Ethernet & USB Clock Generator for Freescale B4/T4-based Systems

840NT4-01

DATA SHEET

General Description

The 840NT4-01 is clock generator designed to provide ethernet and USB clocks for Freescale B4/ T4-based systems. The 840NT4-01 utilizes IDT's FemtoClock NG® PLL technology to synthesize eight low phase-jitter Ethernet reference clocks. The clock generator also provides a 24MHz USB reference clock and a 25MHz reference output.

Recommended Application:

- Freescale B4/ T4 Ethernet /USB clock generator

Output Features:

- Five LVCMOS 125MHz Ethernet outputs
- Three LVCMOS 25MHz/ 125MHz Ethernet outputs
- One LVCMOS 24MHz USB output
- One LVCMOS 25MHz REF output

Features

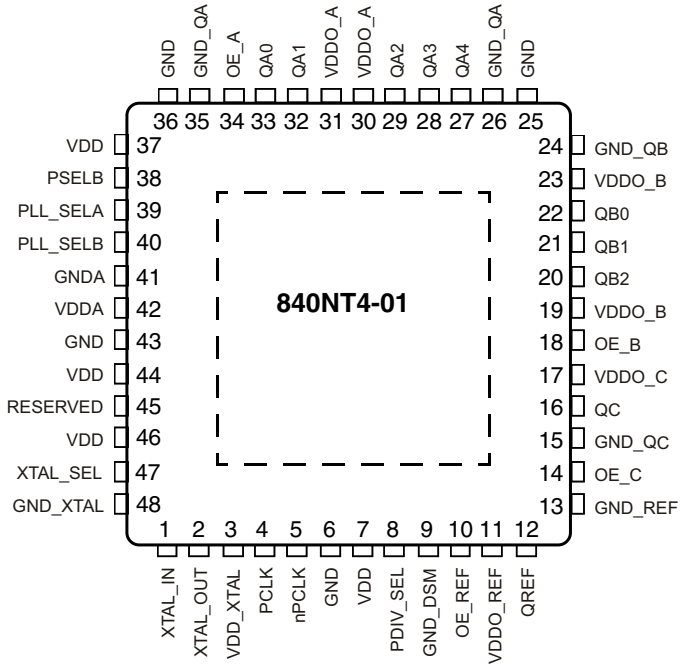
- Ten LVCMOS clock outputs:
  Five LVCMOS 125MHz Ethernet outputs
  Three LVCMOS 25MHz /125MHz Ethernet outputs
  One LVCMOS 24MHz USB output
  One LVCMOS 25MHz REF output
- QREF output can be used to drive other clock drivers, saving a crystal
- Selectable crystal or differential LVPECL input
- RMS Phase Jitter, 125MHz, integration range 12kHz - 20MHz: 0.60ps (typical)
- Cycle-to-Cycle jitter: 20ps (typical)
- Flexible voltage supply modes; supports legacy and future system requirements, minimizes power consumption
  Core voltage: V_{DD}, V_{DD_XTAL}, V_{DDA}
  Output voltage: V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}
  Core / Output
  3.3V / 3.3V
  3.3V / 2.5V
  3.3V / 1.8V
  2.5V / 2.5V
  2.5V / 1.8V
- -40°C to 85°C ambient operating temperature
- Lead-free (RoHS 6) packaging

Table 1. Output Frequency Table

PD* (MHz)	PSELB	PLL_ SELA	PLL_ SELB	F_{OUT} (MHz)			
				QA[4:0]	QB[2:0]	QC	QREF
25	0	0	0	125	125	24	25
25	1	0	0	125	125	24	25
25	0	0	1	125	25	24	25
25	1	0	1	125	25	24	25

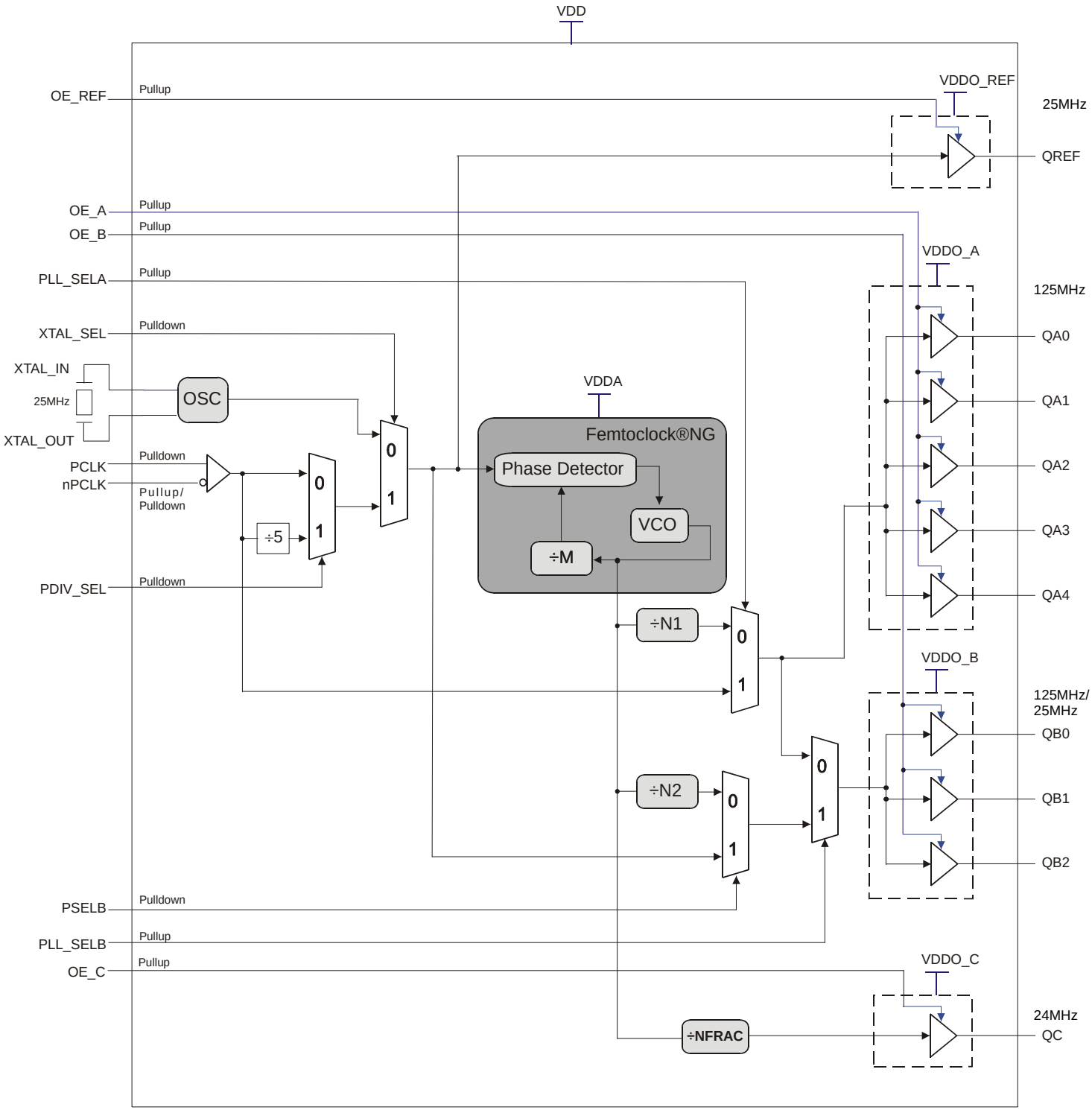
*PD = Phase Detector input frequency.

Pin Assignment



48-lead, 7.0mm x 7.0mm VFQFN

Block Diagram



Pin Description and Pin Characteristic Tables

Table 2. Pin Descriptions[1]

Number	Name	Type		Description
1	XTAL_IN	Input		Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.
2	XTAL_OUT	Input		
3	V_{DD_XTAL}	Power		Power supply pin for XTAL.
4	PCLK	Input	Pulldown	Non-inverting external 25MHz differential LVPECL reference input. LVPECL input levels.
5	nPCLK	Input	Pullup/ Pulldown	Inverting external 25MHz differential LVPECL reference input. LVPECL input levels.
6	GND	Power		Power supply ground.
7	V_{DD}	Power		Core supply pins.
8	PDIV_SEL	Input	Pulldown	Selects input for PCLK (LOW) or ÷5 pre-divider (HIGH). LVCMOS/LVTTL interface levels.
9	GND_DSM	Power		Ground pin for Delta Sigma Modulator.
10	OE_REF	Input	Pullup	Output enable for QREF output. The output is placed in a high-impedance mode on disable. LVCMOS/LVTTL interface levels.
11	V_{DDO_REF}	Power		Output power supply for QREF output.
12	QREF	Output		Single-ended 25MHz, reference clock output. LVCMOS/LVTTL interface levels.
13	GND_REF	Power		Ground pin for QREF clock output.
14	OE_C	Input	Pullup	Output enable for QC output. The QC output is placed in a high-impedance mode on disable. LVCMOS/LVTTL interface levels.
15	GND_QC	Power		Ground pin for QC clock output.
16	QC	Output		Single-ended 24MHz, USB clock output. LVCMOS/LVTTL interface levels.
17	V_{DDO_C}	Power		Output power supply for QC output.
18	OE_B	Input	Pullup	Output enable for Bank QBx outputs. The output bank is placed in a high-impedance mode on disable. LVCMOS/LVTTL interface levels.
19	V_{DDO_B}	Power		Output power supply for Bank QBx clock outputs.
20	QB2	Output		Single-ended 125MHz or 25MHz clock outputs. LVCMOS/LVTTL interface levels.
21	QB1	Output		
22	QB0	Output		
23	V_{DDO_B}	Power		Output power supply for Bank QBx clock outputs.
24	GND_QB	Power		Ground pin for Bank QBx clock outputs.
25	GND	Power		Power supply ground.
26	GND_QA	Power		Ground pin for Bank QAx clock outputs.
27	QA4	Output		Single-ended output clocks, optimized at 125MHz. LVCMOS/LVTTL interface levels.
28	QA3	Output		
29	QA2	Output		
30	V_{DDO_A}	Power		Output power supply for Bank QAx clock outputs.
31	V_{DDO_A}	Power		

Table 2. Pin Descriptions[1] (Continued)

Number	Name	Type		Description
32	QA1	Output		Single-ended output clocks, optimized at 125MHz. LVCMOS/LVTTL interface levels.
33	QA0	Output		
34	OE_A	Input	Pullup	Output enable for Bank QAx outputs. The output bank is placed in a high-impedance mode on disable. LVCMOS/LVTTL interface levels.
35	GND_QA	Power		Ground pin for Bank QAx clock outputs.
36	GND	Power		Power supply ground.
37	V_{DD}	Power		Core supply pins.
38	PSELB	Input	Pulldown	Select pin for Bank QBx first stage mux. Selects input for PLL enabled 25MHz (LOW) or phase detector input frequency (HIGH). LVCMOS/LVTTL interface levels.
39	PLL_SELA	Input	Pullup	Bypasses the PLL for Bank A outputs. When LOW, selects PLL (PLL Enable). When HIGH, bypasses the PLL. LVCMOS/LVTTL interface levels.
40	PLL_SELB	Input	Pullup	Select pin for Bank B second stage mux. Designed to operate with a phase detector input frequency of 25MHz. The Bank B outputs generate 125MHz when select pin is LOW and 25MHz when HIGH. LVCMOS/LVTTL interface levels.
41	GNDA	Power		Ground pin for PLL analog.
42	V_{DDA}	Power		Analog supply pin.
43	GND	Power		Power supply ground.
44	V_{DD}	Power		Core supply pins.
45	RESERVED	Reserved		Reserved pin. Do not connect.
46	V_{DD}	Power		Core supply pins.
47	XTAL_SEL	Input	Pulldown	Select input for XTAL (LOW) or PCLK pre-divider (HIGH). LVCMOS/LVTTL interface levels.
48	GND_XTAL	Power		Ground pin for XTAL.

NOTE 1: *Pullup* and *Pulldown* refer to internal input resistors. See *Table 2, Pin Characteristics,* for typical values.

Table 3. Pin Characteristics[1]

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
C_{IN}	Input Capacitance	PDIV_SEL, OE_REF, OE_A, OE_B, OE_C, PLL_SELA, PLL_SELB, PSELB, XTAL_SEL			3.5		pF
C_{PD}	Power Dissipation Capacitance (per output)		V_{DDO_X} = 3.465V		9		pF
			V_{DDO_X} = 2.625V		8		pF
			V_{DDO_X} = 1.89V		5		pF
R_{PULLUP}	Input Pullup Resistor				50		kΩ
$R_{PULLDOWN}$	Input Pulldown Resistor				50		kΩ
R_{OUT}	Output Impedance		V_{DDO_X} = 3.3V		15		Ω
			V_{DDO_X} = 2.5V		18		Ω
			V_{DDO_X} = 1.8V		26		Ω

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.

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 product at these conditions or any conditions beyond those listed in the *DC Electrical Characteristics* or *AC Electrical 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_{DD} + 0.5V
Outputs, V_O	-0.5V to V_{DDO_X} + 0.5V
Junction Temperature	125°C
Storage Temperature, T_{STG}	-65°C to 150°C

NOTE: V_{DDO_X} denotes V_{DDO_A}, V_{DDO_B}, V_{DDO_C} & V_{DDO_REF}.

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, $V_{DD} = V_{DD\_XTAL} = V_{DDO\_X}$ = 3.3V ± 5%, T_A = -40°C to 85°C[1, 2]

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DD_XTAL}	XTAL Power Supply Voltage		3.135	3.3	3.465	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.06	3.3	V_{DD}	V
V_{DDO_X}	Output Supply Voltage		3.135	3.3	3.465	V
I_{DD} + I_{DD_XTAL}	Power Supply Current				150	mA
I_{DDA}	Analog Supply Current				30	mA
I_{DDO_X}	Output Supply Current	Outputs are Disabled to High-Impedance			8	mA

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.
NOTE 2: I_{DDO_X} denotes, I_{DDO_A} + I_{DDO_B} + I_{DDO_C} + I_{DDO_REF}.

Table 4B. Power Supply DC Characteristics, $V_{DD} = V_{DD\_XTAL}$ = 3.3V ± 5%, V_{DDO_X} = 2.5V ± 5%, T_A = -40°C to 85°C[1, 2]

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DD_XTAL}	XTAL Power Supply Voltage		3.135	3.3	3.465	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.06	3.3	V_{DD}	V
V_{DDO_X}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD} + I_{DD_XTAL}	Power Supply Current				150	mA
I_{DDA}	Analog Supply Current				30	mA
I_{DDO_X}	Output Supply Current	Outputs are Disabled to High-Impedance			4	mA

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.
NOTE 2: I_{DDO_X} denotes, I_{DDO_A} + I_{DDO_B} + I_{DDO_C} + I_{DDO_REF}.

Table 4C. Power Supply DC Characteristics, $V_{DD} = V_{DD\_XTAL} = 3.3V \pm 5\%$, $V_{DDO\_x} = 1.8V \pm 5\%$, $T_A = -40°C$ to $85°C$[1, 2]

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DD_XTAL}	XTAL Power Supply Voltage		3.135	3.3	3.465	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.06	3.3	V_{DD}	V
V_{DDO_X}	Output Supply Voltage		1.71	1.8	1.89	V
I_{DD} + I_{DD_XTAL}	Power Supply Current				150	mA
I_{DDA}	Analog Supply Current				30	mA
I_{DDO_X}	Output Supply Current	Outputs are Disabled to High-Impedance			3	mA

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.
NOTE 2: I_{DDO_X} denotes, $I_{DDO\_A} + I_{DDO\_B} + I_{DDO\_C} + I_{DDO\_REF}$.

Table 4D. Power Supply DC Characteristics, $V_{DD} = V_{DD\_XTAL} = V_{DDO\_X} = 2.5V \pm 5\%$, $T_A = -40°C$ to $85°C$[1, 2]

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DD_XTAL}	XTAL Power Supply Voltage		2.375	2.5	2.625	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.054	2.5	V_{DD}	V
V_{DDO_X}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD} + I_{DD_XTAL}	Power Supply Current				148	mA
I_{DDA}	Analog Supply Current				27	mA
I_{DDO_X}	Output Supply Current	Outputs are Disabled to High-Impedance			4	mA

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.
NOTE 2: I_{DDO_X} denotes, $I_{DDO\_A} + I_{DDO\_B} + I_{DDO\_C} + I_{DDO\_REF}$.

Table 4E. Power Supply DC Characteristics, $V_{DD} = V_{DD\_XTAL} = 2.5V \pm 5\%$, $V_{DDO\_X} = 1.8V \pm 5\%$, $T_A = -40°C$ to $85°C$[1, 2]

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DD_XTAL}	XTAL Power Supply Voltage		2.375	2.5	2.625	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.054	2.5	V_{DD}	V
V_{DDO_X}	Output Supply Voltage		1.71	1.8	1.89	V
I_{DD} + I_{DD_XTAL}	Power Supply Current				148	mA
I_{DDA}	Analog Supply Current				27	mA
I_{DDO_X}	Output Supply Current	Outputs are Disabled to High-Impedance			3	mA

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.
NOTE 2: I_{DDO_X} denotes, $I_{DDO\_A} + I_{DDO\_B} + I_{DDO\_C} + I_{DDO\_REF}$.

Table 4F. LVCMOS/LVTTL DC Characteristics, T_A = -40°C to 85°C[1]

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage		V_{DD} = 3.3V ± 5%	2		V_{DD} + 0.3	V
			V_{DD} = 2.5V ± 5%	1.7		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage		V_{DD} = 3.3V ± 5%	-0.3		0.8	V
			V_{DD} = 2.5V ± 5%	-0.3		0.7	V
I_{IH}	Input High Current	PSELB, XTAL_SEL, PDIV_SEL	V_{DD} = V_{IN} = 3.465V or 2.625V			150	µA
		OE_REF, PLL_SELA, PLL_SELB, OE_A, OE_B, OE_C	V_{DD} = V_{IN} = 3.465V or 2.625V			5	µA
I_{IL}	Input Low Current	PSELB, XTAL_SEL, PDIV_SEL	V_{DD} = 3.465V or 2.625V, V_{IN} = 0V	-5			µA
		OE_REF, PLL_SELA, PLL_SELB, OE_A, OE_B, OE_C	V_{DD} = 3.465V or 2.625V, V_{IN} = 0V	-150			µA
V_{OH}	Output High Voltage		V_{DDO_X} = 3.3V ± 5%; I_{OH} = -12mA	2.6			V
			V_{DDO_X} = 2.5V ± 5%; I_{OH} = -12mA	1.8			V
			V_{DDO_X} = 1.8V ± 5%; I_{OH} = -8mA	1.3			V
V_{OL}	Output Low Voltage;		V_{DDO_X}= 3.3V ± 5%, I_{OL} = 12mA			0.5	V
			V_{DDO_X}= 2.5V ± 5%, I_{OL} = 12mA			0.5	V
			V_{DDO_X} = 1.8V ± 5%, I_{OL} = 8mA			0.4	V

NOTE 1: V_{DDO_X} denotes, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF}.

Table 4G. LVPECL Differential DC Characteristics, V_{DD} = 3.3V ± 5% or 2.5V ± 5%, T_A = -40°C to 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	PCLK, nPCLK	V_{DD} = V_{IN} = 3.465V or 2.625V			150	µA
I_{IL}	Input Low Current	PCLK	V_{DD} = 3.465V or 2.625V, V_{IN} = 0V	-5			µA
		nPCLK	V_{DD} = 3.465V or 2.625V, V_{IN} = 0V	-150			µA
V_{PP}	Peak-to-Peak Voltage[1]			0.3		1.0	V
V_{CMR}	Common Mode Input Voltage[1, 2]			GND + 1.5		V_{DD}	V

NOTE 1: V_{IL} should not be less than -0.3V and VIH should not be greater than V_{DD}.
NOTE 2: Common mode voltage is defined at the crosspoint.

Table 5. Input Frequency Characteristics, $V_{DD} = V_{DD\_XTAL} = 3.3V \pm 5\%$ or $2.5V \pm 5\%$, $T_A = -40°C$ to $85°C$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{IN}	Input Frequency	XTAL_IN, XTAL_OUT			25		MHz
		PCLK, nPCLK	PDIV_SEL = 0		25		MHz
			PDIV_SEL = 1		125		MHz

Table 6. Crystal Characteristics[1]

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation			Fundamental		
Frequency			25		MHz
Load Capacitance (C_L)			12	18	pF
Equivalent Series Resistance (ESR)				50	Ω
Shunt Capacitance				7	pF

NOTE 1: IDT Part#603-25-173 recommended.

AC Electrical Characteristics

Table 7. AC Characteristics, V_{DD} = V_{DD_XTAL} = 3.3V ± 5% or 2.5V ± 5%, V_{DDO_A}, V_{DDO_B}, V_{DDO_C}, V_{DDO_REF} = 3.3V ± 5% or 2.5V ± 5% or 1.8V ± 5%, T_A = -40°C to 85°C[1]

Symbol	Parameter	Test Conditions		Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	PLL Mode		24		125	MHz
tsk(o)	Output Skew[2, 3]	f_{OUT} = 125MHz				120	ps
tsk(b)	Bank Skew[2, 4]	f_{OUT} = 125MHz				50	ps
tjit(Ø)	Phase Jitter, RMS; Integration Range: 12kHz – 20MHz[5, 6]	VDDO = 3.3V	QA[0:4]		0.60		ps
			QB[0:2]		1.20		ps
		VDDO = 2.5V	QA[0:4]		0.45		ps
			QB[0:2]		0.93		ps
		VDDO = 1.8V	QA[0:4]		0.40		ps
			QB[0:2]		0.76		ps
tjit(cc)	Cycle-to-Cycle Jitter[2, 5]	f_{OUT} = 125MHz			20	45	ps
tjit(per)	RMS Period Jitter[2, 5]	f_{OUT} = 125MHz			3	6	ps
t_L	PLL Lock Time				13		ms
odc	Output Duty Cycle	PLL Mode (QAx, QBx, QC)		45		55	%
t_R / t_F	Output Rise/Fall Time	20% to 80%				900	ps

NOTE 1: 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 2: This parameter is defined in accordance with JEDEC Standard 65.

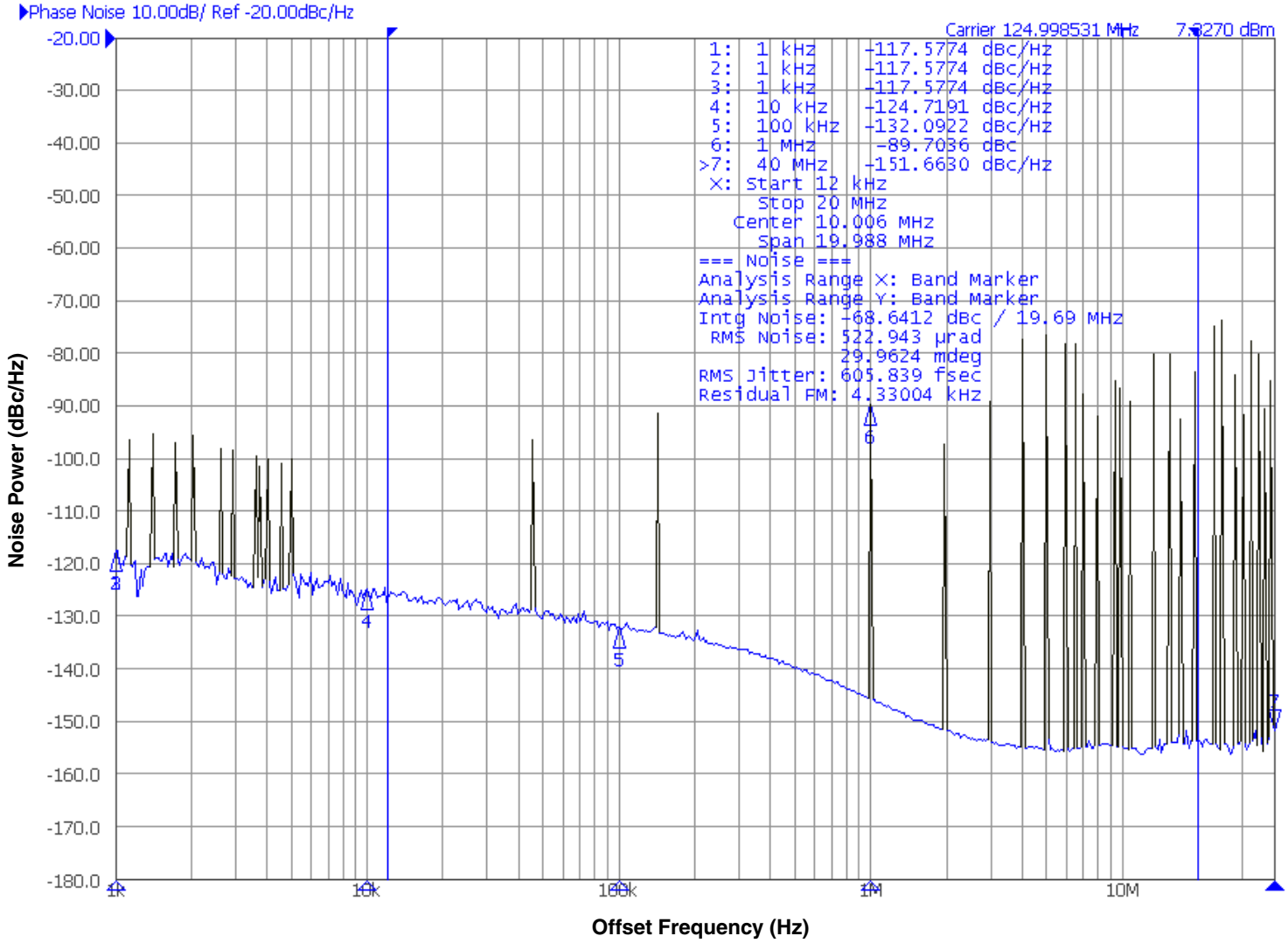
NOTE 3: Defined as skew between outputs at the same supply voltage and with equal load conditions.

NOTE 4: Defined as skew within a bank of outputs at the same voltage and with equal load conditions.

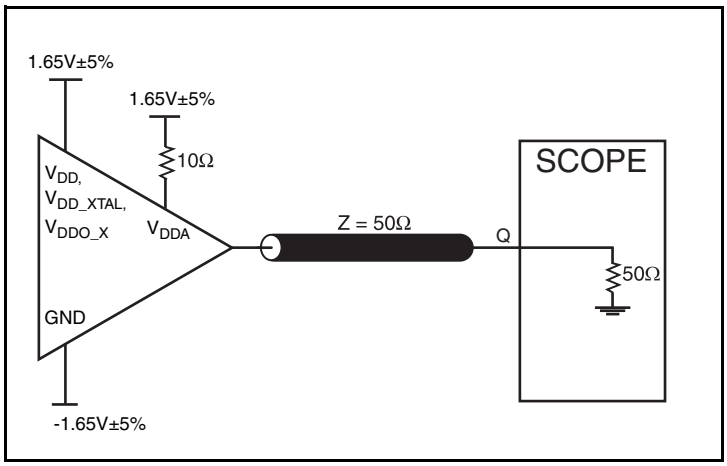
NOTE 5: Jitter performance using XTAL inputs.

NOTE 6: Measured with Bank A at 125MHz, Bank B at 125MHz, QC and QREF enabled.

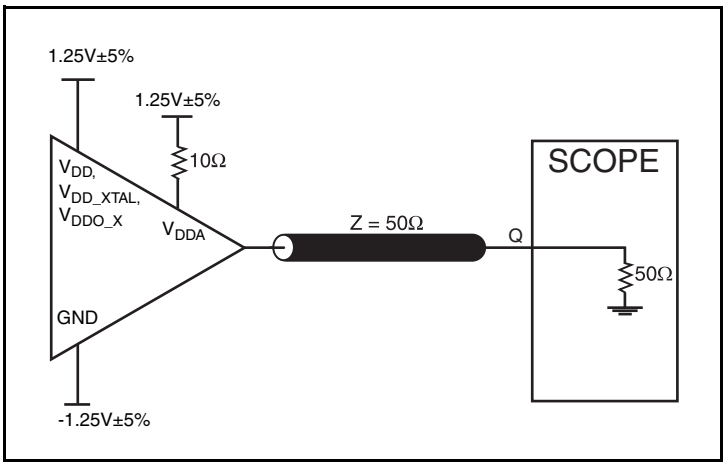
Typical Phase Noise at 125MHz



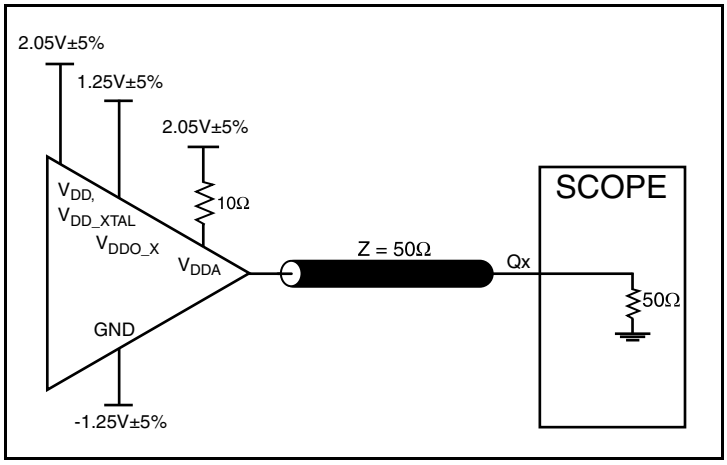
Parameter Measurement Information



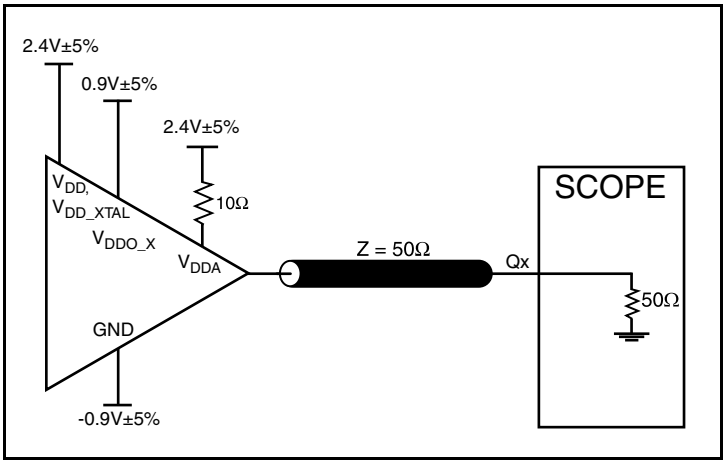
3.3V Core/3.3V LVCMOS Output Load Test Circuit



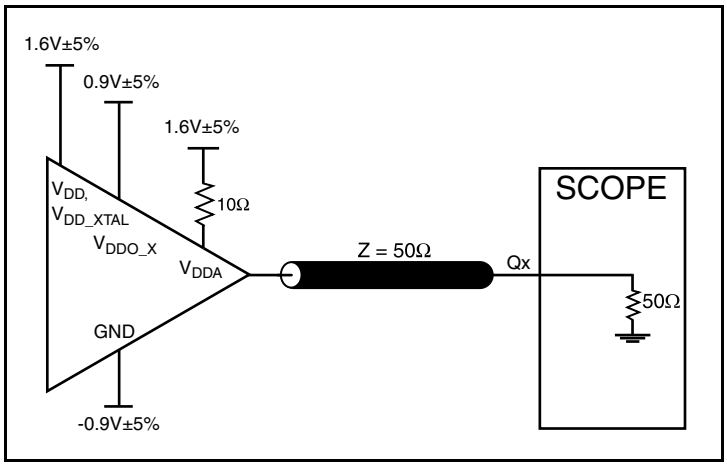
2.5V Core/2.5V LVCMOS Output Load Test Circuit



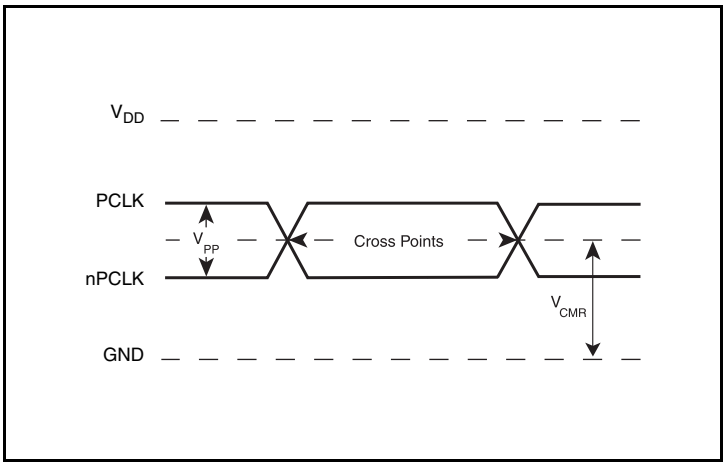
3.3V Core/2.5V LVCMOS Output Load Test Circuit



3.3V Core/1.8V LVCMOS Output Load Test Circuit

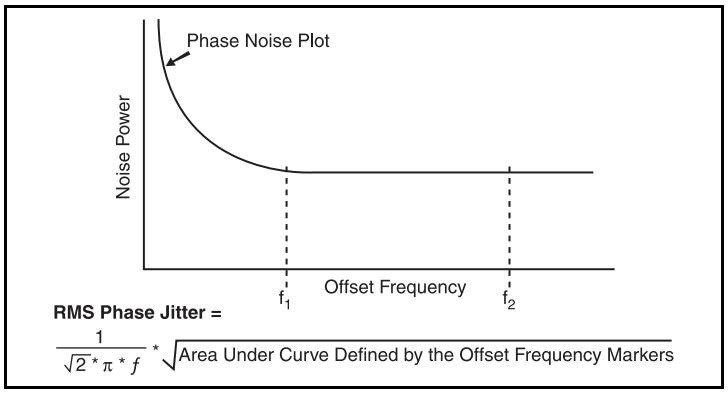


2.5V Core/1.8V LVCMOS Output Load Test Circuit

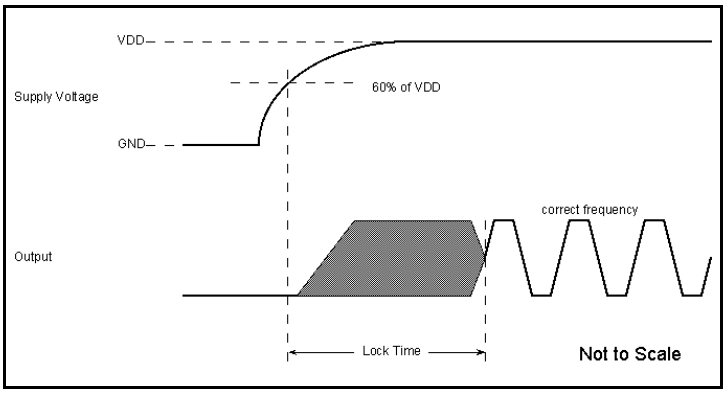


Differential Input Level

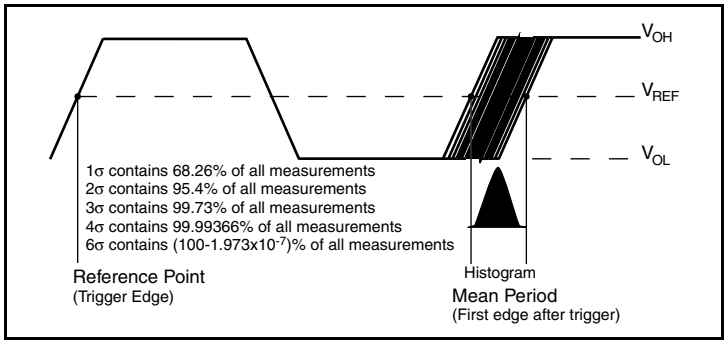
Parameter Measurement Information, continued



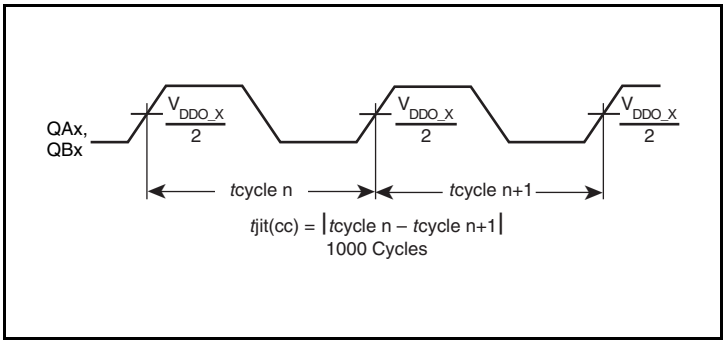
RMS Phase Jitter



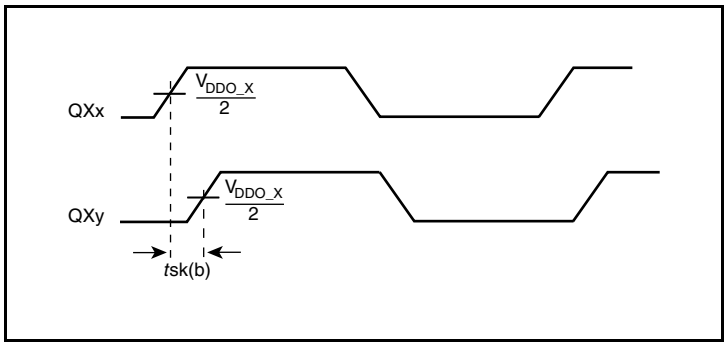
PLL Lock Time



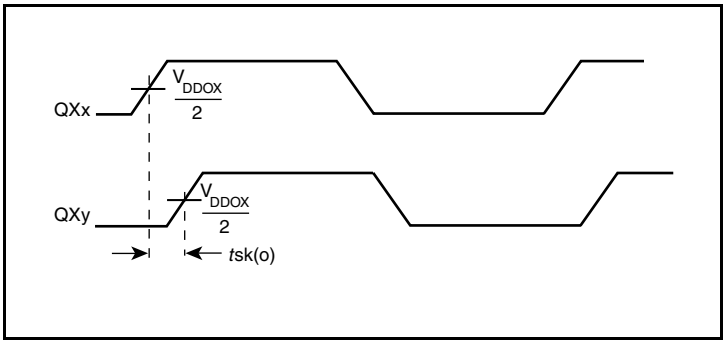
RMS Period Jitter



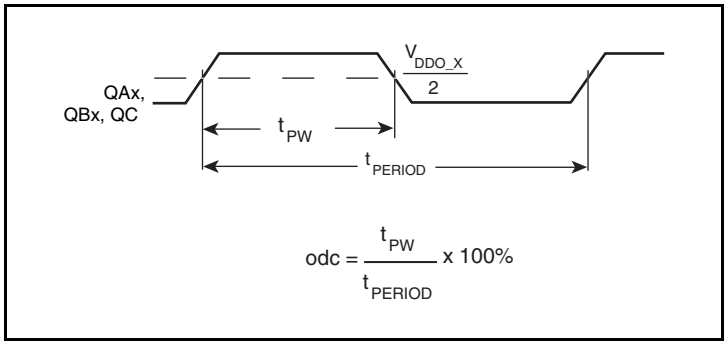
Cycle-to-Cycle Jitter



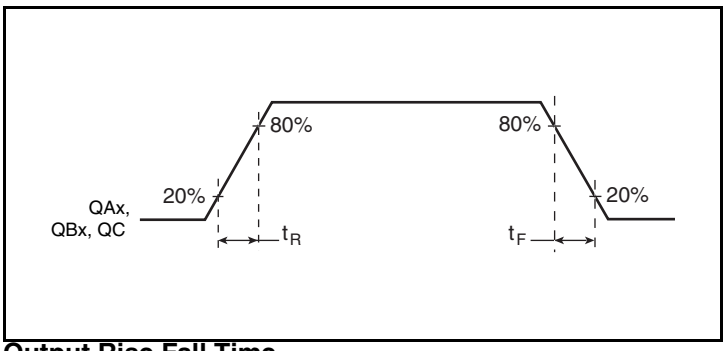
Bank Skew



Output Skew



Output Duty Cycle/Pulse Width/Period



Output Rise Fall Time

Applications Information

Recommendations for Unused Input and Output Pins

Inputs:

LVCMOS Control Pins

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

PCLK/nPCLK Inputs

For applications not requiring the use of the differential input, both PCLK and nPCLK can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from PCLK to ground.

Crystal Inputs

For applications not requiring the use of the crystal oscillator input, both XTAL_IN and XTAL_OUT can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from XTAL_IN to ground.

Outputs:

LVCMOS Outputs

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

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.

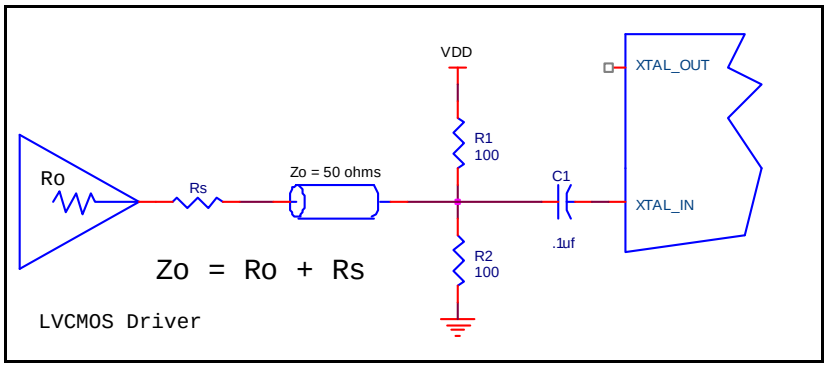


Figure 1A. General Diagram for LVCMOS Driver to XTAL Input Interface

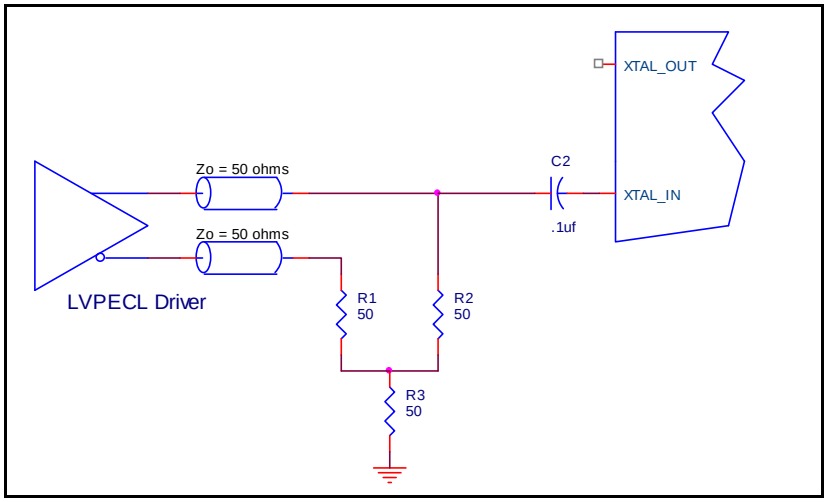


Figure 1B. General Diagram for LVPECL Driver to XTAL Input Interface

3.3V LVPECL Clock Input Interface

The PCLK /nPCLK accepts LVPECL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. *Figure 2A* to *Figure 2B* show interface examples for the PCLK/nPCLK input driven by the most common driver types. The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.

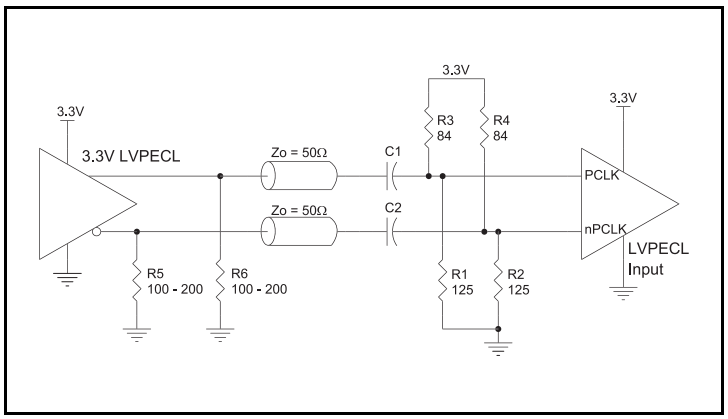


Figure 2A. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver with AC Couple

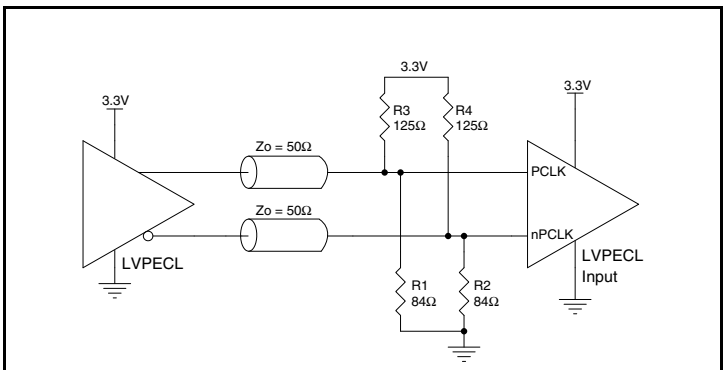


Figure 2B. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver

2.5V LVPECL Clock Input Interface

The PCLK /nPCLK accepts LVPECL and other differential signals. Both V_{SWING} and V_{OH} must meet the V_{PP} and V_{CMR} input requirements. *Figure 3A* to *Figure 3B* show interface examples for the PCLK/nPCLK input driven by the most common driver types. The input interfaces suggested here are examples only. If the driver is from another vendor, use their termination recommendation. Please consult with the vendor of the driver component to confirm the driver termination requirements.

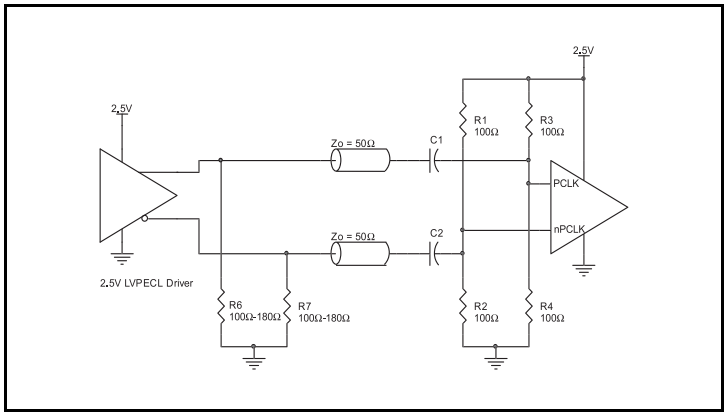


Figure 3A. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver with AC Couple

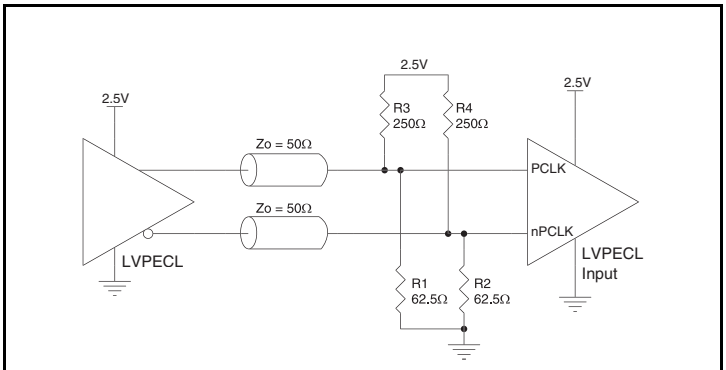


Figure 3B. PCLK/nPCLK Input Driven by a 3.3V LVPECL Driver

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.

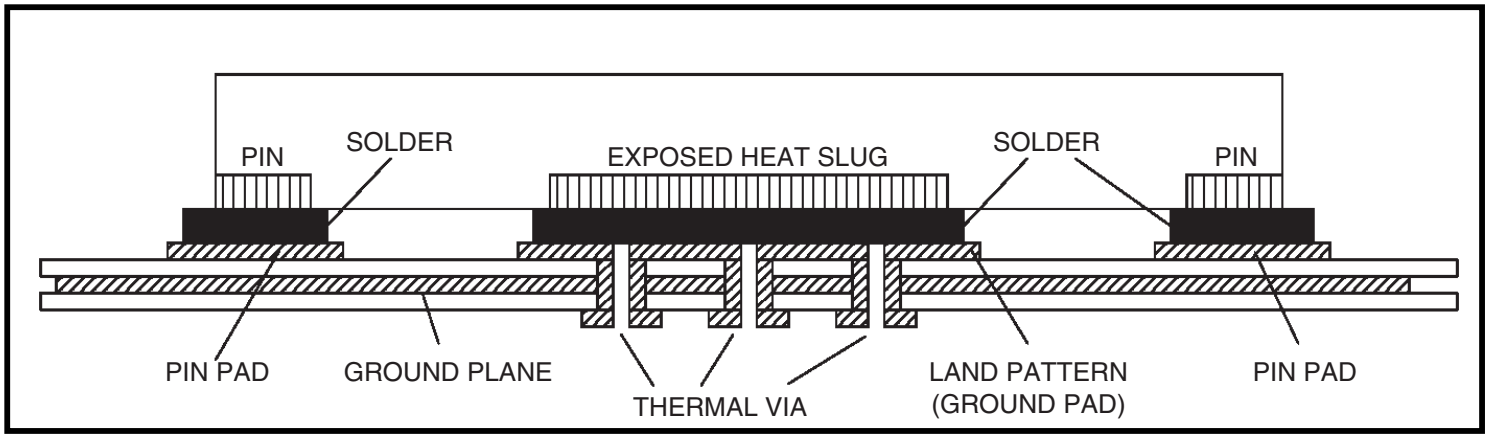


Figure 4. P.C. Assembly for Exposed Pad Thermal Release Path – Side View (drawing not to scale)

Schematic Example

Figure 5 (next page) shows an example 840NT4-01 application schematic. This schematic example focuses on functional connections and is not configuration specific. Refer to the pin description and functional tables in the datasheet to ensure that the logic control inputs are properly set. In this schematic, the device is operated at V_{DD} = V_{DDA} = 2.5V and V_{DDO_A}, V_{DDO_B}, V_{DDO_C} and V_{DDO_REF} = 1.8V.

A 12pF parallel resonant 25MHz crystal (IDT/ Fox Part #603-25-173) is used with the recommended load capacitors C1 = C2 = 3.3pF for frequency accuracy. Depending on the parasitic capacity on the crystal terminals of the printed circuit board layout, these values might require a slight adjustment to optimize the frequency accuracy. Crystals with other load capacitance specifications can be used. This will require adjusting C1 and C2. For this device, the crystal load 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; it reduces the oscillator frequency leaving less tuning margin and noise coupling from power planes and logic transitions on signal traces can pull the phase of the crystal resonance, inducing jitter. Routing I^2C under the crystal is a very common layout error, based on the assumption that it is a low frequency signal and will not affect the crystal oscillation. In fact, I^2C transition times are short enough to capacitively couple into the crystal if they are routed close enough to the crystal traces.

In layout, all capacitive coupling to the crystal from any signal trace is to be minimized, that is to the XTAL_IN and XTAL_OUT pins, traces to the crystal pads, the crystal pads and the tuning capacitors. Using a crystal on the top layer as an example, void all signal and power layers under the crystal connections between the top layer and the ground plane used by the 840NT4-01. Then calculate the parasitic capacity to the ground and determine if it is large enough to preclude tuning the oscillator. If the coupling is excessive, particularly if the first layer under the crystal is a ground plane, a layout option is to void the ground plane and all deeper layers until the next ground plane is reached. The ground connection of the tuning capacitors should first be made between the capacitors on the top layer, then a single ground via is dropped to connect the tuning cap ground to the ground plane as close to the 840NT4-01 as possible as shown in the schematic.

This device package has an ePAD that is connected to ground internally. The ePAD is to be connected to V_{EE}/GND through vias in order to improve heat dissipation.

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 840NT4-01 provides separate power supply pins to isolate any high switching noise from coupling into the internal PLL.

In order to achieve the best possible filtering, it is recommended that the placement of the filter components be on the device side of the PCB as close to the power pins as possible. If space is limited, the 0.1μF capacitor in each power pin filter should be placed on the device side. The other components can be on the opposite side of the PCB.

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 10kHz. 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.

For additional layout recommendations and guidelines, contact clocks@idt.com.

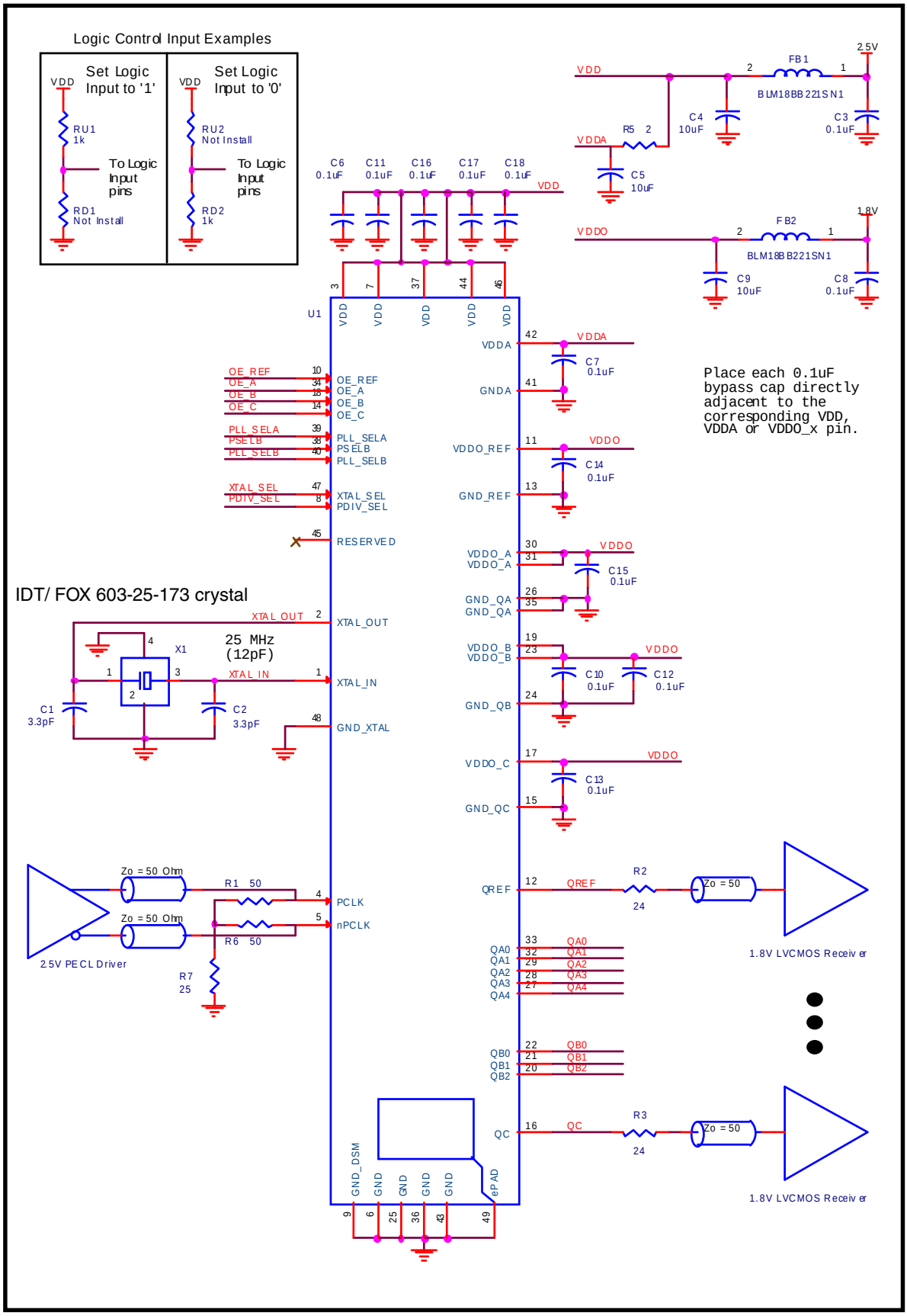


Figure 5. 840NT4-01 Schematic Layout

Power Considerations

This section provides information on power dissipation and junction temperature for the 840NT4-01.
Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 840NT4-01 is the sum of the static power plus the dynamic power dissipation due to loading. The following is the power dissipation for V_{DD} = 3.3V +5% = 3.465V, which gives worst case results.

The maximum core current at 85°C, I_{DDmax} = 150mA

Static Power (max)

= [V_{DD_MAX} * (I_{DD_MAX} + I_{DD_XTAL} + I_{DDA} + I_{DDO_X})]
= [3.465V * (150mA + 30mA + 8mA)]
= 651.4mW

Dynamic Power Dissipation (max), Clocks for Freescale B4/T4 Processor

= [C_{PD} * (N * Frequency + N * Frequency + N * Frequency) * $(V_{DDO})^2$]
= [9pF *(8 * 125MHz + 1 * 25MHz + 1 * 24MHz) * $(3.465V)^2$]
= 113.4mW

Total Power

= Static Power + Dynamic Power Dissipation
= 651.4mW + 113.4mW
= 0.765W

2. Junction Temperature.

Junction temperature, Tj, is the temperature at the junction of the bond wire and bond pad, and 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°C/W per *Table 8* below.

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

85°C + 0.765W * 30°C/W = 108°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 8. Thermal Resistance θ_{JA} for a 48-lead VFQFN Package

θ_{JA} by Velocity			
Meters per Second	**0**	**1**	**2**
Multi-Layer PCB, JEDEC Standard Test Boards	30°C/W	23.1°C/W	19.8°C/W

Reliability Information

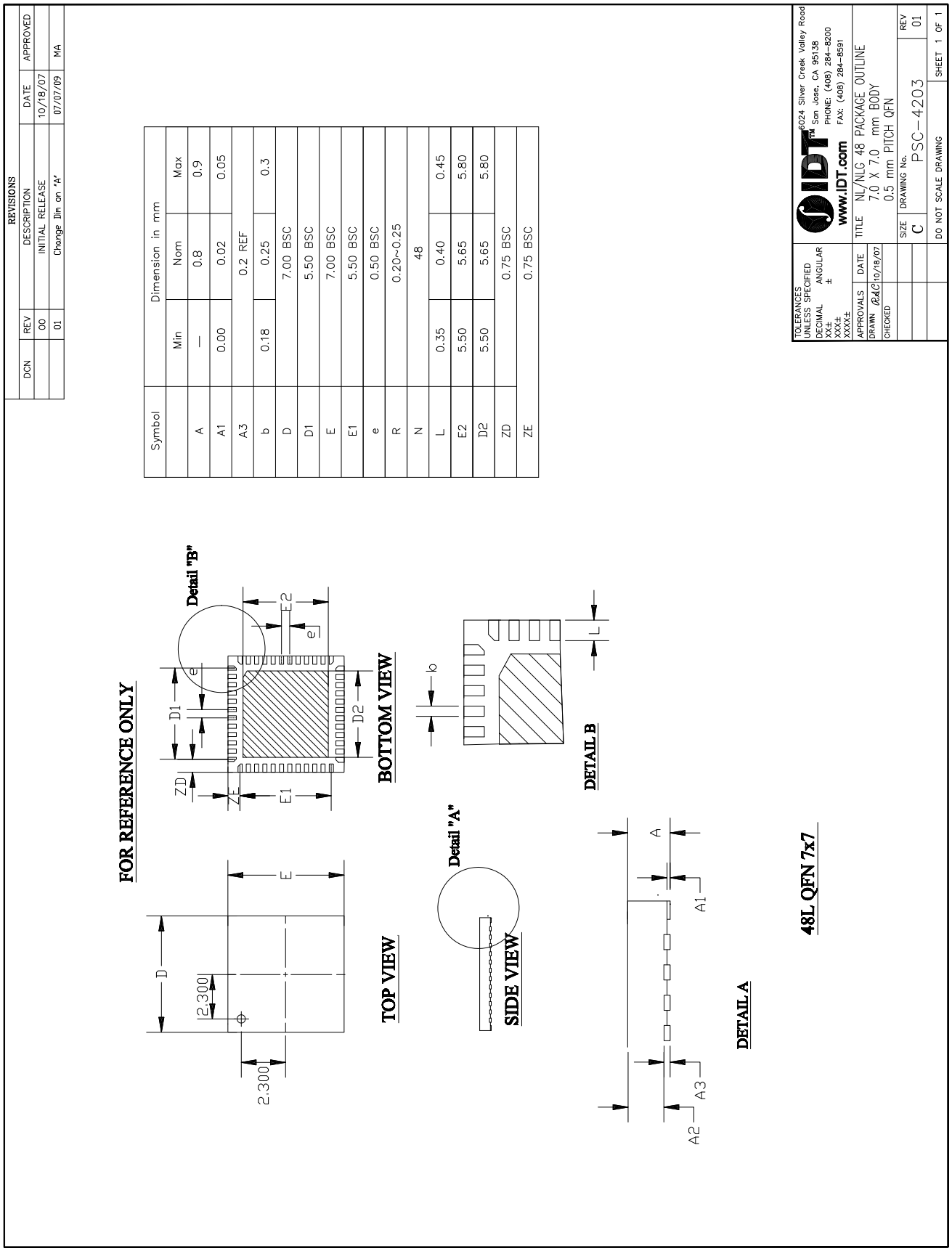
Table 9. θ_{JA} vs. Air Flow Table for a 48-Lead VFQFN

θ_{JA} by Velocity			
Meters per Second	**0**	**1**	**2**
Multi-Layer PCB, JEDEC Standard Test Boards	30°C/W	23.1°C/W	19.8°C/W

Transistor Count

The transistor count for 840NT4-01 is: 24,508

48-Lead VFQFN Package Outline and Package Dimensions



Ordering Information

Table 10. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
840NT4-01NLGI	IDT840NT4-01NLGI	48-Lead VFQFN, Lead-Free	Tray	-40°C to 85°C
840NT4-01NLGI8	IDT840NT4-01NLGI	48-Lead VFQFN, Lead-Free	Tape & Reel	-40°C to 85°C

Revision History Sheet

Rev	Table	Page	Description of Change	Date
2		8 17 18	*Crystal Characteristics* - added note. *Schematic Example* - revised first sentence of paragraph 2. *840NT4-01 Schematic Layout* - revised crystal note.	5/18/15

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