DATA SHEET

General Description

The ICS843S1333D is a high frequency clock generator. The ICS843S1333D uses an external 20MHz crystal to synthesize 1333.33MHz. The ICS843S1333D has excellent cycle-to-cycle and RMS period jitter performance.

The ICS843S1333D operates at 3.3V operating supply and is available in a fully RoHS compliant 8-lead TSSOP package.

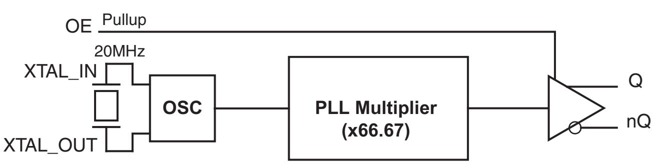
Features

- One differential LVPECL output
- Crystal oscillator interface designed for 18pF, 20MHz parallel resonant crystal
- Cycle-to-Cycle Jitter: 14ps (maximum)
- Period Jitter, RMS: 2.6ps (maximum)
- Output Duty Cycle: 48 – 52%
- Full 3.3V supply mode
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package

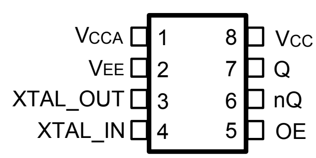
Table 1. Frequency Table

Crystal Frequency (MHz)	Multiplier Value	Output Frequency (MHz)
20	66.67	1333.33

Block Diagram



Pin Assignment



ICS843S1333D
8 Lead TSSOP
4.40mm x 3.0mm x 0.925mm package body
G Package
Top View

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Table 2. Pin Descriptions

Number	Name	Type		Description
1	V_{CCA}	Power		Analog supply pin.
2	V_{EE}	Power		Negative supply pin.
3, 4	XTAL_OUT XTAL_IN	Input		Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output. External tuning capacitor must be used for proper operation.
5	OE	Input	Pullup	Synchronous output enable. When logic HIGH, the outputs are enabled and active. When logic LOW, Q output is forced LOW and nQ output is forced HIGH. LVCMOS/LVTTL interface levels.
6, 7	nQ, Q	Output		Differential output pair. LVPECL interface levels.
8	V_{CC}	Power		Core supply pin.

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

Table 3. Pin Characteristics

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
C_{IN}	Input Capacitance			2		pF
R_{PULLUP}	Input Pullup Resistor			51		kΩ

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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}	4.6V
Inputs, V_I XTAL_IN Other Inputs	 0V to V_{CC} -0.5V to V_{CC} + 0.5V
Outputs, I_O Continuos Current Surge Current	 50mA 100mA
Package Thermal Impedance, θ_{JA}	115.2°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 = 0°C to 70°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		V_{CC} – 0.23	3.3	V_{CC}	V
I_{EE}	Power Supply Current				80	mA
I_{CCA}	Analog Supply Current				23	mA

Table 4B. LVCMOS/LVTTL DC Characteristics, V_{CC} = 3.3V ± 5%, V_{EE} = 0V, T_A = 0°C to 70°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			10	µA
I_{IL}	Input Low Current	V_{CC} = 3.465V, V_{IN} = 0V	-150			µA

Table 4C. LVPECL DC Characteristics, V_{CC} = 3.3V ± 5%, V_{EE} = 0V, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{OH}	Output High Voltage; NOTE 1		V_{CC} – 1.3		V_{CC} – 0.8	V
V_{OL}	Output Low Voltage; NOTE 1		V_{CC} – 2.0		V_{CC} – 1.6	V
V_{SWING}	Peak-to-Peak Output Voltage Swing		0.6		1.0	V

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

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Table 5. Crystal Characteristics

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation		Fundamental			
Frequency			20		MHz
Equivalent Series Resistance (ESR)				50	Ω
Shunt Capacitance				7	pF

AC Electrical Characteristics

Table 6. AC Characteristics, V_{CC} = 3.3V ± 5%, V_{EE} = 0V, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency			1333.33		MHz
tjit(cc)	Cycle-to-Cycle Jitter; NOTE 1				14	ps
tjit(per)	Period Jitter, RMS; NOTE 1				2.6	ps
t_R / t_F	Output Rise/Fall Time	20% to 80%	80		200	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 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE: External tuning capacitor must be used for proper operation.
NOTE 1: This parameter is defined in accordance with JEDEC Standard 65.

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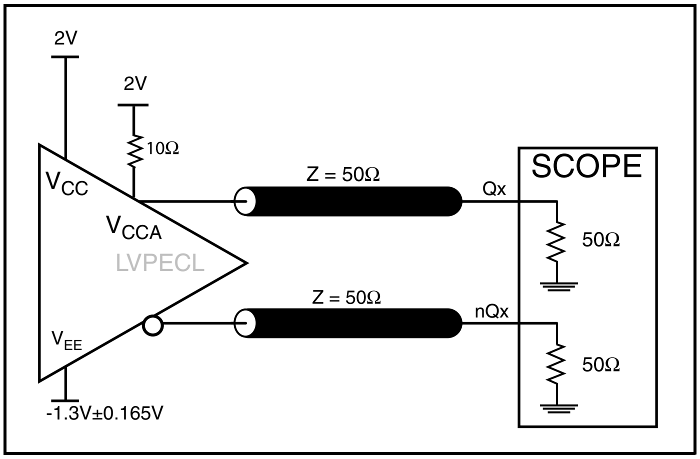
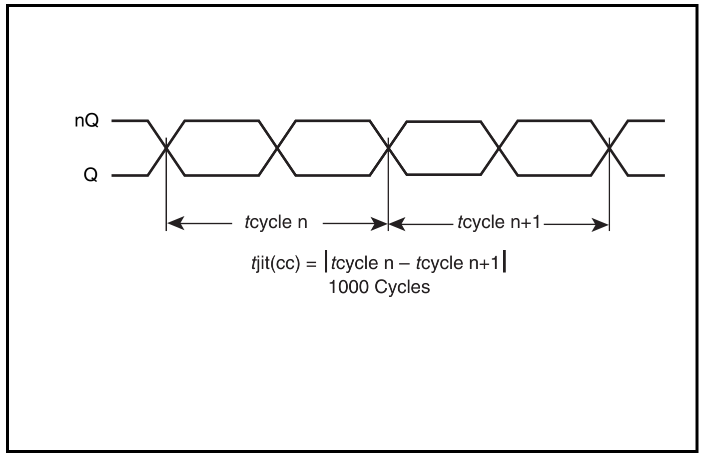
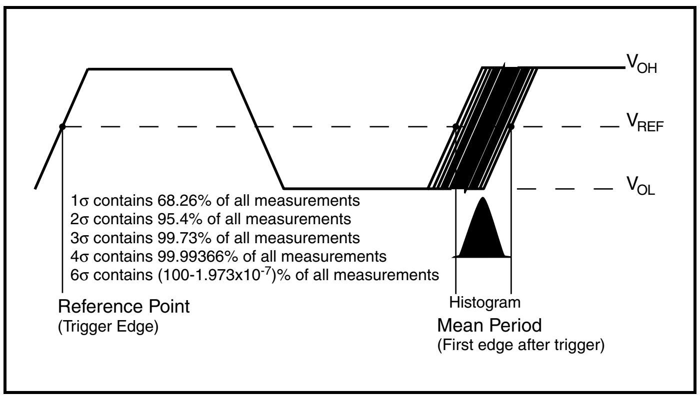
Parameter Measurement Information



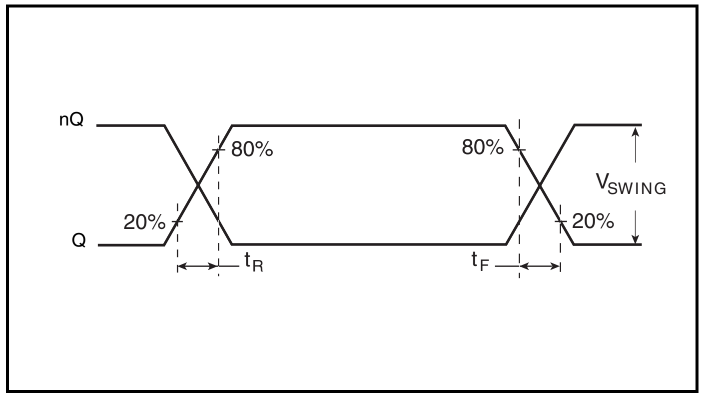
3.3V LVPECL Output Load AC Test Circuit



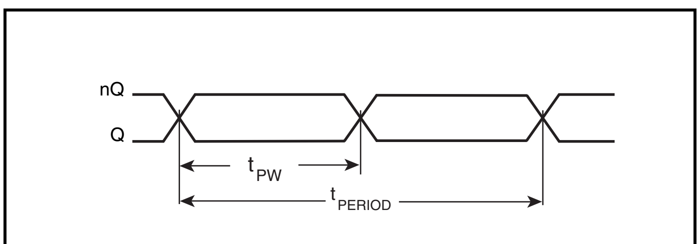
Cycle-to-Cycle Jitter



RMS Period Jitter



Output Rise/Fall Time



$$odc = \frac{t_{PW}}{t_{PERIOD}} \times 100\%$$

Output Duty Cycle/Pulse Width/Period

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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 ICS843S1333D 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 0.01µF 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 10Ω resistor along with a 10µF bypass capacitor be connected to the V_{CCA} pin.

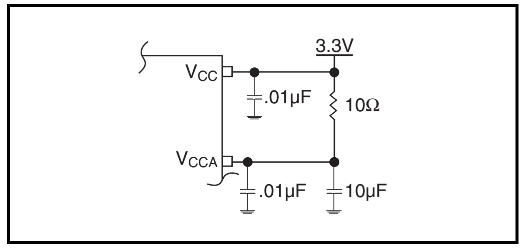

Figure 1. Power Supply Filtering

Crystal Input Interface

The ICS843S1333D has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 2* below were determined using a 20MHz, 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. External tuning capacitor must be used for proper operation.

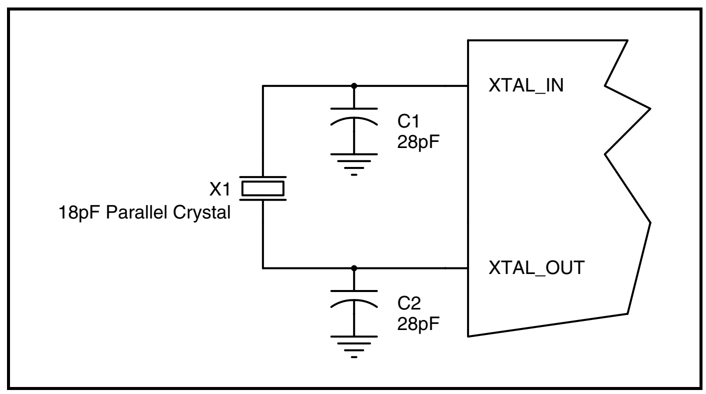

Figure 2. Crystal Input Interface

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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 (Ro) plus the series resistance (Rs) 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.

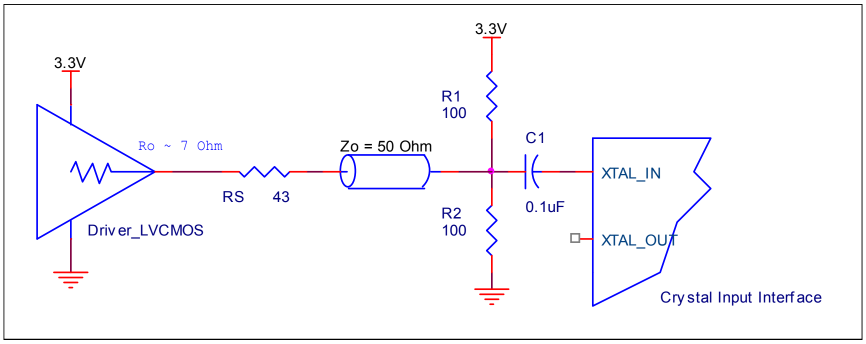

Figure 3A. General Diagram for LVCMOS Driver to XTAL Input Interface

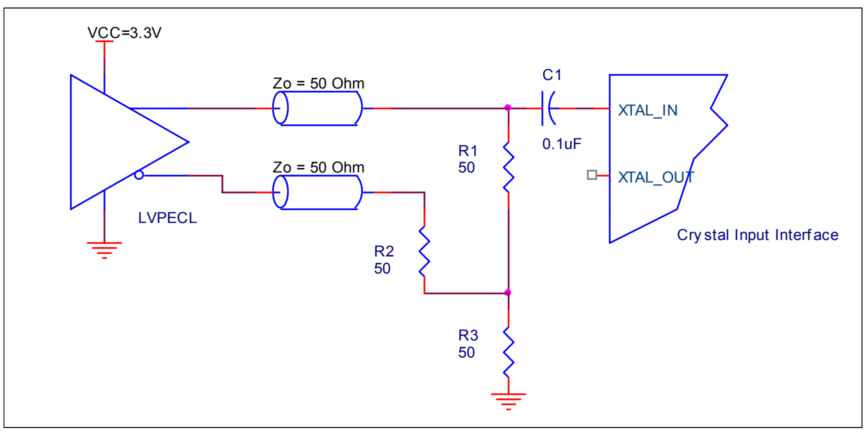

Figure 3B. General Diagram for LVPECL Driver to XTAL Input Interface

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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.

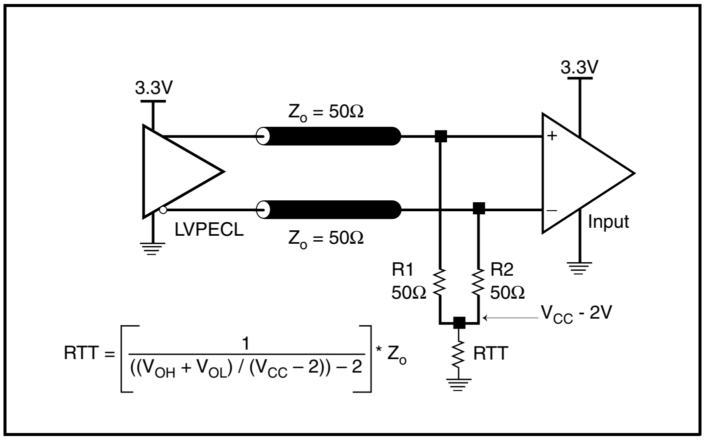

Figure 4A. 3.3V LVPECL Output Termination

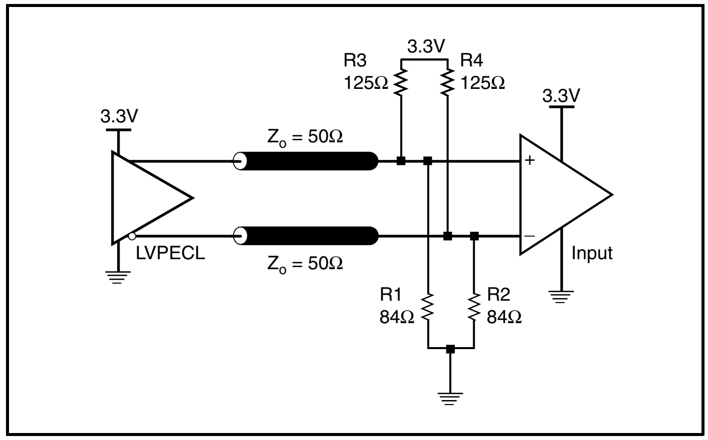

Figure 4B. 3.3V LVPECL Output Termination

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Schematic Example

Figure 5 shows an example of the ICS843S133D application schematic. In this example, the device is operated at V_{CC} = 3.3V. The 18pF parallel resonant 20MHz crystal is used. The C1 and C2 = 28pF 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.

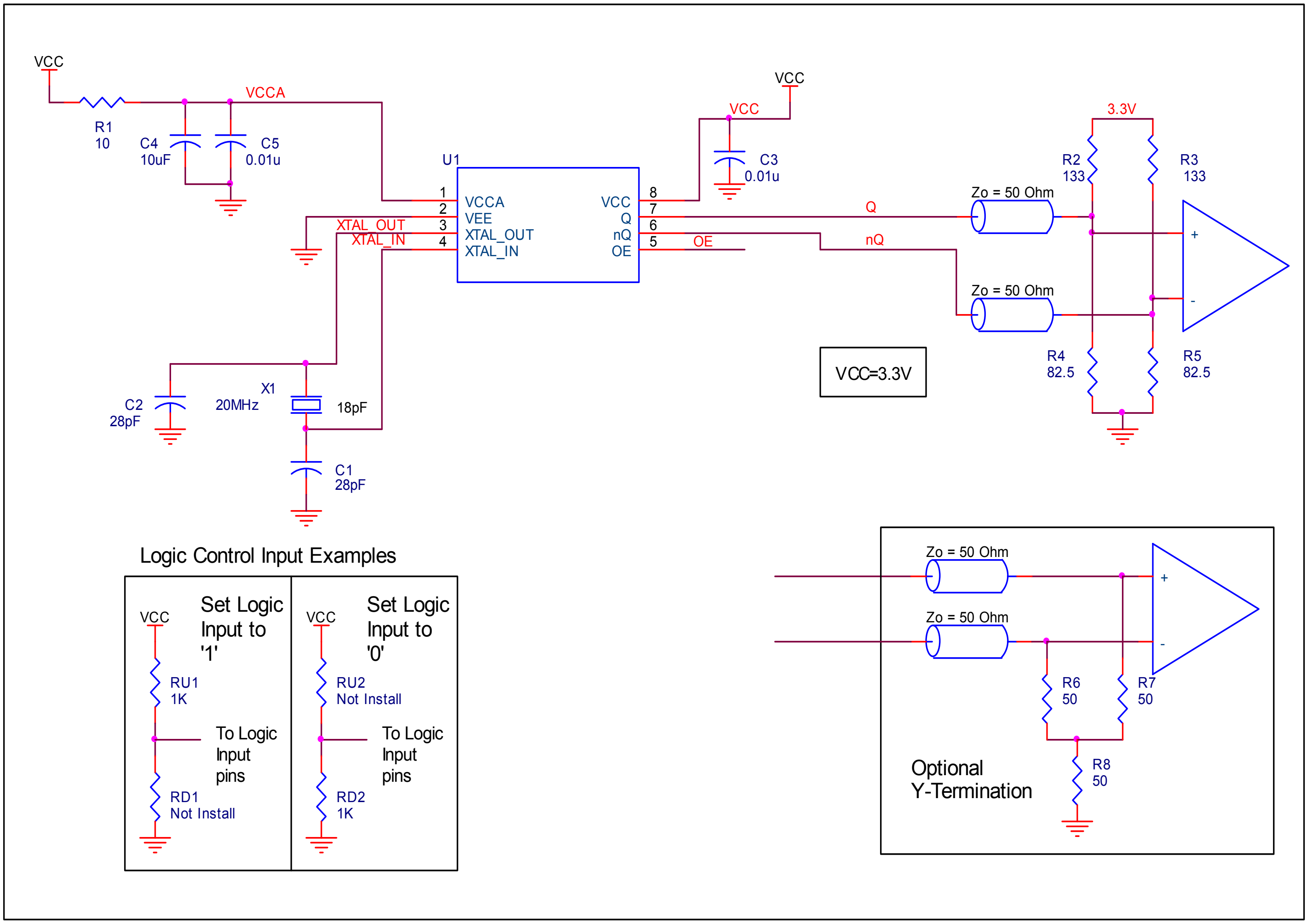

Figure 5. ICS843S1333D Schematic Example

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Power Considerations

This section provides information on power dissipation and junction temperature for the ICS843S1333D.
Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS843S1333D 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.

The maximum current at 70°C is as follows: I_{DD_MAX} = 77.68mA

- Power (core)$_{MAX}$ = V_{CC_MAX} * I_{EE_MAX} = 3.465V * 77.68mA = **269.16mW**
- Power (outputs)$_{MAX}$ = **32mW/Loaded Output pair**

Total Power$_{\_MAX}$ (3.3V, with all outputs switching) = 269.16mW + 32mW = **301.16mW**

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 = θ_{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 115.2°C/W per Table 7 below.

Therefore, Tj for an ambient temperature of 70°C with all outputs switching is:

70°C + 0.301W * 115.2°C/W = 104.7°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 (single layer or multi-layer).

Table 7. 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	115.2°C/W	110.9°C/W	108.8°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 6.*

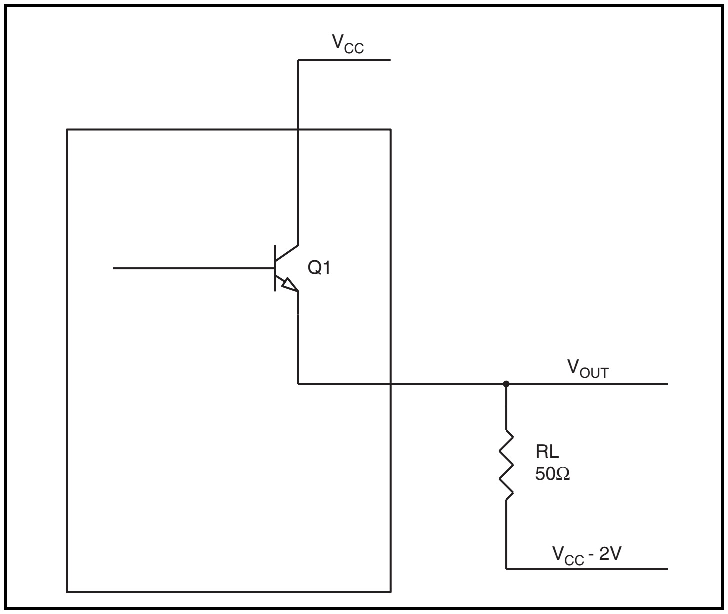

Figure 6. LVPECL Driver Circuit and Termination

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, $V_{OUT} = V_{OH\_MAX} = \mathbf{V_{CC\_MAX} – 0.8V}$
  $(V_{CC\_MAX} – V_{OH\_MAX}) = \mathbf{0.8V}$
- For logic low, $V_{OUT} = V_{OL\_MAX} = \mathbf{V_{CC\_MAX} – 1.6V}$
  $(V_{CC\_MAX} – V_{OL\_MAX}) = \mathbf{1.6V}$

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$Pd\_H = [(V_{OH\_MAX} – (V_{CC\_MAX} – 2V))/R_L] * (V_{CC\_MAX} – V_{OH\_MAX}) = [(2V – (V_{CC\_MAX} – V_{OH\_MAX}))/R_L] * (V_{CC\_MAX} – V_{OH\_MAX}) =$
$[(2V – 0.8V)/50\Omega] * 0.8V = \mathbf{19.2mW}$

$Pd\_L = [(V_{OL\_MAX} – (V_{CC\_MAX} – 2V))/R_L] * (V_{CC\_MAX} – V_{OL\_MAX}) = [(2V – (V_{CC\_MAX} – V_{OL\_MAX}))/R_L] * (V_{CC\_MAX} – V_{OL\_MAX}) =$
$[(2V – 1.6V)/50\Omega] * 1.6V = \mathbf{12.8mW}$

Total Power Dissipation per output pair = Pd_H + Pd_L = **32mW**

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Reliability Information

Table 8. 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	115.2°C/W	110.9°C/W	108.8°C/W

Transistor Count

The transistor count for ICS843S1333D is: 1023

Package Outline and Package Dimensions

Package Outline - G Suffix for 8 Lead TSSOP

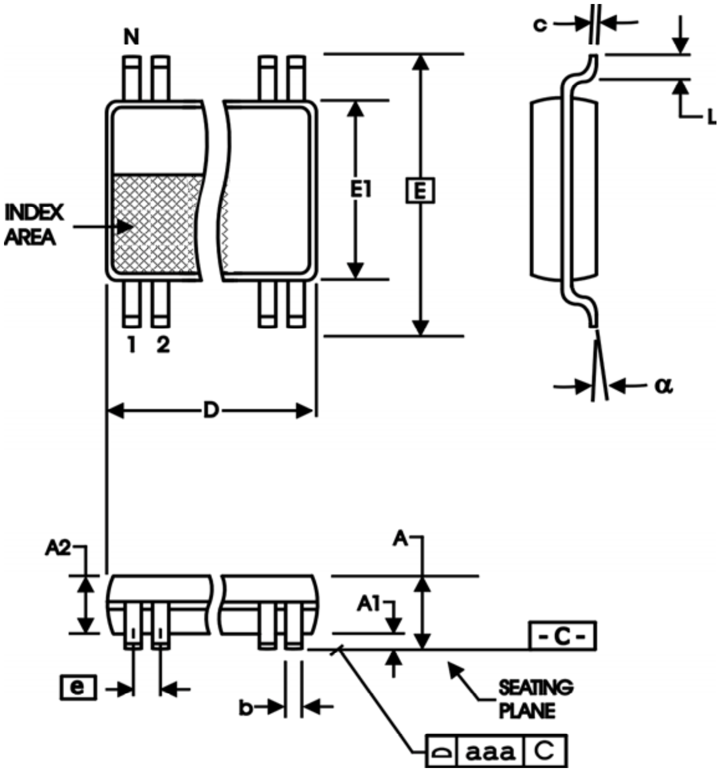

Table 9. Package Dimensions

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

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Ordering Information

Table 10. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
843S1333DGLF	33DL	“Lead-Free” 8 Lead TSSOP	Tube	0°C to 70°C
843S1333DGLFT	33DL	“Lead-Free” 8 Lead TSSOP	2500 Tape & Reel	0°C to 70°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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