



FemtoClock® NG Crystal-to-3.3V LVPECL Clock Generator

843001

DATA SHEET

GENERAL DESCRIPTION

The 843001 is a Fibre Channel Clock Generator and a member of the family of high performance devices from IDT. The 843001 uses either a 26.5625MHz or a 23.4375 crystal to synthesize 106.25MHz, 187.5MHz or 212.5MHz, using the **FREQ_SEL** pin. The 843001 has excellent <1ps phase jitter performance, over the 637kHz – 10MHz integration range. The 843001 is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

FEATURES

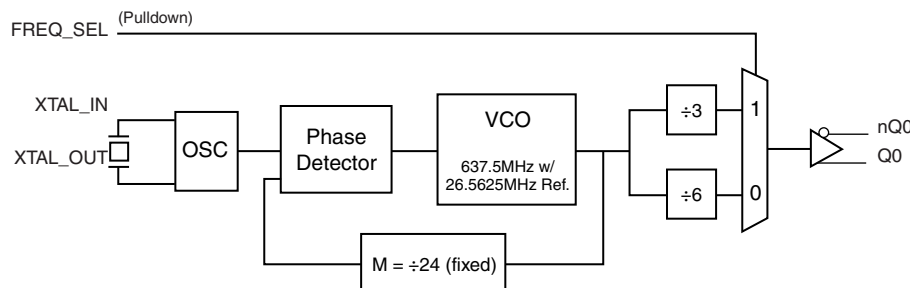
- One differential 3.3V LVPECL output
- Crystal oscillator interface designed for 23.4375MHz or 26.5625MHz, 18pF parallel resonant crystal
- Selectable 106.25MHz, 187.5MHz or 212.5MHz output frequency
- VCO range: 560MHz - 680MHz
- RMS phase jitter @ 106.25MHz, using a 26.5625MHz crystal (637kHz - 10MHz): 0.74ps (typical)
- RMS phase noise at 106.25MHz
Phase noise:

| Offset | Noise Power |
|--------|---------------|
| 100Hz | -95.2 dBc/Hz |
| 1KHz | -118.7 dBc/Hz |
| 10KHz | -129.1 dBc/Hz |
| 100KHz | -129.6 dBc/Hz |
- 3.3V operating supply
- -30°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

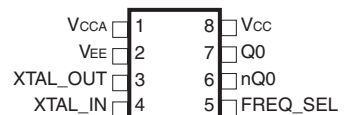
FUNCTION TABLE

| Inputs | | Output Frequencies |
|-------------------|----------|---------------------|
| Crystal Frequency | FREQ_SEL | |
| 26.5625MHz | 0 | 106.25MHz (Default) |
| 26.5625MHz | 1 | 212.5MHz |
| 23.4375MHz | 1 | 187.5MHz |

BLOCK DIAGRAM



PIN ASSIGNMENT



843001

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 _{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 | FREQ_SEL | Input | Pulldown | Frequency select pin. LVCMOS/LVTTL interface levels. |
| 6, 7 | nQ0, Q0 | Output | | Differential clock outputs. LVPECL interface levels. |
| 8 | V _{CC} | 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

| | |
|--|--------------------------|
| 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, θ_{JA} | 101.7°C/W (0 mps) |
| 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 3A. POWER SUPPLY DC CHARACTERISTICS, $V_{CC} = 3.3V \pm 5\%$, $T_A = -30^\circ C$ TO $85^\circ C$

| 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 |
| I_{CCA} | Analog Supply Current | included in I_{EE} | | | 12 | mA |
| I_{EE} | Power Supply Current | | | | 93 | mA |

TABLE 3B. LVCMOS/LVTTL DC CHARACTERISTICS, $V_{CC} = 3.3V \pm 5\%$, $T_A = -30^\circ C$ 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 | FREQ_SEL $V_{CC} = V_{IN} = 3.465V$ | | | 150 | μA |
| I_{IL} | Input Low Current | FREQ_SEL $V_{CC} = 3.465V, V_{IN} = 0V$ | -5 | | | μA |

TABLE 3C. LVPECL DC CHARACTERISTICS, $V_{CC} = 3.3V \pm 5\%$, $T_A = -30^\circ C$ TO $85^\circ C$

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|----------------|---------|----------------|-------|
| V_{OH} | Output High Voltage; NOTE 1 | | $V_{CC} - 1.4$ | | $V_{CC} - 0.9$ | V |
| V_{OL} | Output Low Voltage; 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 terminated with 50Ω to $V_{CC} - 2V$.

TABLE 4. CRYSTAL CHARACTERISTICS

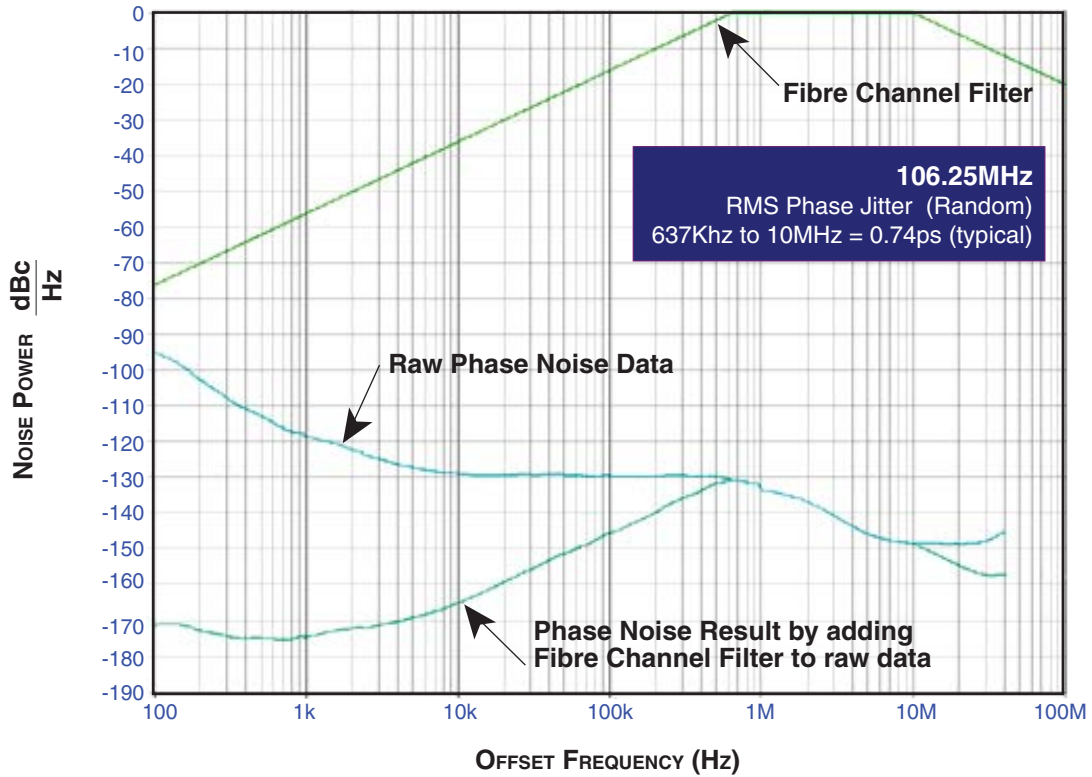
| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | 23.4375 | | 26.5625 | MHz |
| Equivalent Series Resistance (ESR) | | | | 50 | Ω |
| Shunt Capacitance | | | | 7 | pF |

TABLE 5. AC CHARACTERISTICS, $V_{cc} = 3.3V \pm 5\%$, $T_A = -30^{\circ}C$ TO $85^{\circ}C$

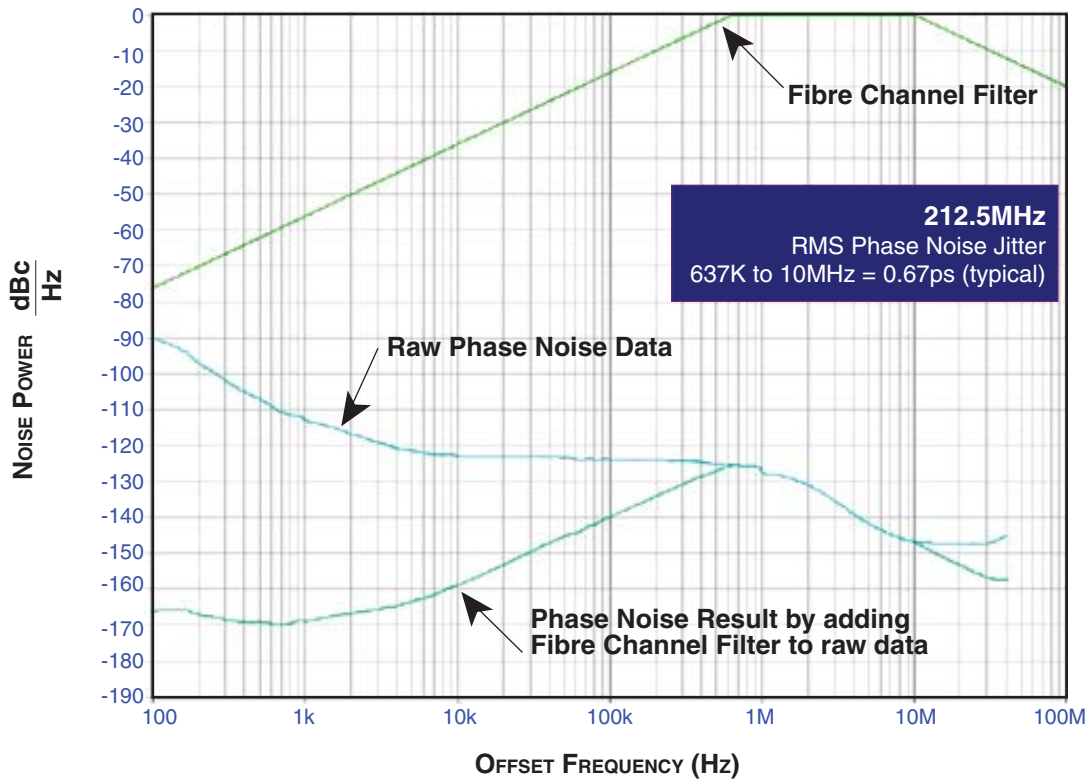
| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------------------|---------------------------------------|-------------------------------|---------|---------|---------|-------|
| f_{OUT} | Output Frequency | FREQ_SEL = 1 | 186.67 | | 226.66 | MHz |
| | | FREQ_SEL = 0 | 93.33 | | 113.33 | MHz |
| $t_{jit}(\emptyset)$ | RMS Phase Jitter, (Random); NOTE 1 | 212.5MHz, (637KHz to 10MHz) | | 0.67 | | ps |
| | | 187.5MHz, (1.875MHz to 20MHz) | | 0.52 | | ps |
| | | 106.25MHz, (637KHz to 10MHz) | | 0.74 | | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | 300 | | 600 | ps |
| odc | Output Duty Cycle | FSEL = 0 | 48 | | 52 | % |
| | | FSEL = 1 | 45 | | 55 | % |

NOTE 1: Please refer to Phase Noise Plot.

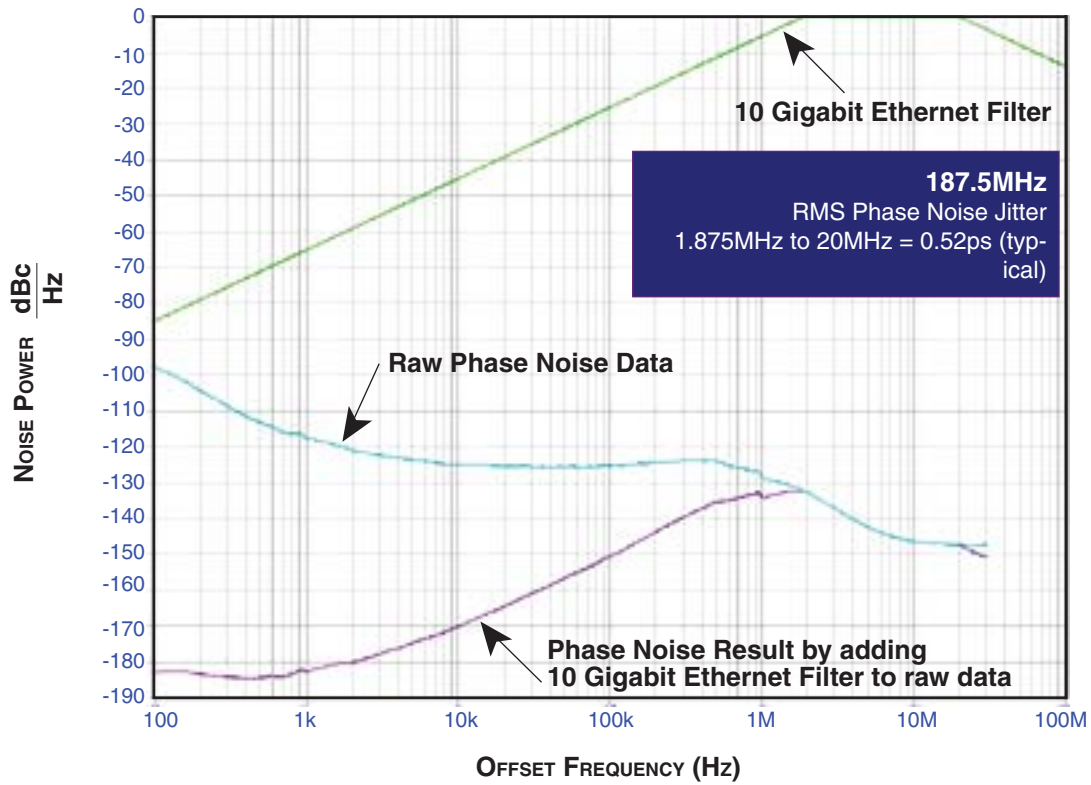
TYPICAL PHASE NOISE AT 106.25MHz



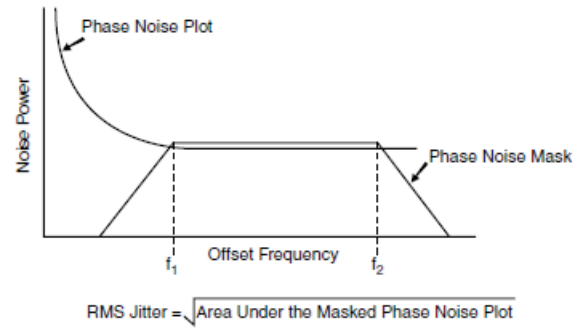
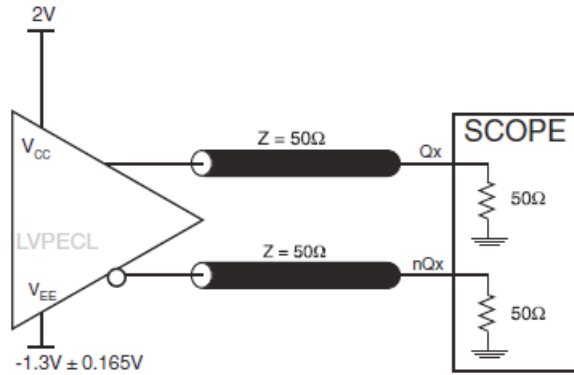
TYPICAL PHASE NOISE AT 212.5MHz



TYPICAL PHASE NOISE AT 187.5MHz

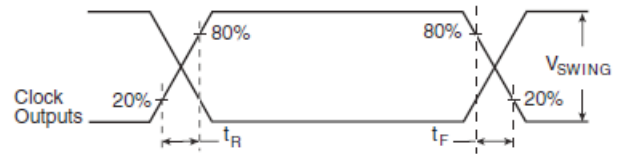
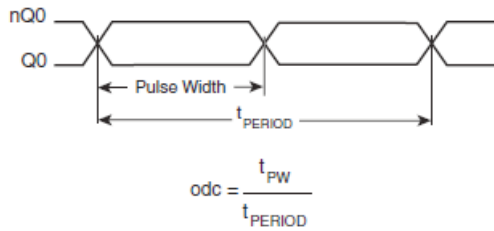


PARAMETER MEASUREMENT INFORMATION



3.3V OUTPUT LOAD AC TEST CIRCUIT

RMS PHASE JITTER



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD

OUTPUT RISE/FALL TIME

APPLICATION INFORMATION

POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The 843001 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 bypass capacitors should be used for each pin. To achieve optimum jitter performance, power supply isolation is required. *Figure 1* illustrates how a 10Ω resistor along with a $10\mu\text{F}$ and a $.01\mu\text{F}$ bypass capacitor should be connected to each V_{CCA} pin.

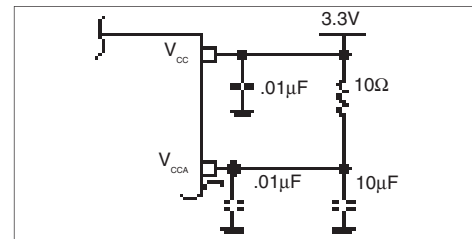


FIGURE 1. POWER SUPPLY FILTERING

CRYSTAL INPUT INTERFACE

The 843001 has been characterized with 18pF parallel resonant crystals. The capacitor values, $C1$ and $C2$, shown in *Figure 2* below were determined using a 26.5625MHz , 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.

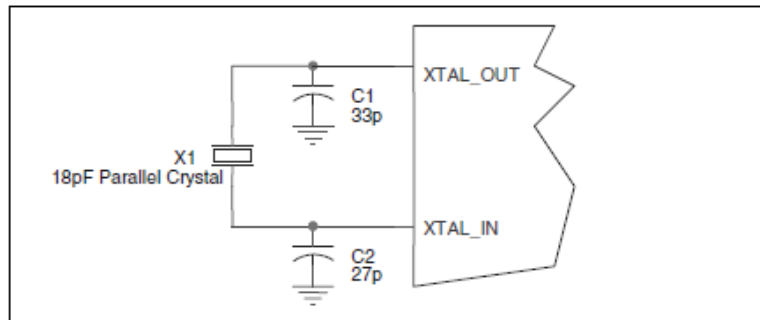


FIGURE 2. CRYSTAL INPUT INTERFACE

LAYOUT GUIDELINE

Figure 3A shows a schematic example of the 843001. An example of LVPECL termination is shown in this schematic. Additional LVPECL termination approaches are shown in the LVPECL Termination Application Note. In this example, an 18pF parallel resonant crystal

is used. The C1 = 27pF and C2 = 33pF are recommended for frequency accuracy. The C1 and C2 values may be slightly adjusted for optimizing frequency accuracy.

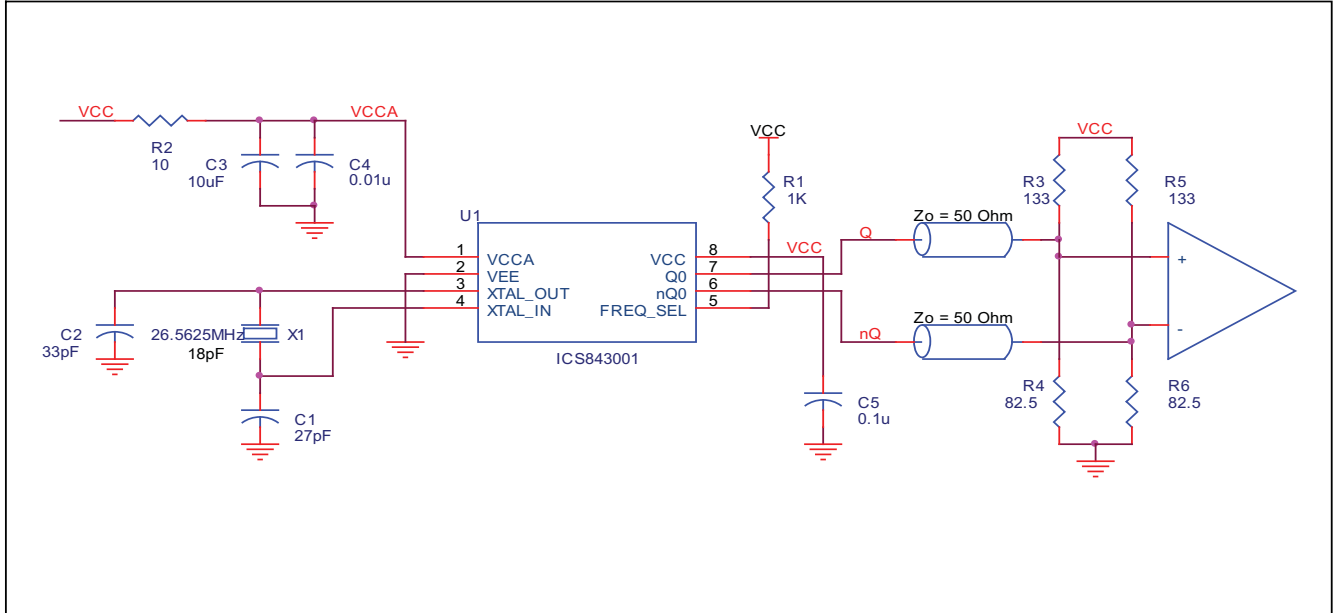


FIGURE 3A. 843001 SCHEMATIC EXAMPLE

PC BOARD LAYOUT EXAMPLE

Figure 3B shows an example of 843001 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.

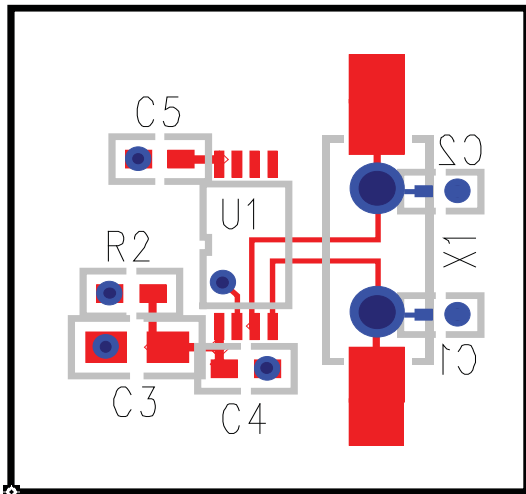


FIGURE 3B. 843001 PC BOARD LAYOUT EXAMPLE

TABLE 6. FOOTPRINT TABLE

| Reference | Size |
|-----------|------|
| C1, C2 | 0402 |
| C3 | |
| C4, C5 | |
| R2 | |

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 843001. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the 843001 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} = $V_{CC_MAX} * I_{EE_MAX} = 3.465V * 93mA = 322.2mW$
- Power (outputs)_{MAX} = **30mW/Loaded Output pair**

$$\text{Total Power}_{MAX} (3.465V, \text{ with all outputs switching}) = 322.2mW + 30mW = 352.2mW$$

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 for HiPerClockS™ devices is 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 a moderate air flow of 1 meter per second and a multi-layer board, the appropriate value is 90.5°C/W per Table 7 below.

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

$$85^\circ\text{C} + 0.352\text{W} * 90.5^\circ\text{C}/\text{W} = 116.9^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

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 (single layer or multi-layer).

TABLE 7. THERMAL RESISTANCE θ_{JA} FOR 8-PIN TSSOP, FORCED CONVECTION

| θ_{JA} by Velocity (Meters per Second) | | | |
|---|-----------|----------|----------|
| | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 101.7°C/W | 90.5°C/W | 89.8°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 4*.

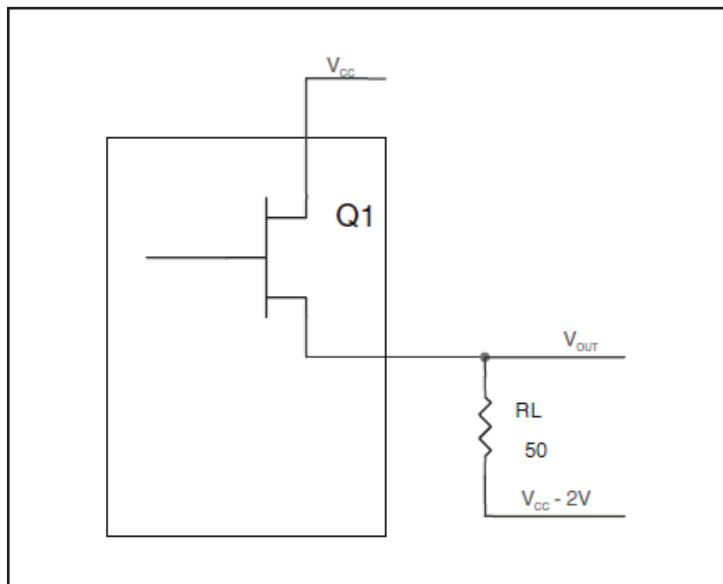


FIGURE 4. LVPECL DRIVER CIRCUIT AND TERMINATION

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 8. θ_{JA} VS. AIR FLOW TABLE FOR 8 LEAD TSSOP

| θ_{JA} by Velocity (Meters per Second) | | | |
|---|-----------|----------|----------|
| | 0 | 1 | 2.5 |
| Multi-Layer PCB, JEDEC Standard Test Boards | 101.7°C/W | 90.5°C/W | 89.8°C/W |

TRANSISTOR COUNT

The transistor count for 843001 is: 1702

PACKAGE OUTLINE - G SUFFIX 8 LEAD TSSOP

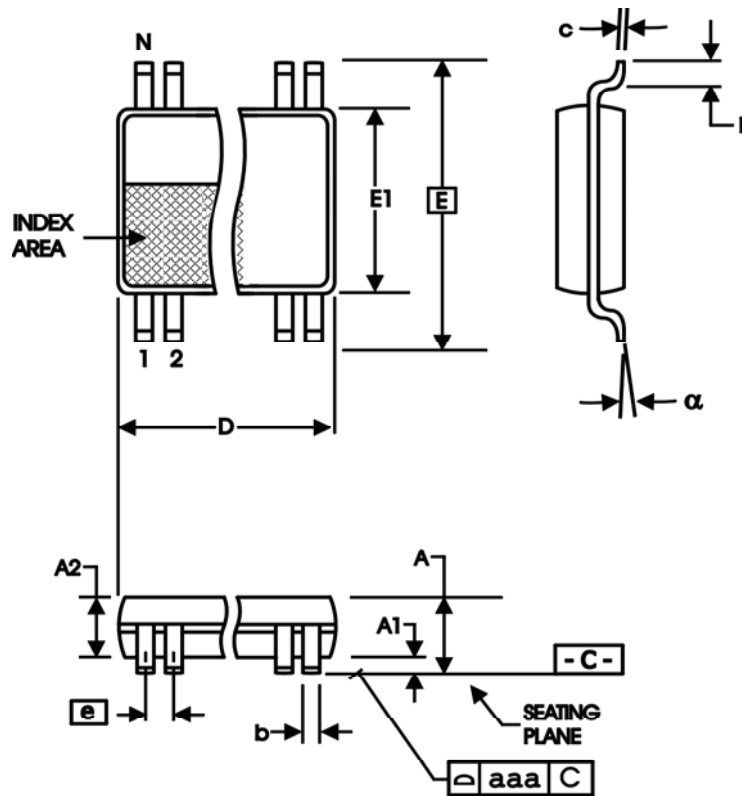


TABLE 9. PACKAGE DIMENSIONS

| SYMBOL | Millimeters | |
|--------|-------------|---------|
| | 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 |
| α | 0° | 8° |
| aaa | -- | 0.10 |

Reference Document: JEDEC Publication 95, MO-153

TABLE 10. ORDERING INFORMATION

| Part/Order Number | Marking | Package | Shipping Packaging | Temperature |
|-------------------|---------|--------------------------|--------------------|---------------|
| 843001AGLF | 001AL | 8 Lead "Lead-Free" TSSOP | Tube | -30°C to 85°C |
| 843001AGLFT | 001AL | 8 Lead "Lead-Free" TSSOP | 2500 Tape & Reel | -30°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.

| REVISION HISTORY SHEET | | | | |
|------------------------|-------|------|---|----------|
| Rev | Table | Page | Description of Change | Date |
| A | | 1 | Corrected block diagram. | 6/1/04 |
| B | T3A | 3 | Power Supply DC Characteristics Table- added ICCA spec. | 8/23/04 |
| B | T10 | 14 | Ordering Information Table - corrected count from 154 to 100 per tube. | 10/13/04 |
| B | T10 | 1 | Added Lead-Free bullet in Features section. | 12/14/04 |
| | | 14 | Ordering Information Table - added "Lead-Free" part. | |
| B | T10 | 14 | Ordering Information Table - corrected Part/Order Number & Marking from ".AG" to ".BG". | 12/04/06 |
| B | T10 | 14 | Ordering Information Table - changed Part/Order Number & Marking back to "AG" from ".BG". | 12/06/06 |
| B | T10 | 14 | Ordering Information - removed leaded devices. Updated data sheet format. | 11/16/15 |



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