Si53301

1:6 Low Jitter Universal Buffer/Level Translator with 2:1 Input Mux

Features

- 6 differential or 12 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 mux with hot-swappable inputs
- Glitchless input clock switching
- Synchronous output enable
- Output clock division: /1, /2, /4
- Loss of signal (LOS) monitors for loss of input clock
- Independent V_{DD} and V_{DDO} : 1.8/2.5/3.3 V
- Selectable LVCMOS drive strength to tailor jitter and EMI performance
- Small size: 32-QFN (5 mm x 5 mm)
- RoHS compliant, Pb-free
- Industrial temperature range: –40 to +85 °C

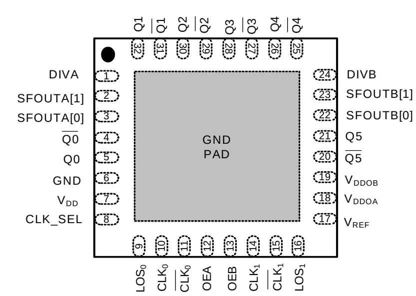
Ordering Information:
See page 28.

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

Si53301

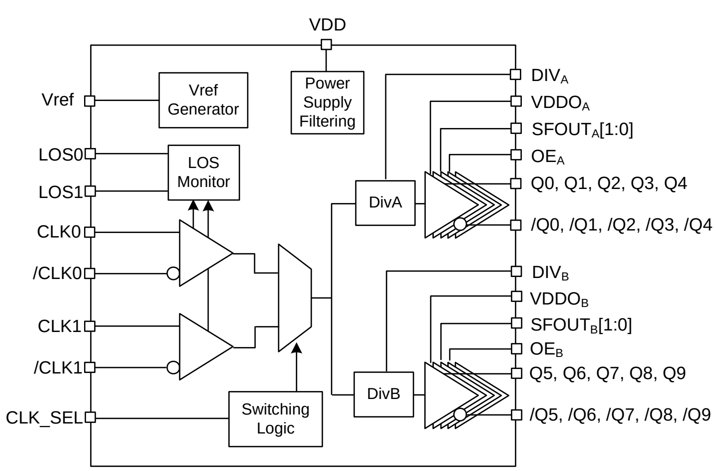


Patents pending

Description

The Si53301 is an ultra low jitter six output differential buffer with pin-selectable output clock signal format and divider selection. The Si53301 features a 2:1 mux with glitchless switching, making it ideal for redundant clocking applications. The Si53301 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 Si53301 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



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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	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
***Note:** Core supply V_{DD} and output buffer supplies V_{DDO} are independent.						

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)	—	35	—	mA
		HCSL, 100 MHz, 2 pF load (3.3 V)	—	35	—	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
Voltage Reference	V_{REF}	V_{REF} pin	—	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	V_{OH}	I_{DD} = –1 mA	0.8xVDD	—	—	V
Output Voltage Low	V_{OL}	I_{DD} = –1 mA	—	—	0.2xVDD	V
Internal Pull-down Resistor	R_{DOWN}	CLK_SEL, DIVX, SFOUTX, OEX	—	25	—	kΩ
Internal Pull-up Resistor	R_{UP}	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_{DD} = 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:** Terminate unused outputs to R_L = 50 Ω to V_{DDOX} – 2 V.						

Table 5. Output Characteristics (Low Power LVPECL)

(V_{DD} = 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
***Note:** R_L = 100 W across Qn and $\overline{Qn}$.						

Table 6. Output Characteristics—CML

(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
Single-Ended Output Swing	V_{SE}	Terminated as shown in Figure 8 (CML termination).	300	400	500	mV

Table 7. Output Characteristics—LVDS

(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
Single-Ended Output Swing	V_{SE}	R_L = 100 Ω across Q_N and $\overline{Q}_N$	247	—	454	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	1.10	V

Table 8. Output Characteristics—LVCMOS
(V_{DD} = V_{DDOX} = 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}		0.80 x V_{DDOX}	—	—	V
Output Voltage Low*	V_{OL}		—	—	0.20 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_{DD} = V_{DDOX} = 3.3 V ± 10%, TA = –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	850	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
LOS Clear Time	T_{LOSCLR}	F < 100 MHz	—	Tper+15	—	ns
		F > 100 MHz	—	25	—	ns
LOS 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. HCL measurements were made with receiver termination. See Figure 8 on page 18.
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 voltages, temperatures, and equal load conditions. 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	LVPECL, LVDS, CML, HCSL[2], Low-Power LVPECL 20/80%	—	—	350	ps
		200 MHz, 20/80%, 2 pF load (LVCMOS)	—	—	750	ps
Minimum Input Pulse Width	T_W		500	—	—	ps
Additive Jitter (Differential Clock Input)	J	V_{DD} = V_{DDOX} = 2.5/3.3 V, LVPECL/ LVDS, F = 725 MHz, 0.75 V/ns input slew rate	—	50	65	fs
Propagation Delay	T_{PLH}, T_{PHL}	LVPECL	500	700	900	ns
		LVDS	—	700	—	ns
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, drive 12 mA to 2 pF	—	60	—	ps
		LVPECL	—	30	75	ps
		LVDS	—	50	—	ps
Part to Part Skew[4]	T_{PS}	Differential	—	—	150	ps
Power Supply Noise Rejection[5]	PSRR	10 kHz sinusoidal noise	—	–65	—	dBc
		100 kHz sinusoidal noise	—	–63	—	dBc
		500 kHz sinusoidal noise	—	–60	—	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. HCL measurements were made with receiver termination. See Figure 8 on page 18.
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 voltages, temperatures, and equal load conditions. 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).

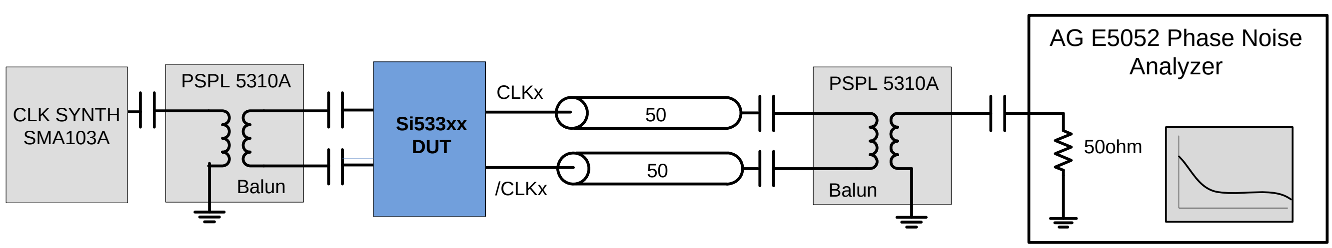


Figure 1. Differential Measurement Method Using a Balun

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 Si53301 is a low jitter, low skew 1:6 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 outputs. 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 Si53301 has a universal input stage that 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. Figures 3 and 4 show the recommended input clock termination options. 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 since 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.

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 (3.3 V)	Yes (3.3 V)	Yes	No

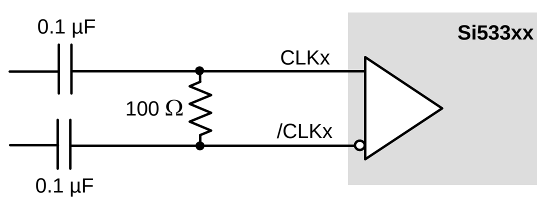


Figure 2. Differential HCSL, LVPECL, Low-Power LVPECL, LVDS, CML AC-Coupled Input Termination

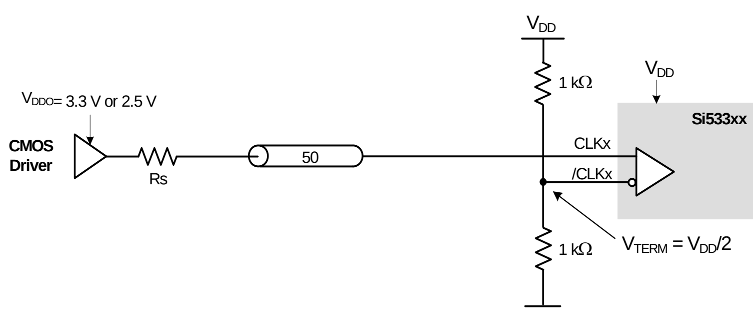


Figure 3. LVCMOS DC-Coupled Input Termination

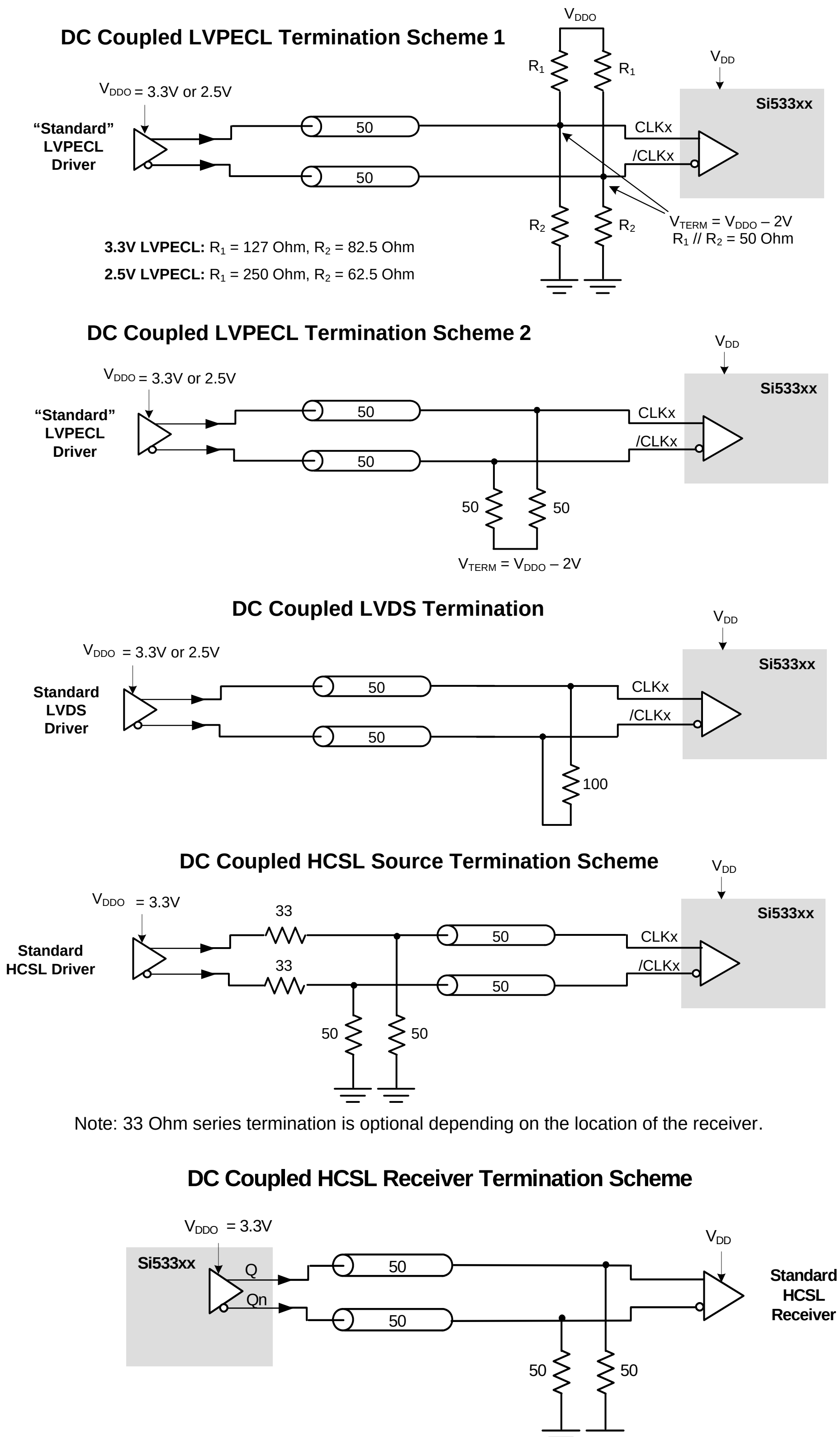


Figure 4. Differential DC-Coupled Input Terminations

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 noninverting input is biased with a 18.75 kΩ pulldown to GND and a 75 kΩ pullup to V_{DD}. The inverting input is biased with a 75 kΩ pullup to V_{DD}.

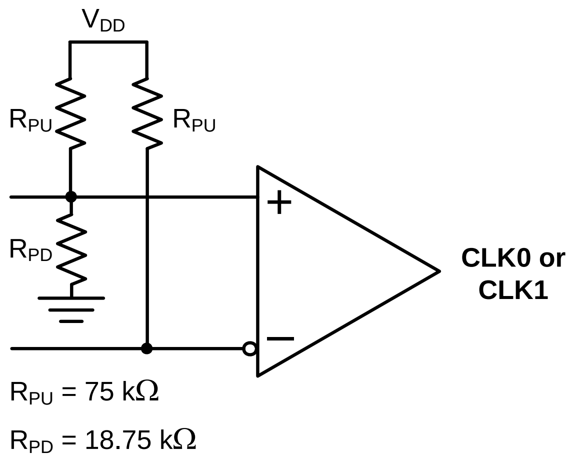


Figure 5. Input Bias Resistors

2.3. Universal, Any-Format Output Buffer

The Si53301 has highly flexible output drivers that 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 or Bank B clock signal formats. 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.

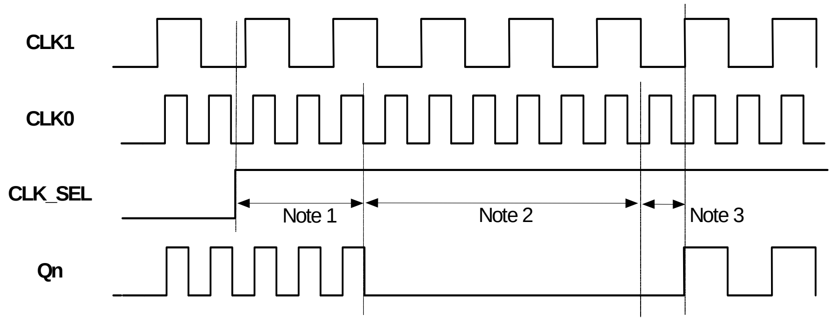
Table 17. Output Signal Format Selection

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	N/A
1	0	LVCMOS, 18 mA drive	LVCMOS, 12 mA drive	N/A
1	1	LVCMOS, 12 mA drive	LVCMOS, 9 mA drive	N/A
Open*	0	LVCMOS, 6 mA drive	LVCMOS, 4 mA drive	N/A
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 $V_{DD}/2$.

2.4. Glitchless Clock Input Switching

The Si53301 features glitchless switching between two valid input clocks. Figure 6 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 6. Glitchless Input Clock Switch

The Si53301 supports glitchless switching between clocks at the same frequency. In addition, the device supports glitchless switching between 2 input clocks that are up to 10x different in frequency. 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.

2.5. Synchronous Output Enable

The Si53301 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 9, “Output Characteristics—HCSL,” on page 7 for output enable and output disable times.

2.6. Flexible Output Divider

The Si53301 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.

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.

2.7. Input Mux and Output Enable Logic

The Si53301 provides 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

2.8. Loss of Signal (LOS) Indicator

The LOS0 and LOS1 indicators monitor for the presence of input clocks CLK0 and CLK1. 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.

2.9. 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.

2.10. Output Clock Termination Options

The recommended output clock termination options are shown below. Unused outputs should be terminated.

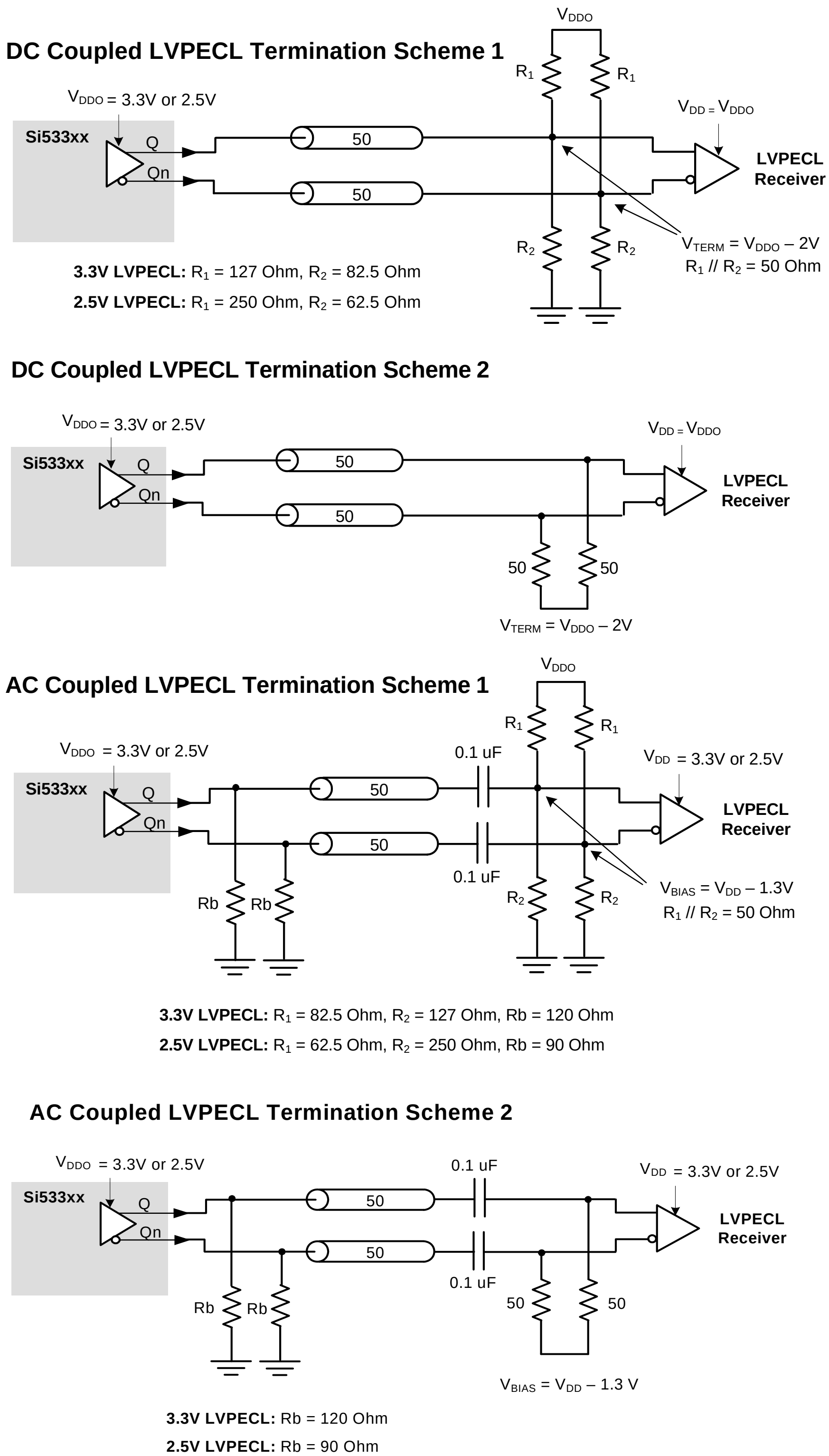


Figure 7. LVPECL Output Termination

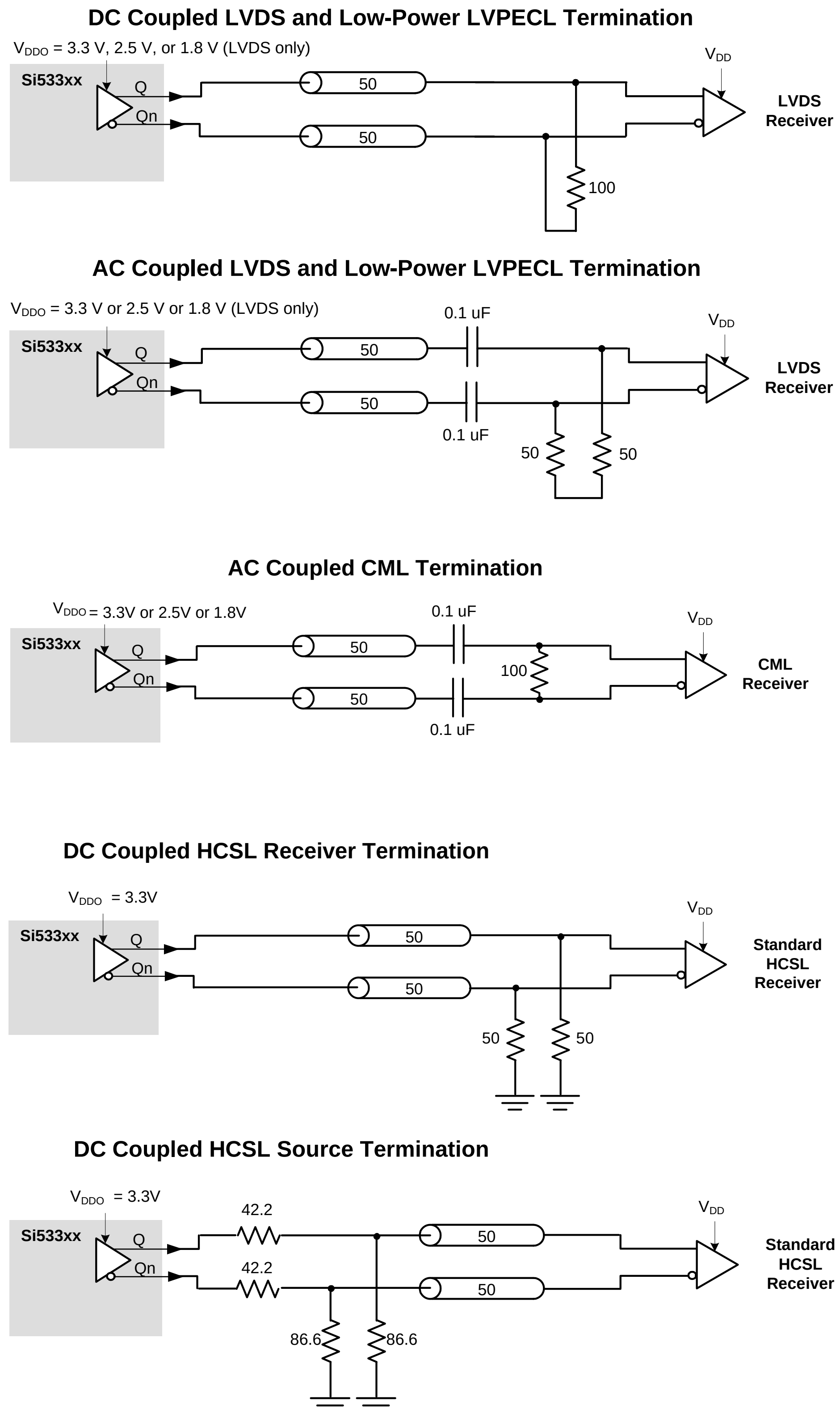


Figure 8. LVDS, CML, HCSL, and Low-Power LVPECL Output Termination

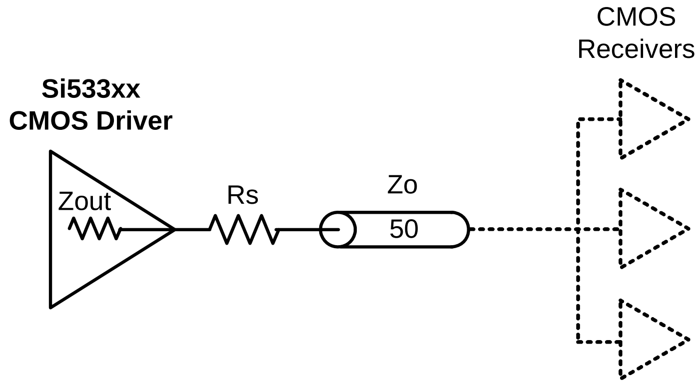


Figure 9. LVCMOS Output Termination

Table 20. Recommended LVCMOS R_S Series Termination

SFOUTX[1]	SFOUTX[0]	R_S (ohms)	
		3.3 V	2.5 V
0	1	33	33
1	0	33	33
1	1	33	33
Open	0	0	0

2.11. AC Timing Waveforms

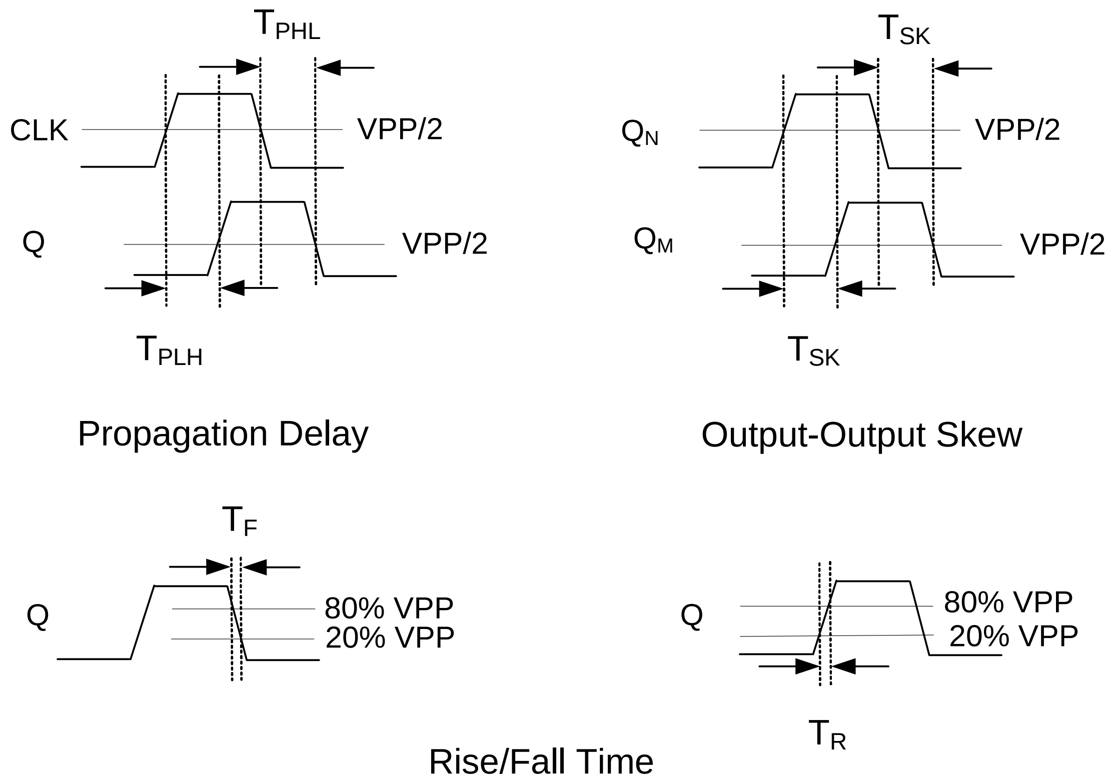


Figure 10. AC Waveforms

2.12. Typical Phase Noise Performance

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

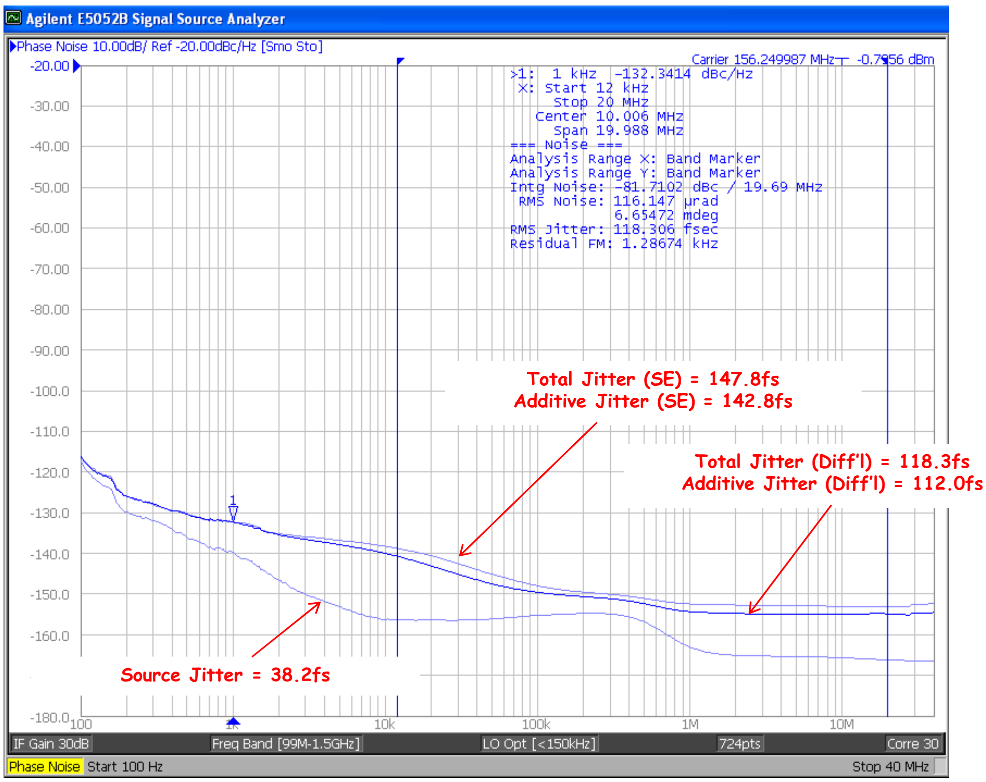
Source Jitter: Reference clock phase noise.

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'l): 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.

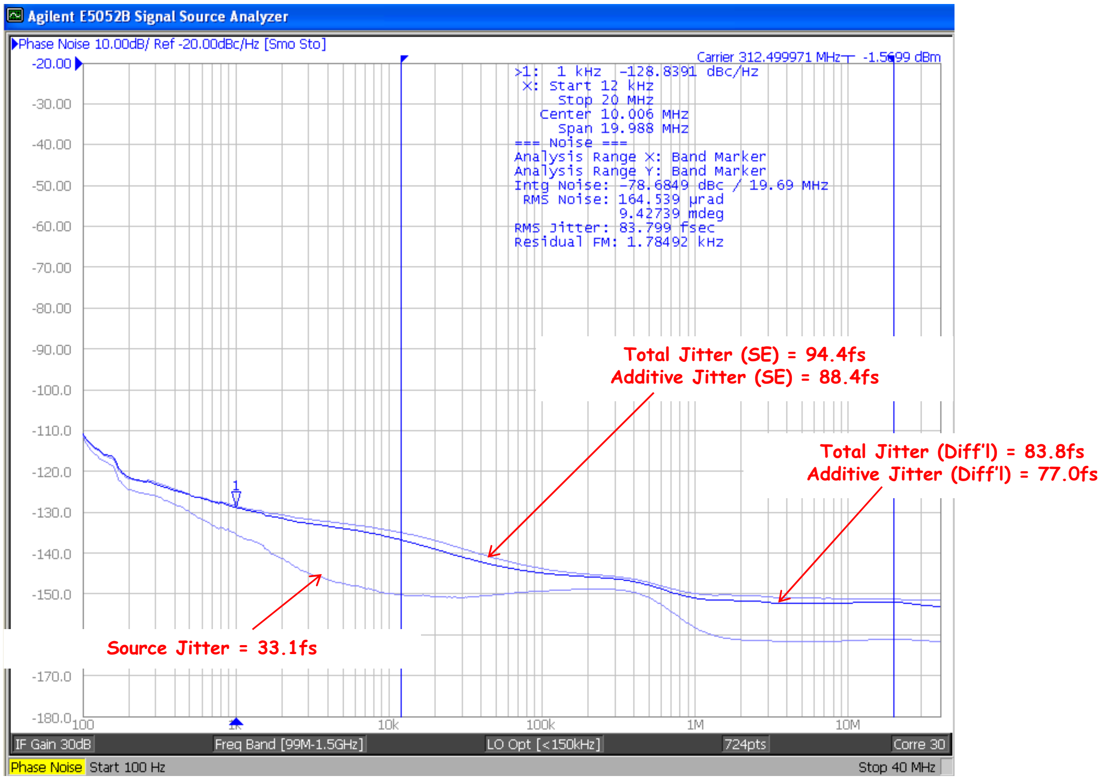
Note: To calculate the total RMS phase jitter when adding a buffer to your clock tree, use the root-sum-square (RSS).

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).



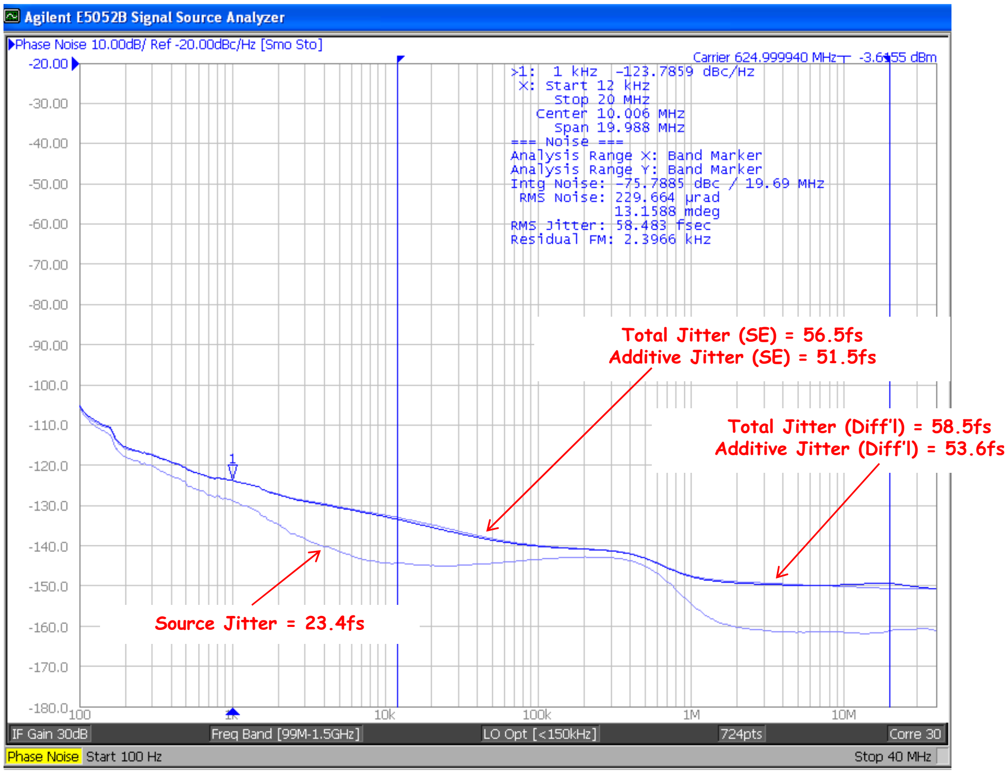
Frequency (MHz)	Diff'l Input Slew Rate (V/ns)	Source Jitter (fs)	Total Jitter (SE) (fs)	Additive Jitter (SE) (fs)	Total Jitter (Diff'l) (fs)	Additive Jitter (Diff'l) (fs)
156.25	1.0	38.2	147.8	142.8	118.3	112.0

Figure 11. 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)
312.5	1.0	33.10	94.39	88.39	83.80	76.99

Figure 12. 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)
625	1.0	23.4	56.5	51.5	58.5	53.6

Figure 13. Differential Total Jitter (625 MHz)

2.13. Input Mux Noise Isolation

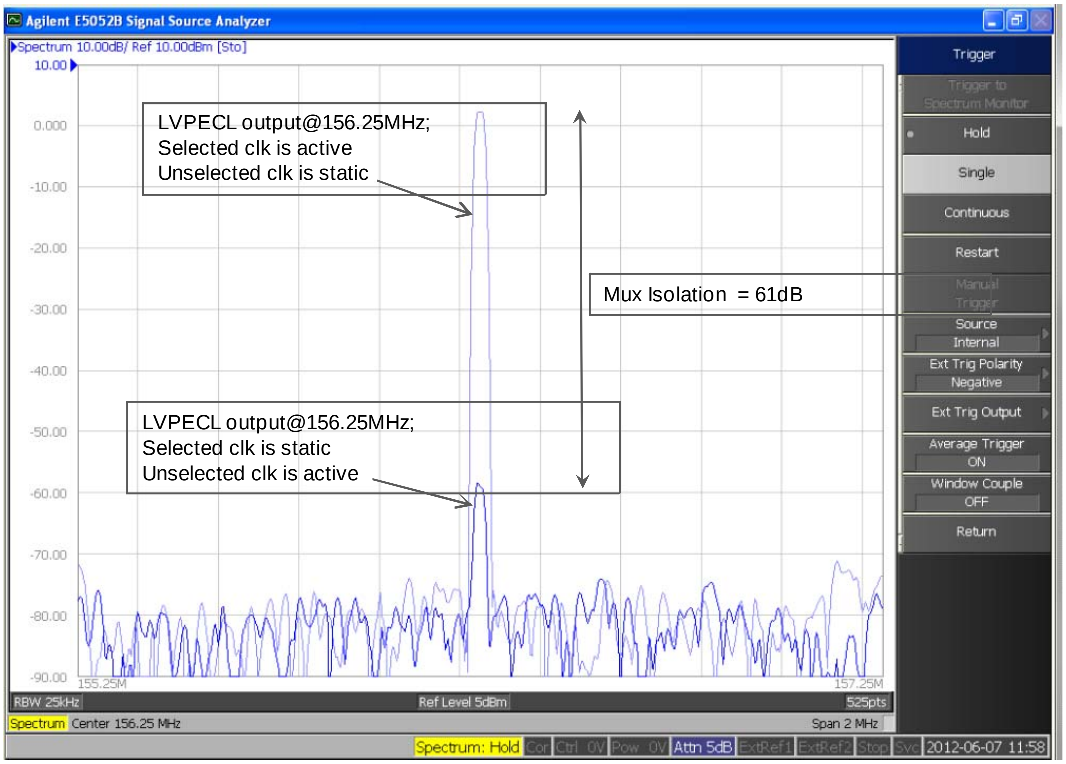


Figure 14. Input Mux Noise Isolation

2.14. 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: 32-Pin QFN

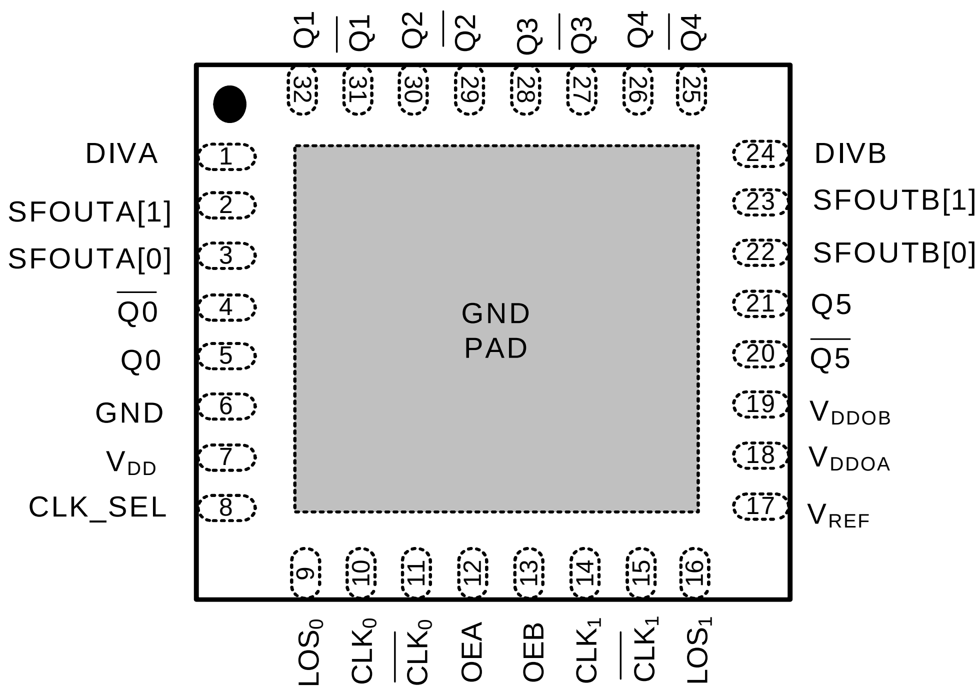


Table 21. Pin Description

Pin	Name	Description
1	DIVA	Output divider control pin for Bank A Three-level input control. Internally biased at V_{DD}/2. Can be left floating or tied to ground or V_{DD}.
2	SFOUTA[1]	Output signal format control pin for Bank A Three-level input control. Internally biased at V_{DD}/2. Can be left floating or tied to ground or V_{DD}.
3	SFOUTA[0]	Output signal format control pin for Bank A Three-level input control. Internally biased at V_{DD}/2. Can be left floating or tied to ground or V_{DD}.
4	$\overline{Q0}$	Output clock 0 (complement)
5	Q0	Output clock 0
6	GND	Ground
7	V_{DD}	Core voltage supply. Bypass with 1.0 µF capacitor and place as close to the V_{DD} pin as possible.

Table 21. Pin Description (Continued)

Pin	Name	Description
8	CLK_SEL	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.
9	LOS0	The LOS0 status pin indicates whether a clock is present (LOS0 = 0) or not present (LOS0 = 1) at the CLK0 pin.
10	CLK0	Input clock 0
11	$\overline{\text{CLK0}}$	Input clock 0 (complement) When the CLK0 is driven by a single-ended input, connect $\overline{\text{CLK0}}$ to VDD/2. See Figure 1, “Differential Measurement Method Using a Balun,” on page 10.
12	OEA	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.
13	OEB	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.
14	CLK1	Input clock 1
15	$\overline{\text{CLK1}}$	Input clock 1 (complement) When the $\overline{\text{CLK1}}$ is driven by a single-ended input, connect $\overline{\text{CLK1}}$ to VDD/2. See Figure 1, “Differential Measurement Method Using a Balun,” on page 10.
16	LOS1	The LOS1 status pin indicates whether a clock is present (LOS1 = 0) or not present (LOS1 = 1) at the CLK1 pin.
17	V_{REF}	Input reference voltage
18	V_{DDOA}	Output voltage supply—Bank A (Outputs: Q0 to Q2) Bypass with 1.0 µF capacitor and place as close to the V_{DDOA} pin as possible.
19	V_{DDOB}	Output voltage supply—Bank B (Outputs: Q3 to Q5) Bypass with 1.0 µF capacitor and place as close to the V_{DDOB} pin as possible.
20	$\overline{\text{Q5}}$	Output clock 5 (complement)
21	Q5	Output clock 5
22	SFOUTB[0]	Output signal format control pin for Bank B. Three-level input control. Internally biased at V_{DD}/2. Can be left floating or tied to ground or V_{DD}.

Table 21. Pin Description (Continued)

Pin	Name	Description
23	SFOUTB[1]	Output signal format control pin for Bank B. Three-level input control. Internally biased at $V_{DD}/2$. Can be left floating or tied to ground or V_{DD}.
24	DIVB	Output divider control pin for Bank B. Three-level input control. Internally biased at $V_{DD}/2$. Can be left floating or tied to ground or V_{DD}.
25	$\overline{Q4}$	Output clock 4 (complement)
26	Q4	Output clock 4
27	$\overline{Q3}$	Output clock 3 (complement)
28	Q3	Output clock 3
29	$\overline{Q2}$	Output clock 2 (complement)
30	Q2	Output clock 2
31	$\overline{Q1}$	Output clock 1 (complement)
32	Q1	Output clock 1
GND Pad	GND	Ground Pad. Power supply ground and thermal relief.

4. Ordering Guide

Part Number	Package	PB-Free, ROHS-6	Temperature
Si53301-B-GM	32-QFN	Yes	–40 to 85 °C

5. Package Outline

5.1. 5x5 mm 32-QFN Package Diagram

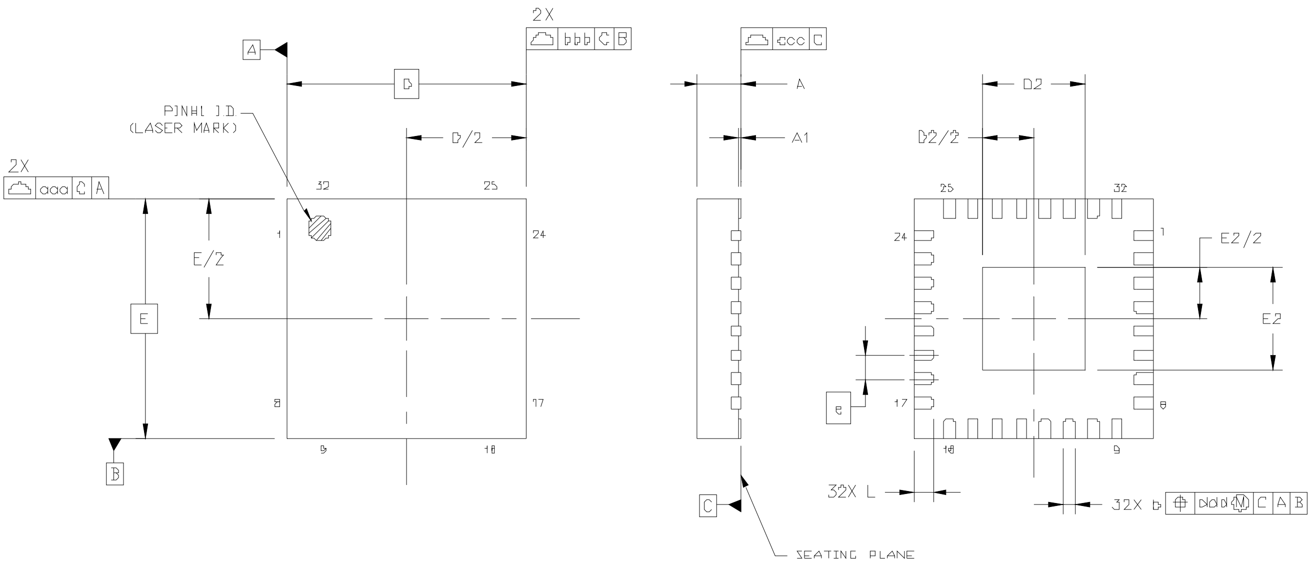


Figure 15. Si53301 5x5 mm 32-QFN Package Diagram

Table 22. Package Dimensions

Dimension	Min	Nom	Max
A	0.80	0.85	1.00
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
c	0.20	0.25	0.30
D		5.00 BSC	
D2	2.00	2.15	2.30
e		0.50 BSC	
E		5.00 BSC	
E2	2.00	2.15	2.30
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.

6. PCB Land Pattern

6.1. 5x5 mm 32-QFN Package Land Pattern

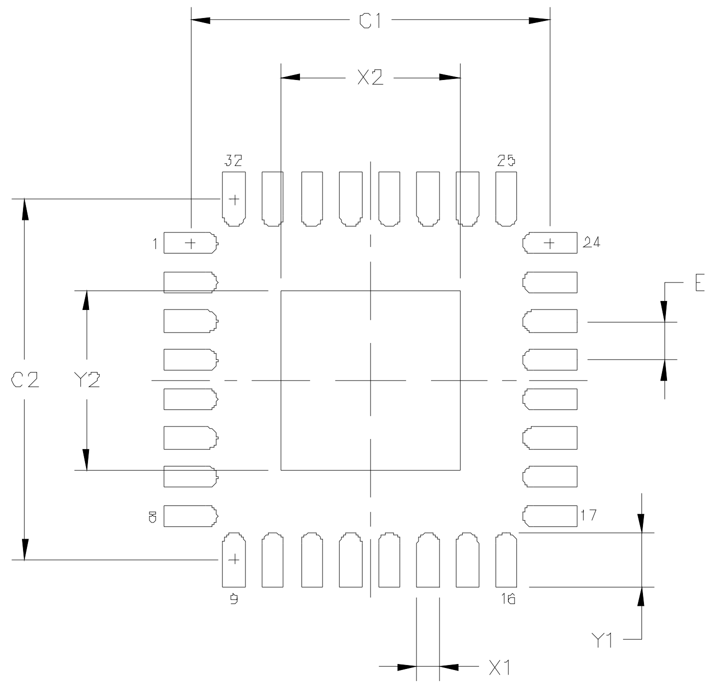


Figure 16. Si53301 5x5 mm 32-QFN Package Land Pattern

Table 23. PCB Land Pattern

Dimension	Min	Max	Dimension	Min	Max
C1	4.52	4.62	X2	2.20	2.30
C2	4.52	4.62	Y1	0.59	0.69
E	0.50 BSC		Y2	2.20	2.30
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

3. 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

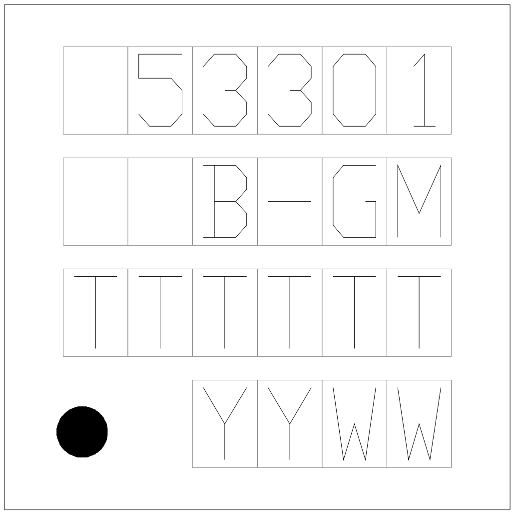
4. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
5. The stencil thickness should be 0.125 mm (5 mils).
6. The ratio of stencil aperture to land pad size should be 1:1 for all perimeter pads.
7. A 2x2 array of 0.75 mm square openings on 1.15 mm pitch should be used for the center ground pad.

Card Assembly

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

7. Top Marking

7.1. Si53301 Top Marking



7.2. Top Marking Explanation

Mark Method:	Laser	
Font Size:	2.0 Point (28 mils) Center-Justified	
Line 1 Marking:	Device Part Number	**53301**
Line 2 Marking:	Device Revision/Type	**B-GM**
Line 3 Marking:	TTTTTT	Manufacturing code
Line 4 Marking	Circle = 0.5 mm Diameter Lower-Left Justified	Pin 1 Identifier
	YY = Year WW = Work Week	Assigned by the Assembly House. Corresponds to the year and work week of the mold date.

Document Change List

Revision 0.31 to Revision 0.4

- Updated part number to revision B.
- Added phase noise plot, PSRR figure, input mux isolation figure.
- Updated AC/DC specifications.

Revision 0.4 to Revision 1.0

Front Page

- Updates functional block diagram and pin assignment figures to add LOS pins.

Recommended Operating Conditions

- Updated Table 1 to clarify notation.
- Spec change: HCSL is supported at 3.3 V only.

Input Clock Specifications Table

- Clarification: Input swing spec clarified applies to differenital input.
- Clarification: Input voltage high/low spec is for LVCMOS input.
- Clarification: Input capaitance with respect to GND.

DC Common Characteristics Table

- Clarification: Denote frequencies for S.E. and Differential outputs for current consumption specs.
- Spec change: Updated Supply/output buffer supply current specs.
- Spec change: LVCMOS is not supported at 1.8 V.
- Spec change: Input high/low voltage levels.
- Correction to show which singals use internal pull-up/pull-down.
- Added specification: Output voltage high/low to support added LOS feature.

Output Voltage Specifications

- Spec change: LVPECL and Low-Power LVPECL output voltage level specifications changes.
- Spec change: LVPECL and low-power LVPECL DC characteristics separated into two tables.
- Spec change: LVCMOS logic levels improved.
- Spec change: HCSL single-ended output swing max/min added.

AC Characteristics

- Ouput rise/fall time spec test conditions, added low-power LVPECL.
- Duty cycle spec added for LVCMOS, updated differential spec and test conditions.
- Spec change: Propagation delay (was TBD)
- Spec change: Added/expanded output enable/disable time specs for three frequencies.
- Spec change: part to part skew updated.
- Spec chnage: Power supply noise rejection updated.
- Spec change: Improved additive Jitter specification.
- Spec change: Output to output skew updated.
- Updated footnotes.

Additive Jitter, Differential Clock Input Table

- Spec changes: Table changed to provide improved specs and add spec previously "TBD" based upon differential measurements.
- Added footnote and test setup Figure 1 for clarity.

Additive Jitter, Single-Ended Clock Input Table

- Spec changes: Table changed to provide improved specs and add specs previously "TBD" based upon differential measurements.
- Added footnote and test setup Figure 1 for clarity.

Pinout Description

- No pin assignments were moved. Two pins previously indicated as NC have been assigned to the LOS function as follows: Pin 9 is LOS0 and Pin 16 is LOS1.
- Pin assignment and descriptions have been edited to reflect this added feature's pin assignment.
- Correction: Top Marking spec/explanation have been corrected.

Other Changes

- Added Figure 1 test setup.
- Input format change: 1.8 V LVCMOS is not supported.
- Clarified support for HCSL is at 3.3 V.
- Updated recommendation in Figure 3 for optimal performance.
- Added dc-coupled receiver termination scheme.
- Output format Selection table reflects LVCMOS (no 1.8 V) and HCSL (3.3 V only).
- Loss of Signal feature is added. Section to describe the loss of signal indicator feature.
- Output termination recommendations: updated to show Low-power LVPECL supported termination.
- Correction: LVCMOS series termination recommendation table.
- Typical phase noise plots updated with improved figures and clearer results.

NOTES:

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