Si53302

1:10 Low Jitter Universal Buffer/Level Translator with 2:1 Input Mux

Features

- 10 differential or 20 LVCMOS outputs
- Ultra-low additive jitter: 45 fs rms
- Wide frequency range: 1 to 725 MHz
- Any-format input with pin selectable output formats: LVPECL, Low Power LVPECL, LVDS, CML, HCSL, LVCMOS
- 2:1 clock input mux
- Glitchless input clock switching
- Synchronous output enable
- Output clock division: /1, /2, /4
- Independent V_{DD} and V_{DDO}: 1.8/2.5/3.3 V
- 1.2/1.5 V LVCMOS output support
- Excellent power supply noise rejection (PSRR)
- Selectable LVCMOS drive strength to tailor jitter and EMI performance
- Loss of signal (LOS) monitors for loss of input clock
- Small size: 44-QFN (7 mm x 7 mm)
- RoHS compliant, Pb-free
- Industrial temperature range: –40 to +85 °C

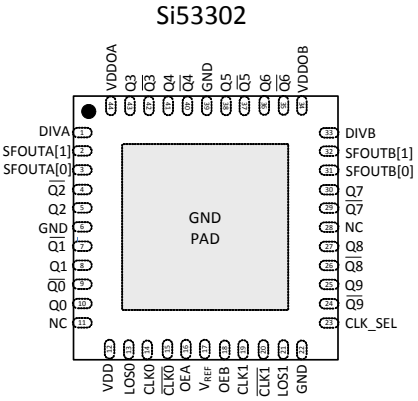


Ordering Information:
See page 29.

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

Pin Assignments

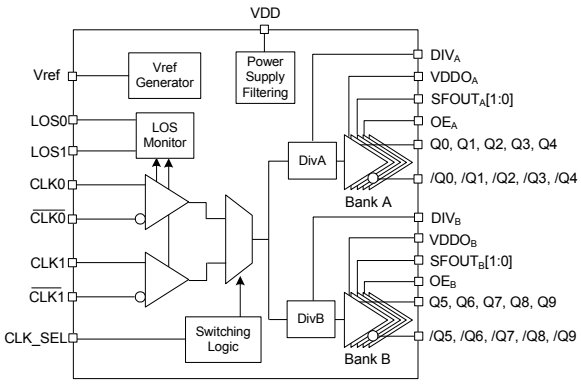


Patents pending

Description

The Si53302 is an ultra low jitter ten output differential buffer with pin-selectable output clock signal format and divider selection. The Si53302 features a 2:1 mux with glitchless switching, making it ideal for redundant clocking applications. The Si53302 utilizes Silicon Laboratories' advanced CMOS technology to fanout clocks from 1 to 725 MHz with guaranteed low additive jitter, low skew, and low propagation delay variability. The Si53302 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



Copyright © 2014 by Silicon Laboratories

TABLE OF CONTENTS

Section	Page
1. Electrical Specifications	**3**
2. Functional Description	**12**
2.1. Universal, Any-Format Input	12
2.2. Input Bias Resistors	14
2.3. Input Clock Voltage Reference (VREF)	14
2.4. Universal, Any-Format Output Buffer	15
2.5. Glitchless Clock Input Switching	16
2.6. Synchronous Output Enable	16
2.7. Flexible Output Divider	17
2.8. Input Mux and Output Enable Logic	17
2.9. Loss of Signal (LOS) Indicator	17
2.10. Power Supply (V_{DD} and V_{DDOX})	17
2.11. Output Clock Termination Options	18
2.12. AC Timing Waveforms	21
2.13. Typical Phase Noise Performance	22
2.14. Input Mux Noise Isolation	25
2.15. Power Supply Noise Rejection	25
3. Pin Description: 44-Pin QFN	**26**
4. Ordering Guide	**29**
5. Package Outline	**30**
5.1. 7x7 mm 44-QFN Package Diagram	30
6. PCB Land Pattern	**31**
6.1. 7x7 mm 44-QFN Package Land Pattern	31
7. Top Marking	**32**
7.1. Si53302 Top Marking	32
7.2. Top Marking Explanation	32
Document Change List	**33**
Contact Information	**34**

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_{DDO} 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 “2.11.1. LVCMOS Output Termination To Support 1.5V and 1.2V”

Table 2. Input Clock Specifications

(V_{DD}=1.8 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%, T_A=–40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Differential Input Common Mode Voltage	V_{CM}	V_{DD} = 2.5 V± 5%, 3.3 V± 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} = 2.5 V± 5%, 3.3 V± 10%	V_{DD} x 0.7	—	—	V
LVCMOS Input Low Voltage	V_{IL}	V_{DD} = 2.5 V± 5%, 3.3 V± 10%	—	—	V_{DD} x 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 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °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 (diff) @200 MHz (CMOS)	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 pF, 200 MHz	—	5	—	mA
		CMOS (2.5 V, SFOUT = Open/0), per output, C_L = 5 pF, 200 MHz	—	8	—	mA
		CMOS (3.3 V, SFOUT = 0/1), per output, C_L = 5 pF, 200 MHz	—	15	—	mA
Input Clock Voltage Reference	V_{REF}	V_{REF} pin I_{REF} = +/-500 µA	—	VDD/2	—	V
Input High Voltage	V_{IH}	SFOUTx, DIVx CLK_SEL, OEx	0.8 x VDD	—	—	V
Input Mid Voltage	V_{IM}	SFOUTx, DIVx 3-level input pins	0.45 x VDD	0.5 x VDD	0.55 x VDD	V
Input Low Voltage	V_{IL}	SFOUTx, DIVx CLK_SEL, OEx	—	—	0.2 x VDD	V
Output Voltage High (LOSx)	V_{OH}	I_{DD} = –1 mA	0.8xVDD	—	—	V
Output Voltage Low (LOSx)	V_{OL}	I_{DD} = 1 mA	—	—	0.2xVDD	V
Internal Pull-down Resistor	R_{DOWN}	CLK_SEL, DIVx, SFOUTx	—	25	—	kΩ
Internal Pull-up Resistor	R_{UP}	OEx, DIVx, SFOUTx	—	25	—	kΩ

***Note:** Low-power LVPECL mode supports an output termination scheme that will reduce overall system power.

Table 4. Output Characteristics (LVPECL)
(V_{DDOX} = 2.5 V ± 5%, or 3.3 V ± 10%,TA = –40 to 85 °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}		0.55	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 V ± 5%, or 3.3 V ± 10%,TA = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output DC Common Mode Voltage	V_{COM}	R_L = 100 Ω across Qn and $\overline{Qn}$	V_{DDOX} – 1.895		V_{DDOX} – 1.275	V
Single-Ended Output Swing	V_{SE}	R_L = 100 Ω across Qn and $\overline{Qn}$	0.25	0.60	0.85	V

Table 6. Output Characteristics—CML
(V_{DDOX} = 1.8 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Single-Ended Output Swing	V_{SE}	Terminated as shown in Figure 9 (CML termination).	300	400	550	mV

Table 7. Output Characteristics—LVDS
(V_{DDOX} = 1.8 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Single-Ended Output Swing	V_{SE}	R_L = 100 Ω across Q_N and $\overline{Q}_N$	247	—	490	mV
Output Common Mode Voltage (V_{DDO} = 2.5 V or 3.3V)	V_{COM1}	V_{DDOX} = 2.38 to 2.63 V, 2.97 to 3.63 V, R_L = 100 Ω across Q_N and $\overline{Q}_N$	1.10	1.25	1.35	V
Output Common Mode Voltage (V_{DDO} = 1.8 V)	V_{COM2}	V_{DDOX} = 1.71 to 1.89 V, R_L = 100 Ω across Q_N and $\overline{Q}_N$	0.85	0.97	1.25	V

Table 8. Output Characteristics—LVCMOS

(V_{DDOX} = 1.8 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output Voltage High*	V_{OH}		0.75 x V_{DDOX}	—	—	V
Output Voltage Low*	V_{OL}		—	—	0.25 x 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 V ± 10%, T_A = –40 to 85 °C))

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

Table 10. AC Characteristics

(V_{DD} = V_{DDOX} = 1.8 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
LOSx Clear Time	T_{LOSCLR}	F < 100 MHz	—	Tper+15	—	ns
		F > 100 MHz	—	25	—	ns
LOSx Activation Time	T_{LOSACT}		—	15	—	µs
Frequency	F	LVPECL, low power LVPECL, LVDS, CML, HCSL	1	—	725	MHz
		LVCMOS	1	—	200	MHz
Duty Cycle **Note:** 50% input duty cycle.	D_C	200 MHz, 20/80% T_R/T_F<10% of period (LVCMOS) (12 mA drive)	40	50	60	%
		20/80% T_R/T_F<10% of period (Differential)	48	50	52	%

Notes:

1. When using the on-chip clock divider, a minimum input clock slew rate of 30 mV/ns is required.
2. HCSL measurements were made with receiver termination. See Figure 9 on page 19.
3. Output to Output skew specified for outputs with an identical configuration.
4. 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.
5. Measured for 156.25 MHz carrier frequency. Sine-wave noise added to V_{DDOX} (3.3 V = 100 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 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Minimum Input Clock Slew Rate[1]	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[2], 20/80%	—	—	280	ps
		CML, 20/80%	—	—	350	ps
		Low-Power LVPECL, 20/80%	—	—	325	ps
		LVCMOS 200 MHz, 20/80%, 2 pF load	—	—	750	ps
Minimum Input Pulse Width	T_W		500	—	—	ps
Propagation Delay	T_{PLH}, T_{PHL}	LVCMOS (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[3]	T_{SK}	LVCMOS (12 mA drive to no load)	—	50	120	ps
		LVPECL	—	35	70	ps
		LVDS	—	35	70	ps
Part to Part Skew[4]	T_{PS}	Differential	—	—	150	ps

Notes:

1. When using the on-chip clock divider, a minimum input clock slew rate of 30 mV/ns is required.
2. HCSL measurements were made with receiver termination. See Figure 9 on page 19.
3. Output to Output skew specified for outputs with an identical configuration.
4. 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.
5. Measured for 156.25 MHz carrier frequency. Sine-wave noise added to V_{DDOX} (3.3 V = 100 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 V ± 5%, 2.5 V ± 5%, or 3.3 V ± 10%,T_A = –40 to 85 °C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Power Supply Noise Rejection[5]	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. When using the on-chip clock divider, a minimum input clock slew rate of 30 mV/ns is required.
2. HCSL measurements were made with receiver termination. See Figure 9 on page 19.
3. Output to Output skew specified for outputs with an identical configuration.
4. 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.
5. Measured for 156.25 MHz carrier frequency. Sine-wave noise added to V_{DDOX} (3.3 V = 100 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_{DD}	Input[1,2]				Output	Additive Jitter (fs rms, 12 kHz to 20 MHz)[3]	
	Freq (MHz)	Clock Format	Amplitude V_{IN} (Single-Ended, Peak-to-Peak)	Differential 20%-80% Slew Rate (V/ns)	Clock Format	Typ	Max
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 1.

Table 12. Additive Jitter, Single-Ended Clock Input

V_{DD}	Input[1,2]				Output	Additive Jitter (fs rms, 12 kHz to 20 MHz)[3]	
	Freq (MHz)	Clock Format	Amplitude V_{IN} (single-ended, peak to peak)	SE 20%-80% Slew Rate (V/ns)	Clock Format	Typ	Max
3.3	200	Single-ended	1.70	1	LVCMOS[4]	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	LVCMOS[4]	130	180
2.5	200	Single-ended	1.70	1	LVCMOS[5]	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	LVCMOS[5]	140	180

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. DC-coupled single-ended inputs.
3. Measured differentially using a balun at the phase noise analyzer input. See Figure 1.
4. Drive Strength: 12 mA, 3.3 V (SFOUT = 11). LVCMOS jitter is measured single-ended.
5. Drive Strength: 9 mA, 2.5 V (SFOUT = 11). LVCMOS jitter is measured single-ended.

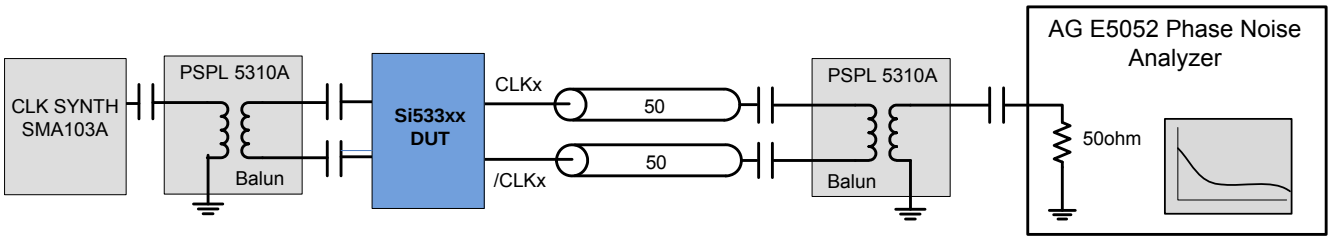


Figure 1. Differential Measurement Method Using a Balun

Table 13. Thermal Conditions

Parameter	Symbol	Test Condition	Value	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	Still air	49.6	°C/W
Thermal Resistance, Junction to Case	θ_{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 kΩ	—	—	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 Si53302 is a low jitter, low skew 1:10 differential buffer with an integrated 2:1 input mux. The device has a universal input that accepts most common differential or LVCMOS input signals. A clock select pin is used to select the active input clock. The selected clock input is routed to two independent banks of five differential clock outputs (Bank A and Bank B). 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 universal input stage enables simple interfacing to a wide variety of clock formats, including LVPECL, low-power LVPECL, LVCMOS, LVDS, HCSL, and CML. Tables 15 and 16 summarize the various ac- and dc-coupling options supported by the device. For the best high-speed performance, the use of differential formats is recommended. For both single-ended and differential input clocks, the fastest possible slew rate is recommended as low slew rates can increased the noise floor and degrade jitter performance. Though not required, a minimum slew rate of 0.75 V/ns is recommended for differential formats and 1.0 V/ns for single-ended formats. See “AN766: Understanding and Optimizing Clock Buffer’s Additive Jitter Performance” for more information.

Table 15. LVPECL, LVCMOS, and LVDS Input Clock Options

	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 Input Clock Options

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

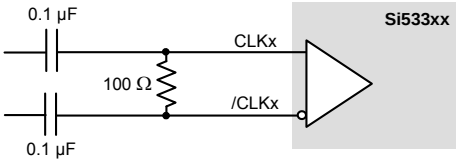


Figure 2. Differential HCSL, LVPECL, Low-Power LVPECL, LVDS, CML AC-Coupled Input Termination

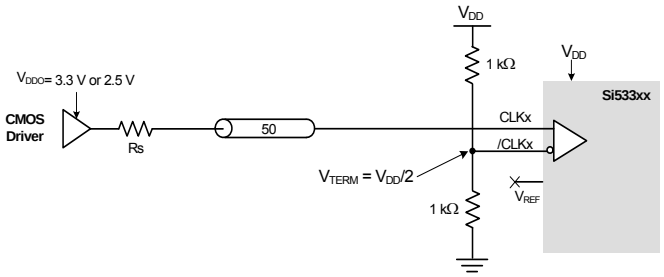
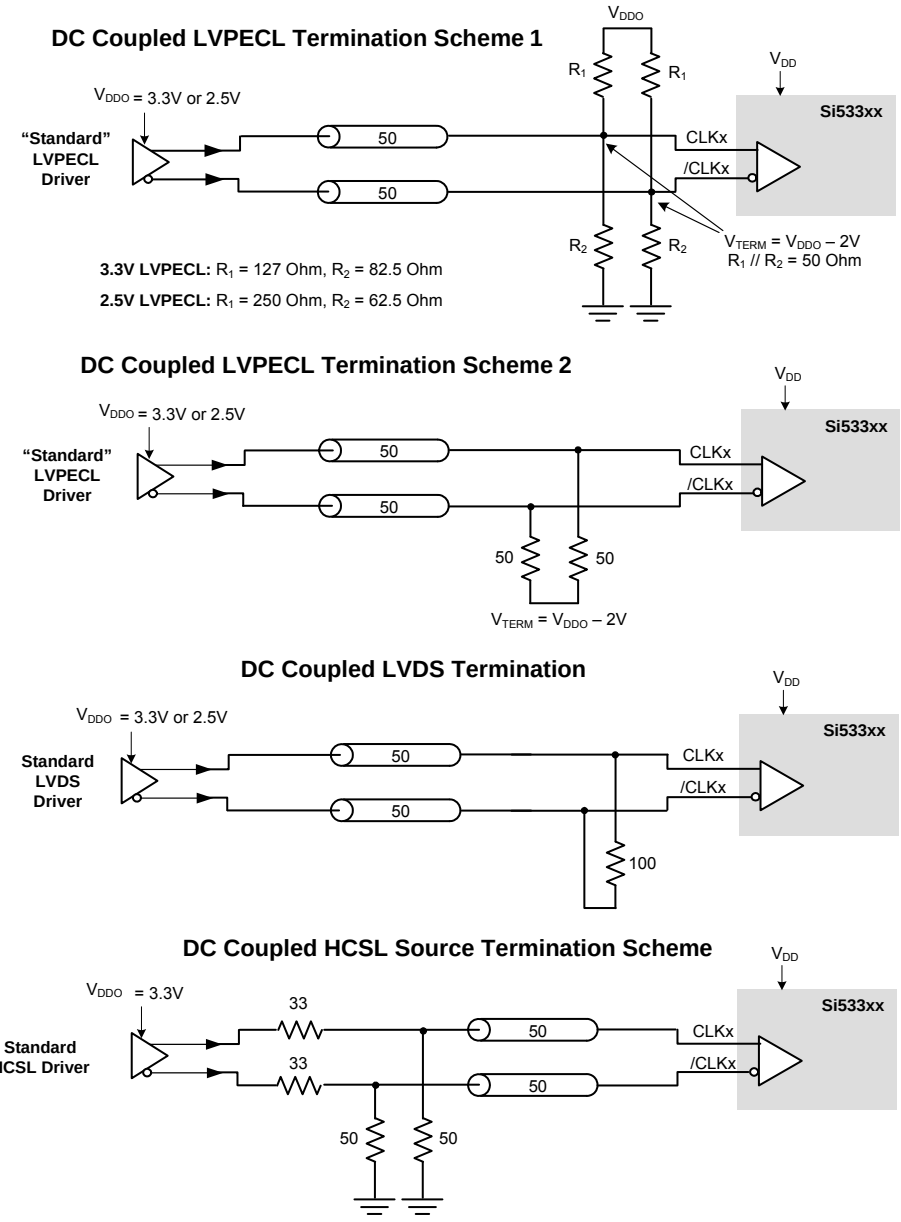


Figure 3. LVCMOS DC-Coupled Input Termination



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

Figure 4. 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 kΩ pull-down to GND and a 75 kΩ pull-up to V_{DD}. The inverting input is biased with a 75 kΩ pull-up to V_{DD}.

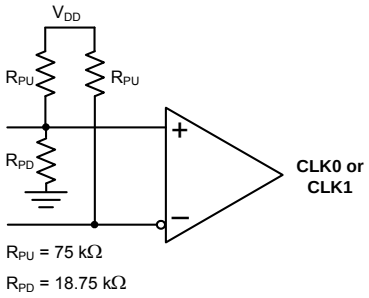


Figure 5. Input Bias Resistors

2.3. Input Clock Voltage Reference (V_{REF})

The V_{REF} pin is used to bias the input receiver when a differential input clock is terminated as a single-ended reference clock to the device. Connect the single-ended input to either CLK0 or CLK1. Use the recommended input termination and bias circuit as shown in Figure 3. Note that the VREF pin should be left floating when LVCMOS or differential clocks are used.

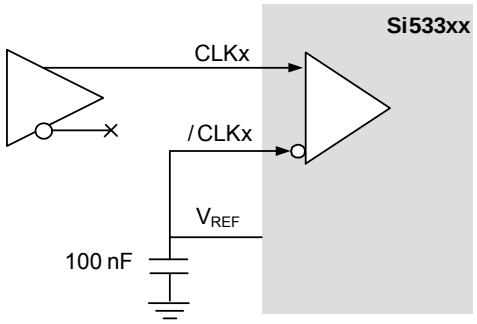


Figure 6. Using Voltage Reference with Single-Ended Input Clock

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 pin-strapped to select the Bank A and Bank B clock signal formats independently. This feature enables the device to be used for format 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.

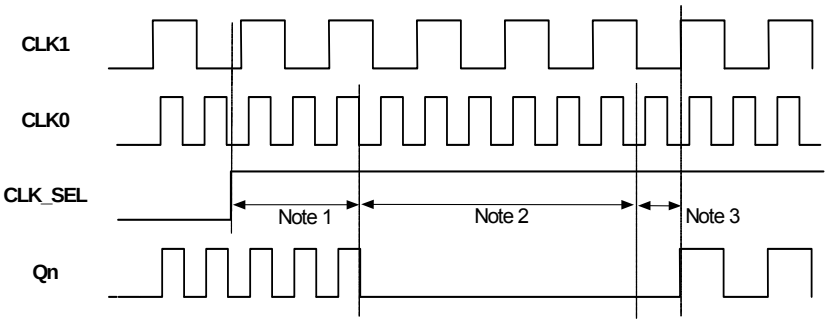
Table 17. Output Signal Format Selection

SFOUTx[1]	SFOUTx[0]	V_{DDOX} = 3.3 V	V_{DDOX} = 2.5 V	V_{DDOX} = 1.8 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 are 3-level input pins. Tie low for “0” setting. Tie high for “1” setting. When left open, the pin floats to $V_{DD}/2$.

2.5. Glitchless Clock Input Switching

The input clock mux features glitchless switching between two valid input clocks. Figure 7 illustrates that switching between input clocks does not generate runt pulses or glitches at the output.



Notes:

1. Q_n continues with CLK0 for 2-3 falling edges of CLK0.
2. Q_n is disabled low for 2-3 falling edges of CLK1 .
3. Q_n starts on the first rising edge after 1 + 2.

Figure 7. Glitchless Input Clock Switch

Glitchless switching between 2 input clocks that are up to 10x different in frequency is supported. When a switchover to a new clock is made, the output will disable low after two or three clock cycles of the previously-selected input clock. The outputs will remain low for up to three clock cycles of the newly-selected clock, after which the outputs will start from the newly-selected input. In the case a switchover to an absent clock is made, the output will glitchlessly stop low and wait for edges of the newly selected clock. A switchover from an absent clock to a live clock will also be glitchless. Note that the CLK_SEL input should not be toggled faster than 1/250th the frequency of the slower input clock.

2.6. Synchronous Output Enable

This buffer features a synchronous output enable (disable) feature. Output enable is sampled and synchronized on the falling edge of the input clock. This feature prevents runt pulses from being generated when the outputs are enabled or disabled.

When OE is low, Q is held low and $\overline{Q}$ is held high for differential output formats. For LVCMOS output format options, both Q and $\overline{Q}$ are held low when OE is set low. The device outputs are enabled when the output enable pin is unconnected. See Table 10, “AC Characteristics,” on page 6 for output enable and output disable times.

2.7. Flexible Output Divider

This buffer 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. Post Divider Selection

DIVx	Divider Value
Open*	÷1 (default)
0	÷2
1	÷4
***Note:** DIVx are 3-level input pins. Tie low for "0" setting. Tie high for "1" setting. When left open, the pin floats to VDD/2.	

2.8. Input Mux and Output Enable Logic

Two clock inputs for applications that need to select between one of two clock sources. The CLK_SEL pin selects the active clock input. The table below summarizes the input and output clock based on the input mux and output enable pin settings.

Table 19. Input Mux and Output Enable Logic

CLK_SEL	CLK0	CLK1	OE[1]	Q[2]
L	L	X	H	L
L	H	X	H	H
H	X	L	H	L
H	X	H	H	H
X	X	X	L	L[3]

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

2.9. Loss of Signal (LOS) Indicator

The LOS0 and LOS1 indicators are used to check for the presence of input clocks CLK0 and CLK1, respectively. The LOS0 and LOS1 pins are checked prior to selecting that clock input or are polled to check for the presence of the currently selected input clock. In the event that an input clock is not present, the associated LOSx pin will assume a logic high (LOSx = 1) state. When a clock is present at the associated input clock pin, the LOSx pin will assume a logic low (LOSx = 0) state.

2.10. 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.

2.11. Output Clock Termination Options

The recommended output clock termination options are shown below.

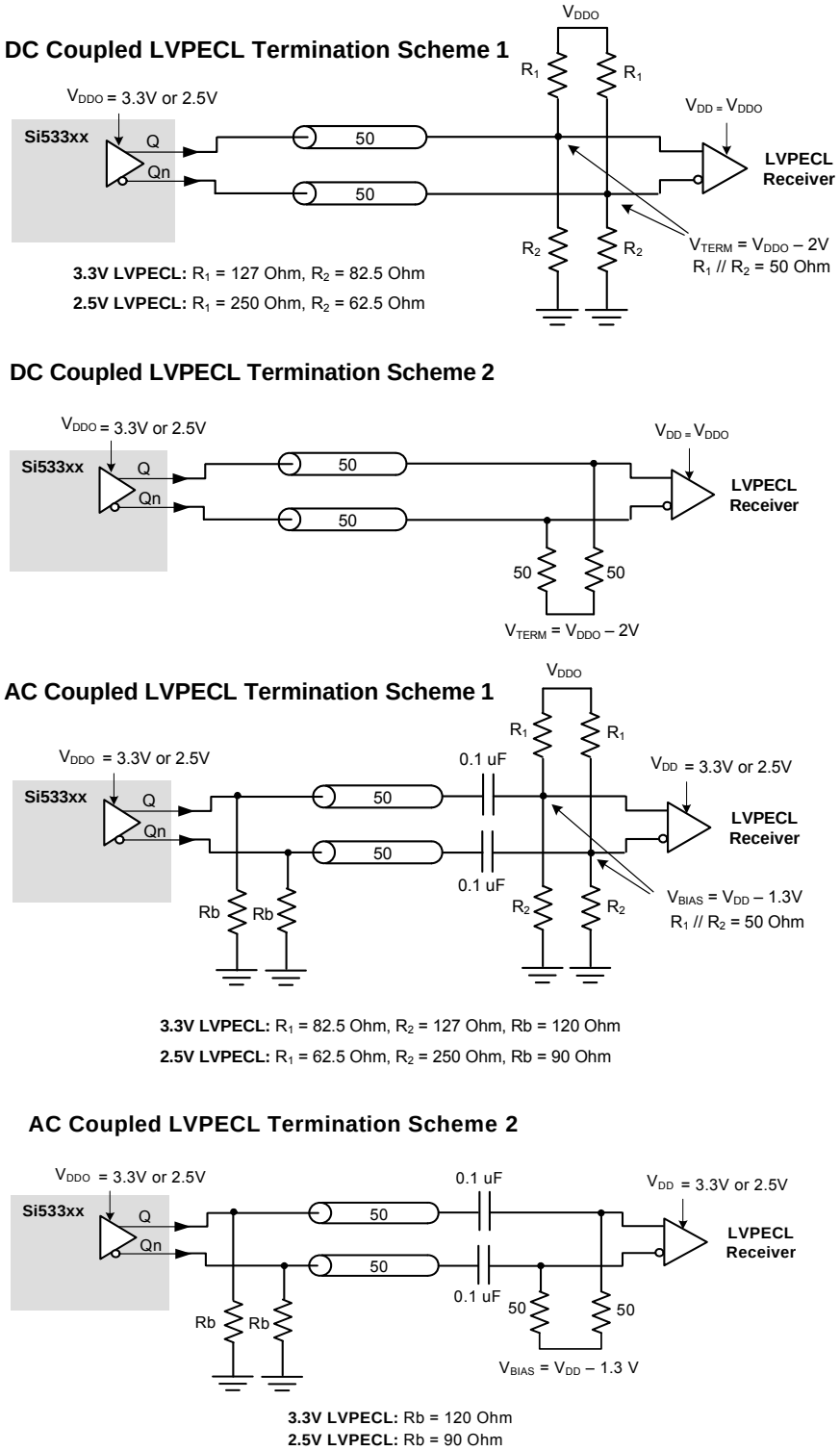
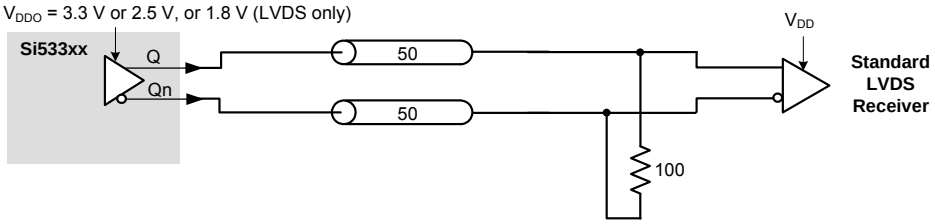
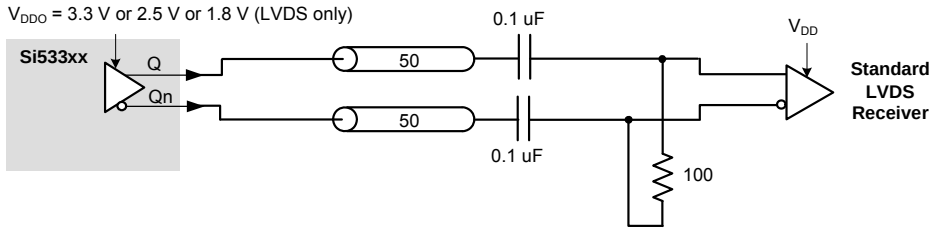


Figure 8. LVPECL Output Termination

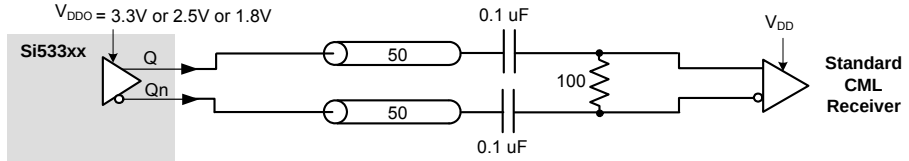
DC Coupled LVDS and Low-Power LVPECL Termination



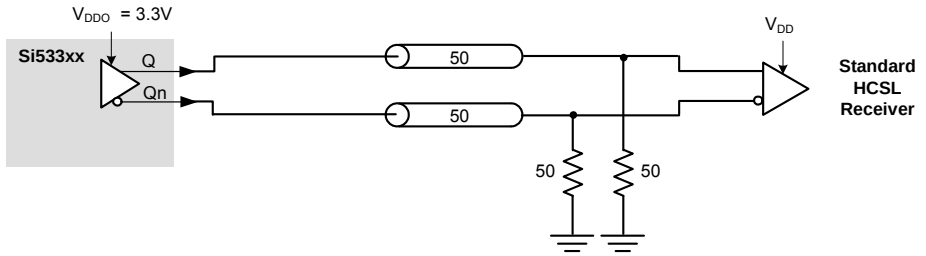
AC Coupled LVDS and Low-Power LVPECL Termination



AC Coupled CML Termination



DC Coupled HCSL Receiver Termination



DC Coupled HCSL Source Termination

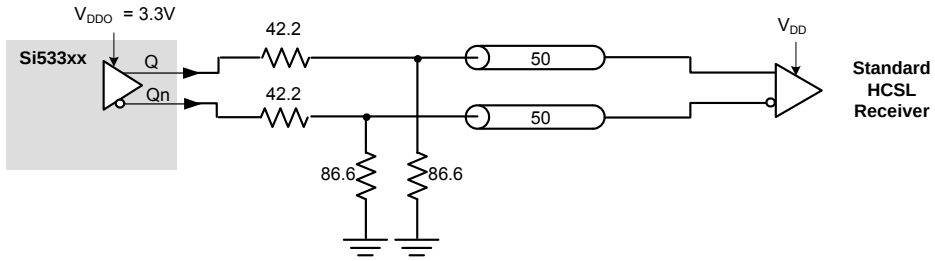


Figure 9. LVDS, CML, HCSL, and Low-Power LVPECL Output Termination

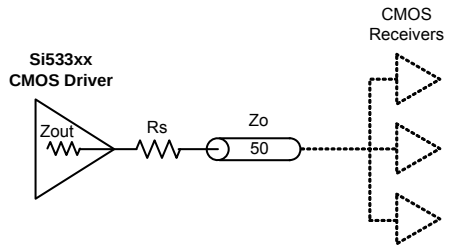


Figure 10. LVCMOS Output Termination

Table 20. Recommended LVCMOS 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

2.11.1. LVCMOS Output Termination To Support 1.5V and 1.2V

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

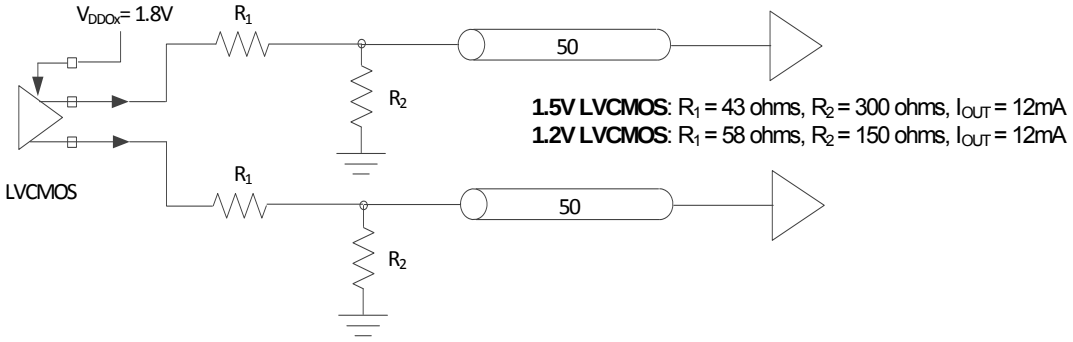


Figure 11. 1.5V and 1.2V LVCMOS Low-Voltage Output Termination

2.12. AC Timing Waveforms

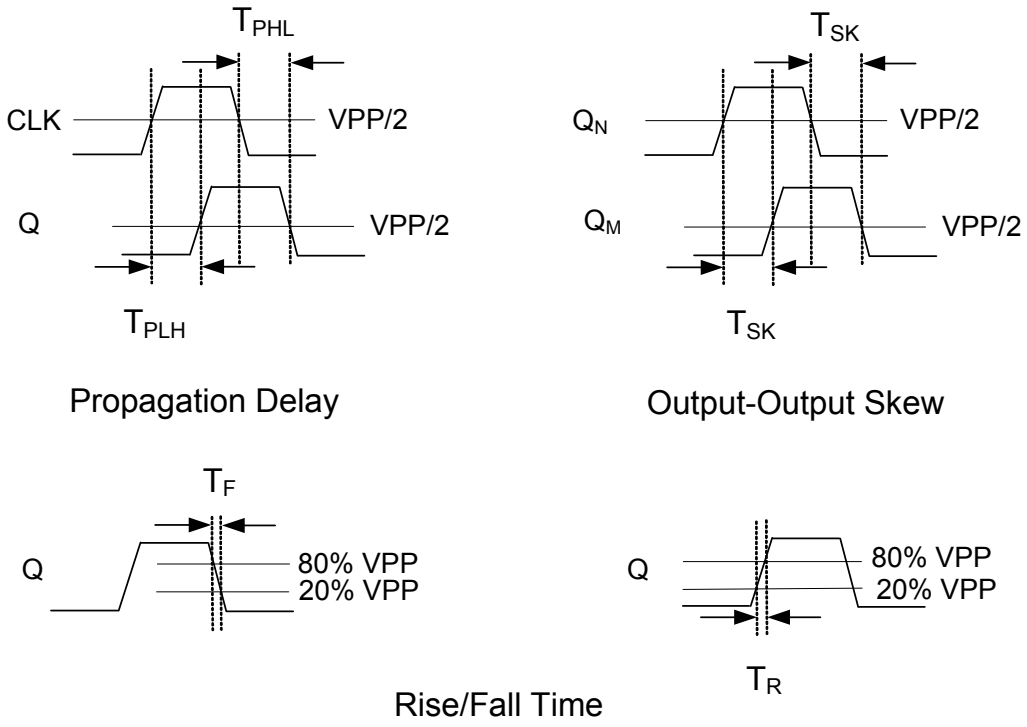


Figure 12. AC Waveforms

2.13. Typical Phase Noise Performance

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

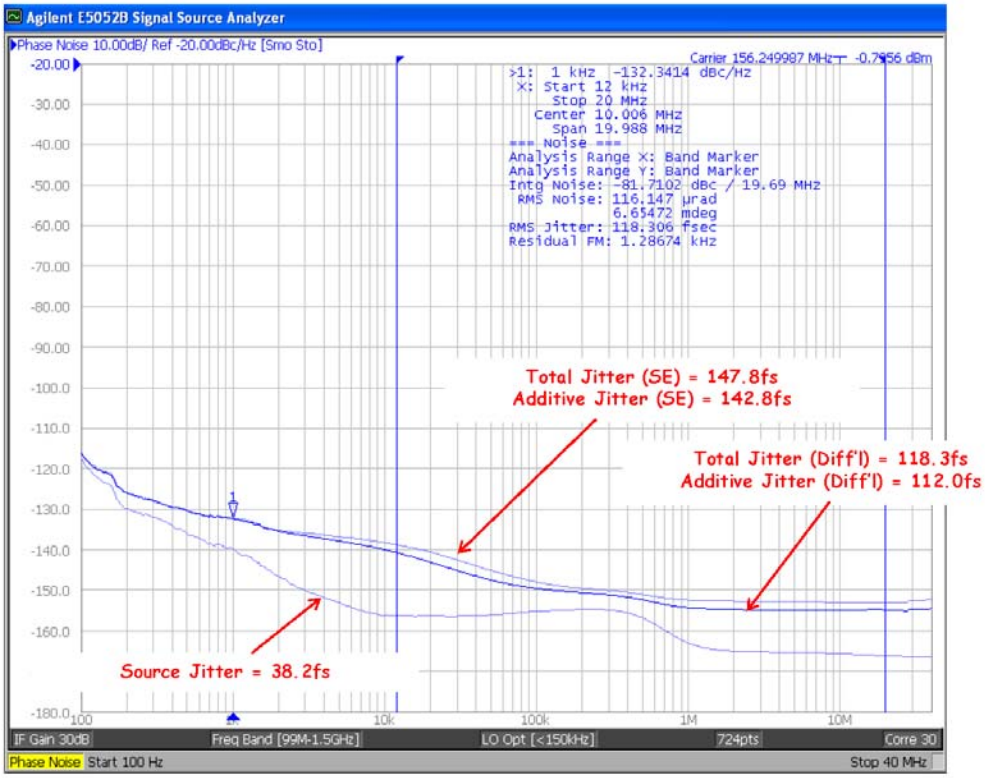
Source Jitter: Reference clock phase noise.

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 1 on page 10.

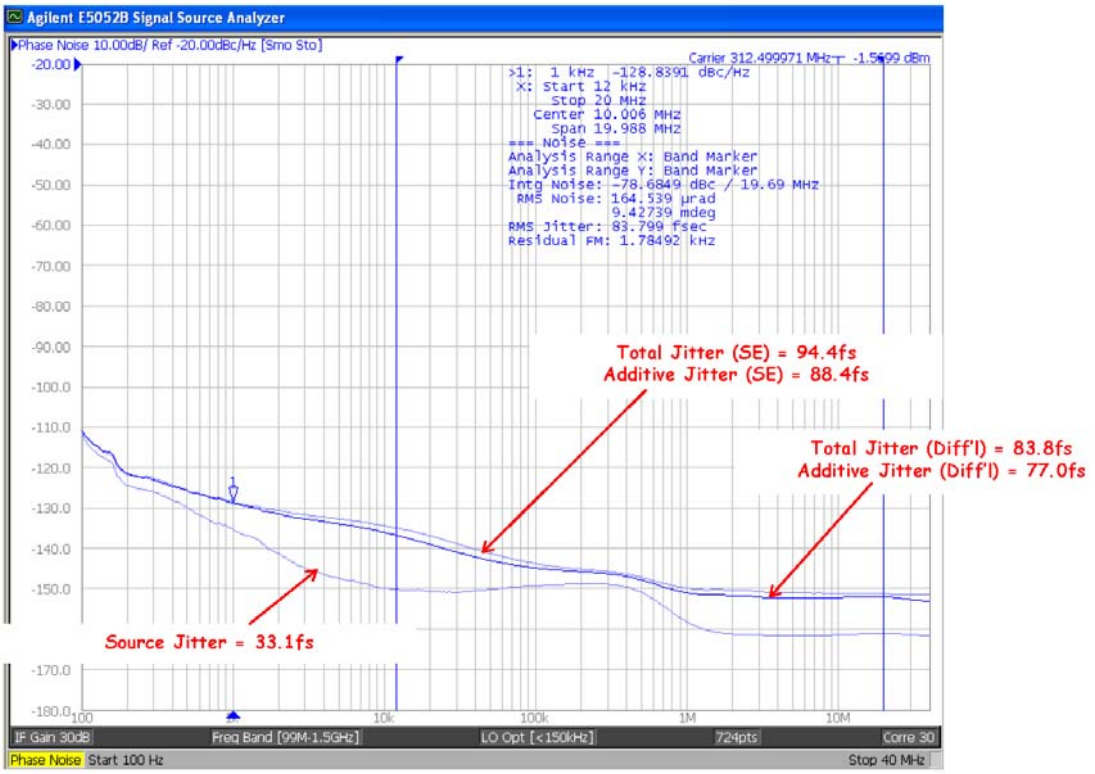
Note: To calculate the total RMS phase jitter when adding a buffer to your clock tree, use the root-sum-square (RSS).

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).



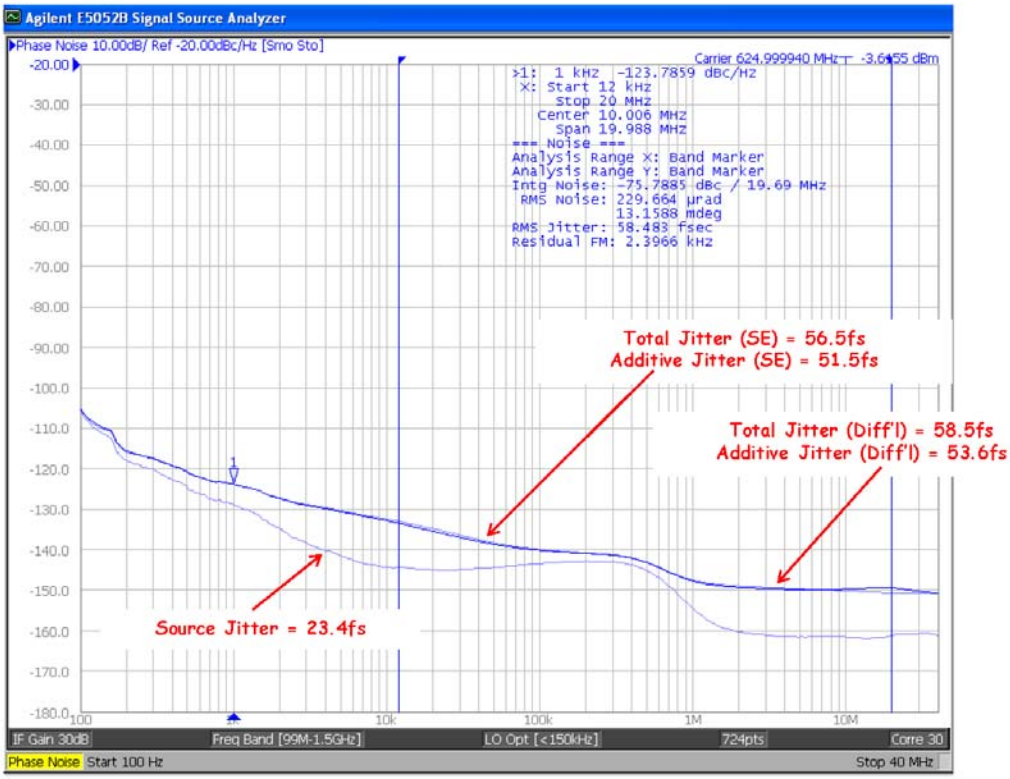
Frequency (MHz)	Diff'l Input Slew Rate (V/ns)	Source Jitter (fs)	Total Jitter (SE) (fs)	Additive Jitter (SE) (fs)	Total Jitter (Diff'l) (fs)	Additive Jitter (Diff'l) (fs)
156.25	1.0	38.2	147.8	142.8	118.3	112.0

Figure 13. Source, Additive, and Total 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)
312.5	1.0	33.10	94.39	88.39	83.80	76.99

Figure 14. Source, Additive, and 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)
625	1.0	23.4	56.5	51.5	58.5	53.6

Figure 15. Source, Additive, and Total Jitter (625 MHz)

2.14. Input Mux Noise Isolation

The buffer's input clock mux is designed to minimize crosstalk between the CLK0 and CLK1. This improves phase jitter performance when clocks are present at both the CLK0 and CLK1 inputs. Figure 16 below is a measurement the input mux's noise isolation.

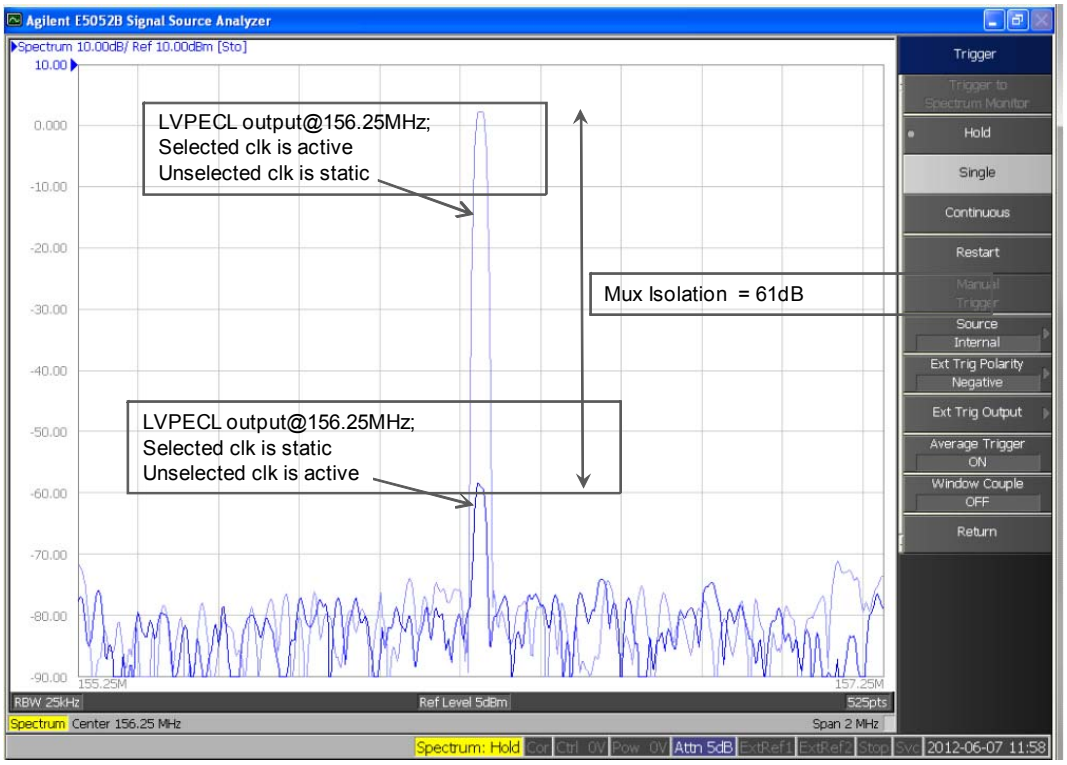


Figure 16. Input Mux Noise Isolation

2.15. 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

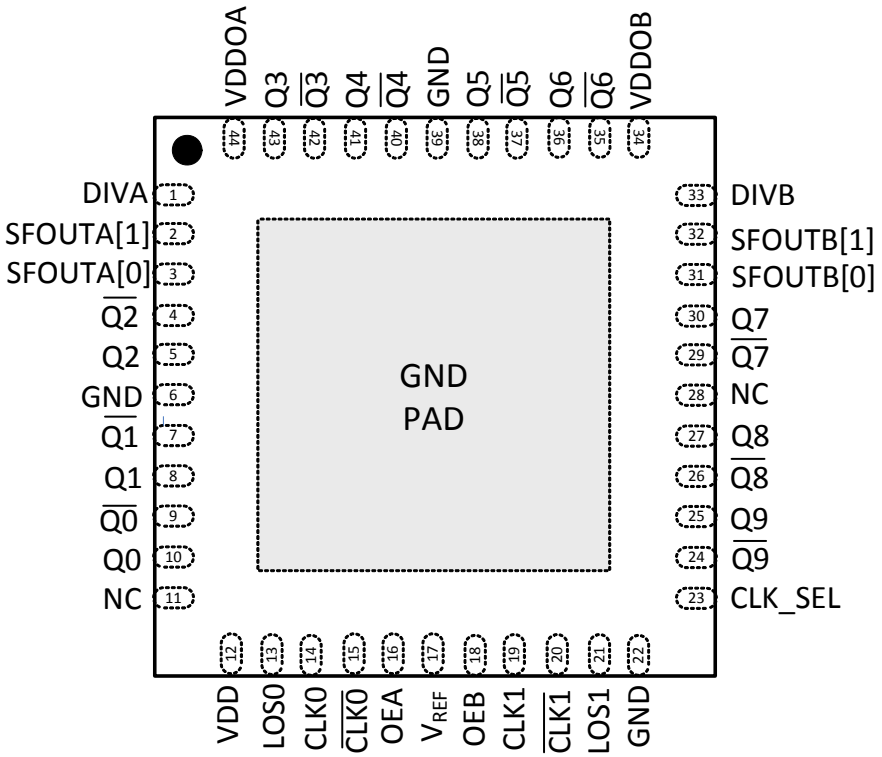


Table 21. Si53302 44-Pin QFN Descriptions

Pin #	Name	Type*	Description
1	DIVA	I	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_{DD}.
2	SFOUTA[1]	I	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_{DD}.
3	SFOUTA[0]	I	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_{DD}.
4	$\overline{Q2}$	O	Output clock 2 (complement)
5	Q2	O	Output clock 2
6	GND	GND	Ground
7	$\overline{Q1}$	O	Output clock 1 (complement)
8	Q1	O	Output clock 1
9	$\overline{Q0}$	O	Output clock 0 (complement)
10	Q0	O	Output clock 0

Table 21. Si53302 44-Pin QFN Descriptions (Continued)

Pin #	Name	Type*	Description
11	NC	—	No connect
12	VDD	P	Core voltage supply Bypass with 1.0 µF capacitor and place close to the VDD pin as possible
13	LOS0	O	The LOS0 status pin indicates whether a clock is present (LOS0 = 0) or not present (LOS0 = 1) at the CLK0 input.
14	CLK0	I	Input clock 0
15	$\overline{\text{CLK0}}$	I	Input clock 0 (complement) When CLK0 is driven by a single-ended input, connect $\overline{\text{CLK0}}$ to VDD/2.
16	OEA	I	Output enable—Bank A When OE = high, the Bank A outputs are enabled When OE = low, Q is held low and $\overline{\text{Q}}$ is held high for differential formats For LVCMOS, both Q and $\overline{\text{Q}}$ are held low when OE is set low OEA contains an internal pull-up resistor
17	V_{REF}	O	Input clock reference voltage used to bias CLK0 or CLK1 clock input pins. V_{REF} is required when a differential input clock is applied to the device and terminated as a single-ended reference. V_{REF} may be left unconnected for LVCMOS or differential clock inputs. See “2.3. Input Clock Voltage Reference (VREF)” for details.
18	OEB	I	Output enable—Bank B When OE = high, the Bank B outputs are enabled When OE = low, Q is held low and $\overline{\text{Q}}$ is held high for differential formats For LVCMOS, both Q and $\overline{\text{Q}}$ are held low when OE is set low OEB contains an internal pull-up resistor.
19	CLK1	I	Input clock 1
20	$\overline{\text{CLK1}}$	I	Input clock 1 (complement) When CLK1 is driven by a single-ended input, connect $\overline{\text{CLK1}}$ to VDD/2.
21	LOS1	O	The LOS1 status pin indicates whether a clock is present (LOS1 = 0) or not present (LOS1 = 1) at the CLK1 input.
22	GND	GND	Ground
23	CLK_SEL	I	MUX input select pin (LVCMOS) Clock inputs are switched without the introduction of glitches When CLK_SEL is high, CLK1 is selected When CLK_SEL is low, CLK0 is selected CLK_SEL contains an internal pull-down resistor
24	$\overline{\text{Q9}}$	O	Output clock 9 (complement)
25	Q9	O	Output clock 9
26	$\overline{\text{Q8}}$	O	Output clock 8 (complement)

Table 21. Si53302 44-Pin QFN Descriptions (Continued)

Pin #	Name	Type*	Description
27	Q8	O	Output clock 8
28	NC	—	No connect
29	$\overline{Q7}$	O	Output clock 7 (complement)
30	Q7	O	Output clock 7
31	SFOUTB[0]	I	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_{DD}.
32	SFOUTB[1]	I	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_{DD}.
33	DIVB	I	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_{DD}.
34	V_{DDOB}	P	Output Clock Voltage Supply—Bank B (Outputs: Q5 to Q9) Bypass with 1.0 µF capacitor and place close to the V_{DDOB} pin as possible
35	$\overline{Q6}$	O	Output clock 6 (complement)
36	Q6	O	Output clock 6
37	$\overline{Q5}$	O	Output clock 5 (complement)
38	Q5	O	Output clock 5
39	GND	GND	Ground
40	$\overline{Q4}$	O	Output clock 4 (complement)
41	Q4	O	Output clock 4
42	$\overline{Q3}$	O	Output clock 3 (complement)
43	Q3	O	Output clock 3
44	V_{DDOA}	P	Output Voltage Supply—Bank A (Outputs: Q0 to Q4) Bypass with 1.0 µF capacitor and place close to the V_{DDOA} pin as possible
GND Pad	GND	GND	Ground Pad Power supply ground and thermal relief
*Pin types are: I = input, O = output, P = power, GND = ground.			

4. Ordering Guide

Part Number[1,2]	Package	PB-Free, ROHS-6	Temperature
Si53302-B-GM	44-QFN	Yes	–40 to 85 °C
Si53301/4-EVB	Evaluation Board	Yes	—

Notes:
1. To buy, go to http://www.supplier-direct.com/silabs/Cart.aspx?supplierUVID=63410000&partnumber=Si53302-B-GM&quantity=1&issample=0.
2. To sample, go to http://www.supplier-direct.com/silabs/Cart.aspx?supplierUVID=63410000&partnumber=Si53302-B-GM&quantity=1&issample=1.

5. Package Outline

5.1. 7x7 mm 44-QFN Package Diagram

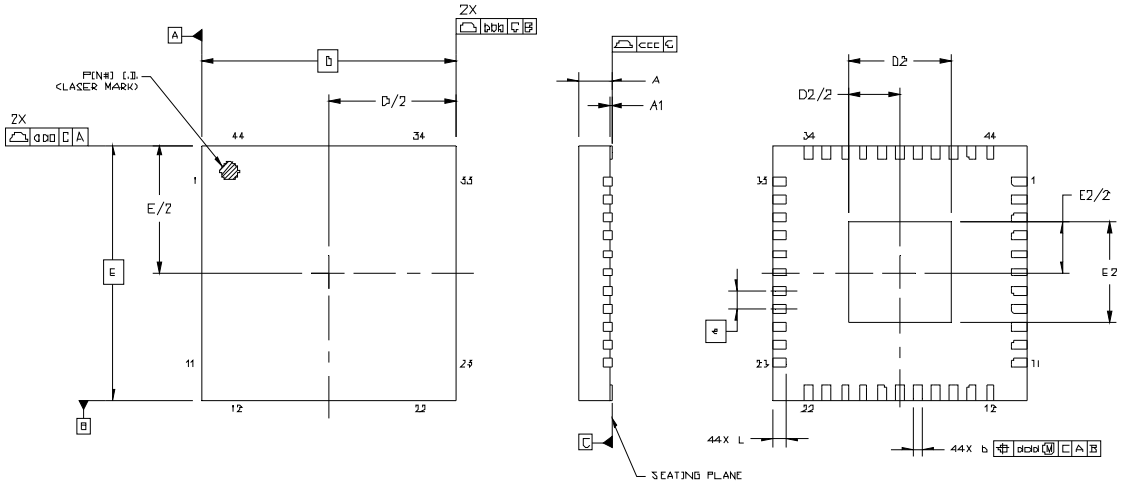


Figure 17. Si53302 7x7 mm 44-QFN Package Diagram

Table 22. 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

Notes:

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This drawing conforms to the JEDEC Solid State Outline MO-220.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

6. PCB Land Pattern

6.1. 7x7 mm 44-QFN Package Land Pattern

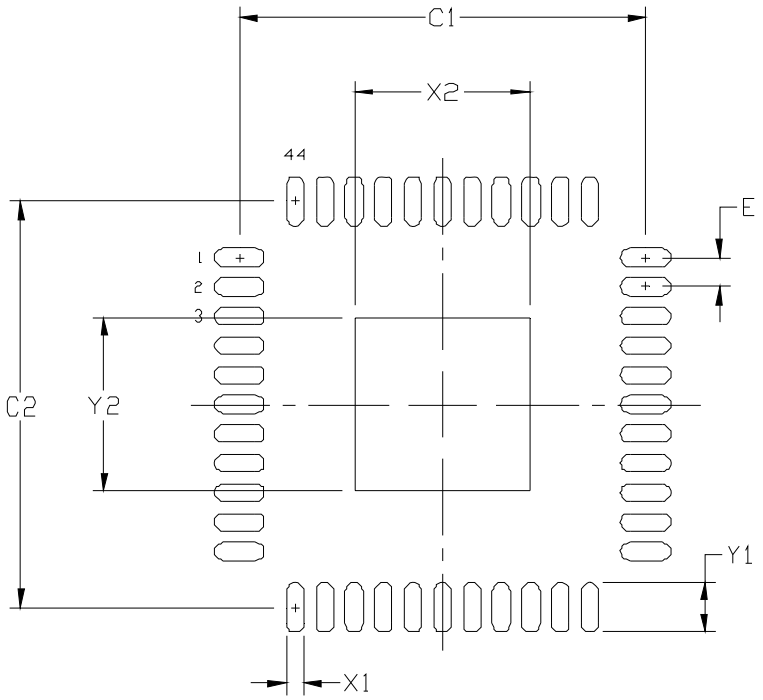


Figure 18. Si53302 7x7 mm 44-QFN Package Land Pattern

Table 23. 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 μm 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. Si53302 Top Marking



7.2. Top Marking Explanation

Mark Method:	Laser	
Font Size:	1.9 Point (26 mils) Right-Justified	
Line 1 Marking:	Device Part Number	**53302-B-GM**
Line 2 Marking:	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.
Line 3 Marking:	Circle = 1.3 mm Diameter Center-Justified	“e3” Pb-Free Symbol
	Country of Origin ISO Code Abbreviation	**TW**
Line 4 Marking	Circle = 0.75 mm Diameter Filled	Pin 1 Identification

Document Change List

Revision 0.41 to 1.0

- Added Loss of Signal (LOS) feature with description and pin assignments.
- Update operating conditions, including LVCMOS and HCSL voltage support.
- Updated Table 2, “Input Clock Specifications,” on page 3.
- Updated Table 3, “DC Common Characteristics,” on page 5.
- Updated Table 4, “Output Characteristics (LVPECL),” on page 6.
- Updated Table 10, “AC Characteristics,” on page 7.
- Updated output voltage specifications
- Improved data for additive jitter specifications.
- Improved typical phase noise plots.
- Updated input/output termination recommendations.

Revision 1.0 to Revision 1.1

- Corrected front-page buffer block diagram.
- Improved performance specifications with more detail.
- Added additional information to clarify the use of the voltage reference feature.
- Added pin type description to Table 21, “Si53302 44-Pin QFN Descriptions,” on page 26.
- Added low-voltage termination options for 1.2 V and 1.5 V LVCMOS support.
- Clarified output clock bank A and bank B assignments.



ClockBuilder Pro

One-click access to Timing tools, documentation, software, source code libraries & more. Available for Windows and iOS (CBGo only).

www.silabs.com/CBPro

Timing Portfolio
www.silabs.com/timing

SW/HW
www.silabs.com/CBPro

Quality
www.silabs.com/quality

Support and Community
community.silabs.com

Disclaimer
Silicon Laboratories intends to provide customers with the latest, accurate, and in-depth documentation of all peripherals and modules available for system and software implementers using or intending to use the Silicon Laboratories products. Characterization data, available modules and peripherals, memory sizes and memory addresses refer to each specific device, and "Typical" parameters provided can and do vary in different applications. Application examples described herein are for illustrative purposes only. Silicon Laboratories reserves the right to make changes without further notice and limitation to product information, specifications, and descriptions herein, and does not give warranties as to the accuracy or completeness of the included information. Silicon Laboratories shall have no liability for the consequences of use of the information supplied herein. This document does not imply or express copyright licenses granted hereunder to design or fabricate any integrated circuits. The products must not be used within any Life Support System without the specific written consent of Silicon Laboratories. A "Life Support System" is any product or system intended to support or sustain life and/or health, which, if it fails, can be reasonably expected to result in significant personal injury or death. Silicon Laboratories products are generally not intended for military applications. Silicon Laboratories products shall under no circumstances be used in weapons of mass destruction including (but not limited to) nuclear, biological or chemical weapons, or missiles capable of delivering such weapons.

Trademark Information
Silicon Laboratories Inc., Silicon Laboratories, Silicon Labs, SiLabs and the Silicon Labs logo, CMEMS®, EFM, EFM32, EFR, Energy Micro, Energy Micro logo and combinations thereof, "the world's most energy friendly microcontrollers", Ember®, EZLink®, EZMac®, EZRadio®, EZRadioPRO®, DSPLL®, ISOmodem ®, Precision32®, ProSLIC®, SiPHY®, USBXpress® and others are trademarks or registered trademarks of Silicon Laboratories Inc. ARM, CORTEX, Cortex-M3 and THUMB are trademarks or registered trademarks of ARM Holdings. Keil is a registered trademark of ARM Limited. All other products or brand names mentioned herein are trademarks of their respective holders.

SILICON LABS

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

http://www.silabs.com