

FEMTOCLOCK™ CRYSTAL-TO-3.3V LVPECL CLOCK GENERATOR

ICS843SDN

General Description

The ICS843SDN is a Gigabit Ethernet Clock Generator. The ICS843SDN uses a 24MHz crystal to synthesize 120MHz. The ICS843SDN uses IDT's 3rd generation low phase noise VCO technology, and can achieve <1ps rms phase jitter performance over the 12kHz – 20MHz integration range. The ICS843SDN is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

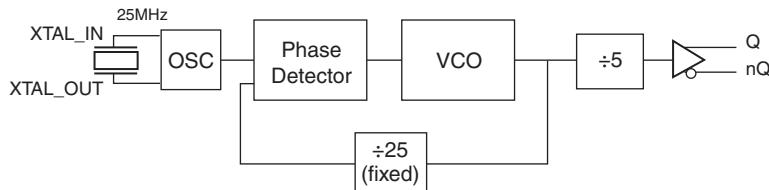
Features

- One differential 3.3V LVPECL output
- Crystal oscillator interface designed for 23.2MHz – 30MHz, 18pF parallel resonant crystal
- Output frequency range: 116MHz – 150MHz
- VCO range: 580MHz – 750MHz
- Output duty cycle range: 47% – 53%
- RMS phase jitter @ 120MHz, using a 24MHz crystal (12kHz – 20MHz): 0.81ps (typical)
- Full 3.3V supply mode
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request
- Available in lead-free (RoHS 6) package

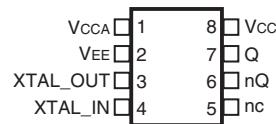
Table 1. Frequency Table - Typical Applications

Crystal Frequency (MHz)	Output Frequency (MHz)
25	125
24	120

Block Diagram



Pin Assignment



ICS843SDN
8 Lead TSSOP
4.40mm x 3.0mm x 0.925mm package body
G Package
Top View

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.
5	nc	Unused	No connect.
6, 7	nQ, Q	Output	Differential output pair. LVPECL interface levels.
8	V _{CC}	Power	Core supply pin.

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 Continuos Current Surge Current	50mA 100mA
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_{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} - 0.10	3.3	V _{CC}	V
I _{EE}	Power Supply Current				83	mA

Table 3B. 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 Current; NOTE 1		V _{CC} - 1.4		V _{CC} - 0.9	V
V _{OL}	Output Low Current; 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 termination with 50Ω to V_{CC} - 2V.

Table 4. Crystal Characteristics

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation	Fundamental				
Frequency; NOTE 1		23.2		30	MHz
Equivalent Series Resistance (ESR)				40	Ω
Shunt Capacitance				7	pF

NOTE: It is not recommended to overdrive the crystal input with an external clock.

NOTE 1: Input frequency is limited to a range of 23.2MHz – 30MHz due to VCO range.

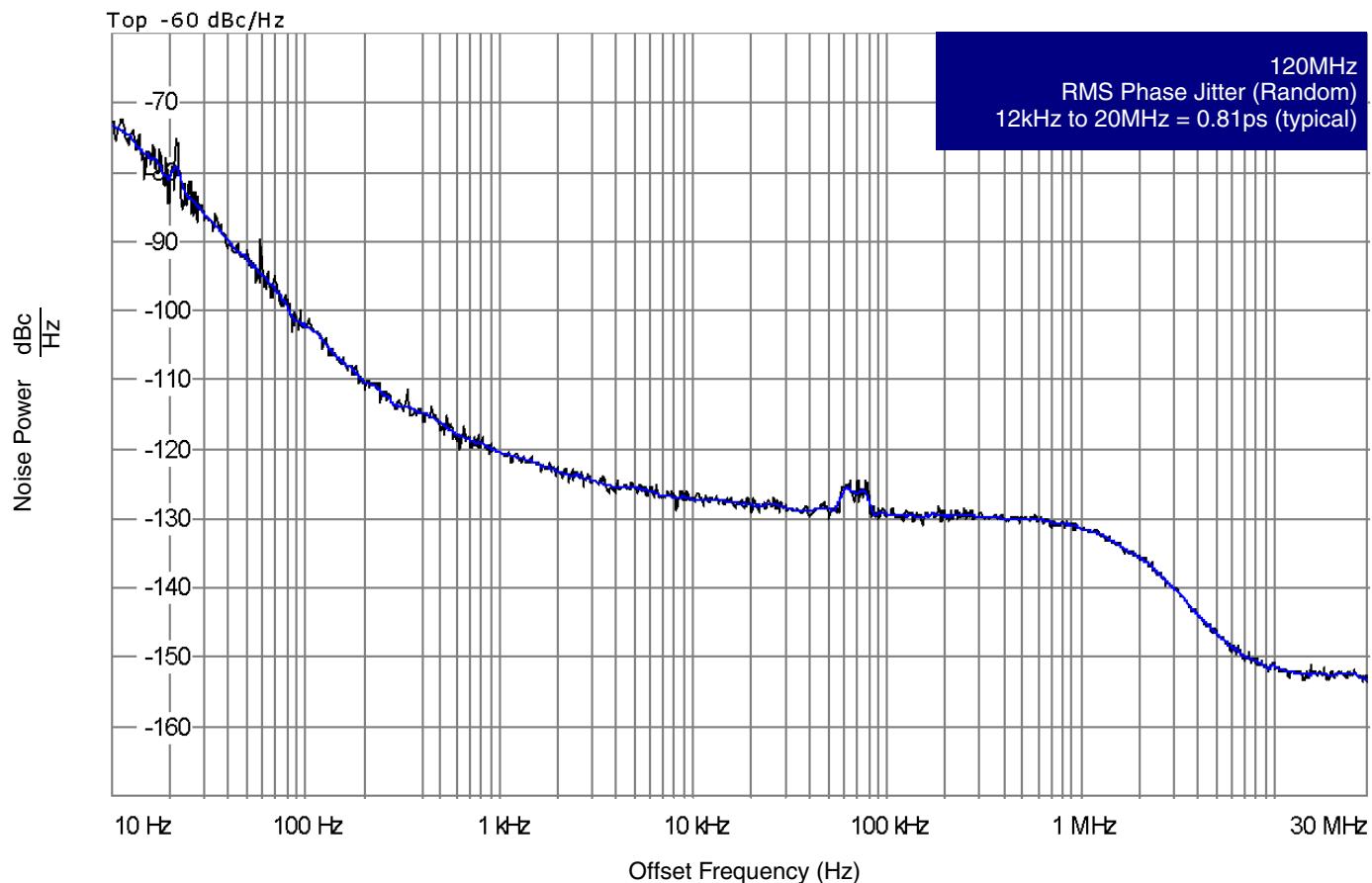
AC Electrical Characteristics

Table 5. AC Characteristics, $V_{CC} = 3.3V \pm 5\%$, $V_{EE} = 0V$, $T_A = 0^\circ C$ to $70^\circ C$

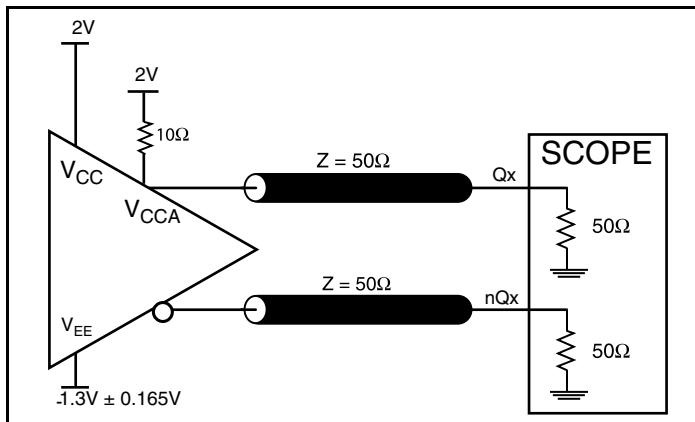
Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency		116		150	MHz
$t_{jitter}(\emptyset)$	RMS Phase Jitter, Random; NOTE 1	120MHz, (Integration Range: 12kHz – 20MHz)		0.81		ps
t_R / t_F	Output Rise/Fall Time	20% to 80%	100		600	ps
odc	Output Duty Cycle		47		53	%

NOTE 1: Please refer to Phase Noise Plot.

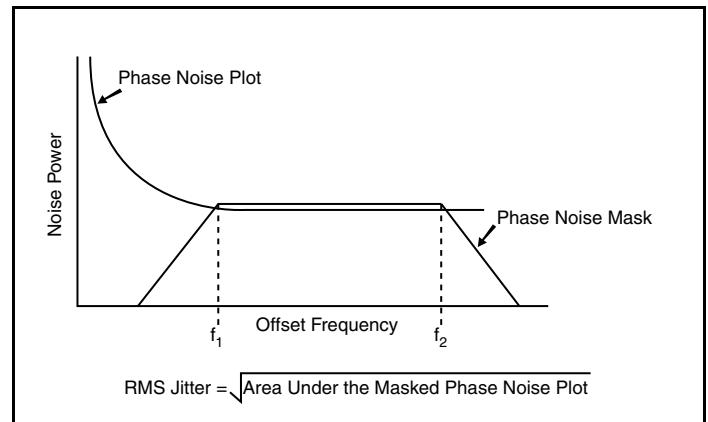
Typical Phase Noise at 120MHz



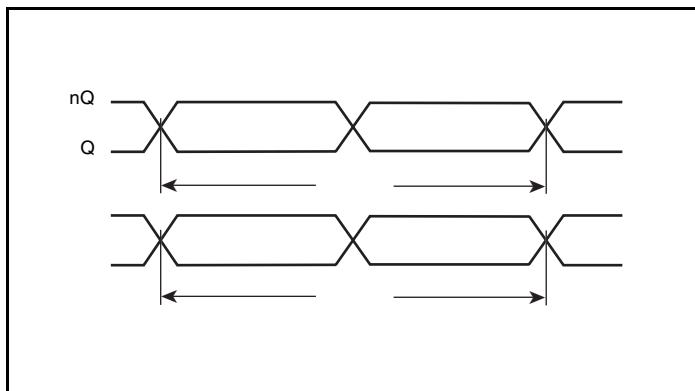
Parameter Measurement Information



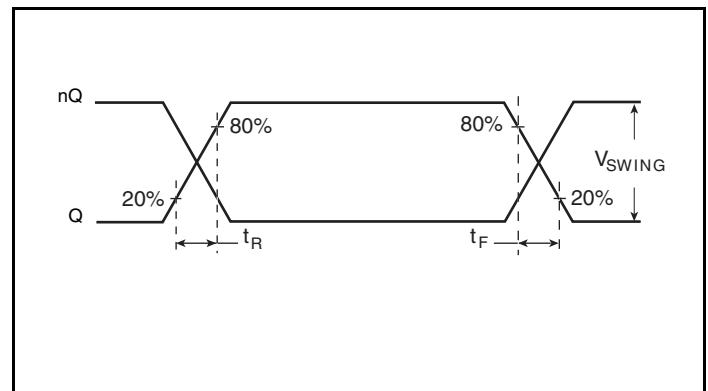
3.3V LVPECL Output Load AC Test Circuit



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 ICS843SDN 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 μ 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 Ω resistor along with a 10 μ F bypass capacitor be connected to the V_{CCA} pin.

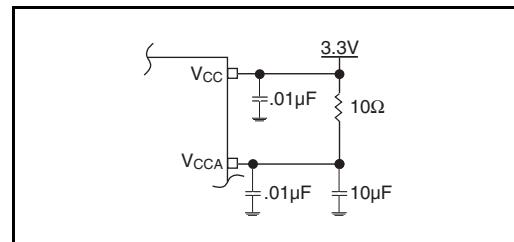


Figure 1. Power Supply Filtering

Crystal Input Interface

The ICS843SDN has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in Figure 2 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.

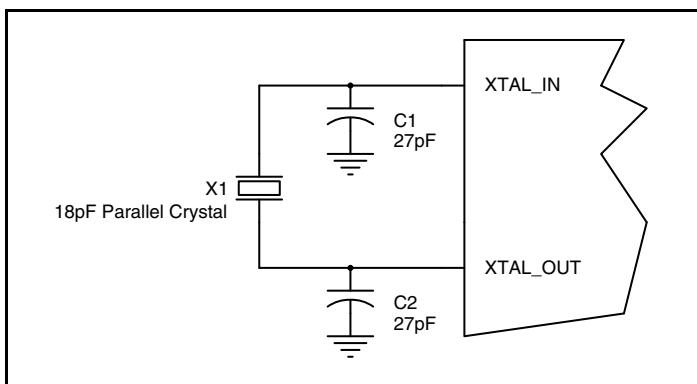


Figure 2. Crystal Input Interface

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.

F_{OUT} and nF_{OUT} 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 50 Ω transmis-

sion 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.

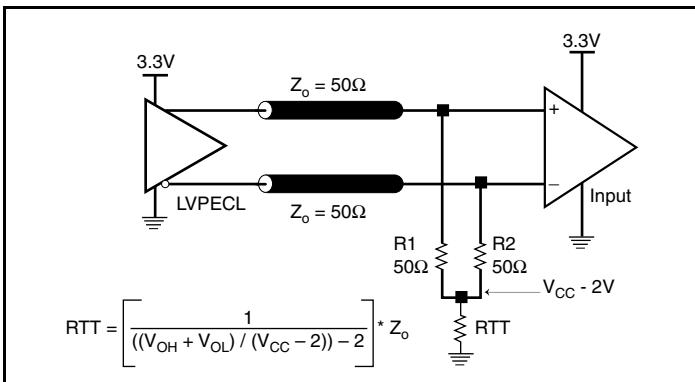


Figure 4A. 3.3V LVPECL Output Termination

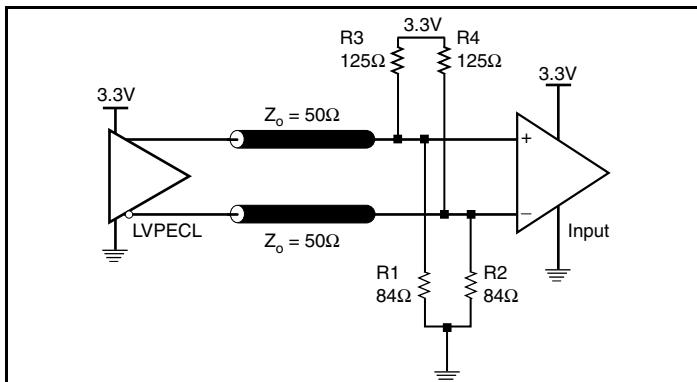


Figure 4B. 3.3V LVPECL Output Termination

Schematic Example

Figure 5A shows an example of the ICS843SDN application schematic. In this example, the device is operated at $V_{CC} = 3.3V$. The 18pF parallel resonant crystal is used. The $C1 = 27pF$ and $C2 = 27pF$ are recommended for frequency accuracy. For a different board layout, the $C1$ and $C2$ values may be slightly adjusted for

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

Note: Thermal pad (E-pad) must be connected to ground (VEE).

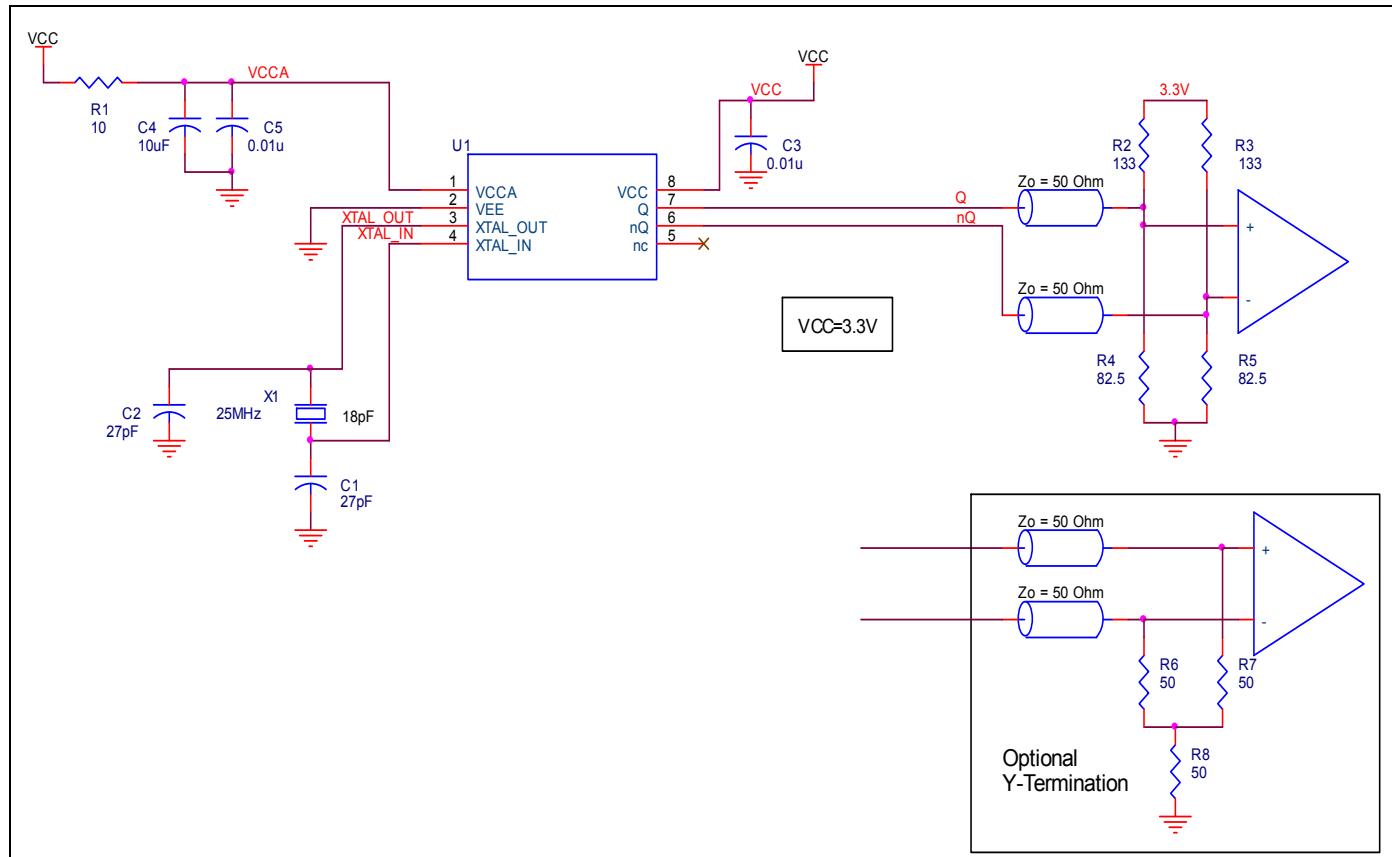


Figure 5A. ICS843SDN Schematic Example

Schematic Example

Figure 5B shows an example of ICS843SDN P.C. board layout. The crystal X1 footprint shown in this example allows installation of either surface mount HC49S or through-hole HC49 package. The footprints of other components in this example are listed in the

Table 6. There should be at least one decoupling capacitor per power pin. The decoupling capacitors should be located as close as possible to the power pins. The layout assumes that the board has clean analog power ground plane.

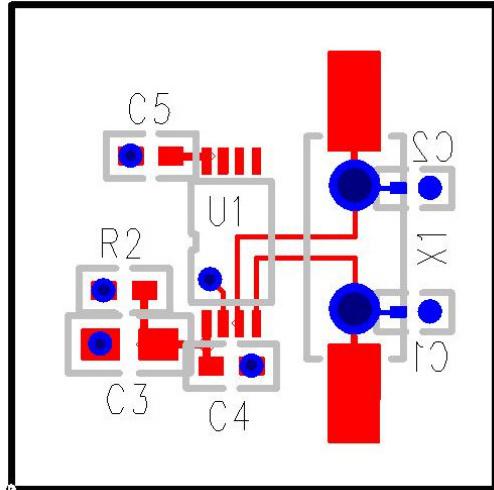


Figure 5B. ICS843SDN PC Board Layout Example

Table 6. Footprint Table

Reference	Size
C1, C2	0402
C3	0805
C4, C5	0603
R2	0603

NOTE: Table 6 lists component sizes shown in this layout example.

Power Considerations

This section provides information on power dissipation and junction temperature for the ICS843SDN. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS843SDN 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} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 83mA = 287.60\text{mW}$
- Power (outputs)_{MAX} = **30mW/Loaded Output pair**

Total Power_{MAX} (3.3V, with all outputs switching) = $287.60\text{mW} + 30\text{mW} = 317.60\text{mW}$

2. Junction Temperature.

Junction temperature, T_j , 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 is 125°C.

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

T_j = Junction Temperature

θ_{JA} = Junction-to-Ambient Thermal Resistance

P_{d_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 7 below.

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

$70^\circ\text{C} + 0.318\text{W} * 129.5^\circ\text{C/W} = 111.2^\circ\text{C}$. This is 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 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	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*.

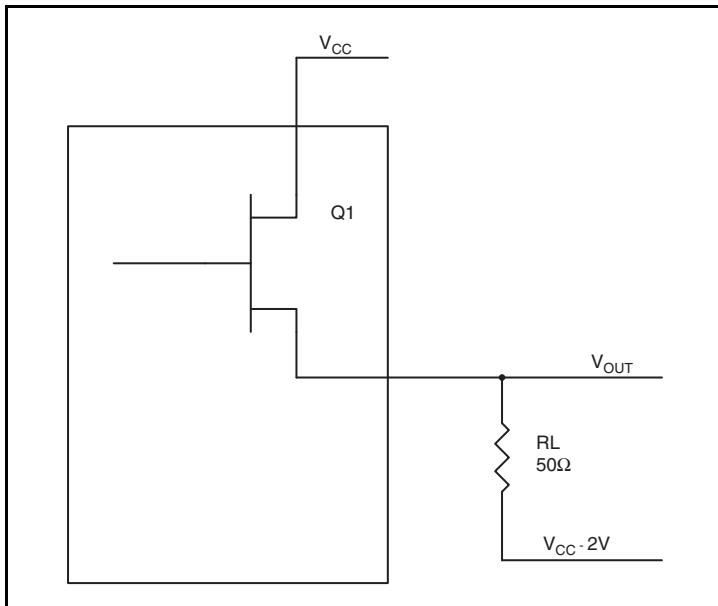


Figure 6. LVPECL Driver Circuit and Termination

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, $V_{OUT} = V_{OL_MAX} = V_{CC_MAX} - 1.7V$
 $(V_{CC_MAX} - V_{OL_MAX}) = 1.7V$

P_{d_H} is power dissipation when the output drives high.

P_{d_L} is the power dissipation when the output drives low.

$$P_{d_H} = [(V_{OH_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - (V_{CC_MAX} - V_{OH_MAX}))/R_L] * (V_{CC_MAX} - V_{OH_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = 19.8\text{mW}$$

$$P_{d_L} = [(V_{OL_MAX} - (V_{CC_MAX} - 2V))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - (V_{CC_MAX} - V_{OL_MAX}))/R_L] * (V_{CC_MAX} - V_{OL_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = 10.2\text{mW}$$

Total Power Dissipation per output pair = $P_{d_H} + P_{d_L} = 30\text{mW}$

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	129.5°C/W	125.5°C/W	123.5°C/W

Transistor Count

The transistor count for ICS843SDN is: 2395

Package Outline and Package Dimensions

Package Outline - G Suffix for 8 Lead TSSOP

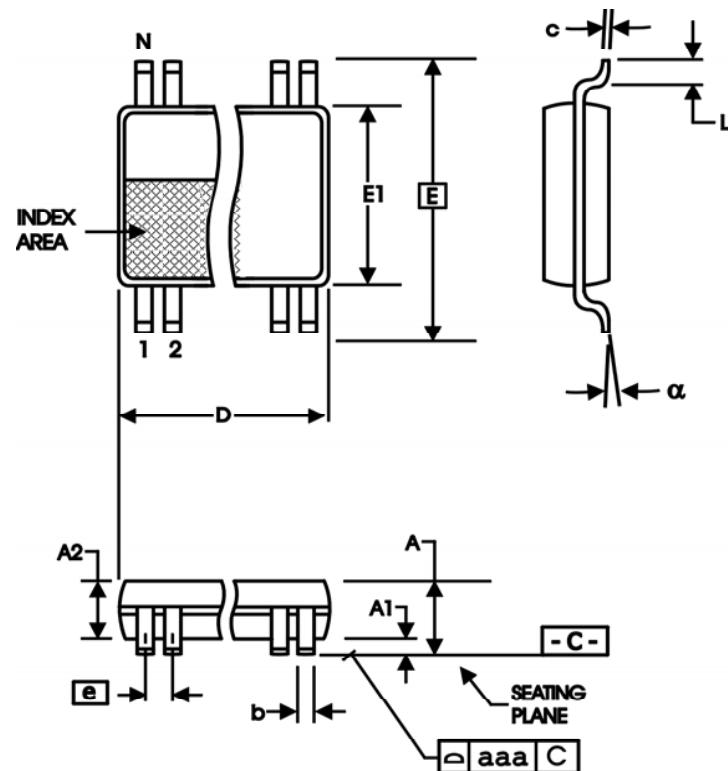


Table 9. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	8	
A		1.20
A1	0.05	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 10. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
843SDNAGLF	SDNAL	“Lead-Free” 8 Lead TSSOP	Tube	0°C to 70°C
843SDNAGLFT	SDNAL	“Lead-Free” 8 Lead TSSOP	Tape & Reel	0°C to 70°C

Revision History Sheet

Rev	Table	Page	Description of Change	Date
A	T4	1	Deleted HiPerClockS references throughout.	10/18/12
		3	Crystal Characteristics Table - added note.	
		6	Deleted application note, <i>LVCMOS to XTAL Interface</i> .	
		7	Added Note: Thermal pad (E-pad) must be connected to ground (VEE).	
	T10	12	Deleted quantity from tape and reel. Deleted lead-free note.	

ICS843SDN

FEMTOCLOCK™ CRYSTAL-TO-3.3V LVPECL CLOCK GENERATOR

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.