Si5361/62/63 Data Sheet

18-Output, Any-Frequency, Any-Output Jitter Attenuator/Clock Multiplier with Ultra-Low Jitter

The Si5361/62/63 Jitter Attenuators combine fifth-generation DSPLL™ and MultiSynth™ technologies with an ultra-low jitter VCO to deliver ultra-low jitter (<55 fs) for high-performance applications like 112G and 224G SerDes and Coherent Optics. They are used in applications that demand the highest level of integration and jitter performance. All PLL components are integrated on-chip, eliminating the risk of noise coupling associated with discrete solutions. The Si5361 has a single-DSPLL with 2 MultiSynths, the Si5362 has 2-DSPLLs with 1 MultiSynth and the Si5363 has 3-DSPLLs. The Si5361H high frequency variant is capable of output frequencies up to 2.75 GHz targeting the optical module markets.

All devices support free-run, synchronous and holdover modes as well as enhanced hitless switching, minimizing the phase transients associated when switching between input clocks. These devices are programmable via a serial interface with in-circuit programmable non-volatile memory (NVM) to enable powering up with a known frequency configuration.

Programming the Si5361/62/63 is easy with Skyworks ClockBuilder™ Pro (CBPro) software. The devices can be factory programmed allowing them to power up to known frequencies and settings or shipped as “blank” devices to give more flexibility.

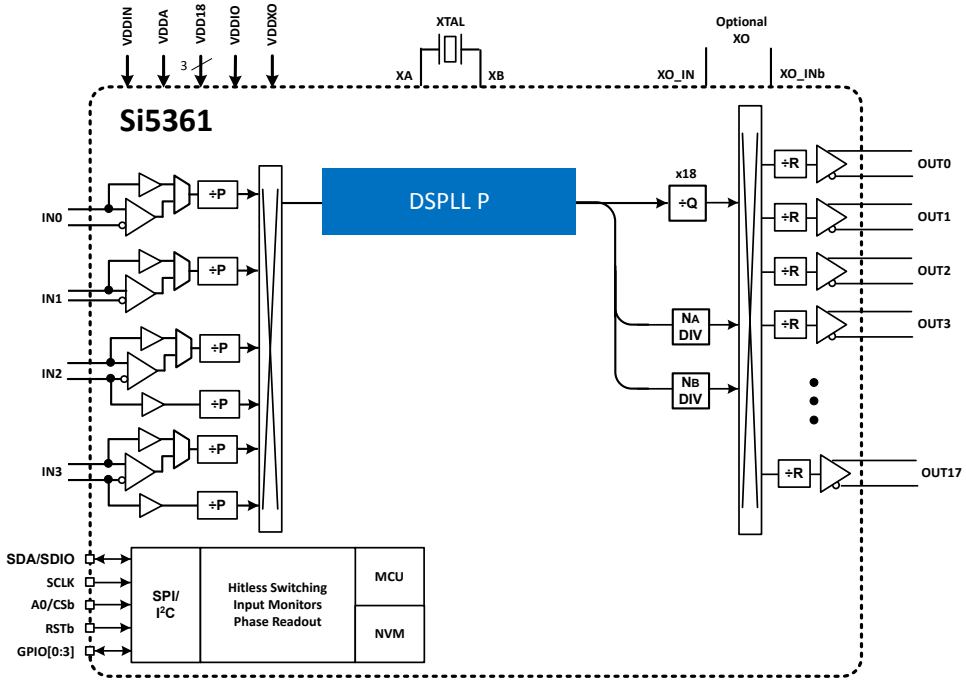
For more information, visit https://www.skyworksinc.com/en/Talk-To-Sales.

Applications

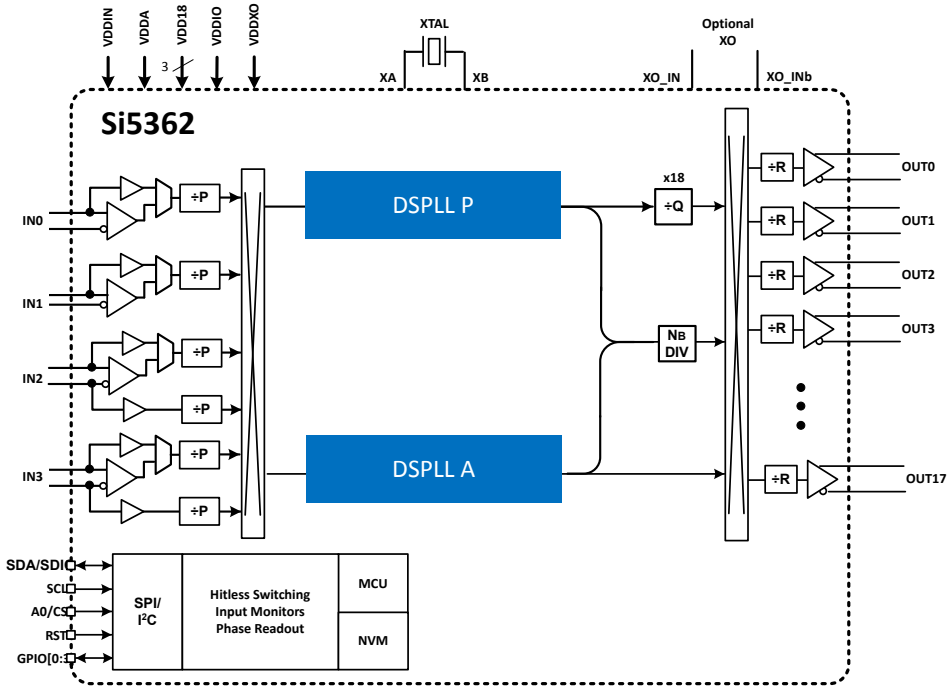
- 56G/112G/224G PAM4 SerDes clocking
- OTN muxponders and transponders
- 100/200/400/600/800G networking line cards
- Synchronous Ethernet
- Datacenter Switches
- Medical imaging
- Test and measurement
- 100G/200G/400G Optical Transceivers

KEY FEATURES

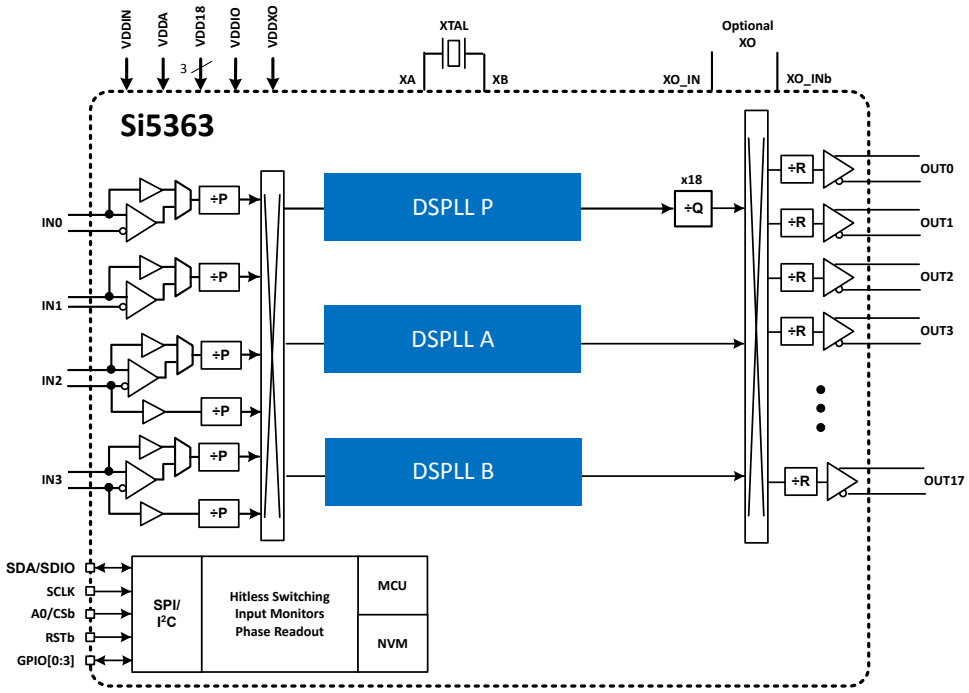
- Utilizes fifth-generation DSPLL™ and MultiSynth™ technologies
- ANY input to ANY combination of output frequencies up to 2.75 GHz
- Ultra low phase jitter (<55 fs typ)
- Enhanced hitless switching minimizes output phase transients (35 ps typ)
- Up to 6 Differential/Single-ended Inputs
- Input frequency range
  - Differential: 8 kHz to 1000 MHz
  - LVCMOS: 8 kHz to 250 MHz
- 18 Outputs
- Output frequency range
  - Differential: 8 kHz to 2.75 GHz
  - LVCMOS: 8 kHz to 250 MHz
- Fixed or user-adjustable output formats
- SmartDriver™ Simplified API interface
- Full suite of status monitors
- Si5361: 1 DSPLL, 2 Multisynths
- Si5362: 2 DSPLL, 1 Multisynth
- Si5363: 3 DSPLL, 0 Multisynth
- Pin compatible with Si5401/02/03 IEEE 1588 PTP network synchronizers
- 72 QFN 10x10 mm
- ClockBuilder™ Pro Configuration Software



Si5361 Simplified Block Diagram—1xDSPLL + 2xMultiSynth



Si5362 Simplified Block Diagram—2xDSPLL + 1xMultiSynth



Si5363 Simplified Block Diagram—3xDSPLL

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1. Feature List

- Generates any output frequency in any format from any input frequency
- Independent XTAL or XO reference inputs eliminates termination resistors
- Ultra-low INTEGER mode jitter performance (DSPLLP+Q):
  - <55 fs RMS typ
- DSPLLA (Si5362/63 only), DSPLLB (Si5363 only)
  - Independent synchronization DSPLLs
  - 100 fs RMS typ
- Programmable loop bandwidth: 20 Hz to 4 kHz
- Hitless input clock switching: automatic or manual with 35 ps typ phase transient
- Four Differential or six Differential/Single-ended clock inputs:
  - Differential: 8 kHz to 1 GHz
  - CMOS: 8 kHz to 250 MHz
- 18 Differential or 36 Single-ended clock outputs:
  - Integer Q dividers: 8 kHz to 2.75 GHz
    - CMOS: 8 kHz to 250 MHz
  - Fractional Divider: 8 kHz to 650 MHz
- User-programmable alarm thresholds
- Highly configurable outputs:
  - Fixed formats LVDS, S-LVDS, LVPECL, LVCMOS, CML, and HCSL
  - User-programmable signal amplitude
- Output-output skew: ±50 ps
- Utilizes fifth-generation DSPLL™ and MultiSynth™ technologies
- Automatic Free-run, Holdover, and Locked modes
- Zero Delay Mode for all PLLs
- Status monitoring (LOS, OOF, PHMON, FLOL and PLOL)
- Core voltage: 3.3 V, 1.8 V
- Output supply pins: 3.3 V, 2.5 V, 1.8 V
- Serial Interface: I^2C or SPI (3 or 4-wire)
- ClockBuilder™ Pro software tool simplifies device configuration
- Package: 72-Lead QFN, 10 x 10 mm
- Extended temperature range:
  - –40 to +95 °C ambient
  - –40 to +105 °C board
- Pb-free, RoHS compliant

2. Ordering Guide

Table 2.1. Device Ordering Part Numbers

Ordering Part Number (OPN)[1]	Number of DSPLLs	Number of Multisynths	Max Output Frequency	Interface	Package
Si5361A-Axxxxx-GM	1	2	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5361B-Axxxxx-GM	1	1	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5361C-Axxxxx-GM	1	0	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5361H-Axxxxx-GM	1	2	2.75 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5361A-A-GM	1	2	1.3 GHz	4-Wire	72-Lead QFN 10 x 10 mm
Si5362A-Axxxxx-GM	2	1	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5362B-Axxxxx-GM	2	0	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5362A-A-GM	2	1	1.3 GHz	4-Wire	72-Lead QFN 10 x 10 mm
Si5363A-Axxxxx-GM	3	0	1.3 GHz	2/3/4-Wire	72-Lead QFN 10 x 10 mm
Si5363A-A-GM	3	0	1.3 GHz	4-Wire	72-Lead QFN 10 x 10 mm

Note:

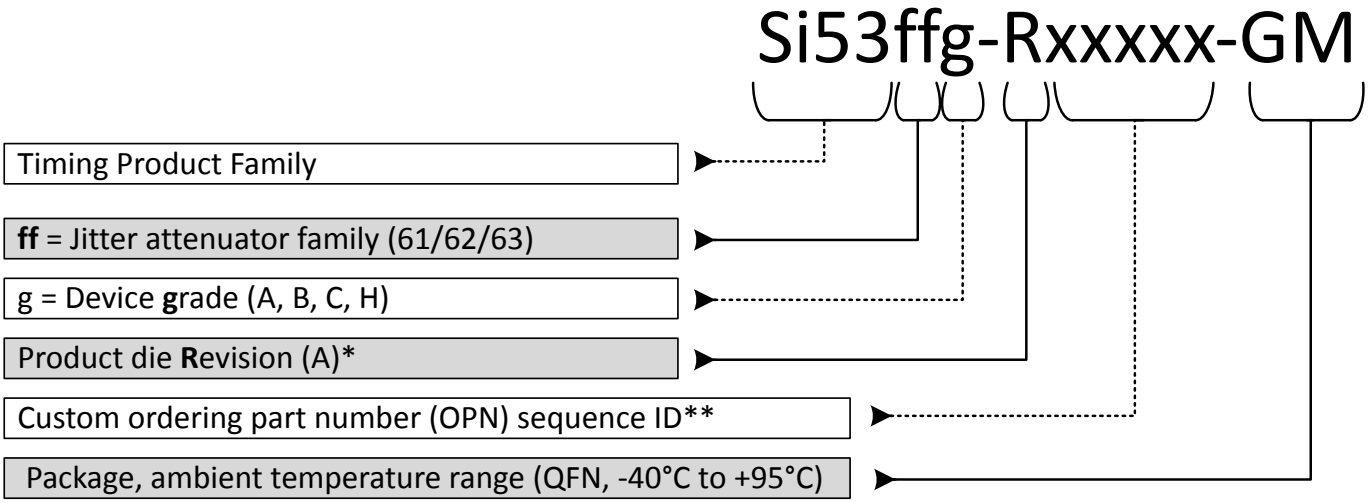
1. The blank part Si536xA-A-GM is preconfigured to be a 4-Wire interface. For Factory programmed plans and blank parts requiring other interface standards like I^2C and 3-Wire, custom part numbers (Axxxxx) are created using CBPro.

Table 2.2. Evaluation Board Ordering Part Numbers

Ordering Part Number (OPN)[1]	Number of DSPLLs	Number of Multisynths	Max Output Frequency	Interface	Package
Si5361-A-EVB	1	2	1.3 GHz	2/3/4-Wire	Si5361 Evaluation Board
Si5362-A-EVB	2	1	1.3 GHz	2/3/4-Wire	Si5362 Evaluation Board
Si5363-A-EVB	3	0	1.3 GHz	2/3/4-Wire	Si5363 Evaluation Board

Note:

1. Factory programmed plans and custom part numbers are created using CBPro software.



*See Ordering Guide table for current product revision.

** 5-digit, assigned by ClockBuilder Pro for all factory-preprogrammed OPN devices.

Figure 2.1. Ordering Guide

3. Electrical Specifications

All minimum and maximum specifications are guaranteed and apply across the recommended operating conditions. Typical values apply at nominal supply voltages and an operating temp of 25 °C unless otherwise noted.

Table 3.1. Absolute Maximum Ratings[1, 2, 3]

Parameter	Symbol	Test Condition	Value	Unit
DC Supply Voltage	V_{DDIN}		–0.5 to 3.8	V
	V_{DDXO}		–0.5 to 3.8	V
	V_{DD18}	<10 s	–0.5 to 2.4	V
	V_{DDA}	<10 s	–0.5 to 3.8	V
	V_{DDO}	<10 s	–0.5 to 3.8	V
	V_{DDIO}	<10 s	–0.5 to 3.8	V
Input Voltage Range	V_{I1}	XO_IN/XO_INb, INx/INxb	–0.85 to 3.8	V
	V_{I2}	GPIO0-3, RSTb, SCLK, SDA/SDIO, A0/CSb	–0.5 to 3.8	V
	V_{I3}	XA/XB	–0.5 to 2.7	V
Latch-up Tolerance	LU		JESD78 Compliant	
ESD Tolerance	HBM	100 pF, 1.5 kΩ	2.0	kV
Storage Range	TSTG		–55 to 150	°C
Maximum Junction Temperature in Operation	T_{JCT}		125	°C
Soldering Temperature (Pb-free profile)[4]	TPEAK		260	°C
Soldering Time at TPEAK (Pb-free profile)[4]	TP		20 to 40	s

Note:

1. Permanent device damage may occur if the absolute maximum ratings are exceeded. Functional operation should be restricted to the conditions as specified in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. RoHS-6 compliant.
3. For more packaging information, go to https://www.skyworksinc.com/Product_Certificate.aspx.
4. The device is compliant with JEDEC J-STD-020.

Table 3.2. Thermal Conditions

Parameter	Symbol	Test Condition	Typical Value		Unit
			JEDEC[1]	CEVB[2]	
Thermal Resistance Junction to Ambient	θ_{JA}	Still Air	16.15	11.17	ºC/W
		1 m/s	10.77	8.10	ºC/W
		2 m/s	9.63	7.53	ºC/W
Thermal Resistance Junction to Board	Ψ_{JB}[3]	Still Air	3.33	3.08	ºC/W
Thermal Resistance Junction to Top Center	Ψ_{JC}	Still Air	0.03	0.05	ºC/W

Note:

1. Based on PCB dimension: 4" x 4.5", PCB thickness: 1.6 mm, Number of Cu Layers: 2.
2. Customer EVB: 8-layer board, board dimensions: ~9x9", all 8-layers are copper poured.
3. Ψ_{JB} can be used to calculate the junction temperature based on the board temperature and power dissipation for a given frequency plan, Tj = T_{PCB} + Ψ_{JB} * P_D. T_{PCB} should be measured as close to the Si5361/2/3 DUT as possible since temperature may vary across the PCB.

Table 3.3. Recommended Operating Conditions

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Ambient Temperature	T_A		–40	25	95	°C
Board Temperature	T_B		–40	65	105	°C
Junction Temperature	TJ_{MAX}[1]		—	—	125	°C
Core Supply Voltage	V_{DD18}		1.71	1.80	1.89	V
	V_{DDA}[2]		3.14	3.30	3.47	V
		Low-Power Mode	1.71	1.80	1.89	V
	V_{DDXO}		3.14	3.30	V_{DDA}[2]	V
		Low-Power Mode	1.71	1.80	1.89	V
Input Supply Voltage	V_{DDIN}		3.14	3.30	V_{DDA}[2]	V
			2.38	2.50	2.62	V
			1.71	1.80	1.89	V
GPIO Supply Voltage	V_{DDIO}		3.14	3.30	V_{DDA}[2]	V
			2.38	2.50	2.62	V
			1.71	1.80	1.89	V
Clock Output Driver Supply Voltage	V_{DDO}		3.14	3.30	V_{DDA}[2]	V
			2.38	2.50	2.62	V
			1.71	1.80	1.89	V

Note:

1. Ambient temperature of 95°C may not be possible with all configurations. This is dependent on device configuration. Tj cannot exceed a max of 125°C.
2. V_{DDA} must be greater than or equal to the highest voltage applied to the device. In Low-Power Mode, all voltage supplies must be set to 1.8 V.

Table 3.4. Performance Characteristics

V_{DD18}= 1.8 V ±5%, V_{DDA}= V_{DDXO} = 3.3 V ±5%; All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C.
Low-Power Mode: V_{DD18}= V_{DDIN}= V_{DDIO}= V_{DDXO}= V_{DDA}= V_{DDO} = 1.8V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Comment	Min	Typ	Max	Units
Initial Start-Up Time	t_{START}	Time from POR to when the device generates free-running clocks from NVM frequency plan	—	25	40	ms
	t_{RDY}	POR to API ready	—	25	30	ms
PLL Lock Time[1]	t_{ACQ}	DSPLLP, IN = 156.25 MHz, BW = 100 Hz FLOL De-assert	—	0.40	0.52	s
		DSPLLP, IN = 156.25 MHz, BW = 100 Hz LOL De-assert	—	1.30	1.60	s
		DSPLLP, IN = 156.25 MHz, BW = 20 Hz FLOL De-assert	—	0.42	0.58	s
		DSPLLP, IN = 156.25MHz, BW = 20 Hz LOL De-assert	—	2.62	2.90	s
		DSPLLA/B, IN = 156.25 MHz, BW = 200 Hz LOL De-assert	—	0.40	0.47	s
		DSPLLA/B, IN = 156.25 MHz, BW = 200 Hz FLOL De-assert	—	0.99	1.20	s
Output Delay Adjustment	t_{QDIV}	Range[2]	$-T_{VCO}$ x 127	—	$+T_{VCO}$ x 127	ps
		Resolution		T_{VCO}	—	ps
		Resolution (fine delay enabled)		$T_{VCO/4}$	—	ps
Jitter Peaking	J_{PK}	All PLLs	—	—	0.1	dB
Maximum Phase Transient During Hitless Switch[3]	t_{SWITCH}		—	35	150	ps
Pull-in Range	ω_P		—	±100	—	ppm
Absolute Input-to-Output Delay + Variation[4, 5]	t_{ZDELAY}	DSPLLP, DSPLLA, DSPLLB (ZDM)	–100	—	100	ps
	$t_{IODELAY}$	DSPLLP (Non ZDM)	–400	—	400	ps
Input-to-Output Delay Variation[6]	$t_{IODELAY\_VAR}$	DSPLLA, DSPLLB (Non ZDM)	–500	—	500	ps

Parameter	Symbol	Comment	Min	Typ	Max	Units
DSPLLP RMS Jitter[7] 12 kHz to 20 MHz	Q Div	625 MHz	—	54	84	fs
		390.625 MHz	—	54	75	fs
		312.5 MHz	—	54	72	fs
		156.25 MHz	—	55	77	fs
		125 MHz	—	60	80	fs
	NA/NB Div	156.25 MHz	—	65	85	fs
		125 MHz	—	83	110	fs
		100 MHz	—	95	155	fs
		25/50 MHz	—	110	255	fs
		322.265625 MHz	—	75	95	fs
		644.53125 MHz	—	65	85	fs
DSPLLA/B RMS Jitter[7] 12 kHz to 20 MHz	NA/NB Div	322.265625 MHz	—	135	205	fs
		156.25 MHz	—	110	140	fs
		155.52 MHz	—	115	150	fs

Note:

1. FLOL de-asserts once frequency lock is achieved. LOL de-asserts once both frequency and phase lock are achieved. Refer to 5.12.2 Lock Acquisition Mode for more details on LOL thresholds.
2. Output delay adjustment range will vary depending on frequency plan. Output delay adjustment range (ns) is displayed in the "Output Skew Control" step of the CBPro Wizard. f_{VCO} range is 10.4 to 13.0 GHz.
3. Phase transient specification only applies to clock switches between two synchronous inputs to a DSPLL configured for a phase buildout clock switching mode in CBPro.
4. Input-to-output (IO) delay is measured at the output driver with respect to the input. $f_{IN} = f_{OUT}$.
5. I/O delay requires clock switching to be configured for Phase Pull-in in CBPro. IO delay is not specified for Phase Buildout (hitless) clock switching mode.
6. Only I/O delay VARIATION is specified for DSPLLA, DSPLLB. Absolute IO delay is dependent on frequency plan.
7. Jitter generation test conditions: XTAL = 54 MHz TXC 7X54070001: f_{VCO} < 11 GHz: f_{OUT} LVDS, DSPLLP BW = 40 Hz.

Table 3.5. DC Characteristics

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Core Supply Current (V_{DD18} + V_{DDA})	I_{DD18}	Si5361[1]	—	395	635	mA
		Si5362[1]		420	660	mA
		Si5363[1]	—	430	670	mA
		Si5361 Low-Power Mode[2]	—	395	620	mA
		Si5362 Low-Power Mode[2]	—	400	625	mA
		Si5363 Low-Power Mode[2]	—	405	640	mA
	I_{DDA}	Si5361[1]	—	200	225	mA
		Si5362[1]	—	200	225	mA
		Si5363[1]	—	200	225	mA
		Si5361 Low-Power Mode[2]	—	195	220	mA
		Si5362 Low-Power Mode[2]	—	195	220	mA
		Si5363 Low-Power Mode[2]	—	195	220	mA
	I_{DD18_PD}	RSTb = 0	—	120	300	mA
	I_{DDA_PD}	RSTb = 0	—	15	16	mA
Peripheral Supply Current (V_{DDIN} + V_{DDIO} + V_{DDXO})	I_{DDIN} + I_{DDIO}	Si5361[1]	—	45	60	mA
		Si5362[1]	—	52	67	mA
		Si5363[1]	—	60	77	mA
		Si5361 Low-Power Mode[2]	—	42	53	mA
		Si5362 Low-Power Mode[2]	—	51	63	mA
		Si5363 Low-Power Mode[2]	—	60	73	mA
	I_{DDXO}	Si5361[1]	—	12	14	mA
		Si5362[1]	—	11	14	mA
		Si5363[1]	—	11	14	mA
		Si5361 Low-Power Mode[2]	—	7	13	mA
		Si5362 Low-Power Mode[2]	—	7	13	mA
		Si5363 Low-Power Mode[2]	—	7	13	mA
	I_{DDIN_PD} + I_{DDIO_PD} + I_{DDXO_PD}	RSTb = 0	—	1	4	mA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output Buffer Supply Current (V_{DDOX})	I_{DDOX} (per output)	LVPECL (2.5 V, 3.3 V) @ 156.25 MHz[3]	—	24	26	mA
		LVDS (2.5 V, 3.3 V) @ 156.25 MHz[3]	—	13	15	mA
		S-LVDS (1.8 V) @ 156.25 MHz[3]	—	12	14	mA
		CML (1.8 V, 2.5 V, 3.3 V) @ 156.25 MHz[3]	—	14	17	mA
		3.3 V LVCMOS @ 156.25 MHz[4]	—	19	22	mA
		2.5 V LVCMOS @ 156.25 MHz[4]	—	15	17	mA
		1.8 V LVCMOS @ 156.25 MHz[4]	—	11	12	mA
		HCSL internal termination (1.8 V, 2.5 V, 3.3 V) @ 156.25 MHz[5]	—	20	23	mA
	I_{DDOX_PD}	RSTb = 0	—	0.23	0.3	mA
Total Power Dissipation	P_D	Si5361[1]	—	1.9	2.8	W
		Si5362[1]	—	2	2.9	W
		Si5363[1]	—	2	2.9	W
		Si5361 Low-Power Mode[2]	—	1.4	2	W
		Si5362 Low-Power Mode[2]	—	1.4	2	W
		Si5363 Low-Power Mode[2]	—	1.4	2	W
Supply Voltage Ramp Rate	T_{VDD}	Fastest V_{DD} ramp rate allowed on startup	—	—	100	V/ms

Note:

1. Typical test configuration: The following frequencies on 12 LVDS outputs: 4–156.25 MHz (Q), 2–312.5 MHz (Q), 1–125 MHz (Q), 1–100 MHz (NB), 1–50 MHz (NB), 2–644. 53125MHz (NA), 1–322.265625 MHz (NA). Excludes power in termination resistors. VDDIN = 1.8 V; VDDO = 3.3 V.
2. Typical test configuration: Same as Note 1, except all supplies set to 1.8 V for Low-Power Mode. Output formats changed to S-LVDS format.
3. Differential outputs terminated into an ac-coupled differential 100 Ω load.
4. LVCMOS outputs measured into a 5-inch, 50 Ω PCB trace with 5 pF load.
5. No external termination; amplitude 800 mVpp_se.

Table 3.6. Input Specifications

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
LVCMOS (XO Applied to XO_IN)						
Input Frequency Range	f_{IN_CMOS}		30.72	—	250	MHz
Slew Rate[1, 2, 3]	SR		0.75	—	—	V/ns
Input Voltage	V_{IL}		—	—	V_{DDXO} x 0.3	V
	V_{IH}		V_{DDXO} x 0.7	—	—	V
Input Resistance	R_{IN}		—	63	—	kΩ
Duty Cycle	DC		40	—	60	%
Capacitance	C_{IN_SE}		—	1.25	—	pF
Differential (XO Applied to XO_IN)						
Input Frequency Range	f_{IN_DIFF}		30.72	—	250	MHz
Voltage Swing[2]	V_{IN_DIFF}		200	350 (LVDS) 800 (LVPECL)	1800	mVpp_se
Slew Rate[1, 2, 3]	SR		0.75	—	—	V/ns
Duty Cycle	DC		40	—	60	%
Capacitance	C_{IN_DIFF}		—	2.5	—	pF
Crystal (Connected to XA/XB Pins)[4]						
Frequency Range	f_{IN_XTAL}		48	—	61.44	MHz
Load Capacitance	C_L		—	8	—	pF
Crystal Drive Level	d_L		—	—	200	µW
Equivalent Series Resistance	R_{ESR}		Refer to the "Si55xx, Si540x, and Si536x Recommended XTAL, XO, VCXO, TCXO, and OCXO Reference Manual" to determine ESR and Shunt Capacitance Values.			
Shunt Capacitance	C0					
Differential (INx/INxb)						
Input Frequency Range	f_{IN_DIFF}	Differential, AC coupled	0.008	—	1000	MHz
	f_{IN_SE}	Single-ended, AC coupled	0.008	—	250	MHz
Voltage Swing	V_{IN_DIFF}	Differential, AC coupled	200	350 (LVDS) 800 (LVPECL)	1800	mVpp_se
	V_{IN_SE}	Single-ended, AC coupled	400	1600	1800	mVpp_se
Slew Rate[3, 5]	SR		0.4	—	—	V/ns
Duty Cycle	DC		40	—	60	%
Capacitance	C_{IN_DIFF}		—	2.5	—	pF

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
LVCMOS (INx/INxb)						
Input Frequency Range	f_{IN_LVCMOS}		0.008	—	250	MHz
Slew Rate[3, 5]	SR		0.2	0.4	—	V/ns
Input Voltage	V_{IL}		—	—	V_{DDIN} x 0.3	V
	V_{IH}		V_{DDIN} x 0.7	—	—	V
Input Resistance	R_{IN}		—	63	—	kΩ
Duty Cycle	DC		40	—	60	%
Capacitance	C_{IN_SE}		—	1.25	—	pF
Other Control Input Pins - RSTb, FINC, FDEC, OE, PLLx_FORCE_HO, PLLx_INSEL[#], IN_FAIL[#]						
Update Rate	f_{UR}	RSTb[6]	—	—	1	Hz
		FINC, FDEC	—	—	800	kHz
Input Voltage	V_{IL}		—	—	V_{DDIO} x 0.3	V
	V_{IH}		V_{DDIO} x 0.7	—	—	V
Minimum Pulse Width	PW		150	—	—	ns
Programmable Internal Pullup, Pulldown	R_{IN}		—	20	—	kΩ

Note:

1. The minimum slew rate on the XO applied to XO_IN is recommended to meet the specified jitter performance.
2. To achieve this slew rate and voltage swing use one of the XOs from the "Si55xx, Si540x, and Si536x Recommended XTAL, XO, VCXO, TCXO, and OCXO Reference Manual" placed as close as possible to the XO_IN pins.
3. Slew rate can be estimated using the following simplified equation: SR = ((0.8 – 0.2) x $V_{IN\_VPP\_se}$)/t_r.
4. To meet specified jitter performance use one of the XTALs from the "Si55xx, Si540x, and Si536x Recommended XTAL, XO, VCXO, TCXO, and OCXO Reference Manual".
5. The minimum slew rate on the input clock applied to INx/INxb is recommended to meet the specified input-to-output delay performance.
6. Glitches and toggles on RSTb more frequent than f_{UR} may cause the device to lock up in reset. Power cycle the device to restore operation.

Table 3.7. Differential Clock Output Specifications

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable= 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C.
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C.

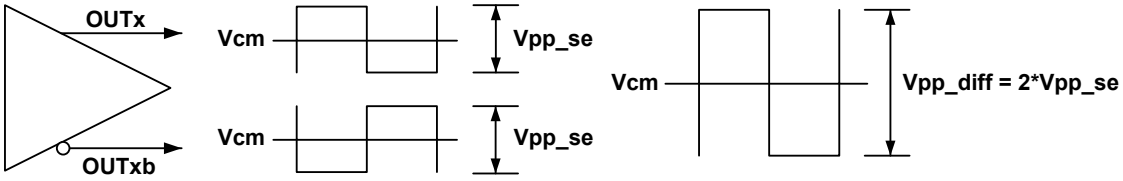
ParameterX	Symbol	Test Condition		Min	Typ	Max	Units
Output Frequency	f_{OUT}	Q Divider[1] (Grade A/B/C)		0.008	—	1300	MHz
		Q Divider[1] (Grade H)		0.008	—	2750	MHz
		NA Divider, NB Divider[2]		0.008	—	650	MHz
Duty Cycle	DC	f < 400 MHz		49.5	50.0	50.5	%
		400 MHz < f < 2.75 GHz		48.0	50.0	52.0	%
Output-to-Output Skew	T_{SK}	Q divider outputs, same differential format		–50	—	50	ps
		Multisynth (NA or NB) outputs, same differential format, same Multisynth					
OUT-OUTb Skew[3]	T_{SK_OUT}	VDDO = 3.3 V	LVPECL, LVDS, CML, HCSL Fast, and custom diff 10 MHz < f < 500 MHz	—	—	10	ps
		VDDO = 2.5 V	LVPECL, LVDS, CML, HCSL Fast, and custom diff 10 MHz < f < 500 MHz	—	—	25	ps
		VDDO = 3.3 V/2.5 V	LVPECL, LVDS, CML, and custom diff > 500 MHz	—	—	25	ps
		VDDO = 1.8 V	CML, S-LVDS, and custom diff All frequencies	—	—	35	ps
		VDDO = 1.8 V	HCSL Fast	—	—	45	ps
Output Voltage Swing[4]	V_{OUT}	VDDO = 3.3 V/2.5 V	LVDS	330xSF	360xSF	380xSF	mVpp_se
		VDDO = 1.8 V	S-LVDS	350xSF	370xSF	410xSF	mVpp_se
		VDDO = 3.3 V/2.5 V	AC-Coupled LVPECL	780xSF	840xSF	910xSF	mVpp_se
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL 800 mVpp_se[5]	510xSF	800xSF	1000xSF	mVpp_se
		VDDO = 3.3 V/2.5 V	HCSL 1200 mVpp_se[5]	1000xSF	1120xSF	1260xSF	mVpp_se
		VDDO = 3.3 V/2.5 V/ 1.8 V	CML	390xSF	420xSF	460xSF	mVpp_se
		VDDO = 3.3 V/2.5 V	Custom Diff 600 mVpp_se	560xSF	610xSF	650xSF	mVpp_se
Output Voltage Swing Scaling Factor (SF) OUT0-15	SF	f < 500 MHz		1.00	1.00	1.00	SF
		500 MHz < f < 1 GHz		0.90	0.95	1.00	SF
		1 GHz < f < 1.5 GHz		0.80	0.90	1.00	SF
		1.5 GHz < f < 2.5 GHz		0.70	0.75	0.85	SF
		f > 2.5 GHz		0.50	0.60	0.75	SF

ParameterX	Symbol	Test Condition		Min	Typ	Max	Units
Output Voltage Swing Scaling Factor (SF) OUT16-17[6]	SF	f < 500 MHz		1.00	1.00	1.00	SF
		500 MHz < f < 1 GHz		0.85	0.95	1.00	SF
		1 GHz < f < 1.5 GHz		0.8	0.9	0.95	SF
		1.5 GHz < f < 2.5 GHz		0.55	0.65	0.75	SF
		f > 2.5 GHz		0.4	0.5	0.6	SF
Common Mode Voltage	V_{CM}	VDDO = 3.3 V/2.5 V	LVDS, Custom Differential, CML, AC-Coupled LVPECL	1.15	1.20	1.25	V
		VDDO = 1.8 V	S-LVDS, CML	0.85	0.90	0.95	V
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL 800 mVpp_se	0.35	0.45	0.52	V
		VDDO = 3.3 V/2.5 V	HCSL 1200 mVpp_se	0.55	0.60	0.68	V
Rise and Fall Times (20% to 80%) OUT0–15	t_r/t_f	VDDO = 3.3 V/2.5 V	LVDS, AC-Coupled LVPECL, Custom Diff	—	125	260	ps
		VDDO = 1.8 V	S-LVDS	—	150	270	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL Fast Slew Rate, 800 mV/1200 mV ext term	—	270	360	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL Standard Slew Rate, 800 mV ext term	—	450	700	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL Standard Slew Rate, 800 mV int term	—	270	420	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	CML	—	150	280	ps
Rise and Fall Times (20% to 80%) OUT16–17	t_r/t_f	VDDO = 3.3 V/2.5 V	LVDS, AC-Coupled LVPECL, Custom Diff	—	140	300	ps
		VDDO = 1.8 V	S-LVDS	—	165	310	ps
		VDDO = 3.3 V/2.5 V	HCSL Fast Slew Rate, 800 mV/1200 mV ext term	—	285	400	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL Standard Slew Rate, 800 mV, ext term	—	465	740	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	HCSL Standard Slew Rate, 800 mV, int term	—	285	460	ps
		VDDO = 3.3 V/2.5 V/ 1.8 V	CML	—	165	320	ps
Differential Output Impedance	Z_O	Differential formats		—	100	—	Ω
		HCSL Fast Slew Rate		—	200	—	Ω
		HCSL Standard Slew Rate, External Termination		—	Hi-Z	—	Ω
Power Supply Noise Rejection[7]	PSR	25 kHz sinusoidal noise		—	–94	—	dBc
		100 kHz sinusoidal noise		—	–95	—	dBc
		500 kHz sinusoidal noise		—	–91	—	dBc
		1 MHz sinusoidal noise		—	–91	—	dBc
Output-to-Output Crosstalk[8]	$XTALK_{OUT}$	Differential outputs, same format		—	–95	—	dBc

ParameterX	Symbol	Test Condition	Min	Typ	Max	Units
Input-to-Output Crosstalk[9]	$XTALK_{IN}$	Differential input and output, same format	—	–90	—	dBc

Note:

1. Q dividers support output frequencies within the specified range equal to f_{VCO}/Q where Q is an integer.
2. NA, NB Multisynths support any output frequency within the specified range.
3. Skew between positive and negative output pins.
4. Output voltage swing is dependent on frequency range. Scale all values by the Output Voltage Swing Scaling Factor (SF). Voltage swing is specified in mVpp_SE as shown below.



5. HCSL output format is not supported for f_{OUT} > 400 MHz.
6. OUT16/17 have programmable slew rate limit capability when configured as SRL LVCMOS. This causes additional attenuation for higher frequency outputs. The Output Voltage Swing Scaling Factor (SF) for OUT16/OUT17 is shown below. It is recommended to use OUT0-15 for f_{OUT} > 500 MHz.
7. Measured for a 156.25 MHz differential output frequency. 100 mVpp sinewave noise added to VDDO = 3.3 V and noise spur amplitude measured.
8. Crosstalk spur measured with the victim running at 156.25 MHz and the aggressor at 155.52 MHz. Victim and aggressor are separated by two unused channels.
9. Crosstalk spur measured with the victim running at 156.25 MHz on OUT0 and the aggressor at 155.52 MHz on IN3.

Table 3.8. LVCMOS Clock Output Specifications

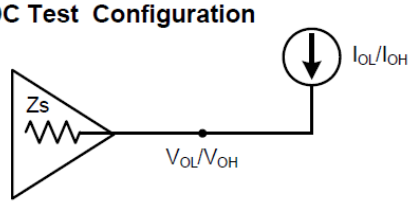
V_{DD18} = 1.8V ±5%, V_{DDA} = V_{DDXO} = 3.3V ±5%, All other supplies programmable= 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Output Frequency	f_{OUT}	Q Divider[1]	0.008	—	250	MHz
		NA or NB Divider[2]	0.008	—	250	MHz
Duty Cycle	DC	f < 100 MHz	49.5	—	50.5	%
		100 MHz < f < 250 MHz	45	—	55	%
Output Voltage High[3]	V_{OH}	VDDO = 3.3 V/2.5 V/1.8 V I_{OH}= –8/–6/–4 mA, I_{OL} = 8/6/4 mA	V_{DDO}x0.85	—	—	V
Output Voltage Low[3]	V_{OL}		—	—	V_{DDO}x0.15	V
Rise and Fall Times (20% to 80%)[4, 5]	t_r/t_f	LVCMOS	0.35	0.8	1.35	ns
		SRL LVCMOS "4 ns rise/fall"	3	4	6	ns
		SRL LVCMOS "6.5 ns rise/fall"	4	6.5	10	ns
		SRL LVCMOS "13 ns rise/fall"	7	13	24	ns
		SRL LVCMOS "25 ns rise/fall"	13	25	42	ns

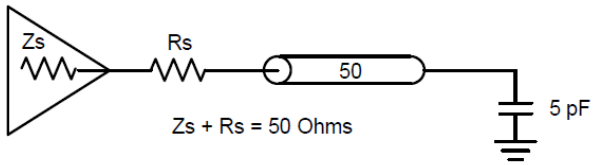
Note:

1. Q dividers support output frequencies within the specified range equal to f_{VCO}/Q where Q is an integer.
2. NA, NB Multisynths support any output frequency within the specified range.
3. V_{OL} /V_{OH} is measured at I_{OL} /I_{OH} as shown in the DC Test Configuration.
4. A 15–25Ω series termination resistor (Rs) is recommended to help match the source impedance to a 50 Ω PCB trace. A 5 pF capacitive load is assumed as shown in the AC Test Configuration.

DC Test Configuration



AC Test Configuration



5. Slew rate limited (SRL) LVCMOS format only available on OUT16/OUT17.

Table 3.9. Output Status Pin Specifications

V_{DDIO}= 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A= –40 to 95 °C.
Low-Power Mode: VDDIO = 1.8 V ±5%.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Status Output Pins (GPIO, SDA)						
Output Voltage High[1]	V_{OH}	I_{OH} = –2 mA	V_{DDIO}x0.85	—	—	V
Output Voltage Low	V_{OL}	I_{OL} = 2 mA	—	—	V_{DDIO}x0.15	V

Note:

1. The V_{OH} specification does not apply to the open-drain SDA output when the serial interface is in I^2C mode. V_{OL} remains valid in all cases.

Table 3.10. I²C Timing Specifications (SCL, SDA)

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%; All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A= –40 to 95 °C.
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C.

Parameter	Symbol	Test Condition	Standard Mode 100 kbps		Fast Mode 400 kbps		Unit
			Min	Max	Min	Max	
SCL Clock Frequency	f_{SCL}		—	100	—	400	kHz
SMBus Timeout	—		25	35	25	35	ms
Hold time (Repeated) START condition	$t_{HD:STA}$		4.0	—	0.6	—	µs
Low Period of the SCL Clock	t_{LOW}		4.7	—	1.3	—	µs
HIGH Period of the SCL Clock	t_{HIGH}		4.0	—	0.6	—	µs
Setup Time for a Repeated START Condition	$t_{SU:STA}$		4.7	—	0.6	—	µs
Data Hold Time	$t_{HD:DAT}$		100	—	100	—	ns
Data Setup Time	$t_{SU:DAT}$		250	—	100	—	ns
Rise Time of both SDA and SCL Signals	t_r		—	1000	20	300	ns
Fall Time of both SDA and SCL Signals	t_f		—	300	—	300	ns
Setup Time for STOP Condition	$t_{SU:STO}$		4.0	—	0.6	—	µs
Bus Free Time between a STOP and STARTCondition	t_{BUF}		4.7	—	1.3	—	µs
Data Valid Time	$t_{VD:DAT}$		—	3.45	—	0.9	µs
Data Valid Acknowledge Time	$t_{VD:ACK}$		—	3.45	—	0.9	µs

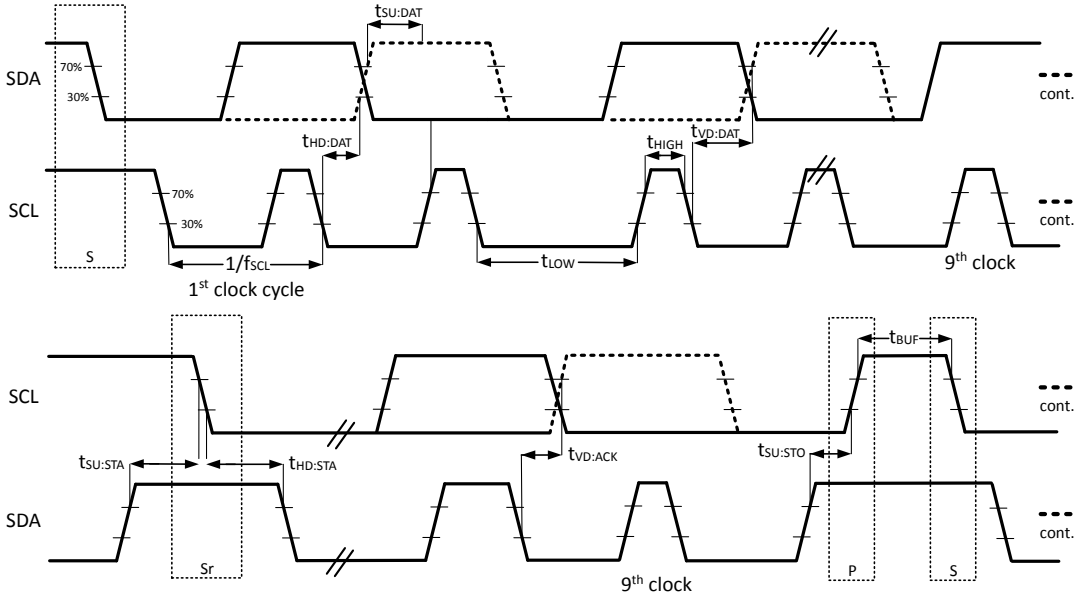


Figure 3.1. I²C Serial Port Timing Standard and Fast Modes

Table 3.11. SPI Timing Specifications (4-Wire)

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Min	Typ	Max	Unit
SCLK Frequency	f_{SPI}	—	—	30	MHz
SCLK Duty Cycle	T_{DC}	40	—	60	%
SCLK Period	T_C	33.333	—	—	ns
Delay Time, SCLK Fall to SDO Active	T_{D1}	—	12.5	20	ns
Delay Time, SCLK Fall to SDO	T_{D2}	—	10	15	ns
Delay Time, CSb Rise to SDO Tri-State	T_{D3}	—	10	20	ns
Setup Time, CSb to SCLK	T_{SU1}	5	—	—	ns
Hold Time, SCLK Fall to CSb	T_{H1}	5	—	—	ns
Setup Time, SDI to SCLK Rise	T_{SU2}	5	—	—	ns
Hold Time, SDI to SCLK Rise	T_{H2}	5	—	—	ns
Delay Time Between Chip Selects (CSb)	T_{CS}	5	—	—	µs

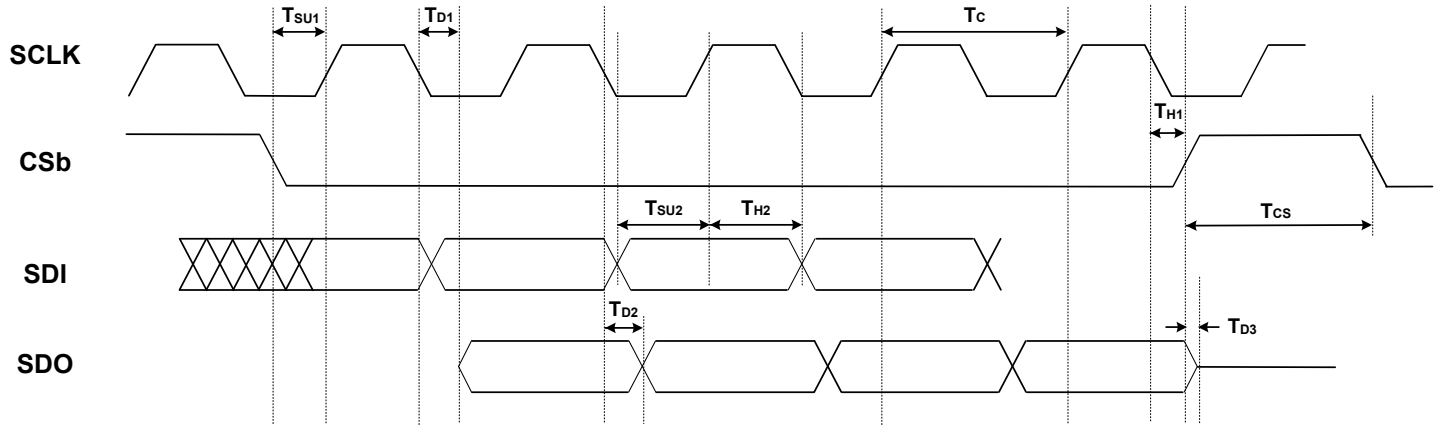


Figure 3.2. 4-Wire SPI Serial Interface Timing

Table 3.12. SPI Timing Specifications (3-Wire)

V_{DD18} = 1.8 V ±5%, V_{DDXO} = V_{DDA} = 3.3 V ±5%, All other supplies programmable 3.3 V ±5%, 2.5 V ±5%, 1.8 V ±5%, T_A = –40 to 95 °C
Low Power Mode: V_{DD18} = V_{DDIN} = V_{DDIO} = V_{DDXO} = V_{DDA} = V_{DDO} = 1.8 V ±5%, T_A = –40 to 95 °C

Parameter	Symbol	Min	Typ	Max	Unit
SCLK Frequency	f_{SPI}	—	—	30	MHz
SCLK Duty Cycle	T_{DC}	40	—	60	%
SCLK Period	T_C	33.33	—	—	ns
Delay Time, SCLK Fall to SDIO Turn-on	T_{D1}	—	12.5	20	ns
Delay Time, SCLK Fall to SDIO Next-bit	T_{D2}	—	10	15	ns
Delay Time, CSb Rise to SDIO Tri-State	T_{D3}	—	10	20	ns
Setup Time, CSb to SCLK	T_{SU1}	5	—	—	ns
Hold Time, CSb to SCLK Fall	T_{H1}	5	—	—	ns
Setup Time, SDI to SCLK Rise	T_{SU2}	5	—	—	ns
Hold Time, SDI to SCLK Rise	T_{H2}	5	—	—	ns
Delay Time Between Chip Selects (CSb)	T_{CS}	5	—	—	µs

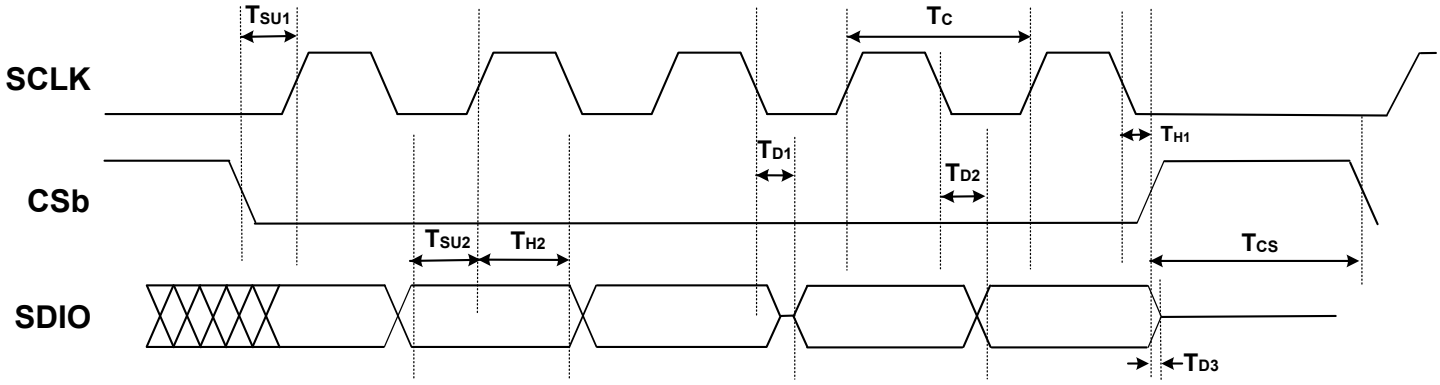


Figure 3.3. 3-Wire SPI Serial Interface Timing

4. Typical Operating Characteristics

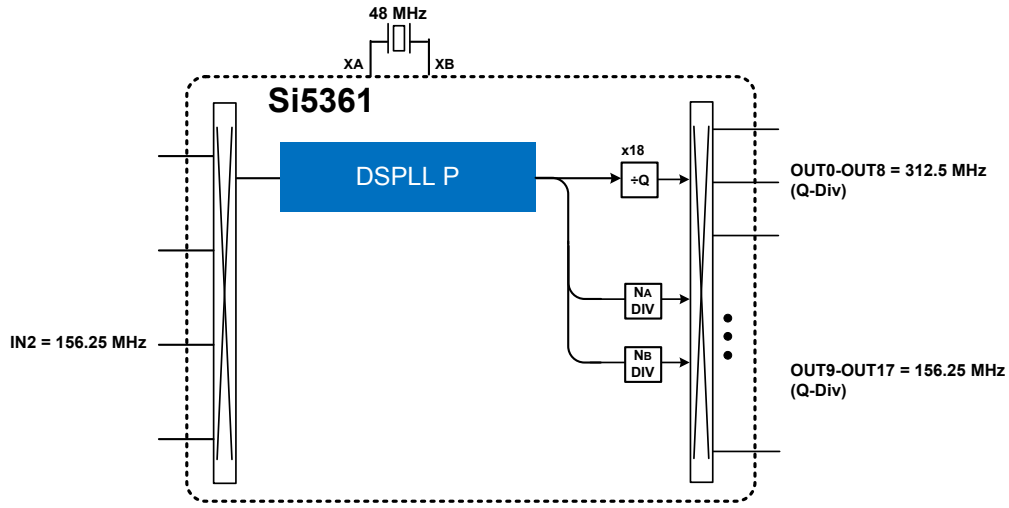


Figure 4.1. Si5361 Typical Operating Circuit

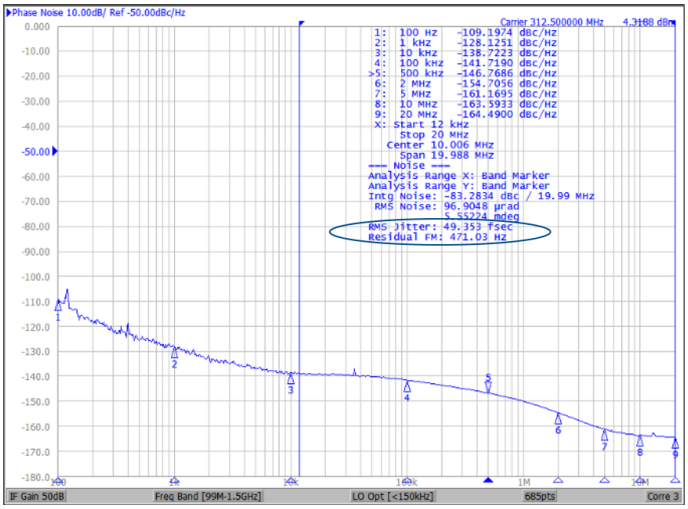


Figure 4.2. 49 fs RMS Jitter for SyncE 312.5 MHz

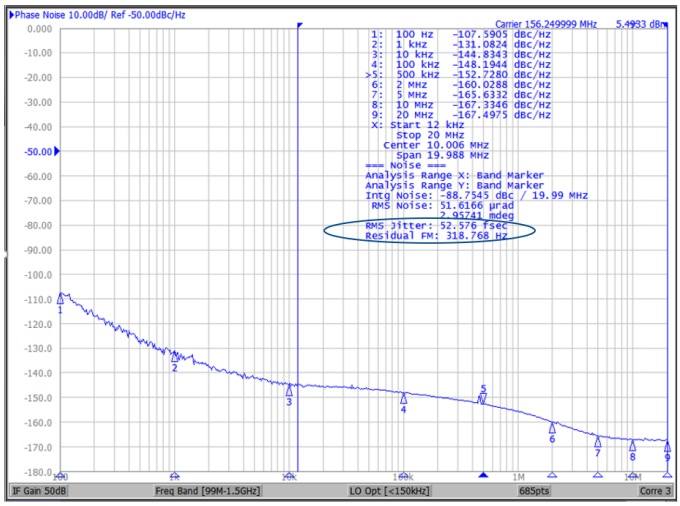


Figure 4.3. 52 fs RMS Jitter for SyncE 156.25 MHz

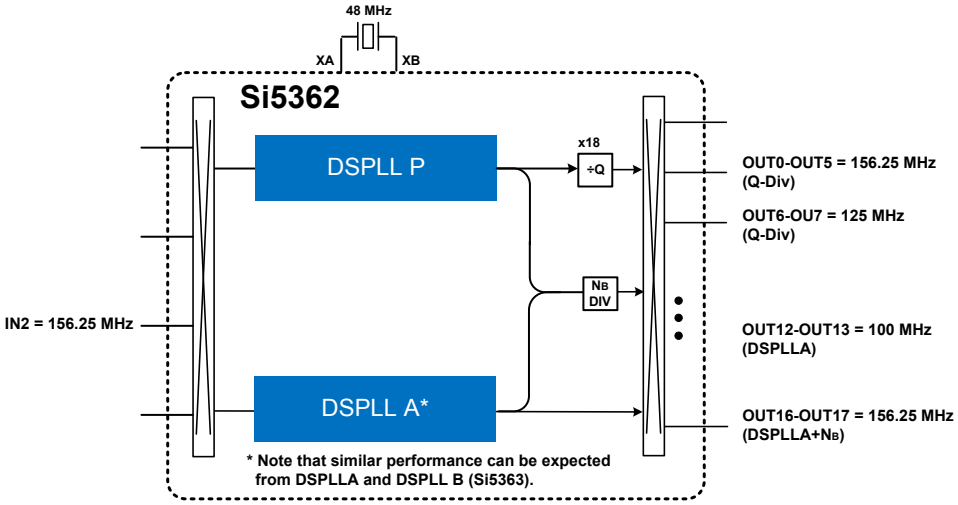


Figure 4.4. Si5362 Typical Operating Circuit

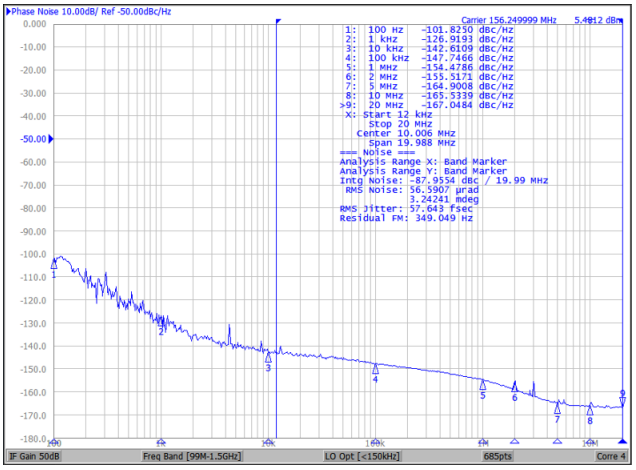


Figure 4.5. 57 fs Jitter for 156.25 MHz LVPECL; Path=DSPLLP+Qdiv

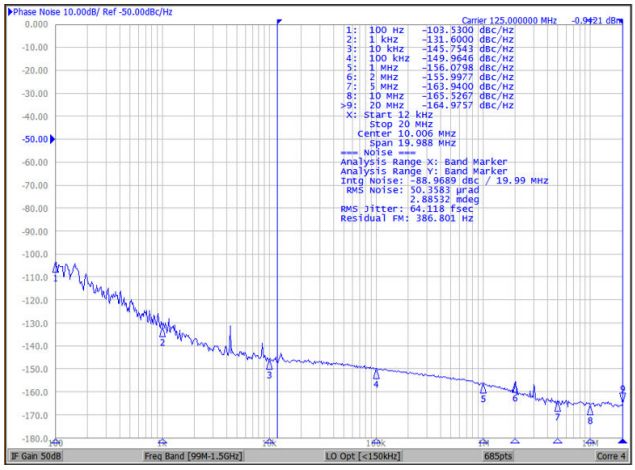


Figure 4.6. 64 fs Jitter for 125 MHz LVDS; Path=DSPLLP+Qdiv

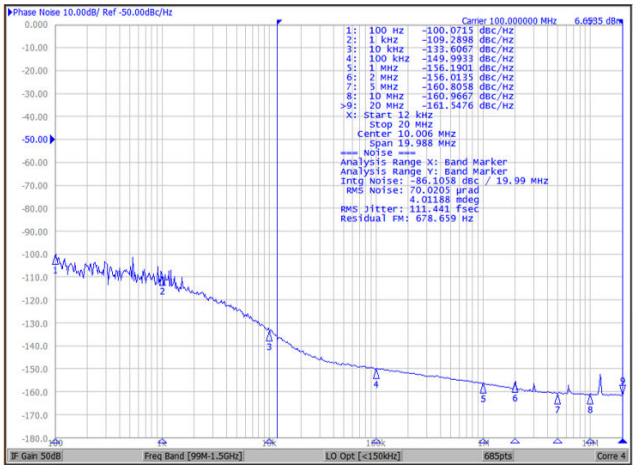


Figure 4.7. 111 fs Jitter 100 MHz LVPECL; Path=DSPLLA

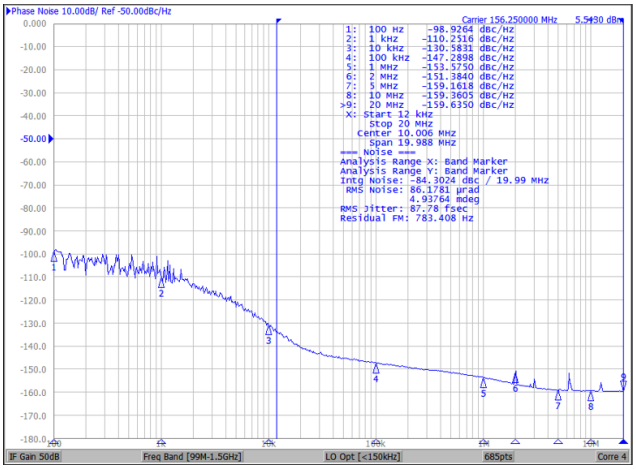


Figure 4.8. 87 fs Jitter for 156.25 MHz LVPECL; Path=DSPLLA+NB

5. Functional Description

The Si5361/62/63's fifth-generation DSPLLs provides jitter attenuation and any-frequency multiplication of the selected input frequency. Fractional input dividers (P) allow the DSPLL to perform hitless switching between input clocks (INx) that are fractionally related. Input switching is controlled manually or automatically using an internal state machine. The oscillator circuit (OSC) provides a frequency reference which determines output frequency stability and accuracy while the device is in free-run or holdover mode. The high-performance MultiSynth dividers (N) generate integer or fractionally related output frequencies for the output stage. A crosspoint switch connects any of the MultiSynth generated frequencies to any of the outputs. Additional integer division (R) determines the final output frequency.

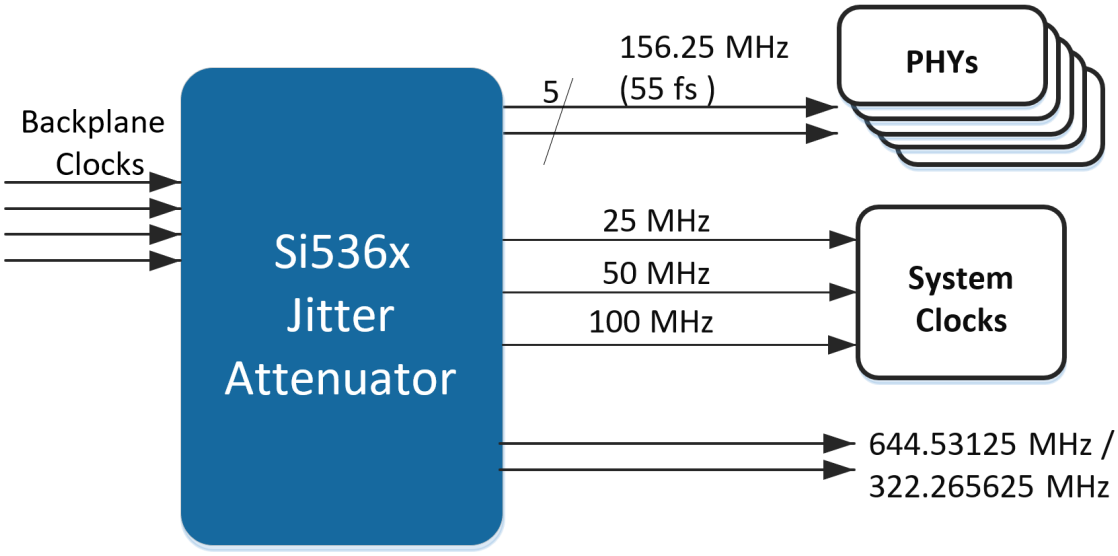


Figure 5.1. Si536x Typical 56G/112G SerDes Application (Up to 3 Domains)

5.1 Frequency Configuration

The frequency configuration of the DSPLL(s) is programmable through the serial interface and can also be stored in non-volatile memory. The combination of input dividers (P), fractional frequency multiplication (M), integer output division (Q), fractional output division (N), and integer output division (R) allows the generation of virtually any output frequency on any of the outputs. All divider values for a specific frequency plan are easily determined using the CBPro utility.

5.2 DSPLL Loop Bandwidth Initial Lock and Fast Lock Settings

The DSPLL loop bandwidth determines the amount of input clock jitter attenuation. Each DSPLL has a configurable loop bandwidth. The DSPLL will always remain stable with low peaking regardless of the loop bandwidth selection.

Each of the DSPLLs, have configurable loop bandwidths. There are three configurations, each has a separate setting for the loop bandwidth:

- **Initial Lock Bandwidth**—The PLL uses this bandwidth when it exits the free-run mode and attempts to lock to a new input clock.
- **Loop Bandwidth**—This sets the bandwidth of the PLL once lock to an input is achieved.
- **Fastlock Bandwidth**—This sets the bandwidth of the PLL when exiting from holdover.

Selecting a low DSPLL loop bandwidth will generally lengthen the lock acquisition time. The fastlock feature allows setting a temporary Fastlock Loop Bandwidth that is used during the lock acquisition process. The DSPLL will revert to its normal loop bandwidth once lock acquisition has completed.

See the Reference Manual and CBPro™ for more information, recommendations, and limits for setting PLL loop bandwidths for different configurations.

5.3 Inputs

There are four differential inputs that can also be configured as single-ended CMOS inputs. Both IN0 and IN1 can support a single CMOS input, while IN2 and IN3 can be configured as dual CMOS inputs. This allows support for up to six CMOS inputs, or any combination of differential and CMOS inputs.

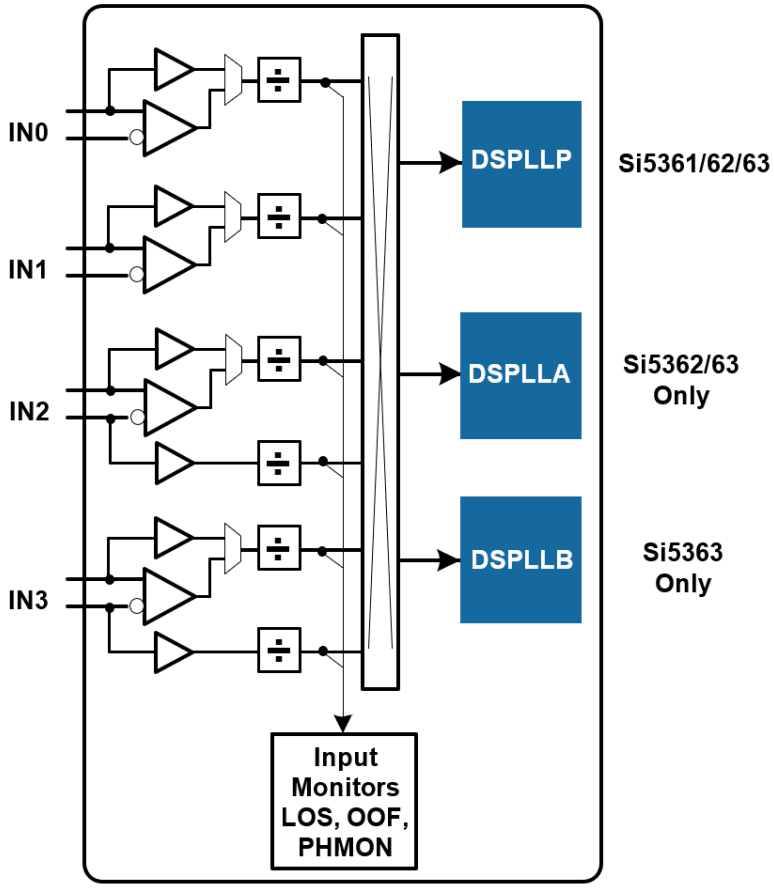


Figure 5.2. Input Structure

5.3.1 Input Terminations

Refer to "AN1357: Si5360/61/62/63 Schematic Design and Board Layout Guidelines" and the "Si5361/62/63 Reference Manual" for guidance on input terminations.

5.3.2 Input Selection

Input selection for any of the PLLs can be controlled manually through pin control, API command, or automatically using an internal state machine.

5.3.2.1 Input Divider

The device utilizes multiple classes of both fractional and integer frequency dividers. The CBPro software will choose the optimal divide values based on the user defined frequency plan. Refer to the "Si5361/62/63 Reference Manual" for guidance on input dividers.

5.3.2.2 Manual Input Selection

In Manual mode, the input selection is made by defining a GPIO pin as an input select pin and changing the input pin voltage level, or by writing an API command. Any of the inputs are available to any of the PLLs through a crosspoint input selection switch. If there is no clock signal on the selected input, or if the input is not valid due to LOS/OOF/PHMON input alarms, the PLL will automatically enter Free-Run/Holdover mode. This applies to all the DSPLLs.

5.3.2.3 Phase Readout PHRD

The Phase Readout Device API can be used to read and measure the phase between multiple input clocks to the Si536x. Unused inputs that are not assigned to a DSPLL can also be configured as phase readout (PHRD) or phase readout feedback (PHRD_FB) inputs. These inputs can be used to measure the phase of an output of the Si536x to the input(s) of known phase. PHRD and PHRD_FB inputs use the same alarms (LOS/OOF/PHMON) as the other clock inputs, but they are not assigned to a DSPLL.

5.3.2.4 Automatic Input Selection

When configured in this mode, each of the PLLs automatically selects a valid input that has the highest configured priority. The priority scheme is independently configurable for each PLL and supports revertive or non-revertive selection. All inputs are continuously monitored for loss of signal (LOS), invalid frequency range (OOF), and phase (PHMON). Only valid inputs that have no LOS, OOF or phase monitor (PHMON) alarms can be selected for synchronization by the automatic state machine. The PLL(s) will enter Free-Run or Holdover mode if there are no valid inputs available.

5.3.3 Unused Inputs

Unused inputs should be configured as “Unused (Powered Down)”, and the pins may be left unconnected or ac-coupled to ground. Refer to "AN1357: Si5360/61/62/63 Schematic Design and Board Layout Guidelines" and the "Si5361/62/63 Reference Manual" for recommendations on how to minimize system noise on any CMOS input or any differential input configured as “Enabled” but not actively being driven by a clock.

5.4 Input Clock Switching

Clock inputs to the Si536x can be either from the same source (0 ppm, same nominal frequency) or different sources (non-0ppm different nominal frequency). The Si536x automatically determines the optimal switching mode depending on the nominal frequency difference between the clocks at the time of the switch.

When switching between 0 ppm inputs, the Si536x performs either a:

- Hitless Switch with phase buildout (PBO) or a
- Phase Pull-in (PPI) switch depending on the setting in CBPro

When switching between non-0 ppm offset, the Si536x performs a frequeny-ramped Input switch with user-programmable frequency ramp rate.

Refer to the Si536x Reference Manual for additional guidance on input clock switching modes. All input clock switches are glitchless meaning there will be no runt pulses generated at the output during the transition.

5.4.1 Hitless Input Switching for 0 ppm clocks Phase Buildout PBO

SyncE applications require that transients are kept to a minimum when switching between inputs. Hitless switching with phase buildout (PBO) is a feature that prevents a phase offset from propagating to the output when switching between two clock inputs that have a fixed phase relationship. A hitless switch can only occur when the two input frequencies are frequency locked, meaning that the nominal frequencies are the same (0 ppm). Due to the nature of hitless switching, the input-to-output delay of the PLL is not preserved. The DSPLL simply absorbs the phase difference between the two input clocks during an input switch. The phase buildout feature supports clock frequencies down to a minimum input frequency of 8 kHz.

5.4.2 Phase Pull-In (PPI) Input Switching for 0 ppm clocks

In some applications, the output phase must track the input phase with minimal delay. When the application requires the input-to-output delay to be preserved after clock switching, the phase pull-in clock switching mode should be selected. In this mode, the output phase will be pulled in at a user-programmable ramp rate referred to as the PPI slope (ns/s). With phase pull-in switching, the output phase always aligns with the newly selected input. PPI is always enabled for zero-delay mode applications.

5.4.3 Ramped Input Switching for non-0 ppm clocks

The ramped switching feature allows the DSPLLs to switch between two input clock frequencies that are non-0ppm without an abrupt frequency transient at the output. When the two input clock frequencies are not the same nominal frequency, the DSPLL will pull in the frequency difference between inputs at the ramp rate that is programmable in CBPro from ppb/s to ppm/s. The Loss-of-Lock (LOL) and LOOP_FILTER_RAMP_IN_PROGRESS indicators (accessible through the Device API) will assert while the DSPLL is ramping to the new clock frequency.

5.5 Outputs

The Si536x supports 18 differential output drivers with configurable voltage swing and common mode voltage covering a wide variety of differential signal formats. In addition to preset differential levels such as LVPECL, LVDS, S-LVDS, CML and HCSL, the Si536x can also be programmed to a custom differential threshold that allows the signal to be sent directly to chipsets from vendors like Broadcom without complicated termination circuits simplifying the complexity of the board layout.

The outputs can also be configured as single-ended LVCMOS (3.3 V, 2.5 V, or 1.8 V) providing up to 36 single-ended outputs, or any combination of differential and single-ended outputs. Two of the output drivers (OUT16 and OUT17) have slew rate control when in LVCMOS mode. This allows limiting the rise time of the output signal to reduce the possibility of crosstalk to adjacent output drivers. The outputs have power supply pins (VDDOx) for output driver groups of 4-2-2-2-2-4-2, which can be powered at 3.3, 2.5, or 1.8 V. The LVCMOS output voltage is set by the VDDOx pin. Refer to 6. Pin Descriptions.

5.5.1 Output Crosspoint

A crosspoint allows any of the output drivers to connect with any of the PLLs. A digital output delay adjustment is possible on each of the Q divider outputs to provide output-to-output alignment for the same output source. The crosspoint configuration and delay adjustments are programmable and are stored in NVM so that the desired output configuration is ready at power up.

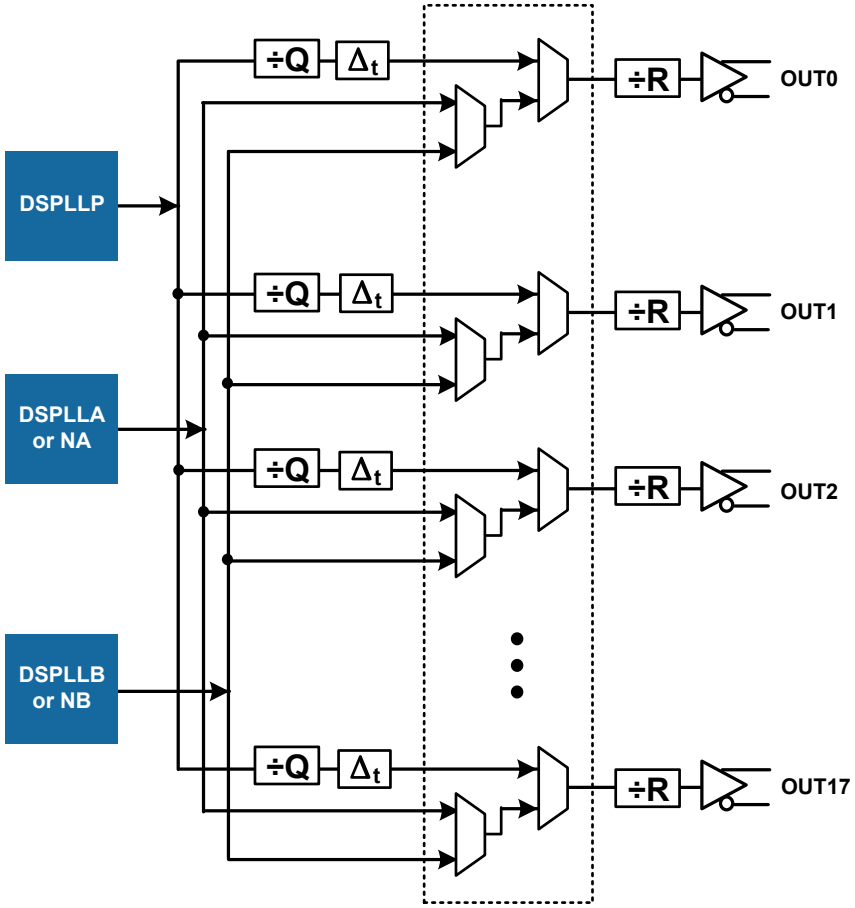


Figure 5.3. Output Structure

5.5.2 Differential and LVCMOS Output Terminations

Refer to "AN1357: Si5360/61/62/63 Schematic Design and Board Layout Guidelines" and the "Si5361/62/63 Reference Manual" for guidance on output terminations.

5.5.3 Slew Rate Limited (SRL) LVCMOS Outputs

The swing of LVCMOS and SRL LVCMOS outputs is rail-to-rail; so, the swing is determined by the voltage of the corresponding VDDO pin of the LVCMOS or SRL LVCMOS output. Each output driver configured as LVCMOS or SRL LVCMOS has two outputs, OUTx/OUTxb. The polarity of each of the two outputs may be independently configured as a noninverted or inverted output as well as enabled or disabled. If the phase between LVCMOS outputs is not critical, it is suggested to configure the pair with one noninverted and one inverted to reduce noise coupling and noise generated on the supply.

OUT16/16b and OUT17/17b may be configured as SRL LVCMOS outputs, which have a lower slew rate and significantly less crosstalk than conventional LVCMOS outputs. Less crosstalk than conventional CMOS outputs is useful in jitter-critical applications.

5.5.4 Output Enable Disable

Each output driver may be enabled/disabled through programmable GPIO pins. There are two output enable groups, OE0 and OE1, which are logically OR'ed together to determine which outputs are enabled at any point in time. CBPro allows the control and selection of the GPIO pin mapping to the outputs.

Outputs may also be enabled/disabled using the device API. If an output is assigned as GPIO controlled, it cannot be controlled via the API. The API controlled output enable allows for more flexibility than the GPIO control as any of the outputs can be individually enabled/disabled via an API command.

5.5.5 State of Disabled Output

The disabled state of an output driver may be configured as stop high, stop low, or Hi-Z. CMOS outputs <2 MHz can also be configured as Hi-Z with weak internal pullup/down.

Differential outputs, when disabled, will maintain the output common-mode voltage even while the output is not toggling. This minimizes disturbances when disabling and enabling clock outputs.

5.5.6 Output Dividers

The device utilizes both integer Q dividers and fractional NA, NB MultiSynth output dividers. The ClockBuilder Pro software chooses the optimal divide values based on the user-defined frequency plan.

A summary of each class of divider is listed below:

1. Output Q Divider: Q17-Q0
   - Integer Only Divide Value
   - Open loop divider taps directly off VCO
2. DSPLLA/B Feedback M Divider: MA, MB
   - Integer or Fractional Divide Value
3. Output N Divider: NA, NB
   - MultiSynth Divider, Integer or Fractional Divide Value
4. Output Divider: R17-R0
   - Integer Only Divide Value
5. Synchronized Dual Outputs
   - If one N divider is used in a closed loop fashion and the other N divider is used in an open loop fashion, the dividers may be cascaded so that the output of each N-divider is derived from the same input clock source and is capable of having a fractional frequency relationship.

5.5.7 Output Skew Control

Output skew control allows outputs that are derived from the Q dividers to be phase adjusted in steps of 1/fvco or 1/(4*fvco) when the fine adjust is enabled. The exact skew adjustment and step sizes are reported on the Output Skew Control Tab of the CBPro Wizard.

5.6 DSPLLP with Output Q-Divider (High Performance Path)

DSPLLP is the high-performance PLL and is routed through the Integer Q-divider to deliver the best jitter performance. DSPLLP controls the central VCO which provides many of the essential functions for the device such as generating ultra-low phase noise clocks and maintaining free-run accuracy and holdover stability for all PLLs (DSPLLP, DSPLLA, DSPLLB). A simple low-cost fixed frequency crystal (XTAL) provides the phase noise reference, and the DSPLLP locks to a clock input for jitter attenuation. The option of using a crystal oscillator (XO) is also available. See the Reference Manual for more information on the configuration modes and CBPro for configuring the modes.

5.7 DSPLLA and DSPLLB with Output Divider NA/NB

In general, both DSPLLA and DSPLLB have identical performance and flexibility and can be independently configured and controlled through the serial interface. Each of the DSPLLs support locked, free-run, and holdover modes of operation. These DSPLLs share the stability from the reference applied to DSPLLP in order to support free-run and holdover modes.

DSPLLA and DSPLLB cannot be routed via the Integer Q divider and instead use N and R dividers to deliver multiple system clocks.

The Si5361 has one DSPLL (DSPLLP) and two fractional Multisynth N dividers (NA/NB).

The Si5362 has two DSPLLs (DSPLLP and DSPLLA) and one fractional Multisynth N divider (NB).

The NB divider can be connected to either DSPLLP or DSPLLA before being fed to the output R dividers.

The Si5363 has three DSPLLs (DSPLLP, DSPLLA, and DSPLLB) that are fed directly to the output R dividers.

5.7.1 DCO Mode

The DCOs in each of the DSPLLs can be frequency controlled in predefined steps ranging from <1 ppt to several ppm. The DCOs can be controlled when its DSPLL is locked to an external input or when it is in Free-Run/Holdover mode. The frequency adjustments are controlled through the serial interface by triggering a Device API command, or by pin control using frequency increments (FINC) or decrements (FDEC). Both the FINC and FDEC pins are available through the configurable GPIO pins. Each DSPLL can be assigned to the FINC and FDEC pins. An FINC will add the frequency step word to the DSPLL output frequency, while an FDEC will decrement it.

5.8 Zero Delay Mode ZDM

Zero Delay mode (ZDM) is a mode of PLL operation where more accurate input-to-output phase delay can be achieved by providing an external feedback from one of the clock outputs to one of the clock inputs. ZDM is available on each of the three PLLs (DSPLLP, DSPLLA, and DSPLLB). For more details on implementing ZDM, see "AN1357: Si5360/61/62/63 Schematic Design and Board Layout Guidelines" and the "Si5361/62/63 Reference Manual".

5.9 External Reference

An external crystal (XTAL) or crystal oscillator (XO) is used in combination with the internal oscillator (OSC) to produce an ultra low jitter reference clock for the DSPLL and for providing a stable reference for the free-run and holdover modes. When using an external XO, it's important to select one that meets the jitter performance requirements of the end application. See the "Si55xx, Si540x, and Si536x Recommended XTAL, XO, VCXO, TCXO, and OCXO Reference Manual" for more details.

5.9.1 XA/XB Inputs

An external crystal (XTAL) connected to the XA/XB pins provides a fixed frequency reference for the PLLs (DSPLLP, DSPLLA, DSPLLB). The device includes internal XTAL loading capacitors which eliminate the need for external capacitors and also has the benefit of reduced noise coupling from external sources. A crystal in the range of 48 to 54 MHz is recommended for best jitter performance.

5.9.2 XO_IN/XO_INb Input

An alternative to using an external XTAL is to connect a crystal oscillator (XO) directly to the XO_IN/XO_INb Input. The XO_IN inputs accommodate both single-ended CMOS as well as differential XOs. Note that XO phase noise at frequencies between the DSPLLP outer loop bandwidth of approximately 20 Hz to 40 kHz and the inner loop bandwidth of approximately 1 MHz will pass through to the output. In addition to selecting XOs with appropriate noise in this frequency band, be sure to filter the VDD supplying power to the XO as many XOs have poor supply rejection.

5.10 GPIO Pins General Purpose Input or Output

There are four GPIO pins which have programmable functions. They can be assigned as either an input or an output from one of the functions shown in the table below. OUT6/11 can be repurposed as GPIs when they are not being used as clock outputs.

The GPI are programmable as either active high or active low via ClockBuilder Pro. Active low GPI are indicated by adding a "b" at the end of the function name for example "OEb" as displayed in ClockBuilder Pro. All GPI pins have a weak pull-up (PU) or pull-down (PD) resistor to set a default state when not externally driven. The default state of the GPI is always de-asserted except for OEx which is asserted by default to enable the outputs. The internal resistance of the PU/PD resistor is 20 kΩ typical.

GPIO selectable status outputs (GPO) are push-pull and do not require any external pull-up or pull-down resistors.

Function	Description
GPIO Selectable Control Inputs (GPI)	
FINC	DCO Frequency Increment.
FDEC	DCO Frequency Decrement.
PLLx_FORCE_HO	Force holdover for DSPLLP, or DSPLL A, or DSPLL B.
PLLx_INSEL[0-2]	Input select pins for DSPLLP, or DSPLL A, or DSPLL B. There are three bits to select from one of six inputs.
IN[0:5]_FAIL	Force input invalid. A low on this pin indicates to the automatic switching state machine that the associated input is not valid for selection. This is useful in applications that use their own input monitoring.
OE0–OE1	Output enable for specific outputs or group of outputs as defined by the grouping assigned in CBPro.
GPIO Selectable Status Outputs (GPO)	
PLLx_LOL	Loss of lock for DSPLLP, DSPLLA, DSPLLB.
INx_LOS	Loss Of Signal status indicator for INx.
XO_OOF	Out Of Frequency status indicator of the reference.
INx_OOF	Out Of Frequency status indicator for INx.
XO_LOS	Loss of signal at XA/XB or XO_IN/XO_INb pins.
PLLx_HO	This pin indicates when DSPLLP, DSPLLA, DSPLLB has entered the holdover state.
INTR	Interrupt pin for the device. Programmable boolean combination of PLLx_LOL, INx_LOS, INx_OOF, PLLx_HO, XO_LOS, XO_OOF.
Serial Interface (I^2C/SPI)	
A1/SDO	A1/SDO of serial interface. Assignable to GPIO3 only.
A0/CSb	A0/CSb of serial interface.
SDA/SDIO	SDA/SDIO of serial interface.
SCLK	SCLK of serial interface.

5.11 Device Initialization and Reset

Once power is applied, the device begins an initialization period where it downloads preconfigured register values and configuration data from NVM and performs other initialization tasks. Communicating with the device through the serial interface is possible once this initialization period is complete. No output clocks will be generated until the initialization is complete. There are two types of resets available. A hard reset is functionally similar to a device power-up. All registers will be restored to the values stored in NVM, and all circuits will be restored to their initial state including the serial interface. A hard reset is initiated using the RSTb pin or by software reset. A soft reset is used to initiate register configuration changes. A hard reset affects all PLLs, while a soft reset can affect all or each PLL individually.

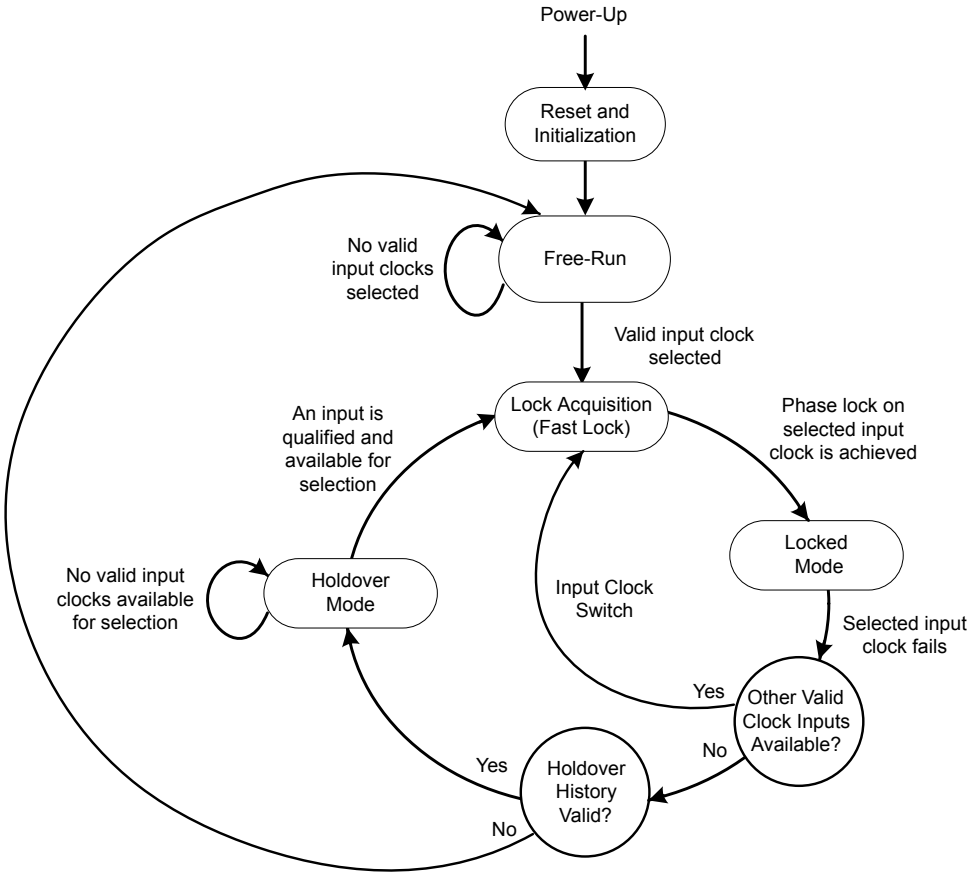


Figure 5.4. Modes of Operation

5.12 Modes of Operation: DSPLLP, DSPLLA, and DSPLLB

Once initialization is complete each PLL independently operates in one of four modes: Free-Run, Lock Acquisition, Locked, or Holdover. A state diagram showing the modes of operation is shown in Figure 5.4 Modes of Operation on page 35. The following sections describe each of these modes in greater detail.

5.12.1 Free-Run Mode

The PLLs will automatically enter Free-Run mode once power is applied to the device and initialization is complete. In this mode, the frequency accuracy of the generated output clocks is entirely dependent on the frequency accuracy of the reference clock source. If an XTAL is connected to the XA/XB pins, then the clock outputs will generate a frequency at the XTAL's accuracy. For example, if an XTAL is operating at –28 ppm, then clock outputs will also be –28 ppm. The same is true if an XO is connected at the XO_IN inputs instead of using XTAL at XA/XB. The frequency stability of the outputs will also be determined by the XTAL or XO.

5.12.2 Lock Acquisition Mode

Each of the PLLs independently monitors its configured inputs for a valid clock. If at least one valid clock is available for synchronization, a PLL will automatically start the lock acquisition process. If the fast lock feature is enabled, they will acquire lock faster than the PLL Loop Bandwidth would provide and then transition to the normal PLL loop bandwidth. During lock acquisition the outputs will generate a clock that follows the VCO frequency change as it pulls-in to the input clock frequency.

The PLL_STATUS API command reports the lock status of a PLL. When the PLL output frequency is within the threshold defined on the Frequency LOL (FLOL) page in ClockBuilder Pro, the PLL_OUT_OF_FREQUENCY bit de-asserts. Some time after that, the PLL will pull in the remaining phase defined on the Phase LOL (PLOL) page in ClockBuilder Pro. Once the PLL is frequency and phase locked, the PLL_LOSS_OF_LOCK (LOL) bit de-asserts and the PLL enters locked mode.

5.12.3 Locked Mode

Once locked, the PLL will generate clock outputs that are both frequency and phase locked to their selected input clocks. The PLL loop bandwidths can be independently configured. Any frequency changes (e.g., because of temperature variations) of the reference clock (XO_IN) within the PLL loop bandwidth will be corrected by the loop ensuring 0 ppm lock to its input clock (IN). Any frequency changes of the reference clock (XO_IN) beyond the PLL loop bandwidth will pass through to the clock output.

5.12.4 Holdover Mode

Any of the PLLs will automatically enter Holdover mode when the selected input clock becomes invalid, holdover history is valid, and no other valid input clocks are available for selection. Each PLL uses an averaged input clock frequency as its final holdover frequency to minimize the disturbance of the output clock phase and frequency when an input clock suddenly fails. The holdover circuit for each PLL stores historical frequency data while locked to a valid input clock. The final averaged holdover frequency value is calculated from a programmable window within the stored historical frequency data. Both the window size and delay are programmable as shown in the figure below. The window size determines the amount of holdover frequency averaging. The delay value allows ignoring frequency data that may be corrupt just before the input clock failure.

The maximum window size is a function of input frequency and is reported in CBPro for each PLL. Up to 5000 seconds of holdover history can be stored.

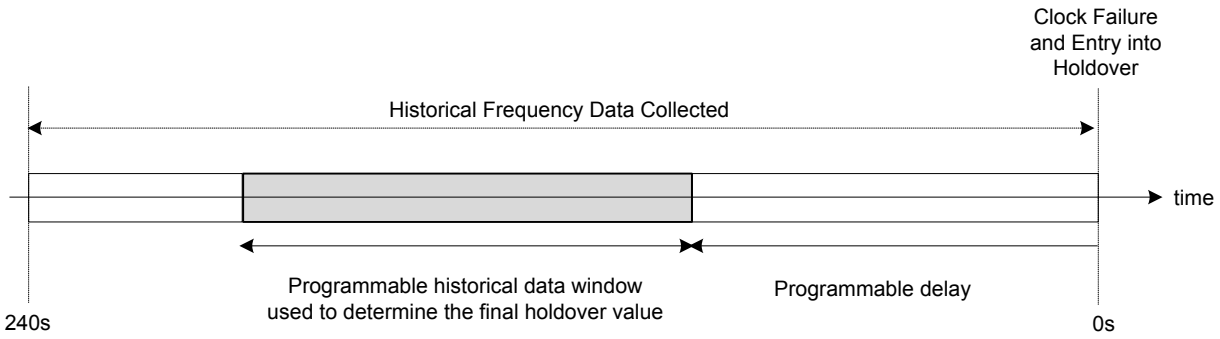


Figure 5.5. Programmable Holdover Window

When entering holdover, a PLL will pull its output clock frequency to the calculated averaged holdover frequency. While in holdover, the output frequency drift is entirely dependent on the external reference clock connected to the XO_IN input. If the input clock becomes valid, a PLL will automatically exit the holdover mode and re-acquire lock to the new input clock. This process involves pulling the output clock frequency to achieve frequency and phase lock with the input clock. This pull-in process is glitchless.

The PLL output frequency when exiting holdover can be ramped. Just before the exit is initiated, the difference between the current holdover frequency and the new desired frequency is measured. Using the calculated difference and a user-selectable ramp rate, the output is linearly ramped to the new frequency. The PLL loop BW does not limit or affect ramp rate selections (and vice versa). CBPro defaults to ramped exit from holdover and free-run. The ramp rate settings are configurable for initial lock (exit from free-run), exit from holdover, and clock switching.

If ramped holdover exit is disabled, the holdover exit is governed either by (1) the PLL loop BW or (2) the PLL Fastlock bandwidth, when enabled.

5.13 Status and Alarms

The Si536x monitors the input clocks and reference input for status and alarms. These states and alarms provide the internal state machine with real time phase and frequency monitoring used for making decisions, such as switching inputs or entering holdover.

5.13.1 Input Clock Status

All input clocks are continuously monitored for faults using the Loss-of-Signal (LOS), Out-of-Frequency (OOF), and Phase Monitor (PHMON) alarms. When a differential input is configured as a dual CMOS input, then each CMOS input is independently monitored. Any enabled alarms for an input, such as LOS/OOF/PHMON, are logically ORed together to produce the "Input Invalid" alarm.

Any input clock with an alarm is not valid until all alarms are cleared. If a PLL is locked to an input clock and that input clock becomes invalid, then the PLL may either switch to a valid input or enter holdover mode, depending on how the device is programmed.

API commands can be used to indicate if an alarm is valid, pending short term fault, under validation or invalid.

5.13.1.1 Loss of Signal LOS

The loss of signal alarm measures the period of each input clock cycle to detect phase irregularities or missing clock edges. Each of the input LOS circuits has its own programmable sensitivity, which allows missing edges or intermittent errors to be ignored. Loss of signal sensitivity is configurable using the CBPro utility. The LOS status for each of the monitors is accessible by checking the INPUT_STATUS API.

5.13.1.2 Out of Frequency (OOF) Detection

All inputs are monitored for frequency accuracy with respect to an OOF reference which is selected in ClockBuilder Pro. The OOF reference can be selected as the XO/XTAL.

The OOF set and clear thresholds must be wider than the combined frequency accuracy of the OOF reference plus the stability of the input clock. A valid input clock frequency is one that remains within the OOF frequency range which is configurable from ±0.1 ppm to ±500 ppm in steps of 0.1 ppm. A configurable amount of hysteresis is also available to prevent the OOF status from toggling at the failure boundary. An example is shown in the figure below. In this case, the OOF monitor is configured with a valid frequency range of ±15 ppm with 5 ppm of hysteresis.

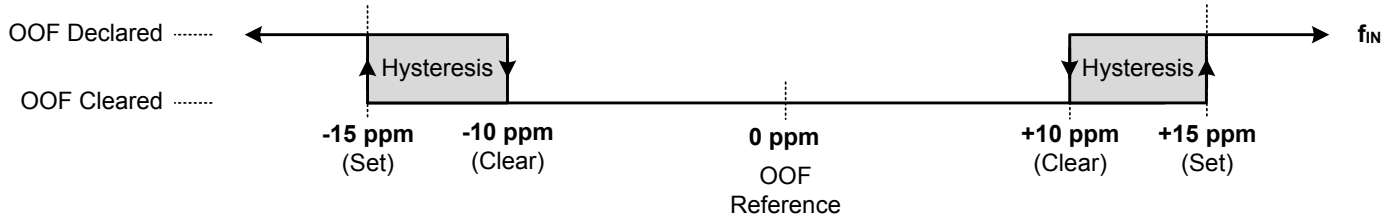


Figure 5.6. Example of Precise OOF Monitoring Assertion and De-assertion Triggers

5.13.1.3 Phase Monitor (PHMON)

If a clock input undergoes a phase transient, a PLL locked to that input will filter the transient by its loop bandwidth; however, the transient will propagate to the output. Transients that propagate to the output have the potential to negatively impact downstream devices.

Phase Monitor (PHMON) alarm monitors the input clock phase or accumulated phase, and, if the the input transient exceeds the programmable threshold, the PHMON alarm will be asserted. PHMON, like the other alarms, is quick to be asserted when the thresholds are violated yet slower to be deasserted to prevent chattering around the threshold.

Each input clock has an independent PHMON alarm. Each alarm can be enabled/disabled individually, and its associated threshold may be independently configured. Note that OOF must be enabled and properly configured for PHMON to operate.

A ZDM input may use the PHMON alarm for monitoring purposes. However, it will have no effect on PLL bandwidth selection and will not cause input switching.

5.13.1.4 Short Term Holdover

The Short-Term Holdover (STHO) feature may be used when the input clock is expected to have a short-term fault and then quickly recover.

If an input clock has STHO enabled, and an LOS/OOF/PHMON alarm is asserted, then a PLL locked to that input will enter holdover and wait for a programmable duration until all alarms on the input clock are deasserted.

If all alarms on the input clock are deasserted before the programmable amount of time has passed, then the PLL will gracefully relock to the same input clock. If all the alarms on the input clock are not deasserted before the programmable amount of time has passed, then the PLL will either switch to the next priority input clock or remain in holdover, depending on the input clock selection settings.

If STHO is disabled, then the PLL will skip the short-term holdover time and immediately switch to the next priority input clock or enter holdover, depending on the input clock selection settings.

STHO may be programmed using Clock Builder Pro to set the duration or to enable or disable the feature for each input clock individually. Note that the STHO setting will affect all PLLs assigned to that input.

5.13.2 PLL Status

DSPLLP, DSPLLA, and DSPLLB are continuously monitored for Loss-of-Lock (LOL). The final LOL status indicator is the logical OR of the Frequency Loss-of-Lock and Phase Loss-of-Lock statuses. See the Reference Manual for more information.

5.13.2.1 Loss of Lock (LOL)

There is a loss of lock (LOL) monitor for each of the PLLs (DSPLLP, DSPLLA, and DSPLLB). The LOL monitor asserts when a PLL has lost synchronization with its selected input clock. Any of the GPIOs can be programmed as a dedicated loss-of-lock pin that reflects the loss-of-lock condition for each of the PLLs. The LOL monitor measures both the frequency and phase difference between the input and feedback clocks of the phase detector. The frequency monitor gives frequency lock detection (FLOL) while the phase monitor indicates true phase lock PLOL by detecting one or more single slips. Both the phase and frequency LOL monitors have clear and set thresholds and a timer to prevent LOL assertion from toggling or chattering as the DSPLL completes lock acquisition. The cycle slip detector also has configurable sensitivity.

5.13.2.2 Frequency Loss of Lock (FLOL)

The Frequency Loss-of-Lock (FLOL) monitor measures the frequency difference between the input clock and the feedback clock. The upper and lower LOL thresholds are programmable, which dictates when the alarm will be asserted or deasserted. It is recommended to program the clear threshold to be less than the set threshold to allow for hysteresis in the FLOL set/clear behavior. This prevents the FLOL alarm from chattering or causing multiple interrupts. FLOL, like the other alarms, is quick to be asserted when the threshold is violated yet slower to be deasserted. The alarm validates that the frequency difference between the input and feedback clocks has truly settled to within the LOL clear threshold before the FLOL alarm is deasserted. The time required to validate the frequency difference increases as the loop bandwidth of the PLL decreases.

5.13.2.2.1 Status Bits

There are four Status Bits that serve as four additional Frequency LOL thresholds. The Status Bit is asserted if the frequency difference between the input clock and feedback clock exceeds the programmable STB threshold. The assertion or de-assertion of an STB does not contribute to the FLOL or LOL status. Rather, they serve as a way to track the lock acquisition process for DSPLL's with a loop bandwidth of ~20 Hz. The status bits may be read via the API. In the lock acquisition process, the de-assertion of a STB does not indicate that the PLL is frequency locked. This is because the frequency may chatter around the STB threshold. On the other hand, the de-assertion of FLOL requires the frequency difference to truly settle below the LOL clear threshold.

5.13.2.3 Phase Loss of Lock (PLOL)

The Phase Loss-of-Lock (PLOL) alarm measures the phase difference between the input clock and feedback clock. The PLOL set threshold is programmable so the alarm will assert or deassert depending on phase difference between the input and feedback clocks relative to the threshold setting. It is recommended to set the clear threshold below the set threshold to allow for hysteresis. This prevents the alarm from chattering or causing multiple interrupts. During the lock acquisition process the input clock and feedback clock will likely have a significant frequency mismatch so the PLOL is asserted until FLOL is deasserted. Once FLOL has been deasserted, the two frequencies are stable with respect to each other. Then the feedback clock phase can be pulled in to within the PLOL clear threshold.

5.13.2.4 Cycle Slip Detection

DSPLLP, DSPLLA, and DSPLLB may be monitored for cycle slips. Like the PLOL alarm, cycle slip detection is not enabled until FLOL is deasserted. Additionally, PLOL must be enabled for cycle slip detection to be enabled. Cycle slips both in the positive and negative direction are monitored. The API can be used to read the total count of positive cycle slips, negative cycle slips and the total count or both positive and negative slips.

5.13.3 External Reference Status

An external reference must always be provided to the device. The Si536x will monitor the external reference input for LOS, OOF, LOL. If a fault is detected on the external reference, then the outputs will be disabled. Any external reference faults may be read via the API.

5.13.4 Interrupt Status

The interrupt flag is asserted when any of the status indicators of the device changes state. The interrupt status may be assigned a GPIO pin, or it may be checked using an API command to show which status indicator caused the interrupt to be asserted.

The Interrupt Pin page in CBPro lists all the status indicators that can be programmed to activate the interrupt pin.

The status indicators that are enabled are logically OR'd together so that the assertion of any of these status indicators will cause the interrupt pin to assert. The interrupt pin status depends on the sticky versions of the individual status indicators, so the interrupt pin will stay asserted until the sticky status indicators are cleared.

5.14 Serial Interface

Configuration and operation of the Si536x is controlled by reading and writing API commands using the I^2C or SPI interface. The SPI mode operates in either four-wire or three- wire modes. The following table defines the GPIO pins assigned to the SPI port. For more information, see "AN1360: Serial Communications and API Programming Guide for Si536x, Si540x, and Si55xx Devices".

Table 5.1. Serial Interface Pins

Pin Number	3-Wire SPI	4-Wire SPI	I^2C
55	CSb	CSb	A0
52	SDIO	SDI	SDA
53	SCLK	SCLK	SCK
56	Unused	SDO	A1

5.15 NVM Programming

At power-up, the device downloads its default configuration and settings from internal one-time-programmable (OTP) non-volatile memory (NVM). The NVM can be pre-programmed at the factory with a custom frequency plan such that the device starts generating clocks on its first power-up, or the NVM can be programmed in the field using the API command set. NVM programming must be done with VDDA set to 3.3 V. The NVM can only be burned one time, either at the factory or in the field. For more details on NVM programming, refer to "AN1360: Serial Communications and API Programming Guide for Si536x, Si540x, and Si55xx Devices" and the "Si5361/62/63 Reference Manual".

5.16 Application Programming Interface API

Communication between the customer's HOST processor and the Si536x internal microcontroller (MCU) is accomplished through the serial interface. The Si536x MCU contains API firmware that allows users simple command level access to the device's registers. For more details on the Device API and for instructions on programming the clock device, see "AN1360: Serial Communications and API Programming Guide for Si536x, Si540x, and Si55xx Devices" and the "Si5361/62/63 Reference Manual".

5.17 Power Supplies

The Si5361/62/63 has 14 power supply pins. The separate power supplies are used for different functions, providing power locally where it is needed on the die to improve isolation. When no outputs are enabled for a particular VDDOx, that supply pin may be left unconnected. Please refer to the "Si5361/62/63 Reference Manual" for more details on power management and filtering recommendations.

5.17.1 Power Supply Sequencing

There are no power sequencing requirements between supplies. VDDA and VDD18 should be powered up before releasing RSTb. VDDA must be equal to the highest voltage supply.

5.17.2 Power Supply Ramp Rate

Power supply ramp times must stay within the maximum supply voltage ramp rate as defined in Table 3.5 DC Characteristics on page 14.

5.17.3 Low-Power Mode

In Low-Power Mode, the analog core supply voltage (VDDA) of the Si5361/62/63 is set to 1.8 V in order to reduce power consumption. Since VDDA must be equal to the highest voltage applied to the Si5361/62/63, in Low-Power Mode, all voltage supplies including VDDO must be 1.8 V. A 1.8 V VDDO restricts the output format to S-LVDS, LVCMOS, or HCSL. If standard LVPECL / LVDS common-mode voltages are required in Low-Power Mode, select ac-coupled HCSL / S-LVDS output formats, respectively, with corresponding common-mode bias on the receiver side of the ac coupling capacitors. Please refer to the "Si5361/62/63 Reference Manual" for VDDXO and XO/XTAL connections and terminations for Low-Power Mode.

6. Pin Descriptions

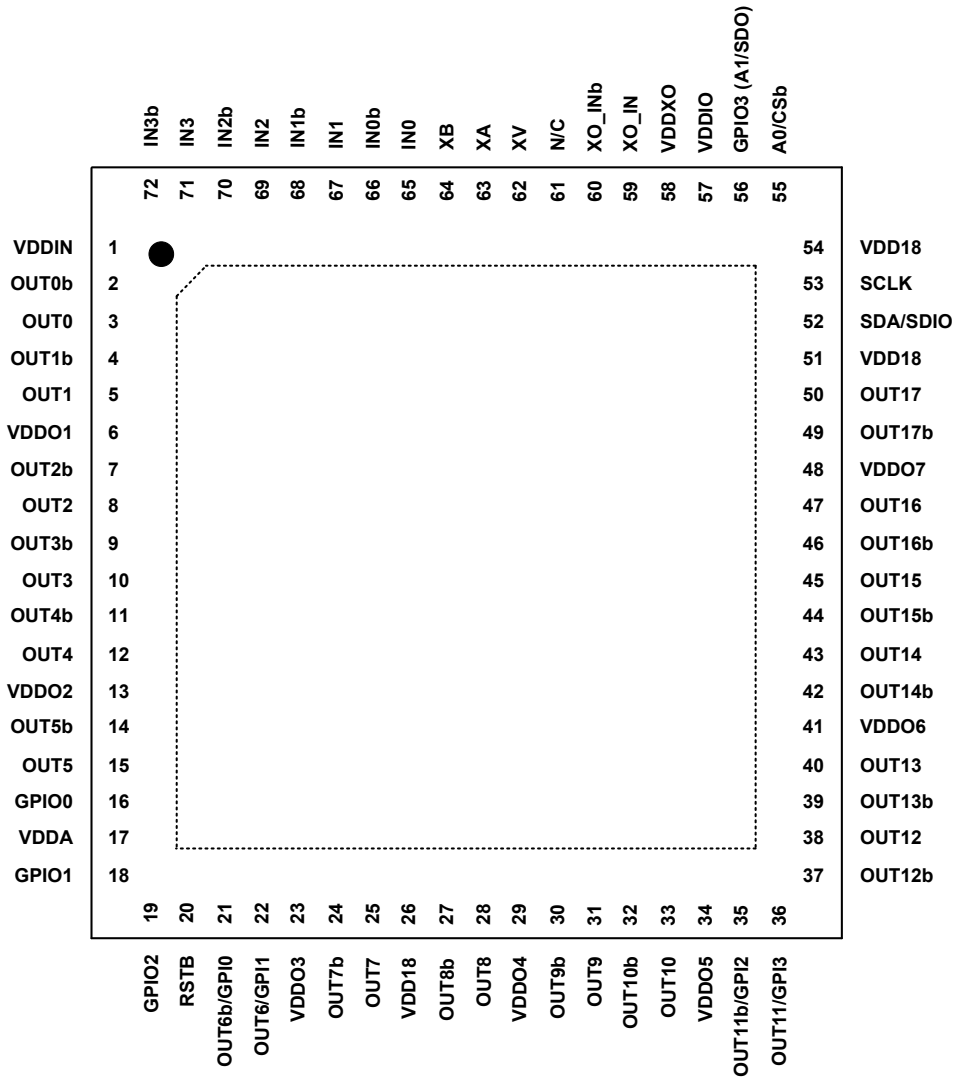


Table 6.1. Pin Descriptions

Pin Name	Pin Number	Pin Type[1]	Function
Inputs			
XO_IN	59	I	**Input for low phase noise (XO)**
XO_INb	60		
XV	62	I	**XTAL Shield** Connect this pin directly to the XTAL and capacitor ground pins. Do not ground the XV pin. XV should be isolated from the PCB ground plane. Refer to the Si5361/62/63 Reference Manual for layout guidelines.
XA	63	I	**Crystal Input** Input pins for external crystal (XTAL). XA and XB pins can be left unconnected when not in use.
XB	64		

Pin Name	Pin Number	Pin Type[1]	Function
IN0	65	I	**Clock Inputs** IN0–IN3 accept an input clock for synchronizing the device. They support both differential and single-ended clock signals. When operating in single-ended mode, inputs IN2 and IN3 can provide two SE inputs each for a total of six inputs. Refer to the Si536x Reference Manual for input termination options. These pins are high-impedance and must be terminated externally. IN0–IN3 can be disabled in CBPro and the pins left unconnected if unused.
IN0b	66		
IN1	67		
IN1b	68		
IN2	69		
IN2b	70		
IN3	71		
IN3b	72		
Outputs			
OUT0b	2	O	**Output Clocks** The output clocks can be programmed as single-ended CMOS or differential LVDS, S-LVDS, CML, HCSL or ac-coupled LVPECL and support a programmable signal amplitude and common-mode voltage. Desired output signal format is configurable in CBPro. Termination recommendations are provided in the Si536x Reference Manual. Unused outputs should be left unconnected.
OUT0	3		
OUT1b	4		
OUT1	5		
OUT2b	7		
OUT2	8		
OUT3b	9		
OUT3	10		
OUT4b	11		
OUT4	12		
OUT5b	14		
OUT5	15		
OUT6b/GPI0	21	I or O	**Output Clocks with Input Option** Output 6 can alternatively be assigned as two General Purpose Inputs (GPI0, GPI1) that can be programmed to have any of the input control functions listed in 5.10 GPIO Pins General Purpose Input or Output. Regardless of whether Output 6 is functioning as a clock output or GPI, the power supply will be VDDO3.
OUT6/GPI1	22		
OUT7b	24	O	**Output Clocks** The output clocks can be programmed as single-ended CMOS or differential LVDS, S-LVDS, CML, HCSL or ac-coupled LVPECL and support a programmable signal amplitude and common-mode voltage. The desired output signal format is configurable in CBPro. Termination recommendations are provided in the Si536x Reference Manual. Unused outputs should be left unconnected.
OUT7	25		
OUT8b	27		
OUT8	28		
OUT9b	30		
OUT9	31		
OUT10b	32		
OUT10	33		
OUT11b/GPI2	35	I or O	**Output Clocks with Input Option** Output 11 can alternatively be assigned as two General Purpose Inputs (GPI2, GPI3) that can be programmed to have any of the input control functions listed in GPIO Pin Descriptions. Regardless of whether Output 11 is functioning as a clock output or GPI, the power supply will be VDDO5.
OUT11/GPI3	36		

Pin Name	Pin Number	Pin Type[1]	Function
OUT12b	37	O	**Output Clocks** The output clocks can be programmed as single-ended CMOS or differential LVDS, S-LVDS, CML, HCSL or ac-coupled LVPECL and support a programmable signal amplitude and common-mode voltage. Desired output signal format is configurable in CBPro. Termination recommendations are provided in the Si536x Reference Manual. Unused outputs should be left unconnected.
OUT12	38		
OUT13b	39		
OUT13	40		
OUT14b	42		
OUT14	43		
OUT15b	44		
OUT15	45		
OUT16b	46	O	**Output Clocks with Programmable LVCMOS Slew Rate** When outputs 16 and 17 are configured as LVCMOS outputs, they can also have the slew rate adjusted.
OUT16	47		
OUT17b	49		
OUT17	50		
Serial Interface			
SDA/SDIO	52	I/O	**Serial Data Interface** This is the bidirectional data pin (SDA) for the I^2C interface. This pin must be pulled high to V_{DDIO} using an external resistor of at least 1 kΩ.
SCLK	53	I	**Serial Clock Input Interface** This is the bidirectional I^2C clock pin. Clock stretching (i.e., driving SCL low to insert wait-states) will be utilized when operating at rates greater than 100 kHz. This pin must be pulled up to V_{DDIO} using an external resistor of at least 1 kΩ.
A0/CSb	55	I	**I^2C Address Select** This pin functions as the optional A0 I^2C address input pin. Attach a 4.7 kΩ pull-up resistor to V_{DDIO}, or a 4.7 kΩ pull-down resistor to ground to select the I^2C slave address. This pin can be left floating if unused.
GPIO3 (A1/SDO)	56	O	**Serial Data Out Pin when Operating in 4-wire SPI Mode** This can also function as the GPIO3 pin when operating in 3-wire SPI mode.
Control/Status			
GPIO0	16	I or O	**Programmable General Purpose Input or Outputs** These pins can be programmed to the functions defined in GPIO Pin Descriptions. See "Si5361/62/63 Reference Manual" for more details.
GPIO1	18		
GPIO2	19		
RSTb	20	I	**Device Reset** This pin functions as an active-low reset input and is used to generate a device reset when held low for at least the specified Minimum Pulse Width. This resets the device back to a known state and reloads the NVM frequency plan and application. If there is no frequency plan in NVM, the reset pin will return the device to the bootloader state in which it is waiting for the frequency plan and application to be downloaded by the host controller. This pin is internally pulled up with a ~20 kΩ resistor to VDDIO.
Power			
VDDIN	1	P	**Input Clock Supply Voltage** Supply voltage 3.3 V, 2.5 V or 1.8 V for the input clock buffers.

Pin Name	Pin Number	Pin Type[1]	Function
VDDO1	6	P	**Output Clock Supply Voltage 1–7** Supply voltage 3.3 V, 2.5 V, or 1.8 V for outputs. Leave VDDO pins of unused output drivers unconnected. An alternate option is to connect the VDDO pin to a power supply and disable the output driver to minimize current consumption. A 0402 1 µF capacitor should be placed very near each of these pins. VDDO may not exceed VDDA. The banks of outputs are powered as follows: VDDO1 – OUT[0:3] VDDO2 – OUT[4:5] VDDO3 – OUT[6:7] VDDO4 – OUT[8:9] VDDO5 – OUT[10:11] VDDO6 – OUT[12:15] VDDO7 – OUT[16:17] Data sheet jitter performance requires all outputs in a given bank to operate at a single frequency.
VDDO2	13		
VDDO3	23		
VDDO4	29		
VDDO5	34		
VDDO6	41		
VDDO7	48		
VDDA	17	P	**Core Analog Supply Voltage** This core supply can operate from a 3.3 V or 1.8 V power supply for low power mode. Note that all other supply voltages must be equal or lower voltage than the VDDA pin so in low power mode no other supply can exceed 1.8 V. See the Si536x Reference Manual for power supply filtering recommendations. A 0402 1 µF capacitor should be placed very near each of these pins.
VDD18	26	P	**Core Supply Voltage 1.8 V** The device core operates from a 1.8 V supply. See the Si536x Reference Manual for power supply filtering recommendations. A 0402 1 µF capacitor should be placed very near each of these pins.
VDD18	51		
VDD18	54		
VDDIO	57	P	**Control, Status IO Clock Supply Voltage** Supply voltage 3.3 V, 2.5 V, or 1.8 V for the serial interface, Control, and Status inputs and outputs.
VDDXO	58	P	**Reference Supply Voltage** Supply voltage of 3.3 V or 1.8 V supported for the reference. For best performance, VDDXO should be the same voltage as the VDD_XO.
GND PAD	Package Bottom	P	**Exposed Die Attach Pad** The exposed die attach pad (ePAD) on the bottom of the package must be connected to electrical ground.
No Connect			
N/C	61	N/C	Leave this pin floating.

Note:

1. I = Input, O = Output, P = Power, N/C = No Connect.

7. Package Outline

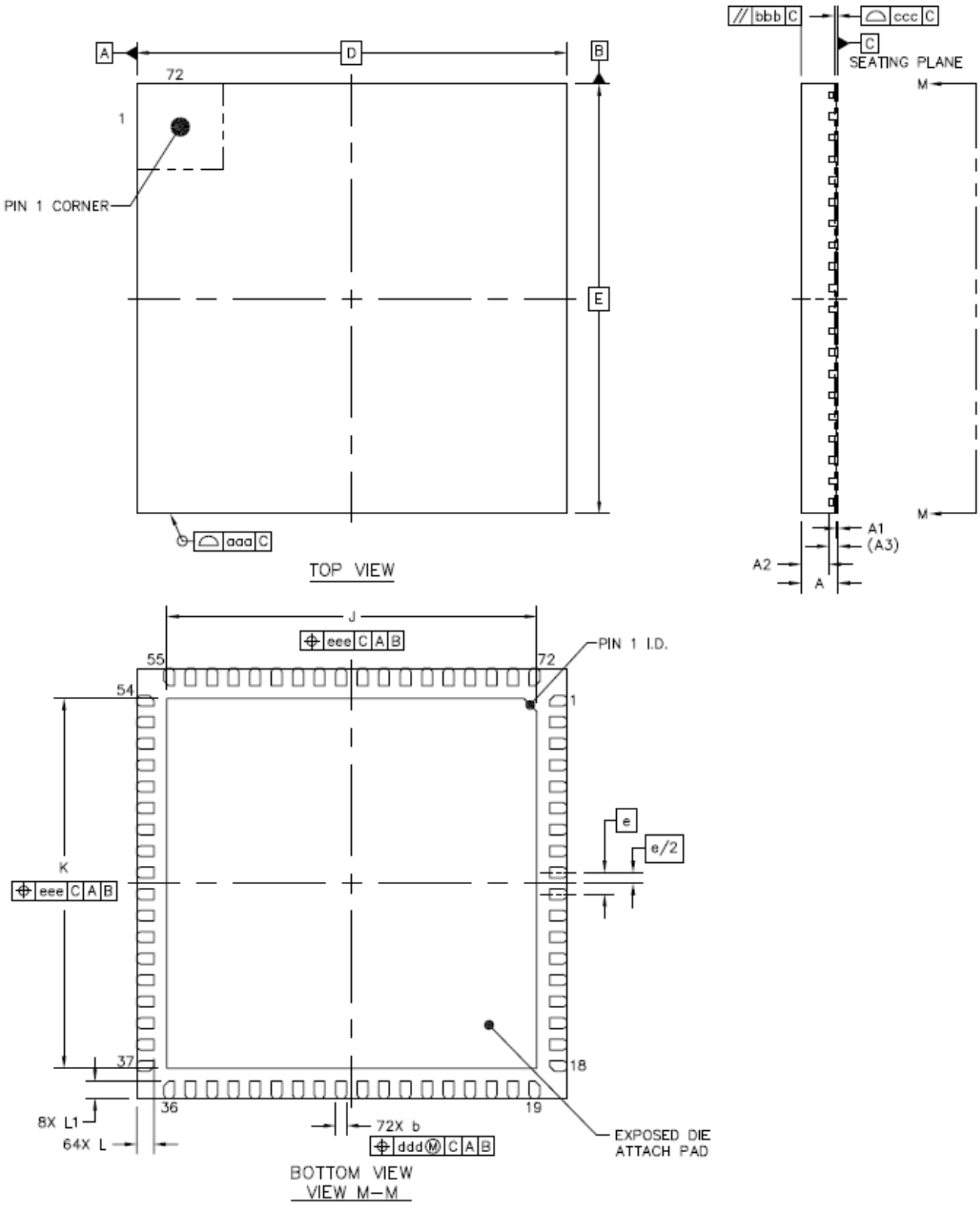


Figure 7.1. 72-QFN Package Diagram

Table 7.1. Package Dimensions

		Symbol	Min	Typ	Max
Total Thickness		A	0.8	0.85	0.9
Stand Off		A1	0	0.035	0.05
Mold Thickness		A2	–	0.65	–
L/F Thickness		A3		0.203 REF	
Lead Width		b	0.2	0.25	0.3
Body Size	X	D		10 BSC	
	Y	E		10 BSC	
Lead Pitch		e		0.5 BSC	
EP Size	X	J	8.5	8.6	8.7
	Y	K	8.5	8.6	8.7
Lead Length		L	0.35	0.4	0.45
		L1	0.3	0.4	0.45
Package Edge Tolerance		aaa		0.1	
Mold Flatness		bbb		0.1	
Coplanarity		ccc		0.08	
Lead Offset		ddd		0.1	
Exposed Pad Offset		eee		0.1	
Weight		N/A	—	0.35 g	—

Note:

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 JEDEC Solid State Outline MO-220.

8. PCB Land Pattern

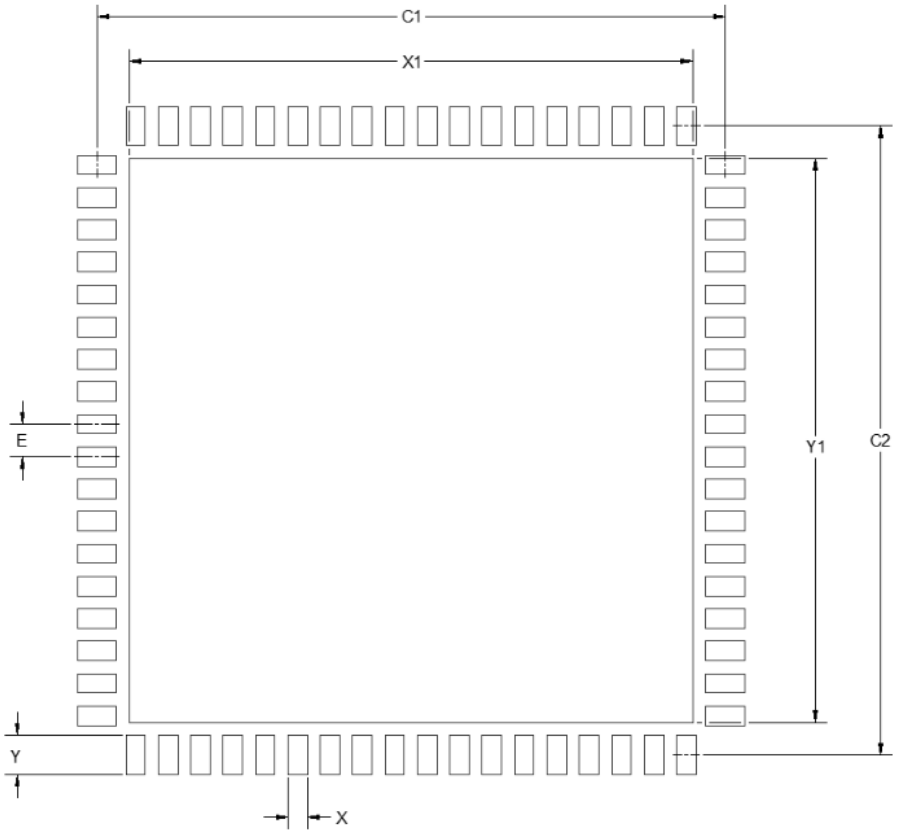


Figure 8.1. PCB Land Pattern

Table 8.1. PCB Land Pattern Dimensions

Dimension	mm
C1	9.70
C2	9.70
E	0.50
X	0.30
Y	0.60
X1	8.70
Y1	8.70

Note:

General

1. All dimensions shown are in millimeters (mm).
2. This Land Pattern Design is based on the IPC-7351 guidelines.
3. All dimensions shown are at Maximum Material Condition (MMC). Least Material Condition (LMC) is calculated based on a Fabrication Allowance of 0.05 mm.

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 pads.
4. A 4x4 array of 1.45 mm square openings on a 2.00 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.

**Above notes and stencil design are shared as recommendations only. A customer or user may find it necessary to use different parameters and fine tune their SMT process as required for their application and tooling.*

9. Top Marking

Figure 9.1. Si536x Top Marking

Table 9.1. Top Marking Explanation

Line	Characters	Description
1	Si536xA-	Base part number and Device Grade: A = Device Grade. (Refer to 2. Ordering Guide for latest device grade information).
2	Rxxxxx-GM	R = Product revision. (Refer to Ordering Guide for latest revision). xxxxx = Customer specific NVM sequence number. Optional NVM code assigned for custom, factory pre-programmed devices. Characters are not included for standard, factory default configured devices. See 2. Ordering Guide for more information. -GM = Package (QFN) and temperature range (–40 to +95 °C)
3	YYWWTTTTTT	YYWW = Characters correspond to the year (YY) and work week (WW) of package assembly. TTTTTT = Manufacturing trace code.
4	Circle w/ 0.6 mm (72-QFN) diameter	Pin 1 indicator; left-justified
	e3	Pb-free symbol; Center-Justified
	TW	TW = Taiwan; Country of Origin (ISO Abbreviation)

10. Revision History

Revision 206394B

November, 2022

- Updated Table 3.3 Recommended Operating Conditions on page 11.
  - Changed symbol for Core Supply Voltage from V_{DDREF} to V_{DDXO}.
- Updated Table 3.4 Performance Characteristics on page 12.
  - Updated PLL Lock Time Parameter with Note 1 stating that “FLOL de-asserts once frequency lock is achieved. LOL de-asserts once both frequency and phase lock are achieved. Refer to 5.12.2 Lock Acquisition Mode for more details on LOL thresholds.”
  - Updated Note 7 with "XTAL = 54 MHz TXC 7X54070001".
- Updated Table 3.6 Input Specifications on page 16.
  - Reduced max spec for Input Frequency Range for Differential (XO Applied to XO_IN) from 983.04 MHz to 250 MHz.
- Updated Table 3.7 Differential Clock Output Specifications on page 18.
  - Increased max spec for Output Frequency Parameter, test condition Q-Divider Grade A/B/C, from 1200 MHz to 1300 MHz.
  - Updated specs for OUT-OUTb Skew Parameter.
  - Updated specs for Rise and Fall Times (20% to 80%) OUT0–15 Parameter.
- Updated Table 6.1 Pin Descriptions on page 41.
  - Changed Pin 21 GPIO from OUT6b/GPI1 to OUT6b/GPI0.
  - Changed Pin 22 GPIO from OUT6/GPI0 to OUT6/GPI1.
  - Changed Pin 35 GPIO from OUT11b/GPI3 to OUT11b/GPI2.
  - Changed Pin 36 GPIO from OUT11/GPI2 to OUT11/GPI3.

Revision 206394A

October, 2022

- Initial release.

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