General Description

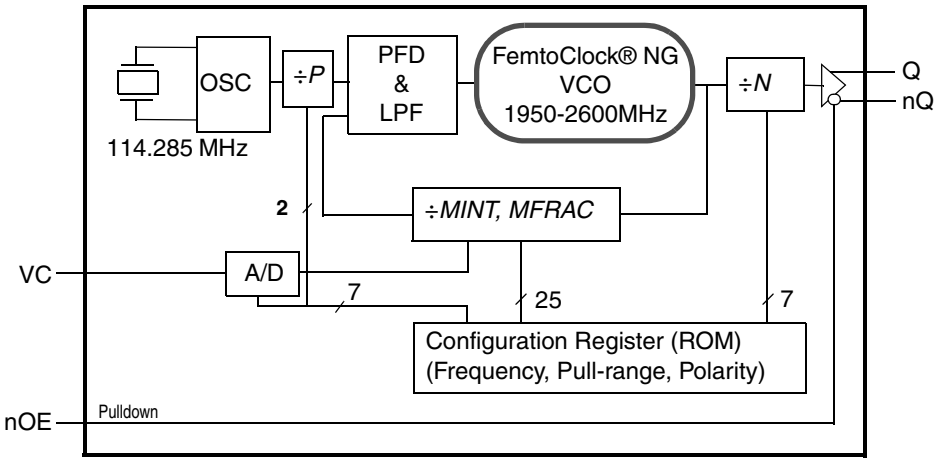
The IDT8N3SV76 is an LVPECL Frequency-Programmable VCXO with very flexible frequency and pull-range programming capabilities. The device uses IDT's fourth generation FemtoClock® NG technology for an optimum of high clock frequency and low phase noise performance. The device accepts a 2.5V or 3.3V supply and is packaged in a small, lead-free (RoHS 6) 6-lead ceramic 5mm x 7mm x 1.55mm package.

The device can be factory-programmed to any frequency in the range of 15.476MHz to 866.67MHz and from 975MHz to 1,300MHz to the very high degree of frequency precision of 218Hz or better. The extended temperature range supports wireless infrastructure, telecommunication and networking end equipment requirements.

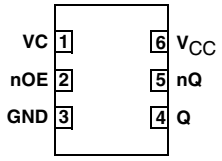
Features

- Fourth Generation FemtoClock® NG technology
- Programmable clock output frequency from 15.476MHz to 866.67MHz and from 975MHz to 1,300MHz
- Frequency programming resolution is 218Hz and better
- Factory-programmable VCXO pull range and control voltage polarity
- Absolute pull range (APR) programmable from typical ±4.5ppm to ±754.5ppm
- One 2.5V or 3.3V LVPECL clock output
- Output enable control input, LVCMOS/LVTTL compatible
- RMS phase jitter @ 156.25MHz (12kHz - 20MHz): 0.5ps (typical),
- 2.5V or 3.3V supply voltage
- -40°C to 85°C ambient operating temperature
- Lead-free (RoHS 6) 6-lead ceramic 5mm x 7mm x 1.55mm package

Block Diagram



Pin Assignment



IDT8N3SV76
6-lead ceramic 5mm x 7mm x 1.55mm package body
CD Package
Top View

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Pin Description and Characteristic Tables

Table 1. Pin Descriptions

Number	Name	Type		Description
1	VC	Input		VCXO Control Voltage input.
2	nOE	Input	Pulldown	Output enable pin. See Table 3A for function. LVCMOS/LVTTL interface levels.
3	V_{EE}	Power		Negative power supply.
4, 5	Q, nQ	Output		Differential clock output. LVPECL interface levels.
6	V_{CC}	Power		Positive power supply.

NOTE: *Pullup* refers 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	nOE			5.5		pF
		VC			10		pF
$R_{PULLDOWN}$	Input Pulldown Resistor				50		kΩ

Function Tables

Table 3A. nOE Configuration

Input	
nOE	Output Enable
0 (default)	Q, nQ outputs are enabled.
1	Q, nQ outputs are in high-impedance state.

Table 3B. Output Frequency Range

15.476MHz to 866.67MHz
975MHz to 1,300MHz

NOTE: Supported output frequency range. The output frequency can be programmed to any frequency in this range and to a precision of 218Hz or better.

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Principles of Operation

The block diagram consists of the internal 3RD overtone crystal and oscillator which provide the reference clock f_{XTAL} of 114.285MHz. The PLL includes the FemtoClock® NG VCO along with the Pre-divider (*P*), the feedback divider (*M*) and the post divider (*N*). The *P*, *M*, and *N* dividers determine the output frequency based on the f_{XTAL} reference. The feedback divider is fractional supporting a huge number of output frequencies. Internal registers are used to hold up the factory pre-set configuration setting. The *P*, *M*, and *N* frequency configurations support an output frequency range of 15.476MHz to 866.67MHz and 975MHz to 1,300MHz.

The devices use the fractional feedback divider with a delta-sigma modulator for noise shaping and robust frequency synthesis capability. The relatively high reference frequency minimizes phase noise generated by frequency multiplication and allows more efficient shaping of noise by the delta-sigma modulator. The output frequency is determined by the 2-bit pre-divider (*P*), the feedback divider (M) and the 7-bit post divider (*N*). The feedback divider (*M*) consists of both a 7-bit integer portion (*MINT*) and an 18-bit fractional portion (*MFRAC*) and provides the means for high-resolution frequency generation. The output frequency f_{OUT} is calculated by:

$$f_{OUT} = f_{XTAL} \cdot \frac{1}{P \cdot N} \cdot \left[MINT + \frac{MFRAC + 0.5}{2^{18}} \right]$$

Frequency Configuration

An order code is assigned to each frequency configuration and the VCXO pull-range programmed by the factory (default frequencies). For more information on the available default frequencies and order codes, please see the Ordering Information Section in this document. For available order codes, see the *FemtoClock NG Ceramic-Package XO and VCXO Ordering Product Information* document.

For more information on programming capabilities of the device for custom frequency and pull-range configurations, see the *FemtoClock NG Ceramic 5x7 Module Programming Guide.*

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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_{CC}	3.63V
Inputs, V_I	-0.5V to V_{CC} + 0.5V
Outputs, I_O (LVPECL) Continuous Current Surge Current	 50mA 100mA
Package Thermal Impedance, θ_{JA}	49.4°C/W (0 mps)
Storage Temperature, T_{STG}	-65°C to 150°C

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, V_{CC} = 3.3V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{CC}	Power Supply Voltage		3.135	3.3	3.465	V
I_{EE}	Power Supply Current			130	157	mA

Table 4B. Power Supply DC Characteristics, V_{CC} = 2.5V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{CC}	Power Supply Voltage		2.375	2.5	2.625	V
I_{EE}	Power Supply Current			125	152	mA

Table 4C. LVPECL DC Characteristics, V_{CC} = 3.3V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Output High Voltage; NOTE 1		V_{CC} – 1.4		V_{CC} – 0.8	V
V_{OL}	Output Low Voltage; NOTE 1		V_{CC} – 2.0		V_{CC} – 1.7	V
V_{SWING}	Peak-to-Peak Output Voltage Swing		0.6		1.0	V

NOTE 1: Outputs terminated with 50Ω to V_{CC} – 2V.

Table 4D. LVPECL DC Characteristics, V_{CC} = 2.5V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Output High Voltage; NOTE 1		V_{CC} – 1.4		V_{CC} – 0.8	V
V_{OL}	Output Low Voltage; NOTE 1		V_{CC} – 2.0		V_{CC} – 1.5	V
V_{SWING}	Peak-to-Peak Output Voltage Swing		0.4		1.0	V

NOTE 1: Outputs terminated with 50Ω to V_{CC} – 2V.

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Table 4E. LVCMOS/LVTTL DC Characteristic, V_{CC} = 3.3V ± 5% or 2.5V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage		V_{CC} = 3.3V	2		V_{CC} + 0.3	V
			V_{CC} = 2.5V	1.7		V_{CC} + 0.3	V
V_{IL}	Input Low Voltage		V_{CC} = V_{IN} = 3.465V	-0.3		0.8	V
			V_{CC} = V_{IN} = 2.5V	-0.3		0.7	V
I_{IH}	Input High Current	nOE	V_{CC} = V_{IN} = 3.465V or 2.625V			150	µA
I_{IL}	Input Low Current	nOE	V_{CC} = 3.465V or 2.625V, V_{IN} = 0V	-10			µA

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AC Electrical Characteristics

Table 5A. AC Characteristics, V_{CC} = 3.3V ± 5% or 2.5V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency Q, nQ		15.476		866.67	MHz
			975		1,300	MHz
f_I	Initial Accuracy	Measured @ 25°C, $V_C = V_{CC}/2$			±10	ppm
f_S	Temperature Stability	Option code = A or B			±100	ppm
		Option code = E or F			±50	ppm
		Option code = K or L			±20	ppm
f_A	Aging	Frequency drift over 10 year life			±3	ppm
		Frequency drift over 15 year life			±5	ppm
f_T	Total Stability	Option code A, B (10 year life)			±113	ppm
		Option code E, F (10 year life)			±63	ppm
		Option code K, L (10 year life)			±33	ppm
t_{jit}(cc)	Cycle-to-Cycle Jitter; NOTE 1			6	12	ps
t_{jit}(per)	RMS Period Jitter; NOTE 1			1.8	2.8	ps
t_{jit}(Ø)	RMS Phase Jitter (Random); NOTE 2	156.25MHz, Integration Range: 12kHz - 20MHz			0.66	ps
t_{jit}(Ø)	RMS Phase Jitter (Random); NOTE 2	156.25MHz, Integration Range: 1kHz - 40MHz		0.9	1.3	ps
t_{jit}(Ø)	RMS Phase Jitter (Random); NOTE 2,3,4 f_{XTAL} = 114.285mhz	500MHz ≤ f_{OUT} ≤ 1300MHz		0.44	0.77	ps
		100MHz ≤ f_{OUT} ≤ 500MHz		0.52	0.90	ps
		15MHz ≤ f_{OUT} ≤ 100MHz		0.72	1.2	ps
Φ_N(100)	Single-side band phase noise, 100Hz from Carrier	156.25MHz		-69		dBc/Hz
Φ_N(1k)	Single-side band phase noise, 1kHz from Carrier	156.25MHz		-98		dBc/Hz
Φ_N(10k)	Single-side band phase noise, 10kHz from Carrier	156.25MHz		-123		dBc/Hz
Φ_N(100k)	Single-side band phase noise, 100kHz from Carrier	156.25MHz		-128		dBc/Hz
Φ_N(1M)	Single-side band phase noise, 1MHz from Carrier	156.25MHz		-140		dBc/Hz
Φ_N(10M)	Single-side band phase noise, 10MHz from Carrier	156.25MHz		-145		dBc/Hz
PSNR	Power Supply Noise Rejection	50mV Sinusoidal Noise 1kHz - 50MHz		-71.2		dBc
t_R / t_F	Output Rise/Fall Time	20% to 80%	80		500	ps
odc	Output Duty Cycle		45		55	%
$t_{STARTUP}$	Device startup time after power up				10	ms

Notes continued on next page.

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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: Characterized with $V_C = V_{CC}/2$.
NOTE: XTAL parameters (initial accuracy, temperature stability, aging and total stability) are guaranteed by manufacturing.
NOTE 1: This parameter is defined in accordance with JEDEC standard 65.
NOTE 2: Refer to the phase noise plot.
NOTE 3: Please see the FemtoClock® NG Ceramic 5x7 Modules Programming guide for more information on PLL feedback modes and the optimum configuration for phase noise.

Table 5B. VCXO Control Voltage Input (V_C) Characteristics, V_{CC} = 3.3V ± 5% or 2.5V ± 5%, V_{EE} = 0V, T_A = -40°C to 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
K_V	Oscillator Gain, NOTE 1, 2, 3	V_{CC} = 3.3V	7.57		477.27	ppm/V
	Oscillator Gain, NOTE 1, 2, 3	V_{CC} = 2.5V	10		630	ppm/V
L_{VC}	Control Voltage Linearity; NOTE 4	BSL Variation	-1	±0.1	+1	%
BW	Modulation Bandwidth			100		kHz
Z_{VC}	VC Input Impedance			500		kΩ
VC_{NOM}	Nominal Control Voltage			$V_{CC}/2$		V
V_C	Control Voltage Tuning Range; NOTE 4		0		V_{CC}	V

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: V_C = 10% to 90% of V_{CC}.
NOTE 2: Nominal oscillator gain: Pull range divided by the control voltage tuning range of 3.3V. E.g. for ADC_GAIN [6:0] = 000001 the pull range is ± 12.5ppm, resulting in an oscillator gain of 25ppm ÷ 3.3V = 7.57ppm/V.
NOTE 3: For best phase noise performance, use the lowest K_V that meets the requirements of the application.
NOTE 4: BSL = Best Straight Line Fit: Variation of the output frequency vs. control voltage V_C, in percent. V_C ranges from 10% to 90% V_{CC}.

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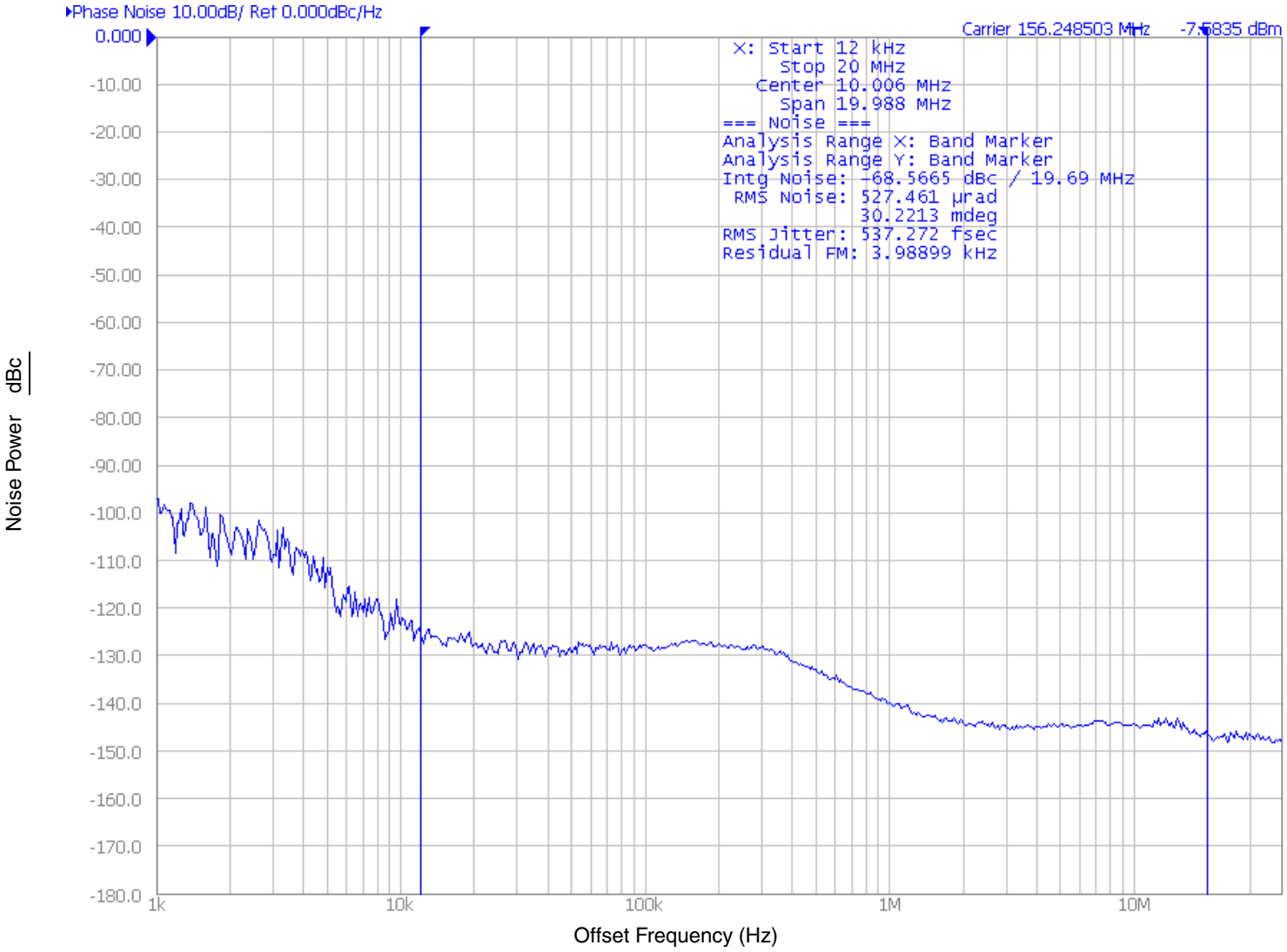
Typical Phase Noise at 156.25MHz (12kHz - 20MHz)



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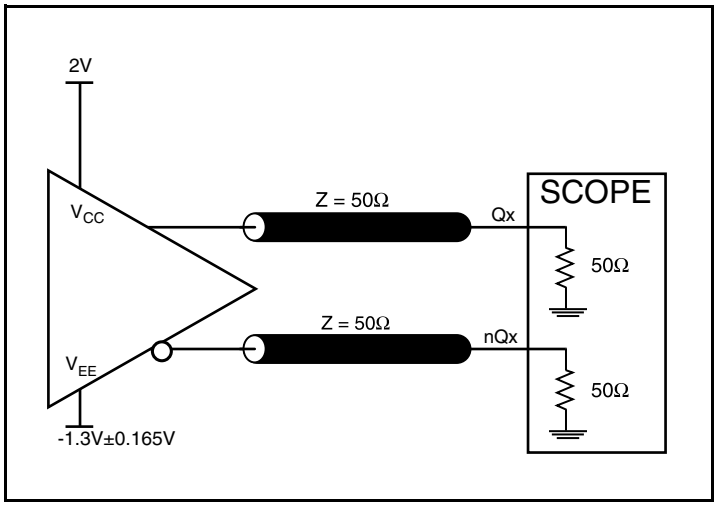
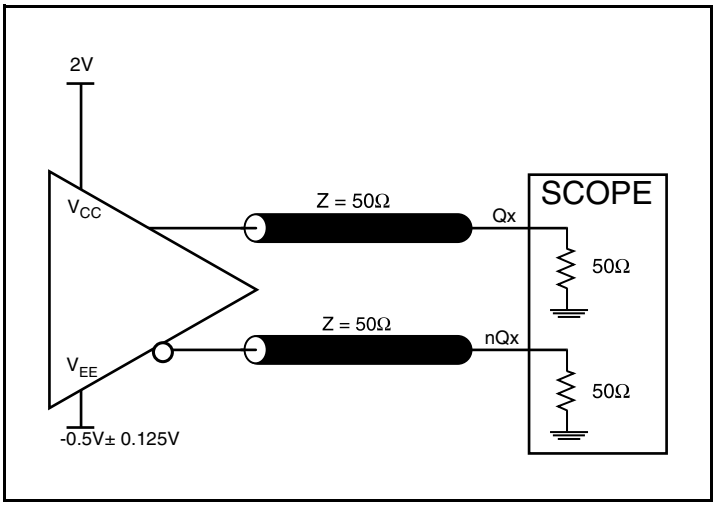
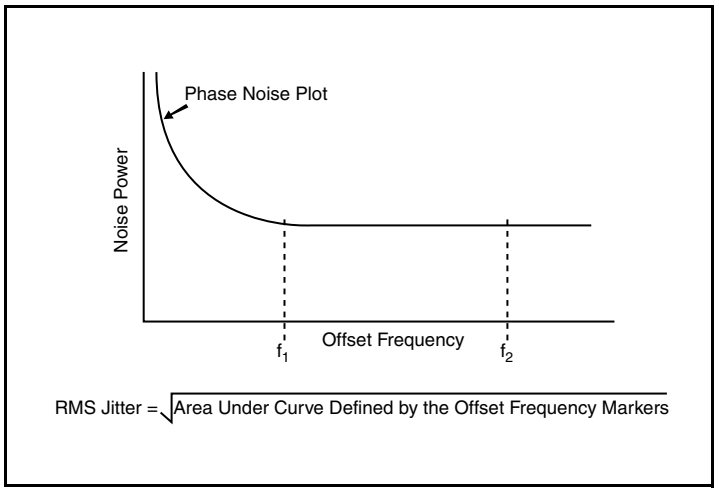
Parameter Measurement Information



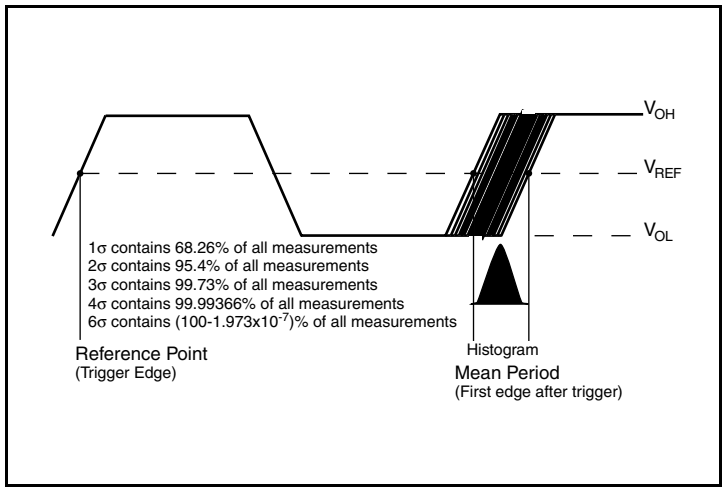
3.3V LVPECL Output Load AC Test Circuit



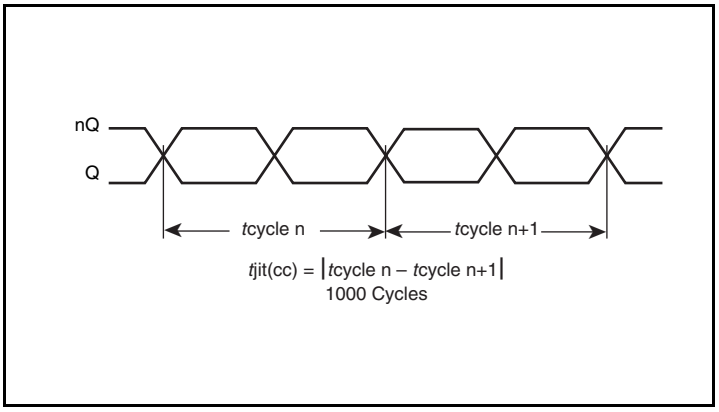
2.5V LVPECL Output Load AC Test Circuit



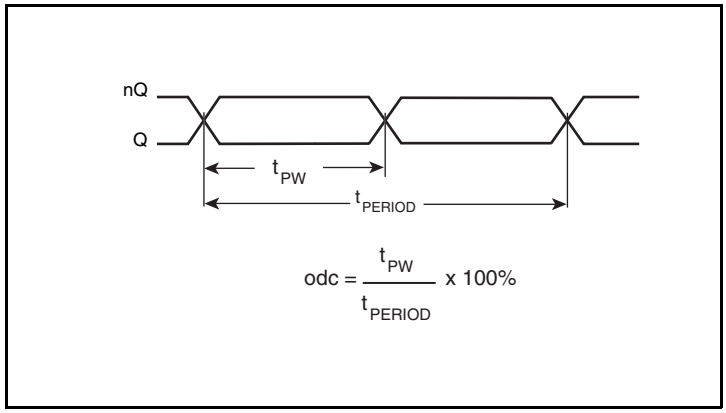
RMS Phase Jitter



RMS Period Jitter



Cycle-to-Cycle Jitter



Output Duty Cycle/Pulse Width/Period

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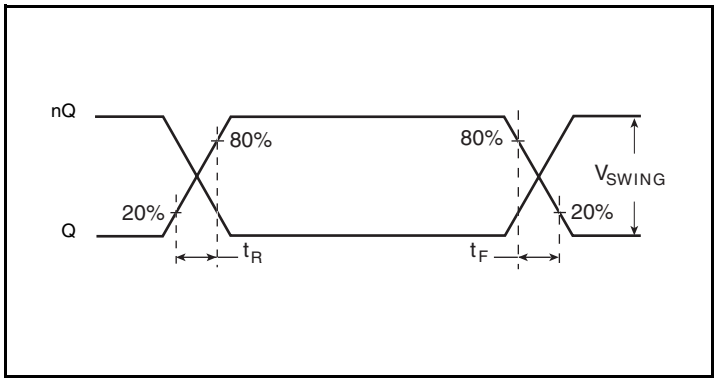
Parameter Measurement Information, continued



Output Rise/Fall Time

Applications Information

Termination for 3.3V LVPECL Outputs

The clock layout topology shown below is a typical termination for LVPECL outputs. The two different layouts mentioned are recommended only as guidelines.

The differential outputs are low impedance follower outputs that generate ECL/LVPECL compatible outputs. Therefore, terminating resistors (DC current path to ground) or current sources must be used for functionality. These outputs are designed to drive 50Ω transmission lines. Matched impedance techniques should be used to maximize operating frequency and minimize signal distortion. *Figures 1A and 1B* show two different layouts which are recommended only as guidelines. Other suitable clock layouts may exist and it would be recommended that the board designers simulate to guarantee compatibility across all printed circuit and clock component process variations.

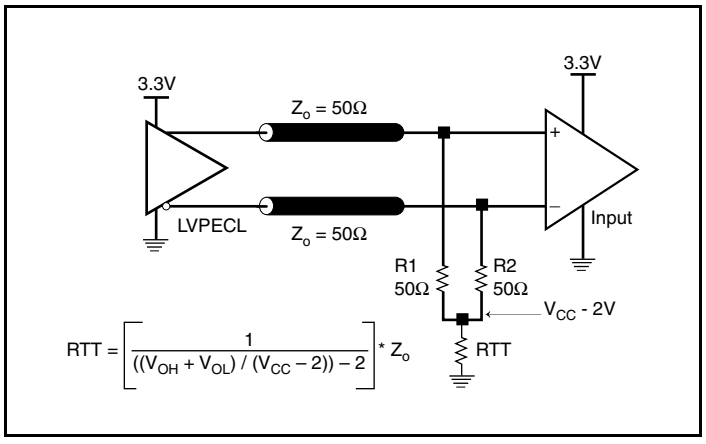


Figure 1A. 3.3V LVPECL Output Termination

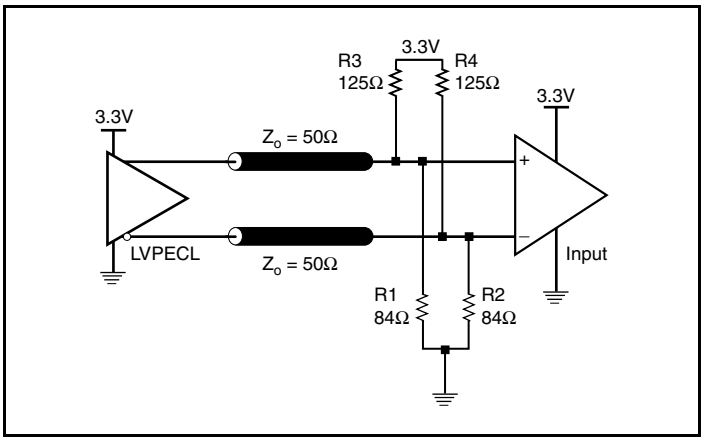


Figure 1B. 3.3V LVPECL Output Termination

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Termination for 2.5V LVPECL Outputs

Figure 2A and *Figure 2B* show examples of termination for 2.5V LVPECL driver. These terminations are equivalent to terminating 50Ω to V_{CC} – 2V. For V_{CC} = 2.5V, the V_{CC} – 2V is very close to ground level. The R3 in Figure 2B can be eliminated and the termination is shown in *Figure 2C.*

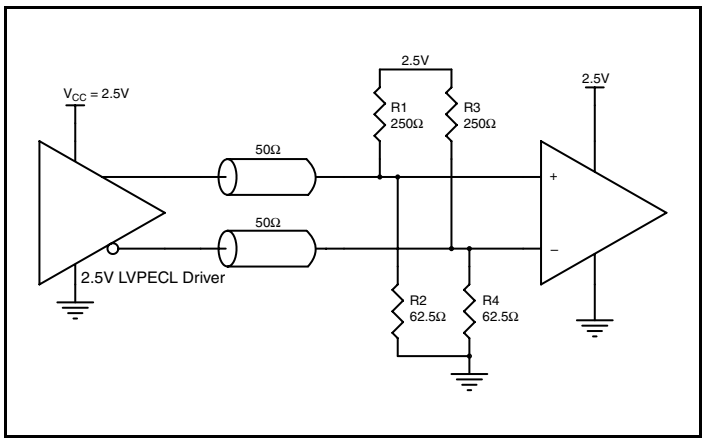

Figure 2A. 2.5V LVPECL Driver Termination Example

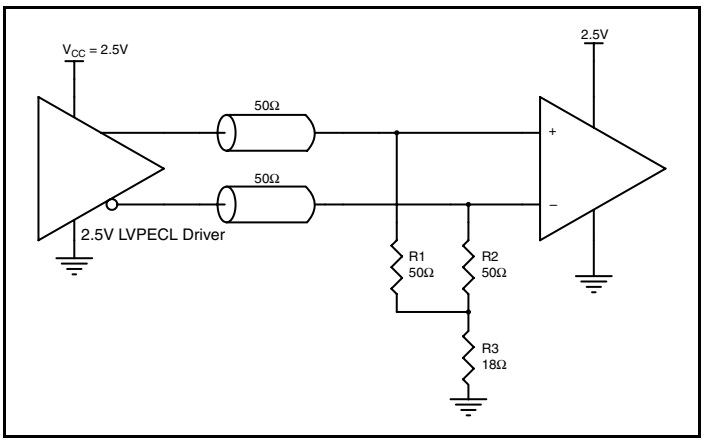

Figure 2B. 2.5V LVPECL Driver Termination Example

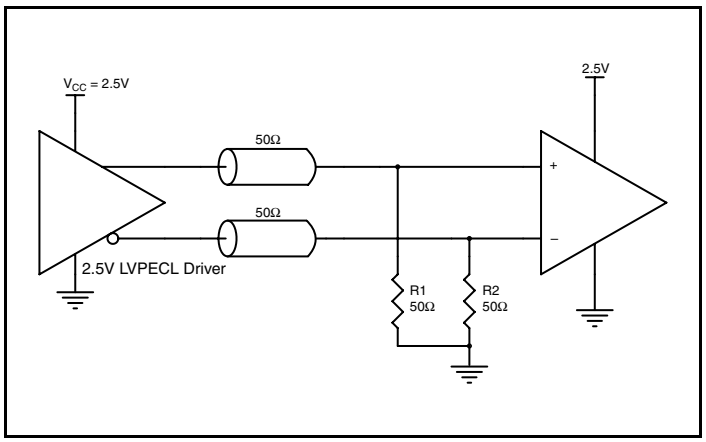

Figure 2C. 2.5V LVPECL Driver Termination Example

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Schematic Layout

Figure 3 shows an example of IDT8N3SV76 application schematic. In this example, the device is operated at V_{CC} = 3.3V. 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.

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 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 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.

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 that the logic control inputs are properly set.

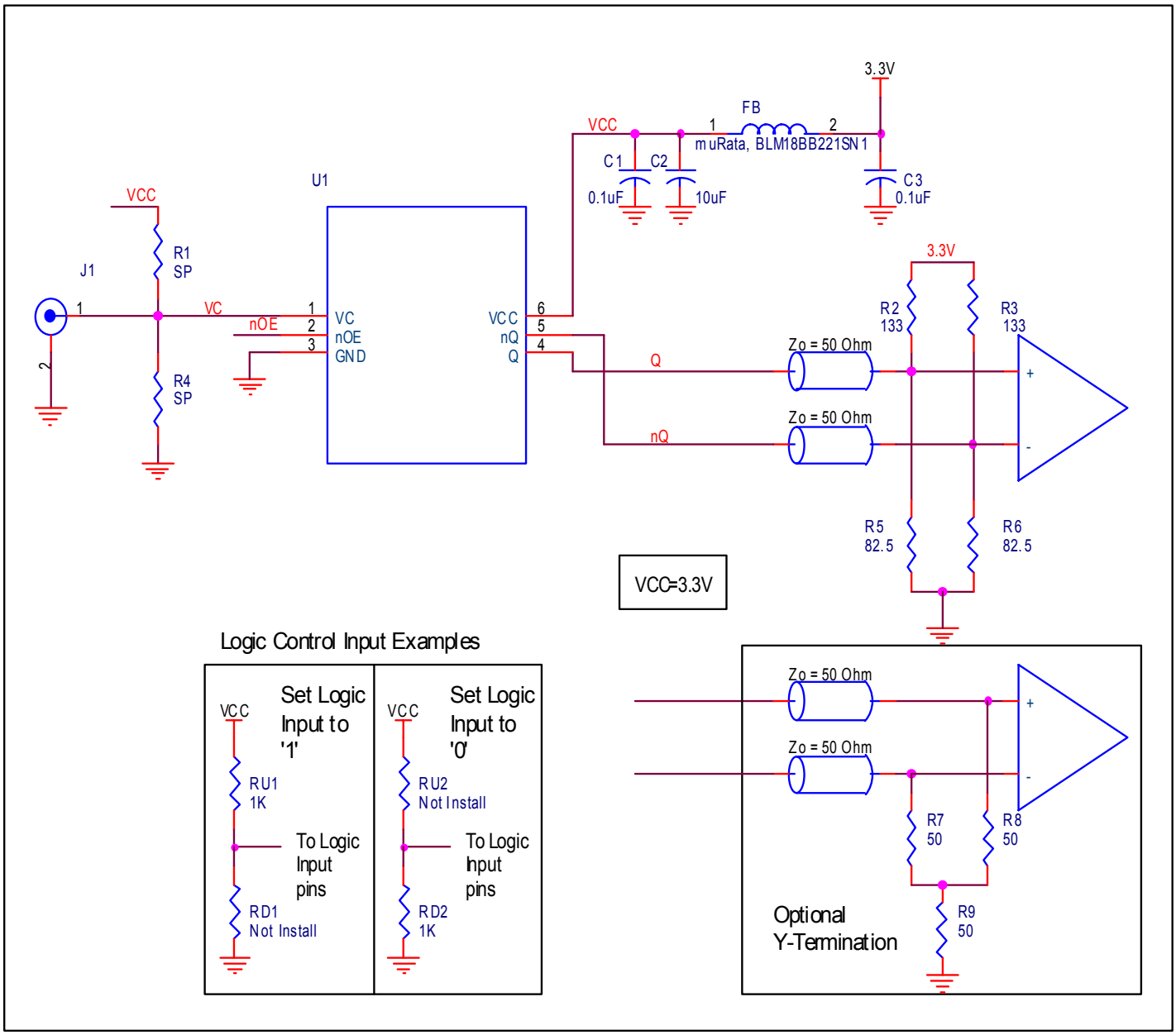

Figure 3. IDT8N3SV76 Application Schematic

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Power Considerations

This section provides information on power dissipation and junction temperature for the IDT8N3SV76.
Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the IDT8N3SV76 is the sum of the core power plus the power dissipated in the load(s).
The following is the power dissipation for V_{CC} = 3.3V + 5% = 3.465V, which gives worst case results.

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

- Power $(core)_{MAX} = V_{CC_MAX} * I_{EE_MAX}$ = 3.465V * 157mA = **554.40mW**
- Power $(outputs)_{MAX}$ = **30mW/Loaded Output pair**

Total Power$_{_MAX}$ (3.3V, with all outputs switching) = 544.0mW + 30mW = **574.0mW**

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 49.4°C/W per Table 6 below.

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

85°C + 0.574W * 49.4°C/W = 113.4°C. This is well 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 6 Lead Ceramic VFQFN, Forced Convection

θ_{JA} by Velocity			
Meters per Second	**0**	**1**	**2**
Multi-Layer PCB, JEDEC Standard Test Boards	49.4°C/W	44.2°C/W	42.1°C/W

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3. Calculations and Equations.

The purpose of this section is to calculate the power dissipation for the LVPECL output pair.

LVPECL output driver circuit and termination are shown in *Figure 4.*

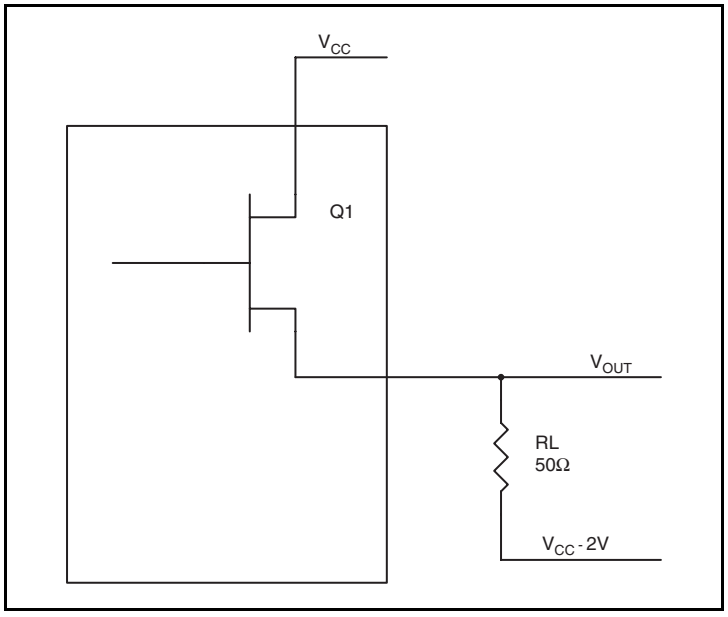

Figure 4. LVPECL Driver Circuit and Termination

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load, and a termination voltage of V_{CC} – 2V.

- For logic high, $V_{OUT} = V_{OH_MAX} =$ **V_{CC_MAX} – 0.9V**
  ($V_{CC_MAX} – V_{OH_MAX}$) = **0.9V**
- For logic low, $V_{OUT} = V_{OL_MAX} =$ **V_{CC_MAX} – 1.7V**
  ($V_{CC_MAX} – V_{OL_MAX}$) = **1.7V**

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$Pd_H = [(V_{OH_MAX} – (V_{CC_MAX} – 2V))/R_L] * (V_{CC_MAX} – V_{OH_MAX}) = [(2V – (V_{CC_MAX} – V_{OH_MAX}))/R_L] * (V_{CC_MAX} – V_{OH_MAX}) =$
$[(2V – 0.9V)/50\Omega] * 0.9V =$ **19.8mW**

$Pd_L = [(V_{OL_MAX} – (V_{CC_MAX} – 2V))/R_L] * (V_{CC_MAX} – V_{OL_MAX}) = [(2V – (V_{CC_MAX} – V_{OL_MAX}))/R_L] * (V_{CC_MAX} – V_{OL_MAX}) =$
$[(2V – 1.7V)/50\Omega] * 1.7V =$ **10.2mW**

Total Power Dissipation per output pair = Pd_H + Pd_L = **30mW**

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Reliability Information

Table 7. θ_{JA} vs. Air Flow Table for a 6-lead Ceramic 5mm x 7mm Package

θ_{JA} vs. Air Flow			
Meters per Second	**0**	**1**	**2**
Multi-Layer PCB, JEDEC Standard Test Boards	49.4°C/W	44.2°C/W	42.1°C/W

Transistor Count

The transistor count for IDT8N3SV76 is: 47,414

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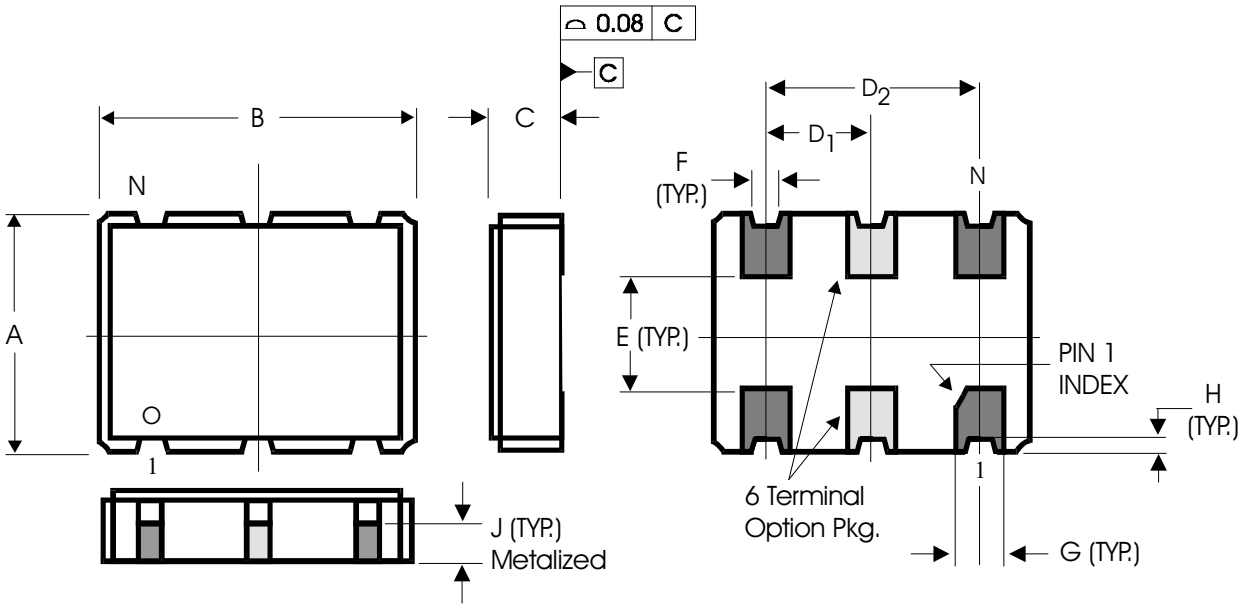
Package Outline and Package Dimensions



SYMBOL	DIMENSION IN MM		
	MIN.	NOM.	MAX.
A	4.85	5.00	5.15
B	6.85	7.00	7.15
C	1.35	1.50	1.65
D_1	2.41	2.54	2.67
D_2	4.95	5.08	5.21
E	2.47	2.6	2.73
F	0.47	0.60	0.73
G	1.27	1.40	1.53
H	-	0.15 Ref.	-
J	-	0.65 Ref.	-

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Ordering Information for FemtoClock® NG Ceramic-Package XO and VCXO Products

The programmable VCXO and XO devices support a variety of devices options such as the output type, number of default frequencies, power supply voltage, ambient temperature range and the frequency accuracy. The device options, default frequencies and default VCXO pull range must be specified at the time of order and are programmed by IDT before the shipment. Table 8 specifies the available order codes, including the device options. Example part number: the order code 8N3SV76FC-0001CDI specifies a programmable VCXO with a voltage supply of 2.5V, a ±50 ppm crystal frequency accuracy, industrial temperature range, a lead-free (6/6 RoHS) 6-lead ceramic 5mm x 7mm x 1.55mm package and is factory-programmed to the default frequencies of 100MHz and the VCXO pull range of min. ±100 ppm.

Other default frequencies and order codes are available from IDT on request.

Table 8. Order Codes

Part/Order Number

8N X X XXX X X - dddd XX X X

FemtoClock NG

I/O Identifier
0: LVCMOS
3: LVPECL
4: LVDS

Number of Default Frequencies
S: 1: Single
D: 2: Dual
Q: 4: Quad

Part Number

	Function	#pins	OE fct. at pin
001	XO	10	OE@2
003	XO	10	OE@1
V01	VCXO	10	OE@2
V03	VCXO	10	OE@1
V75	VCXO	6	OE@2
V76	VCXO	6	nOE@2
V85	VCXO	6	—
085	XO	6	OE@1
270	XO	6	OE@1
271	XO	6	OE@2
272	XO	6	nOE@2
273	XO	6	nOE@1

Option Code (Supply Voltage and Frequency-Stability)
A: V_{CC} = 3.3V±5%, ±100ppm
B: V_{CC} = 2.5V±5%, ±100ppm
E: V_{CC} = 3.3V±5%, ±50ppm
F: V_{CC} = 2.5V±5%, ±50ppm
K: V_{CC} = 3.3V±5%, ±20ppm
L: V_{CC} = 2.5V±5%, ±20ppm

Die Revision
C

Default-Frequency and VCXO Pull Range
See document *FemtoClock NG Ceramic-Package XO and VCXO Ordering Product Information.*

dddd	f_{XTAL} (MHz)	PLL feedback	Use for
0000 to **0999**	114.285	Fractional	VCXO, XO
1000 to **1999**	100.000	Integer	XO
2000 to **2999**		Fractional	XO

Last digit = **L**: configuration pre-programmed and not changeable

Package Code
CD: Lead-Free, 6/10-lead ceramic 5mm x 7mm x 1.55mm

Ambient Temperature Range
"**I**": Industrial: (T_A = -40°C to 85°C)
(no letter) : (T_A = 0°C to 70°C)

Shipping Package
8: Tape & Reel
(no letter): Tray

NOTE: For order information, see the *FemtoClock NG Ceramic-Package XO and VCXO Ordering Product Information* document.

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Table 9. Device Marking

Marking	Industrial Temperature Range (T_A = -40°C to 85°C)	Commercial Temperature Range (T_A = 0°C to 70°C)
	IDT8N3SV76**y**C-**dddd**CDI	IDT8N3SV76**y**C-**dddd**CD
	y = Option Code, **dddd**=Default-Frequency and VCXO Pull Range	

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We've Got Your Timing Solution

6024 Silver Creek Valley Road
San Jose, California 95138

Sales
800-345-7015 (inside USA)
+408-284-8200 (outside USA)
Fax: 408-284-2775
www.IDT.com/go/contactIDT

Technical Support
netcom@idt.com
+480-763-2056

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