## AEC-Q100, Ultra-low Jitter Differential Oscillator



#### **Features**

- AEC-Q100 with extended temperature range (-40°C to 105°C)
- Any frequency between 1 MHz and 220 MHz, accurate to 6 decimal places. For frequency between 220 and 725 MHz, see SiT9387
- LVPECL, LVDS and HCSL output signaling types
- 0.23 ps RMS (typ) phase jitter (random, 12 kHz to 20 MHz)
- Frequency stability as low as ±25 ppm contact SiTime
- Industry-standard packages: 3.2 x 2.5, 7.0 x 5.0 mm
   Contact SiTime for 5.0 x 3.2 mm package

# **Applications**

- Automotive, and other high reliability electronics
- Infotainment systems, collision detection devices and in-vehicle 10/40/100 Gbps Ethernet

## **Electrical Characteristics**

All Min and Max limits in the Electrical Characteristics tables are specified over temperature and rated operating voltage with standard output termination show in the termination diagrams. Typical values are at 25°C and nominal supply voltage.

Table 1. Electrical Characteristics — Common to LVPECL, LVDS and HCSL

Parameter	Symbol	Min.	Тур.	Max.	Unit	Condition	
Falametei	Syllibol	IVIIII.		uency Rang		Condition	
Output Frequency Range	f	1	_	220	MHz	Accurate to 6 decimal places	
Carpar requesto, range		<u> </u>	Fregu	ency Stabili		/ todalate to a decimal places	
Frequency Stability		-25	-	+25	ppm	Inclusive of initial tolerance, operating temperature, rated power supply voltage and load variations. Contact SiTime for ± 25 ppm.	
		-50	-	+50	ppm	Inclusive of initial tolerance, operating temperature, rated power supply voltage and load variations.	
First Year Aging	F_1y	-	±1	-	ppm	At 25°C	
			Temp	erature Rang	ge		
O	_	-40	-	+85	°C	Industrial	
Operating Temperature Range	T_use	-40	-	+105	ç	Extended Industrial	
			Sup	ply Voltage			
	Vdd	2.97	3.3	3.63	V		
Summly Voltage		2.7	3.0	3.3	V		
Supply Voltage		2.52	2.8	3.08	V		
		2.25	2.5	2.75	V		
			Input (	Characterist	ics		
Input Voltage High	VIH	70%	-	-	Vdd	Pin 1, OE	
Input Voltage Low	VIL	-	-	30%	Vdd	Pin 1, OE	
Input Pull-up Impedance	Z_in	_	100	-	kΩ	Pin 1, OE logic high or logic low	
			Output	Characteris	stics		
Duty Cycle	DC	45	-	55	%		
			Startup	and OE Tim	ing		
Start-up Time	T_start	_	-	3.0	ms	Measured from the time Vdd reaches its rated minimum value.	
OE Enable/Disable Time	T_oe	-	-	3.8	μs	f = 156.25 MHz.	



Table 2. Electrical Characteristics - LVPECL

Parameter	Symbol	Min.	Тур.	Max.	Unit	Condition	
				Current C	onsump	otion	
<b>Current Consumption</b>	ldd	-	_	89	mA	Excluding Load Termination Current, Vdd = 3.3V or 2.5V	
OE Disable Supply Current	I_OE	-	-	58	mA	OE = Low	
Output Disable Leakage Current	I_leak	_	0.15	ı	μΑ	OE = Low	
Maximum Output Current	I_driver	-	-	32	mA	Maximum average current drawn from OUT+ or OUT-	
	Output Characteristics						
Output High Voltage	VOH	Vdd-1.1	-	Vdd-0.7	V	See Figure 2	
Output Low Voltage	VOL	Vdd-1.9	-	Vdd-1.5	V	See Figure 2	
Output Differential Voltage Swing	V_Swing	1.2	1.6	2.0	٧	See Figure 3	
Rise/Fall Time	Tr, Tf	_	225		ps	20% to 80%, see Figure 2	
				J	itter		
RMS Phase Jitter (random)	T_phj	-	0.220		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 7.0 x 5.0 mm package.	
		-	0.225		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 3.2 x 2.5 mm package.	
		_	0.1	- 1	ps	f = 156.25, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels.	
RMS Period Jitter <sup>[1]</sup>	T_jitt	_	1.0		ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3V or 2.5V	

## Notes:

## Table 3. Electrical Characteristics - LVDS

Parameter	Symbol	Min.	Тур.	Max.	Unit	Condition
			(	Current Co	onsumpti	on
Current Consumption	ldd	_	_	79	mA	Excluding Load Termination Current, Vdd = 3.3V or 2.5V
OE Disable Supply Current	I_OE	-	-	58	mA	OE = Low
Output Disable Leakage Current	I_leak	-	0.15	-	μА	OE = Low
Output Characteristics						
Differential Output Voltage	VOD	250	-	455	mV	See Figure 4
VOD Magnitude Change	ΔVOD	_	-	50	mV	See Figure 4
Offset Voltage	VOS	1.125	-	1.375	V	See Figure 4
VOS Magnitude Change	ΔVOS	_	-	50	mV	See Figure 4
Rise/Fall Time	Tr, Tf	-	400		ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 4
					Jitter	
RMS Phase Jitter (random)	T_phj	-	0.215		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 7.0 x 5.0 mm package.
			0.235		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 3.2 x 2.5 mm package.
		-	0.1	-	ps	f = 156.25, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels.
RMS Period Jitter <sup>[2]</sup>	T_jitt	_	1.0		ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3V or 2.5V

#### Notes:

2. Measured according to JESD65B

<sup>1.</sup> Measured according to JESD65B



Table 4. Electrical Characteristics - HCSL

Parameter	Symbol	Min.	Тур.	Max.	Unit	Condition
				Current C	onsump	otion
Current Consumption	ldd	1		89	mA	Excluding Load Termination Current, Vdd = 3.3V or 2.5V
OE Disable Supply Current	I_OE	Í	_	58	mA	OE = Low
Output Disable Leakage Current	I_leak	ı	0.15	ı	μΑ	OE = Low
Maximum Output Current	I_driver	Í	-	35	mA	Maximum average current drawn from OUT+ or OUT-
Output Characteristics						
Output High Voltage	VOH	0.60	-	0.90	V	See Figure 2
Output Low Voltage	VOL	-0.05	-	0.08	V	See Figure 2
Output Differential Voltage Swing	V_Swing	1.2	1.4	1.80	V	See Figure 3
Rise/Fall Time	Tr, Tf	-	360		ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 2
				•	Jitter	
RMS Phase Jitter (random)	T_phj	-	0.220		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 7.0 x 5.0 mm package.
			0.230		ps	f = 156.25 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs, 3.2 x 2.5 mm package.
		-	0.1	_	ps	f = 156.25, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels.
RMS Period Jitter <sup>[3]</sup>	T_jitt	_	1.0		ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3V or 2.5V

## Notes:

3. Measured according to JESD65B

## **Table 5. Pin Description**

Pin	Мар	Functionality					
1	OE/NC	Output Enable (OE)	H <sup>[4]</sup> : specified frequency output L: output is high impedance				
	Non (		H or L or Open: No effect on output frequency or other device functions				
2	NC	NA	No Connect; Leave it floating or connect to GND for better heat dissipation				
3	GND	Power	Vdd Power Supply Ground				
4	OUT+	Output	Oscillator output				
5	OUT-	Output	Complementary oscillator output				
6	Vdd	Power Power supply voltage <sup>[5]</sup>					

# Top View OE/NC 1 6 VDD NC 2 5 OUTGND 3 4 OUT+

Figure 1. Pin Assignments

## Notes:

- 4. In OE mode, a pull-up resistor of 10  $k\Omega$  or less is recommended if pin 1 is not externally driven.
- 5. A capacitor of value 0.1  $\mu$ F or higher between Vdd and GND is required. An additional 10  $\mu$ F capacitor between Vdd and GND is required for the best phase jitter performance



## **Table 6. Absolute Maximum Ratings**

Attempted operation outside the absolute maximum ratings may cause permanent damage to the part.

Actual performance of the IC is only guaranteed within the operational specifications, not at absolute maximum ratings.

Parameter	Min.	Max.	Unit
Vdd	-0.5	4.0	V
VIH		Vdd + 0.3V	V
VIL	-0.3		V
Storage Temperature	-65	150	°C
Maximum Junction Temperature		130	°C
Soldering Temperature (follow standard Pb-free soldering guidelines)		260	°C

# Table 7. Thermal Considerations<sup>[6]</sup>

Package	θ <sub>JA</sub> , 4 Layer Board (°C/W)	θ <sub>JC</sub> , Bottom (°C/W)
3225, 6-pin	80	30
7050, 6-pin	52	19

#### Notes:

6. Refer to JESD51 for  $\theta_{JA}$  and  $\theta_{JC}$  definitions, and reference layout used to determine the  $\theta_{JA}$  and  $\theta_{JC}$  values in the above table.

# Table 8. Maximum Operating Junction Temperature<sup>[7]</sup>

Max Operating Temperature (ambient)	Maximum Operating Junction Temperature
70°C	95°C
85°C	110°C
105°C	-

#### Notes:

7. Datasheet specifications are not guaranteed if junction temperature exceeds the maximum operating junction temperature.

## **Table 9. Environmental Compliance**

•			
Parameter	Test Conditions	Value	Unit
Mechanical Shock Resistance	MIL-STD-883F, Method 2002	10,000	g
Mechanical Vibration Resistance	MIL-STD-883F, Method 2007	70	g
Soldering Temperature (follow standard Pb free soldering guidelines)	MIL-STD-883F, Method 2003	260	°C
Moisture Sensitivity Level	MSL1 @ 260°C		
Electrostatic Discharge (HBM)	HBM, JESD22-A114	2,000	V
Charge-Device Model ESD Protection	JESD220C101	750	V
Latch-up Tolerance	JESD78 Co	ompliant	



# **Waveform Diagrams**

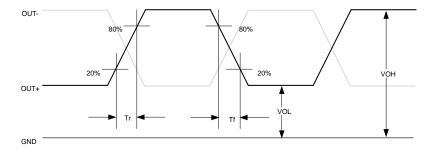


Figure 2. LVPECL/HCSL Voltage Levels per Differential Pin (OUT+/OUT-)

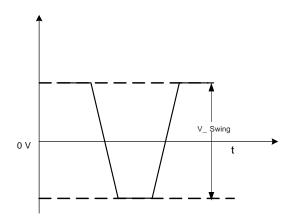


Figure 3. LVPECL/HCSL Voltage Levels across Differential Pair

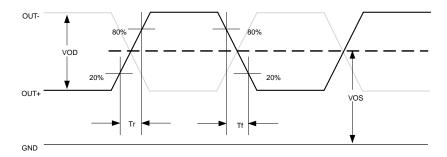


Figure 4. LVDS Voltage Levels per Differential Pin (OUT+/OUT-)



# **Termination Diagrams**

## LVPECL:

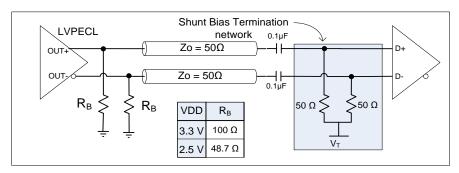


Figure 5. LVPECL with AC-coupled termination

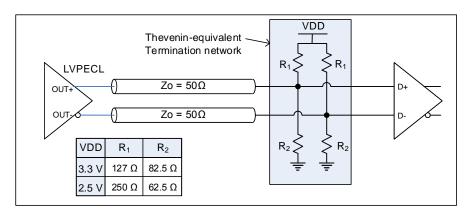


Figure 6. LVPECL DC-coupled load termination with Thevenin equivalent network

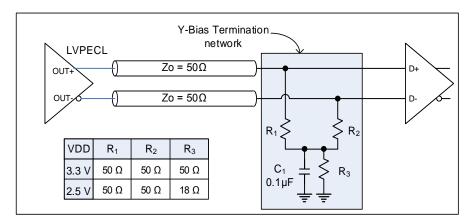


Figure 7. LVPECL with Y-Bias termination



# **Termination Diagrams (Continued)**

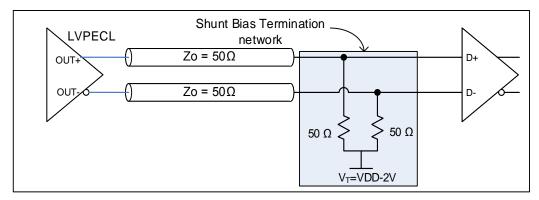


Figure 8. LVPECL with DC-coupled parallel shunt load termination



# **Termination Diagrams (Continued)**

## LVDS:

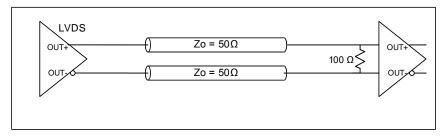


Figure 9. LVDS single DC termination at the load

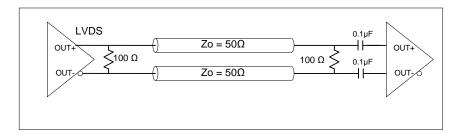


Figure 10. LVDS double AC termination with capacitor close to the load

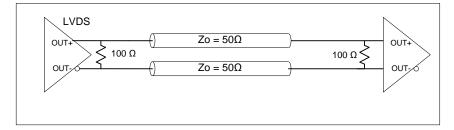


Figure 11. LVDS double DC termination



# **Termination Diagrams (Continued)**

# HCSL:

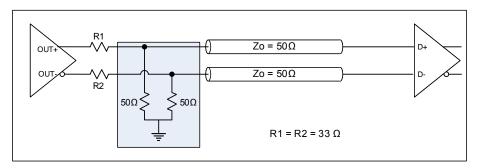
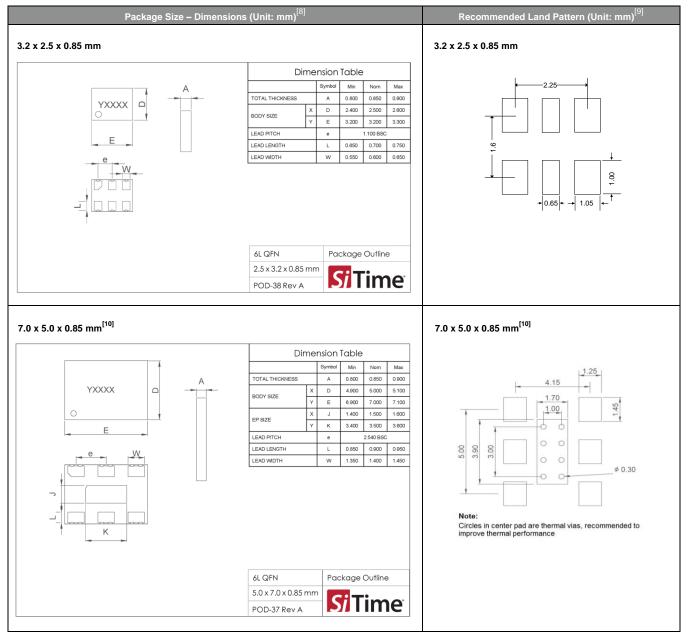


Figure 12. HCSL interface termination



## **Dimensions and Patterns**

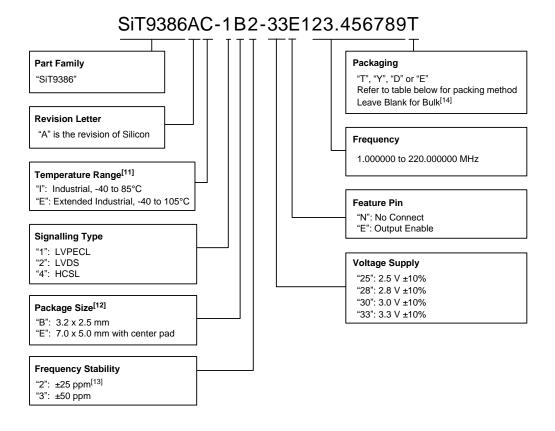


## Notes:

- 8. Top Marking: Y denotes manufacturing origin and XXXX denotes manufacturing lot number. The value of "Y" will depend on the assembly location of the device.
- 9. A capacitor of value 0.1 μF or higher between Vdd and GND is required. An additional 10 μF capacitor between Vdd and GND is required for the best phase jitter performance
- 10. The center pad has no electrical function. Soldering down the center pad to the GND is recommended for best thermal dissipation, but is optional.



# **Ordering Information**



#### Notes:

- 11. Contact SiTime for higher temperature range options.
- 12. Contact SiTime for 5.0 x 3.2 mm package.
- 13. Contact SiTime for ±25 ppm option.
- 14. Bulk is available for sampling only.

## Table 10. Ordering Codes for Supported Tape & Reel Packing Method

Device Size (mm x mm)	8 mm T&R (3ku)	8 mm T&R (1ku)	12 mm T&R (3ku)	12 mm T&R (1ku)	16 mm T&R (3ku)	16 mm T&R (1ku)
7.0 x 5.0	_	_	_	_	Т	Y
3.2 x 2.5	D	Е	Т	Υ	_	_



#### Table 11. Additional Information

Document	Description	Download Link
ECCN #: EAR99	Five character designation used on the commerce Control List (CCL) to identify dual use items for export control purposes.	
Part number Generator	Tool used to create the part number based on desired features.	_
Time Machine II	MEMS oscillator programmer	http://www.sitime.com/support/time-machine-oscillator-programmer
Field Programmable Oscillators	Devices that can be programmable in the field by Time Machine II	http://www.sitime.com/products/field-programmable-oscillators
Manufacturing Notes	Tape & Reel dimension, reflow profile and other manufacturing related info	http://www.sitime.com/component/docman/doc_download/243-manufacturing-notes-for-sitime-oscillators
Qualification Reports	RoHS report, reliability reports, composition reports	http://www.sitime.com/support/quality-and-reliability
Performance Reports	Additional performance data such as phase noise, current consumption and jitter for selected frequencies	http://www.sitime.com/support/performance-measurement-report
Termination Techniques	Termination design recommendations	http://www.sitime.com/support/application-notes
Layout Techniques	Layout recommendations	http://www.sitime.com/support/application-notes

## **Table 12. Revision History**

Revision	Release Date	Change Summary
0.1	03/11/2017	Initial draft
0.87	11/06/2017	Updated package drawings Corrected tape/reel ordering information Updated Electrical Characteristics based on characterization Included max numbers for IPJ Added additional information table Corrected formatting issues Increased temperature range from 95°C to 105°C Removed ±10 ppm options for automotive and industrial temperature ranges Changed ±20 ppm to "contact SiTime" Updated termination diagrams Lower mechanical shock from 20,000 to 10,000 g
0.90	11/24/2017	Ordering information updates and page layout changes

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