

General Description



The ICS844251I-14 is an Ethernet Clock Generator. The ICS844251I-14 uses an 18pF parallel resonant crystal over the range of 23.2MHz – 30MHz. For Ethernet applications, a 25MHz crystal is used. The device has excellent <1ps phase jitter performance, over the 1.875MHz – 20MHz integration range. The ICS844251I-14 is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

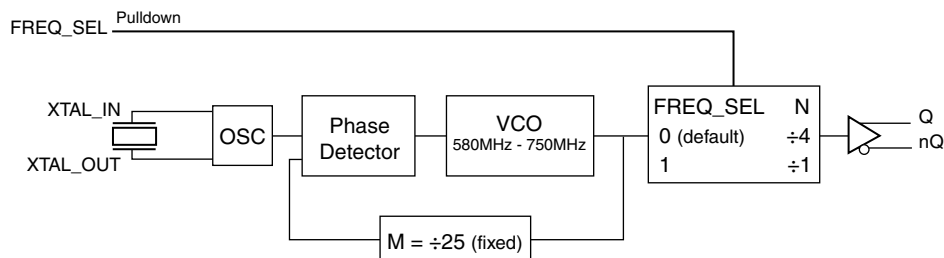
Features

- One differential LVDS output pair
- Crystal oscillator interface designed for an 18pF, parallel resonant crystal (23.2MHz – 30MHz)
- Output frequency ranges: 145MHz – 187.5MHz and 580MHz – 750MHz
- VCO range: 580MHz – 750MHz
- RMS phase jitter at 156.25MHz, using a 25MHz crystal (1.875MHz – 20MHz): 0.53ps (typical)
- Full 2.5V output supply mode
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

Common Configuration Table

Inputs					Output Frequency Range (MHz)
Crystal Frequency (MHz)	FREQ_SEL	M	N	Multiplication Value M/N	
25	1	25	1	25	625
26.67	1	25	1	25	666.67
25 (default)	0	25	4	6.25	156.25

Block Diagram



Pin Assignment

VDDA	1	8	VDD
GND	2	7	Q
XTAL_OUT	3	6	nQ
XTAL_IN	4	5	FREQ_SEL

ICS844251I-14

8 Lead TSSOP

**4.40mm x 3.0mm x 0.925mm
package body
G Package
Top View**

Table 1. Pin Descriptions

Number	Name	Type		Description
1	V _{DDA}	Output		Analog supply pin.
2	GND	Power		Power supply ground.
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. LVDS interface levels.
8	V _{DD}	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 _{IN}	Input Capacitance			4		pF
R _{PULLDOWN}	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_{DD}	4.6V
Inputs, V_I XTAL_IN Other Inputs	0V to V_{DD} -0.5V to $V_{DD} + 0.5V$
Outputs, I_O Continuous Current Surge Current	10mA 15mA
Package Thermal Impedance, θ_{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, $V_{DD} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DDA}	Analog Supply Voltage		$V_{DD} - 0.10$	2.5	V_{DD}	V
I_{DD}	Power Supply Current				95	mA
I_{DDA}	Analog Supply Current				10	mA

Table 3B. LVCMOS/LVTTL DC Characteristics, $V_{DD} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage		1.7		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage		-0.3		0.7	V
I_{IH}	Input High Current	$V_{DD} = V_{IN} = 2.625V$			150	μA
I_{IL}	Input Low Current	$V_{DD} = 2.625V$, $V_{IN} = 0V$	-5			μA

Table 3C. LVDS DC Characteristics, $V_{DD} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OD}	Differential Output Voltage		247		454	mV
ΔV_{OD}	V_{OD} Magnitude Change				50	mV
V_{OS}	Offset Voltage		1.0		1.4	V
ΔV_{OS}	V_{OS} Magnitude Change				50	mV

Table 4. Crystal Characteristics

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation		Fundamental			
Frequency		23.2		30	MHz
Equivalent Series Resistance (ESR)				50	Ω
Shunt Capacitance				7	pF

AC Electrical Characteristics

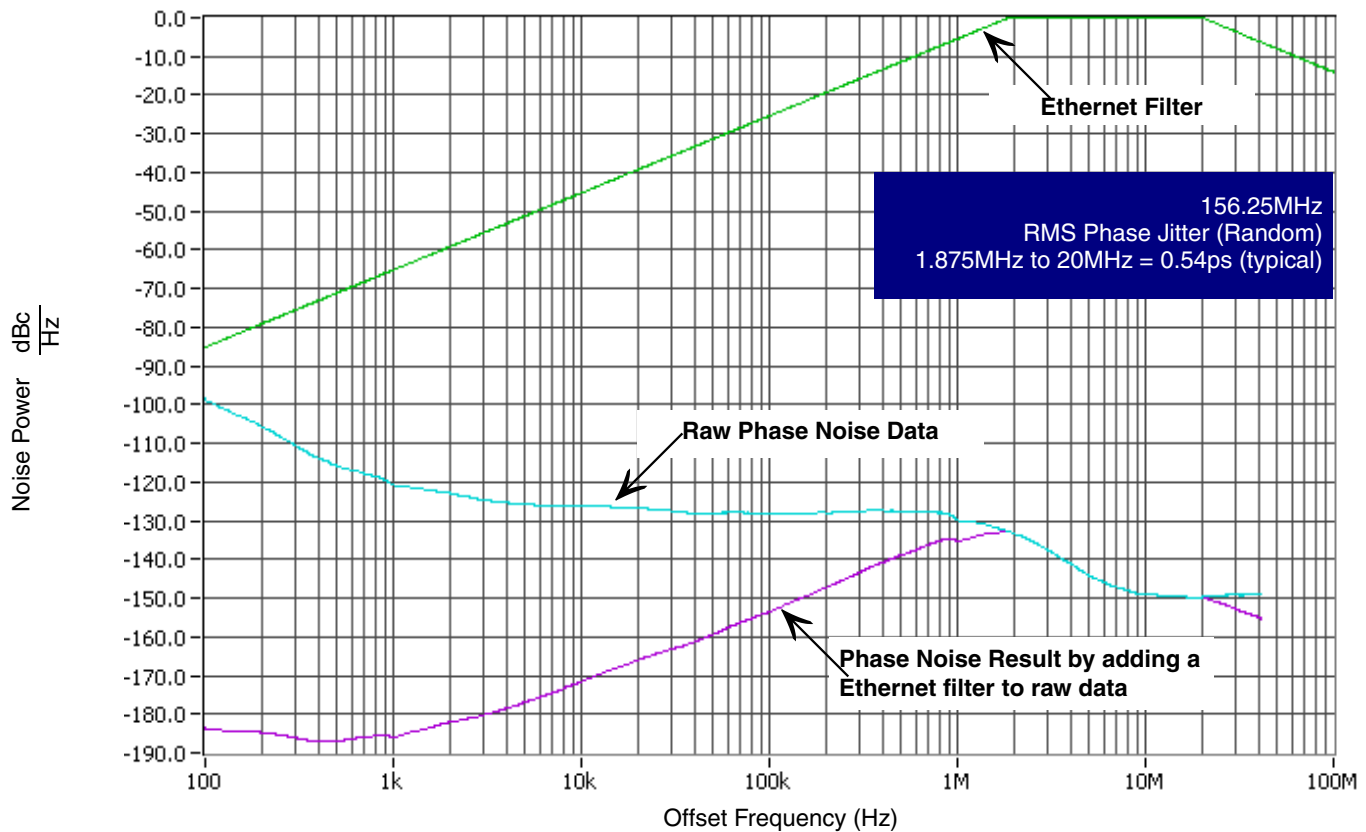
Table 5. AC Characteristics, $V_{DD} = 2.5V \pm 5\%$, $T_A = -40^\circ C$ to $85^\circ C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	FREQ_SEL = 0	145		187.5	MHz
		FREQ_SEL = 1	580		750	MHz
$j_{it}(\phi)$	RMS Phase Jitter, Random; NOTE 1	156.25MHz, Integration Range: 1.875MHz – 20MHz		0.54		ps
		625MHz, Integration Range: 1.875MHz – 20MHz		0.45		ps
t_R / t_F	Output Rise/Fall Time	20% to 80%	70		550	ps
odc	Output Duty Cycle	FREQ_SEL = 0	48		52	%
		FREQ_SEL = 1	46		54	%

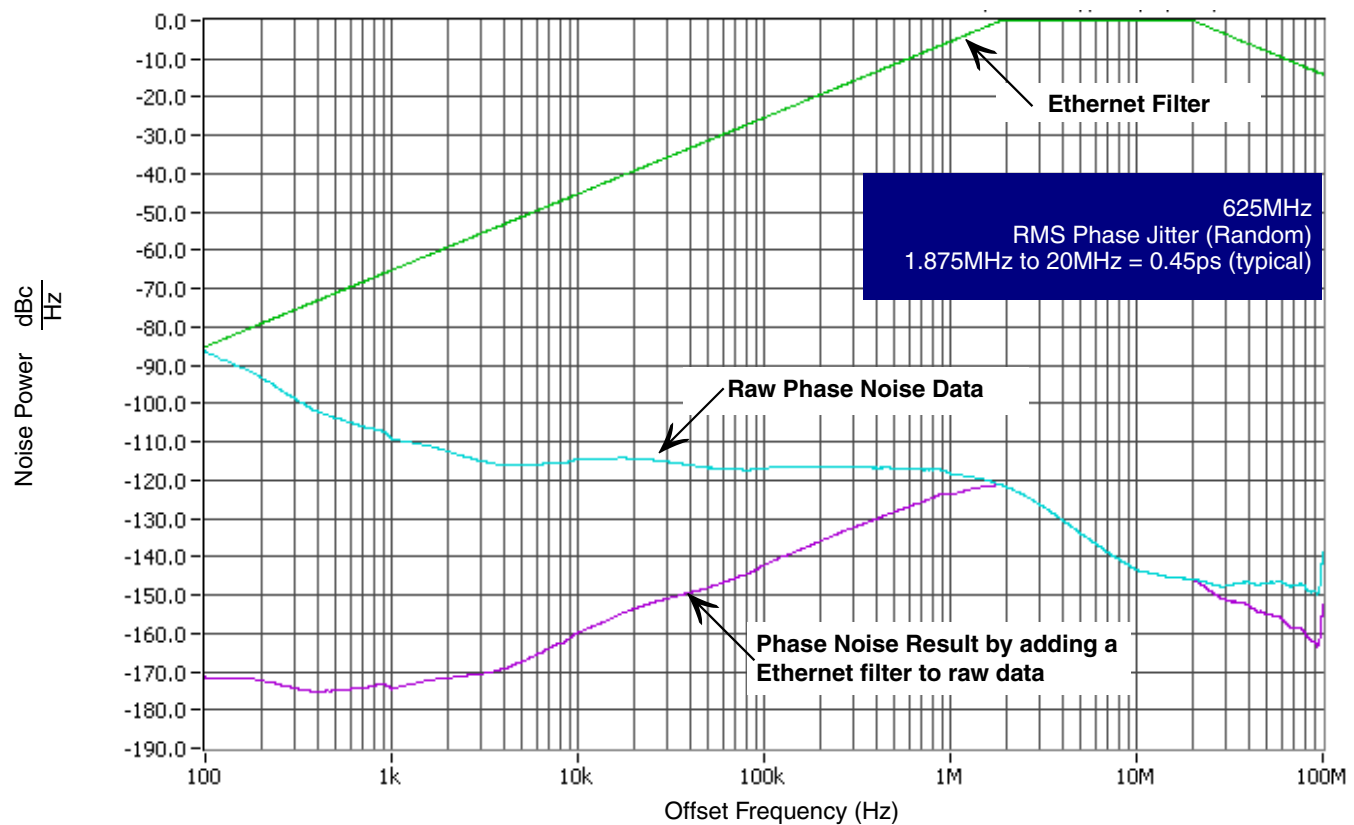
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lpm. The device will meet specifications after thermal equilibrium has been reached under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

NOTE 1: Refer to Phase Noise Plots.

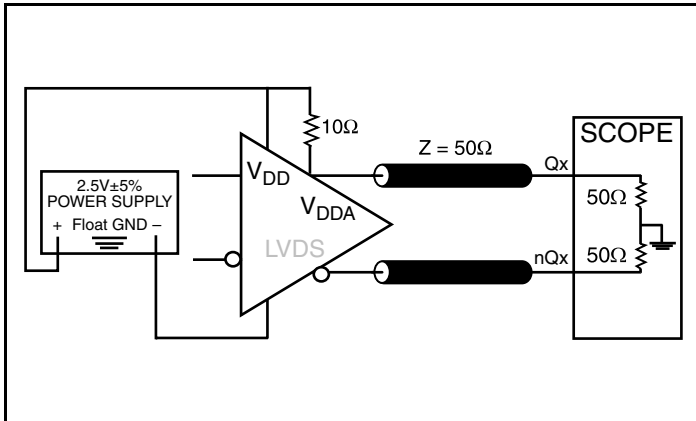
Typical Phase Noise at 156.25MHz



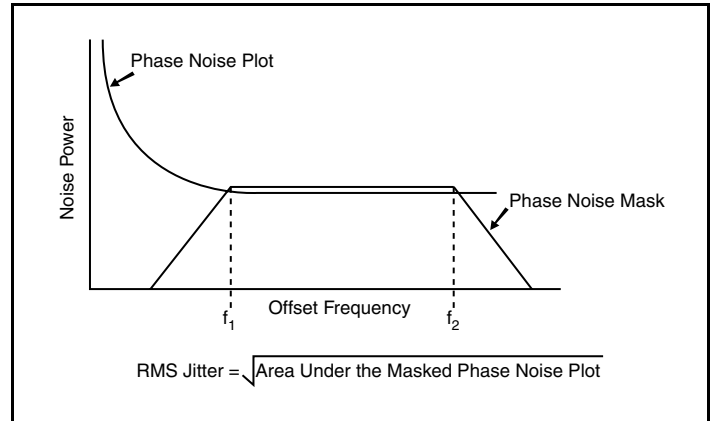
Typical Phase Noise at 625MHz



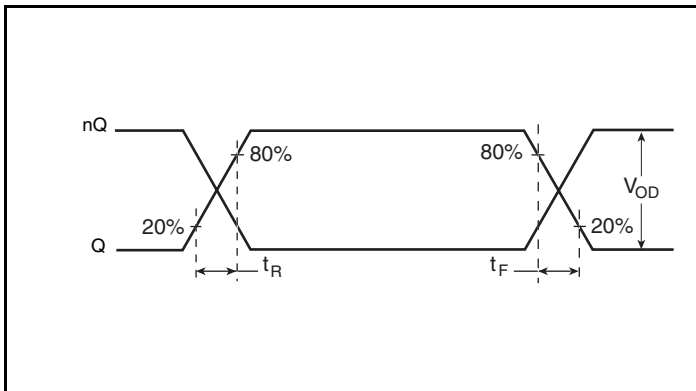
Parameter Measurement Information



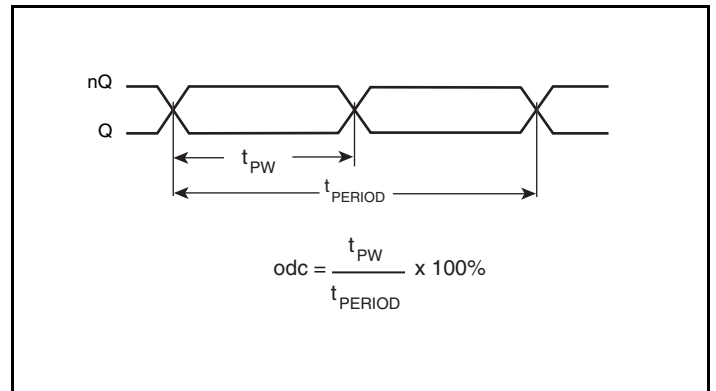
LVDS Output Load AC Test Circuit



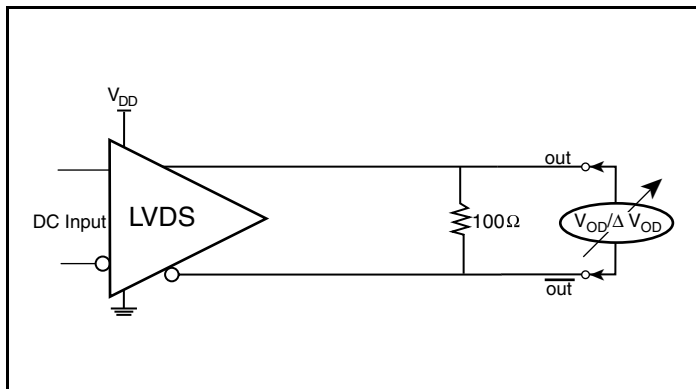
RMS Phase Jitter



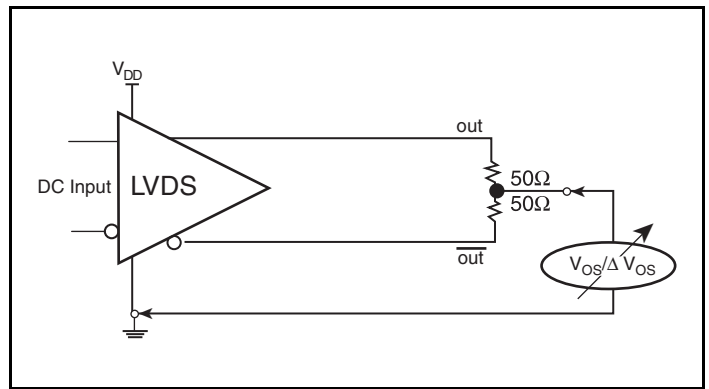
Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period



DIFFERENTIAL OUTPUT VOLTAGE SETUP



OFFSET VOLTAGE SETUP

Application Information

Crystal Input Interface

The ICS844251I-14 has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 1* below were determined using a 25MHz, 18pF 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.

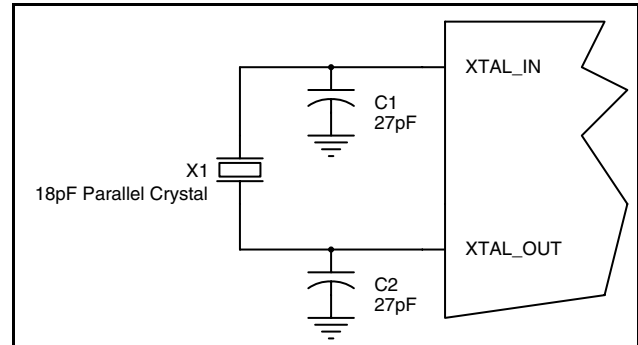


Figure 1. Crystal Input Interface

Overdriving the XTAL Interface

The XTAL_IN input can accept a single-ended LVCMOS signal through an AC coupling capacitor. A general interface diagram is shown in *Figure 3A*. The XTAL_OUT pin can be left floating. The maximum amplitude of the input signal should not exceed 2V and the input edge rate can be as slow as 10ns. This configuration requires that the output impedance of the driver (R_o) plus 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, R1 and R2 in parallel should equal the transmission line impedance. For most 50Ω applications, R1 and R2 can be 100Ω. This can also be accomplished by removing R1 and making R2 50Ω. By overdriving the crystal oscillator, the device will be functional, but note, the device performance is guaranteed by using a quartz crystal.

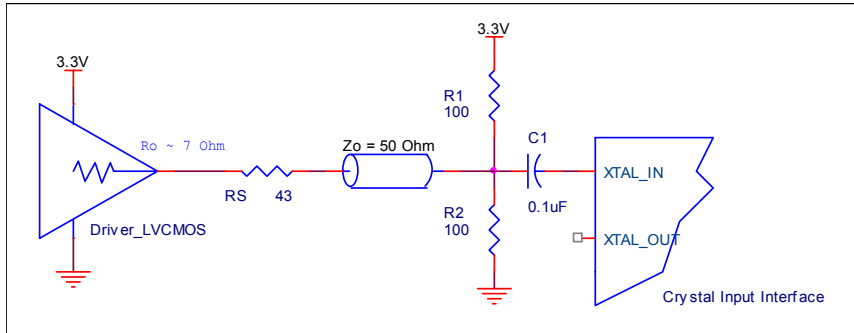


Figure 3A. General Diagram for LVCMOS Driver to XTAL Input Interface

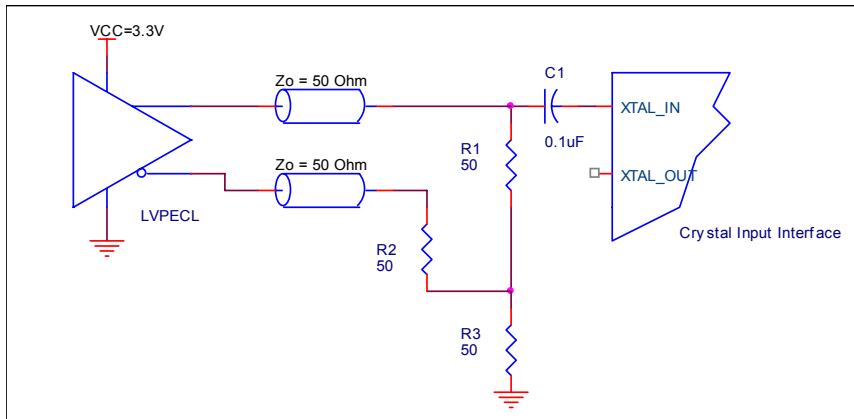


Figure 3B. General Diagram for LVPECL Driver to XTAL Input Interface

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 ICS844251I-14 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. V_{DD} and V_{DDA} 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 3* illustrates this for a generic V_{DD} pin and also shows that V_{DDA} requires that an additional 10Ω resistor along with a $10\mu\text{F}$ bypass capacitor be connected to the V_{DDA} pin.

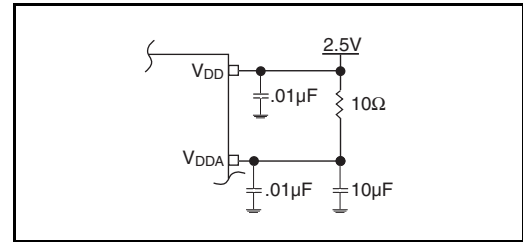


Figure 3. Power Supply Filtering

2.5V LVDS Driver Termination

Figure 4 shows a typical termination for LVDS driver in characteristic impedance of 100Ω differential (50Ω single) transmission line

environment. For buffer with multiple LVDS driver, it is recommended to terminate the unused outputs.

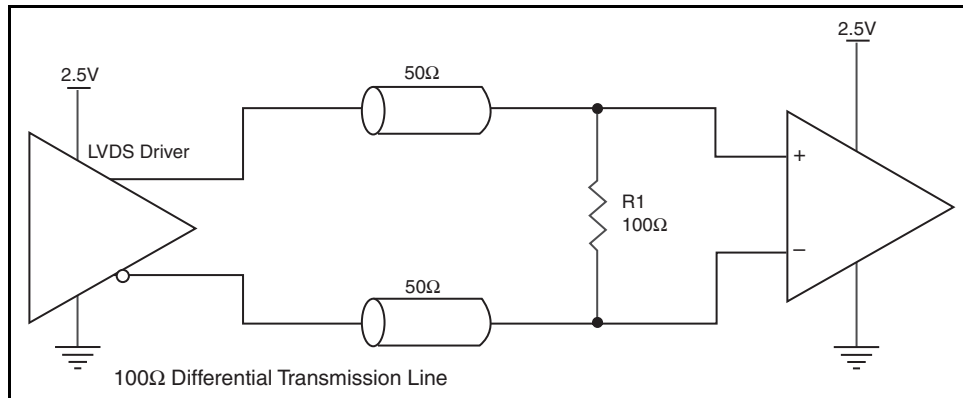


Figure 4. Typical LVDS Driver Termination

Schematic Example

Figure 5 shows an example of ICS844251I-14 application schematic. In this example, the device is operated at $V_{DD} = 2.5V$. The decoupling capacitor should be located as close as possible to the power pin. The 18pF parallel resonant 25MHz crystal is used. The $C1 = 27pF$

and $C2 = 27pF$ are recommended for frequency accuracy. For different board layouts, the $C1$ and $C2$ may be slightly adjusted for optimizing frequency accuracy. For the LVDS output drivers, place a 100Ω resistor as close to the receiver as possible.

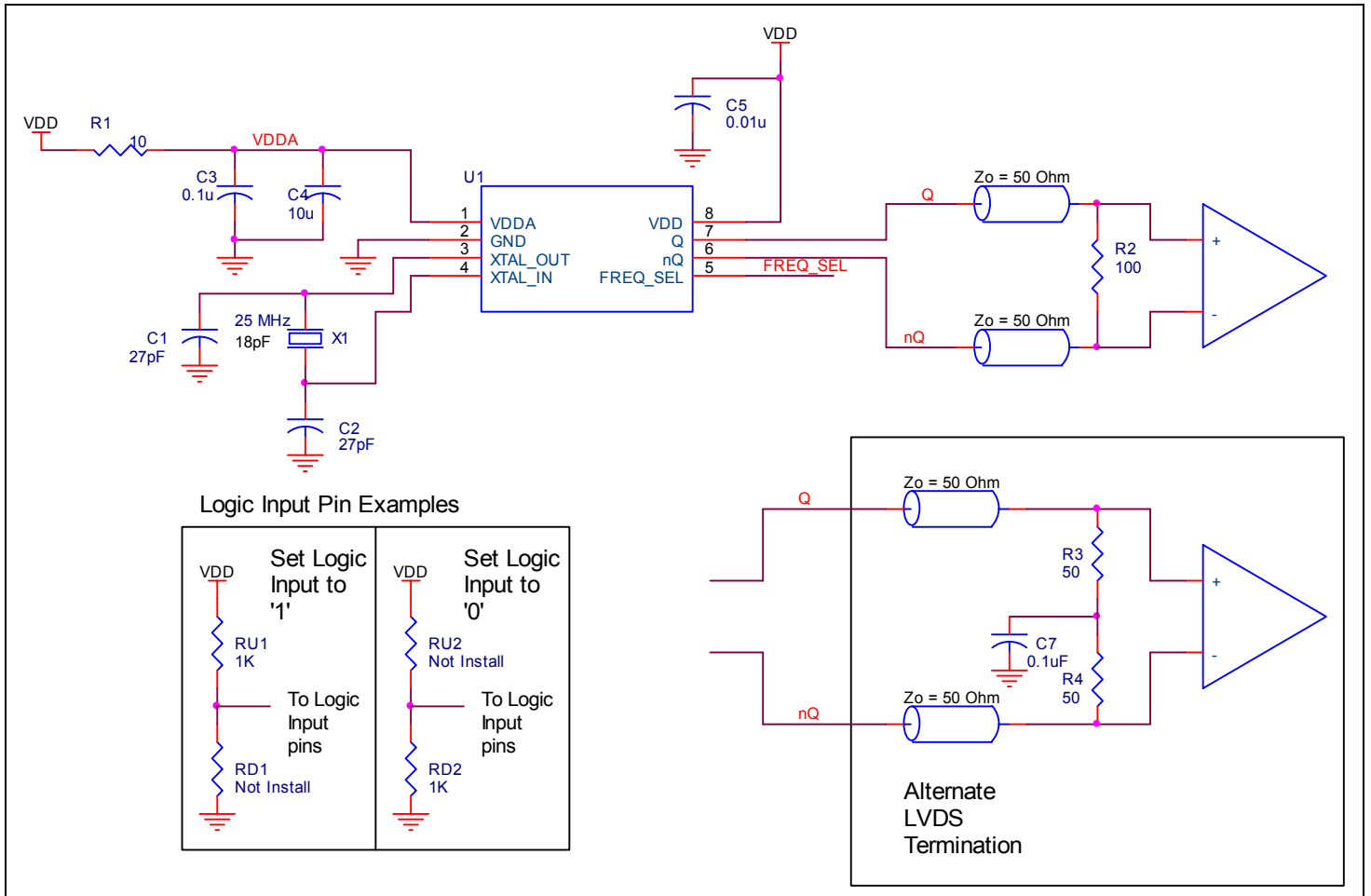


Figure 5. ICS844251I-14 Schematic Example

Power Considerations

This section provides information on power dissipation and junction temperature for the ICS844251I-14. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS844251I-14 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 $V_{DD} = 2.5V + 5\% = 2.625V$, which gives worst case results.

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

- Power (core)_{MAX} = $V_{DD_MAX} * (I_{DD_MAX} + I_{DDA_MAX}) = 2.625V * (95mA + 10mA) = \mathbf{275.625mW}$

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

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 129.5°C/W per Table 6 below.

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

$$85^\circ\text{C} + 0.276\text{W} * 129.5^\circ\text{C/W} = 120.7^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

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 θ_{JA} for 8 Lead TSSOP, Forced Convection

θ_{JA} by Velocity			
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

Reliability Information

Table 7. θ_{JA} vs. Air Flow Table for a 8 Lead TSSOP

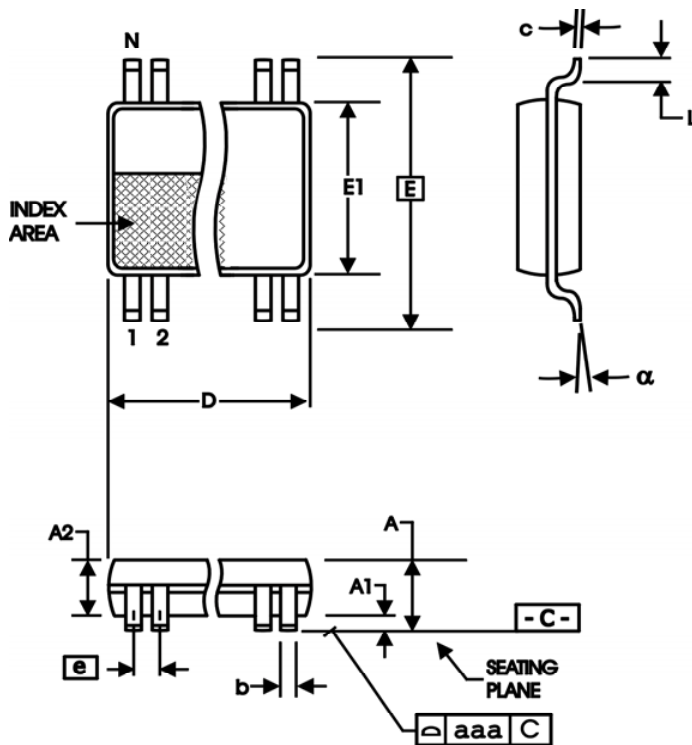
θ_{JA} vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	129.5°C/W	125.5°C/W	123.5°C/W

Transistor Count

The transistor count for ICS844251I-14 is: 2401

Package Outline and Package Dimensions

Table 8. Package Dimensions



Package Outline - G Suffix for 8 Lead TSSOP

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	8	
A		1.20
A1	0.5	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
α	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
844251BGI-14LF	BI14L	"Lead-Free" 8 Lead TSSOP	Tube	-40°C to 85°C
844251BGI-14LFT	BI14L	"Lead-Free" 8 Lead TSSOP	2500 Tape & Reel	-40°C to 85°C

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

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Revision History Sheet

Rev	Table	Page	Description of Change	Date
A		1	Front page corrected Genneraator typo to Generator.	2/24/10
		3	Absolute Maximum Ratings, updated Inputs.	
		7	Updated Overdriving the XTAL Interface section.	



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