



# ICS8432-111

## 700MHz/350MHz

### DIFFERENTIAL-TO-3.3V LVPECL FREQUENCY SYNTHESIZER

**PRODUCT DISCONTINUATION NOTICE - LAST TIME BUY EXPIRES JULY 31, 2015**

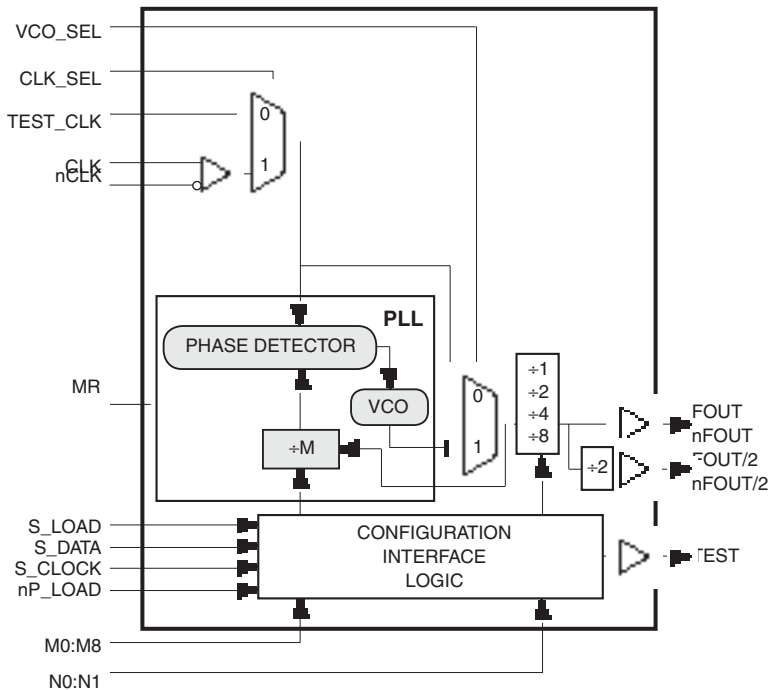
## GENERAL DESCRIPTION

The ICS8432-111 is a general purpose, dual output Differential-to-3.3V LVPECL High Frequency Synthesizer. The ICS8432-111 has a selectable differential CLK, nCLK pair or LVCMOS/LVTTL TEST\_CLK. The TEST\_CLK input accepts LVCMOS or LVTTL input levels and translates them to 3.3V LVPECL levels. The CLK, nCLK pair can accept most standard differential input levels. The VCO operates at a frequency range of 200MHz to 700MHz. The VCO frequency is programmed in steps equal to the value of the input differential or single ended reference frequency. Output frequencies up to 700MHz for FOUT and 350MHz for FOUT/2 can be programmed using the serial or parallel interfaces to the configuration logic. The low phase noise characteristics and the multiple frequency outputs of the ICS8432-111 makes it an ideal clock source for Fibre Channel 1 and 2, and Infiniband applications.

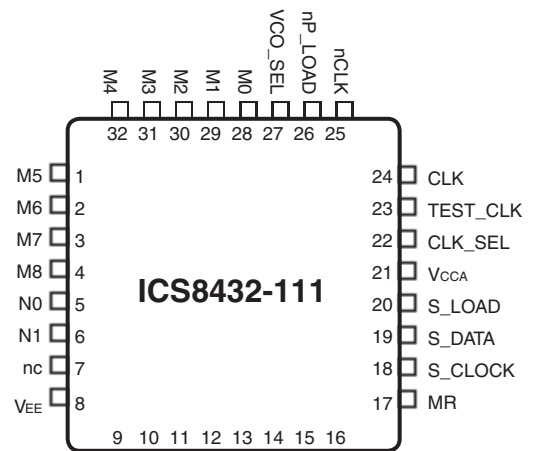
## FEATURES

- Dual differential 3.3V LVPECL outputs
- Selectable differential CLK, nCLK pair or LVCMOS TEST\_CLK
- CLK, nCLK pair can accept the following differential input levels: LVPECL, LVDS, LVHSTL, SSTL, HCSL
- TEST\_CLK can accept the following input types: LVCMOS or LVTTL
- Maximum FOUT frequency: 700MHz  
Maximum FOUT/2 frequency: 350MHz
- CLK, nCLK or TEST\_CLK input frequency: 40MHz
- VCO range: 250MHz to 700MHz
- Parallel or serial interface for programming counter and VCO frequency multiplier and dividers
- RMS period jitter: 5ps (maximum)
- Cycle-to-cycle jitter: 40ps (maximum)
- 3.3V supply voltage
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package
- For functional replacement device use 8432DY-101LF

## BLOCK DIAGRAM



## PIN ASSIGNMENT



**32-Lead LQFP**  
7mm x 7mm x 1.4mm package body  
**Y Package**  
Top View

#### FUNCTIONAL DESCRIPTION

*NOTE: The functional description that follows describes operation using a 25MHz clock input. Valid PLL loop divider values for different input frequencies are defined in the Input Frequency Characteristics, Table 5, NOTE 1.*

The ICS8432-111 features a fully integrated PLL and therefore requires no external components for setting the loop bandwidth. A differential clock input is used as the input to the ICS8432-111. This input is fed into the phase detector. A 25MHz clock input provides a 25MHz phase detector reference frequency. The VCO of the PLL operates over a range of 250MHz to 700MHz. The output of the M divider is also applied to the phase detector.

The phase detector and the M divider force the VCO output frequency to be M times the reference frequency by adjusting the VCO control voltage. Note, that for some values of M (either too high or too low), the PLL will not achieve lock. The output of the VCO is scaled by a divider prior to being sent to each of the LVPECL output buffers. The divider provides a 50% output duty cycle.

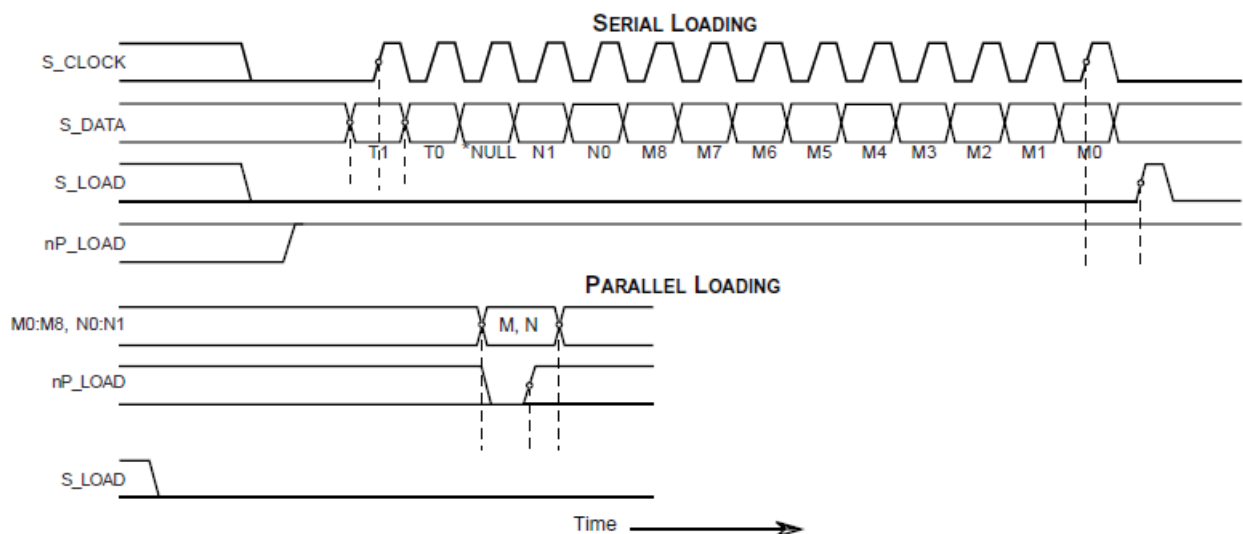
The programmable features of the ICS8432-111 support two input modes to program the PLL M divider and N output divider. The two input operational modes are parallel and serial. *Figure 1* shows the timing diagram for each mode. In parallel mode, the nP\_LOAD input is initially LOW. The data on inputs M0 through M8 and N0 and N1 is passed directly to the M divider and N output divider. On the LOW-to-HIGH transition of the nP\_LOAD input, the data is latched and the M divider remains loaded until the next LOW transition on nP\_LOAD or until a serial

event occurs. As a result, the M and N bits can be hardwired to set the M divider and N output divider to a specific default state that will automatically occur during power-up. The TEST output is LOW when operating in the parallel input mode. The relationship between the VCO frequency, the input frequency and the M divider is defined as follows:  $f_{VCO} = f_{IN} \times M$

The M value and the required values of M0 through M8 are shown in Table 3B, Programmable VCO Frequency Function Table. When the input clock is at 25MHz, the valid M values for which the PLL will achieve lock are defined as  $10 \leq M \leq 28$ . The frequency out is defined as follows:  $f_{OUT} = \frac{f_{VCO}}{N} = f_{IN} \times \frac{M}{N}$

Serial operation occurs when nP\_LOAD is HIGH and S\_LOAD is LOW. The shift register is loaded by sampling the S\_DATA bits with the rising edge of S\_CLOCK. The contents of the shift register are loaded into the M divider and N output divider when S\_LOAD transitions from LOW-to-HIGH. The M divide and N output divide values are latched on the HIGH-to-LOW transition of S\_LOAD. If S\_LOAD is held HIGH, data at the S\_DATA input is passed directly to the M divider and N output divider on each rising edge of S\_CLOCK. The serial mode can be used to program the M and N bits and test bits T1 and T0. The internal registers T0 and T1 determine the state of the TEST output as follows:

T1	T0	TEST Output
0	0	LOW
0	1	S_Data, Shift Register Input
1	0	Output of M divider
1	1	CMOS Fout/2



**FIGURE 1. PARALLEL & SERIAL LOAD OPERATIONS**

\*NOTE: The NULL timing slot must be observed.



**TABLE 1. PIN DESCRIPTIONS**

Number	Name	Type		Description
1	M5	Input	Pullup	M counter/divider inputs. Data latched on LOW-to-HIGH transition of nP_LOAD input. LVCMOS/LVTTL interface levels.
2, 3, 4, 28, 29, 30, 31, 32	M6, M7, M8, M0, M1, M2, M3, M4	Input	Pulldown	
5, 6	N0, N1	Input	Pulldown	
7	nc	Unused		
8, 16	V <sub>EE</sub>	Power		
9	TEST	Output		Test output which is ACTIVE in the serial mode of operation. Output driven LOW in parallel mode. LVCMOS/LVTTL interface levels.
10	V <sub>CC</sub>	Power		Core supply pin.
11, 12	FOUT/2, nFOUT/2	Output		Half frequency differential output for the synthesizer. 3.3V LVPECL interface levels.
13	V <sub>CCO</sub>	Power		Output supply pin.
14, 15	FOUT, nFOUT	Output		Differential output for the synthesizer. 3.3V LVPECL interface levels.
17	MR	Input	Pulldown	Active High Master Reset. When logic HIGH, the internal dividers are reset causing the true outputs FOUTx to go low and the inverted outputs nFOUTx to go high. When logic LOW, the internal dividers are the outputs are enabled. Assertion of MR does not effect loaded M, N, and T values. LVCMOS/LVTTL interface levels.
18	S_CLOCK	Input	Pulldown	Clocks in serial data present at S_DATA input into the shift register on the rising edge of S_CLOCK. LVCMOS/LVTTL interface levels.
19	S_DATA	Input	Pulldown	Shift register serial input. Data sampled on the rising edge of S_CLOCK. LVCMOS/LVTTL interface levels.
20	S_LOAD	Input	Pulldown	Controls transition of data from shift register into the dividers. LVCMOS/LVTTL interface levels.
21	V <sub>CCA</sub>	Power		Analog supply pin.
22	CLK_SEL	Input	Pullup	Selects between differential clock input or test input as the PLL reference source. LVCMOS/LVTTL interface levels. Selects CLK, nCLK inputs when HIGH. Selects TEST_CLK when LOW.
23	TEST_CLK	Input	Pulldown	Test clock input. LVCMOS/LVTTL interface levels.
24	CLK	Input	Pulldown	Non-inverting differential clock input.
25	nCLK	Input	Pullup	Inverting differential clock input.
26	nP_LOAD	Input	Pulldown	Parallel load input. Determines when data present at M8:M0 is loaded into M divider, and when data present at N1:N0 sets the N output divider value. LVCMOS/LVTTL interface levels.
27	VCO_SEL	Input	Pullup	Determines whether synthesizer is in PLL or bypass mode. LVCMOS/LVTTL interface levels.

NOTE: Pullup and Pulldown 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 <sub>IN</sub>	Input Capacitance			4		pF
R <sub>PULLUP</sub>	Input Pullup Resistor			51		kΩ
R <sub>PULLDOWN</sub>	Input Pulldown Resistor			51		kΩ



**TABLE 3A. PARALLEL AND SERIAL MODE FUNCTION TABLE**

Inputs							Conditions
MR	nP_LOAD	M	N	S_LOAD	S_CLOCK	S_DATA	
H	X	X	X	X	X	X	Reset. Forces outputs LOW.
L	L	Data	Data	X	X	X	Data on M and N inputs passed directly to the M divider and N output divider. TEST output forced LOW.
L	↑	Data	Data	L	X	X	Data is latched into input registers and remains loaded until next LOW transition or until a serial event occurs.
L	H	X	X	L	↑	Data	Serial input mode. Shift register is loaded with data on S_DATA on each rising edge of S_CLOCK.
L	H	X	X	↑	L	Data	Contents of the shift register are passed to the M divider and N output divider.
L	H	X	X	↓	L	Data	M divider and N output divider values are latched.
L	H	X	X	L	X	X	Parallel or serial input do not affect shift registers.
L	H	X	X	H	↑	Data	S_DATA passed directly to ripple counter as it is clocked.

NOTE: L = LOW  
H = HIGH  
X = Don't care  
↑ = Rising edge transition  
↓ = Falling edge transition

**TABLE 3B. PROGRAMMABLE VCO FREQUENCY FUNCTION TABLE**

VCO Frequency (MHz)	M Count	256	128	64	32	16	8	4	2	1
		M8	M7	M6	M5	M4	M3	M2	M1	M0
250	10	0	0	0	0	0	1	0	1	0
275	11	0	0	0	0	0	1	0	1	1
•	•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•
650	26	0	0	0	0	1	1	0	1	0
675	27	0	0	0	0	1	1	0	1	1
700	28	0	0	0	0	1	1	1	0	0

NOTE 1: These M count values and the resulting frequencies correspond to differential input or TEST\_CLK input frequency of 25MHz.

**TABLE 3C. PROGRAMMABLE OUTPUT DIVIDER FUNCTION TABLE**

Inputs		N Divider Value	Output Frequency (MHz)			
			FOUT		FOUT/2	
N1	N0		Minimum	Maximum	Minimum	Maximum
0	0	1	250	700	125	350
0	1	2	125	350	62.5	175
1	0	4	62.5	175	31.25	87.5
1	1	8	31.25	87.5	15.625	43.75



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#### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{CC}$	4.6V
Inputs, $V_i$	-0.5V to $V_{CC} + 0.5V$
Outputs, $I_o$	
Continuous Current	50mA
Surge Current	100mA
Package Thermal Impedance, $\theta_{JA}$	47.9°C/W (0 lfpm)
Storage Temperature, $T_{STG}$	-65°C to 150°C

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.

**TABLE 4A. POWER SUPPLY DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{CC}$	Core Supply Voltage		3.135	3.3	3.465	V
$V_{CCA}$	Analog Supply Voltage		3.135	3.3	3.465	V
$V_{CCO}$	Output Supply Voltage		3.135	3.3	3.465	V
$I_{EE}$	Power Supply Current				140	mA
$I_{CCA}$	Analog Supply Current				15	mA

**TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage	VCO_SEL, CLK_SEL, S_LOAD, S_DATA, S_CLOCK, nP_LOAD, N0:N1, M0:M8, MR	2		$V_{CC} + 0.3$	V
		TEST_CLK	2		$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage	VCO_SEL, CLK_SEL, S_LOAD, S_DATA, S_CLOCK, nP_LOAD, N0:N1, M0:M8, MR	-0.3		0.8	V
		TEST_CLK			1.3	V
$I_{IH}$	Input High Current	M0-M4, M6-M8, N0, N1, S_CLOCK, S_DATA, S_LOAD, TEST_CLK, nP_LOAD, MR	$V_{CC} = V_{IN} = 3.465V$		150	$\mu A$
		M5, CLK_SEL, VCO_SEL	$V_{CC} = V_{IN} = 3.465V$		5	$\mu A$
$I_{IL}$	Input Low Current	M0-M4, M6-M8, N0, N1, S_CLOCK, S_DATA, S_LOAD, TEST_CLK, nP_LOAD, MR	$V_{CC} = 3.465V$ , $V_{IN} = 0V$	-5		$\mu A$
		M5, CLK_SEL, VCO_SEL	$V_{CC} = 3.465V$ , $V_{IN} = 0V$	-150		$\mu A$
$V_{OH}$	Output High Voltage	TEST; NOTE 1	2.6			V
$V_{OL}$	Output Low Voltage	TEST; NOTE 1			0.5	V

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CCO}/2$ . See Parameter Information, 3.3V Output Load Test Circuit.



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### DIFFERENTIAL-TO-3.3V LVPECL FREQUENCY SYNTHESIZER

**TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$I_{IH}$	Input High Current	CLK	$V_{CC} = V_{IN} = 3.465V$		150	$\mu A$
		nCLK	$V_{CC} = V_{IN} = 3.465V$		5	$\mu A$
$I_{IL}$	Input Low Current	CLK	$V_{CC} = 3.465V, V_{IN} = 0V$	-5		$\mu A$
		nCLK	$V_{CC} = 3.465V, V_{IN} = 0V$	-150		$\mu A$
$V_{PP}$	Peak-to-Peak Input Voltage		0.15		1.3	V
$V_{CMR}$	Common Mode Input Voltage; NOTE 1, 2		$V_{EE} + 0.5$		$V_{CC} - 0.85$	V

NOTE 1: Common mode voltage is defined as  $V_{IH}$ .

NOTE 2: For single ended applications, the maximum input voltage for CLK, nCLK is  $V_{CC} + 0.3V$ .

**TABLE 4D. LVPECL DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OH}$	Output High Voltage; NOTE 1		$V_{CCO} - 1.4$		$V_{CCO} - 0.9$	V
$V_{OL}$	Output Low Voltage; NOTE 1		$V_{CCO} - 2.0$		$V_{CCO} - 1.7$	V
$V_{SWING}$	Peak-to-Peak Output Voltage Swing		0.6		1.0	V

NOTE 1: Outputs terminated with 50  $\Omega$  to  $V_{CCO} - 2V$ .

**TABLE 5. INPUT FREQUENCY CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{IN}$	Input Frequency	TEST_CLK; NOTE 1	10		40	MHz
		CLK, nCLK; NOTE 1	10		40	MHz
		S_CLOCK			50	MHz

NOTE 1: For the input frequency range, the M value must be set for the VCO to operate within the 250MHz to 700MHz range. Using the minimum input frequency of 10MHz, valid values of M are  $25 \leq M \leq 70$ . Using the maximum frequency of 40MHz, valid values of M are  $7 \leq M \leq 17$ .



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### DIFFERENTIAL-TO-3.3V LVPECL FREQUENCY SYNTHESIZER

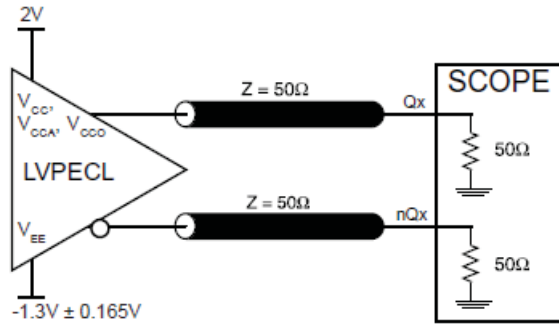
**TABLE 6. AC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$F_{OUT}$	Output Frequency		31.25		700	MHz
$F_{OUT}/2$	Output Frequency		15.625		350	MHz
tjit(cc)	Cycle-to-Cycle Jitter; NOTE 2				40	ps
tjit(per)	Period Jitter, RMS; NOTE 2	$f_{OUT} > 100$			5	ps
tsk(o)	Output Skew; NOTE 1, 2				60	ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	200		700	ps
$t_s$	Setup Time	M, N to nP_LOAD			5	ns
		S_DATA to S_CLOCK			5	ns
		S_CLOCK to S_LOAD			5	ns
$t_H$	Hold Time	M, N to nP_LOAD			5	ns
		S_DATA to S_CLOCK			5	ns
		S_CLOCK to S_LOAD			5	ns
odc	Output Duty Cycle	$f_{OUT}/2$ ; $f_{OUT}$ , $N > 1$	47		53	%
$t_{PW}$	Output Pulse Width		$t_{Period}/2 - 150$		$t_{Period}/2 + 150$	ps
$t_{LOCK}$	PLL Lock Time				1	ms

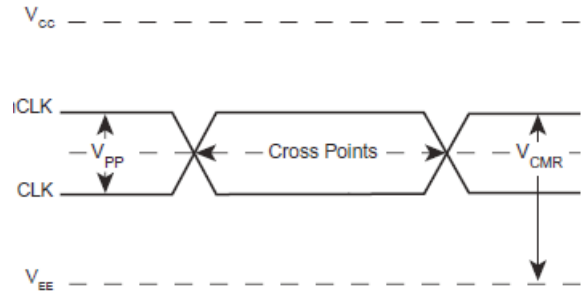
NOTE 1: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at the output differential cross points.

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

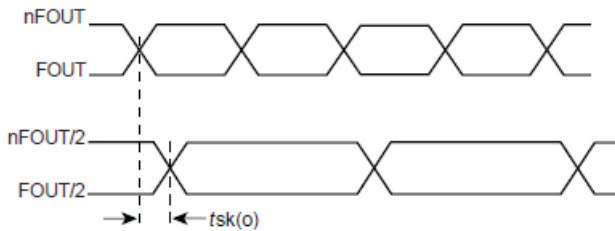
## PARAMETER MEASUREMENT INFORMATION



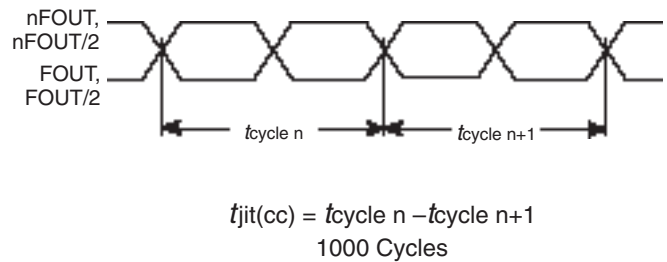
**3.3V OUTPUT LOAD AC TEST CIRCUIT**



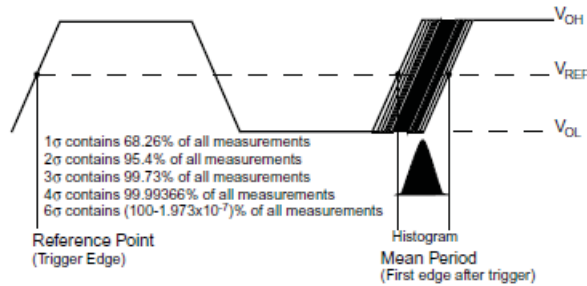
**DIFFERENTIAL INPUT LEVEL**



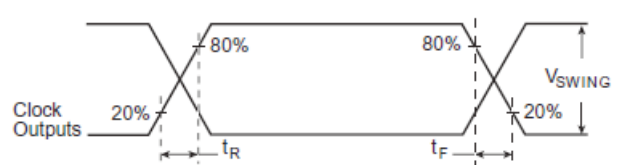
**OUTPUT SKEW**



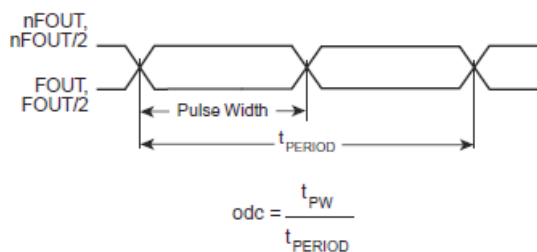
**CYCLE-TO-CYCLE JITTER**



**PERIOD JITTER**



**OUTPUT RISE/FALL TIME**



**OUTPUT DUTY CYCLE/OUTPUT PULSE WIDTH/PERIOD**



## APPLICATION INFORMATION

### POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The ICS8432-111 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL.  $V_{cc}$ ,  $V_{cca}$ , and  $V_{cco}$  should be individually connected to the power supply plane through vias, and bypass capacitors should be used for each pin. To achieve optimum jitter performance, power supply isolation is required. *Figure 2* illustrates how a  $10\Omega$  resistor along with a  $10\mu\text{F}$  and a  $.01\mu\text{F}$  bypass capacitor should be connected to each  $V_{cca}$  pin.

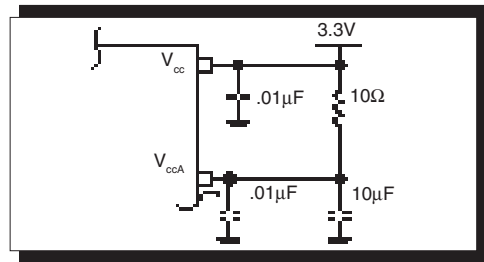


FIGURE 2. POWER SUPPLY FILTERING

### WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

*Figure 3* shows how the differential input can be wired to accept single ended levels. The reference voltage  $V_{REF} = V_{cc}/2$  is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio

of R1 and R2 might need to be adjusted to position the  $V_{REF}$  in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and  $V_{cc} = 3.3\text{V}$ ,  $V_{REF}$  should be 1.25V and  $R2/R1 = 0.609$ .

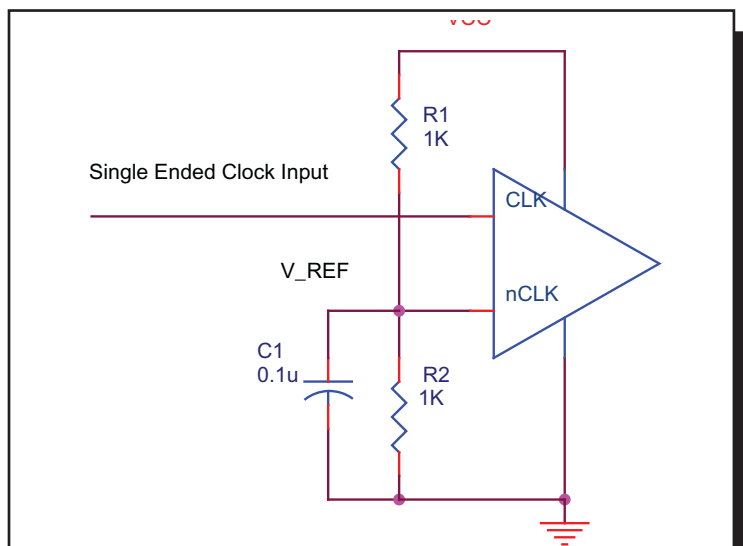


FIGURE 3. SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

#### TERMINATION FOR 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.

FOUT and nFOUT 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 4A and 4B* 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.

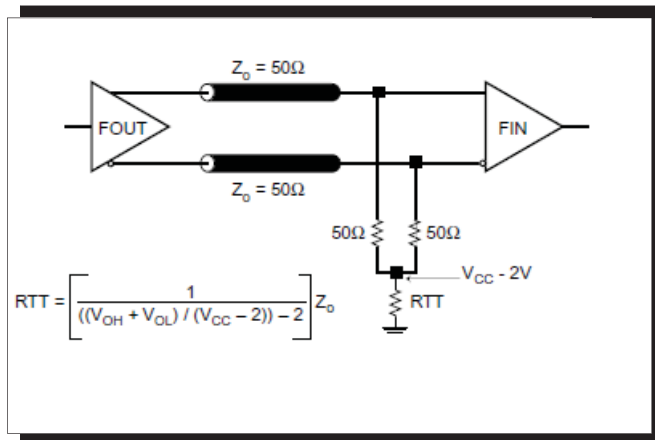


FIGURE 4A. LVPECL OUTPUT TERMINATION

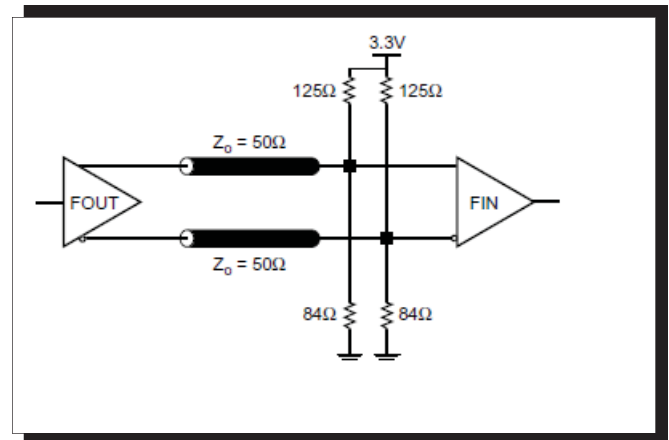
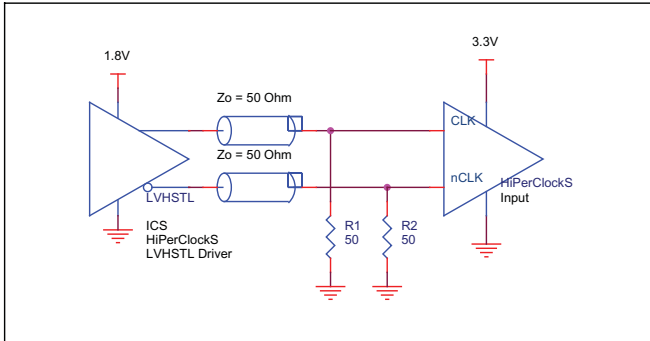


FIGURE 4B. LVPECL OUTPUT TERMINATION

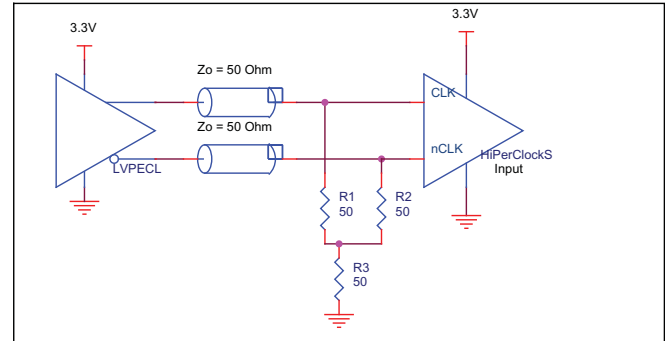
#### DIFFERENTIAL CLOCK INPUT INTERFACE

The CLK/nCLK accepts LVDS, LVPEACL, LVHSTL, SSTL, HCSL and other differential signals. Both  $V_{SWING}$  and  $V_{OH}$  must meet the  $V_{PP}$  and  $V_{CMR}$  input requirements. Figures 5A to 5E show interface examples for the CLK/nCLK input driven by the most common driver types. The input interfaces suggested here are examples only. Please consult with the vendor of the driver

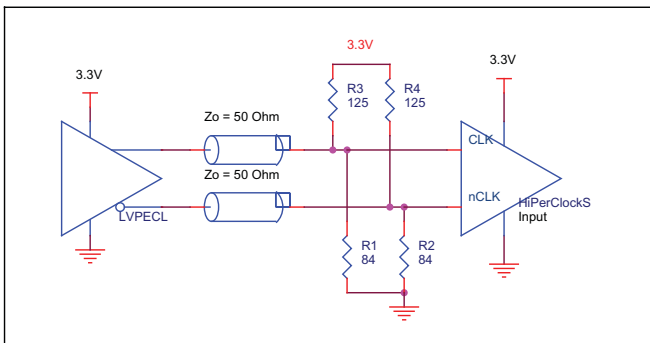
component to confirm the driver termination requirements. For example in *Figure 5A*, the input termination applies for LVHSTL drivers. If you are using an LVHSTL driver from another vendor, use their termination recommendation.



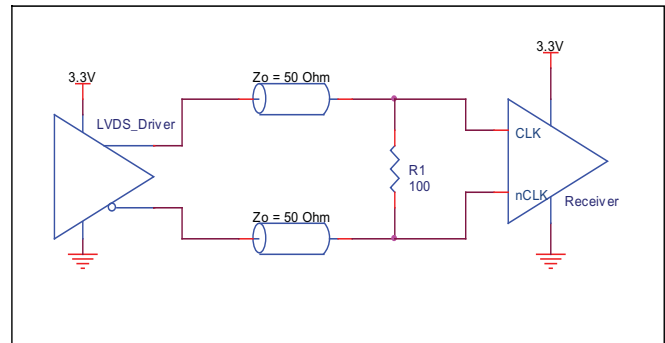
**FIGURE 5A. CLK/nCLK INPUT DRIVEN BY LVHSTL DRIVER**



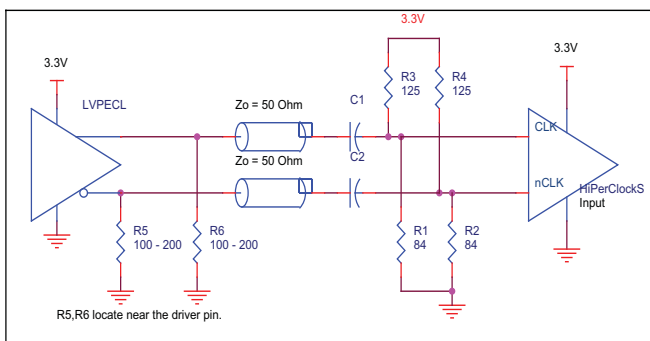
**FIGURE 5B. CLK/nCLK INPUT DRIVEN BY 3.3V LVPEACL DRIVER**



**FIGURE 5C. CLK/nCLK INPUT DRIVEN BY 3.3V LVPEACL DRIVER**



**FIGURE 5D. CLK/nCLK INPUT DRIVEN BY 3.3V LVDS DRIVER**



**FIGURE 5E. CLK/nCLK INPUT DRIVEN BY 3.3V LVPEACL DRIVER WITH AC COUPLE**



## POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the ICS8432-111. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the ICS8432-111 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)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 140mA = 485.1mW$
- Power (outputs)<sub>MAX</sub> = **30mW/Loaded Output pair**  
If all outputs are loaded, the total power is  $2 * 30mW = 60mW$

**Total Power**<sub>MAX</sub> (3.465V, with all outputs switching) =  $485.1mW + 60mW = 545.1mW$

### 2. Junction Temperature.

Junction temperature, T<sub>j</sub>, 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 for the devices is 125°C.

The equation for T<sub>j</sub> is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

T<sub>j</sub> = Junction Temperature

$\theta_{JA}$  = junction-to-ambient thermal resistance

Pd<sub>total</sub> = Total device power dissipation (example calculation is in section 1 above)

T<sub>A</sub> = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 42.1°C/W per Table 7 below.

Therefore, T<sub>j</sub> for an ambient temperature of 70°C with all outputs switching is:

$70°C + 0.545W * 42.1°C/W = 93°C$ . This is well below the limit of 125°C.

This calculation is only an example. T<sub>j</sub> will obviously vary depending on the number of loaded outputs, supply voltage, air flow, and the type of board (single layer or multi-layer).

**Table 7. THERMAL RESISTANCE  $\theta_{JA}$  FOR 32-PIN LQFP, FORCED CONVECTION**

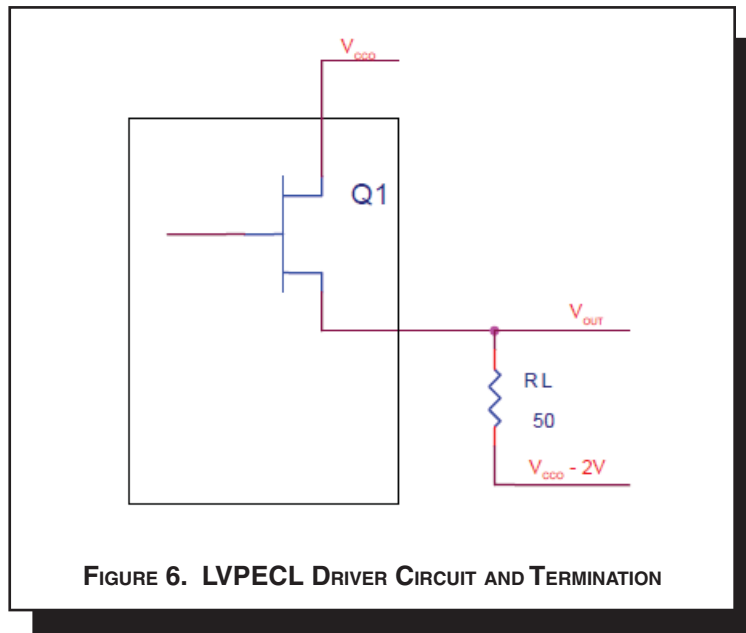
<b><math>\theta_{JA}</math> by Velocity (Linear Feet per Minute)</b>			
	<b>0</b>	<b>200</b>	<b>500</b>
Single-Layer PCB, JEDEC Standard Test Boards	67.8°C/W	55.9°C/W	50.1°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	47.9°C/W	42.1°C/W	39.4°C/W

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

3. Calculations and Equations.

The purpose of this section is to derive the power dissipated into the load.

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



**FIGURE 6. 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  $V_{CCO} - 2V$ .

- For logic high,  $V_{OUT} = V_{OH\_MAX} = V_{CCO\_MAX} - 0.9V$

$$(V_{CCO\_MAX} - V_{OH\_MAX}) = 0.9V$$

- For logic low,  $V_{OUT} = V_{OL\_MAX} = V_{CCO\_MAX} - 1.7V$

$$(V_{CCO\_MAX} - V_{OL\_MAX}) = 1.7V$$

$Pd\_H$  is power dissipation when the output drives high.

$Pd\_L$  is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OH\_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = 19.8mW$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CCO\_MAX} - 2V))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CCO\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CCO\_MAX} - V_{OL\_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = 10.2mW$$

Total Power Dissipation per output pair =  $Pd\_H + Pd\_L = 30mW$



**ICS8432-111**

700MHz/350MHz

DIFFERENTIAL-TO-3.3V LVPECL FREQUENCY SYNTHESIZER

## RELIABILITY INFORMATION

**TABLE 8.  $\theta_{JA}$  VS. AIR FLOW TABLE FOR 32 LEAD LQFP**

$\theta_{JA}$ by Velocity (Linear Feet per Minute)			
	<b>0</b>	<b>200</b>	<b>500</b>
Single-Layer PCB, JEDEC Standard Test Boards	67.8°C/W	55.9°C/W	50.1°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	47.9°C/W	42.1°C/W	39.4°C/W

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

### TRANSISTOR COUNT

The transistor count for ICS8432-111 is: 3765

### PACKAGE OUTLINE - Y SUFFIX FOR 32 LEAD LQFP

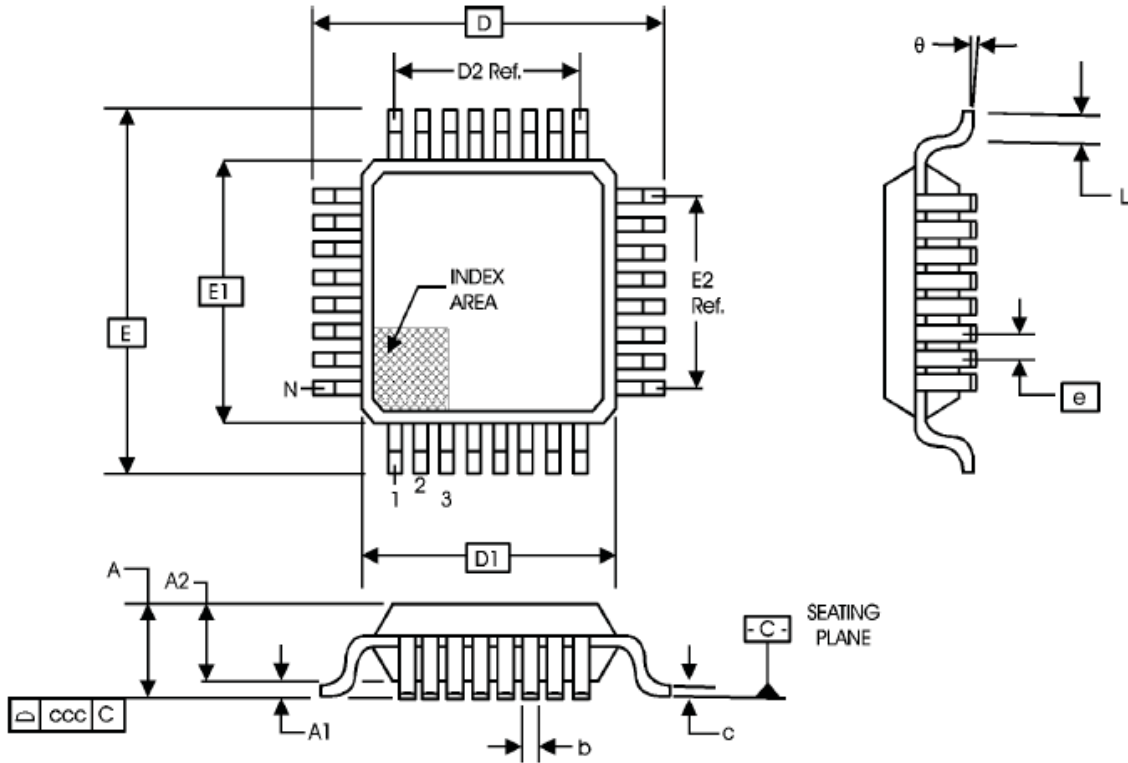


TABLE 9. PACKAGE DIMENSIONS

JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			
SYMBOL	BBA		
	MINIMUM	NOMINAL	MAXIMUM
N	32		
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.30	0.37	0.45
c	0.09	--	0.20
D	9.00 BASIC		
D1	7.00 BASIC		
D2	5.60 Ref.		
E	9.00 BASIC		
E1	7.00 BASIC		
E2	5.60 Ref.		
e	0.80 BASIC		
L	0.45	0.60	0.75
theta	0°	--	7°
ccc	--	--	0.10

Reference Document: JEDEC Publication 95, MS-026



**ICS8432-111**  
700MHz/350MHz  
DIFFERENTIAL-TO-3.3V LVPECL FREQUENCY SYNTHESIZER

**TABLE 10. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
8432CY-111LF	ICS8432C111L	32 lead "Lead Free" LQFP	Tray	0°C to +70°C
8432CY-111LFT	ICS8432C111L	32 lead "Lead Free" LQFP	1000 Tape and Reel	0°C to +70°C

NOTE: "LF" suffix to the part number are the PB-free configuration, RoHS compliant

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REVISION HISTORY SHEET				
Rev	Table	Page	Description of Change	Date
B	T4A	5 12	Power Supply table - adjusted the $I_{EE}$ limit from 120mA max. to 140mA max. Adjusted Power Dissipation to comply with $I_{EE}$ .	3/3/04
C	T4D	1 2 6 12 - 13	Features Section - added lead-free bullet. Corrected Figure 1, Paralle & Serial Load Operations Diagram LVPECL DC Characteristics Table -corrected $V_{OH}$ max. from $V_{CCO} - 1.0V$ to $V_{CCO} - 0.9V$ Power Considerations - corrected power dissipation to reflect $V_{OH}$ max in Table 4D. Ordering Information Table - added lead-free part number and note.	4/12/07
C	T10	16 18	Updated datasheet's header/footer with IDT from ICS. Ordering Information Table - removed ICS prefix from Part/Order Number column. Added LF marking and corrected non-LF marking. Added Contact Page.	10/5/10
C		1	Product Discontinuation Notice - CQ-14-05 Features Section - Removed reference to leaded device and added replacement device	9/11/14



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