FemtoClock® NG LVDS Clock Synthesizer

IDT8V44N003I

DATA SHEET

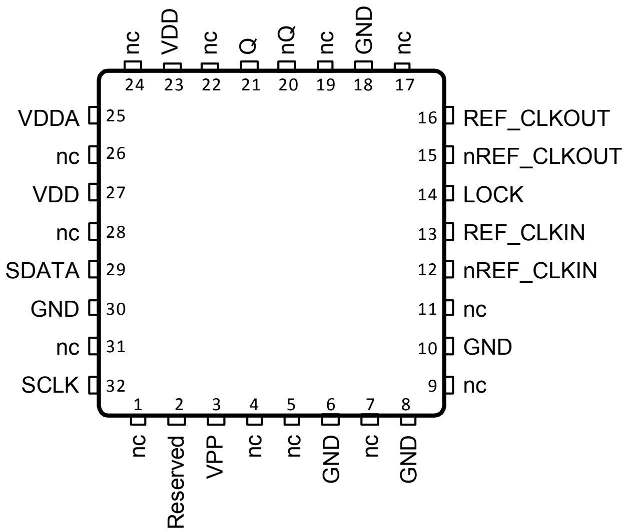
General Description

The IDT8V44N003I is a programmable LVDS synthesizer designed for applications requiring frequency conversion from a differential or single-end reference source. The device is designed to provide optimum performance of low phase noise and high power supply noise rejection over a wide range of output frequencies. Oscillator level phase noise performance is achieved through the use of IDT's Fourth Generation FemtoClock®NG PLL technology. Default output frequency settings are factory programmable via a one time programmable ROM while the I^2C interface can be used to program the output frequency after power up. A buffered copy of the input reference clock is provided at both LVDS output levels for applications requiring efficient board space utilization.

Features

- Fourth generation FemtoClock® (NG) technology
- Reference clock input accepts differential HCSL, LVDS, LVPECL or single-ended sine wave or LVCMOS input levels
- Input frequency range of 20MHz to 500MHz
- Output frequency range of 50MHz to 1.2GHz
- Buffered copy of input reference clock at LVDS output levels
- PLL lock indicator
- Full 3.3V output supply mode
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

Pin Assignment



IDT8V44N003I

32 Lead VFQFN
5mm x 5mm x 0.925mm Package Body
NL Package
Top View

Block Diagram

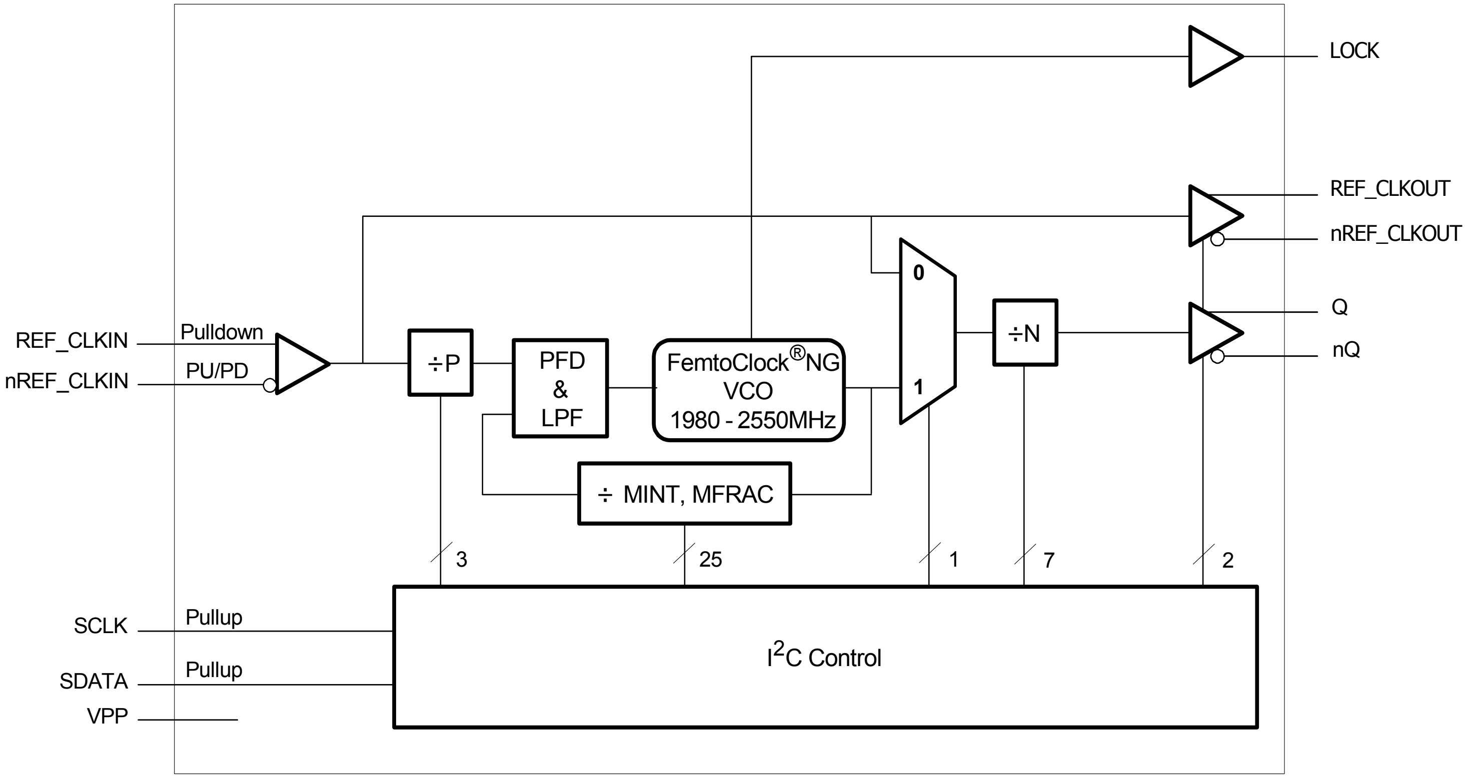


Table 1. Pin Descriptions

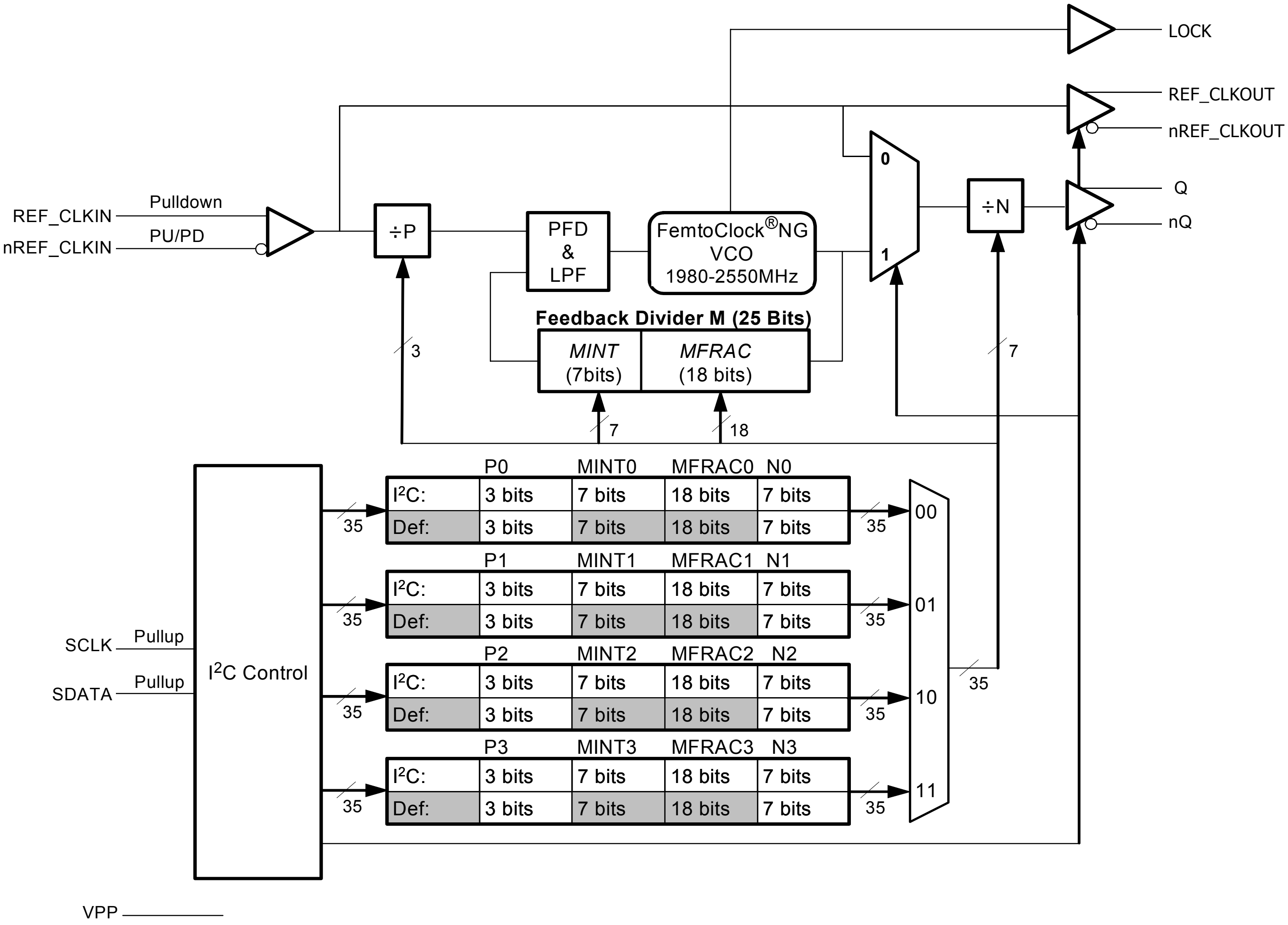
Number	Name	Type		Description
1, 4, 5, 7, 9, 11, 17, 19, 22, 24, 26, 28, 31	nc	Unused		These pins are to be left unconnected.
2	Reserved	Reserve		Reserved pin. This pin is left unconnected.
3	VPP	Input	Pullup	Must be connected to ground for proper operation.
6, 8, 10, 18, 30	GND	Power		Power supply ground.
12	nREF_CLKIN	Input	Pullup/ Pulldown	Inverting differential PLL reference clock input.
13	REF_CLKIN	Input	Pulldown	Non-inverting differential PLL reference clock input.
14	LOCK	Output		PLL lock indicator. LVCMOS/LVTTL interface levels.
15, 16	nREF_CLKOUT, REF_CLKOUT	Output		Differential output pair. Buffered copy of REF_CLKIN. LVDS interface levels.
20, 21	nQ, Q	Output		Differential output pair. LVDS interface levels.
23, 27	V_{DD}	Power		Power supply pins.
25	V_{DDA}	Power		Analog power supply pin.
29	SDATA	Input/ Output	Pullup	I^2C data input. Input: LVCMOS/LVTTL interface levels. Output: Open Drain.
32	SCLK	Input	Pullup	I^2C clock input. LVCMOS/LVTTL interface levels.

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

Table 2. Pin Characteristics

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
C_{IN}	Input Capacitance			3.5		pF
R_{PULLUP}	Input Pullup Resistor			51		kΩ
$R_{PULLDOWN}$	Input Pulldown Resistor			51		kΩ

Block Diagram with Programming Registers



Register Settings

Table 3A. I^2C Register Map

Register	Binary Register Address	Register Bit							
		D7	D6	D5	D4	D3	D2	D1	D0
0	00000	CP0[1]	CP0[0]	MINT0[4]	MINT0[3]	MINT0[2]	MINT0[1]	MINT0[0]	MFRAC0[17]
1	00001	CP1[1]	CP1[0]	MINT1[4]	MINT1[3]	MINT1[2]	MINT1[1]	MINT1[0]	MFRAC1[17]
2	00010	CP2[1]	CP2[0]	MINT2[4]	MINT2[3]	MINT2[2]	MINT2[1]	MINT2[0]	MFRAC2[17]
3	00011	CP3[1]	CP3[0]	MINT3[4]	MINT3[3]	MINT3[2]	MINT3[1]	MINT3[0]	MFRAC3[17]
4	00100	MFRAC0[16]	MFRAC0[15]	MFRAC0[14]	MFRAC0[13]	MFRAC0[12]	MFRAC0[11]	MFRAC0[10]	MFRAC0[9]
5	00101	MFRAC1[16]	MFRAC1[15]	MFRAC1[14]	MFRAC1[13]	MFRAC1[12]	MFRAC1[11]	MFRAC1[10]	MFRAC1[9]
6	00110	MFRAC2[16]	MFRAC2[15]	MFRAC2[14]	MFRAC2[13]	MFRAC2[12]	MFRAC2[11]	MFRAC2[10]	MFRAC2[9]
7	00111	MFRAC3[16]	MFRAC3[15]	MFRAC3[14]	MFRAC3[13]	MFRAC3[12]	MFRAC3[11]	MFRAC3[10]	MFRAC3[9]
8	01000	MFRAC0[8]	MFRAC0[7]	MFRAC0[6]	MFRAC0[5]	MFRAC0[4]	MFRAC0[3]	MFRAC0[2]	MFRAC0[1]
9	01001	MFRAC1[8]	MFRAC1[7]	MFRAC1[6]	MFRAC1[5]	MFRAC1[4]	MFRAC1[3]	MFRAC1[2]	MFRAC1[1]
10	01010	MFRAC2[8]	MFRAC2[7]	MFRAC2[6]	MFRAC2[5]	MFRAC2[4]	MFRAC2[3]	MFRAC2[2]	MFRAC2[1]
11	01011	MFRAC3[8]	MFRAC3[7]	MFRAC3[6]	MFRAC3[5]	MFRAC3[4]	MFRAC3[3]	MFRAC3[2]	MFRAC3[1]
12	01100	MFRAC0[0]	N0[6]	N0[5]	N0[4]	N0[3]	N0[2]	N0[1]	N0[0]
13	01101	MFRAC1[0]	N1[6]	N1[5]	N1[4]	N1[3]	N1[2]	N1[1]	N1[0]
14	01110	MFRAC2[0]	N2[6]	N2[5]	N2[4]	N2[3]	N2[2]	N2[1]	N2[0]
15	01111	MFRAC3[0]	N3[6]	N3[5]	N3[4]	N3[3]	N3[2]	N3[1]	N3[0]
16	10000	reserved	reserved	reserved	reserved	reserved	reserved	reserved	reserved
17	10001	reserved	reserved	reserved	reserved	OE_REF	Q_ENABLE	LVDS_SWING	unused
18	10010	reserved	reserved	nPLL_BYPASS	FSEL[1] reserved	FSEL[0] reserved	reserved	reserved	reserved
19	10011	reserved	reserved	reserved	reserved	reserved	reserved	reserved	reserved
20	10100	P0[1]	P0[0]	MINT0[5]	MINT0[6]	P0[2]	DG0	DSM_ENA0	LF0
21	10101	P1[1]	P1[0]	MINT1[5]	MINT1[6]	P1[2]	DG1	DSM_ENA1	LF1
22	10110	P2[1]	P2[0]	MINT2[5]	MINT2[6]	P2[2]	DG2	DSM_ENA2	LF2
23	10111	P3[1]	P3[0]	MINT3[5]	MINT3[6]	P3[2]	DG3	DSM_ENA3	LF3

Table 3B. I²C Register Function Descriptions

Bits	Name	Function
MINTn[6:0]	Integer Feedback Divider Register n (n = 0...3)	Sets the integer portion of the feedback divider value. Can be set to a value of 4 to 127. For binary values < 4, the value is x+4. So programming 0000000 would yield a feedback divider of ÷4, 0000001 = ÷5, etc. It should also be noted that with a reference of 100MHz and P=1, the minimum value loaded into this register should be 20 to remain above the minimum VCO frequency of 1980MHz.
MFRACn[17:0]	Fractional Feedback Divider Register n (n = 0...3)	Sets the fractional value of the feedback divider resulting in a fraction of MFRAC0[17:0]÷2^{18}. From a 100MHz reference, this means the frequency is incriminated by about 381Hz÷*5* for each LSB increment.
Nn[6:0]	Output Divider Register n (n = 0...3)	Sets the output divider. The output divider value can range from 2, 3, 4, 5, 6 and 8, 10, 12 to 126 (step: 2). See Table 3D for the output divider coding.
Pn[2:0]	Input Divider Register n (n = 0...4)	Sets the input divider. The divider value has the range of 1, 2, 4, 8 and 0.5. See Table 3C for the divider coding.
FSEL[1:0]	Frequency Select	Frequency Select Control used to select 1 of 4 frequency settings. See Table 3H default frequency setting.
Q_ENABLE	Q Output Enable	Q, nQ output enable. 1 = Output disabled (Q = low, nQ = high) 0 = Output enabled
LVDS_SWING	LVDS Swing	Normal LVDS output swing when LOW. Swing >400mV when HIGH. Recommended setting = 1
DG0	Dither Gain	Recommended setting = 1
DG1	Dither Gain	Recommended setting = 1
DG2	Dither Gain	Recommended setting = 1
DG3	Dither Gain	Recommended setting = 1
DSM_ENAn	DSM Enable (n = 0...3)	Delta Sigma Modulator Enable. 0 = DSM not enabled 1 = DSM Enabled (default)
LFn	Loop Filter Value (n = 0...3)	Together with CPn[1:0] sets the PLL loop parameters. A higher value results in lower bandwidth. Contact IDT for a recommendation for changing LFn.
CPn[1:0]	Charge Pump Current	Together with LFn sets the loop parameters. A higher value results in higher loop bandwidth (opposite of LFn). Contact IDT for a recommendation for changing LFn.
OE_REF	REF_CLKOUT Output Enable	REF_CLKOUT, nREF_CLKOUT 1 = Output disabled 0 = Output enabled
nPLL_BYPASS	PLL Bypass	PLL Bypass. The output frequency = reference clock divided by *N*. 0 = PLL Bypass 1 = PLL Enable (default)

Table 3C. Input Divider P Coding

Register Bit			Input Divider *P*
P_n2	P_n1	P_n0	
0	0	0	1
0	0	1	2
0	1	0	4
0	1	1	8
1	X	X	0.5

Table 3D. PLL Post Divider N Coding

Register Bit	Frequency Divider *N*	Output Frequency Range	
$N_n[6:0]$		$f_{OUT,MIN}$ (MHz)	$f_{OUT,MAX}$ (MHz)
000000X	2	990	1275
0000010	2	990	1275
0000011	3	660	850
0000100	4	495	637.5
0000101	5	396	510
000011X	6	330	425
000100X	8	247.5	318.75
000101X	10	198	255
000110X	12	165	212.5
000111X	14	141.4286	182.143
001000X	16	123.75	159.375
...	N (even integer)	$(1980 \div N)$	$(2550 \div N)$
111101X	124	15.96774	20.565
111111X	126	15.71429	20.238

NOTE: “X” can be either 0 or 1 (don’t care).

Serial Interface Configuration Description

The IDT8V44003I has an I^2C-compatible configuration interface to access any of the internal registers (Table 3A) for frequency and PLL parameter programming. The IDT8V44003I acts as a slave device on the I^2C bus and has the address 0b1101110. The interface accepts byte-oriented block write and block read operations. An address byte (P) specifies the register address (Table 3A) as the byte position of the first register to write or read. Data bytes (registers) are accessed in sequential order from the lowest to the highest byte (most significant bit first, see Tables 3F, 3G). Read and write block transfers can be stopped after any complete byte transfer. It is recommended to terminate the I^2C read or write transfer after accessing byte #23 by sending a stop command.

For full electrical I^2C compliance, it is recommended to use external pull-up resistors for SDATA and SCLK. The internal pull-up resistors have a size of 51kΩ typical.

Table 3E. I^2C Device Slave Address

1	1	0	1	1	1	0	R/W

Table 3F. Block Write Operation

Bit	1	2:8	9	10	11:18	19	20:27	28	29-36	37	...	...	...
Description	START	Slave Address	W(0)	ACK	Address Byte P	ACK	Data Byte (P)	ACK	Data Byte (P+1)	ACK	Data Byte ...	ACK	STOP
Length (bits)	1	7	1	1	8	1	8	1	8	1	8	1	1

Table 3G. Block Read Operation

Bit	1	2:8	9	10	11:18	19	20	21:27	28	29	30:37	38	39-46	47	...	...	...
Description	START	Slave Address	W (0)	A C K	Address Byte P	A C K	Repeated START	Slave Address	R (1)	A C K	Data Byte (P)	A C K	Data Byte (P+1)	A C K	Data Byte ...	A C K	STOP
Length (bits)	1	7	1	1	8	1	1	7	1	1	8	1	8	1	8	1	1

Table 3H. Default Frequency Settings

Register Bit FSEL[1:0]	Output Frequency, f_{OUT} (MHz)
00 (default)	480
01	480
10	240
11	240

NOTE: Output frequency based on REF_CLKIN = 80MHz

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 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 (LVCMOS)	-0.5V to V_{DD} + 0.5V
Outputs, V_O (LVCMOS)	-0.5V to V_{DD}+ 0.5V
Outputs, I_O (LVDS) Continuos Current Surge Current	 10mA 15mA
Package Thermal Impedance, θ_{JA}	43.7°C/W (0 mps)
Storage Temperature, T_{STG}	-65°C to 150°C
HBM – ESD Protection (Human Body Model); NOTE 1	2.500kV
CDM – ESD Protection (Charged Device Model); NOTE 1	1500V

NOTE 1: According to JEDEC/JESD 22-A114/22-C101.

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, V_{DD} = 3.3V ± 5%, T_A = -40°C to 85°C

Symbol	**Parameter**	**Test Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDA}	Analog Supply Voltage		V_{DD} – 0.17	3.3	V_{DD}	V
I_{DD}	Core Supply Current				136	mA
I_{DDA}	Analog Supply Current				17	mA

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

Symbol	**Parameter**		**Test Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
V_{IH}	Input High Voltage		V_{DD} = 3.3V	2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage		V_{DD} = 3.3V	-0.3		0.8	V
I_{IH}	Input High Current	SCLK, SDATA	V_{DD} = V_{IN} = 3.465V			5	µA
I_{IL}	Input Low Current	SCLK, SDATA	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
V_{OH}	Output High Voltage	LOCK	I_{OH} = -8mA	2.6			V
V_{OL}	Output Low Voltage	LOCK	I_{OL} = 8mA			0.5	V

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

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	REF_CLKIN, nREF_CLKIN	$V_{DD} = V_{IN}$ = 3.465V			150	µA
I_{IL}	Input Low Current	REF_CLKOUT	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA
		nREF_CLKOUT	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
V_{PP}	Peak-to-Peak Input Voltage			0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1			1.1		V_{DD}	V

NOTE 1. Common mode voltage is defined as the crosspoint.

Table 4D. LVDS DC Characteristics, V_{DD} = 3.3V ± 5%, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OD}	Differential Output Voltage		270		530	mV
ΔV_{OD}	V_{OD} Magnitude Change				50	mV
V_{OS}	Offset Voltage		1.06		1.38	V
ΔV_{OS}	V_{OS} Magnitude Change				50	mV

AC Electrical Characteristics

Table 5. AC Characteristics, V_{DD} = 3.3V ± 5%, T_A = -40°C to 85°C

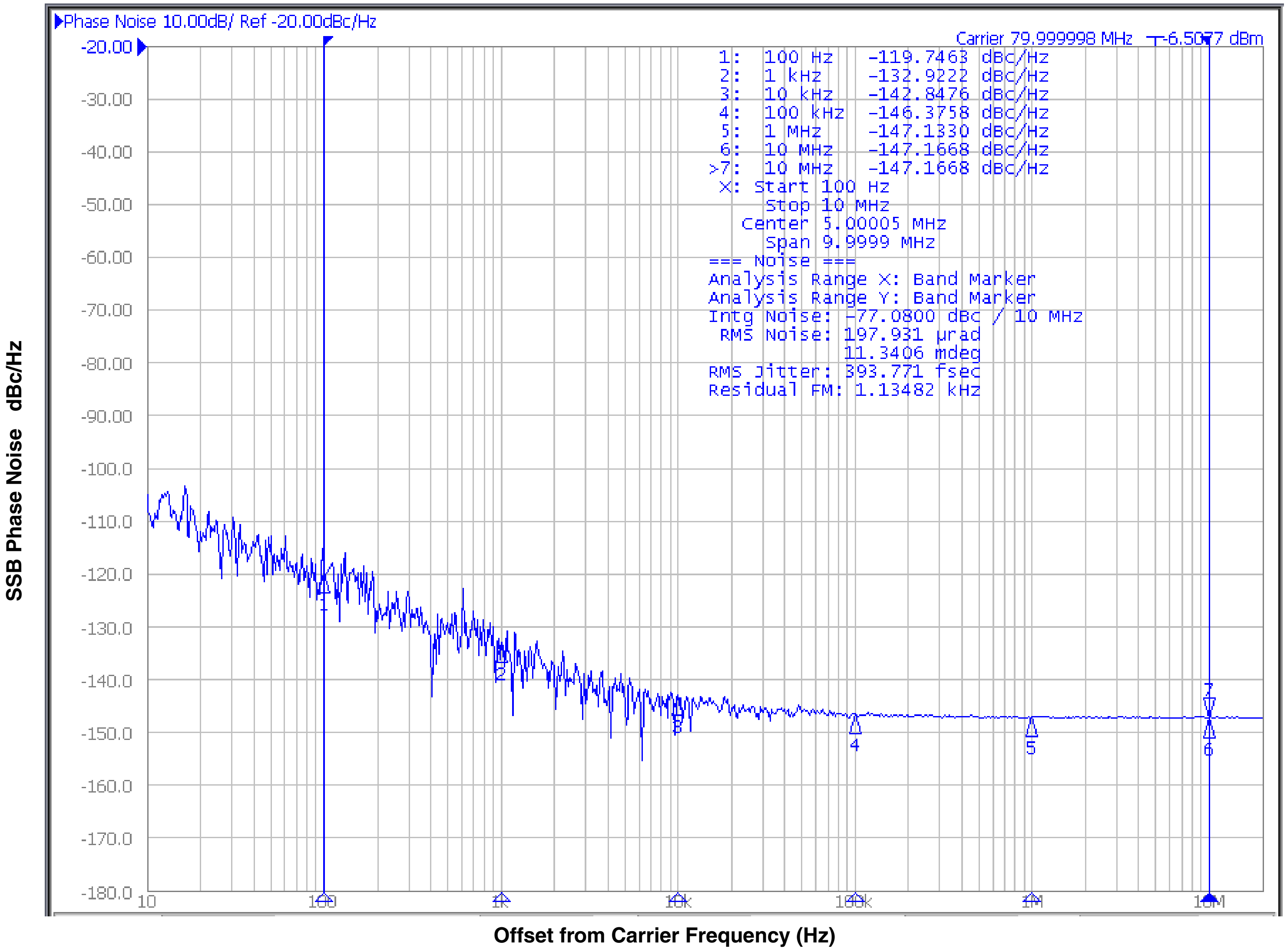
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{IN}	Input Frequency	REF_CLKIN, nREF_CLKIN		20	80	500	MHz
f_{OUT}	Output Frequency	Q, nQ		50	480	1200	MHz
		REF_CLKOUT, nREF_CLKOUT			80		MHz
$t$jit(Ø)	RMS Phase Jitter, Random; NOTE 3		REF_CLKIN = 80MHz, Q = 480MHz, Integration Range: (10kHz - 125MHz)		0.30	0.45	ps
$t$jit	Buffer Additive Phase Jitter, RMS; See Additive Phase Jitter Section; NOTE 3		REF_CLKIN = 80MHz, REF_CLKOUT= 80MHz, Integration Range: (100Hz - 10MHz)		0.35	0.45	ps
t_{PD}	Propagation Delay; NOTE 1		REF_CLKIN to REF_CLKOUT	0.8		1.35	ns
$\Phi_N1(100)$	Single-Side Band Noise Power, 100Hz from Carrier		f_{OUT} (Q) = 480MHz		-96.64		dBc/Hz
$\Phi_N1(1k)$	Single-Side Band Noise Power, 1kHz from Carrier		f_{OUT} (Q) = 480MHz		-104.57		dBc/Hz
$\Phi_N1(10k)$	Single-Side Band Noise Power, 10kHz from Carrier		f_{OUT} (Q) = 480MHz		-113.20		dBc/Hz
$\Phi_N1(100k)$	Single-Side Band Noise Power, 100kHz from Carrier		f_{OUT} (Q) = 480MHz		-122.79		dBc/Hz
$\Phi_N1(1M)$	Single-Side Band Noise Power, 1MHz from Carrier		f_{OUT} (Q) = 480MHz		-128.71		dBc/Hz
$\Phi_N1(10M)$	Single-Side Band Noise Power, 10MHz from Carrier		f_{OUT} (Q) = 480MHz		-145.79		dBc/Hz
$\Phi_N2(100)$	Single-Side Band Noise Power, 100Hz from Carrier		Φ_NIN (100) = -100dBc/Hz, REF_CLKOUT = 80MHz		-120.73		dBc/Hz
$\Phi_N2(1k)$	Single-Side Band Noise Power, 1kHz from Carrier		Φ_NIN (1k) = -130dBc/Hz, REF_CLKOUT = 80MHz		-133.593		dBc/Hz
$\Phi_N2(10k)$	Single-Side Band Noise Power, 10kHz from Carrier		Φ_NIN (10k) = -148dBc/Hz, REF_CLKOUT = 80MHz		-145.273		dBc/Hz
$\Phi_N2(100k)$	Single-Side Band Noise Power, 100kHz from Carrier		Φ_NIN (100k) = -150dBc/Hz, REF_CLKOUT = 80MHz		-146.428		dBc/Hz
$\Phi_N2(1M)$	Single-Side Band Noise Power, 1MHz from Carrier		Φ_NIN (1M) = -150dBc/Hz, REF_CLKOUT = 80MHz		-147.038		dBc/Hz
$\Phi_N2(10M)$	Single-Side Band Noise Power, 10MHz from Carrier		Φ_NIN (10M) = -150dBc/Hz, REF_CLKOUT = 80MHz		-147.16		dBc/Hz
Φ_{SPUR}	Single-Side Band Spur Power				-63	-50	dBc
Output$_{\_ISOLATION}$	Output Isolation: NOTE 2		Q, nQ (480MHz) to ±REF_CLKOUT, nREF_CLKOUT		-55.1	-49	dB
			Q, nQ to REF_CLKOUT (High Impedance)		-57	-50	dB
t_R / t_F	Output Rise/Fall Time	Q, nQ	f_{OUT} < 500MHz, 20% to 80%	175		590	ps
			500MHz ≤ f_{OUT} < 1GHz, 20% to 80%	110		420	ps
			f_{OUT} ≥ 1GHz, 20% to 80%	75		245	ps
		REF_CLKOUT, nREF_CLKOUT	20% to 80%	160		610	ps

Continued on next page.

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
odc	Output Duty Cycle	Q, nQ	f_{OUT} < 1GHz	46		54	%
			$f_{OUT} \geq$ 1GHz	43		57	%
		REF_CLKOUT, nREF_CLKOUT		44		56	%
t_{LOCK}	PLL Lock Time	LOCK				20	ms

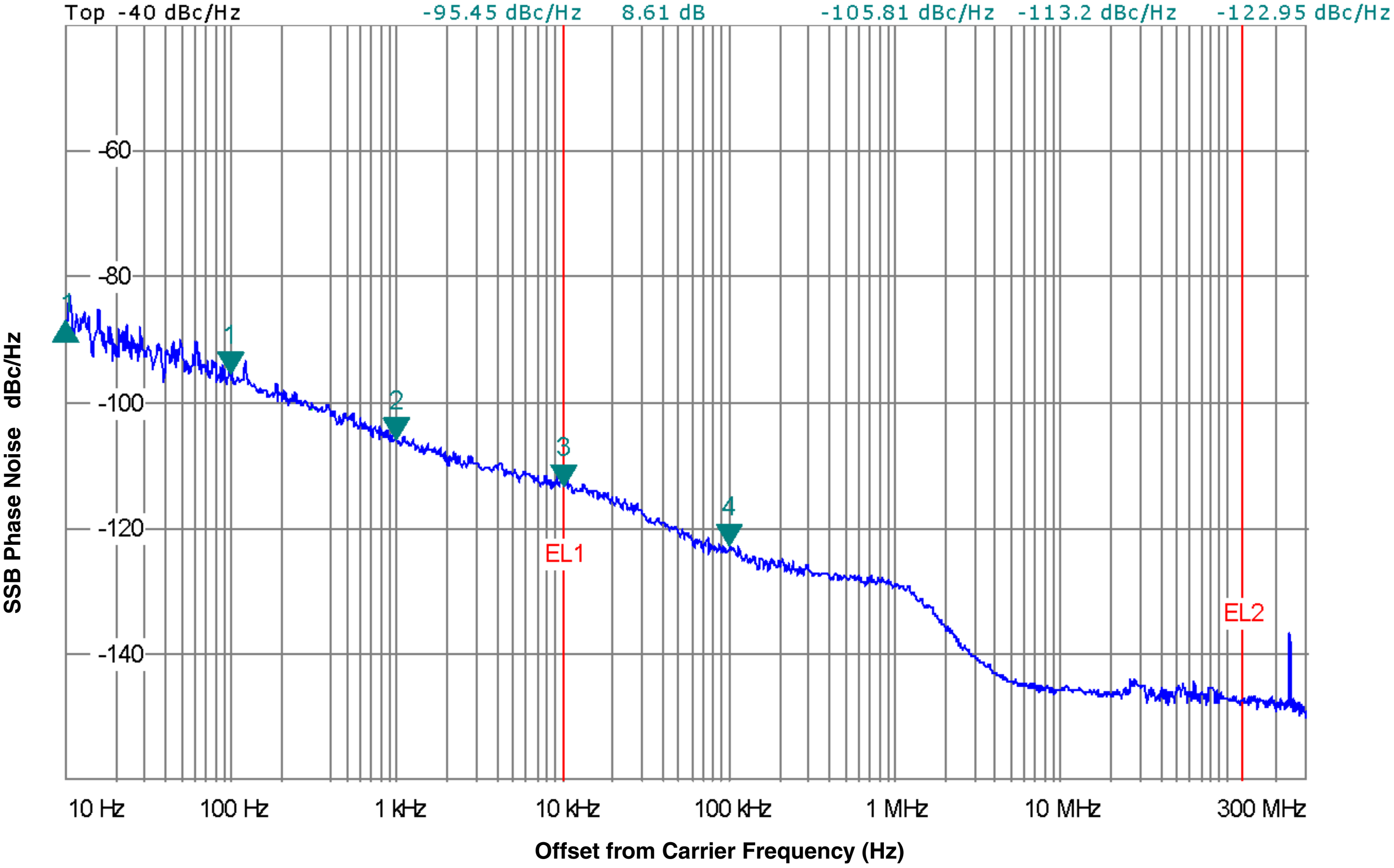
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the differential input crossing point to the differential output crossing point.
NOTE 2: Q, nQ outputs measured differentially. See *Output Isolation diagram* in the *Parameter Measurement Information section.*
NOTE 3. Measured using a Rohde & Schwarz SMA100 signal generator, 9kHz to 6GHz as the input source with ±500mV sinewave single-ended input to REF_CLKIN.

Single Side Band Noise Power (80MHz)



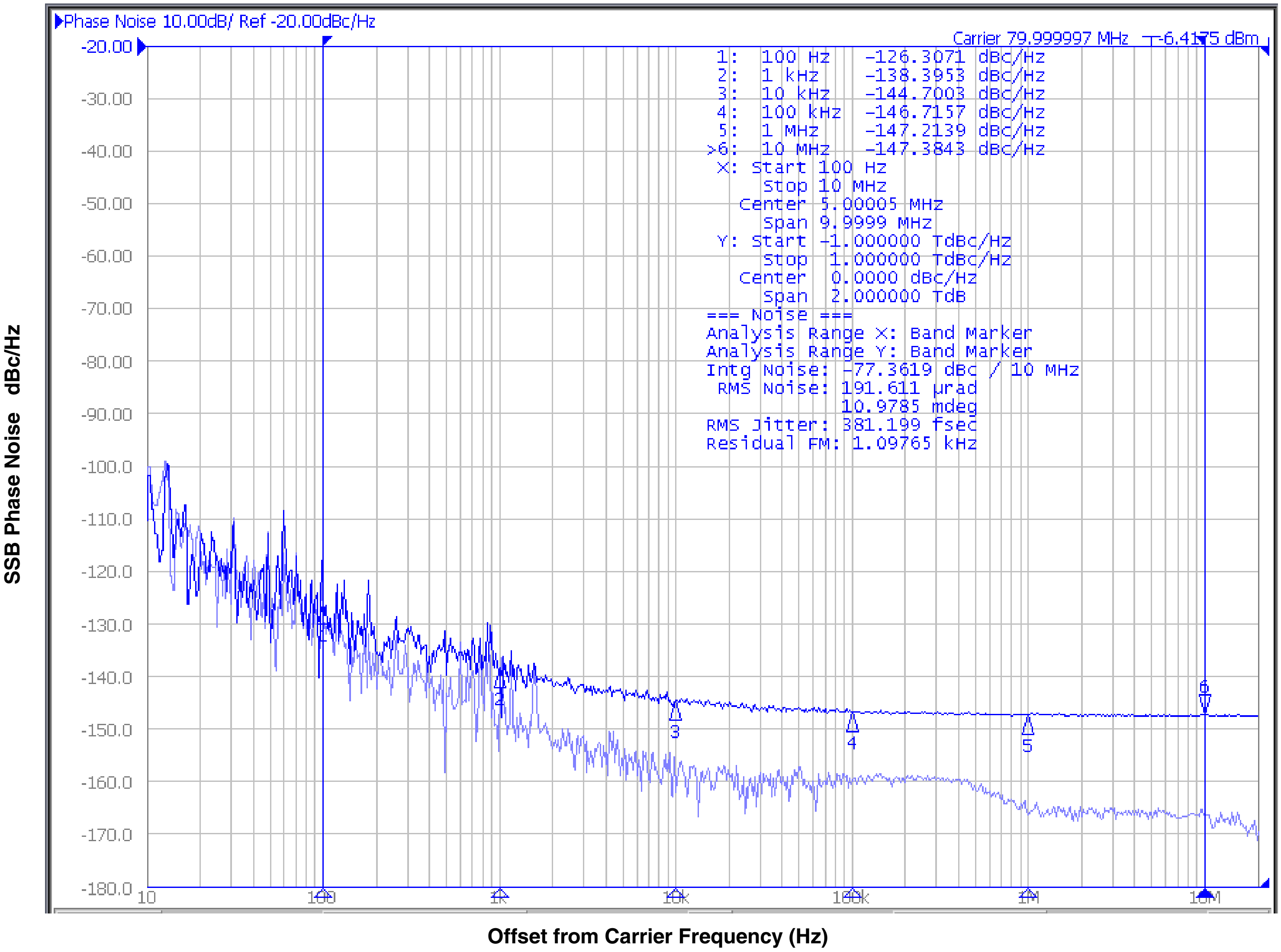
```
 1:  100 Hz    -119.7463 dBc/Hz
 2:  1 kHz     -132.9222 dBc/Hz
 3:  10 kHz    -142.8476 dBc/Hz
 4:  100 kHz   -146.3758 dBc/Hz
 5:  1 MHz     -147.1330 dBc/Hz
 6:  10 MHz    -147.1668 dBc/Hz
>7:  10 MHz    -147.1668 dBc/Hz
 X: Start 100 Hz
     Stop 10 MHz
   Center 5.00005 MHz
     Span 9.9999 MHz
=== Noise ===
Analysis Range X: Band Marker
Analysis Range Y: Band Marker
Intg Noise: -77.0800 dBc / 10 MHz
 RMS Noise: 197.931 µrad
            11.3406 mdeg
RMS Jitter: 393.771 fsec
Residual FM: 1.13482 kHz
```

RMS Phase Jitter (480MHz)



Additive Phase Jitter

The spectral purity in a band at a specific offset from the fundamental compared to the power of the fundamental is called the ***dBc Phase Noise.*** This value is normally expressed using a Phase noise plot and is most often the specified plot in many applications. Phase noise is defined as the ratio of the noise power present in a 1Hz band at a specified offset from the fundamental frequency to the power value of the fundamental. This ratio is expressed in decibels (dBm) or a ratio of the power in the 1Hz band to the power in the fundamental. When the required offset is specified, the phase noise is called a ***dBc*** value, which simply means dBm at a specified offset from the fundamental. By investigating jitter in the frequency domain, we get a better understanding of its effects on the desired application over the entire time record of the signal. It is mathematically possible to calculate an expected bit error rate given a phase noise plot.



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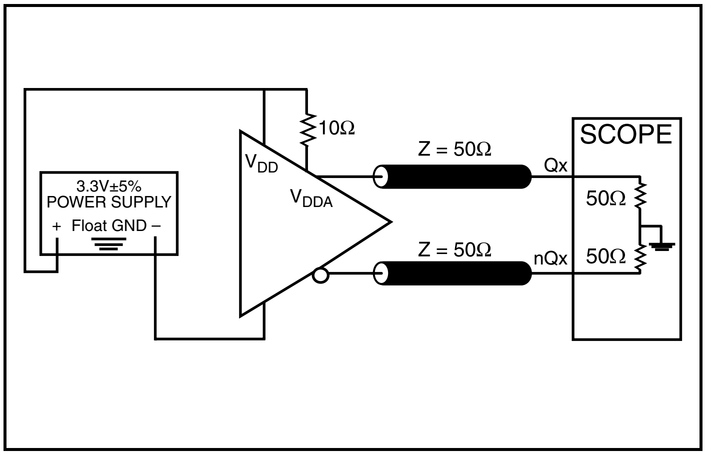
 1:  100 Hz     -126.3071 dBc/Hz
 2:  1 kHz      -138.3953 dBc/Hz
 3:  10 kHz     -144.7003 dBc/Hz
 4:  100 kHz    -146.7157 dBc/Hz
 5:  1 MHz      -147.2139 dBc/Hz
>6:  10 MHz     -147.3843 dBc/Hz
 X: Start 100 Hz
     Stop 10 MHz
   Center 5.00005 MHz
     Span 9.9999 MHz
 Y: Start -1.000000 TdBc/Hz
     Stop  1.000000 TdBc/Hz
   Center  0.0000 dBc/Hz
     Span  2.000000 TdB
=== Noise ===
Analysis Range X: Band Marker
Analysis Range Y: Band Marker
Intg Noise: -77.3619 dBc / 10 MHz
 RMS Noise: 191.611 µrad
            10.9785 mdeg
RMS Jitter: 381.199 fsec
Residual FM: 1.09765 kHz
```

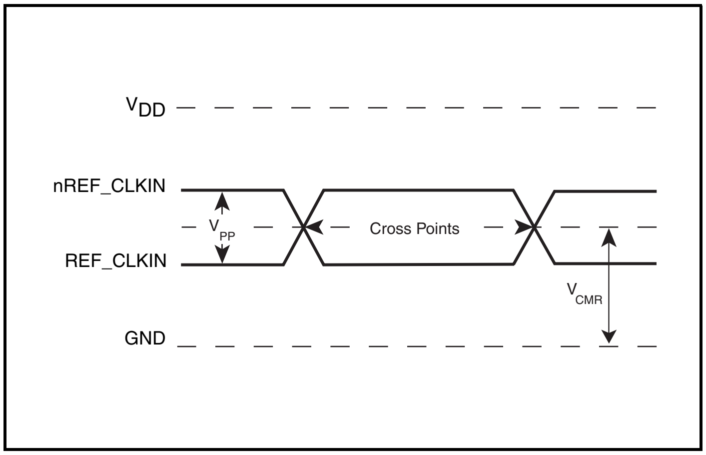
As with most timing specifications, phase noise measurements has issues relating to the limitations of the equipment. Often the noise floor of the equipment is higher than the noise floor of the device. This is illustrated above. The device meets the noise floor of what is shown, but can actually be lower. The phase noise is dependent on the input source and measurement equipment.

Measured using a Rohde & Schwarz SMA100 as the input source.

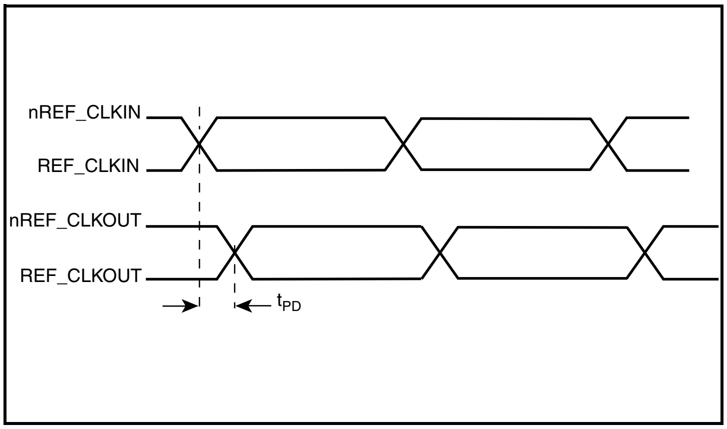
Parameter Measurement Information



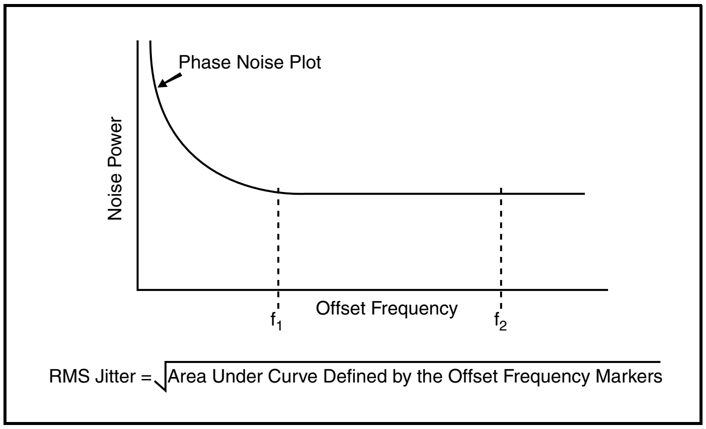
3.3V LVDS Output Load AC Test Circuit



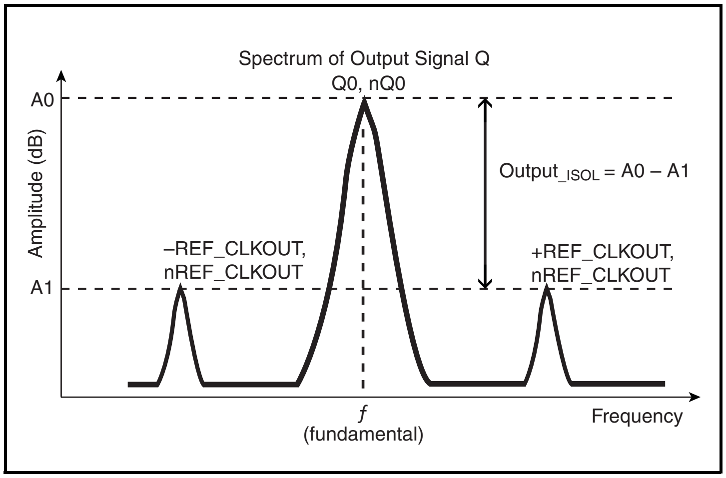
Differential Input Level



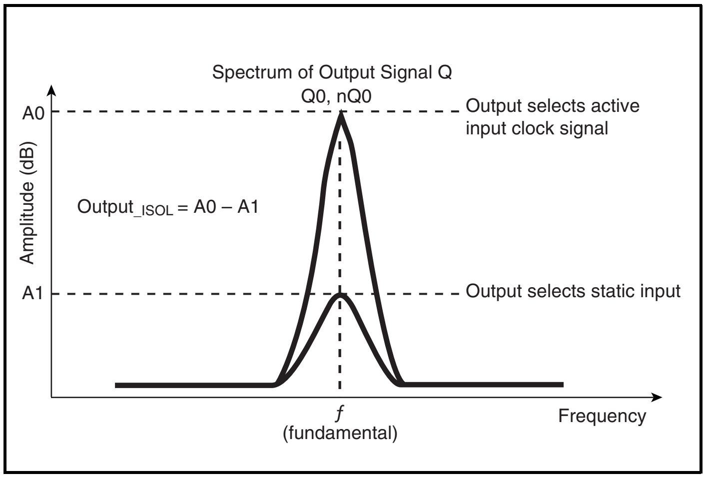
Propagation Delay



RMS Phase Jitter

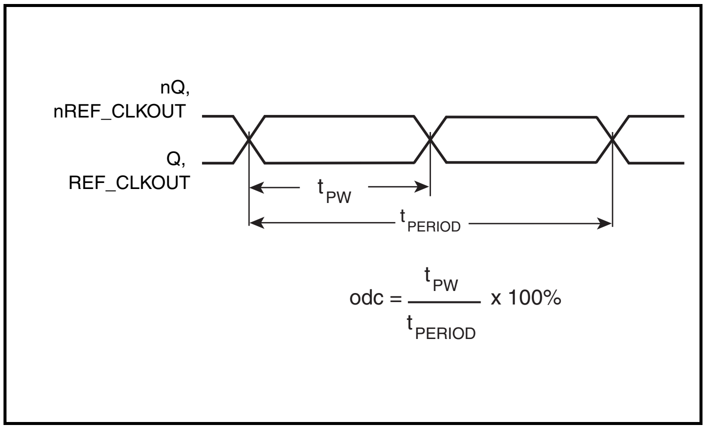


Output Isolation (Q, nQ (480MHz) to ±REF_CLKOUT, nREF_CLKOUT)

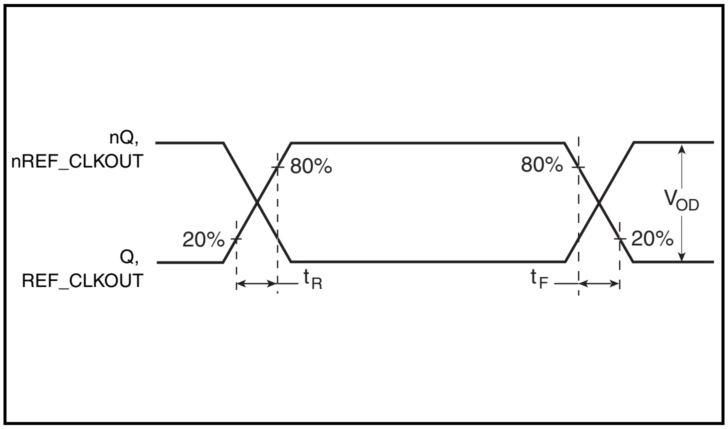


Output Isolation

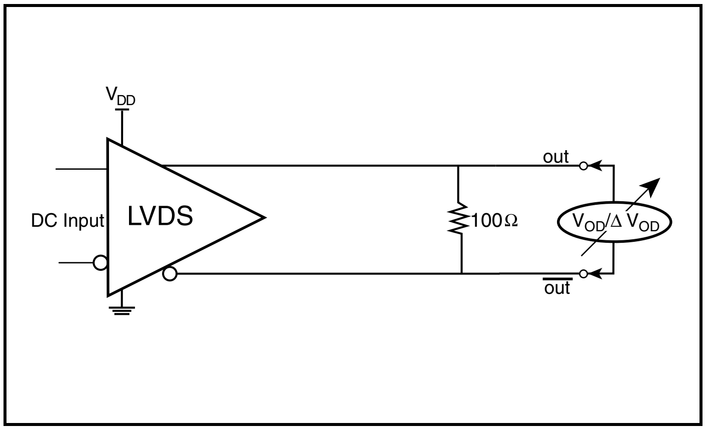
Parameter Measurement Information, continued



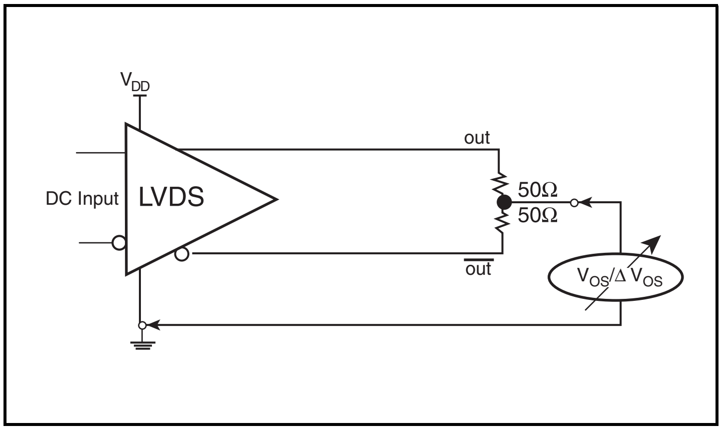
LVDS Output Duty Cycle/Pulse Width/Period



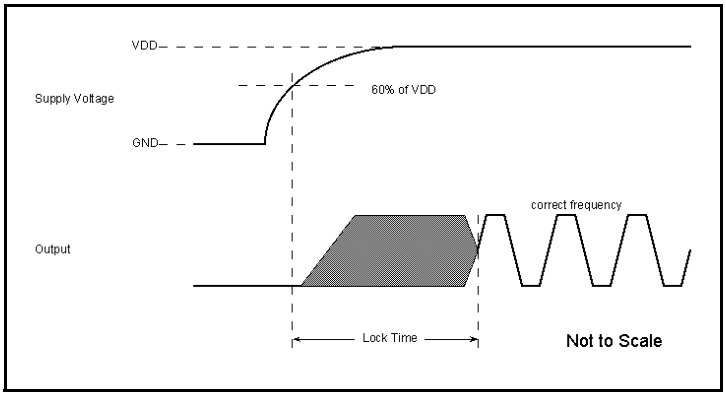
LVDS Output Rise/Fall Time



Differential Output Voltage Setup



Offset Voltage Setup



PLL Lock 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.

Outputs:

LVDS Outputs

All unused LVDS output pairs can be either left floating or terminated with 100Ω across. If they are left floating, we recommend that there

Wiring the Differential Input to Accept Single-Ended Levels

Figure1 shows how a differential input can be wired to accept single ended levels. The reference voltage $V_1 = V_{DD}/2$ is generated by the bias resistors R1 and R2. The bypass capacitor (C1) is used to help filter noise on the DC bias. This bias circuit should be located as close to the input pin as possible. The ratio of R1 and R2 might need to be adjusted to position the V_1 in the center of the input voltage swing. For example, if the input clock swing is 2.5V and V_{DD} = 3.3V, R1 and R2 value should be adjusted to set V_1 at 1.25V. The values below are for when both the single ended swing and V_{DD} are at the same voltage. 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 input will attenuate the signal in half. This can be done in one of two ways. First, R3 and R4 in parallel should equal the transmission line impedance. For most 50Ω applications, R3 and R4 can be 100Ω. The values of the resistors can be increased to reduce the loading for slower and weaker LVCMOS driver. When using single-ended signaling, the noise rejection benefits of differential signaling are reduced. Even though the differential input can handle full rail LVCMOS signaling, it is recommended that the amplitude be reduced. The datasheet specifies a lower differential amplitude, however this only applies to differential signals. For single-ended applications, the swing can be larger, however V_{IL} cannot be less than -0.3V and V_{IH} cannot be more than V_{DD} + 0.3V. Though some of the recommended components might not be used, the pads should be placed in the layout. They can be utilized for debugging purposes. The datasheet specifications are characterized and guaranteed by using a differential signal.

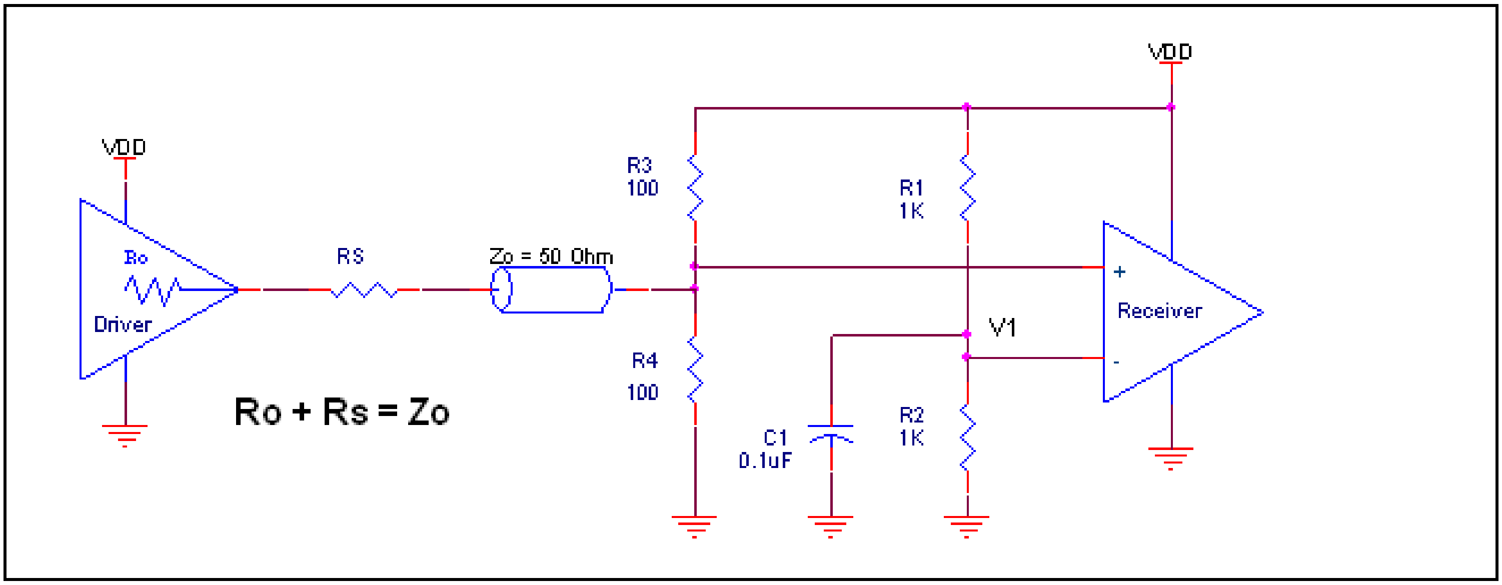


Figure 1. Recommended Schematic for Wiring a Differential Input to Accept Single-ended Levels

3.3V LVPECL Clock Input Interface

The REF_CLK/nREF_CLK accepts LVPECL, LVDS, HCSL and other differential signals. Both differential signals must meet the V_{PP} and V_{CMR} input requirements. *Figures 2A to 2D* show interface examples for the REF_CLK/nREF_CLK 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.

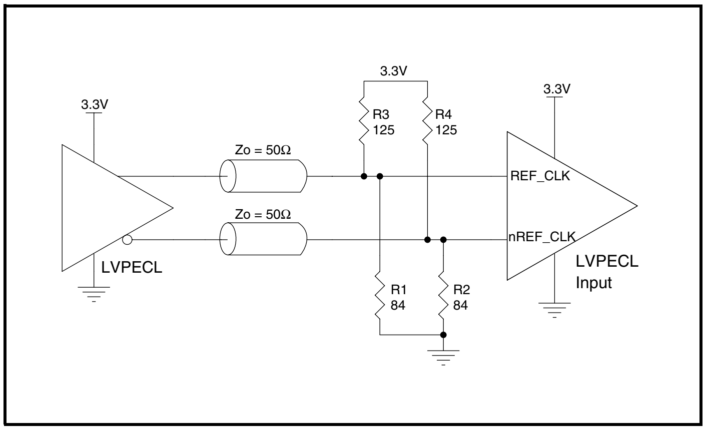


Figure 2A. REF_CLK/nREF_CLK Input Driven by a 3.3V LVPECL Driver

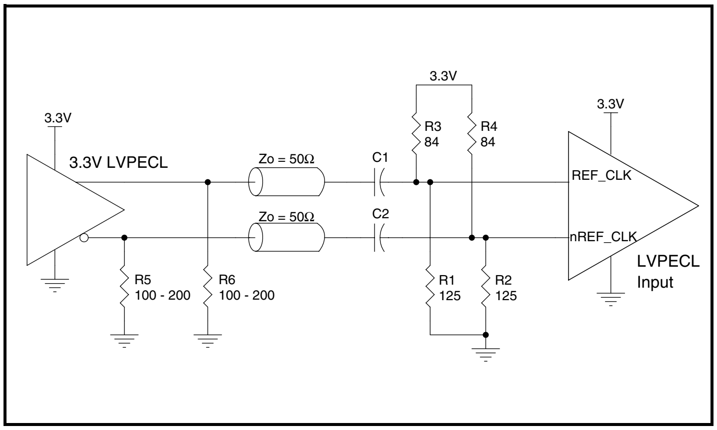


Figure 2B. REF_CLK/nREF_CLK Input Driven by a 3.3V LVPECL Driver with AC Couple

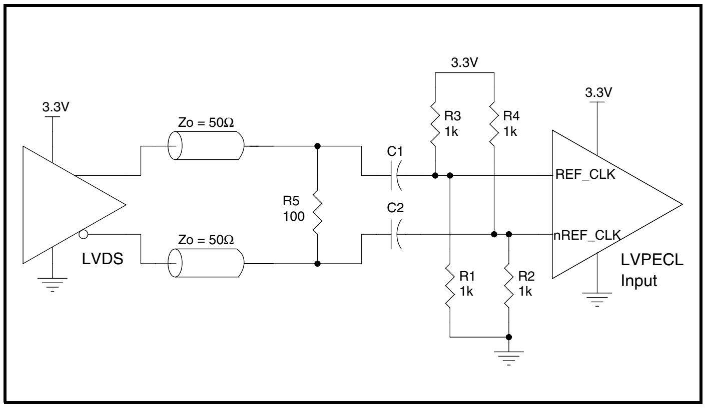


Figure 2C. REF_CLK/nREF_CLK Input Driven by a 3.3V LVDS Driver

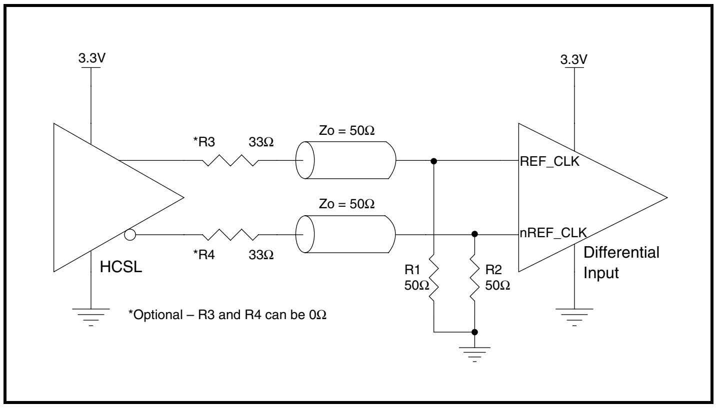


Figure 2D. REF_CLK/nREF_CLK Input Driven by a 3.3V HCSL Driver

LVDS Driver Termination

A general LVDS interface is shown in *Figure 3A.* Standard termination for LVDS type output structure requires both a 100Ω parallel resistor at the receiver and a 100Ω differential transmission line environment. In order to avoid any transmission line reflection issues, the 100Ω resistor 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 3A can be used with either type of output structure. If using a non-standard termination, it is recommended to contact IDT and confirm if the output is a current source or a voltage source type structure. In addition, since these outputs are LVDS compatible, the amplitude and common mode input range of the input receivers should be verified for compatibility with the output.

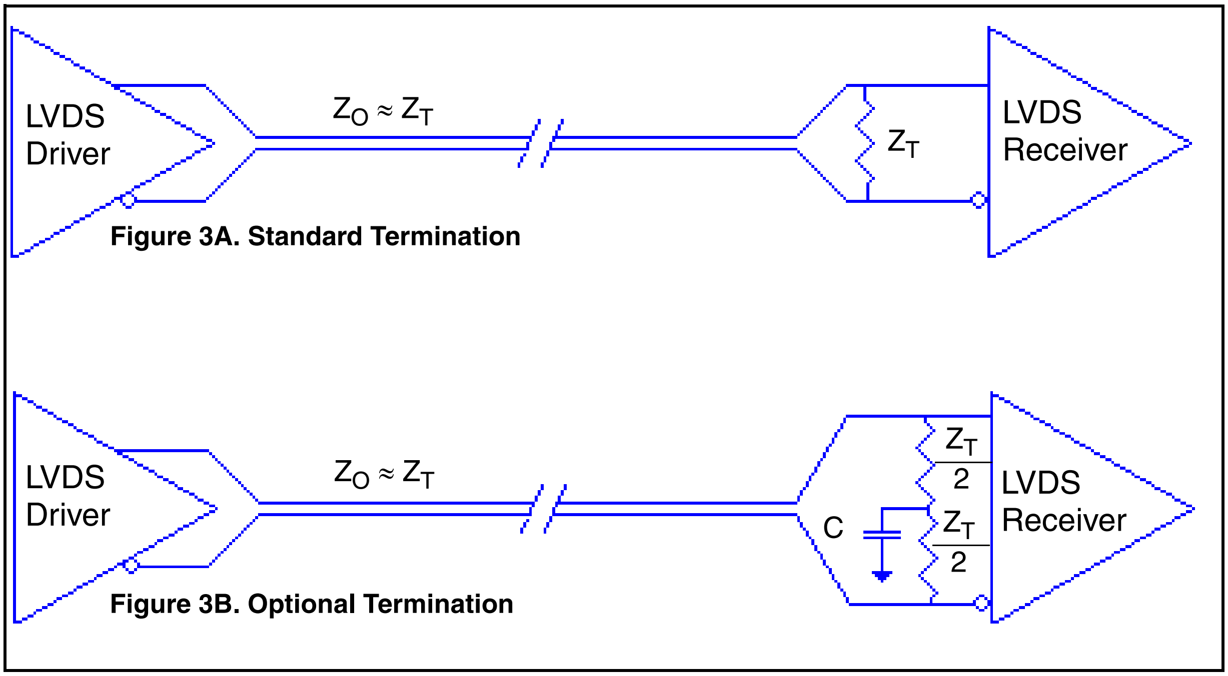


Figure 3A. Standard Termination

Figure 3B. Optional Termination

LVDS Driver Termination

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.

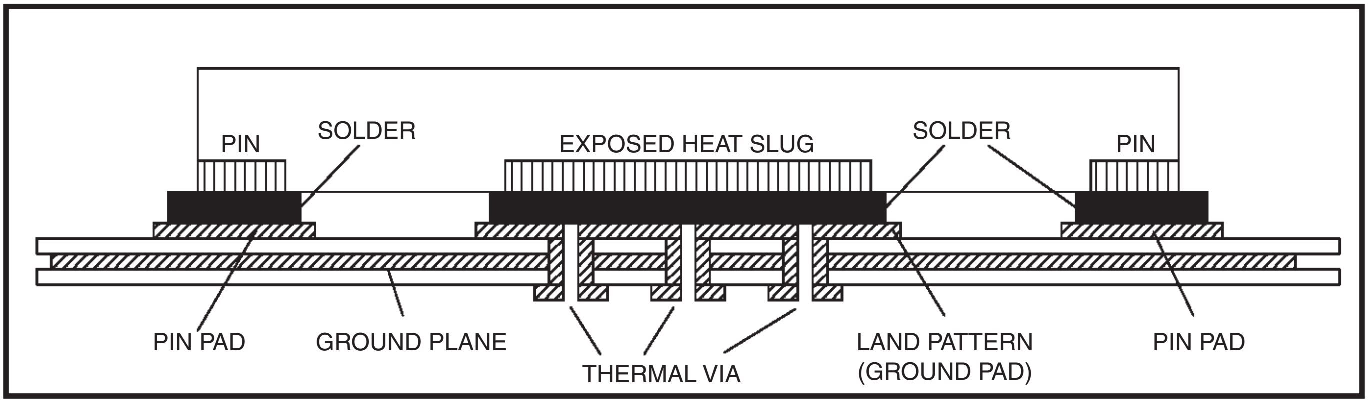


Figure 4. P.C. Assembly for Exposed Pad Thermal Release Path – Side View (drawing not to scale)

Schematic Example

Figure 5 shows an example of IDT8V44N003I application schematic. Input and output terminations shown are intended as examples only and may not represent the exact user configuration.

As with any high speed analog circuitry, the power supply pins are vulnerable to noise. To achieve optimum jitter performance, power supply isolation is required. The IDT8V44N003I provides separate power V_{DD} and V_{DDA} power supplies to isolate 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 0.1uF capacitor in each power pin filter should be placed on the device side of the PCB and the other components can be placed on the opposite side.

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 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 supply 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 capacitances in the local area of all devices.

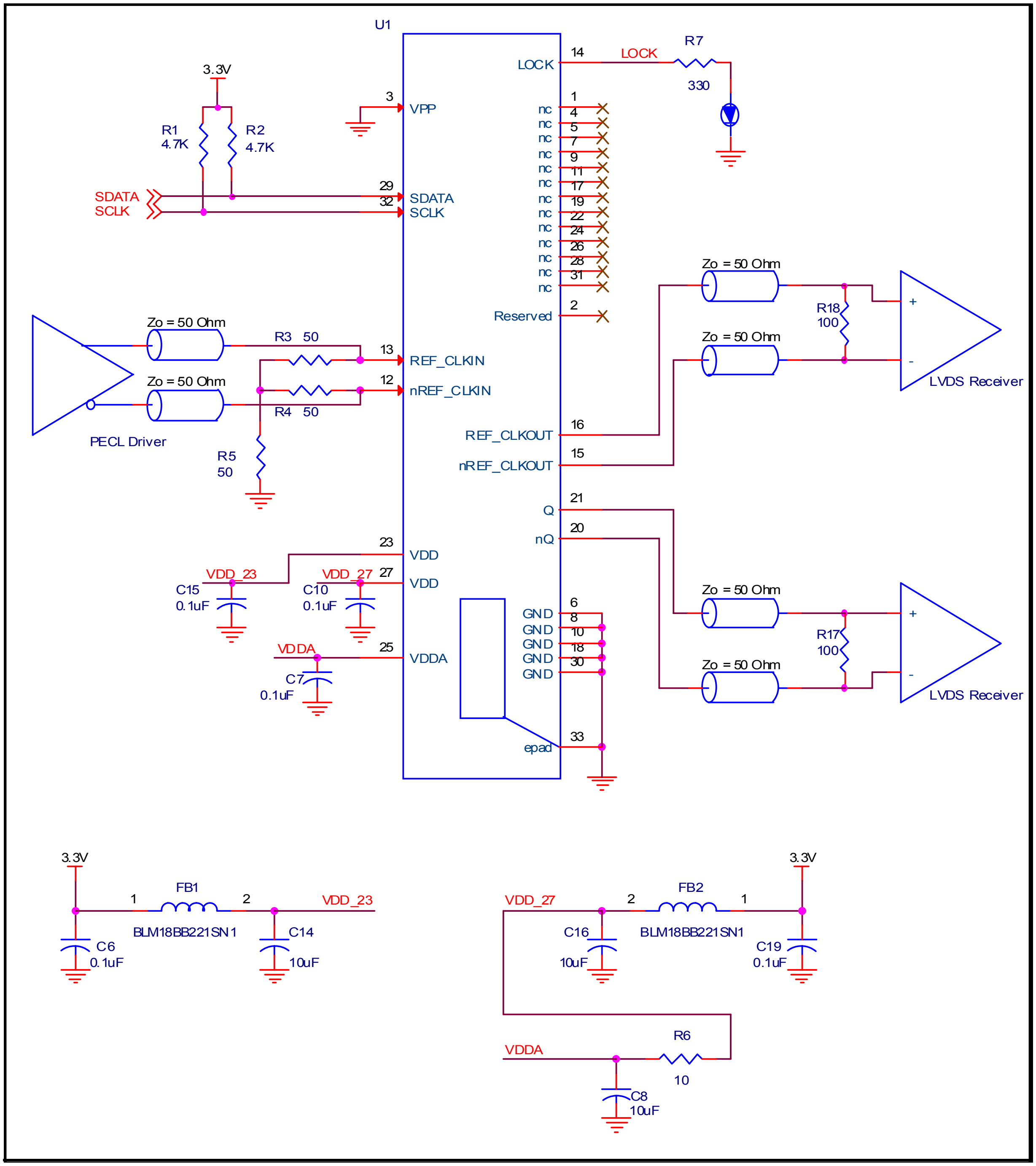


Figure 5. IDT8V44N003I Application Schematic

Power Considerations

This section provides information on power dissipation and junction temperature for the IDT8V44N003I.
Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the IDT8V44N003I is the sum of the core power plus the analog power plus the power dissipated in the load(s). The following is the power dissipation for V_{DD} = 3.3V + 5% = 3.465V, which gives worst case results.

- Power $(core)_{MAX} = V_{DD\_MAX} * (I_{DD\_MAX} + I_{DDA\_MAX})$ = 3.465V * (136mA + 17mA) = **530.145mW**

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: $Tj = \theta_{JA} * Pd\_total + T_A$

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 43.7°C/W per Table 6 below.

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

85°C + 0.530W * 43.7°C/W = 108.2°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 6. Thermal Resistance θ_{JA} for 32 Lead VFQFN, Forced Convection

θ_{JA} by Velocity			
Meters per Second	**0**	**1**	**2.5**
Multi-Layer PCB, JEDEC Standard Test Boards	43.7°C/W	38.2°C/W	34.2°C/W

Reliability Information

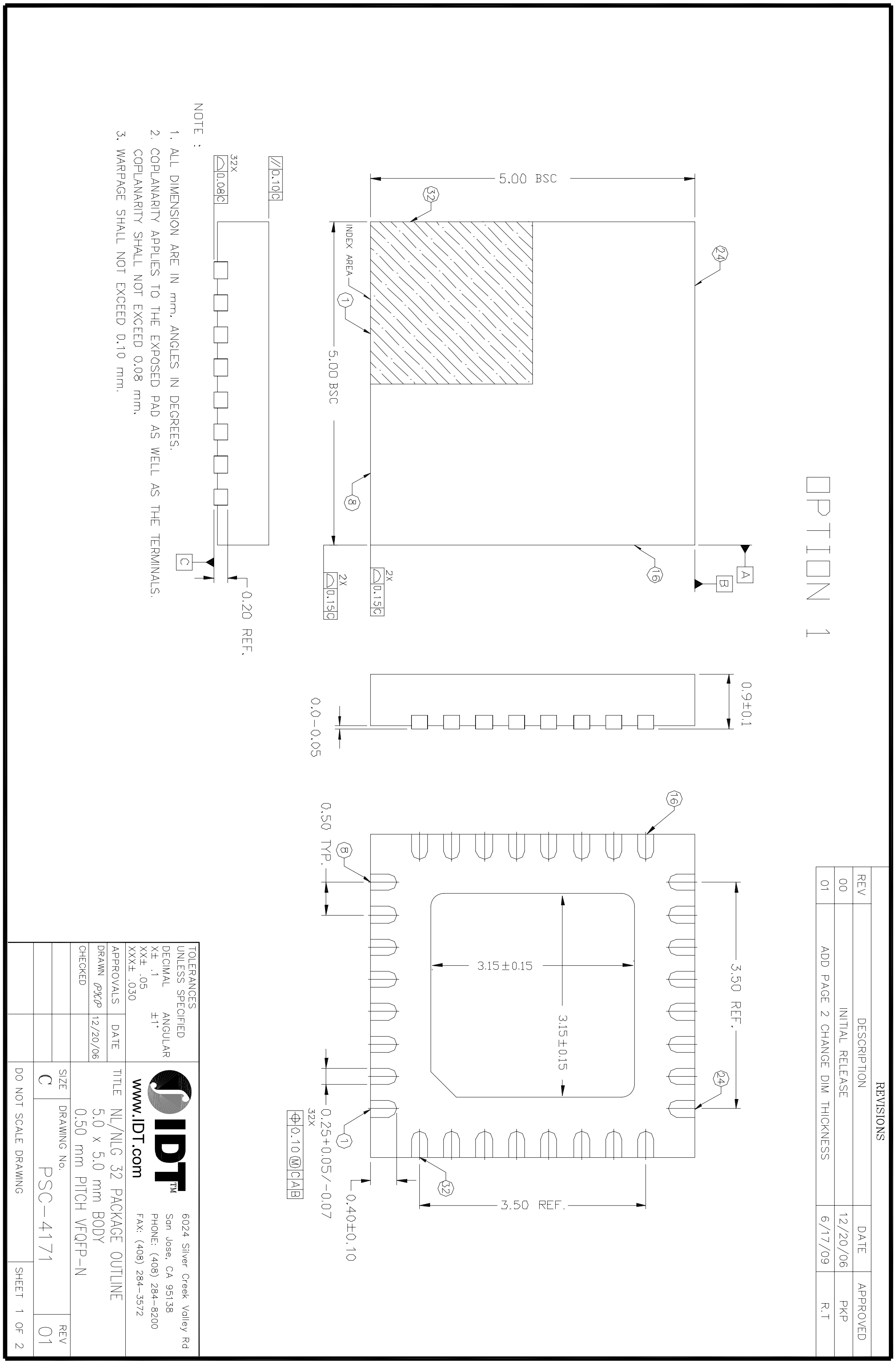
Table 7. θ_{JA} vs. Air Flow Table for a 32 Lead VFQFN

θ_{JA} vs. Air Flow			
Meter per Second	**0**	**1**	**2.5**
Multi-Layer PCB, JEDEC Standard Test Boards	43.7°C/W	38.2°C/W	34.2°C/W

Transistor Count

The transistor count for IDT8V44N003I is: 47,632

Package Outline and Package Dimensions



Ordering Information

Table 8. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
8V44N003NLGI	IDT8V44N003NLGI	“Lead-Free” 32 Lead VFQFN	Tray	-40°C to 85°C
8V44N003NLGI8	IDT8V44N003NLGI	“Lead-Free” 32 Lead VFQFN	2500 Tape & Reel	-40°C to 85°C

NOTE: Parts that are ordered with an "G" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

Revision History Sheet

Rev	Table	Page	Description of Change	Date
A		2	Corrected block diagram, missing line from PFD to VCO to mux.	4/24/12

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