Description

The 9FGV1008B is a member of IDT's PhiClock™ programmable clock generator family. The 9FGV1008B provides one integer frequency, one copy of a fractional or spread spectrum output frequency, and one copy of the crystal reference input. Two select pins allow for hardware selection of the desired configuration, or two I^2C bits allow easy software selection of the desired configuration. The user may configure any one of the four OTP configurations as the default when operating in I^2C mode. Four unique I^2C addresses are available, allowing easy I^2C access to multiple components.

Typical Applications

- HPC
- Storage
- 10G/25G/100G Ethernet
- Fiber Optic Modules
- eSSDs

Key Specifications

- 224fs rms typical phase jitter at 156.25MHz (12kHz–20MHz)
- PCIe Gen1–4 compliant (spread spectrum off)
- PCIe Gen1–3 compliant (spread spectrum on)
- See AN-1001 for PCIe Gen4 applications requiring spread spectrum

PCIe Clocking Architectures

- Common Clocked (CC)
- Independent Reference without spread spectrum (SRnS)
- See AN-1001 for Independent Reference with spread-spectrum (SRIS) applications

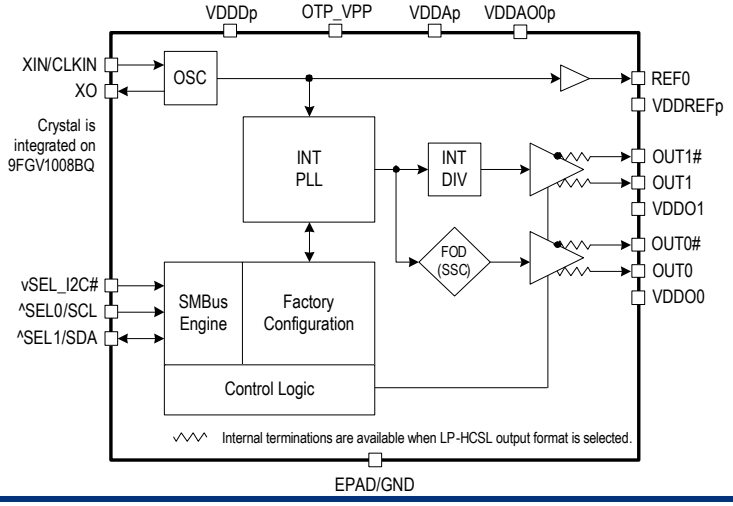
Features

- 1.8V–3.3V core V_{DD} and V_{DDREF}
- Individual 1.8V–3.3V V_{DDO} for each output pair
- Supports HCSL, LVDS and LVCMOS I/O standards
- Supports LVPECL and CML logic with easy AC coupling – see AN-891 for alternate terminations
- HCSL utilizes IDT's LP-HCSL technology for improved performance, lower power and higher integration:
  - Programmable output impedance of 85Ω or 100Ω
- On-board OTP supports up to 4 complete configurations
- Configuration selected via strapping pins or I^2C
- Internal crystal load capacitors
- < 135mW at 1.8V with outputs running at 100MHz (LP-HCSL)
- 4 programmable I^2C addresses: D0, D2, D4, D6
- Supported by IDT Timing Commander™ software and web configurator
- Space saving 3 × 3 mm 16-LGA package with integrated crystal option (9FGV1008BQ)
- Programmable spread spectrum modulation frequency and amount

Output Features

- 2 programmable output pairs plus 1 LVCMOS REF output
- 1 integer output frequency and 1 fractional or spread spectrum output frequency per configuration
- 10MHz–325MHz LVDS or LP-HCSL outputs
- 10MHz–200MHz LVCMOS outputs
- 10MHz–156.25MHz spread spectrum or fractional output

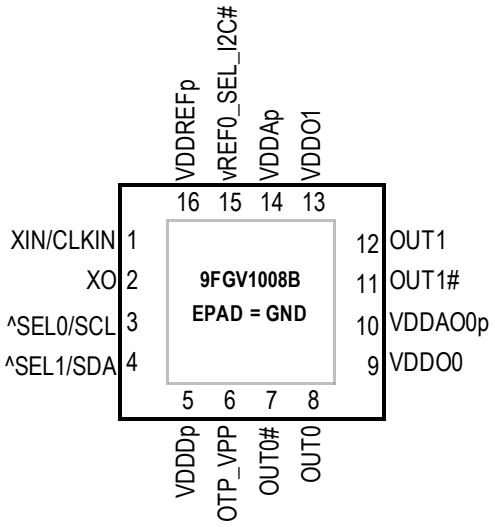
Block Diagram



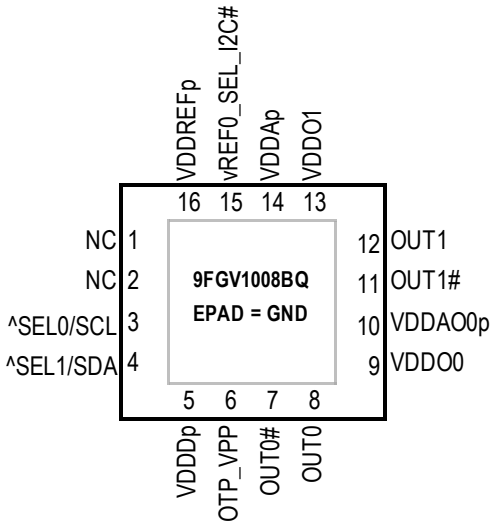
Contents

Pin Assignments

Figure 1. Pin Assignments for 3 x 3 mm 16-LGA Package – Top View



16-LGA 3 x 3 mm, 0.5mm pitch
^ prefix indicates internal pull-up resistor
v prefix indicates internal pull-down resistor



16-LGA 3 x 3 mm, 0.5mm pitch
^ prefix indicates internal pull-up resistor
v prefix indicates internal pull-down resistor

Pin Descriptions

Table 1. Pin Descriptions

Note: Unused outputs can be programmed off and left floating. V_{DDREF} and V_{DDO0} have to be connected.

Number	Name	Type	Description
1[a]	XIN/CLKIN	Input	Crystal input or reference clock input.
2[a]	XO	Output	Crystal output.
3	^SEL0/SCL	Input	Select pin for internal frequency configurations/I^2C clock pin. Function is determined by state of SEL_I2C# upon power-up. This pin has an internal pull-up.
4	^SEL1/SDA	I/O	Select pin for internal frequency configurations/I^2C data pin. Function is determined by state of SEL_I2C# upon power-up. This pin has an internal pull-up.
5	VDDDp	Power	Digital power. 1.8V to 3.3V. VDDAp and VDDDp should be connected to the same power supply.
6	OTP_VPP	Power	Voltage for programming OTP. During normal operation, this pin should be connected to the same power rail as V_{DDD}.
7	OUT0#	Output	Complementary output clock 0.
8	OUT0	Output	Output clock 0.
9	VDDO0	Power	Power supply for output 0.
10	VDDAO0p	Power	Analog power supply for output 0. This pin should be connected to the same power rail as output 0 and filtered appropriately. Programmable for nominal voltages of 1.8V, 2.5V or 3.3V.
11	OUT1#	Output	Complementary output clock 1.
12	OUT1	Output	Output clock 1.
13	VDDO1	Power	Power supply for output 1.

Table 1. Pin Descriptions (Cont.)

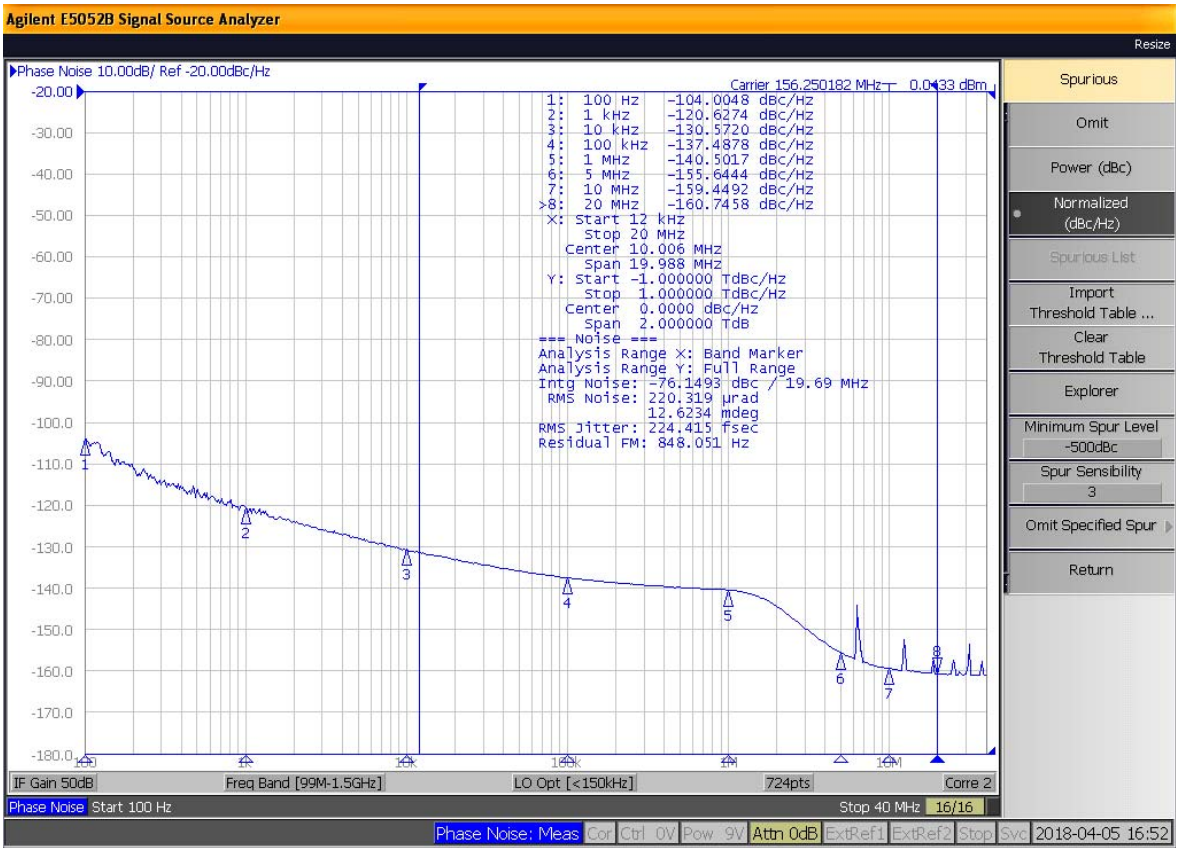
Note: Unused outputs can be programmed off and left floating. V_{DDREF} and V_{DDO0} have to be connected.

Number	Name	Type	Description
14	VDDAp	Power	Power supply for analog circuits. VDDAp and VDDDp should be connected to the same power supply. Programmable for nominal voltages of 1.8V, 2.5V or 3.3V.
15	vREF0_SEL_I2C#	Latched I/O	Latched input/LVCMOS output. At power-up, the state of this pin is latched to select the state of the I^2C pins. After power up, the pin acts as an LVCMOS reference output. This pin has an internal pull-down. 1 = SEL0/SEL1. 0 = SCL/SDA.
16	VDDREFp	Power	Power supply for REF0 and REF1 and the internal XO. Programmable to 1.8V, 2.5V or 3.3V.
17	EPAD	GND	Connect to ground.

[a] These pins are “No connect” on the 9FGV100xQ integrated quartz versions and should have no stubs.

Phase Noise Plot

Figure 2. 9FGV1008B Phase Noise Plot



Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the 9FGV1008B at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 2. Absolute Maximum Ratings

Parameter	Rating
Supply Voltage, V_{DDA}, V_{DDD}, V_{DDO}	3.9V
Storage Temperature, T_{STG}	-65°C to 150°C
ESD Human Body Model	2000V
Junction Temperature	125°C
Inputs	
XIN/CLKIN	0V to 1.2V voltage swing
Other Inputs	-0.5V to V_{DDD}
Outputs	
Outputs, V_{DDO} (LVCMOS)	-0.5V to V_{DDO} + 0.5V
Outputs, IO (SDA)	10mA

Thermal Characteristics

Table 3. Thermal Characteristics

Parameter	Symbol	Conditions	Package	Typical Values	Units	Notes
Thermal Resistance (Devices with external crystal)	θ_{JC}	Junction to case.	LTG16 (16-LGA)	66	°C/W	1
	θ_{Jb}	Junction to base.		5.1	°C/W	1
	θ_{JA0}	Junction to air, still air.		63	°C/W	1
	θ_{JA1}	Junction to air, 1 m/s air flow.		56	°C/W	1
	θ_{JA3}	Junction to air, 3 m/s air flow.		51	°C/W	1
	θ_{JA5}	Junction to air, 5 m/s air flow.		49	°C/W	1
Thermal Resistance Q-series (Devices with internal crystal)	θ_{JC}	Junction to case.	LTG16 (16-LGA)	82.1	°C/W	1
	θ_{Jb}	Junction to base.		42.3	°C/W	1
	θ_{JA0}	Junction to air, still air.		93.6	°C/W	1
	θ_{JA1}	Junction to air, 1 m/s air flow.		87.1	°C/W	1
	θ_{JA3}	Junction to air, 3 m/s air flow.		83.3	°C/W	1

[1] EPAD soldered to board.

Recommended Operating Conditions

Table 4. Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{DDOx}	Power supply voltage for supporting 1.8V outputs.	1.71	1.8	1.89	V
	Power supply voltage for supporting 2.5V outputs.	2.375	2.5	2.625	V
	Power supply voltage for supporting 3.3V outputs.	3.135	3.3	3.465	V
V_{DDD}	Power supply voltage for core logic functions.	1.71		3.465	V
V_{DDA}	Analog power supply voltage. Use filtered analog power supply if available.	1.71		3.465	V
T_A	Operating temperature, ambient.	-40		85	°C
C_L	Maximum load capacitance (3.3V LVCMOS only).			15	pF
t_{PU}	Power-up time for all V_{DD}s to reach minimum specified voltage (power ramps must be monotonic).	0.05		5	ms

Electrical Characteristics

V_{DDx} = 3.3V ±5%, 2.5V ±5%, 1.8V ±5%, T_A = -40°C to +85°C unless stated otherwise.

Table 5. Common Electrical Characteristics

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units	Notes
Input Frequency	f_{IN}	Crystal input frequency.	8		50	MHz	1
		CLKIN input frequency.	1		240	MHz	5
Output Frequency	f_{OUT}	Differential clock output (LVDS/LP-HCSL).	10		325	MHz	
		Single-ended clock output (LVCMOS).	10		200	MHz	
		Spread spectrum configuration.	10		156.25	MHz	6
VCO Frequency	f_{VCO}	VCO operating frequency range.	2400	2500	2600	MHz	
Loop Bandwidth	f_{BW}	Input frequency = 25MHz.	0.06		0.9	MHz	
Input High Voltage	V_{IH}	SEL[1:0].	0.7 × V_{DDD}		V_{DDD} + 0.3	V	
Input Low Voltage	V_{IL}	SEL[1:0].	GND - 0.3		0.8	V	
Input High Voltage	V_{IH}	REF/SEL_I2C#.	0.65 × V_{DDD}		V_{DDD} + 0.3	V	
Input Low Voltage	V_{IL}	REF/SEL_I2C#.	-0.3		0.4	V	
Input High Voltage	V_{IH}	XIN/CLKIN.	0.8		1.2	V	
Input Low Voltage	V_{IL}	XIN/CLKIN.	-0.3		0.4	V	
Input Rise/Fall Time	T_R/T_F	SEL1/SDA, SEL0/SCL.			300	ns	
Input Capacitance	C_{IN}	SEL[1:0].		3	7	pF	
Internal Pull-up Resistor	R_{UP}	SEL[1:0] at 25°C.	200	237	300	kΩ	
Internal Pull-down Resistor	R_{DOWN}	REF/SEL_I2C#.	200	237	300	kΩ	
Programmable Capacitance at XIN and XO (XIN in parallel with XO)	C_L	XIN/CLKIN, XO.	0		8	pF	

Table 5. Common Electrical Characteristics (Cont.)

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units	Notes
Input Duty Cycle	t2	CLKIN, measured at V_{DDREF}/2.	40	50	60	%	
Output Duty Cycle	t3	LVCMOS, f_{OUT} > 156.25MHz.	40	50	60	%	
		LVCMOS, $f_{OUT} \leq$ 156.25MHz.	45	50	55	%	
		LVDS, LP-HCSL outputs.	45	49.9	55	%	
Clock Jitter	t6	Cycle-to-cycle jitter (Peak-to-Peak). See Test Frequencies for Jitter Measurements for configurations.		27		ps	4
		Reference clock RMS phase jitter (12kHz to 5MHz integration range). See Test Frequencies for Jitter Measurements for configurations.		317		fs rms	4
		OUTx RMS phase jitter(12kHz to 20MHz integration range) differential output. See Test Frequencies for Jitter Measurements for configurations.		224		fs rms	4
Lock Time	t8	PLL lock time from V_{DD}s reaching 1.5V.		5	10	ms	2,3

[1] Practical lower frequency is determined by loop filter settings.

[2] Includes loading the configuration bits from OTP to registers.

[3] Actual PLL lock time depends on the loop configuration.

[4] Actual jitter is configuration dependent. These values are representative of what the device can achieve.

[5] Input doubler off. Maximum input frequency with input doubler on is 160MHz.

[6] With internal low pass filter enabled. When disabled, maximum frequency is 325MHz.

Table 6. Test Frequencies for Jitter Measurements

Device	XIN/CLKIN	OUT0	OUT1	Unit	Notes
9FGV1008B 9FGV1008BQ5	50	100	156.25	MHZ	1,2

[1] All outputs measured with 100MHz outputs both spreading and non-spreading.

[2] Outputs configured as LP-HCSL or LVDS with REF output off unless noted.

Table 7. LVCMOS Output Electrical Characteristics

V_{DDO} = 3.3V ±5%, 2.5V ±5%, 1.8V ±5%, T_A = -40°C to +85°C unless stated otherwise.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Slew Rate	S_R	3.3V ±5%, 20% to 80% of V_{DDO} (output load = 4.7pF).	2.6	3.7	4.7	V/ns
		2.5V ±5%, 20% to 80% of V_{DDO} (output load = 4.7pF).	1.5	2.4	4.7	
		1.8V ±5%, 20% to 80% of V_{DDO} (output load = 4.7pF).	0.8	1.7	3.2	
Output High Voltage	V_{OH}	I_{OH} = -15mA at 3.3V.	0.8 × V_{DDO}		V_{DDO}	V
		I_{OH} = -12mA at 2.5V.				
		I_{OH} = -8mA at 1.8V.				
Output Low Voltage	V_{OL}	I_{OL} = 15mA at 3.3V.		0.22	0.4	V
		I_{OL} = 12mA at 2.5V.				
		I_{OL} = 8mA at 1.8V.				
Output Leakage Current	I_{OZDD}	Outputs tri-stated, V_{DDO},V_{DDREF} = 3.465V.		0	5	µA
CMOS Output Driver Impedance	R_{OUT}	T_A = 25°C.		17		Ω

Table 8. LVDS Output Electrical Characteristics

V_{DDO} = 3.3V ±5%, 2.5V ±5%, 1.8V ±5%, T_A = -40°C to +85°C unless stated otherwise.

Parameter	Symbol	Minimum	Typical	Maximum	Units
Differential Output Voltage for the TRUE Binary State	V_{OT} (+)	247	328	454	mV
Differential Output Voltage for the FALSE Binary State	V_{OT} (-)	-454	-332	-247	mV
Change in V_{OT} between Complementary Output States	ΔV_{OT}			50	mV
Output Common Mode Voltage (Offset Voltage) at 3.3V +5% and 2.5V +5%	V_{OS}	1.125	1.19	1.55	V
Output Common Mode Voltage (Offset Voltage) at 1.8V +5%	V_{OS}	0.8	0.86	0.95	V
Change in V_{OS} between Complementary Output States	ΔV_{OS}		0	50	mV
Outputs Short Circuit Current, V_{OUT}+ or V_{OUT}- = 0V or V_{DD}	I_{OS}		6	12	mA
Differential Outputs Short Circuit Current, V_{OUT}+ = V_{OUT}-	I_{OSD}		3	12	mA
Rise Times Tested at 20%–80%	T_R		257	375	ps
Fall Times Tested at 80%–20%	T_F		287	375	ps

Table 9. Low-Power (LP) Push-Pull HCSL Differential Outputs

V_{DDO} = 3.3V ±5%, 2.5V ±5%, 1.8V ±5%, T_A = -40°C to +85°C unless stated otherwise.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units	Notes
Slew Rate	$T_{R/F}$	Scope averaging on.	1.25	2.5	4	V/ns	2,3,16
Slew Rate Matching	$\Delta T_{R/F}$			9	20	%	1,14,16
Crossing Voltage (abs)	V_{CROSS}	Scope averaging off.	250	424	550	mV	1,4,5,16
Crossing Voltage (var)	ΔV_{CROSS}	Scope averaging off.		16	140	mV	1,4,9,16
Average Clock Period Accuracy	T_{PERIOD_AVG}	Outputs set to 100MHz for PCIe applications.	-100	0	+2600	ppm	2,10,12,13
Absolute Period	T_{PERIOD_ABS}	Includes jitter and spread modulation.	9.949	10	10.101	ns	2,6
Voltage High	V_{HIGH}		660	785	850	mV	1
Voltage Low	V_{LOW}		-150	13	150	mV	1
Absolute Maximum Voltage	V_{MAX}			808	1150	mV	1,7,15
Absolute Minimum Voltage	V_{MIN}		-300	-54		mV	1,8,15

[1] Measured from single-ended waveform.

[2] Measured from differential waveform.

[3] Measured from -150mV to +150mV on the differential waveform (derived from REFCLK+ minus REFCLK-). The signal must be monotonic through the measurement region for rise and fall time. The 300mV measurement window is centered on the differential zero crossing.

[4] Measured at crossing point where the instantaneous voltage value of the rising edge of REFCLK+ equals the falling edge of REFCLK-.

[5] Refers to the total variation from the lowest crossing point to the highest, regardless of which edge is crossing. Refers to all crossing points for this measurement.

[6] Defined as the absolute minimum or maximum instantaneous period. This includes cycle to cycle jitter, relative ppm tolerance, and spread spectrum modulation.

[7] Defined as the maximum instantaneous voltage including overshoot.

[8] Defined as the minimum instantaneous voltage including undershoot.

[9] Defined as the total variation of all crossing voltages of rising REFCLK+ and falling REFCLK-. This is the maximum allowed variance in V_{CROSS} for any particular system.

[10] Refer to Section 8.6 of the PCI Express Base Specification, Revision 4.0 for information regarding ppm considerations.

[11] System board compliance measurements must use the test load. REFCLK+ and REFCLK- are to be measured at the load capacitors CL. Single ended probes must be used for measurements requiring single ended measurements. Either single ended probes with math or differential probe can be used for differential measurements. Test load C_L = 2pF.

[12] PCIe Gen1 through Gen4 specify ±300ppm frequency tolerances. The PhiClock devices already meet the tighter ±100ppm frequency tolerances proposed for PCIe Gen5 and required by most servers.

[13] "ppm" refers to parts per million and is a DC absolute period accuracy specification. 1ppm is 1/1,000,000th of 100.000000MHz exactly or 100Hz. For 100ppm, then we have an error budget of 100Hz/ppm × 100ppm = 10kHz. The period is to be measured with a frequency counter with measurement window set to 100ms or greater. The ±100ppm applies to systems that do not employ Spread Spectrum clocking, or that use common clock source. For systems employing Spread Spectrum clocking, there is an additional 2,500ppm nominal shift in maximum period resulting from the 0.5% down spread resulting in a maximum average period specification of +2,600ppm for Common Clock architectures. Separate Reference Clock architectures may have a lower allowed spread percentage.

[14] Matching applies to rising edge rate for REFCLK+ and falling edge rate for REFCLK-. It is measured using a ±75mV window centered on the median cross point where REFCLK+ rising meets REFCLK- falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations. The rise edge rate of REFCLK+ should be compared to the fall edge rate of REFCLK-; the maximum allowed difference should not exceed 20% of the slowest edge rate.

[15] At default amplitude settings.

[16] Guaranteed by design and characterization.

Table 10. Filtered Phase Jitter Parameters – PCIe Common Clocked (CC) Architectures

T_{AMB} = over the specified operating range. Supply Voltages per normal operation conditions; see Test Loads for loading conditions.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Specification Limits	Units	Notes
PCIe Phase Jitter	$t_{jphPCIeG1-CC}$	PCIe Gen1.		24	43	86	ps (p-p)	1,2,3
	$t_{jphPCIeG2-CC}$	PCIe Gen2 Low Band 10kHz < f < 1.5MHz (PLL BW of 5–16MHz, 8–16MHz, CDR = 5MHz).		0.7	1.4	3	ps (rms)	1,2
		PCIe Gen2 High Band 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5–16MHz, 8–16MHz, CDR = 5MHz).		1.8	2.6	3.1	ps (rms)	1,2
	$t_{jphPCIeG3-CC}$	PCIe Gen3 (PLL BW of 2–4MHz, 2–5MHz, CDR = 10MHz).		0.44	0.65	1	ps (rms)	1,2
	$t_{jphPCIeG4-CC}$	PCIe Gen4 (SSC off) (PLL BW of 2–4MHz, 2–5MHz, CDR = 10MHz).		0.30	0.445	0.5	ps (rms)	1,2,6

Table 11. Filtered Phase Jitter Parameters – PCIe Independent Reference (IR) Architectures

T_{AMB} = over the specified operating range. Supply Voltages per normal operation conditions; see Test Loads for loading conditions.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Industry Limits	Units	Notes
PCIe Phase Jitter	$t_{jphPCIeG2-SRIS}$	PCIe Gen2 (PLL BW of 16MHz, CDR = 5MHz).		1.2	1.53	2	ps (rms)	1,2,4, 5
	$t_{jphPCIeG3-SRIS}$	PCIe Gen3 (PLL BW of 2–4MHz, CDR = 10MHz).		0.37	0.45	0.7	ps (rms)	1,2,4, 5,6

Notes for PCIe Filtered Phase Jitter tables:

[1] Applies to all differential outputs, guaranteed by design and characterization. Equipment noise removed from results. See PCI Express® Measurement Techniques for Gen5 and Beyond White Paper for details.

[2] Based on PCIe Base Specification Rev4.0 version 1.0. See http://www.pcisig.com for latest specifications.

[3] Sample size of at least 100K cycles. This figure extrapolates to 108ps pk-pk at 1M cycles for a BER of 1^{-12}.

[4] IR is the new name for Separate Reference Independent Spread (SRIS) and Separate Reference no Spread (SRNS) PCIe clock architectures.

[5] According to the PCIe Base Specification Rev4.0 version 1.0, the jitter transfer functions and corresponding jitter limits are not defined for the IR clock architecture. Widely accepted industry limits using widely accepted industry filters are used to populate this table. The PCIe Base Specification Rev5.0 is expected to resolve this.

[6] For PCIe Gen3 SRIS performance with SSC on, or for improved PCIe Gen4 CC performance, see application note AN-1001.

Table 12. Current Consumption

V_{DDO} = 3.3V ±5%, 2.5V ±5%, 1.8V ±5%, T_A = -40°C to +85°C unless stated otherwise.

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units	Notes
V_{DDREF} Supply Current	I_{DDREF}	50MHz REFCLK.		5	7	mA	
Core Supply Current	I_{DDCORE}	2500MHz VCO, SSC Off.		32	45	mA	3
		2500MHz VCO, SSC On.		39	56	mA	3
Output Buffer Supply Current (V_{DDO1})	I_{DDOx}	LVDS, 325MHz.		18	22	mA	2
		LP-HCSL, 100MHz.		16	21	mA	2
		LVCMOS, 50MHz.		14	18	mA	1,2
		LVCMOS, 200MHz.		22	34	mA	1,2
Output Buffer Supply Current (V_{DDO0})		LVDS, 325MHz.		16	21	mA	2
		LP-HCSL.		16	20	mA	2
		LVCMOS, 50MHz.		13	18	mA	1,2
		LVCMOS, 200MHz.		21	33	mA	1,2
Total Power Down Current	I_{DDPD}	Programmable outputs in HCSL mode, B37[0] = 0.		19	25	mA	1,2
		Programmable outputs in LVDS mode, B37[0] = 0.		25	35	mA	1,2
		Programmable outputs in LVCMOS1 mode, B37[0] = 0.		17	23	mA	1,2
		Programmable outputs in HCSL mode, B37[6,0] = 0.		9	12	mA	1,2
		Programmable outputs in LVDS mode, B37[6,0] = 0.		15	22	mA	1,2
		Programmable outputs in LVCMOS1 mode, B37[6,0] = 0.		7	10	mA	1,2

[1] Single CMOS driver active for each output pair.

[2] See Test Loads for details.

[3] $I_{DDCORE} = I_{DDA} + I_{DDD} + I_{DDAO}$.

Table 13. Spread Spectrum Generation Specifications

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Output Frequency	f_{OUT}	Output frequency range of spread spectrum outputs.	10		156.25	MHz
Mod. Frequency	$f_{MODPCIe}$	PCIe compliant -0.5% spread modulation.	30	31.5	33	kHz
Mod. Frequency	f_{MOD}	Modulation frequency.	30	31.5	63	kHz
Spread%	SSC%	Amount of spread value (programmable) – down spread.	-0.1	-0.5	-3.0	%
		Amount of spread value (programmable) – center spread.	±0.05		±1.5	

I²C Bus Characteristics

Table 14. I²C Bus DC Characteristics

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Input High Level	V_{IH}		0.7 × V_{DDD}			V
Input Low Level	V_{IL}				0.3 × V_{DDD}	V
Hysteresis of Inputs	V_{HYS}		0.05 × V_{DDD}			V
Input Leakage Current	I_{IN}		-1		30	µA
Output Low Voltage	V_{OL}	I_{OL} = 3mA.			0.4	V

Table 15. I²C Bus AC Characteristics

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Serial Clock Frequency (SCL)	F_{SCLK}	—	10		400	kHz
Bus Free Time between STOP and START	t_{BUF}	—	1.3			µs
Setup Time, START	$t_{SU:START}$	—	0.6			µs
Hold Time, START	$t_{HD:START}$	—	0.6			µs
Setup Time, Data Input (SDA)	$t_{SU:DATA}$	—	0.1			µs
Hold Time, Data Input (SDA) [1]	$t_{HD:DATA}$	—	0			µs
Output Data Valid from Clock	t_{OVD}	—			0.9	µs
Capacitive Load for Each Bus Line	C_B	—			400	pF
Rise Time, Data and Clock (SDA, SCL)	t_R	—	20 + 0.1 × C_B		300	ns
Fall Time, Data and Clock (SDA, SCL)	t_F	—	20 + 0.1 × C_B		300	ns
HIGH Time, Clock (SCL)	t_{HIGH}	—	0.6			µs
LOW Time, Clock (SCL)	t_{LOW}	—	1.3			µs
Setup Time, STOP	$t_{SU:STOP}$	—	0.6			µs

[1] A device must internally provide a hold time of at least 300ns for the SDA signal (referred to the $V_{IH(MIN)}$ of the SCL signal) to bridge the undefined region of the falling edge of SCL.

Test Loads

Figure 3. LVCMOS AC/DC Test Load

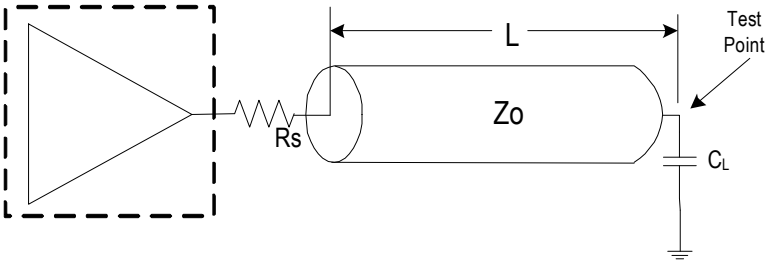


Table 16. Parameters for LVCMOS AC/DC Test Load

Rs (Ω)	Zo (Ω)	L (inches)	C_L (pF)
33	50	5	4.7

Figure 4. LP-HCSL AC/DC Test Load (standard PCIe source-terminated test load)

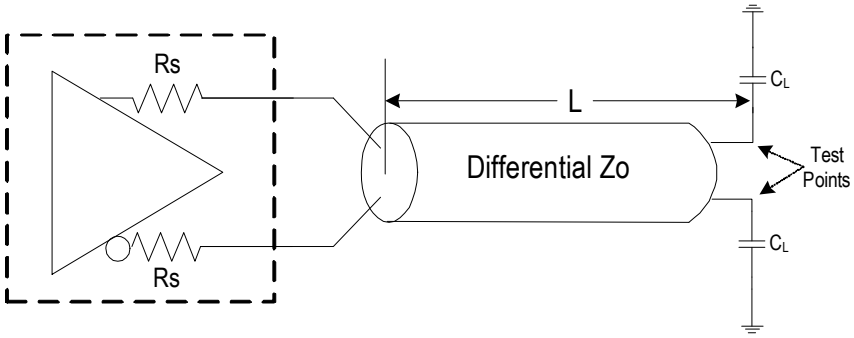


Table 17. Parameters for LP-HCSL AC/DC Test Load

Rs (Ω)	Zo (Ω)	L (inches)	C_L (pF)
Internal	100	5	2

Figure 5. LVDS AC/DC Test Load

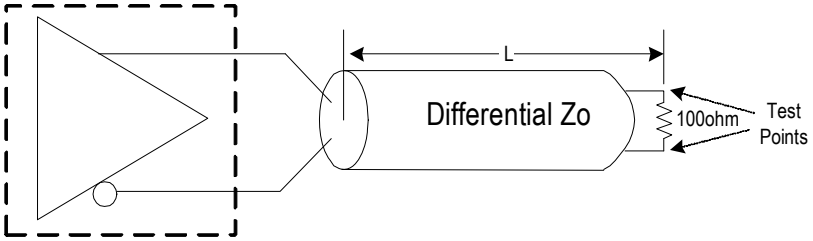
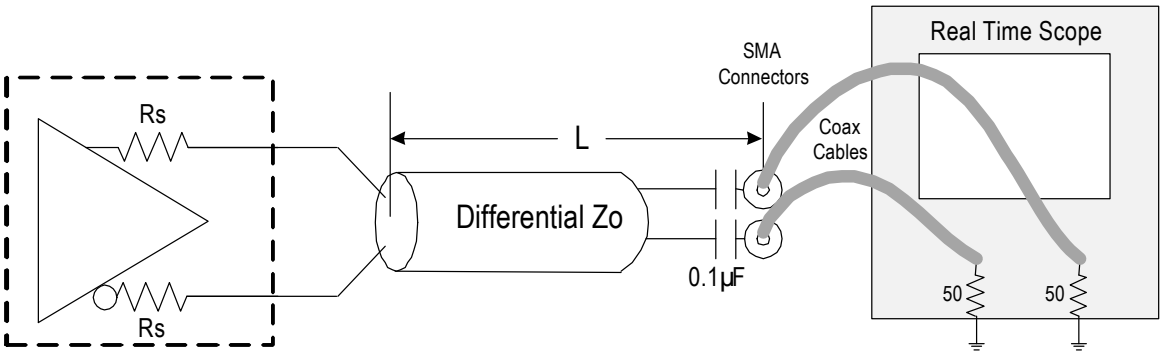


Table 18. Parameters for LVDS AC/DC Test Load

Rs (Ω)	Zo (Ω)	L (inches)	C_L (pF)
N/A	100	5	N/A

Figure 6. Test Setup for PCIe Jitter Measurements[1]



[1] This test setup is used to obtain clock period files for PCIe phase jitter calculations.

Table 19. Parameters for PCIe Jitter Test Load

Rs (Ω)	Zo (Ω)	L (inches)	C_L (pF)
Internal	100	5	N/A

Crystal Characteristics

Table 20. Recommended Crystal Characteristics

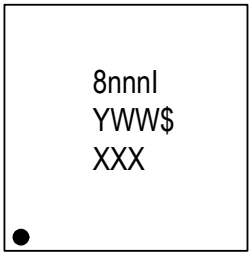
Parameter	Value	Units
Frequency	8–50	MHz
Resonance Mode	Fundamental	–
Frequency Tolerance at 25°C	±20	ppm maximum
Frequency Stability, REF at 25°C Over Operating Temperature Range	±20	ppm maximum
Temperature Range (commercial)	0 to +70	°C
Temperature Range (industrial)	-40 to +85	°C
Equivalent Series Resistance (ESR)	50	Ω maximum
Shunt Capacitance (C_O)	7	pF maximum
Load Capacitance (C_L)	8	pF maximum
Drive Level	0.1	mW maximum
Aging Per Year	±5	ppm maximum

Package Outline Drawings

The package outline drawings are appended at the end of this document and are accessible from the link below. The package information is the most current data available.

www.idt.com/document/psc/16-lga-package-outline-drawing-30-x-30-x-110-mm-body-05mm-pitch-ltg16p1

Marking Diagrams



9FGV1008 (external crystal)

9FGV1008Q (internal crystal)

1. Line 1: truncated part number
2. “YWW” denotes the last digits of the year and week the part was assembled.
3. “$” denotes mark code.
4. “XXX” denotes the last three characters of the lot number.

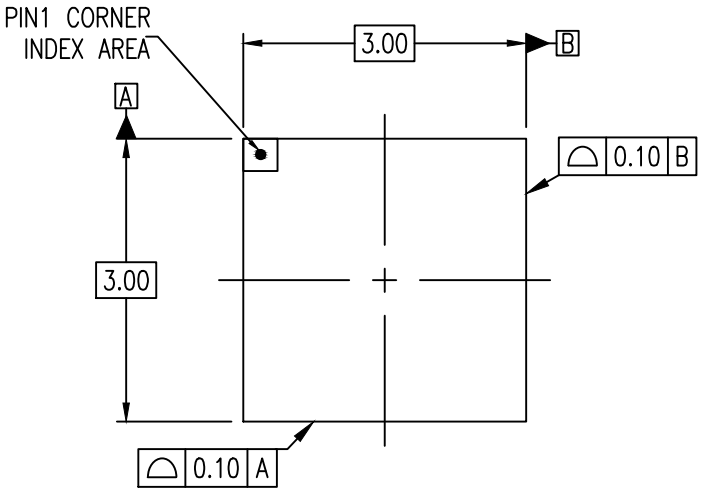
Ordering Information

Orderable Part Number	Package	Carrier Type	Temperature	Crystal
9FGV1008BnnnLTGI	3 × 3 mm, 0.5mm pitch 16-LGA	Tray	-40 to +85°C	External
9FGV1008BnnnLTGI8	3 × 3 mm, 0.5mm pitch 16-LGA	Reel	-40 to +85°C	External
9FGV1008BQ5aaLTGI	3 × 3 mm, 0.5mm pitch 16-LGA	Tray	-40 to +85°C	50MHz Internal
9FGV1008BQ5aaLTGI8	3 × 3 mm, 0.5mm pitch 16-LGA	Reel	-40 to +85°C	50MHz Internal

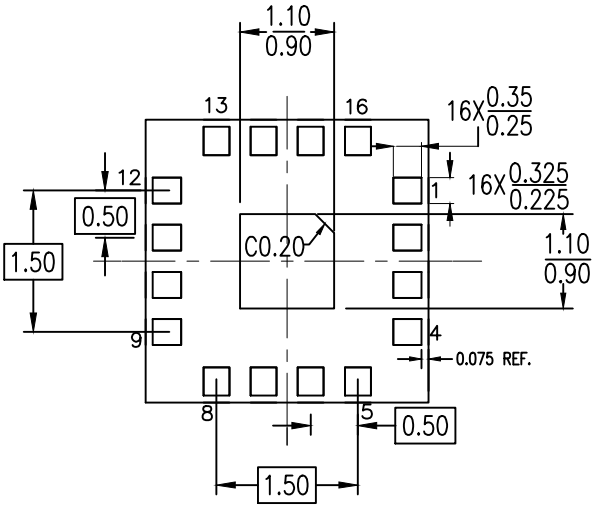
“G” indicates RoHS 6.6 compliance.
“nnn” are decimal digits indicating a specific configuration.
“aa” are alphanumeric digits indicating a specific configuration.
“Q5” indicates internal 50MHz crystal.

Revision History

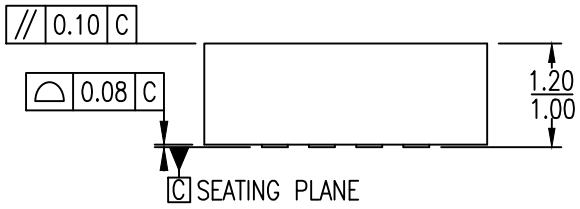
Revision Date	Description of Change
October 1, 2018	Initial release.



TOP VIEW

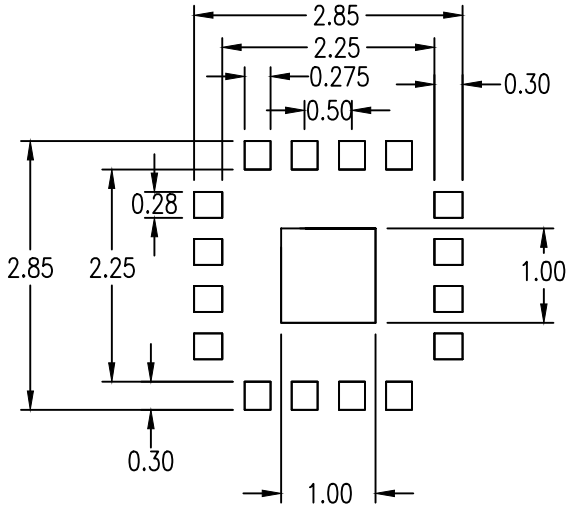


BOTTOM VIEW



SIDE VIEW

NOTES:
1. ALL DIMENSIONING AND TOLERANCING CONFORM TO ANSI Y14.5M–1982.
2. ALL DIMENSIONS ARE IN MILLIMETERS.



RECOMMENDED LAND PATTERN DIMENSION

NOTES:

1. ALL DIMENSION ARE IN mm. ANGLES IN DEGREES.
2. TOP DOWN VIEW. AS VIEWED ON PCB.
3. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

Package Revision History		
Date Created	Rev No.	Description
Nov 6, 2017	Rev 02	Modify Solder Mask & Epad Chamfer
Sept 29, 2017	Rev 01	Modify Land Pattern

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