General Description

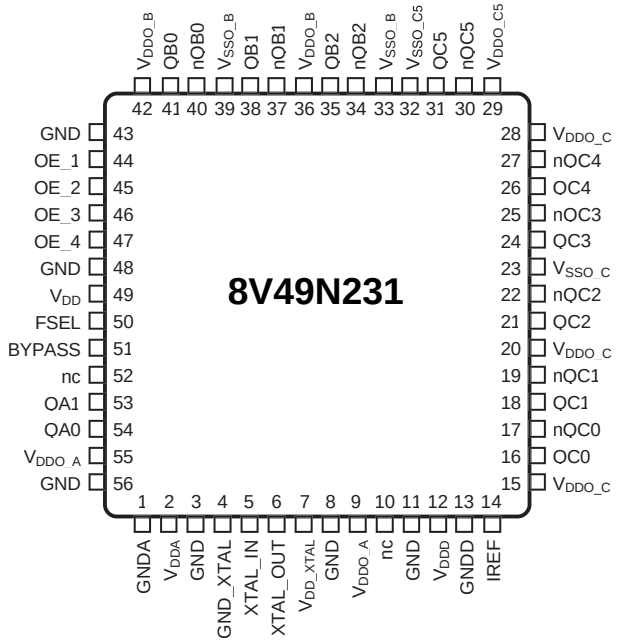
The 8V49N231 is a high-performance PLL-based clock generator designed to interface with Broadcom XLP2xxx processors. The 8V49N231 has one 25MHz crystal input to generate output frequencies to support XLP Core/DDR3, USB, SGMII/XAUI and PCIe reference clocks in a single chip. The 8V49N231 low jitter VCO easily meets PCI Express Gen 1, 2 and 3 requirements.

Excellent phase noise performance is maintained with IDT's Fourth Generation FemtoClock® NG technology.

Features

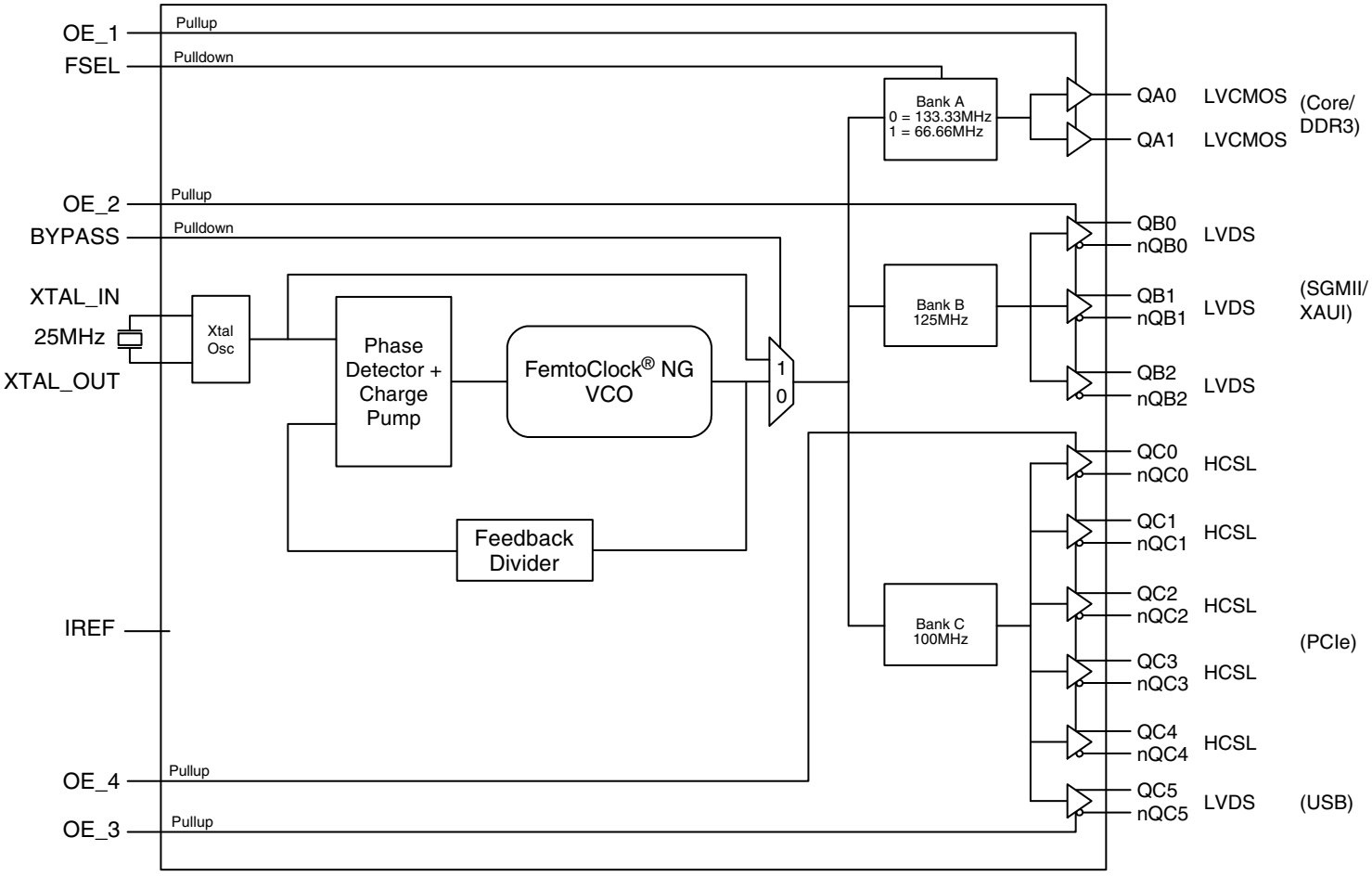
- Fourth Generation FemtoClock® NG PLL technology
- Eleven outputs to support 133.33MHz/66.66MHz, 100MHz, 125MHz for core/DDR3, USB, SGMII/XAUI and PCIe reference clocks
- Two 1.8V LVCMOS clock outputs for core/DDR3 at 133.33MHz or 66.66MHz
- One LVDS clock output for USB at 100MHz
- Three LVDS clock outputs for SGMII/XAUI at 125MHz
- Five HCSL clock outputs for PCIe at 100MHz
- Crystal oscillator interface designed for 25MHz, parallel resonant crystal
- PCI Express Gen 1 (2.5Gb/s), Gen 2 (5Gb/s) and Gen 3 (8Gb/s) jitter compliant
- Power supply modes:
  Core / Output
  3.3V / 3.3V (HCSL, LVDS outputs)
  3.3V / 1.8V (LVCMOS outputs only)
- Lead-free (RoHS 6) packaging
- -40°C to 85°C ambient operating temperature

Pin Assignment



56-Lead, 8mm x 8mm VFQFN

Block Diagram



Pin Descriptions and Characteristics

Table 1. Pin Descriptions

Number	Name	Type		Description
1	GNDA	Power		Analog power supply ground pin.
2	V_{DDA}	Power		Analog power supply pin.
3, 8, 11, 43, 48, 56	GND	Power		Power supply ground pin.
4	GND_XTAL	Power		XTAL ground pin.
5 6	XTAL_IN, XTAL_OUT	Input		Parallel resonant crystal interface. XTAL_IN is the input, XTAL_OUT is the output.
7	V_{DD_XTAL}	Power		XTAL power supply pin.
12	V_{DDD}	Power		Digital power supply pin.
13	GNDD			Digital ground supply pin.
14	IREF	Input		HCSL current reference resistor output. An external fixed precision resistor (475Ω) from this pin to ground provides a reference current used for HCSL outputs.
15, 20, 28	V_{DDO_C}	Power		Bank C HCSL output supply pins.
16, 17 18, 19 21, 22 24, 25 26, 27	QC0, nQC0 QC1, nQC1 QC2, nQC2 QC3, nQC3 QC4, nQC4	Output		Differential output pairs. HCSL interface levels.
23	V_{SSO_C}	Power		Bank C HCSL output supply ground pin.
29	V_{DDO_C5}	Power		Bank C QC5, nQC5 LVDS output power supply pin.
30, 31	nQC5, QC5	Output		Differential output pair. LVDS interface levels.
32	V_{SSO_C5}	Power		Bank C QC5, nQC5 LVDS output power supply ground pin.
33, 39	V_{SSO_B}	Power		Bank B LVDS output power ground pins.
34, 35 37, 38 40, 41	nQB2, QB2 nQB1, QB1 nQB0, QB0	Output		Differential output pairs. LVDS interface levels.
36, 42	V_{DDO_B}	Power		Bank B output power supply pins.
44, 45, 46, 47	OE_1, OE_2 OE_3, OE_4	Input	Pullup	Output enable pins. See Table 3B. LVCMOS/LVTTL interface levels.
49	V_{DD}	Power		Core supply pin.
50	FSEL	Input	Pulldown	Selects QAx output frequency. See Table 3A. LVCMOS/LVTTL interface levels.
51	BYPASS	Input	Pulldown	PLL Bypass mode select pin. See Table 3C for function. LVCMOS/LVTTL interface levels.
52, 10	nc	Unused		No connect.
53, 54	QA1, QA0	Output		Single-ended LVCMOS/LVTTL outputs.
55, 9	V_{DDO_A}	Power		Bank A output supply pin using an 1.8V supply mode.

NOTE: *Pulldown* and *Pullup* refer to an internal input resistor. See Table 2, *Pin Characteristics*, for typical values.

Table 2. Pin Characteristics

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
C_{IN}	Input Capacitance		OE[1:4], BYPASS, FSEL		3.5		pF
$R_{PULLDOWN}$	Input Pulldown Resistor				51		kΩ
R_{PULLUP}	Input Pullup Resistor				51		kΩ
R_{OUT}	Output Impedance	QA[0:1]	V_{DDO_A} = 1.8V		30		Ω

Function Tables

Table 3A. Frequency Select Table

FSEL	QAx Outputs
0 (default)	133.33MHz
1	66.66MHz

Table 3B. OE Function Table

OEx	Output State
0	High Impedance
1 (default)	Enabled

Table 3C. PLL BYPASS Function Table

BYPASS	Operation
1	PLL is bypassed. The reference frequency is divided by the selected output dividers in Bank A, Bank B, Bank C. AC specifications do not apply in PLL BYPASS mode.
0 (default)	PLL is enabled. The reference frequency is multiplied by the PLL feedback divider and then divided by the selected output dividers in Bank A, Bank B, Bank C.

Absolute Maximum Ratings

NOTE: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of the product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

Item	Rating
Supply Voltage, V_{DD}	3.63V
Inputs, V_I XTAL_IN Other Inputs	 0V to 2V -0.5V to V_{DDO_X} + 0.5V
Outputs, V_O (LVCMOS)	-0.5V to V_{DDO_A} + 0.5V
Outputs, V_O (LVDS) Continuous Current	10mA 15mA
Outputs, V_O (HCSL)	-0.5V to V_{DDO_C} + 0.5V
Junction Temperature, T_J	125°C
Storage Temperature, T_{STG}	-65°C to 150°C

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics,

$V_{DD} = V_{DD\_XTAL} = V_{DDD} = V_{DDO\_B} = V_{DDO\_C} = V_{DDO\_C5}$ = 3.3V ± 5%, V_{DDO_A} = 1.8V ± 5%, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DDX}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.1		V_{DD}	V
V_{DDO_X}	Output Supply Voltage		3.135	3.3	3.465	V
V_{DDO_A}	Output Supply Voltage (Bank A)		1.71	1.8	1.89	V
I_{DDX}	Power Supply Current			115	132	mA
I_{DDA}	Analog Supply Current			49	58	mA
I_{DDO_X}	Output Supply Current	HCSL output are disabled, LVDS outputs are terminated with 100Ω and LVCMOS outputs QA are terminated with 50Ω to 0.9V		77	97	mA
I_{DDO_A}	Output Supply Current (Bank A)			12	15	mA

NOTE: V_{DDO_X} denotes, V_{DDO_B}, V_{DDO_C}, V_{DDO_C5}.
NOTE: I_{DDO_X} denotes, I_{DDO_B}, I_{DDO_C}, I_{DDO_C5}.
NOTE: V_{DDX} denotes, V_{DD}, V_{DDD}, V_{DD_XTAL}.
NOTE: I_{DDX} denotes, I_{DD}, I_{DDD}, I_{DD_XTAL}.

Table 4B. LVCMOS/LVTTL Input DC Characteristics, V_{DD} = 3.3V ± 5%, V_{DDO_A} = 1.8V ± 5%, T_A = -40°C to 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage			2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage			-0.3		0.8	V
I_{IH}	Input High Current	FSEL, BYPASS	V_{DD} = V_{IN} = 3.465V			150	µA
		OE_[4:1]	V_{DD} = V_{IN} = 3.465V			5	µA
I_{IL}	Input Low Current	FSEL, BYPASS	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA
		OE_[4:1]	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
V_{OH}	Output High Voltage	QA[1:0]	V_{DDO_A} = 1.89V I_{OH} = -6mA	1.5			V
V_{OL}	Output Low Voltage	QA[1:0]	V_{DDO_A} = 1.89V I_{OL} = 6mA			0.4	V

Table 4C. LVDS Power Supply DC Characteristics,
V_{DD} = V_{DD_XTAL} = V_{DDD} = V_{DDO_B} = V_{DDO_C} = V_{DDO_C5} = 3.3V ± 5%,V_{DDO_A} = 1.8V ± 5%, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OD}	Differential Output Voltage		247	355	454	mV
ΔV_{OD}	V_{OD} Magnitude Change				50	mV
V_{OS}	Offset Voltage		1.125	1.25	1.375	V
ΔV_{OS}	V_{OS} Magnitude Change				50	mV

Table 5. Crystal Characteristics

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation			Fundamental		
Frequency			25		MHz
Capacitance Loading (C_L)			12	18	pF
Equivalent Series Resistance (ESR)				80	Ω
Shunt Capacitance				7	pF

AC Electrical Characteristics

Table 6A. LVCMOS AC Electrical Characteristics, $V_{DD} = V_{DD\_XTAL} = V_{DDD} = 3.3V \pm 5\%$, $V_{DDO\_A} = 1.8V \pm 5\%$, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency		66.66		133.33	MHz
t_{JIT}	RMS Phase Jitter (Random); NOTE 1	f_{OUT} = 133.33MHz, Integration Range (12kHz to 20MHz)		250	300	fs
		f_{OUT} = 66.66MHz, Integration Range (12kHz to 20MHz)		364	525	fs
ϕn(100)	Single-side Band Phase Noise for f_{out} = 133.33MHz	100Hz from carrier		-102		dBc/Hz
ϕn(1k)		1kHz from carrier		-122		dBc/Hz
ϕn(10k)		10kHz from carrier		-132		dBc/Hz
ϕn(100k)		100kHz from carrier		-137		dBc/Hz
ϕn(1M)		1MHz from carrier		-145		dBc/Hz
ϕn(10M)		10MHz from carrier		-152		dBc/Hz
$t_{JIT(cc)}$	Cycle-to-Cycle Jitter; NOTE 2	f_{OUT} = 133.33MHz		14	40	ps
		f_{OUT} = 66.66MHz		12	30	ps
odc	Output Duty Cycle		47	50	53	%
t_R / t_F	Output Rise/ Fall Time	20% to 80%	650	840	1150	ps

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE: Data taken in PLL mode.
NOTE 1: Refer to the phase noise plot.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at $V_{DDO\_A}/2$.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same temperature, same frequency and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at $V_{DDO\_A}/2$.

Table 6B. LVDS AC Electrical Characteristics, $V_{DD} = V_{DD\_XTAL} = V_{DDD} = V_{DDO\_B} = V_{DDO\_C5}$ = 3.3V ± 5%, T_A = -40°C to 85°C.

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output frequency			100	125	MHz
t_{JIT}	RMS Phase Jitter (Random); NOTE 1	f_{OUT} = 100MHz, Integration Range (12kHz to 20MHz)		265	325	fs
		f_{OUT} = 125MHz, Integration Range (12kHz to 20MHz)		311	475	fs
ϕn(100)	Single-side Band Phase Noise for f_{out} = 125MHz	100Hz from carrier		-104		dBc/Hz
ϕn(1k)		1kHz from carrier		-126		dBc/Hz
ϕn(10k)		10kHz from carrier		-134		dBc/Hz
ϕn(100k)		100kHz from carrier		-138		dBc/Hz
ϕn(1M)		1MHz from carrier		-147		dBc/Hz
ϕn(10M)		10MHz from carrier		-155		dBc/Hz
$t_{JIT(cc)}$	Cycle-to-Cycle Jitter; NOTE 2	f_{OUT} = 100MHz			20	ps
		f_{OUT} = 125MHz			20	ps
tsk(o)	Output Skew; NOTE 2, 3				70	ps
odc	Output Duty Cycle		47	50	53	%
t_R / t_F	Output Rise/ Fall Time	20% to 80%	100	214	450	ps
t_{HZ}	Valid to HZ			4		ns
t_{VALID}	HZ to valid			600		ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE: Data taken in PLL mode.
NOTE 1: Refer to the phase noise plots.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the differential crosspoint.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same temperature, same frequency and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at differential crosspoint.

Table 6C. HCSL AC Electrical Characteristics, $V_{DD} = V_{DD\_XTAL} = V_{DDD} = V_{DDO\_C} = 3.3V \pm 5\%$, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output frequency			100		MHz
t_{JIT}	RMS Phase Jitter (Random); NOTE 1	f_{OUT} = 100MHz, Integration Range (12kHz to 20MHz)		325	400	fs
ϕn(100)	Single-side Band Phase Noise for f_{out} = 100MHz	100Hz from carrier		-105		dBc/Hz
ϕn(1k)		1kHz from carrier		-126		dBc/Hz
ϕn(10k)		10kHz from carrier		-138		dBc/Hz
ϕn(100k)		100kHz from carrier		-139		dBc/Hz
ϕn(1M)		1MHz from carrier		-147		dBc/Hz
ϕn(10M)		10MHz from carrier		-152		dBc/Hz
$t_{JIT(CC)}$	Cycle-to-Cycle Jitter; NOTE 2	f_{OUT} = 100MHz		10	20	ps
*t*sk(o)	Output Skew; NOTE 2, 3				60	ps
t_{HZ}	Valid to HZ			16		ns
t_{VALID}	HZ to Valid			37		ns
V_{MAX}	Absolute Maximum Output Voltage; NOTE 5, 6				1150	mV
V_{MIN}	Absolute Minimum Output Voltage; NOTE 5, 7		-150			mV
V_{CROSS}	Absolute Crossing Voltage; NOTE 4, 7, 8		250		550	mV
ΔV_{CROSS}	Total Variation of V_{CROSS} over all edges; NOTE 5, 8, 9	V_{DDO_A}			140	mV
t_{SLEW}±	Rise/Fall Edge Rate; NOTE 11, 12	Measured between -150mV to +150mV	0.6		4.0	V/ns
odc	Output Duty Cycle		47		53	%

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE: Data taken in PLL mode.
NOTE 1: Refer to the phase noise plots.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the differential crosspoint.
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same temperature, same frequency and with equal load conditions. Using the same type of inputs on each device, the outputs are measured at the differential crosspoint.
NOTE 5: Measurement taken from single-ended waveform.
NOTE 6: Defined as the maximum instantaneous voltage including overshoot.
NOTE 7: Defined as the minimum instantaneous voltage including undershoot. See Parameter Measurement Information Section.
NOTE 8: Measured at crosspoint where the instantaneous voltage value of the rising edge of QCx equals the falling edge of nQCx. See Parameter Measurement Information Section.
NOTE 9: Refers to the total variation from the lowest crosspoint to the highest, regardless of which edge is crossing. Refers to all crosspoints for this measurement. See Parameter Measurement Information Section.
NOTE 12: Defined as the total variation of all crossing voltage of rising QCx and falling nQCx. This is the maximum allowed variance in the V_{CROSS} for any particular system. See Parameter Measurement Information Section.
NOTE 11: Measurement taken from a differential waveform.
NOTE 12: Measured from -150mV to +150mV on the differential waveform (derived from QCx minus nQCx). 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. See Parameter Measurement Information Section.

Table 6D. PCI Express Jitter Specifications, $V_{DD} = V_{DD\_XTAL} = V_{DDD} = V_{DDO\_C} = 3.3V \pm 5\%$, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	PCIe Industry Specification	Units
t_j (PCIe Gen 1)	Phase Jitter Peak-to-Peak; NOTE 1, 4	f = 100MHz, 25MHz Crystal Input Evaluation Band: 0Hz - Nyquist (clock frequency/2)		9	14	86	ps
$t_{REFCLK\_HF\_RMS}$ (PCIe Gen 2)	Phase Jitter RMS; NOTE 2, 4	f = 100MHz, 25MHz Crystal Input High Band: 1.5MHz - Nyquist (clock frequency/2)		0.73	1.0	3.1	ps
$t_{REFCLK\_LF\_RMS}$ (PCIe Gen 2)	Phase Jitter RMS; NOTE 2, 4	f = 100MHz, 25MHz Crystal Input Low Band: 10kHz - 1.5MHz		0.04	0.5	3.0	ps
t_{REFCLK_RMS} (PCIe Gen 3)	Phase Jitter RMS; NOTE 3, 4	f = 100MHz, 25MHz Crystal Input Evaluation Band: 0Hz - Nyquist (clock frequency/2)		0.16	0.2	0.8	ps

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions. For additional information, refer to the *PCI Express Application Note section* in the datasheet.

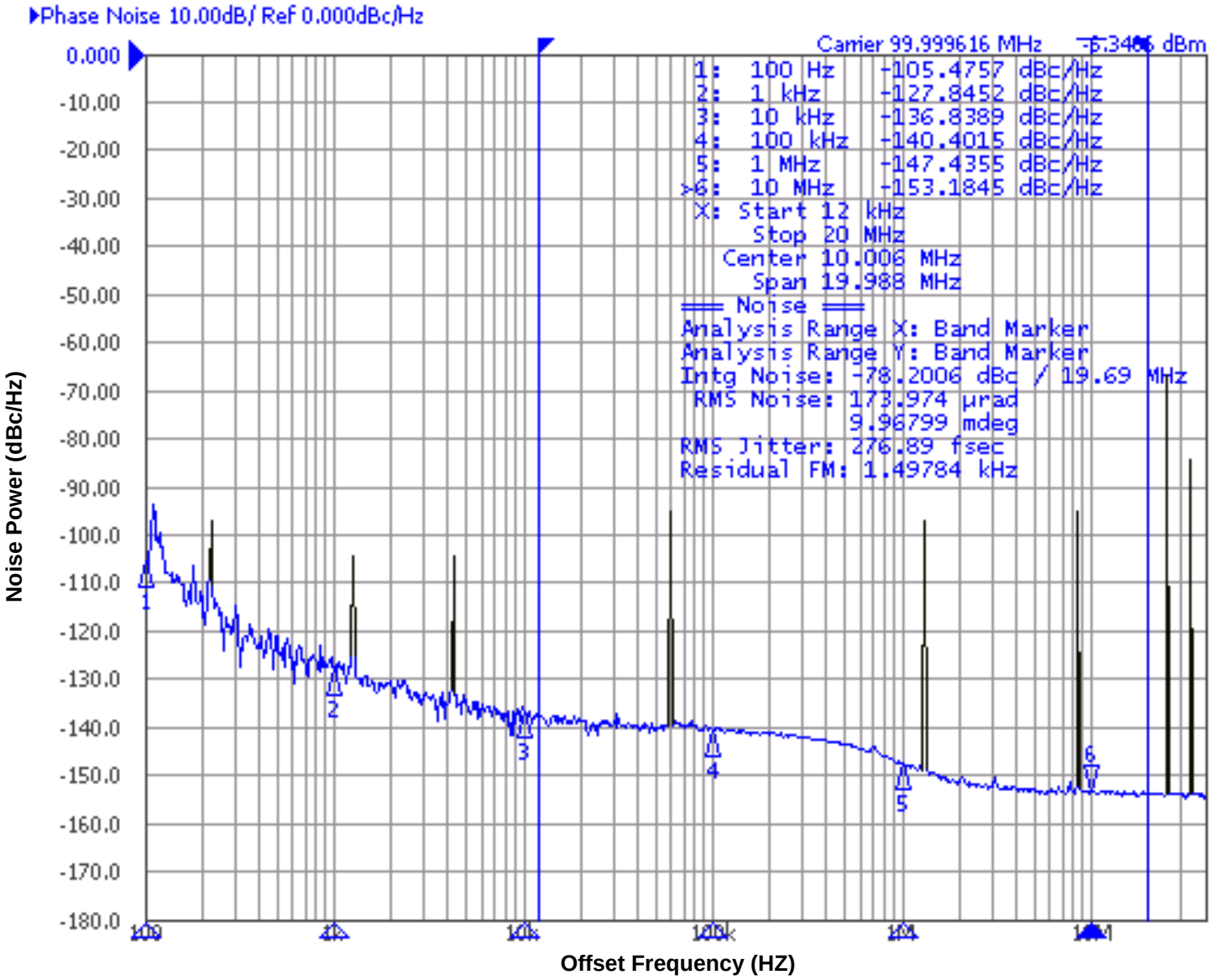
NOTE 1: Peak-to-Peak jitter after applying system transfer function for the Common Clock Architecture. Maximum limit for PCI Express Gen 1 is 86ps peak-to-peak for a sample size of 10^6 clock periods.

NOTE 2: RMS jitter after applying the two evaluation bands to the two transfer functions defined in the Common Clock Architecture and reporting the worst case results for each evaluation band. Maximum limit for PCI Express Generation 2 is 3.1ps RMS for $t_{REFCLK\_HF\_RMS}$ (High Band) and 3.0ps RMS for $t_{REFCLK\_LF\_RMS}$ (Low Band).

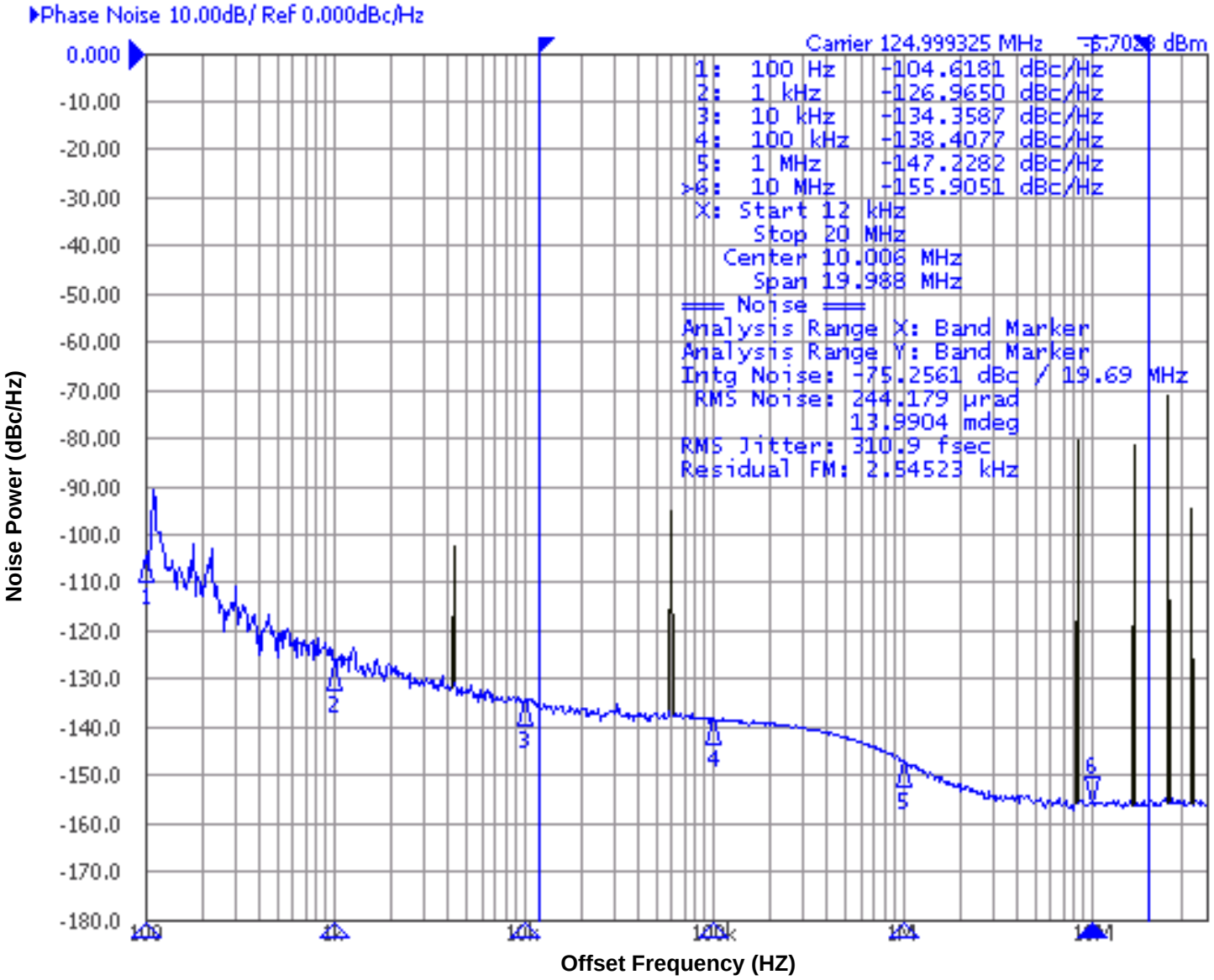
NOTE 3: RMS jitter after applying system transfer function for the common clock architecture. This specification is based on the *PCI Express Base Specification Revision 0.7, October 2009* and is subject to change pending the final release version of the specification.

NOTE 4: This parameter is guaranteed by characterization. Not tested in production.

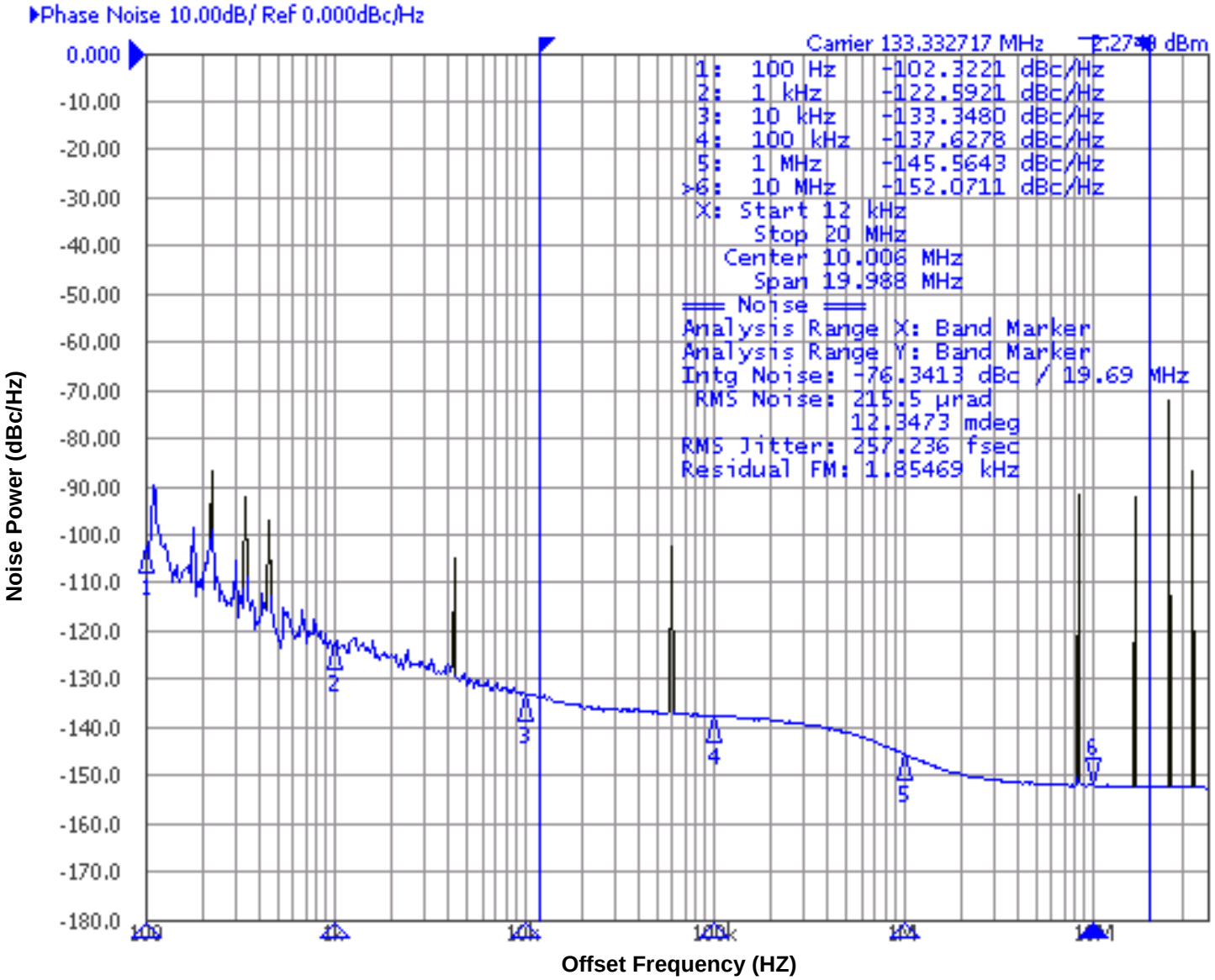
Typical Phase Noise at 100MHz, Bank C output



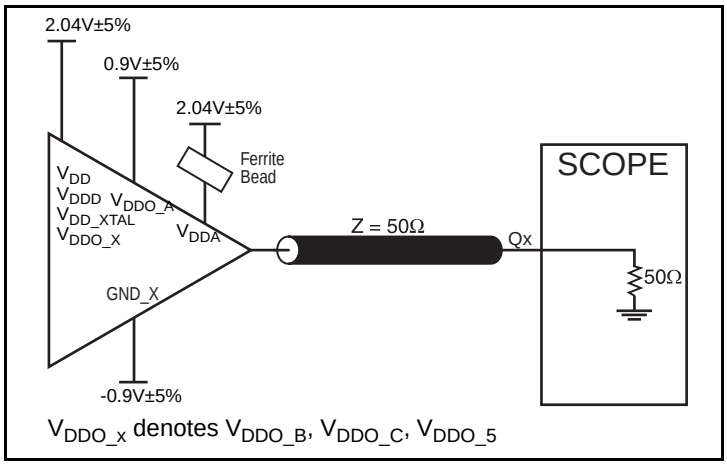
Typical Phase Noise at 125MHz, Bank B output



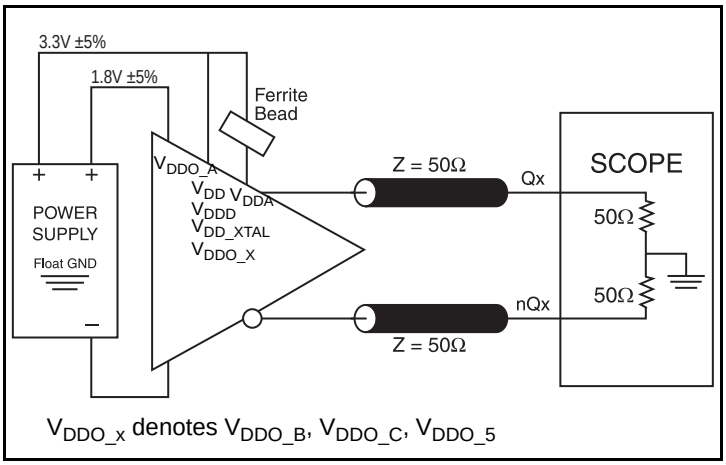
Typical Phase Noise at 133.33MHz, Bank A output



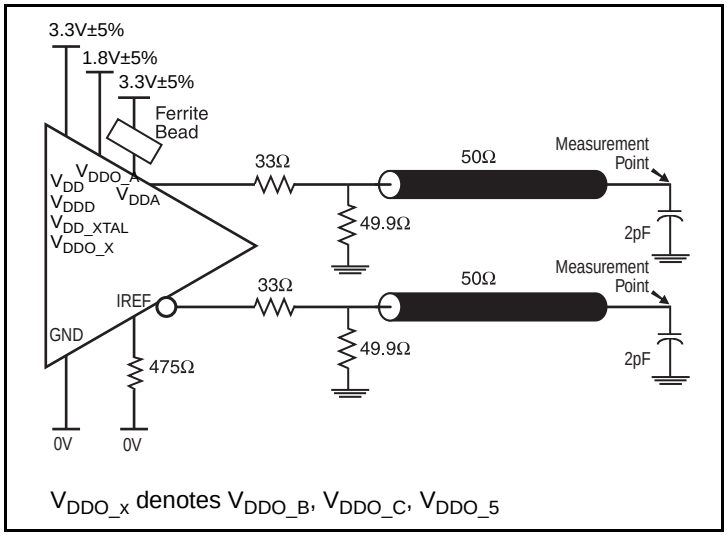
Parameter Measurement Information



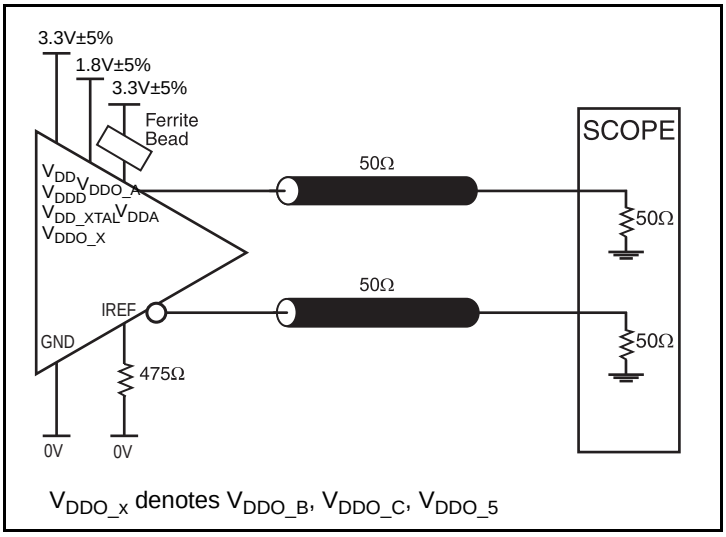
LVCMOS Output Load Test Circuit



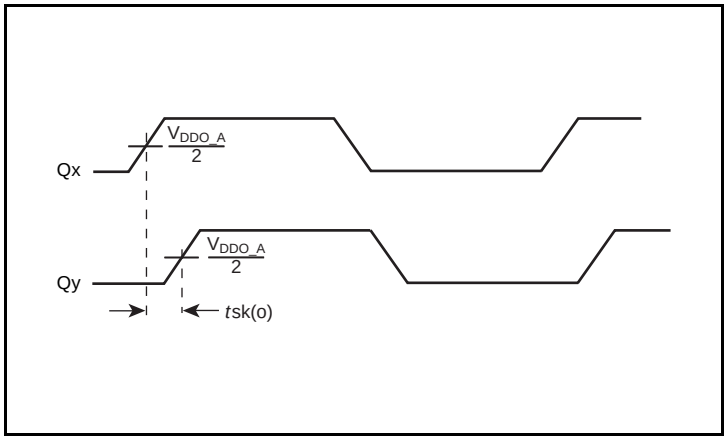
LVDS Output Load Test Circuit



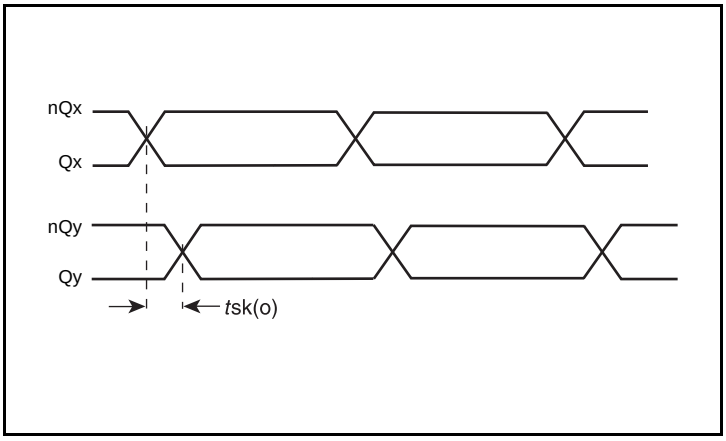
HCSL Output Load Test Circuit



HCSL Output Load Test Circuit

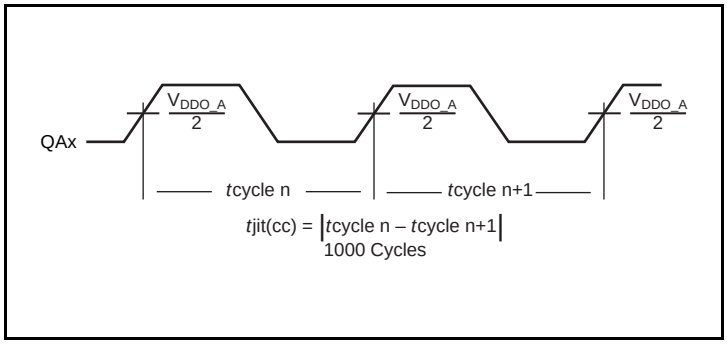


LVCMOS Output Skew

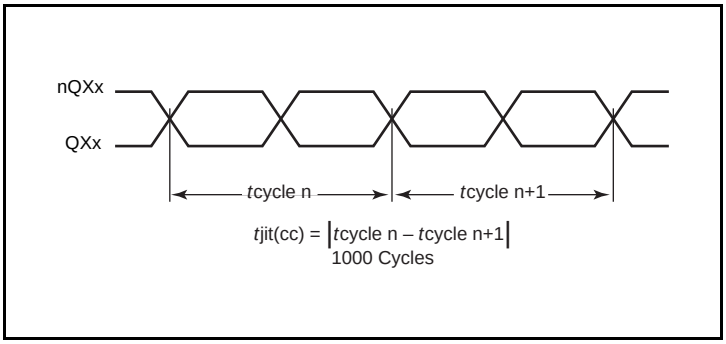


Output Skew (Differential Outputs)

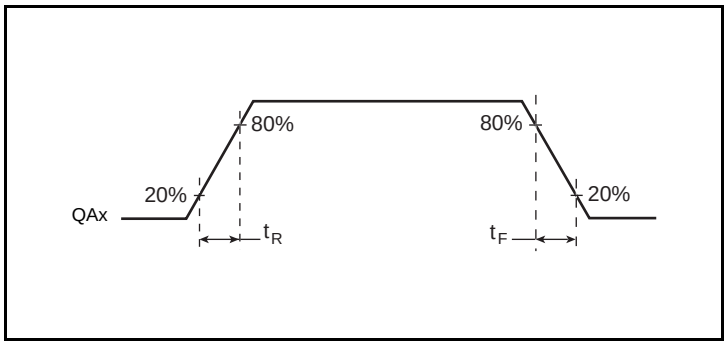
Parameter Measurement Information, continued



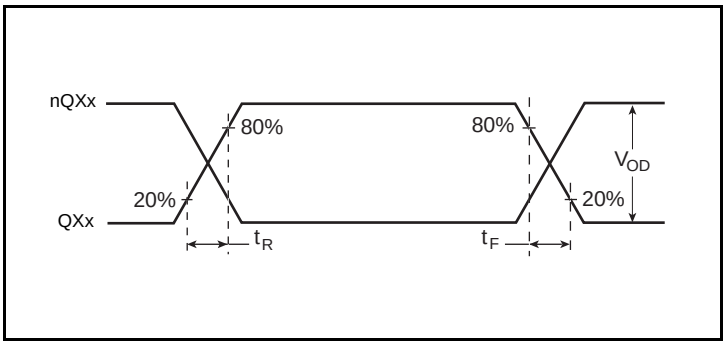
Cycle-to-Cycle Jitter (LVCMOS Output)



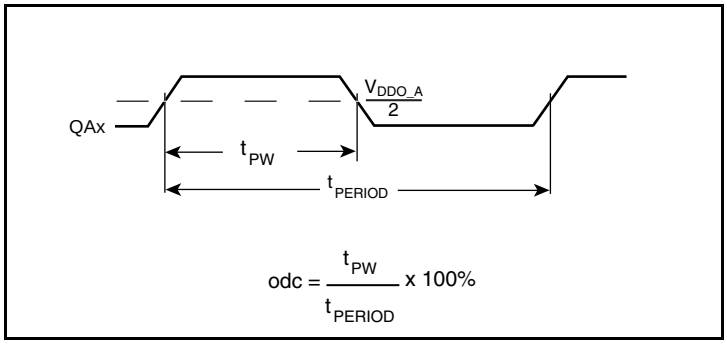
Cycle-to-Cycle Jitter (Differential Output)



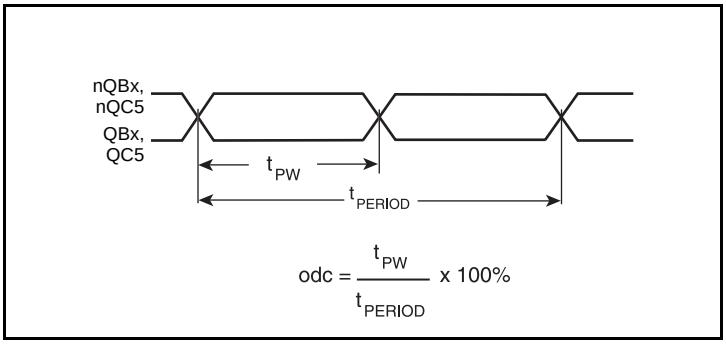
LVCMOS Output Rise/Fall Time



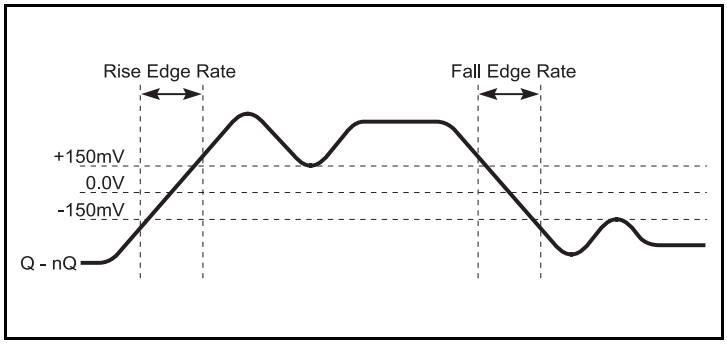
LVDS Output Rise/Fall Time



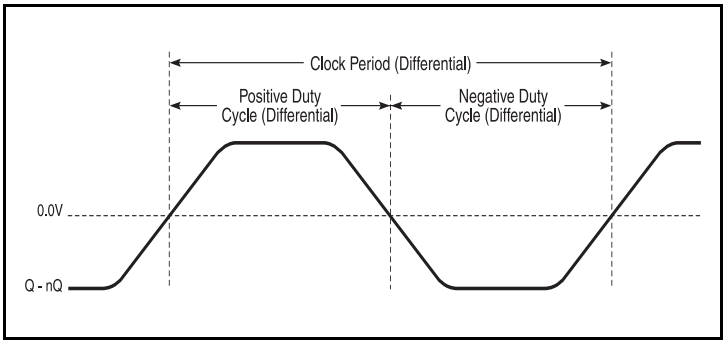
LVCMOS Output Duty Cycle



Differential Output Duty Cycle

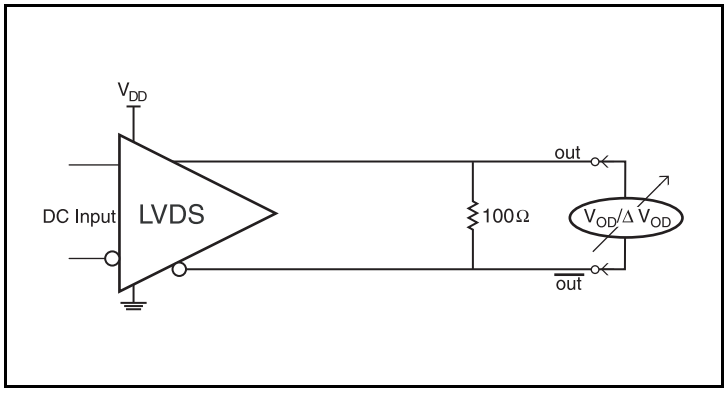


HCSL Output Points for Rise/Fall Edge Rate

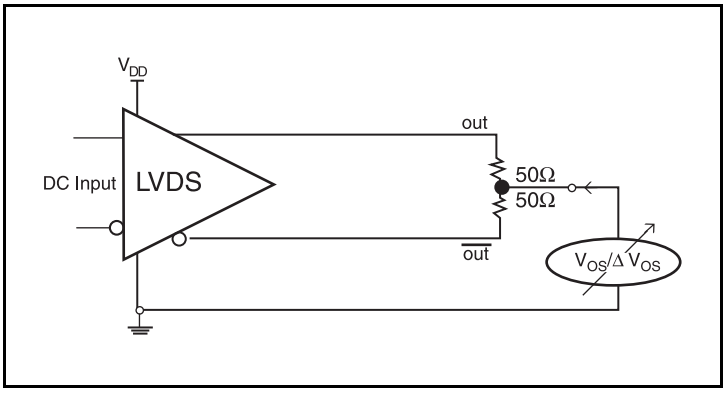


Differential Measurement Points for Duty Cycle/Period

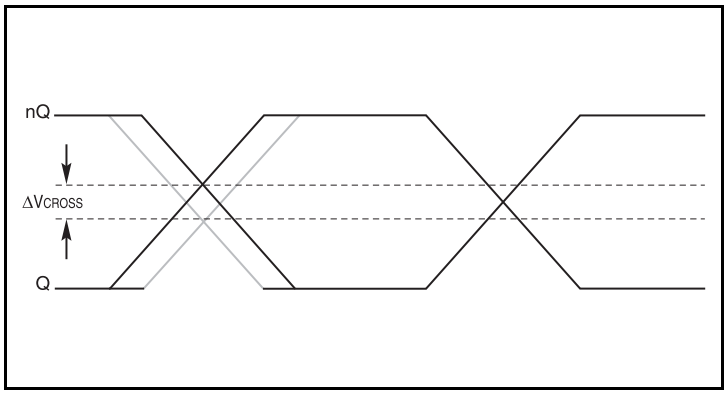
Parameter Measurement Information, continued



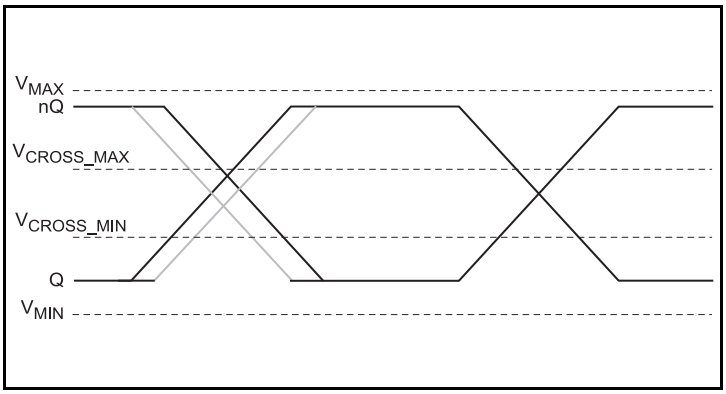
Differential Output Voltage Setup



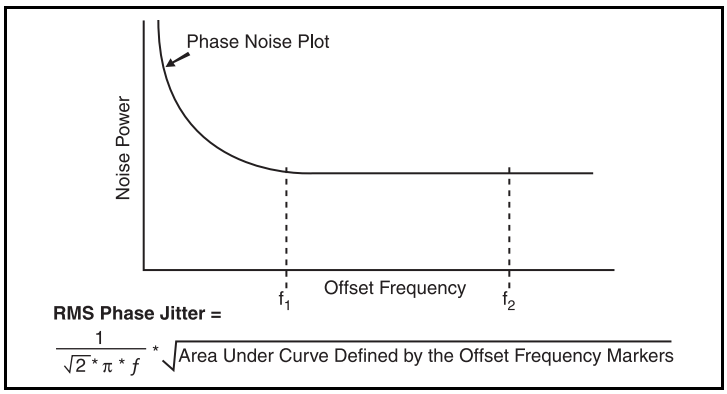
Offset Voltage Setup



Single-ended Measurement Points for Delta Crosspoint



Single-ended Measurement Points for Absolute Crosspoint/Swing



RMS Phase Jitter

Applications Information

Overdriving the XTAL Interface

The XTAL_IN input can be overdriven by an LVCMOS driver or by one side of a differential driver through an AC coupling capacitor. The XTAL_OUT pin can be left floating. The amplitude of the input signal should be between 500mV and 1.8V and the slew rate should not be less than 0.2V/ns. For 3.3V LVCMOS inputs, the amplitude must be reduced from full swing to at least half the swing in order to prevent signal interference with the power rail and to reduce internal noise. *Figure 1A* shows an example of the interface diagram for a high speed 3.3V LVCMOS driver. This configuration requires that the sum of the output impedance of the driver (Ro) and the series resistance (Rs) equals the transmission line impedance. In addition, matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First, R1 and R2 in parallel should equal the transmission line impedance. For most 50Ω applications, R1 and R2 can be 100Ω. This can also be accomplished by removing R1 and changing R2 to 50Ω. The values of the resistors can be increased to reduce the loading for a slower and weaker LVCMOS driver. *Figure 1B* shows an example of the interface diagram for an LVPECL driver. This is a standard LVPECL termination with one side of the driver feeding the XTAL_IN input. It is recommended that all components in the schematics be placed in the layout. Though some components might not be used, they can be utilized for debugging purposes. The datasheet specifications are characterized and guaranteed by using a quartz crystal as the input.

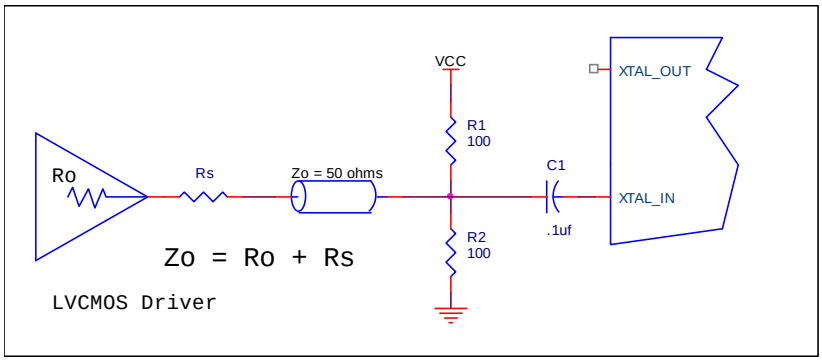


Figure 1A. General Diagram for LVCMOS Driver to XTAL Input Interface

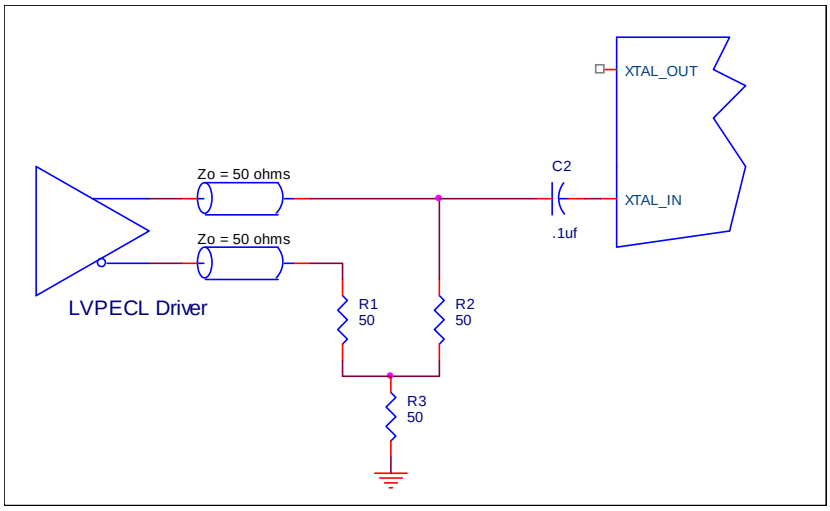


Figure 1B. General Diagram for LVPECL Driver to XTAL Input Interface

Recommendations for Unused Input and Output Pins

Inputs:

LVCMOS Control Pins

All control pins have internal pullup or pulldown resistors; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

Outputs:

LVCMOS Outputs

All unused LVCMOS outputs can be left floating. There should be no trace attached.

LVDS Outputs

All unused LVDS outputs can be either left floating or terminated with 100Ω across. If they are left floating, there should be no trace attached.

HCSL Outputs

All unused differential outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

LVDS Driver Termination

For a general LVDS interface, the recommended value for the termination impedance (Z_T) is between 90Ω and 132Ω. The actual value should be selected to match the differential impedance (Z_0) of your transmission line. A typical point-to-point LVDS design uses a 100Ω parallel resistor at the receiver and a 100Ω differential transmission-line environment. In order to avoid any transmission-line reflection issues, the components should be surface mounted and must be placed as close to the receiver as possible. IDT offers a full line of LVDS compliant devices with two types of output structures: current source and voltage source. The standard termination schematic as shown in *Figure 2A* can be used with either type of output structure. *Figure 2B*, which can also be used with both output types, is an optional termination with center tap capacitance to help filter common mode noise. The capacitor value should be approximately 50pF. If using a non-standard termination, it is recommended to contact IDT and confirm if the output structure is current source or voltage source type. In addition, since these outputs are LVDS compatible, the input receiver's amplitude and common-mode input range should be verified for compatibility with the output.

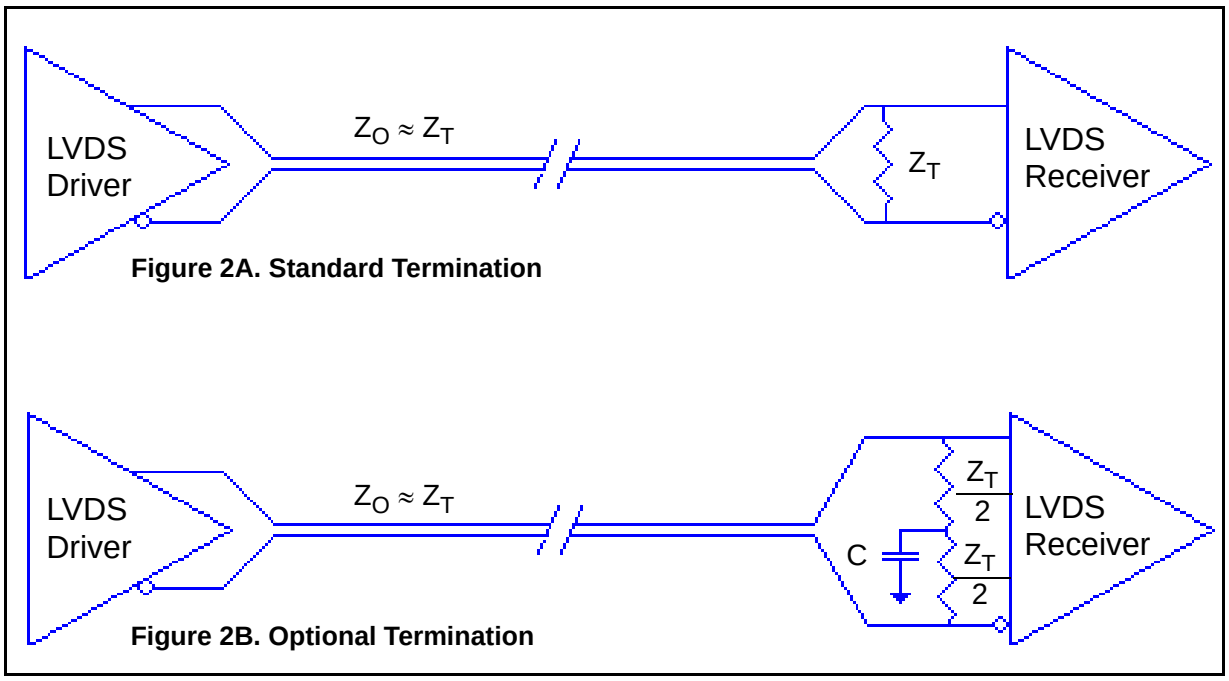


Figure 2A. Standard Termination

Figure 2B. Optional Termination

LVDS Termination

Recommended Termination

Figure 3A is the recommended source termination for applications where the driver and receiver will be on a separate PCBs. This termination is the standard for PCI Express™ and HCSL output types. All traces should be 50Ω impedance single-ended or 100Ω differential.

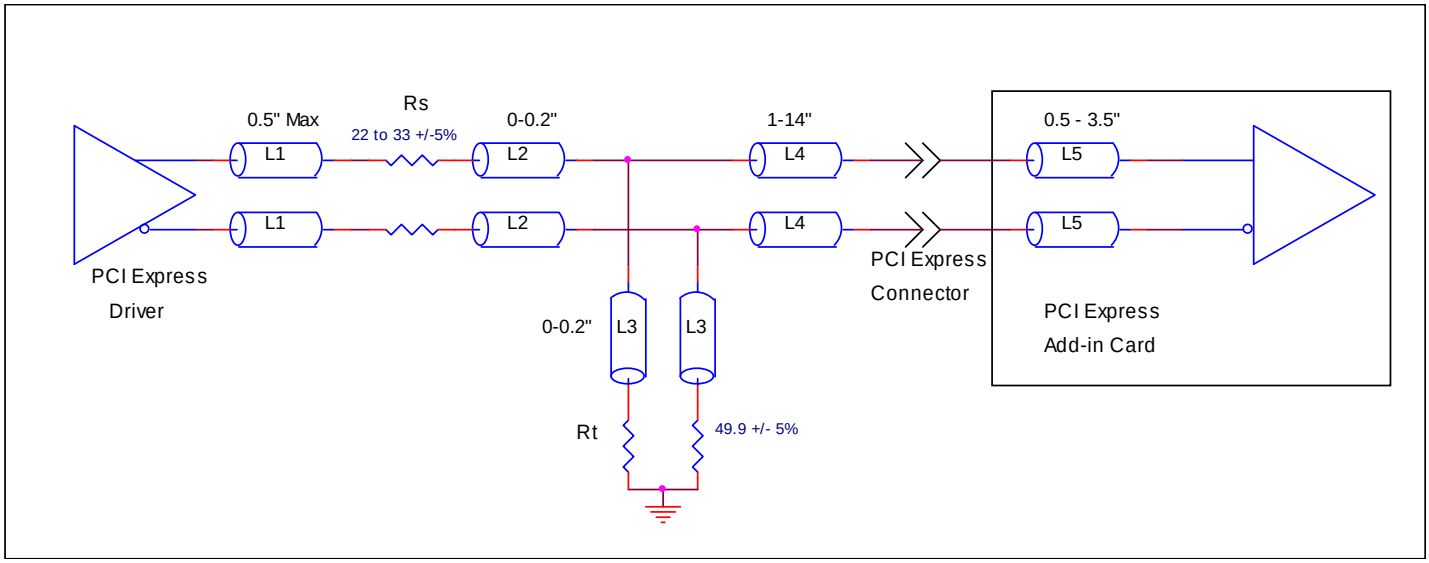


Figure 3A. Recommended Source Termination (where the driver and receiver will be on separate PCBs)

Figure 3B is the recommended termination for applications where a point-to-point connection can be used. A point-to-point connection contains both the driver and the receiver on the same PCB. With a matched termination at the receiver, transmission-line reflections will be minimized. In addition, a series resistor (Rs) at the driver offers flexibility and can help dampen unwanted reflections. The optional resistor can range from 0Ω to 33Ω. All traces should be 50Ω impedance single-ended or 100Ω differential.

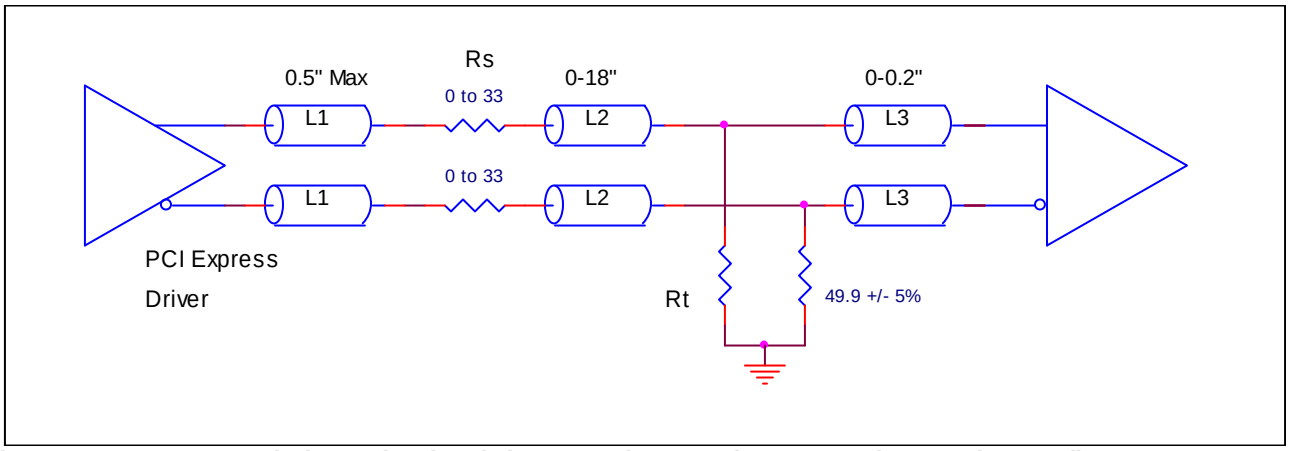


Figure 3B. Recommended Termination (where a point-to-point connection can be used)

VFQFN EPAD Thermal Release Path

In order to maximize both the removal of heat from the package and the electrical performance, a land pattern must be incorporated on the Printed Circuit Board (PCB) within the footprint of the package corresponding to the exposed metal pad or exposed heat slug on the package, as shown in *Figure 4.* The solderable area on the PCB, as defined by the solder mask, should be at least the same size/shape as the exposed pad/slug area on the package to maximize the thermal/electrical performance. Sufficient clearance should be designed on the PCB between the outer edges of the land pattern and the inner edges of pad pattern for the leads to avoid any shorts.

While the land pattern on the PCB provides a means of heat transfer and electrical grounding from the package to the board through a solder joint, thermal vias are necessary to effectively conduct from the surface of the PCB to the ground plane(s). The land pattern must be connected to ground through these vias. The vias act as “heat pipes”. The number of vias (i.e. “heat pipes”) are application specific and dependent upon the package power dissipation as well as electrical conductivity requirements. Thus, thermal and electrical analysis and/or testing are recommended to determine the minimum number needed. Maximum thermal and electrical performance is achieved when an array of vias is incorporated in the land pattern. It is recommended to use as many vias connected to ground as possible. It is also recommended that the via diameter should be 12 to 13mils (0.30 to 0.33mm) with 1oz copper via barrel plating. This is desirable to avoid any solder wicking inside the via during the soldering process which may result in voids in solder between the exposed pad/slug and the thermal land. Precautions should be taken to eliminate any solder voids between the exposed heat slug and the land pattern. Note: These recommendations are to be used as a guideline only. For further information, please refer to the Application Note on the Surface Mount Assembly of Amkor’s Thermally/Electrically Enhance Leadframe Base Package, Amkor Technology.

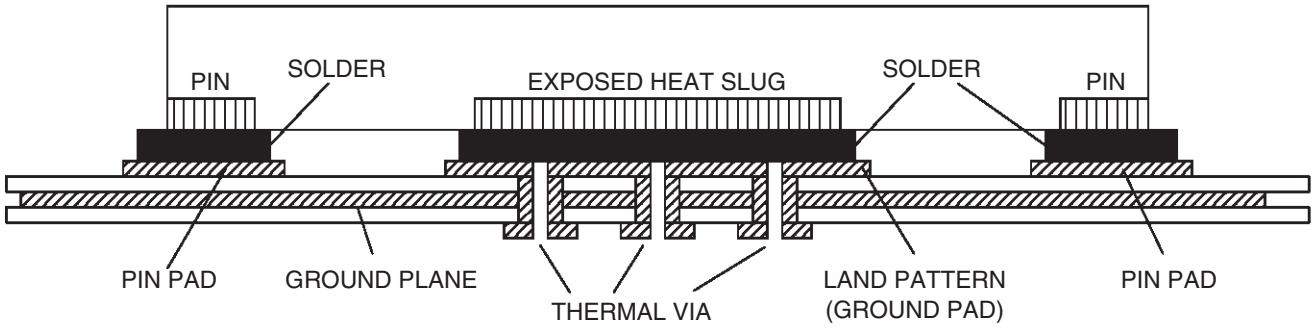


Figure 4. P.C. Assembly for Exposed Pad Thermal Release Path – Side View (drawing not to scale)

PCI Express Application Note

PCI Express jitter analysis methodology models the system response to reference clock jitter. The block diagram below shows the most frequently used *Common Clock Architecture* in which a copy of the reference clock is provided to both ends of the PCI Express Link.

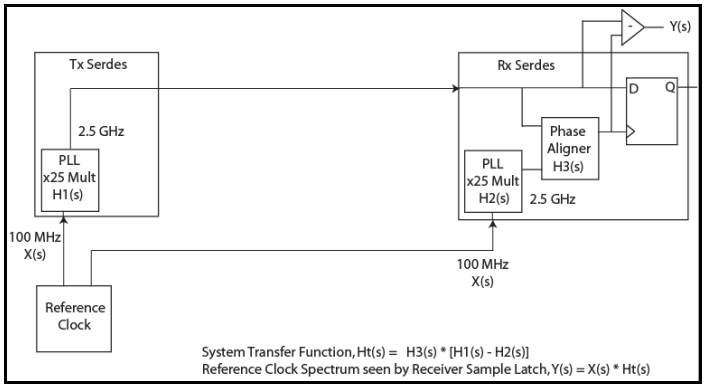
In the jitter analysis, the transmit (Tx) and receive (Rx) serdes PLLs are modeled as well as the phase interpolator in the receiver. These transfer functions are called H1, H2, and H3 respectively. The overall system transfer function at the receiver is:

$$Ht(s) = H3(s) \times [H1(s) - H2(s)]$$

The jitter spectrum seen by the receiver is the result of applying this system transfer function to the clock spectrum X(s) and is:

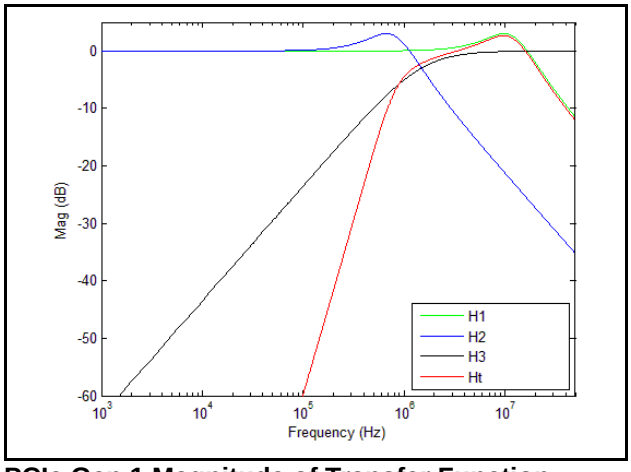
$$Y(s) = X(s) \times H3(s) \times [H1(s) - H2(s)]$$

In order to generate time domain jitter numbers, an inverse Fourier Transform is performed on X(s)*H3(s) * [H1(s) - H2(s)].



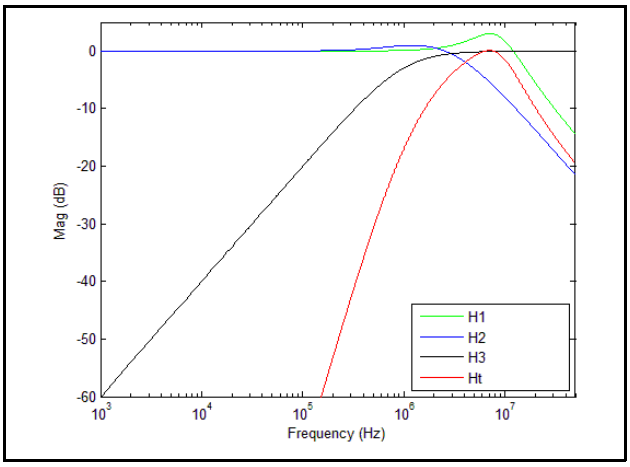
PCI Express Common Clock Architecture

For **PCI Express Gen 1**, one transfer function is defined and the evaluation is performed over the entire spectrum: DC to Nyquist (e.g for a 100MHz reference clock: 0Hz – 50MHz) and the jitter result is reported in peak-peak.

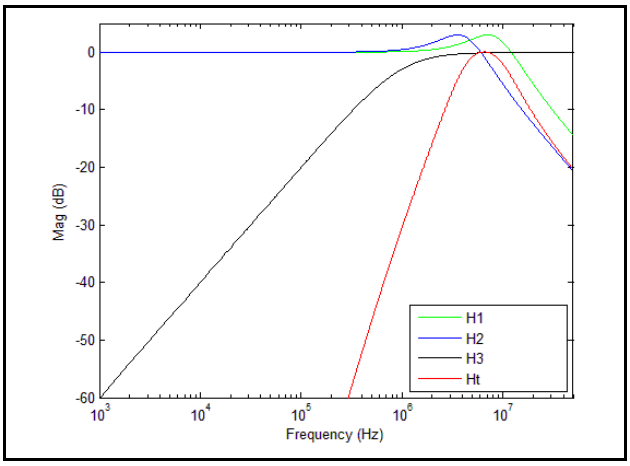


PCIe Gen 1 Magnitude of Transfer Function

For **PCI Express Gen 2**, two transfer functions are defined with 2 evaluation ranges and the final jitter number is reported in rms. The two evaluation ranges for PCI Express Gen 2 are 10kHz – 1.5MHz (Low Band) and 1.5MHz – Nyquist (High Band). The plots show the individual transfer functions as well as the overall transfer function Ht.

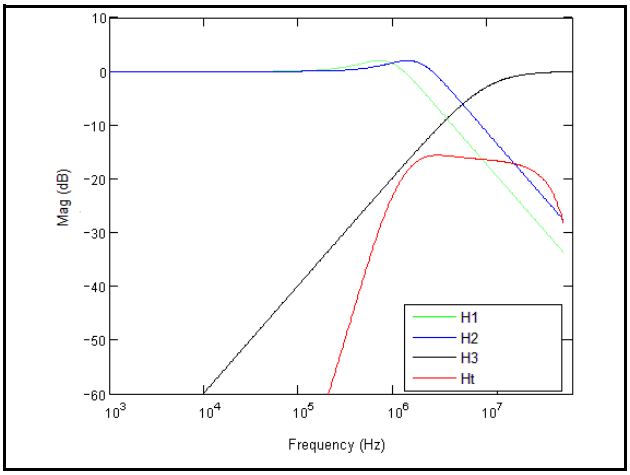


PCIe Gen 2A Magnitude of Transfer Function



PCIe Gen 2B Magnitude of Transfer Function

For **PCI Express Gen 3**, one transfer function is defined and the evaluation is performed over the entire spectrum. The transfer function parameters are different from Gen 1 and the jitter result is reported in RMS.



PCIe Gen 3 Magnitude of Transfer Function

For a more thorough overview of PCI Express jitter analysis methodology, please refer to IDT Application Note *PCI Express Reference Clock Requirements.*

Schematic Layout

Figure 5 shows an example 8V49N231 application schematic. The schematic example focuses on functional connections and is not configuration specific. Refer to the pin description and functional tables in the datasheet to ensure the logic control inputs are properly set. Input and output terminations shown are intended as examples only and may not represent the exact user configuration.

The schematic example shows two different HCSL output terminations; the standard termination for the case in which the HCSL receiver is on the same PCB as the 8V49N231 as well as the termination for an attached PCIe add-in card.

In this example a 12pF parallel resonant 25MHz crystal is used with load caps C1 = C2 = 10pF. Crystals with other load capacitance specifications can be used, for example, a CL=18pF crystal can be used with two 22pF tuning capacitors. Depending on the parasitics of the printed circuit board layout, the values of C1 and C2 might require a slight adjustment to optimize the frequency accuracy. For this device, the crystal tuning capacitors are required for proper operation.

Crystal layout is very important to minimize capacitive coupling between the crystal pads and leads and other metal in the circuit board. Capacitive coupling to other conductors has two adverse effects. The first is that it reduces the oscillator frequency, leaving less tuning margin. Second, noise on power planes and logic transitions on signal traces can pull the phase of voltages on the XTAL_IN and XTAL_OUT pins of the oscillator.

Using a crystal on the top layer as an example, void all signal and power layers under the crystal, XTAL_IN, XTAL_OUT and the input pins of the 8V49N231 between the top layer and the ground plane for the 8V49N231. If the ground plane for the 8V49N231 is the first layer under the crystal, then void enough power and signal planes to minimize the coupling capacity. Ensure that the ground under the crystal is the same ground as used for the tuning caps and the oscillator.

As with any high speed analog circuitry, the power supply pins are vulnerable to random noise. To achieve optimum jitter performance, power supply isolation is required. The 8V49N231 provides separate V_{DD}, V_{DDD}, V_{DDA}, V_{DD_XTAL} and V_{DDO_REF}, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, and V_{DDO_C5} pins to isolate any high speed switching noise at the outputs from coupling into the internal PLL.

In order to achieve the best possible filtering, it is highly recommended that the 0.1µF capacitors be placed on the 8V49N231 side of the PCB as close to the power pins as possible. This is represented by the placement of these capacitors in the schematic. If space is limited, the ferrite beads, 10µf capacitors and the 0.1µF capacitors connected directly to 3.3V can be placed on the opposite side of the PCB. If space permits, place all filter components on the device side of the board.

Power supply filter recommendations are a general guideline to be used for reducing external noise from coupling into the devices. The filter performance is designed for a wide range of noise frequencies. This low-pass filter starts to attenuate noise at approximately 10 kHz. If a specific frequency noise component is known, such as switching power supplies frequencies, it is recommended that component values be adjusted and if required, additional filtering be added. Additionally, good general design practices for power plane voltage stability suggests adding bulk capacitance in the local area of all devices.

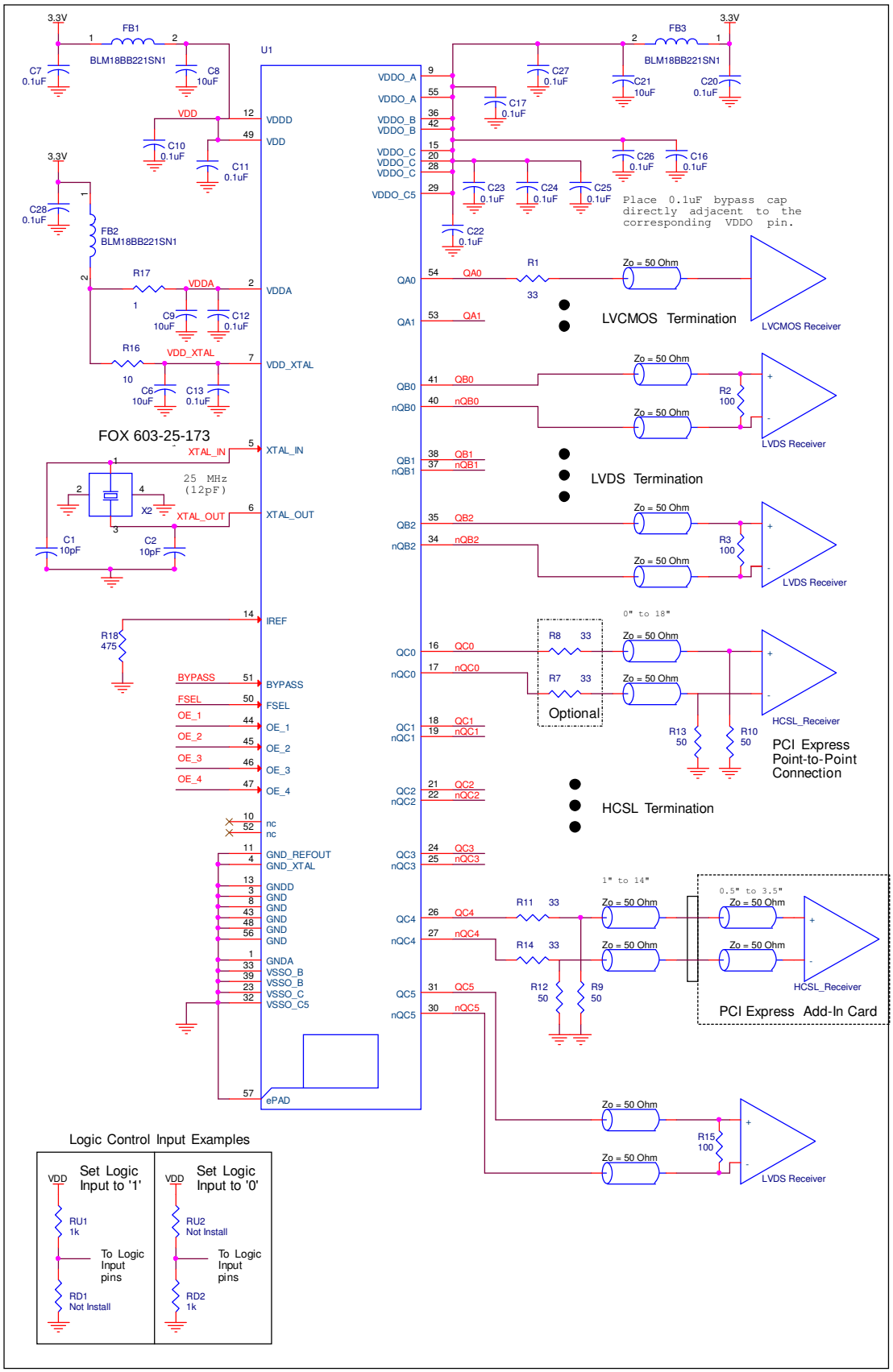


Figure 5. 8V49N231 Schematic Example

Power Considerations

This section provides information on power dissipation and junction temperature for the 8V49N231.
Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 8V49N231 is the sum of the core power plus analog power plus the power dissipation due to loading. The following is the power dissipation for V_{DD} = 3.3V + 5% = 3.465V, which gives worst case results at 85°C.

NOTE: Please refer to Section 3 for details on calculating power dissipated in the outputs.

- Power (core)$_{MAX}$ = V_{DD_MAX} * (I_{DD_MAX} + I_{DDA_MAX}) = 3.465V * (132mA + 58mA) = **658.35mW**
- The maximum current at 85°C is as follows
  I_{DD_MAX} = 132mA
  I_{DDA_max} = 58mA
  I_{DDO_A} = 15mA
  I_{DDO_x} = 97mA
  (I_{DDO_x} denote IDDO_B+IDDO_C+IDDO_C5)
- HCSL Output Power (output)$_{MAX}$ = **44.5mW/Loaded Output pair**
  If all outputs are loaded, the total power is 5 * 44.5mW = **222.5mW**
  LVDS and LVCMOS Outputs Power (output)$_{MAX}$ = 3.465V * 97mA + 1.89V * 15mA = **364.455mW**

Total Power$_{_MAX}$ = 658.35mW + 222.5mW + 364.455mW = **1245.31mW**

2. Junction Temperature.

Junction temperature, Tj, is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is 125°C. Limiting the internal transistor junction temperature, Tj, to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for Tj is as follows: Tj = θ_{JA} * Pd_total + T_A

Tj = Junction Temperature

θ_{JA} = Junction-to-Ambient Thermal Resistance

Pd_total = Total Device Power Dissipation (example calculation is in section 1 above)

T_A = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance θ_{JA} must be used. Assuming no air flow and a multi-layer board, the appropriate value is 30.5°C/W per Table 7 below.

Therefore, Tj for an ambient temperature of 85°C with all outputs switching is:

85°C + 1.25W * 30.5°C/W = 123°C. This is below the limit of 125°C.

This calculation is only an example. Tj will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

Table 7. Thermal Resistance θ_{JA} for 56-Lead VFQFN, Forced Convection

θ_{JA} vs. Air Flow			
Meters per Second	**0**	1	2
Multi-Layer PCB, JEDEC Standard Test Boards	30.5°C/W	26.4°C/W	24.7°C/W

3. Calculations and Equations.

The purpose of this section is to calculate power dissipation on the IC per HCSL output pairs.

HCSL output driver circuit and termination are shown in *Figure 6.*

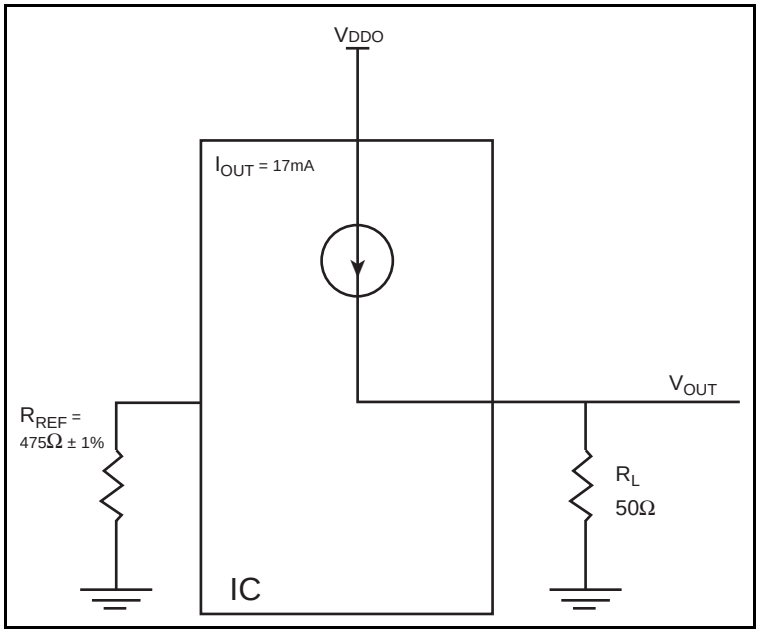


Figure 6. HCSL Driver Circuit and Termination

HCSL is a current steering output which sources a maximum of 17mA of current per output. To calculate worst case on-chip power dissipation, use the following equations which assume a 50Ω load to ground.

The highest power dissipation occurs at V_{DD_MAX}.

Power = $(V_{DD\_MAX} – V_{OUT}) * I_{OUT}$
since $V_{OUT} = I_{OUT} * R_L$

Power = $(V_{DD\_MAX} – I_{OUT} * R_L) * I_{OUT}$

= (3.465V – 17mA * 50Ω) * 17mA

Total Power Dissipation per output pair = 44.5mW

Reliability Information

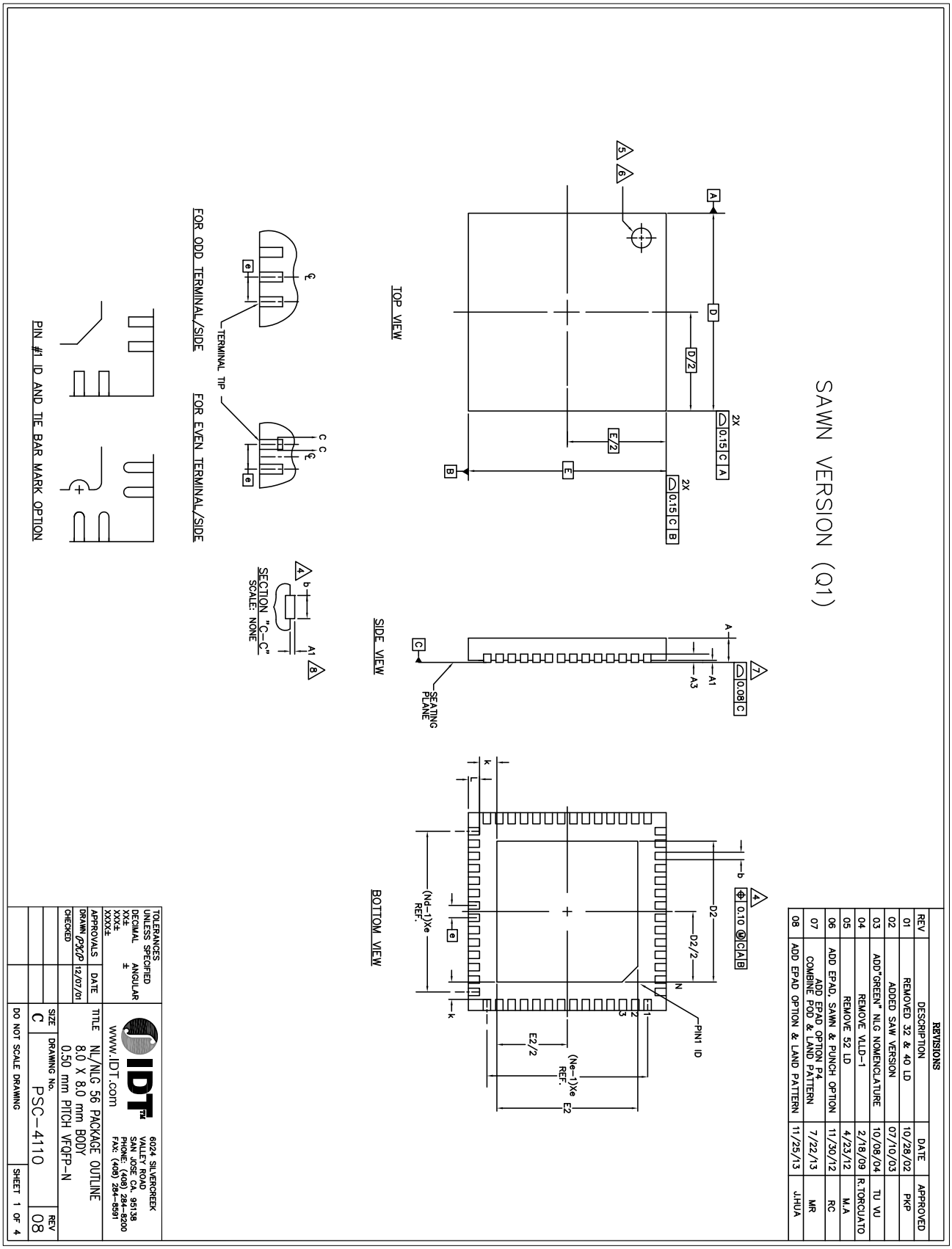
Table 8. θ_{JA} vs. Air Flow Table for a 56-Lead VFQFN

θ_{JA} vs. Air Flow			
Meters per Second	**0**	**1**	**2**
Multi-Layer PCB, JEDEC Standard Test Boards	30.5 °C/W	26.4°C/W	24.7°C/W

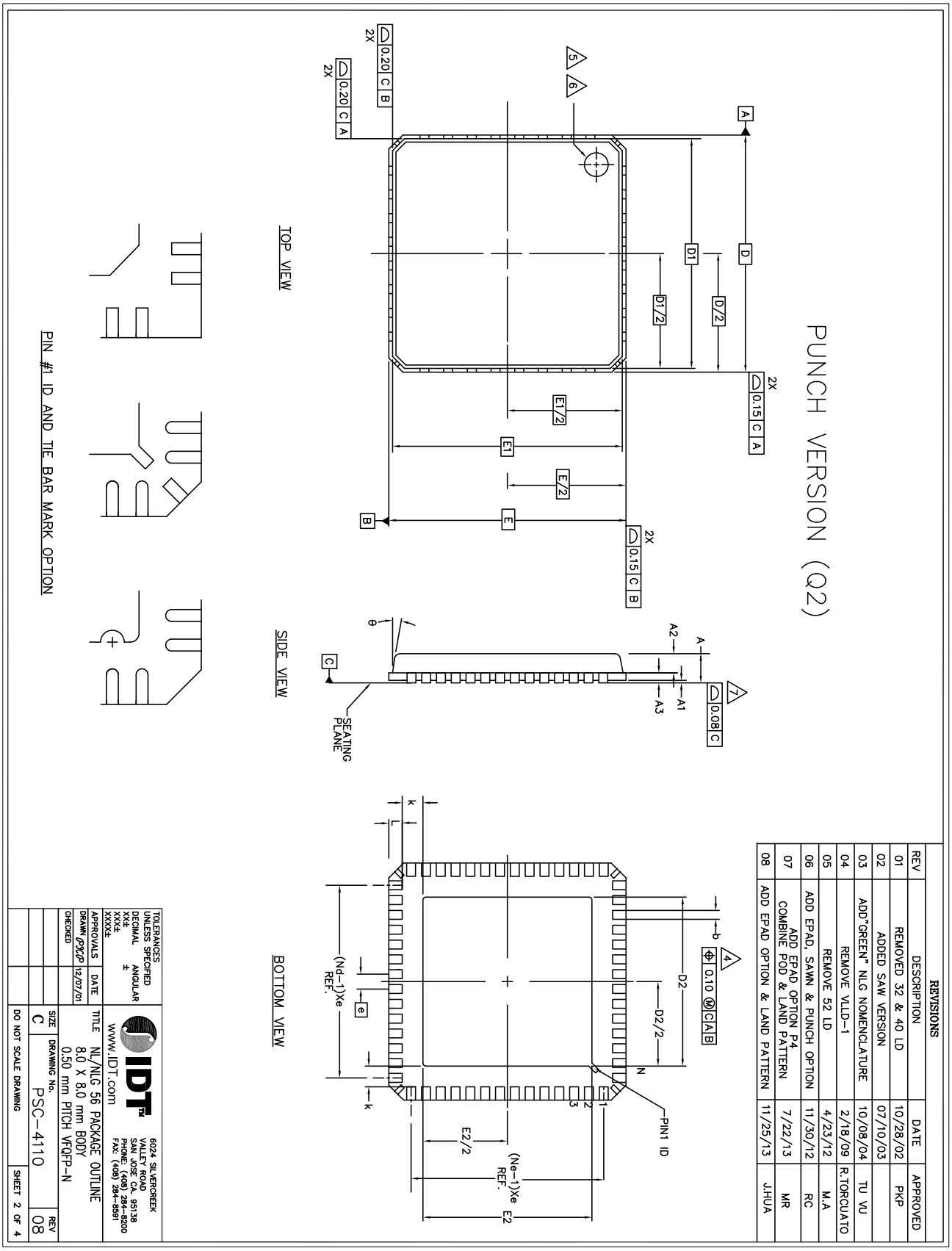
Transistor Count

The transistor count for 8V49N231 is: 178,395

56-Lead VFQFN Package Outline and Package Dimensions



56-Lead VFQFN Package Outline and Package Dimensions, continued



56-Lead VFQFN Package Outline and Package Dimensions, continued

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
01	REMOVED 32 & 40 LD	10/28/02	PKP
02	ADDED SAW VERSION	07/10/03	
03	ADD"GREEN" NLG NOMENCLATURE	10/08/04	TU VU
04	REMOVE VLLD-1	2/18/09	R.TORCUATO
05	REMOVE 52 LD	4/23/12	M.A
06	ADD EPAD, SAWN & PUNCH OPTION	11/30/12	RC
07	ADD EPAD OPTION P4 COMBINE POD & LAND PATTERN	7/22/13	MR
08	ADD EPAD OPTION & LAND PATTERN	11/25/13	J.HUA

PUNCH OPTION

Q			
SYMBOL	DIMENSION		
	MIN.	NOM.	MAX.
P	–	–	0.60
D1	7.75 BASIC		
E1	7.75 BASIC		
A2	–	0.65	0.70

EPAD OPTION

SYMBOL	P1			P2			P3			P4		
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX
E2	6.15	6.30	6.45	6.45	6.60	6.75	5.05	5.20	5.35	5.80	5.90	6.00
D2	6.15	6.30	6.45	6.45	6.60	6.75	4.35	4.50	4.65	5.80	5.90	6.00

SYMBOL	P5		
	MIN	NOM	MAX
E2	5.95	6.05	6.15
D2	5.95	6.05	6.15

COMMON DIMENSION

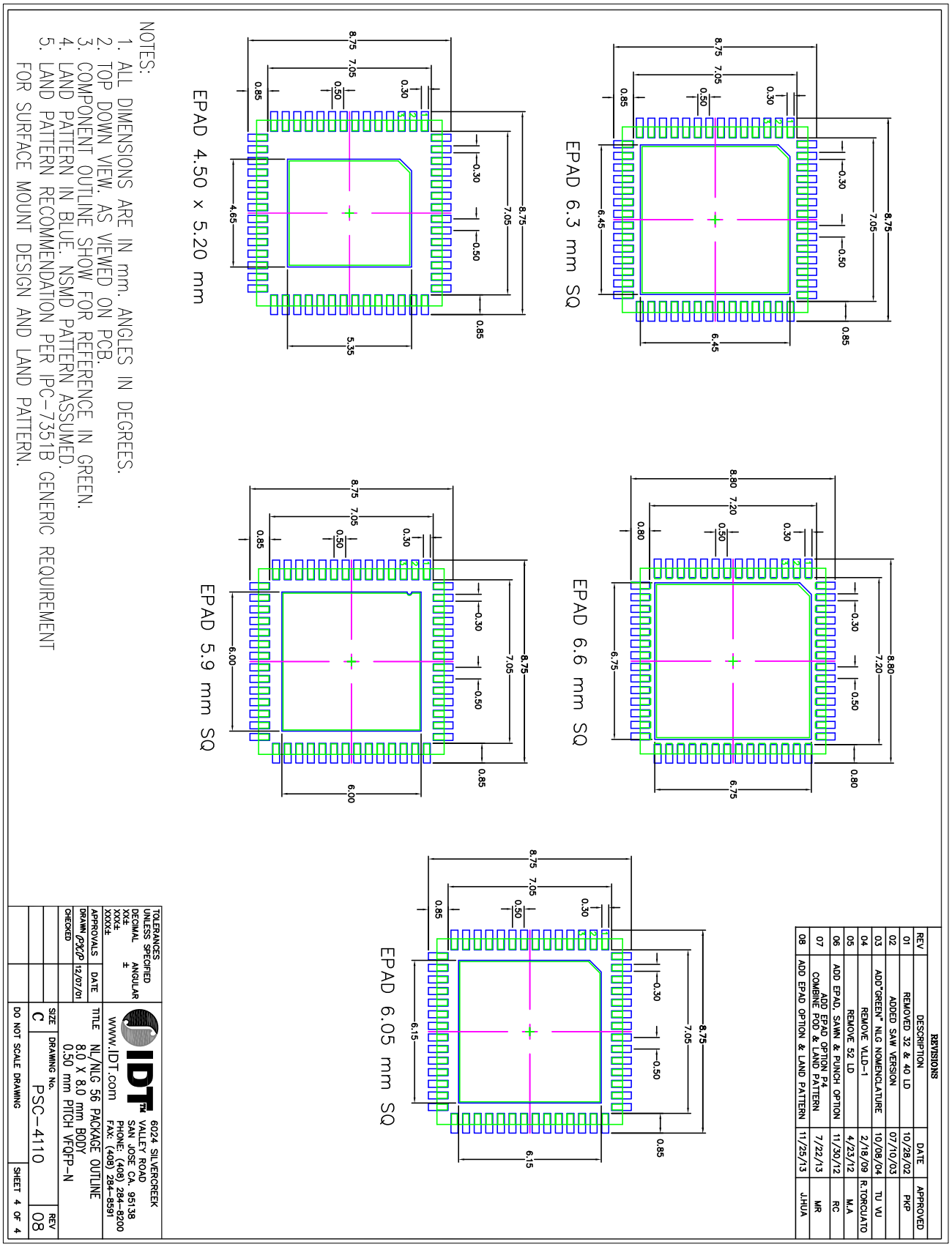
SYMBOL	DIMENSION			NOTE
	MIN.	NOM.	MAX.	
e	0.50 BSC			
N	56			2
Nd	14			2
Ne	14			2
L	0.30	0.40	0.50	
b	0.18	0.25	0.30	4
D2	SEE EPAD OPTION			
E2	SEE EPAD OPTION			
A	0.80	0.9	1.00	
A1	0.00	0.02	0.05	
A3	0.20 REF.			
D	8.00 BSC			
E	8.00 BSC			
θ	–	–	12°	
k	0.20	–	–	

NOTES:
1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M. – 1994.
2. N IS THE NUMBER OF TERMINALS.
   Nd IS THE NUMBER OF TERMINALS IN X-DIRECTION &
   Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION.
3. ALL DIMENSIONS ARE IN MILLIMETERS.
4. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.30mm FROM TERMINAL TIP.
5. THE PIN #1 IDENTIFIER MUST EXIST ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR OTHER FEATURE OF PACKAGE BODY.
6. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
7. APPLIED TO EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDED PART OF EXPOSED PAD FROM MEASURING.
8. APPLIED ONLY FOR TERMINALS.
9. NOT AN ACTUAL IO.

NOTE: 56-Lead E-Pad D2 / E2 dimension size: 4.5mm x 5.2mm

TOLERANCES UNLESS SPECIFIED DECIMAL XX± XXX± XXXX± ANGULAR ±		IDT™ www.IDT.com	6024 SILVERCREEK VALLEY ROAD SAN JOSE CA. 95138 PHONE: (408) 284-8200 FAX: (408) 284-8591
APPROVALS	DATE	TITLE	NL/NLG 56 PACKAGE OUTLINE 8.0 X 8.0 mm BODY 0.50 mm PITCH VFQFP-N
DRAWN PKP	12/07/01		
CHECKED		SIZE C	DRAWING No. PSC-4110 REV 08
		DO NOT SCALE DRAWING	SHEET 3 OF 4

56-Lead VFQFN Package Outline and Package Dimensions, continued



Ordering Information

Table 9. Ordering Information Table

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
8V49N231NLGI	IDT8V49N231NLGI	Lead-Free, 56-lead VFQFN	Tray	-40°C to 85°C
8V49N231NLGI8	IDT8V49N231NLGI	Lead-Free, 56-lead VFQFN	Tape & Reel	-40°C to 85°C

Revision History Sheet

Rev	Table	Page	Description of Change	Date
B		23	Updated Application Schematics. Deleted part number prefix/suffix throughout the datasheet. Updated datasheet header/footer.	7/24/15
C		23	Application Schematic, IDT crystal part number was replaced by FOX part number.	11/2/16

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