SiT9387

AEC-Q100, 220 to 725 MHz Ultra-low Jitter Differential Oscillator

Features

- AEC-Q100 Grade 2 temperature range (-40°C to 105°C). Grade 3 and Grade 4 also available
- Any frequency between 220.000001 MHz and 725 MHz, accurate to 6 decimal places. For HCSL output signaling, maximum frequency is 500 MHz – contact SiTime for higher frequency options. For frequency between 1 and 220 MHz, see SiT9386
- LVPECL, LVDS and HCSL output signaling
- Frequency stability as low as ±10 ppm – contact SiTime
- 0.23 ps RMS (typ) phase jitter (random, 12 kHz to 20 MHz)
- 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

- 100 Gbps Ethernet, SONET, SATA, SAS, Fibre Channel
- Telecom, networking, instrumentation, storage, servers

Electrical Characteristics

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

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.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Frequency Range						
Output Frequency Range	f	220.000001	–	725	MHz	Accurate to 6 decimal places
Frequency Stability						
Frequency Stability		-10	–	+10	ppm	Inclusive of initial tolerance, operating temperature, rated power supply voltage and load variations. Contact SiTime for ±10 ppm
		-20	–	+20	ppm	Inclusive of initial tolerance, operating temperature, rated power supply voltage and load variations
		-25	–	+25	ppm	
		-50	–	+50	ppm	
First Year Aging	F_aging1	–	±1	–	ppm	At 25°C
Temperature Range						
Operating Temperature Range	T_use	-20	–	+70	°C	AEC-Q100 Grade 4
		-40	–	+85	°C	AEC-Q100 Grade 3
		-40	–	+105	°C	AEC-Q100 Grade 2
Supply Voltage						
Supply Voltage	Vdd	2.97	3.30	3.63	V	
		2.70	3.00	3.30	V	
		2.52	2.80	3.08	V	
		2.25	2.50	2.75	V	
Input Characteristics						
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 Characteristics						
Duty Cycle	DC	45	–	55	%	
Startup and OE Timing						
Startup 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 = 322.265625 MHz. Measured from the time OE pin reaches rated VIH and VIL to the time clock pins reach 90% of swing and high-Z. See Figure 6 and Figure 7

Table 2. Electrical Characteristics – LVPECL Specific

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	Idd	–	–	94	mA	Excluding Load Termination Current, Vdd = 3.3 V or 2.5 V
OE Disable Supply Current	I_OE	–	–	63	mA	OE = Low
Output Disable Leakage Current	I_leak	–	0.15	–	µA	OE = Low
Maximum Output Current	I_driver	–	–	33	mA	Maximum average current drawn from OUT+ or OUT-
Output Characteristics						
Output High Voltage	VOH	Vdd-1.15	–	Vdd-0.7	V	See Figure 2
Output Low Voltage	VOL	Vdd-2.0	–	Vdd-1.5	V	See Figure 2
Output Differential Voltage Swing	V_Swing	1.2	1.6	2.0	V	See Figure 3
Rise/Fall Time	Tr, Tf	–	225	330	ps	20% to 80%, see Figure 3
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter[1]	T_jitt	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.220	0.270	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40 to 85ºC
		–	0.220	0.300	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 156.25 or 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, includes spurs, all Vdd levels
Jitter – 3.2 x 2.5 mm package						
RMS Period Jitter[1]	T_jitt	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.225	0.282	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40 to 85ºC
		–	0.225	0.315	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, Includes spurs, all Vdd levels

Notes:

1. Measured according to JESD65B.

Table 3. Electrical Characteristics – LVDS Specific

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	Idd	–	–	85	mA	Excluding Load Termination Current, Vdd = 3.3 V or 2.5 V
OE Disable Supply Current	I_OE	–	–	63	mA	OE = Low
Output Disable Leakage Current	I_leak	–	0.15	–	µA	OE = Low
Output Characteristics						
Differential Output Voltage	VOD	250	–	530	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	–	370	505	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 5
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter[2]	T_jitt	–	0.92	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.215	0.265	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40 to 85ºC
		–	0.215	0.280	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, Includes spurs, all Vdd levels
Jitter – 3.2 x 2.5 mm package						
RMS Period Jitter[2]	T_jitt	–	0.92	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.235	0.282	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40 to 85ºC.
		–	0.235	0.310	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, Includes spurs, all Vdd levels

Notes:

2. Measured according to JESD65B.

Table 4. Electrical Characteristics – HCSL Specific

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current Consumption						
Current Consumption	Idd	–	–	97	mA	Excluding Load Termination Current, Vdd = 3.3 V or 2.5 V
OE Disable Supply Current	I_OE	–	–	63	mA	OE = Low
Output Disable Leakage Current	I_leak	–	0.15	–	µA	OE = Low
Maximum Output Current	I_driver	–	–	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	1.9	V	See Figure 3
Rise/Fall Time	Tr, Tf	–	360	505	ps	Measured with 2 pF capacitive loading to GND, 20% to 80%, see Figure 3
Jitter – 7.0 x 5.0 mm package						
RMS Period Jitter[3]	T_jitt	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.215	0.265	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40-85ºC
		–	0.215	0.282	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, Includes spurs, all Vdd levels
Jitter – 3.2 x 2.5 mm package						
RMS Period Jitter[3]	T_jitt	–	1.0	1.6	ps	f = 100, 156.25 or 212.5 MHz, Vdd = 3.3 V or 2.5 V
RMS Phase Jitter (random)	T_phj	–	0.235	0.282	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature ranges -20 to 70ºC and -40 to 85ºC.
		–	0.235	0.305	ps	f = 322.265625 MHz, Integration bandwidth = 12 kHz to 20 MHz, all Vdd levels, includes spurs. Temperature range -40 to 105ºC
		–	0.1	–	ps	f = 322.265625 MHz, IEEE802.3-2005 10GbE jitter mask integration bandwidth = 1.875 MHz to 20 MHz, Includes spurs, all Vdd levels

Notes:

3. Measured according to JESD65.

Table 5. Pin Description

Pin	Map	Functionality	
1	OE/NC	Output Enable (OE)	H[4]: specified frequency output L: output is high impedance
		Non Connect (NC)	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[5]

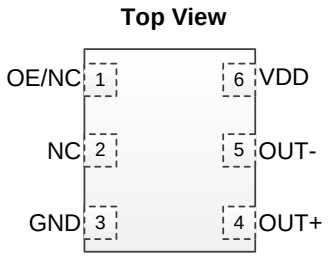


Figure 1. Pin Assignments

Notes:

4. In OE mode, a pull-up resistor of 10 kΩ or less is recommended if pin 1 is not externally driven.
5. 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.

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	ºC
Maximum Junction Temperature		130	ºC
Soldering Temperature (follow standard Pb-free soldering guidelines)		260	ºC

Table 7. Thermal Considerations[6]

Package	θ_{JA}, 4 Layer Board (°C/W)	θ_{JC}, Bottom (°C/W)
3225, 6-pin	80	30
7050, 6-pin	52	19

Notes:

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

Table 8. Maximum Operating Junction Temperature[7]

Max Operating Temperature (ambient)	Maximum Operating Junction Temperature
70°C	95°C
85°C	110°C
105°C	130°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 Compliant		

Waveform Diagrams

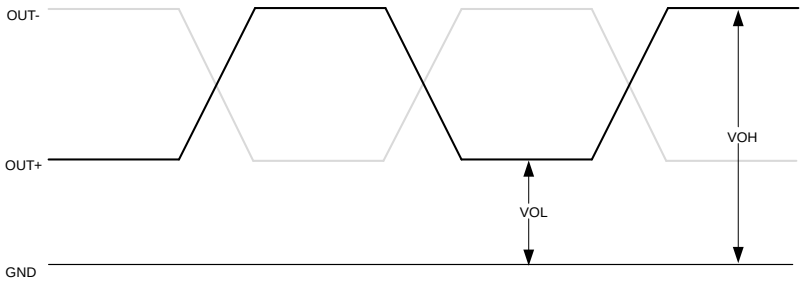


Figure 2. LVPECL/HCSL Voltage Levels per Differential Pin (OUT+/OUT-)

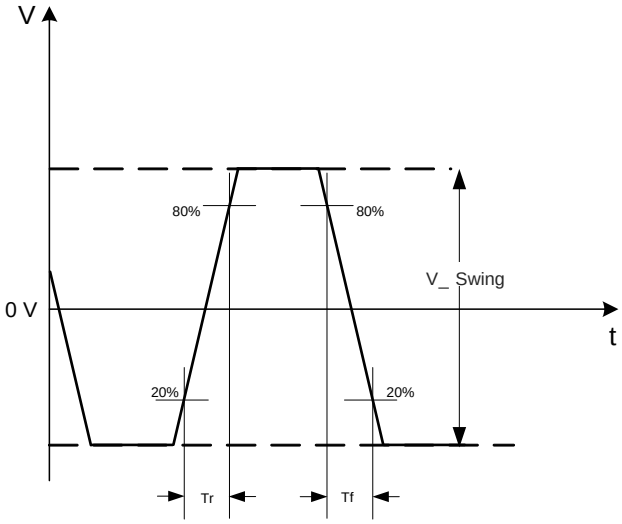


Figure 3. LVPECL/HCSL Voltage Levels across Differential Pair

Waveform Diagrams (continued)

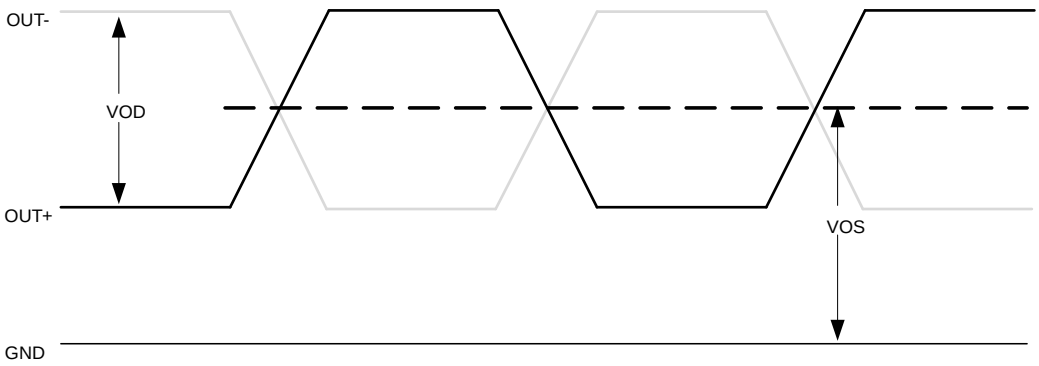


Figure 4. LVDS Voltage Levels per Differential Pin (OUT+/OUT-)

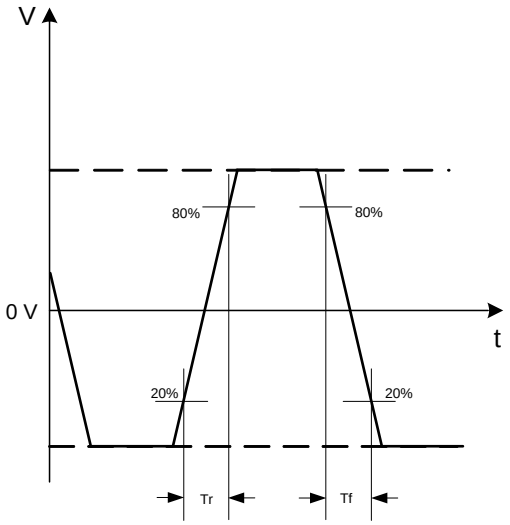


Figure 5. LVDS Differential Waveform

Timing Diagrams

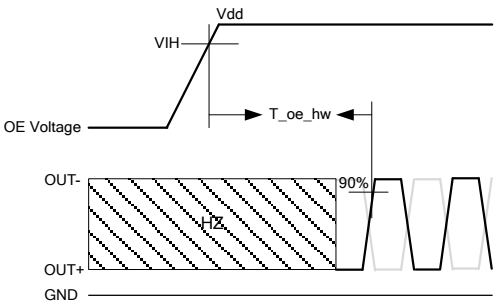


Figure 6. Hardware OE Enable Timing

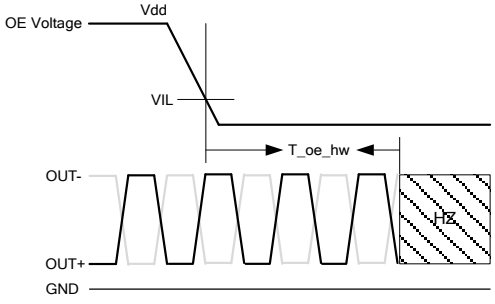


Figure 7. Hardware OE Disable Timing

Termination Diagrams

LVPECL

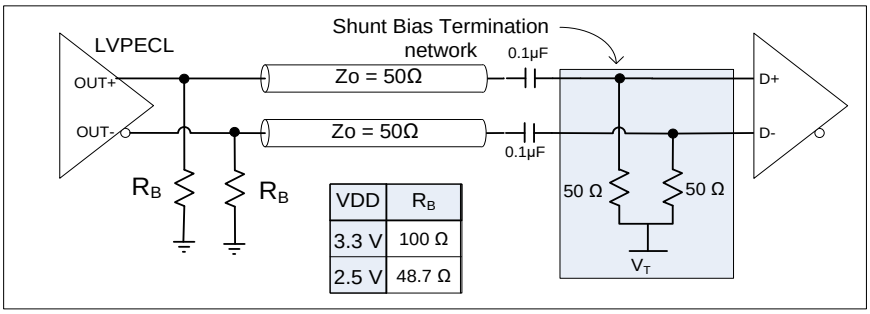


Figure 8. LVPECL with AC-coupled termination

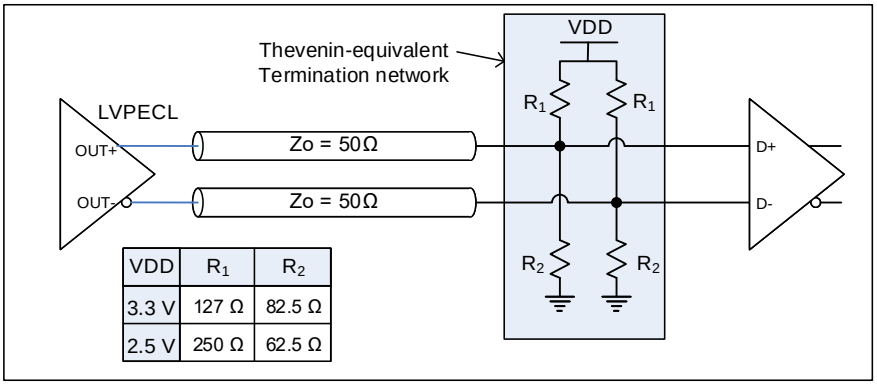


Figure 9. LVPECL DC-coupled load termination with Thevenin equivalent network

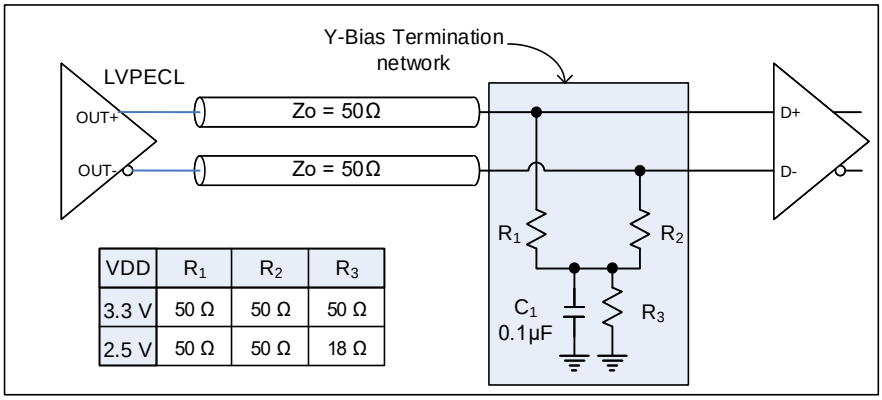


Figure 10. LVPECL with Y-Bias termination

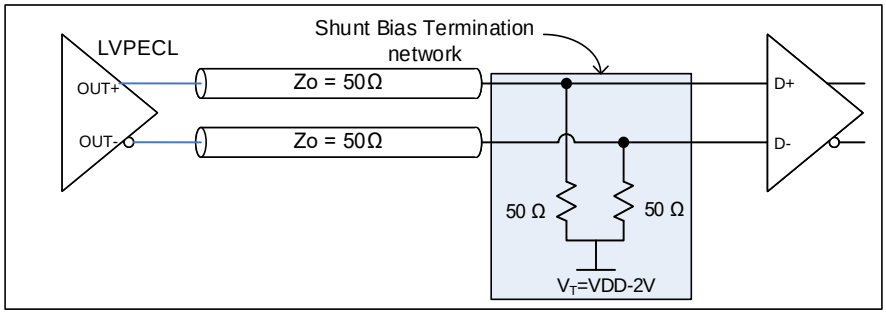


Figure 11. LVPECL with DC-coupled parallel shunt load termination

Termination Diagrams (continued)

LVDS

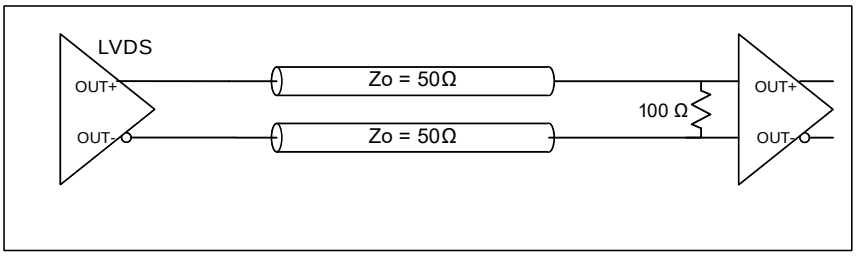


Figure 12. LVDS single DC termination at the load

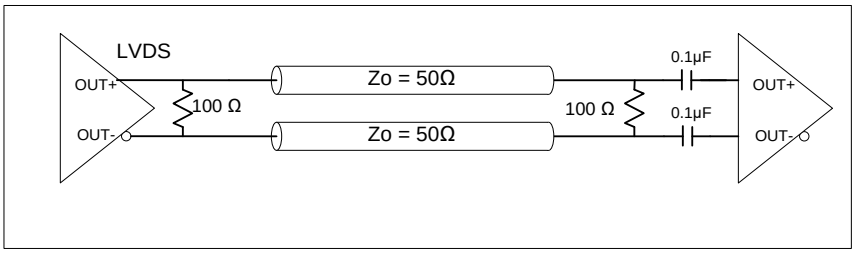


Figure 13. LVDS double AC termination with capacitor close to the load

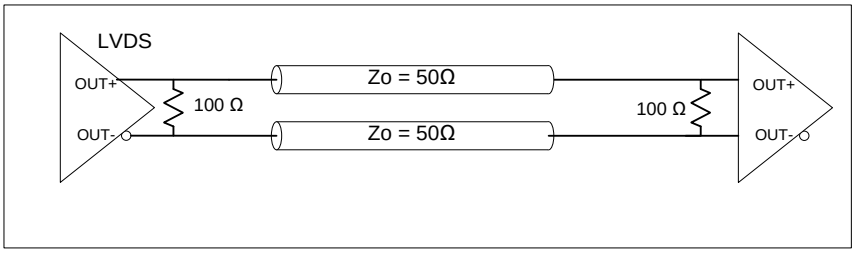


Figure 14. LVDS double DC termination

HCSL

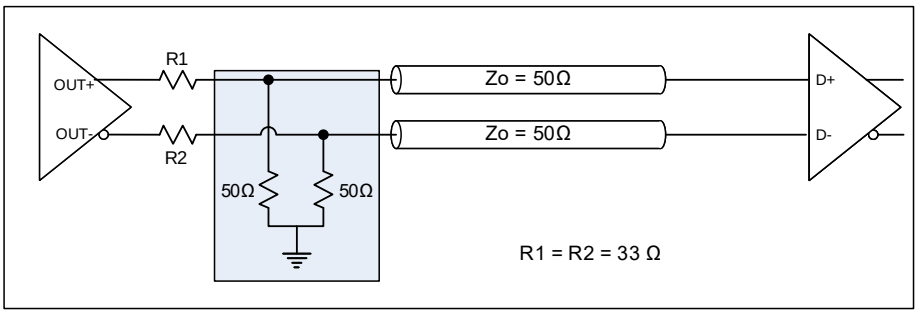
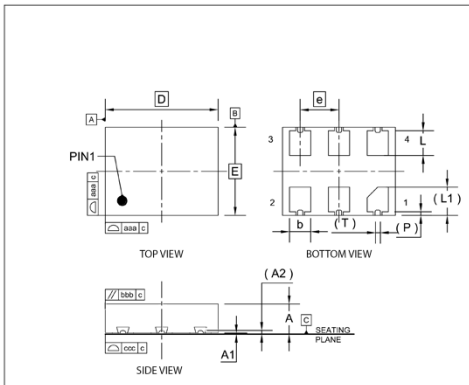


Figure 15. HCSL interface termination

Dimensions and Patterns

Package Size – Dimensions (Unit: mm)[8]	Recommended Land Pattern (Unit: mm)[9]

3.2 x 2.5 x 0.85 mm

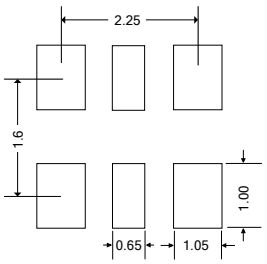


		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.800	0.850	0.900
STAND OFF		A1	0.000	0.035	0.050
BODY SIZE	X	D		3.200 BSC	
	Y	E		2.500 BSC	
LEAD WIDTH		b	0.550	0.600	0.650
LEAD LENGTH		L	0.650	0.700	0.750
		L1		0.800 REF	
LEAD PITCH		e		1.100 BSC	
PACKAGE TOLERNCE		aaa		0.100	
MOLD FLATNESS		bbb		0.100	
COPLANARITY		ccc		0.080	
DIMPLE WIDTH		T		0.150 REF	
DIMPLE LENGTH		P		0.150 REF	
DIMPLE DEPTH		A2		0.100 REF	

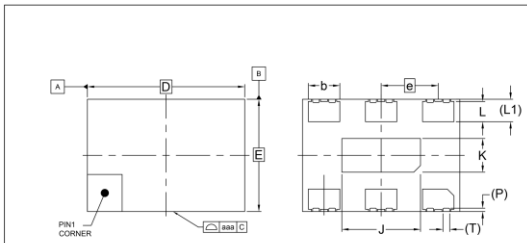
Notes
1. All dimensions are in millimeters

Package Outline	
6L PQFD	POD-038-PQFD-006-C03225
3.200x2.500x0.850 mm	SiTime
2020/09/23 Rev C00	

3.2 x 2.5 x 0.85 mm



7.0 x 5.0 x 0.85 mm[10]

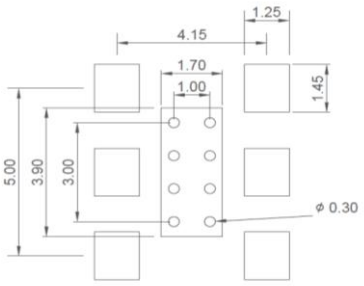


		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.800	0.850	0.900
STAND OFF		A1	0.000	0.035	0.050
BODY SIZE	X	D		7.000 BSC	
	Y	E		5.000 BSC	
EP SIZE	X	J	3.400	3.500	3.600
	Y	K	1.400	1.500	1.600
LEAD WIDTH		b	1.350	1.400	1.450
LEAD LENGTH		L	0.850	0.900	0.950
		L1		1.000 REF	
LEAD PITCH		e		2.540 BSC	
PACKAGE TOLERANCE		aaa		0.100	
MOLD FLATNESS		bbb		0.100	
COPLANRITY		ccc		0.080	
DIMPLE WIDTH		T		0.300 REF	
DIMPLE LENGTH		P		0.150 REF	
DIMPLE DEPTH		A2		0.100 REF	

Notes
1. Dimensioning and tolerancing conform to ASME Y14.5-2009
2. All dimensions are in millimeters

Package Outline	
6L PQFV	POD-PQFV-006-C07050-037
5.000x7.000x0.850 mm	SiTime
2019/03/13 Rev B00	

7.0 x 5.0 x 0.85 mm[10]

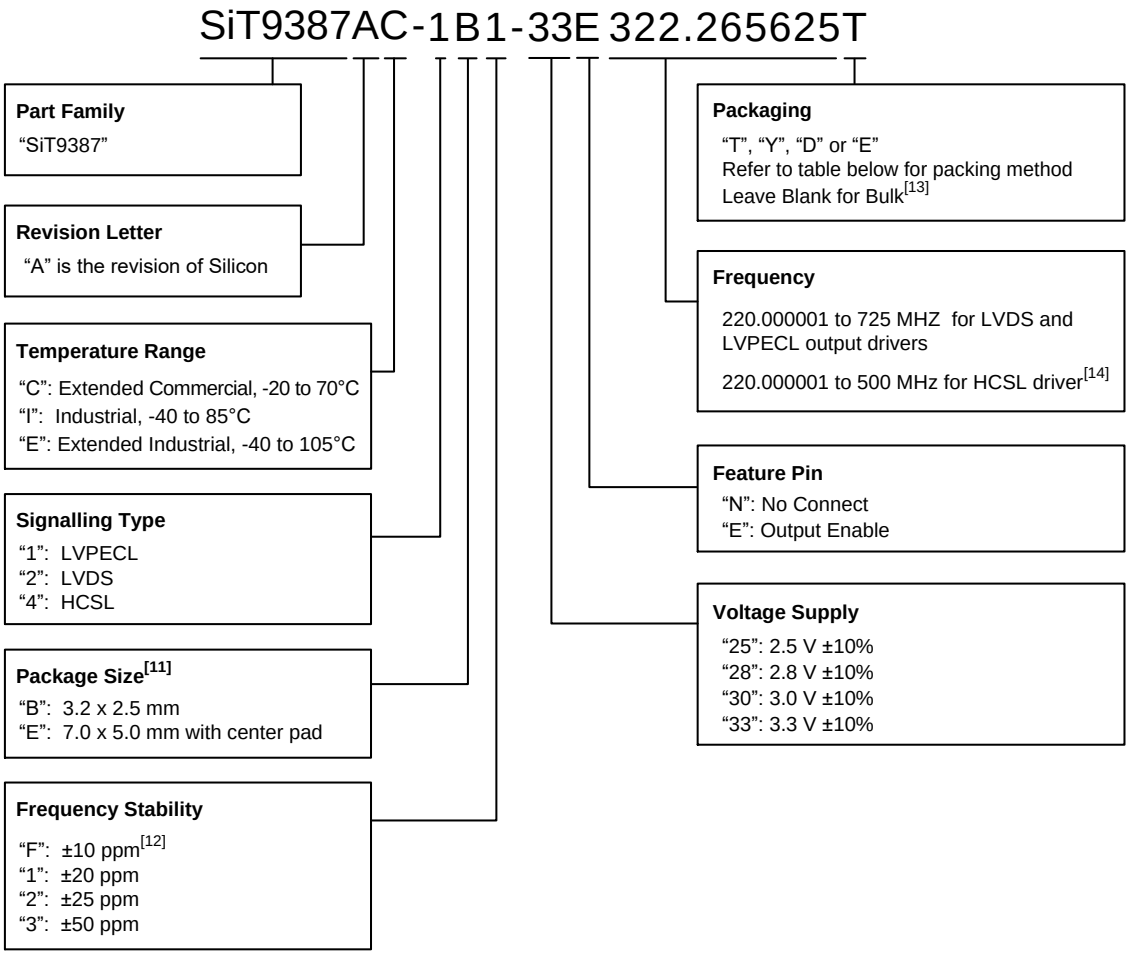


Note:
Circles in center pad are thermal vias, recommended to improve thermal performance

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 5.0 x 3.2 mm package.
12. Contact SiTime for ±10 ppm option.
13. Bulk is available for sampling only.
14. Contact SiTime for higher frequency HCSL options.

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	—	—	—	—	T	Y
3.2 x 2.5	D	E			—	—

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.	https://www.sitime.com/part-number-generator
Manufacturing Notes	Tape & Reel dimension, reflow profile and other manufacturing related info	https://www.sitime.com/sites/default/files/gated/Manufacturing-Notes-for-SiTime-Products.pdf
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	11-Mar-2017	Initial draft
0.87	6-Nov-2017	Updated package drawings Corrected tape/reel ordering information Updated Electrical Characteristics based on characterization Added additional information table Corrected formatting issues added temperature range to 105ºC Changed ±10 ppm to “contact SiTime” Updated termination diagrams Lower mechanical shock from 20,000 to 10,000 *g*
0.90	24-Nov-2017	Ordering information updates and page layout changes
1.0	15-Mar-2019	Updated Electrical Characteristics tables Updated waveform diagrams Added OE enable/disable timing diagrams Updated package dimensions Added an AEC-Q100 Grade 4 temperature option Updated the ordering information
1.01	9-Mar-2021	Updated L1 and Dimple Width package dimensions for 3.2 x 2.5 mm package Updated hyperlinks and changed rev table date format

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