

## General Description

The 843251I-04 is a 10Gb/12Gb Ethernet Clock Generator. The 843251I-04 can synthesize 10 Gigabit Ethernet and 12 Gigabit Ethernet with a 25MHz crystal. It can also generate SATA and 10Gb Fibre Channel reference clock frequencies with the appropriate choice of crystals. The 843251I-04 has excellent phase jitter performance and is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

## Features

- One differential 3.3V LVPECL output
- Crystal oscillator interface designed for 18pF parallel resonant crystal
- Crystal input frequency range: 19.33MHz – 30MHz
- Output frequency range: 145MHz – 187.5MHz
- VCO range: 580MHz – 750MHz
- RMS phase jitter @ 156.25MHz, (1.875MHz – 20MHz): 0.39ps (typical)
- Full 3.3V supply mode
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

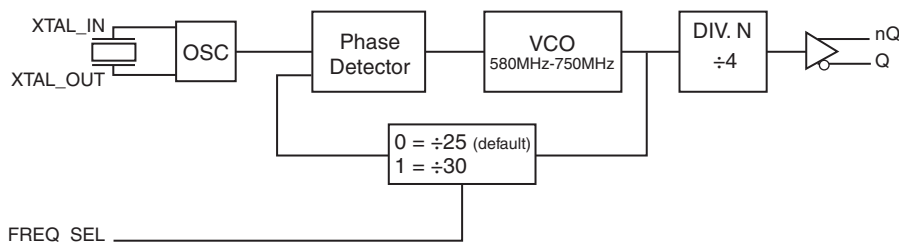
### Configuration Table with 25MHz Crystal

Inputs				Output Frequency (MHz)	Application
Crystal Frequency (MHz)	Feedback Divide	VCO Frequency (MHz)	N Output Divide		
25	30	750	4	187.5	12 Gigabit Ethernet
25	25	625	4	156.25	10 Gigabit Ethernet

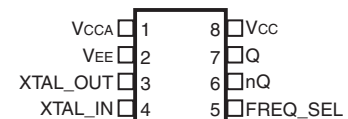
### Configuration Table with Selectable Crystals

Inputs				Output Frequency (MHz)	Application
Crystal Frequency (MHz)	Feedback Divide	VCO Frequency (MHz)	N Output Divide		
20	30	600	4	150	SATA
21.25	30	637.5	4	159.375	10 Gigabit Fibre Channel
24	25	600	4	150	SATA
25.5	25	637.5	4	159.375	10 Gigabit Fibre Channel
30	25	750	4	187.5	12 Gigabit Fibre Channel

## Block Diagram



## Pin Assignment



**843251I-04**  
**8 Lead TSSOP**  
**4.40mm x 3.0mm package body**

## Pin Description and Pin Characteristic Tables

**Table 1. Pin Descriptions**

Number	Name	Type		Description
1	V <sub>CCA</sub>	Unused		Analog supply pin.
2	V <sub>EE</sub>	Power		Negative supply pin.
3, 4	XTAL_OUT XTAL_IN	Input		Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.
5	FREQ_SEL	Input	Pulldown	Frequency select pin. LVCMOS/LVTTL interface levels.
6, 7	nQ, Q	Output		Differential output pair. LVPECL interface levels.
8	V <sub>CC</sub>	Power		Core supply pin.

NOTE: 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>PULLDOWN</sub>	Input Pulldown Resistor			51		kΩ

## 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, $V_{CC}$	4.6V
Inputs, $V_I$	-0.5V to $V_{CC} + 0.5V$
Outputs, $I_O$ Continuous Current Surge Current	50mA 100mA
Package Thermal Impedance, $\theta_{JA}$	129.5°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 3A. Power Supply DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{CC}$	Positive Supply Voltage		3.135	3.3	3.465	V
$V_{CCA}$	Analog Supply Voltage		$V_{CC} - 0.13$	3.3	$V_{CC}$	V
$I_{EE}$	Power Supply Current				70	mA
$i_{CCA}$	Analog Supply Current				13	mA

**Table 3B. LVCMOS/LVTTL DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{IH}$	Input High Voltage		2		$V_{CC} + 0.3$	V
$V_{IL}$	Input Low Voltage		-0.3		0.8	V
$I_{IH}$	Input High Current	$V_{CC} = V_{IN} = 3.465V$			150	$\mu A$
$I_{IL}$	Input Low Current	$V_{CC} = 3.465V$ , $V_{IN} = 0V$	-5			$\mu A$

**Table 3C. LVPECL DC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$**

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

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

**Table 4. Crystal Characteristics**

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation		Fundamental			
Frequency		19.33		30	MHz
Equivalent Series Resistance (ESR)				50	$\Omega$
Shunt Capacitance				7	pF

## AC Electrical Characteristics

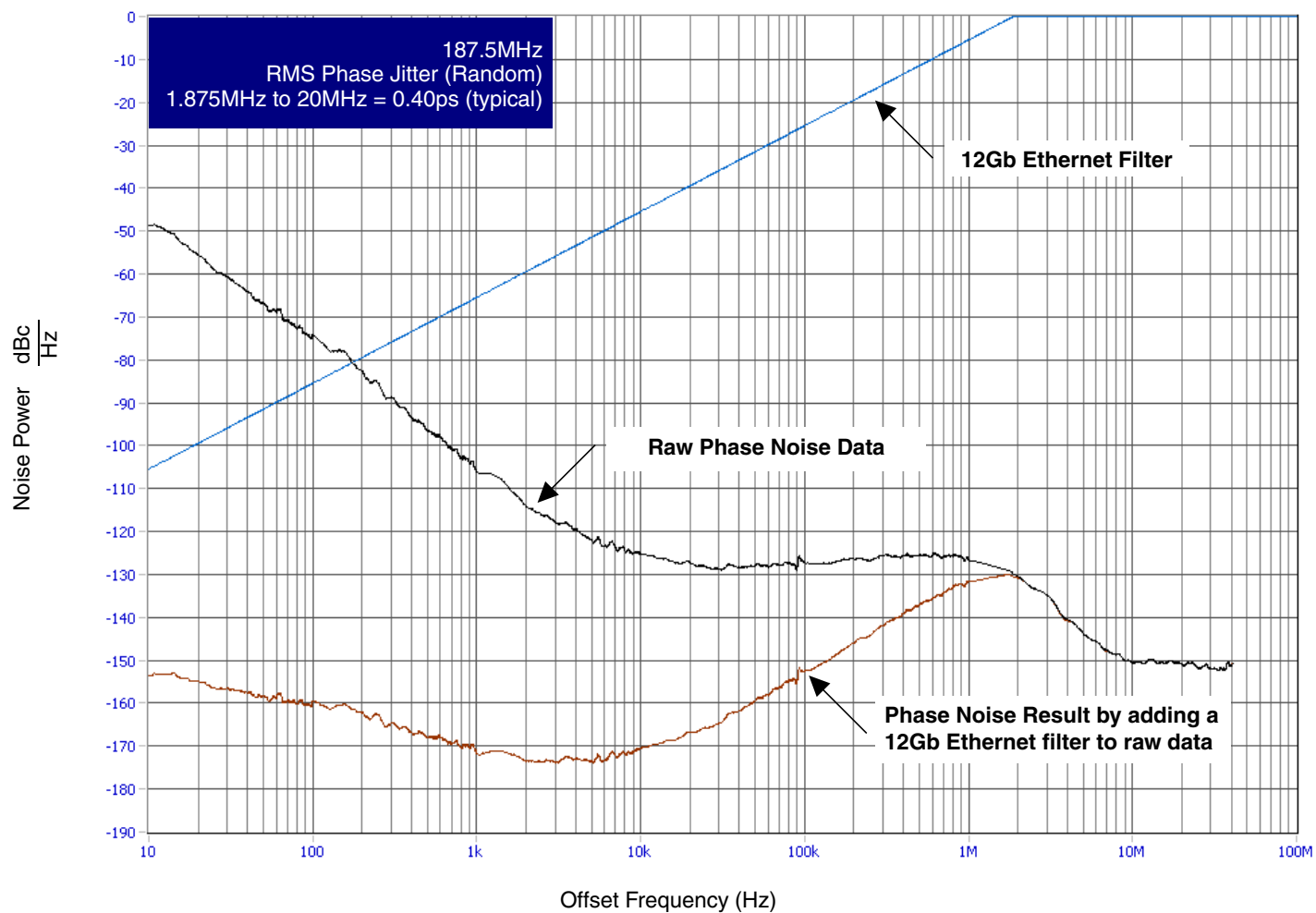
**Table 5. AC Characteristics,  $V_{CC} = 3.3V \pm 5\%$ ,  $V_{EE} = 0V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency		145		187.5	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter, Random; NOTE 1	156.25MHz, (Integration Range: 1.875MHz – 20MHz)		0.39		ps
		187.5MHz, (Integration Range: 1.875MHz – 20MHz)		0.40		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	285		415	ps
odc	Output Duty Cycle		48		52	%

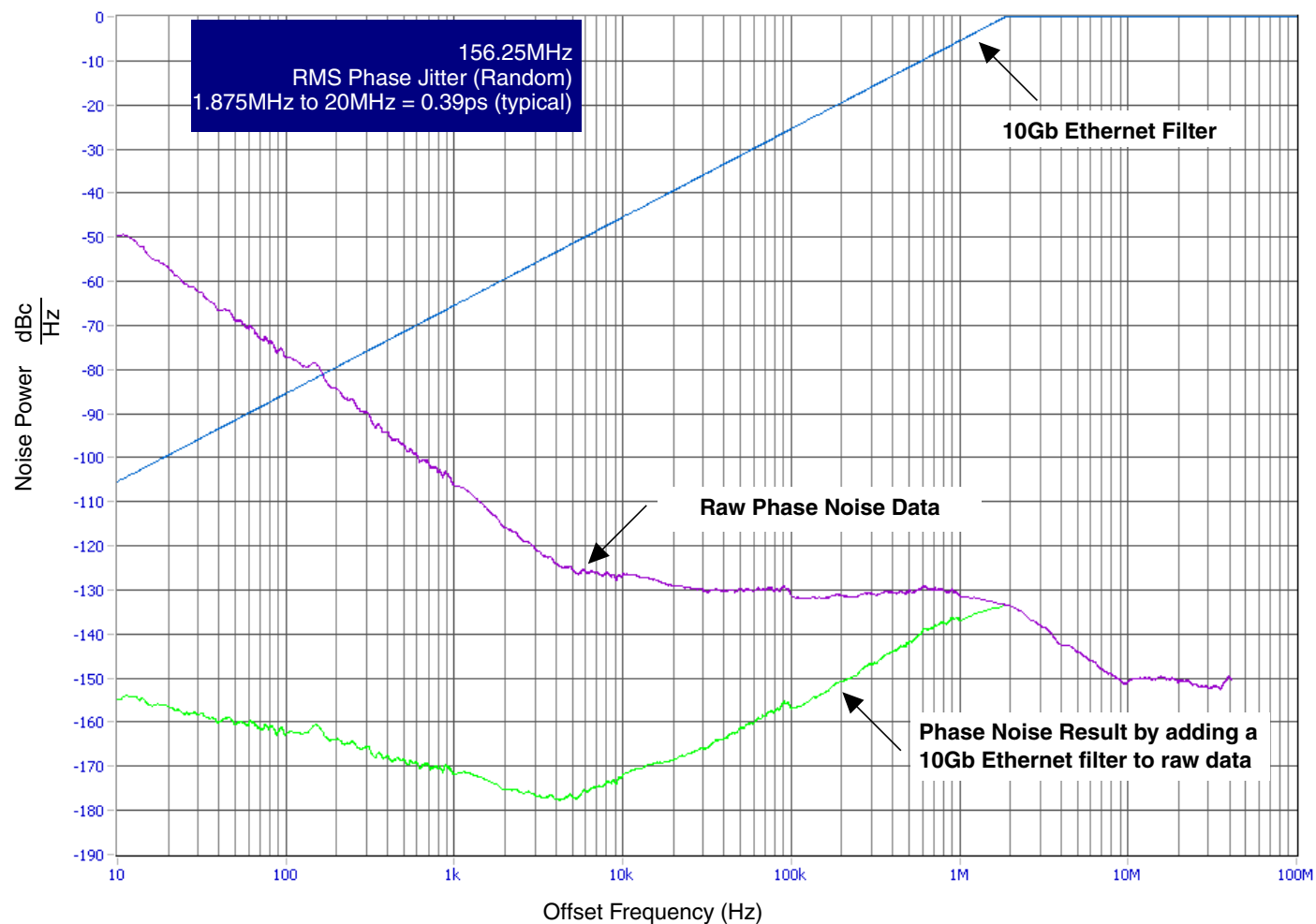
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

NOTE 1: Please refer to Phase Noise Plots.

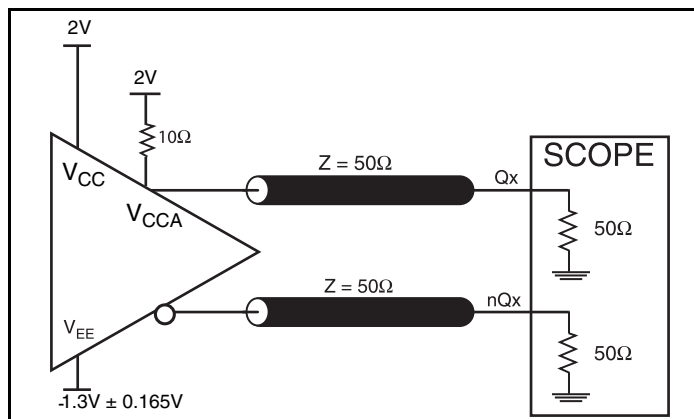
## Typical Phase Noise at 187.5MHz



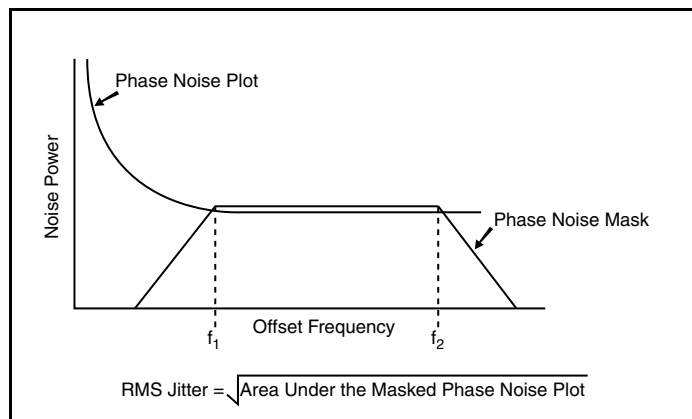
## Typical Phase Noise at 156.25MHz



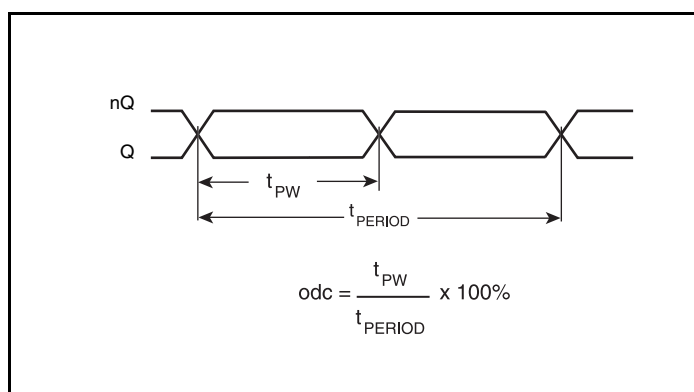
## Parameter Measurement Information



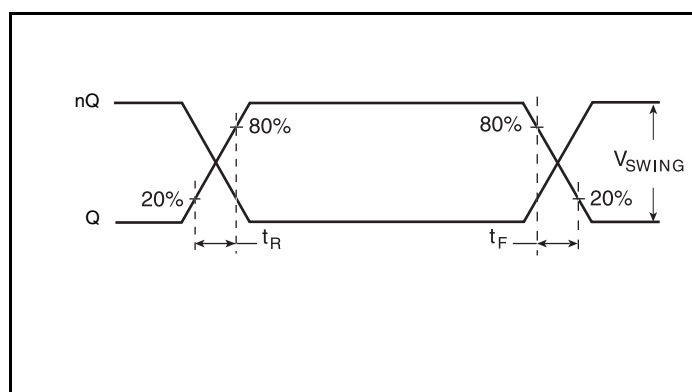
3.3V LVPECL Output Load AC Test Circuit



RMS Phase Jitter



Output Duty Cycle/Pulse Width/Period



Output Rise/Fall Time

## Application Information

### Power Supply Filtering Technique

As in 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 843251I-04 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL.  $V_{CC}$  and  $V_{CCA}$  should be individually connected to the power supply plane through vias, and  $0.01\mu\text{F}$  bypass capacitors should be used for each pin. *Figure 1* illustrates this for a generic  $V_{CC}$  pin and also shows that  $V_{CCA}$  requires that an additional  $10\Omega$  resistor along with a  $10\mu\text{F}$  bypass capacitor be connected to the  $V_{CCA}$  pin.

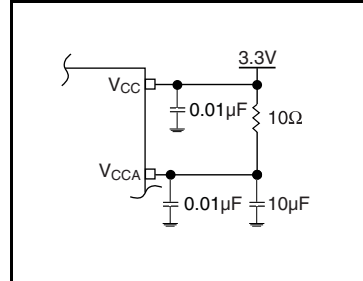


Figure 1. Power Supply Filtering

### Crystal Input Interface

The 843251I-04 has been characterized with  $18\text{pF}$  parallel resonant crystals. The capacitor values,  $C1$  and  $C2$ , shown in *Figure 2* below were determined using a  $25\text{MHz}$ ,  $18\text{pF}$  parallel resonant crystal and were chosen to minimize the ppm error. The optimum  $C1$  and  $C2$  values can be slightly adjusted for different board layouts.

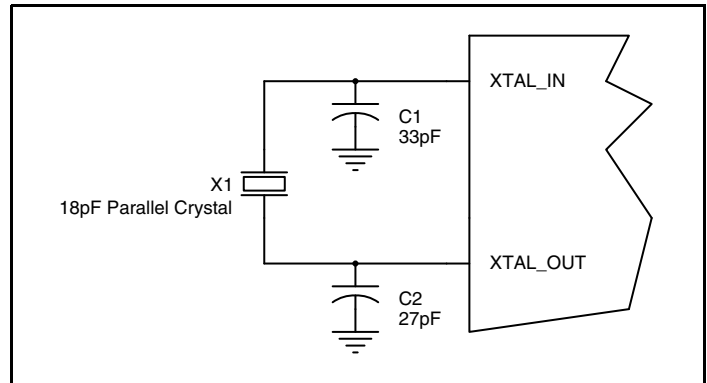


Figure 2. Crystal Input Interface



## 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 3A* 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 ( $R_o$ ) and the series resistance ( $R_s$ ) 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,  $R_1$  and  $R_2$  in parallel should equal the transmission line impedance. For most 50Ω applications,  $R_1$  and  $R_2$  can be 100Ω. This can also be accomplished by removing  $R_1$  and changing  $R_2$  to 50Ω. The values of the resistors can be increased to reduce the loading for a slower and weaker LVCMOS driver. *Figure 3B* 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.

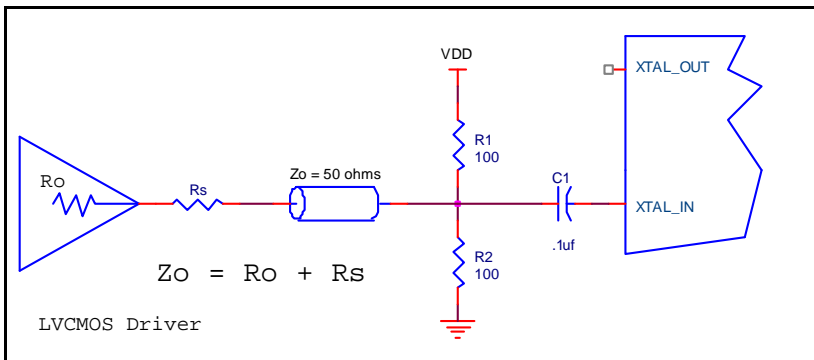


Figure 3A. General Diagram for LVCMOS Driver to XTAL Input Interface

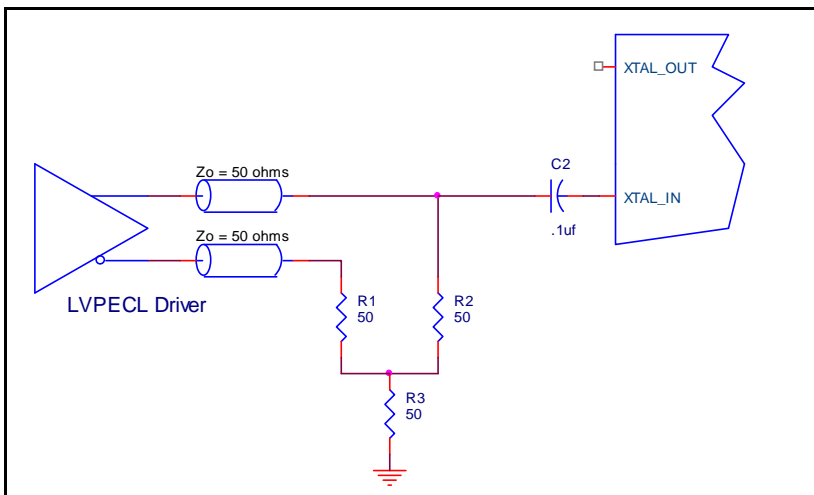


Figure 3B. General Diagram for LVPECL Driver to XTAL Input Interface

## 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 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.

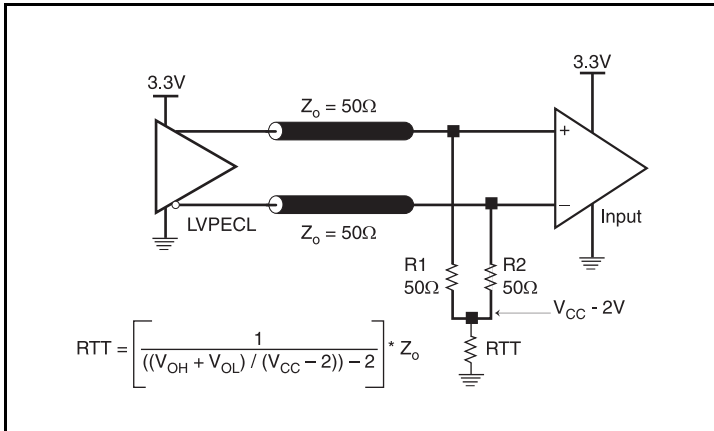


Figure 4A. 3.3V LVPECL Output Termination

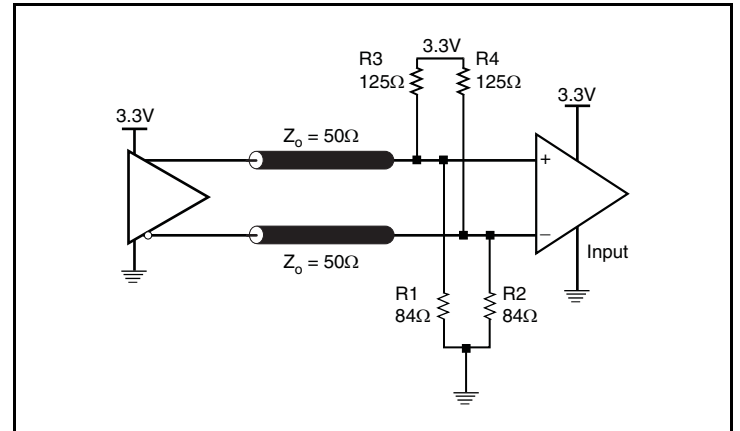


Figure 4B. 3.3V LVPECL Output Termination

## Schematic Example

Figure 5 shows an example of 843251I-04 application schematic. In this example, the device is operated at  $V_{CC} = 3.3V$ . The 18pF parallel resonant 25MHz crystal is used. The  $C1 = 33pF$  and  $C2 = 27pF$  are recommended for frequency accuracy. For different board layout, the  $C1$  and  $C2$  may be slightly adjusted for optimizing

frequency accuracy. Two examples of LVPECL termination are shown in this schematic. Additional termination approaches are shown in the *LVPECL Termination Application Note*.

Note: Thermal pad (E-pad) must be connected to ground ( $V_{EE}$ ).

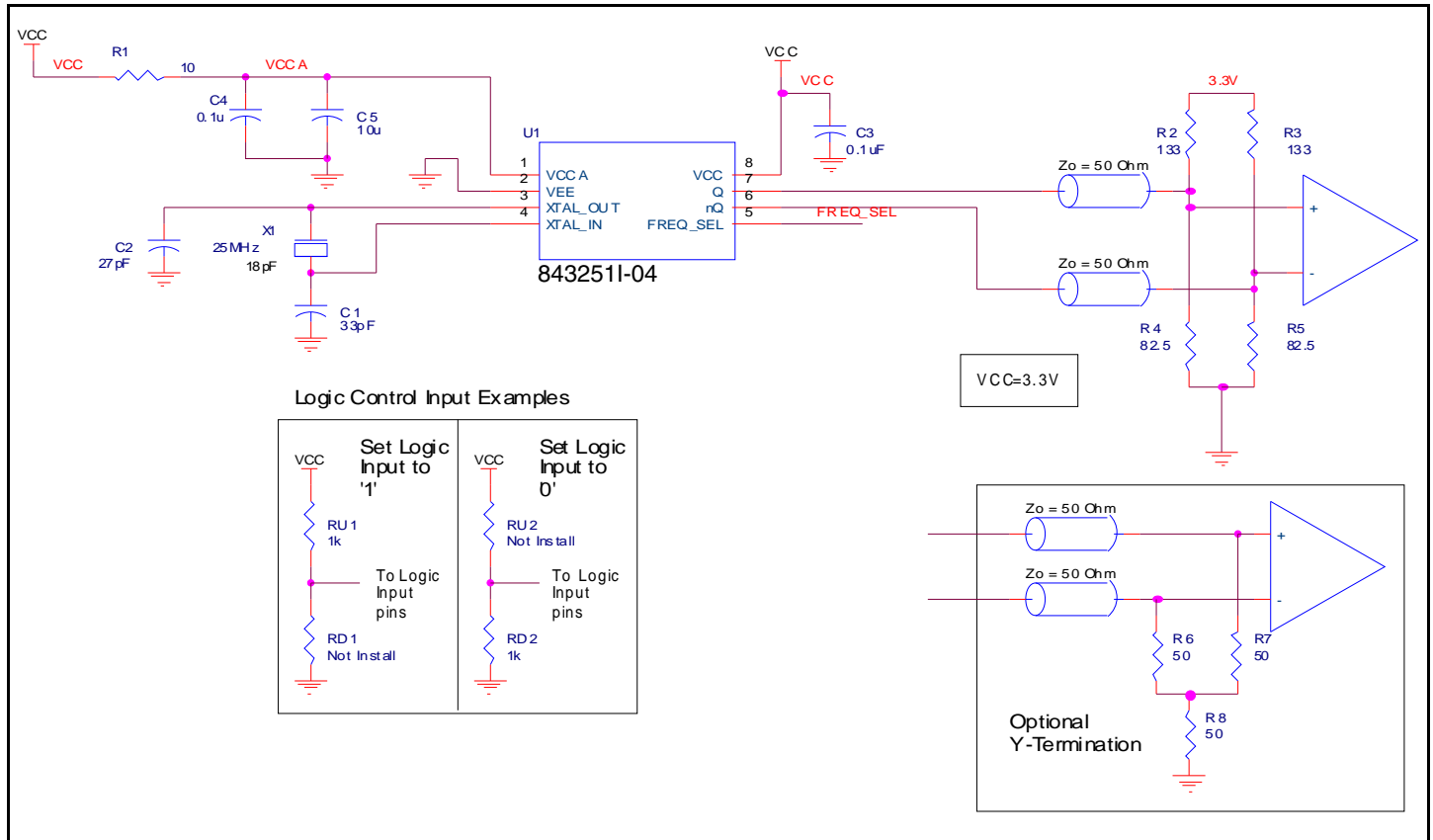


Figure 5. 843251I-04 Schematic Example

# Power Considerations

This section provides information on power dissipation and junction temperature for the 843251I-04. Equations and example calculations are also provided.

## 1. Power Dissipation.

The total power dissipation for the 843251I-04 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> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 70mA = \mathbf{242.55mW}$
- Power (outputs)<sub>MAX</sub> = **30mW/Loaded Output pair**

**Total Power**<sub>MAX</sub> (3.3V, with all outputs switching) = 242.55mW + 30mW = **272.55mW**

## 2. Junction Temperature.

Junction temperature,  $T_j$ , 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,  $T_j$ , to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for  $T_j$  is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

$T_j$  = Junction Temperature

$\theta_{JA}$  = 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  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is 129.5°C/W per Table 6 below.

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

$85^\circ C + 0.273W * 129.5^\circ C/W = 120.4^\circ C$ . This is well below the limit of 125°C.

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

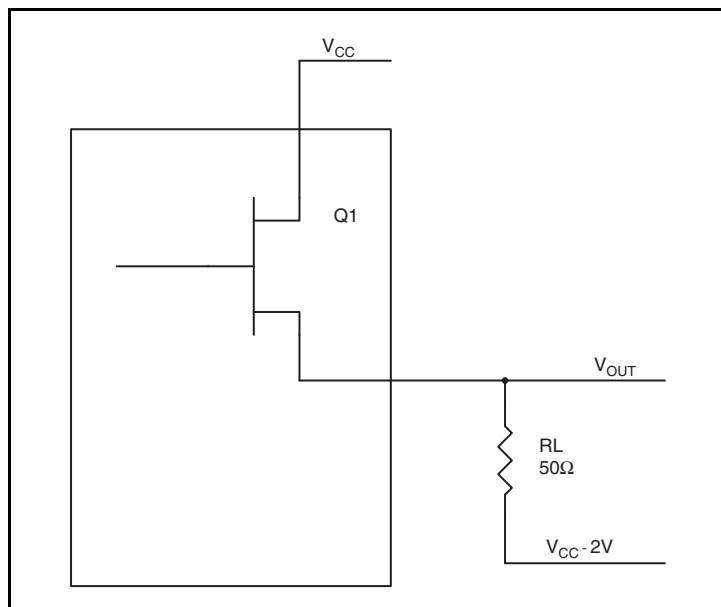
**Table 6. Thermal Resistance  $\theta_{JA}$  for 8 Lead TSSOP, Forced Convection**

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	129.5°C/W	125.5°C/W	123.5°C/W

### 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  $V_{CC} - 2V$ .

- 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.

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

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

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = \mathbf{30mW}$$

## Reliability Information

Table 7.  $\theta_{JA}$  vs. Air Flow Table for a 8 Lead TSSOP

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	129.5°C/W	125.5°C/W	123.5°C/W

## Transistor Count

The transistor count for 843251I-04 is: 1891

## Package Outline and Package Dimensions

Package Outline - G Suffix for 8 Lead TSSOP

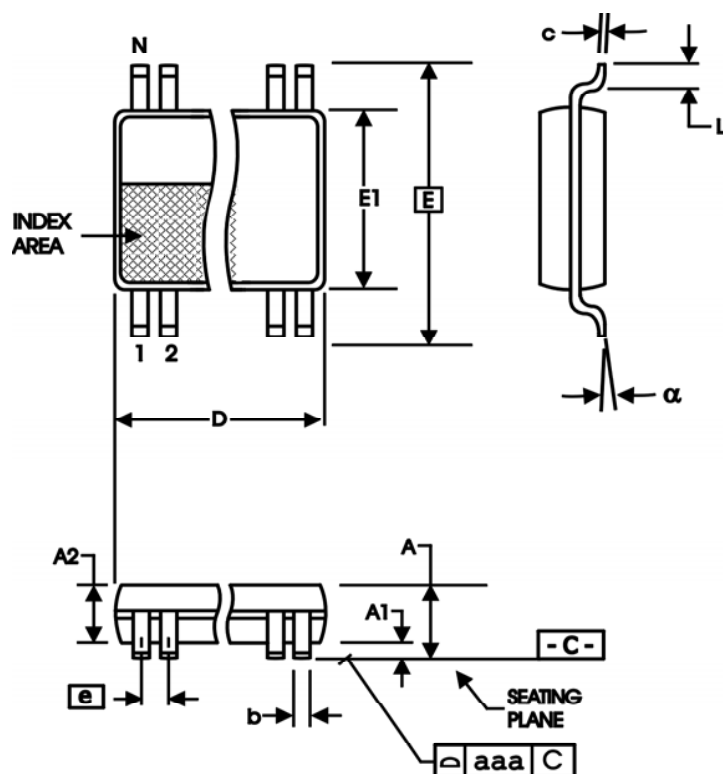


Table 8. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	8	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	2.90	3.10
E	6.40 Basic	
E1	4.30	4.50
e	0.65 Basic	
L	0.45	0.75
$\alpha$	0°	8°
aaa		0.10

Reference Document: JEDEC Publication 95, MO-153

## Ordering Information

Table 9. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
843251AGI-04LF	AI04L	8 Lead TSSOP, Lead-Free	Tube	-40°C to 85°C
843251AGI-04LFT	AI04L	8 Lead TSSOP, Lead-Free	Tape & Reel	-40°C to 85°C

## Revision History Sheet

Rev	Table	Page	Description of Change	Date
B	T9		Updated header/footer throughout the datasheet.	10/29/15
			Deleted <i>IDT</i> prefix from part number.	
		11	Deleted HiperClocks reference throughout the datasheet.	
		8	Application Information:	
		9	added <i>Overdriving the XTAL Interface</i> ,	
		10	updated <i>Termination for 3.3V LVPECL Outputs</i> ,	
		11	updated Figure 5, Schematic Example	
		15	Ordering Information Table - deleted: leaded part rows, Tape & Reel Count, and table note.	





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### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

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