure 5. Differential DC-Coupled Input Terminations**

## 2.2. Input Bias Resistors

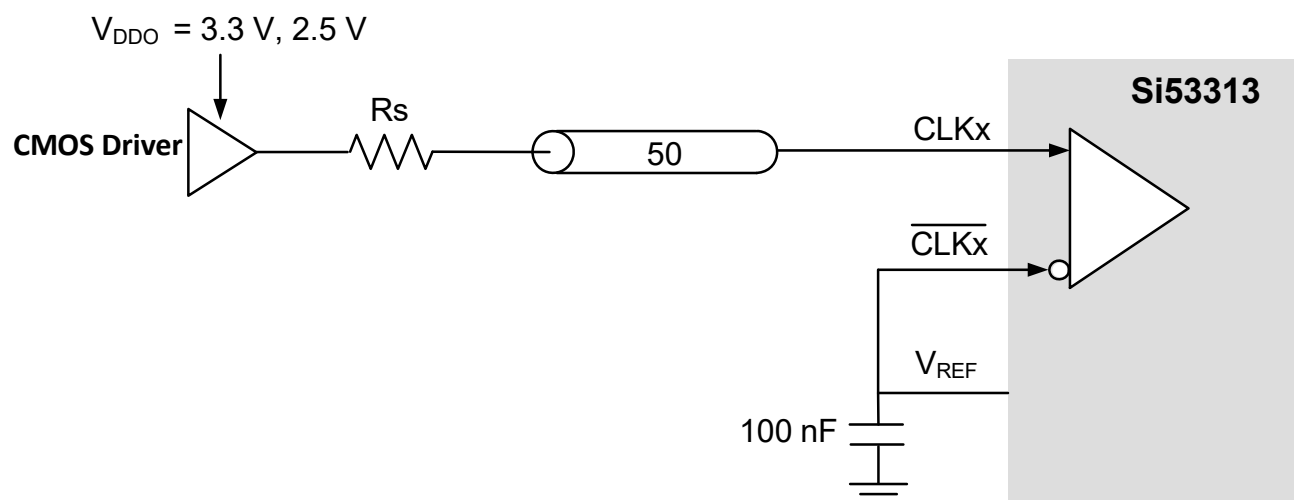
Internal bias resistors ensure a differential output low condition in the event that the clock inputs are not connected. The non-inverting input is biased with a 18.75 k $\Omega$  pulldown to GND and a 75 k $\Omega$  pullup to V<sub>DD</sub>. The inverting input is biased with a 75 k $\Omega$  pullup to V<sub>DD</sub>.



**Figure 6. Input Bias Resistors**

## 2.3. Voltage Reference (V<sub>REF</sub>)

The V<sub>REF</sub> pin can be used to bias the input receiver, as shown in Figure 7 when a single-ended input clock (such as LVCMOS) is used. Note that V<sub>REF</sub> = V<sub>DD</sub>/2 and should be compatible with the VCM rating of the single-ended input clock driving the CLK0 or CLK1 inputs. To optimize jitter and duty cycle performance, use the circuit in Figure 4. V<sub>REF</sub> pin should be left floating when differential clocks are used.



**Figure 7. Using Voltage Reference with Single-Ended Input Clock**

## 2.4. Universal, Any-Format Output Buffer

The highly flexible output drivers support a wide range of clock signal formats, including LVPECL, low power LVPECL, LVDS, CML, HCSL, and LVCMOS. SFOUTx[1] and SFOUTx[0] are 3-level inputs that can be pinstrapped to select the Bank A and Bank B clock signal formats independently. This feature enables the device to be used for format/level translation in addition to clock distribution, minimizing the number of unique buffer part numbers required in a typical application and simplifying design reuse. For EMI reduction applications, four LVCMOS drive strength options are available for each  $V_{DDO}$  setting.

**Table 17. Output Signal Format Selection**

SFOUTx[1]	SFOUTx[0]	$V_{DDOX} = 3.3 \text{ V}$	$V_{DDOX} = 2.5 \text{ V}$	$V_{DDOX} = 1.8 \text{ V}$
Open*	Open*	LVPECL	LVPECL	N/A
0	0	LVDS	LVDS	LVDS
0	1	LVCMOS, 24 mA drive	LVCMOS, 18 mA drive	LVCMOS, 12 mA drive
1	0	LVCMOS, 18 mA drive	LVCMOS, 12 mA drive	LVCMOS, 9 mA drive
1	1	LVCMOS, 12 mA drive	LVCMOS, 9 mA drive	LVCMOS, 6 mA drive
Open*	0	LVCMOS, 6 mA drive	LVCMOS, 4 mA drive	LVCMOS, 2 mA drive
Open*	1	LVPECL Low power	LVPECL Low power	N/A
0	Open*	CML	CML	CML
1	Open*	HCSL	N/A	N/A

**\*Note:** SFOUTx[1:0] are 3-level input pins. Tie low for “0” setting. Tie high for “1” setting. When left open, the pin is internally biased to  $V_{DD}/2$ .

## 2.5. Flexible Output Divider

The Si53313 provides optional clock division in addition to clock distribution. The divider setting for each bank of output clocks is selected via 3-level control pins as shown in the table below. Leaving the DIVx pins open will force a divider value of 1, which is the default mode of operation. Note that when using the on-chip clock divider, a minimum input clock slew rate of 30 mV/ns is required.

**Table 18. Divider Selection**

DIVx*	Divider Value	Frequency Range
Open	÷1 (default)	dc to 1.25 GHz
0	÷2	dc to 725 MHz
1	÷4	dc to 725 MHz

**\*Note:** DIVx are 3-level input pins. Tie low for “0” setting. Tie high for “1” setting. When left open, the pin is internally biased to  $V_{DD}/2$ .

## 2.6. Output Enable Logic

Each 1:5 output has an independent clock input (CLK0/CLK1) and an output enable pin. Table 19 summarizes the input and output clock based upon the state of the input clock and the OE pin.

**Table 19. Input Clock and Output Enable Logic**

CLK	OE <sup>1</sup>	Q <sup>2</sup>
L	H	L
H	H	H
X	L	L <sup>3</sup>

**Notes:**

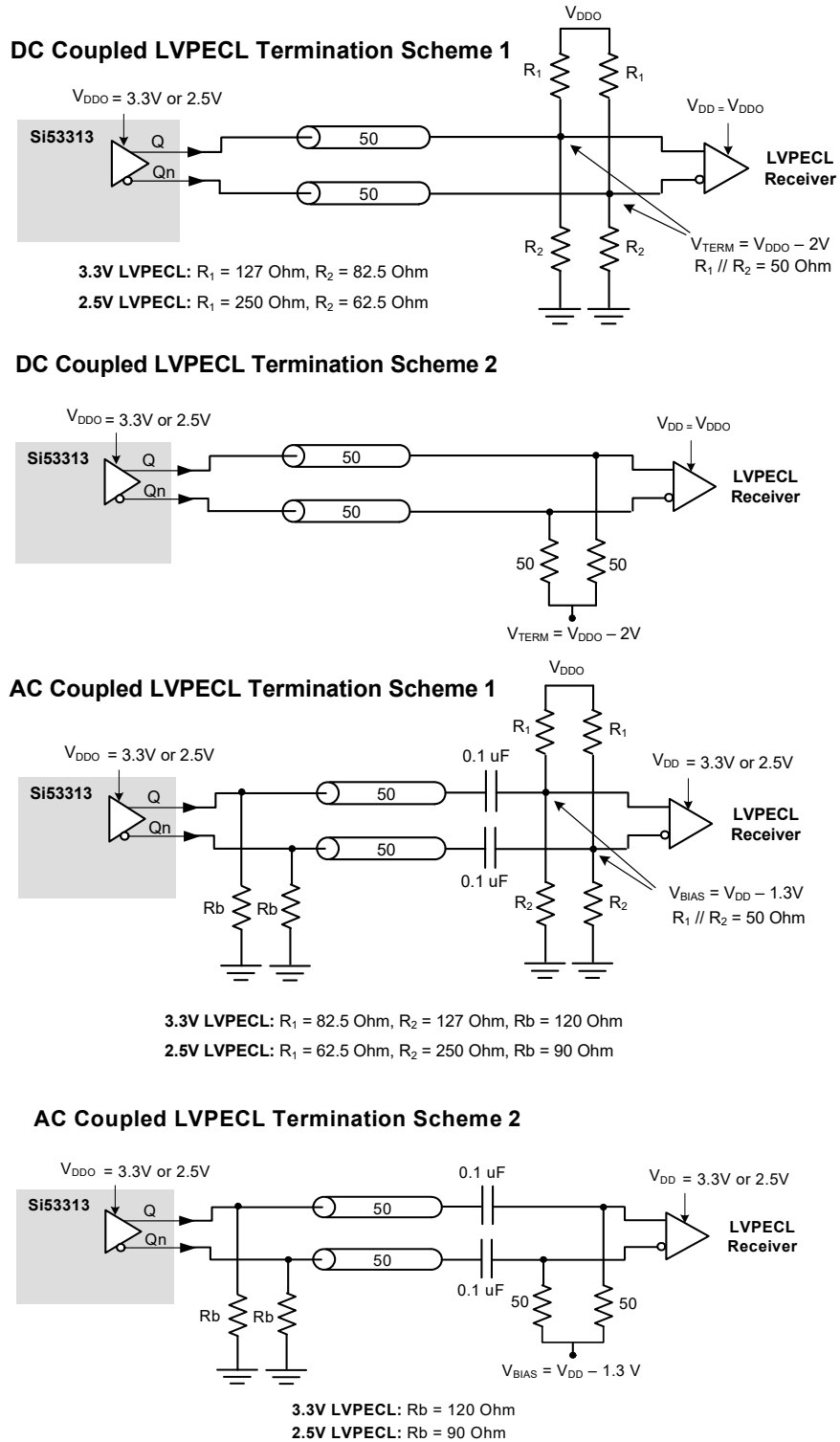
1. Output enable active high.
2. On the next negative transition of CLK0 or CLK1.
3. Single-ended: Q = low,  $\bar{Q}$  = low  
Differential: Q = low,  $\bar{Q}$  = high.

## 2.7. Power Supply ( $V_{DD}$ and $V_{DDOX}$ )

The device includes separate core ( $V_{DD}$ ) and output driver supplies ( $V_{DDOX}$ ). This feature allows the core to operate at a lower voltage than  $V_{DDO}$ , reducing current consumption in mixed supply applications. The core  $V_{DD}$  supports 3.3 V, 2.5 V, or 1.8 V. Each output bank has its own  $V_{DDOX}$  supply, supporting 3.3 V, 2.5 V, or 1.8 V as defined in Table 1 on page 3.

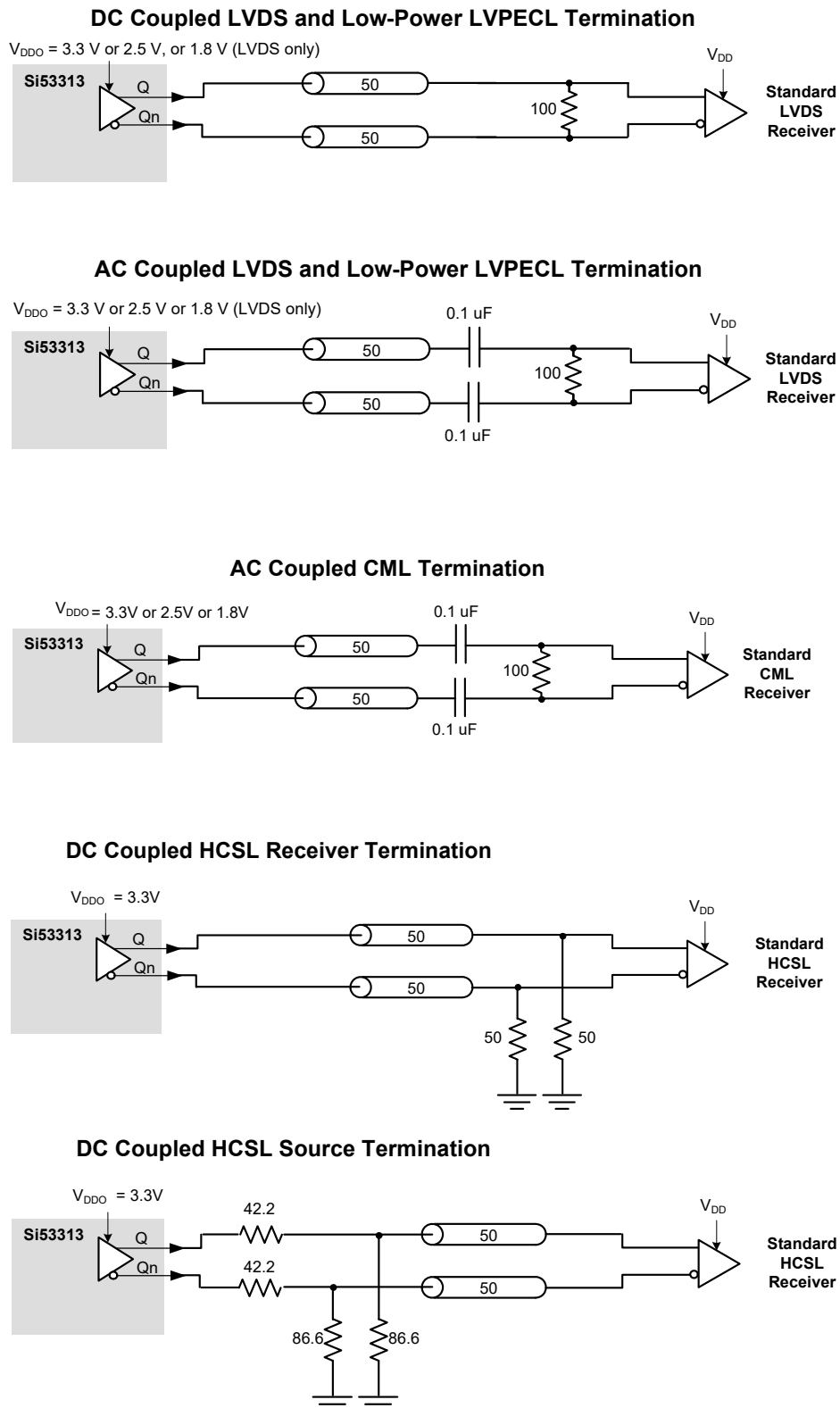
## 2.8. Output Clock Termination Options

The recommended output clock termination options are shown below. Unused output clocks should be left floating.

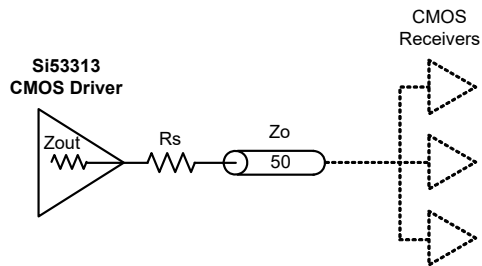


**Figure 8. LVPECL Output Termination**





**Figure 9. LVDS, CML, HCSL, and Low-Power LVPECL Output Termination**



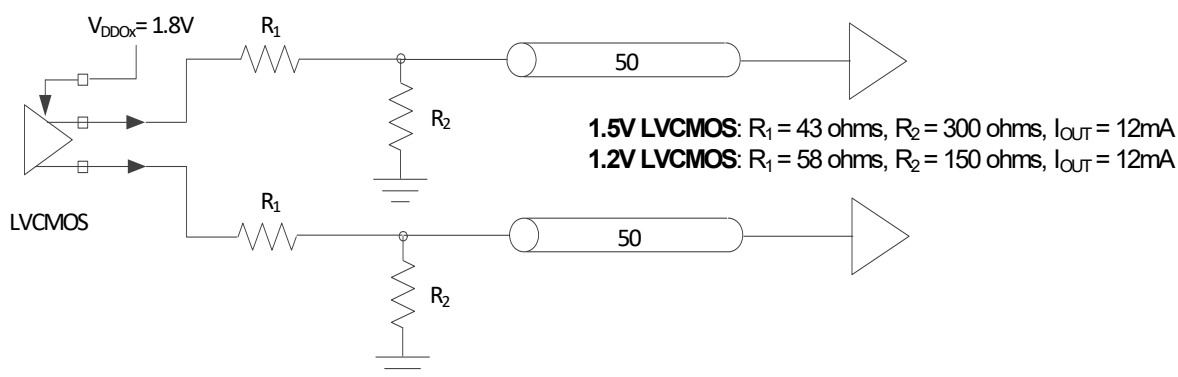
**Figure 10. LVC MOS Output Termination**

**Table 20. Recommended LVC MOS  $R_S$  Series Termination**

SFOUTx[1]	SFOUTx[0]	$R_S$ (ohms)		
		3.3 V	2.5 V	1.8 V
0	1	33	33	33
1	0	33	33	33
1	1	33	33	0
Open	0	0	0	0

### 2.8.1. LVC MOS Output Termination To Support 1.5 V and 1.2 V

LVC MOS clock outputs are natively supported at 1.8 V, 2.5 V, and 3.3 V. However, 1.2 V and 1.5 V LVC MOS clock outputs can be supported via a simple resistor divider network that will translate the buffer's 1.8 V output to a lower voltage as shown in Figure 11.



**Figure 11. 1.5V and 1.2V LVC MOS Low-Voltage Output Termination**

## 2.9. AC Timing Waveforms

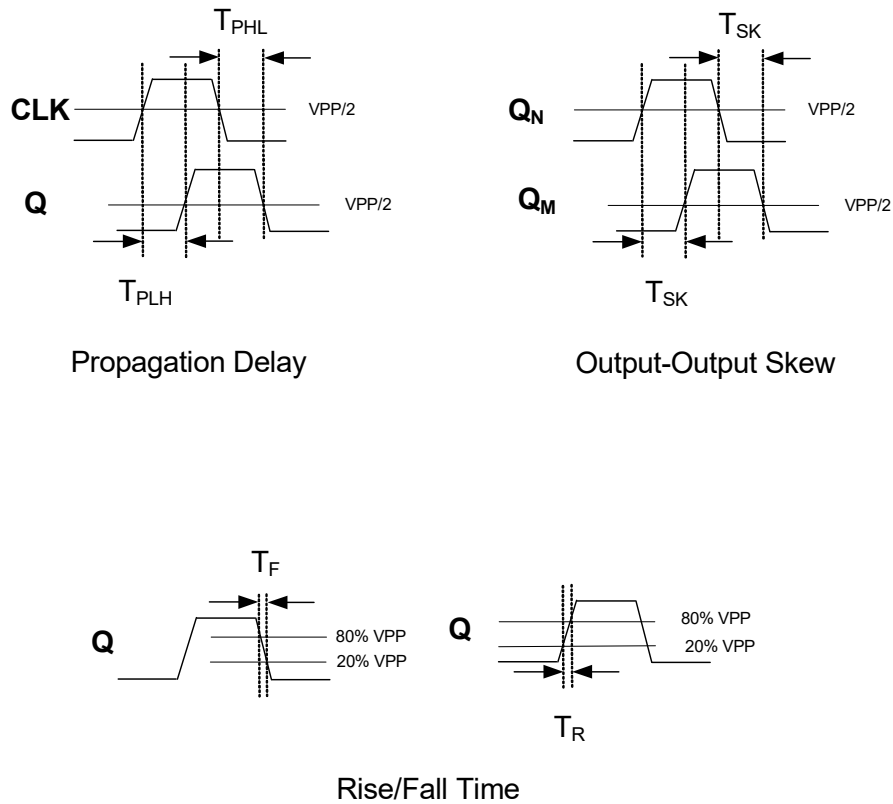


Figure 12. AC Waveforms

## 2.10. Typical Phase Noise Performance

Each of the following three figures shows three phase noise plots superimposed on the same diagram.

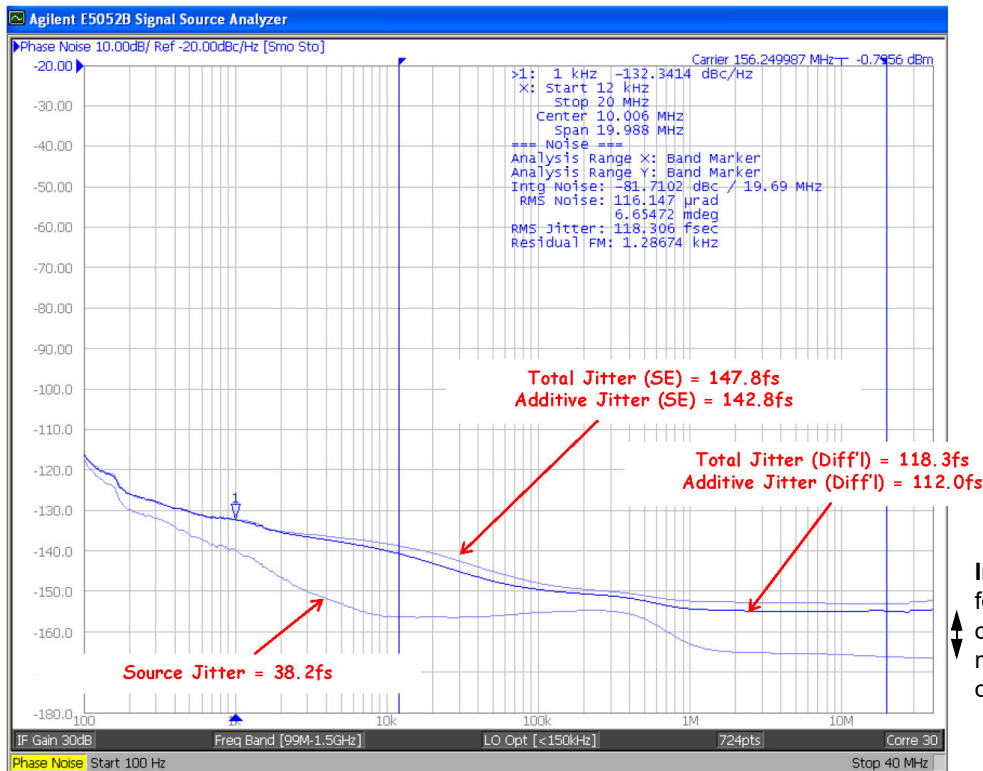
**Source Jitter:** Reference clock phase noise.

**Total Jitter (SE):** Combined source and clock buffer phase noise measured as a single-ended output to the phase noise analyzer and integrated from 12 kHz to 20 MHz.

**Total Jitter (Diff):** Combined source and clock buffer phase noise measured as a differential output to the phase noise analyzer and integrated from 12 kHz to 20 MHz. The differential measurement as shown in each figure is made using a balun. See Figure 2 on page 9.

**Note:** To calculate the total RMS phase jitter when adding a buffer to your clock tree, use the root-sum-square (RSS).

The total jitter is a measure of the source plus the buffer's additive phase jitter. The additive jitter (rms) of the buffer can then be calculated (via root-sum-square addition).

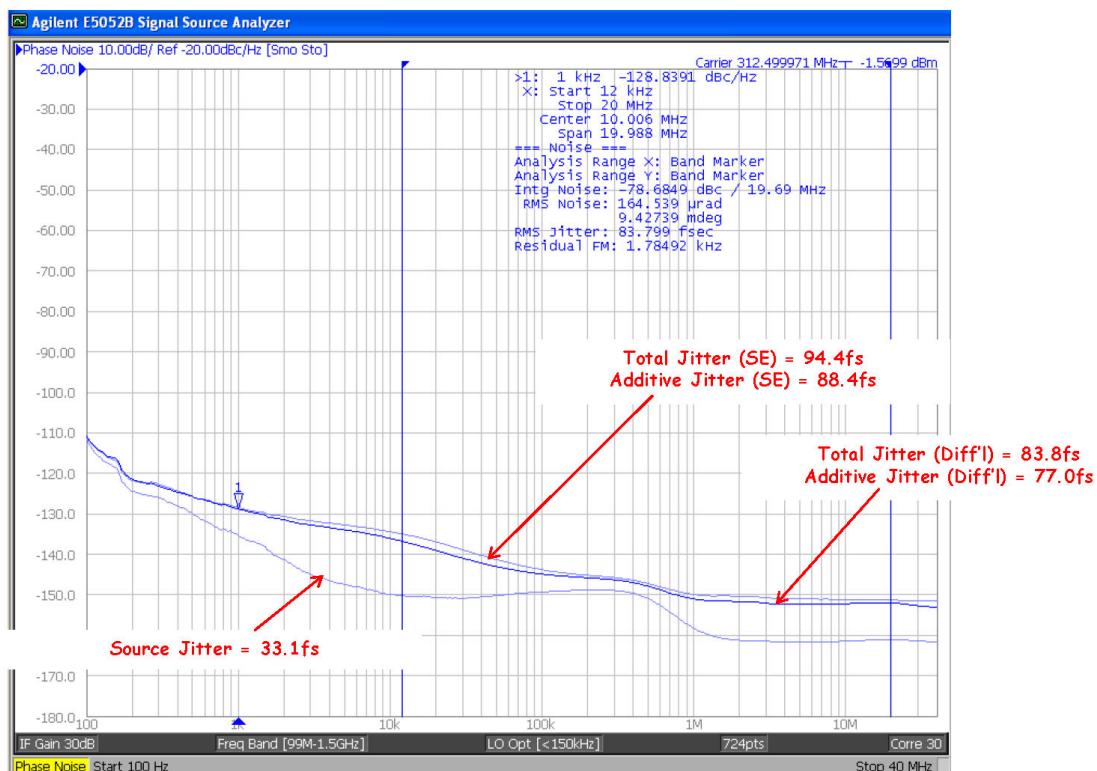


**Important:** See AN925 for additional information on the dependence of measured additive jitter on the input source jitter.

Figure 13. Source Jitter (156.25 MHz)

Table 21. Source Jitter (156.25 MHz)

Frequency (MHz)	Diff'l Input Slew Rate (V/ns)	Source Jitter (fs)	Total Jitter (SE) (fs)	Additive Jitter (SE) (fs)	Total Jitter (Diff'l) (fs)	Additive Jitter (Diff'l) (fs)
156.25	1.0	38.2	147.8	142.8	118.3	112.0



**Figure 14. Single-ended Total Jitter (312.5 MHz)**

**Table 22. Single-ended Total Jitter (312.5 MHz)**

Frequency (MHz)	Diff'l Input Slew Rate (V/ns)	Source Jitter (fs)	Total Jitter (SE) (fs)	Additive Jitter (SE) (fs)	Total Jitter (Diff'l) (fs)	Additive Jitter (Diff'l) (fs)
312.5	1.0	33.10	94.39	88.39	83.80	76.99

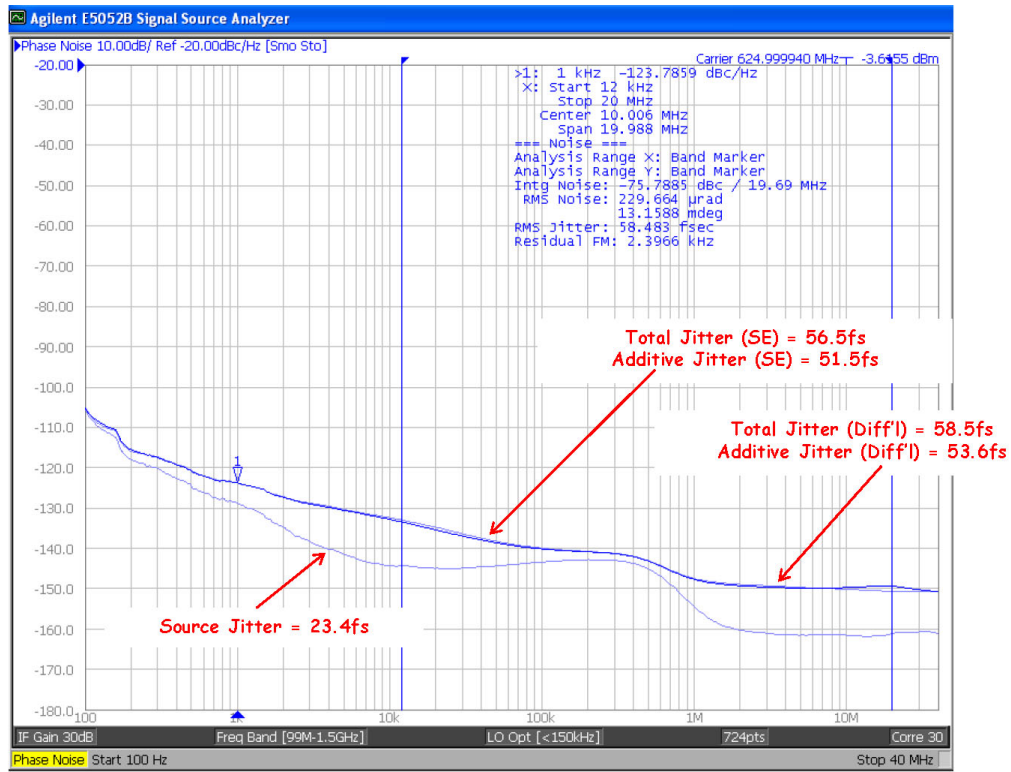


Figure 15. Differential Total Jitter (625 MHz)

Table 23. Differential Total Jitter (625 MHz)

Frequency (MHz)	Diff'l Input Slew Rate (V/ns)	Source Jitter (fs)	Total Jitter (SE) (fs)	Additive Jitter (SE) (fs)	Total Jitter (Diff'l) (fs)	Additive Jitter (Diff'l) (fs)
625	1.0	23.4	56.5	51.5	58.5	53.6

## 2.11. Input Mux Noise Isolation

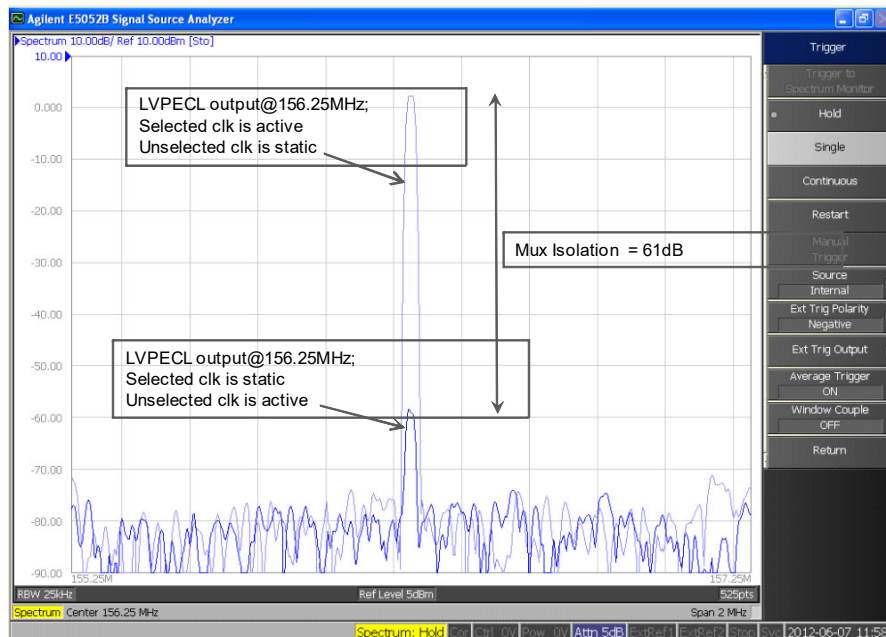
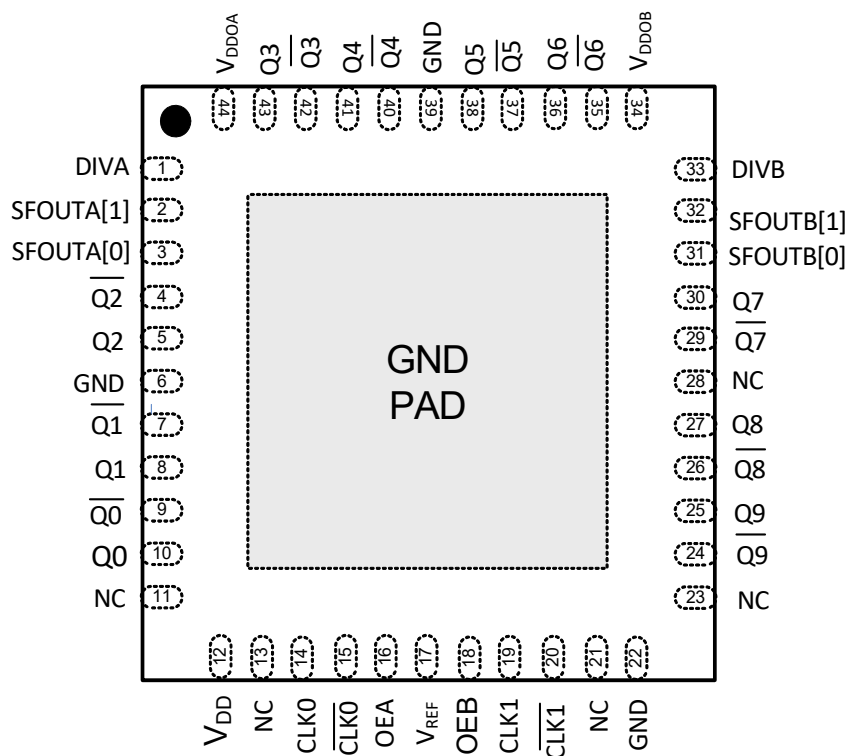


Figure 16. Input Mux Noise Isolation

## 2.12. Power Supply Noise Rejection

The device supports on-chip supply voltage regulation to reject noise present on the power supply, simplifying low jitter operation in real-world environments. This feature enables robust operation alongside FPGAs, ASICs and SoCs and may reduce board-level filtering requirements. For more information, see “AN491: Power Supply Rejection for Low Jitter Clocks”.

## 3. Pin Description: 44-Pin QFN



**Table 24. Pin Description**

Pin #	Name	Description
1	DIVA	Output divider control pin for Bank A Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
2	SFOUTA[1]	Output signal format control pin for Bank A Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
3	SFOUTA[0]	Output signal format control pin for Bank A Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
4	$\overline{Q2}$	Output clock 2 (complement)
5	Q2	Output clock 2
6	GND	Ground
7	$\overline{Q1}$	Output clock 1 (complement)
8	Q1	Output clock 1



Table 24. Pin Description (Continued)

Pin #	Name	Description
9	$\overline{Q0}$	Output clock 0 (complement)
10	Q0	Output clock 0
11	NC	No connect
12	VDD	Core voltage supply Bypass with 1.0 $\mu$ F capacitor placed as close to the VDD pin as possible
13	NC	No connect
14	CLK0	Input clock 0
15	$\overline{CLK0}$	Input clock 0 (complement) When the CLK0 is driven by a single-end LVCMOS input, connect CLK0 to VDD/2.
16	OEA	Output enable—Bank A When OE = high, the Bank A outputs are enabled When OE = low, Q is held low and $\overline{Q}$ is held high for differential formats For LVCMOS, both Q and $\overline{Q}$ are held low when OE is set low OEA contains an internal pull-up resistor
17	V <sub>REF</sub>	Reference voltage for single-ended CMOS clocks. V <sub>REF</sub> is an output voltage and is equal to V <sub>DD</sub> /2. It can be used to bias the /CLK input for single ended input clocks. See "2.3. Voltage Reference (VREF)" on page 13.
18	OEB	Output enable—Bank B When OE = high, the Bank B outputs are enabled When OE = low, Q is held low and $\overline{Q}$ is held high for differential formats For LVCMOS, both Q and $\overline{Q}$ are held low when OE is set low OEB contains an internal pull-up resistor.
19	CLK1	Input clock 1
20	$\overline{CLK1}$	Input clock 1 (complement) When the $\overline{CLK1}$ is driven by a single-end LVCMOS input, connect $\overline{CLK1}$ to VDD/2.
21	NC	No connect
22	GND	Ground
23	NC	No connect
24	$\overline{Q9}$	Output clock 9 (complement)
25	Q9	Output clock 9
26	$\overline{Q8}$	Output clock 8 (complement)
27	Q8	Output clock 8
28	NC	No connect
29	$\overline{Q7}$	Output clock 7 (complement)

**Table 24. Pin Description (Continued)**

Pin #	Name	Description
30	Q7	Output clock 7
31	SFOUTB[0]	Output signal format control pin for Bank B Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
32	SFOUTB[1]	Output signal format control pin for Bank B Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
33	DIVB	Output divider configuration bit for Bank B Three-level input control. Internally biased at VDD/2. Can be left floating or tied to ground or V <sub>DD</sub> .
34	V <sub>DDOB</sub>	Output Clock Voltage Supply—Bank B (Outputs: Q5 to Q9) Bypass with 1.0 μF capacitor and place close to the V <sub>DDOB</sub> pin as possible
35	$\overline{Q6}$	Output clock 6 (complement)
36	Q6	Output clock 6
37	$\overline{Q5}$	Output clock 5 (complement)
38	Q5	Output clock 5.
39	GND	Ground.
40	$\overline{Q4}$	Output clock 4 (complement)
41	Q4	Output clock 4.
42	$\overline{Q3}$	Output clock 3 (complement)
43	Q3	Output clock 3
44	V <sub>DDOA</sub>	Output Voltage Supply—Bank A (Outputs: Q0 to Q4) Bypass with 1.0 μF capacitor and place close to the V <sub>DDOA</sub> pin as possible
GND Pad	GND	Ground Pad Power supply ground and thermal relief

## 4. Ordering Guide

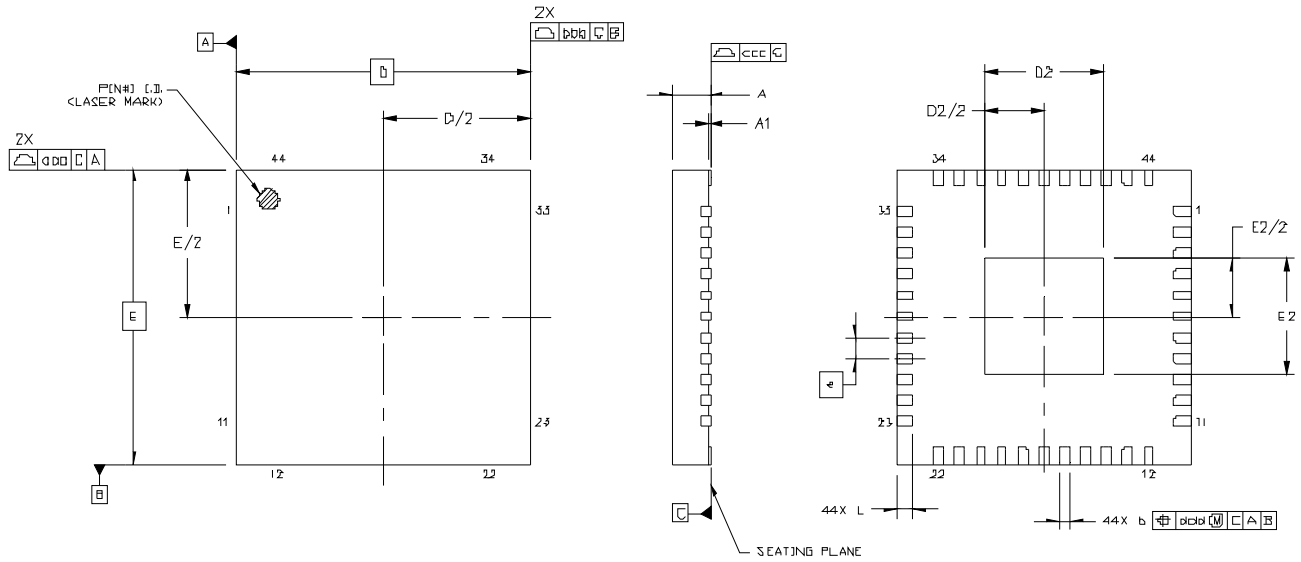
Part Number	Package	PB-Free, ROHS-6	Temperature
Si53313-B-GM <sup>1</sup>	44-QFN	Yes	-40 to 85 °C
Si53301/4-EVB <sup>2</sup>	Evaluation Board	Yes	—

**Notes:**

1. To buy the Si53313-B-GM, go to <https://www.skyworksinc.com/support-ia#distributors>.
2. The Si53301/4-EVB is used to evaluate the Si53313-B-GM. To buy the Si53301/4-EVB, please go to <https://www.skyworksinc.com/support-ia#distributors>.

## 5. Package Outline

### 5.1. 7x7 mm 44-QFN Package Diagram



**Figure 17. Si53313 7x7 mm 44-QFN Package Diagram**

Table 25. Package Diagram Dimensions

Dimension	Min	Nom	Max
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
D	7.00 BSC		
D2	2.65	2.80	2.95
e	0.50 BSC		
E	7.00 BSC		
E2	2.65	2.80	2.95
L	0.30	0.40	0.50
aaa	—	—	0.10
bbb	—	—	0.10
ccc	—	—	0.08
ddd	—	—	0.10
<b>Notes:</b>			
<ol style="list-style-type: none"> <li>All dimensions shown are in millimeters (mm) unless otherwise noted.</li> <li>Dimensioning and Tolerancing per ANSI Y14.5M-1994.</li> <li>This drawing conforms to the JEDEC Solid State Outline MO-220.</li> <li>Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.</li> </ol>			

## 6. PCB Land Pattern

### 6.1. 7x7 mm 44-QFN Package Land Pattern

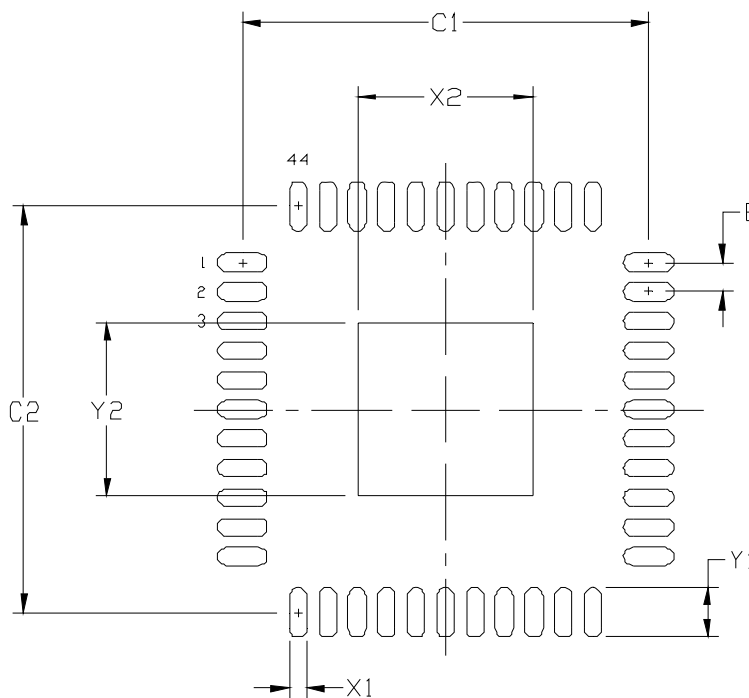


Figure 18. Si53313 7x7 mm 44-QFN Package Land Pattern

Table 26. PCB Land Pattern

Dimension	Min	Max	Dimension	Min	Max
C1	6.80	6.90	X2	2.85	2.95
C2	6.80	6.90	Y1	0.75	0.85
E	0.50 BSC		Y2	2.85	2.95
X1	0.20	0.30			

**Notes:**

**General**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. This Land Pattern Design is based on the IPC-7351 guidelines.

**Solder Mask Design**

1. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60  $\mu\text{m}$  minimum, all the way around the pad.

**Stencil Design**

1. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
2. The stencil thickness should be 0.125 mm (5 mils).
3. The ratio of stencil aperture to land pad size should be 1:1 for all perimeter pads.
4. A 2x2 array of 1.0 mm square openings on 1.45 mm pitch should be used for the center ground pad.

**Card Assembly**

1. A No-Clean, Type-3 solder paste is recommended.
2. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

## 7. Top Marking

### 7.1. Si53313 Top Marking



### 7.2. Top Marking Explanation

<b>Mark Method:</b>	Laser	
<b>Font Size:</b>	1.9 Point (26 mils) Right-Justified	
<b>Line 1 Marking:</b>	Device Part Number	<b>53313-B-GM</b>
<b>Line 2 Marking:</b>	YY=Year WW=Work Week	Assigned by Assembly Supplier. Corresponds to the year and work week of the mold date.
	TTTTTT=Mfg Code	Manufacturing Code from the Assembly Purchase Order form.
<b>Line 3 Marking:</b>	Circle=1.3 mm Diameter Center-Justified	"e3" Pb-Free Symbol
	Country of Origin ISO Code Abbreviation	<b>TW</b>
<b>Line 4 Marking</b>	Circle = 0.75 mm Diameter Filled	Pin 1 Identification

## DOCUMENT CHANGE LIST

### Revision 0.4 to Revision 1.0

- Updated features list.
- Updated tables 1–14 to reflect characterization before Rev 1.0 release.
- Updated sections 2.1, 2.3, 2.4, and 2.7 to add more clarity to description and diagrams.
- Added section 2.8.1 "LVCMOS Output Termination To Support 1.5 V and 1.2 V".
- Update section 2.10 with current phase noise plots.
- Update ordering information and website links.





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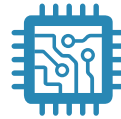
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