Si5326

PRELIMINARY DATA SHEET

ANY-RATE PRECISION CLOCK MULTIPLIER/JITTER ATTENUATOR

Description

The Si5326 is a jitter-attenuating precision clock multiplier for applications requiring sub 1 ps jitter performance. The Si5326 accepts dual clock inputs ranging from 2 kHz to 710 MHz and generates two clock outputs ranging from 2 kHz to 945 MHz and select frequencies to 1.4 GHz. The two outputs are divided down separately from a common source. The device provides virtually any frequency translation combination across this operating range. The Si5326 input clock frequency and clock multiplication ratio are programmable through an I^2C or SPI interface. The Si5326 is based on Silicon Laboratories' 3rd-generation DSPLL® technology, which provides any-rate frequency synthesis and jitter attenuation in a highly integrated PLL solution that eliminates the need for external VCXO and loop filter components. The DSPLL loop bandwidth is digitally programmable, providing jitter performance optimization at the application level. Operating from a single 1.8, 2.5, or 3.3 V supply, the Si5326 is ideal for providing clock multiplication and jitter attenuation in high performance timing applications.

Applications

- SONET/SDH OC-48/OC-192 line cards
- GbE/10GbE, 1/2/4/8/10GFC line cards
- ITU G.709 and custom FEC line cards
- Optical modules
- Wireless basestations
- Data converter clocking
- xDSL
- SONET/SDH + PDH clock synthesis
- Test and measurement

Features

- Generates any frequency from 2 kHz to 945 MHz and select frequencies to 1.4 GHz from an input frequency of 2 kHz to 710 MHz
- Ultra-low jitter clock outputs w/jitter generation as low as 0.3 ps rms (50 kHz–80 MHz)
- Integrated loop filter with selectable loop bandwidth (60 Hz to 8.4 kHz)
- Meets OC-192 GR-253-CORE jitter specifications
- Dual clock inputs w/manual or automatically controlled hitless switching
- Dual clock outputs with selectable signal format (LVPECL, LVDS, CML, CMOS)
- Support for ITU G.709 and custom FEC ratios (255/238, 255/237, 255/236)
- LOL, LOS, FOS alarm outputs
- Digitally-controlled output phase adjust
- I^2C or SPI programmable
- On-chip voltage regulator for 1.8, 2.5, or 3.3 V ±10% operation
- Small size: 6 x 6 mm 36-lead QFN
- Pb-free, ROHS compliant

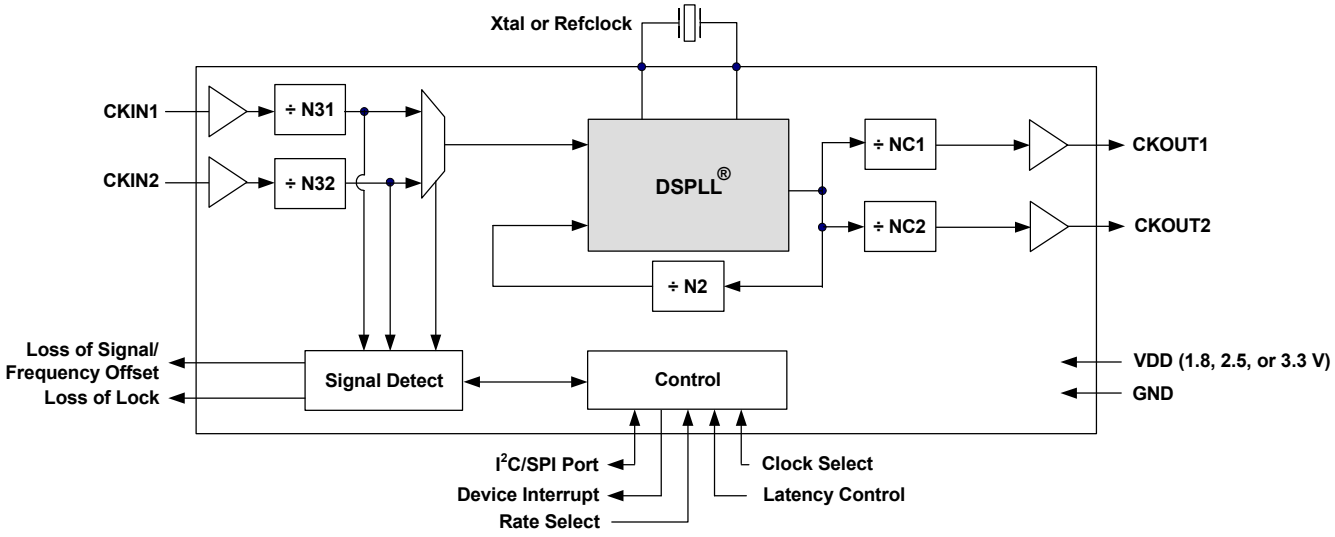


Table 1. Performance Specifications

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Temperature Range	T_A		–40	25	85	ºC
Supply Voltage	V_{DD}		2.97	3.3	3.63	V
			2.25	2.5	2.75	V
			1.62	1.8	1.98	V
Supply Current	I_{DD}	f_{OUT} = 622.08 MHz Both CKOUTs enabled LVPECL format output	—	251	279	mA
		CKOUT2 disabled	—	217	243	mA
		f_{OUT} = 19.44 MHz Both CKOUTs enabled CMOS format output	—	204	234	mA
		CKOUT2 disabled	—	194	220	mA
		Tristate/Sleep Mode	—	TBD	TBD	mA
Input Clock Frequency (CKIN1, CKIN2)	CK_F	Input frequency and clock multiplication ratio determined by programming device PLL dividers. Consult Silicon Laboratories configuration software DSPLL*sim* to determine PLL divider settings for a given input frequency/clock multiplication ratio combination.	0.002	—	710	MHz
Output Clock Frequency (CKOUT1, CKOUT2)	CK_{OF}		0.002 970 1213	—	945 1134 1417	MHz
Input Clocks (CKIN1, CKIN2)						
Differential Voltage Swing	CKN_{DPP}		0.25	—	1.9	VPP
Common Mode Voltage	CKN_{VCM}	1.8 V ±10%	0.9	—	1.4	V
		2.5 V ±10%	1.0	—	1.7	V
		3.3 V ±10%	1.1	—	1.95	V
Rise/Fall Time	CKN_{TRF}	20–80%	—	—	11	ns
Duty Cycle	CKN_{DC}	Whichever is less	40	—	60	%
			50	—	—	ns
Output Clocks (CKOUT1, CKOUT2)						
Common Mode	V_{OCM}	LVPECL 100 Ω load line-to-line	V_{DD} – 1.42	—	V_{DD} – 1.25	V
Differential Output Swing	V_{OD}		1.1	—	1.9	
Single Ended Output Swing	V_{SE}		0.5	—	0.93	V
Rise/Fall Time	CKO_{TRF}	20–80%	—	230	350	ps

Note: For a more comprehensive listing of device specifications, please consult the Silicon Laboratories Any-Rate Precision Clock Family Reference Manual. This document can be downloaded from www.silabs.com/timing.

Table 1. Performance Specifications (Continued)
(V_{DD} = 1.8, 2.5, or 3.3 V ±10%, T_A = –40 to 85 ºC)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Duty Cycle	CKO_{DC}		45	—	55	%
PLL Performance						
Jitter Generation	J_{GEN}	f_{OUT} = 622.08 MHz, LVPECL output format 50 kHz–80 MHz	—	0.3	TBD	ps rms
		12 kHz–20 MHz	—	0.3	TBD	ps rms
		800 Hz–80 MHz	—	TBD	TBD	ps rms
Jitter Transfer	J_{PK}		—	0.05	0.1	dB
External Reference Jitter Transfer	J_{PKEXTN}		—	TBD	TBD	dB
Phase Noise	CKO_{PN}	f_{OUT} = 622.08 MHz 100 Hz offset	—	TBD	TBD	dBc/Hz
		1 kHz offset	—	TBD	TBD	dBc/Hz
		10 kHz offset	—	TBD	TBD	dBc/Hz
		100 kHz offset	—	TBD	TBD	dBc/Hz
		1 MHz offset	—	TBD	TBD	dBc/Hz
Subharmonic Noise	SP_{SUBH}	Phase Noise @ 100 kHz Offset	—	TBD	TBD	dBc
Spurious Noise	SP_{SPUR}	Max spur @ n x F3 (n ≥ 1, n x F3 < 100 MHz)	—	TBD	TBD	dBc
Package						
Thermal Resistance Junction to Ambient	Theta JA	Still Air	—	TBD	—	ºC/W

Note: For a more comprehensive listing of device specifications, please consult the Silicon Laboratories Any-Rate Precision Clock Family Reference Manual. This document can be downloaded from www.silabs.com/timing.

Table 2. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	–0.5 to 3.6	V
LVCMOS Input Voltage	V_{DIG}	–0.3 to (V_{DD} + 0.3)	V
Operating Junction Temperature	T_{JCT}	–55 to 150	ºC
Storage Temperature Range	T_{STG}	–55 to 150	ºC
ESD HBM Tolerance (100 pF, 1.5 kΩ)		2	kV
ESD MM Tolerance		200	V
Latch-Up Tolerance		JESD78 Compliant	

Note: Permanent device damage may occur if the Absolute Maximum Ratings are exceeded. Functional operation should be restricted to the conditions as specified in the operation sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods of time may affect device reliability.

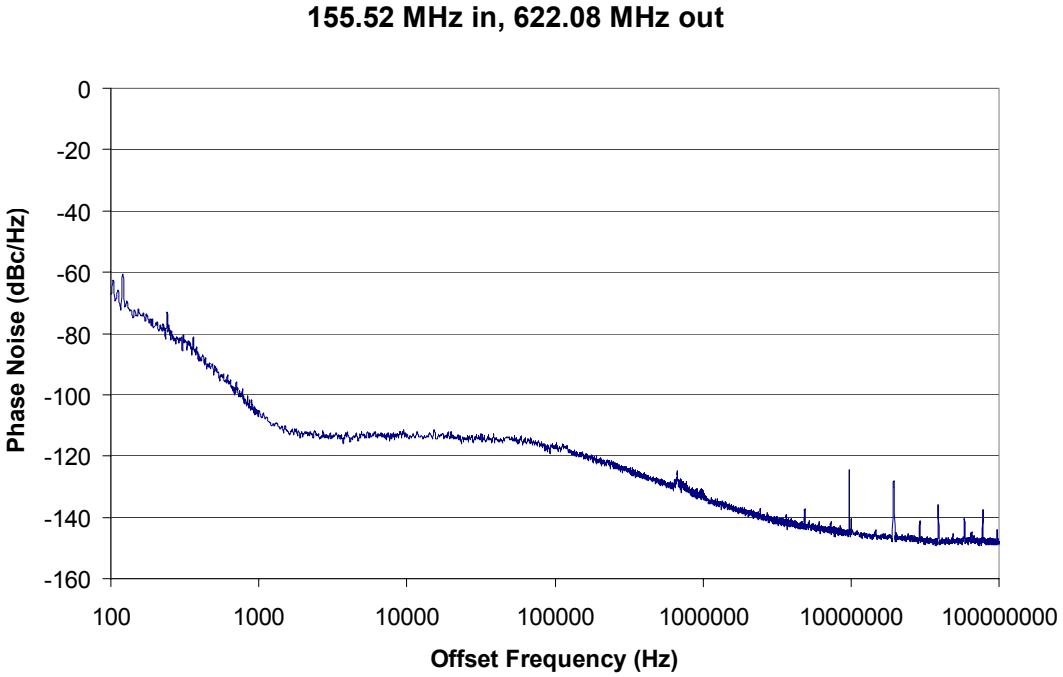
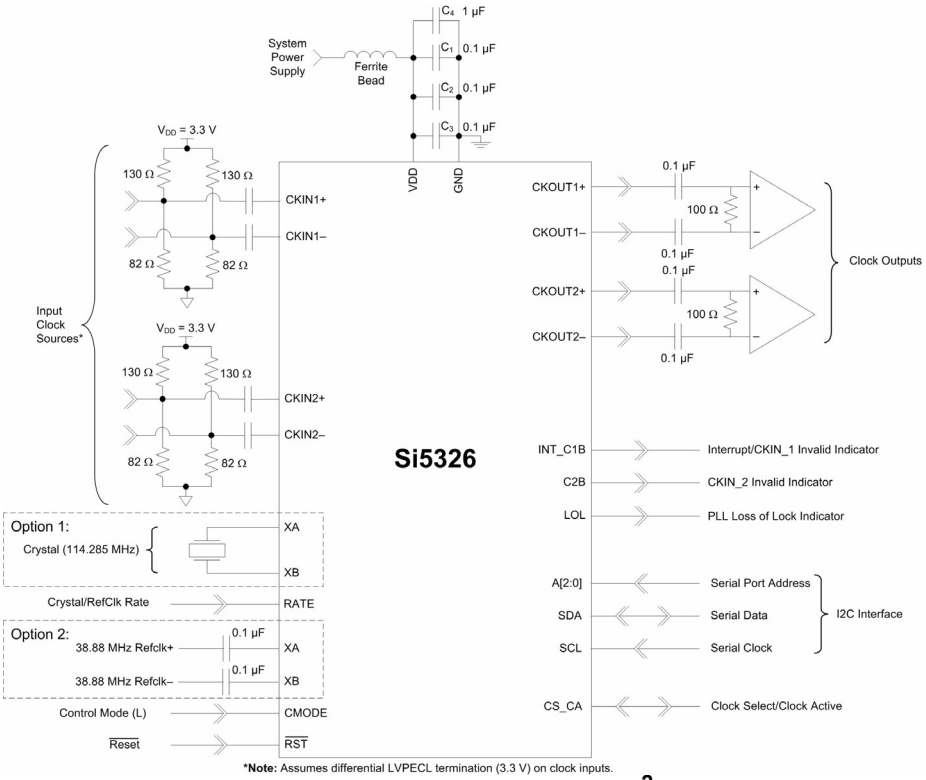
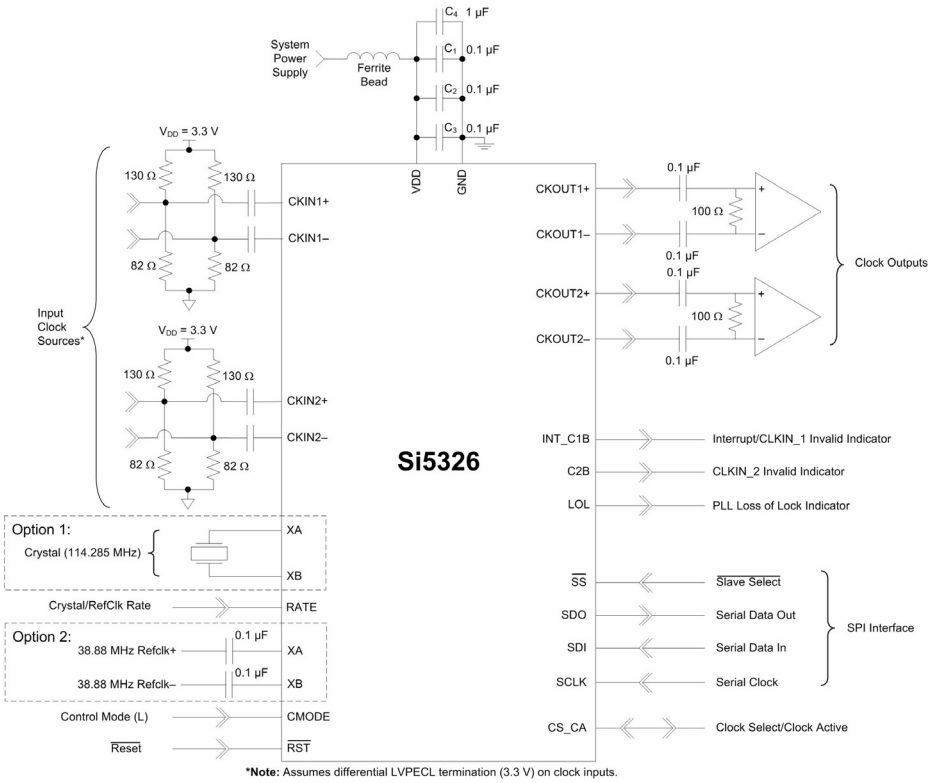


Figure 1. Typical Phase Noise Plot



*Note: Assumes differential LVPECL termination (3.3 V) on clock inputs.

Figure 2. Si5326 Typical Application Circuit (I^2C Control Mode)



*Note: Assumes differential LVPECL termination (3.3 V) on clock inputs.

Figure 3. Si5326 Typical Application Circuit (SPI Control Mode)

1. Functional Description

The Si5326 is a jitter-attenuating precision clock multiplier for applications requiring sub 1 ps jitter performance. The Si5326 accepts dual clock inputs ranging from 2 kHz to 710 MHz and generates two independent, synchronous clock outputs ranging from 2 kHz to 945 MHz and select frequencies to 1.4 GHz. The device provides virtually any frequency translation combination across this operating range. Independent dividers are available for each input clock and output clock, so the Si5326 can accept input clocks at different frequencies and it can generate output clocks at different frequencies. The Si5326 input clock frequency and clock multiplication ratio are programmable through an I^2C or SPI interface. Silicon Laboratories offers a PC-based software utility, DSPLL*sim*, that can be used to determine the optimum PLL divider settings for a given input frequency/clock multiplication ratio combination that minimizes phase noise and power consumption. This utility can be downloaded from www.silabs.com/timing.

The Si5326 is based on Silicon Laboratories' 3rd-generation DSPLL® technology, which provides any-rate frequency synthesis and jitter attenuation in a highly integrated PLL solution that eliminates the need for external VCXO and loop filter components. The Si5326 PLL loop bandwidth is digitally programmable and supports a range from 60 Hz to 8.4 kHz. The DSPLL*sim* software utility can be used to calculate valid loop bandwidth settings for a given input clock frequency/clock multiplication ratio.

The Si5326 supports hitless switching between the two input clocks in compliance with GR-253-CORE and GR-1244-CORE that greatly minimizes the propagation of phase transients to the clock outputs during an input clock transition (<200 ps typ). Manual and automatic revertive and non-revertive input clock switching options are available. The Si5326 monitors both input clocks for loss-of-signal and provides a LOS alarm when it detects missing pulses on either input clock. The device monitors the lock status of the PLL. The lock detect algorithm works by continuously monitoring the phase of the input clock in relation to the phase of the feedback clock. The Si5326 also monitors frequency offset alarms (FOS), which indicate if an input clock is within a specified frequency precision relative to the frequency of a reference clock. Both Stratum 3/3E and SONET Minimum Clock (SMC) FOS thresholds are supported.

The Si5326 provides a digital hold capability that allows the device to continue generation of a stable output clock when the selected input reference is lost. During digital hold, the DSPLL generates an output frequency based on a historical average frequency that existed a fixed amount of time before the error event occurred, eliminating the effects of phase and frequency transients that may occur immediately preceding digital hold.

Fine phase adjustment is available and is set using the *FLAT* register bits. The nominal range and resolution of the *FLAT*[14:0] latency adjustment word are: ±110 ps and 3.05 ps respectively.

The Si5326 has two differential clock outputs. The electrical format of each clock output is independently programmable to support LVPECL, LVDS, CML, or CMOS loads. If not required, the second clock output can be powered down to minimize power consumption. The phase difference between the selected input clock and the output clocks is adjustable in 200 ps increments for system skew control. In addition, the phase of one output clock may be adjusted in relation to the phase of the other output clock. The resolution varies from 800 ps to 2.2 ns depending on the PLL divider settings. Consult the DSPLL*sim* configuration software to determine the phase offset resolution for a given input clock/clock multiplication ratio combination. For system-level debugging, a bypass mode is available which drives the output clock directly from the input clock, bypassing the internal DSPLL. The device is powered by a single 1.8, 2.5, or 3.3 V supply.

1.1. External Reference

An external, high quality 38.88 MHz clock or a low-cost 114.285 MHz 3rd overtone crystal is used as part of a fixed-frequency oscillator within the DSPLL. This external reference is required for the device to perform jitter attenuation. Silicon Laboratories recommends using a high-quality crystal from TXC (www.txc.com.tw), part number 7MA1400014. An external 38.88 MHz clock from a high quality OCXO or TCXO can also be used as a reference for the device.

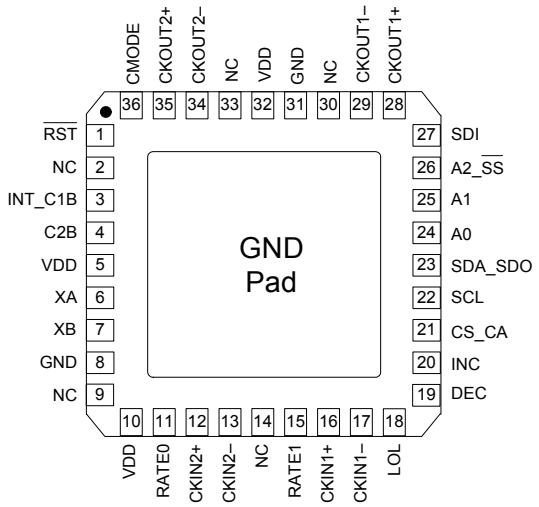
In digital hold, the DSPLL remains locked to this external reference. Any changes in the frequency of this reference when the DSPLL is in digital hold will be tracked by the output of the device. Note that crystals can have temperature sensitivities.

1.2. Further Documentation

Consult the Silicon Laboratories Any-Rate Precision Clock Family Reference Manual (FRM) for more detailed information about the Si5326. The FRM can be downloaded from www.silabs.com/timing.

Silicon Laboratories has developed a PC-based software utility called DSPLL*sim* to simplify device configuration, including frequency planning and loop bandwidth selection. This utility can be downloaded from www.silabs.com/timing.

2. Pin Descriptions: Si5326



Pin numbers are preliminary and subject to change.

Pin #	Pin Name	I/O	Signal Level	Description
1	$\overline{\text{RST}}$	I	LVCMOS	**External Reset.** Active low input that performs external hardware reset of device. Resets all internal logic to a known state and forces the device registers to their default value. Clock outputs are tristated during reset. After rising edge of $\overline{\text{RST}}$ signal, the Si5326 will perform an internal self-calibration. This pin has a weak pull-up.
2, 9, 14, 30, 33	NC	—	—	**No Connect.** This pin must be left unconnected for normal operation.
3	INT_C1B	O	LVCMOS	**Interrupt/CKIN1 Invalid Indicator.** This pin functions as a device interrupt output or an alarm output for CKIN1. If used as an interrupt output, *INT_PIN* must be set to 1. The pin functions as a maskable interrupt output with active polarity controlled by the *INT_POL* register bit. If used as an alarm output, the pin functions as a LOS (and optionally FOS) alarm indicator for CKIN1. Set *CK1_BAD_PIN* = 1 and *INT_PIN* = 0. 0 = CKIN1 present. 1 = LOS (FOS) on CKIN1. The active polarity is controlled by *CK_BAD_POL*. If no function is selected, the pin tristates.
Note: Internal register names are indicated by underlined italics, e.g. *INT_PIN*. See Si5326 Register Map.				

Pin #	Pin Name	I/O	Signal Level	Description
4	C2B	O	LVCMOS	**CKIN2 Invalid Indicator.** This pin functions as a LOS (and optionally FOS) alarm indicator for CKIN2 if *CK2_BAD_PIN* = 1. 0 = CKIN2 present. 1 = LOS (FOS) on CKIN2. The active polarity can be changed by *CK_BAD_POL*. If *CK2_BAD_PIN* = 0, the pin tristates.
5, 10, 32	V_{DD}	V_{DD}	Supply	**Supply.** The device operates from a 1.8, 2.5, or 3.3 V supply. Bypass capacitors should be associated with the following Vdd pins: 5 0.1 µF 10 0.1 µF 32 0.1 µF A 1.0 µF should be placed as close to the device as is practical.
7 6	XB XA	I	Analog	**External Crystal or Reference Clock.** External crystal should be connected to these pins to use internal oscillator based reference. If external reference is used, apply reference clock to XA input and leave XB pin floating. External reference must be from a high-quality clock source (TCXO, OCXO). Frequency of crystal or external clock is set by RATE[1:0] pins.
8, 31	GND	GND	Supply	**Ground.** Must be connected to system ground. Minimize the ground path impedance for optimal performance of this device.
11 15	RATE0 RATE1	I	3-Level	**External Crystal or Reference Clock Rate.** Three level inputs that select the type and rate of external crystal or reference clock to be applied to the XA/XB port. LM = 38.88 MHz external clocks MM = 114.285 MHz 3rd OT crystal HH = converts part to Si5325, and no external crystal or reference is needed
16 17	CKIN1+ CKIN1–	I	Multi	**Clock Input 1.** Differential input clock. This input can also be driven with a single-ended signal. Input frequency range is 2 kHz to 710 MHz.
12 13	CKIN2+ CKIN2–	I	Multi	**Clock Input 2.** Differential input clock. This input can also be driven with a single-ended signal. Input frequency range is 2 kHz to 710 MHz.
18	LOL	O	LVCMOS	**PLL Loss of Lock Indicator.** This pin functions as the active high PLL loss of lock indicator if the LOL_PIN register bit is set to 1. 0 = PLL locked. 1 = PLL unlocked. If *LOL_PIN* = 0, this pin will tristate. Active polarity is controlled by the *LOL_POL* bit. The PLL lock status will always be reflected in the *LOL_INT* read only register bit.

Note: Internal register names are indicated by underlined italics, e.g. *INT_PIN*. See Si5326 Register Map.

Pin #	Pin Name	I/O	Signal Level	Description
19	DEC	I	LVCMOS	**Latency Decrement.** A pulse on this pin decreases the input to output device latency by $1/f_{OSC}$ (approximately 200 ps). There is no limit on the range of latency adjustment by this method. Pin control is enabled by setting *INCDEC_PIN* = 1. If *INCDEC_PIN* = 0, this pin is ignored and output latency is controlled via the *CLAT* register. If both INC and DEC are tied high, phase buildout is disabled and the device maintains a fixed-phase relationship between the selected input clock and the output clock during an input clock switch. This pin has a weak pull-down.
20	INC	I	LVCMOS	**Latency Increment.** A pulse on this pin increases the input to output device latency by $1/f_{OSC}$ (approximately 200 ps). There is no limit on the range of latency adjustment by this method. Pin control is enabled by setting *INCDEC_PIN* = 1. If *INCDEC_PIN* = 0, this pin is ignored and output latency is controlled via the *CLAT* register. If both INC and DEC are tied high, phase buildout is disabled and the device maintains a fixed-phase relationship between the selected input clock and the output clock during an input clock switch. This pin has a weak pull-down.
21	CS_CA	I/O	LVCMOS	**Input Clock Select/Active Clock Indicator.** In manual clock selection mode, this pin functions as the manual input clock selector if the *CKSEL_PIN* is set to 1. 0 = Select CKIN1. 1 = Select CKIN2. If *CKSEL_PIN* = 0, the *CKSEL_REG* register bit controls this function and this input tristates. In automatic clock selection mode, this pin indicates which of the two input clocks is currently the active clock. If alarms exist on both clocks, CK_ACTV will indicate the last active clock that was used before entering the digital hold state. The *CK_ACTV_PIN* register bit must be set to 1 to reflect the active clock status to the CK_ACTV output pin. 0 = CKIN1 active input clock. 1 = CKIN2 active input clock. If *CK_ACTV_PIN* = 0, this pin will tristate. The CK_ACTV status will always be reflected in the *CK_ACTV_REG* read only register bit. This pin has a weak pull-down.
22	SCL	I	LVCMOS	**Serial Clock/Serial Clock.** This pin functions as the serial clock input for both SPI and I^2C modes.
Note: Internal register names are indicated by underlined italics, e.g. *INT_PIN*. See Si5326 Register Map.				

Pin #	Pin Name	I/O	Signal Level	Description
23	SDA_SDO	I/O	LVCMOS	**Serial Data.** In I^2C control mode (CMODE = 0), this pin functions as the bidirectional serial data port. In SPI control mode (CMODE = 1), this pin functions as the serial data output.
25 24	A1 A0	I	LVCMOS	**Serial Port Address.** In I^2C control mode (CMODE = 0), these pins function as hardware controlled address bits. In SPI control mode (CMODE = 1), these pins are ignored.
26	A2_$\overline{SS}$	I	LVCMOS	**Serial Port Address/Slave Select.** In I^2C control mode (CMODE = 0), this pin functions as a hardware controlled address bit. In SPI control mode (CMODE = 1), this pin functions as the slave select input.
27	SDI	I	LVCMOS	**Serial Data In.** In I^2C control mode (CMODE = 0), this pin is ignored. In SPI control mode (CMODE = 1), this pin functions as the serial data input.
29 28	CKOUT1– CKOUT1+	O	Multi	**Output Clock 1.** Differential output clock with a frequency range of 10 MHz to 1.4175 GHz. Output signal format is selected by *SFOUT1_REG* register bits. Output is differential for LVPECL, LVDS, and CML compatible modes. For CMOS format, both output pins drive identical single-ended clock outputs.
34 35	CKOUT2– CKOUT2+	O	Multi	**Output Clock 2.** Differential output clock with a frequency range of 10 MHz to 1.4175 GHz. Output signal format is selected by *SFOUT2_REG* register bits. Output is differential for LVPECL, LVDS, and CML compatible modes. For CMOS format, both output pins drive identical single-ended clock outputs.
36	CMODE	I	LVCMOS	**Control Mode.** Selects I^2C or SPI control mode for the Si5326. 0 = I^2C Control Mode 1 = SPI Control Mode
GND PAD	GND	GND	Supply	**Ground Pad.** The ground pad must provide a low thermal and electrical impedance to a ground plane.
Note: Internal register names are indicated by underlined italics, e.g. *INT_PIN*. See Si5326 Register Map.				

3. Ordering Guide

Ordering Part Number	Output Clock Frequency Range	Package	Temperature Range
Si5326A-B-GM	2 kHz–945 MHz 970–1134 MHz 1.213–1.417 GHz	36-Lead 6 x 6 mm QFN	–40 to 85 °C
Si5326B-B-GM	2 kHz–808 MHz	36-Lead 6 x 6 mm QFN	–40 to 85 °C
Si5326C-B-GM	2 kHz–346 MHz	36-Lead 6 x 6 mm QFN	–40 to 85 °C

4. Package Outline: 36-Pin QFN

Figure 4 illustrates the package details for the Si5326. Table 3 lists the values for the dimensions shown in the illustration.

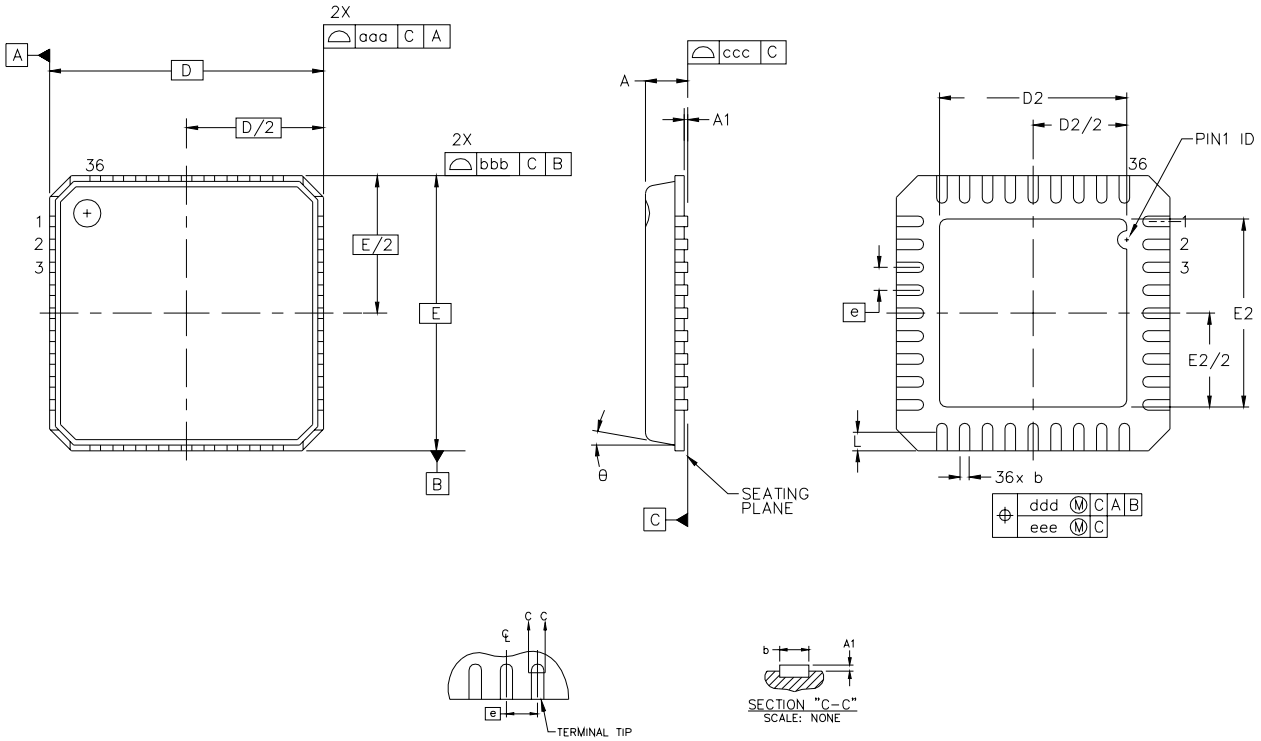


Figure 4. 36-Pin Quad Flat No-lead (QFN)

Table 3. Package Dimensions

Symbol	Millimeters		
	Min	Nom	Max
A	0.80	0.85	0.90
A1	0.00	0.01	0.05
b	0.18	0.23	0.30
D		6.00 BSC	
D2	3.95	4.10	4.25
e		0.50 BSC	
E		6.00 BSC	
E2	3.95	4.10	4.25

Symbol	Millimeters		
	Min	Nom	Max
L	0.50	0.60	0.75
θ	—	—	12º
aaa	—	—	0.10
bbb	—	—	0.10
ccc	—	—	0.05
ddd	—	—	0.10
eee	—	—	0.05

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 JEDEC outline MO-220, variation VJJD.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020C specification for Small Body Components.

5. Recommended PCB Layout

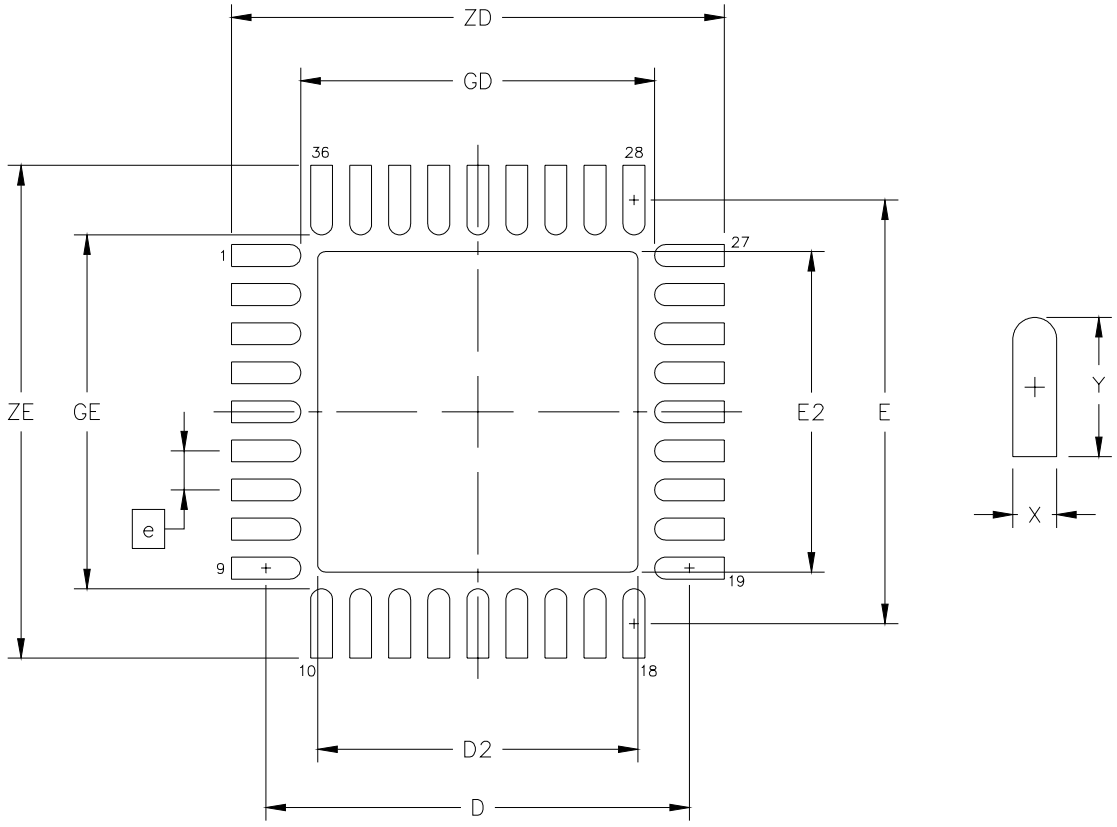


Figure 5. PCB Land Pattern Diagram

Table 4. PCB Land Pattern Dimensions

Dimension	MIN	MAX
e	0.50 BSC.	
E	5.42 REF.	
D	5.42 REF.	
E2	4.00	4.20
D2	4.00	4.20
GE	4.53	—
GD	4.53	—
X	—	0.28
Y	0.89 REF.	
ZE	—	6.31
ZD	—	6.31

Notes (General):

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing is per the ANSI Y14.5M-1994 specification.
3. This Land Pattern Design is based on IPC-SM-782 guidelines.
4. All dimensions shown are at Maximum Material Condition (MMC). Least Material Condition (LMC) is calculated based on a Fabrication Allowance of 0.05 mm.

Notes (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.

Notes (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 the perimeter pads.
4. A 4 x 4 array of 0.80 mm square openings on 1.05 mm pitch should be used for the center ground pad.

Notes (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-020C specification for Small Body Components.

DOCUMENT CHANGE LIST

Revision 0.1 to Revision 0.2

- Updated LVTTL to LVCMOS is Table 2, “Absolute Maximum Ratings,” on page 3.
- Added Figure 1, “Typical Phase Noise Plot,” on page 4.
- Updated Figure 2, “Si5326 Typical Application Circuit (I^2C Control Mode),” and Figure 3, “Si5326 Typical Application Circuit (SPI Control Mode),” on page 5 to show preferred external reference interface.
- Updated “2. Pin Descriptions: Si5326”.
  - Added RATE0 and changed RATE to RATE1 and expanded RATE[1:0] description.
  - Changed font of register names to *underlined italics*.
- Updated "3. Ordering Guide" on page 11.
- Added "4. Package Outline: 36-Pin QFN" on page 12.
- Added “5. Recommended PCB Layout”.

CONTACT INFORMATION

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