


FEMTOCLOCKS™ CRYSTAL-TO-LVHSTL FREQUENCY SYNTHESIZER

ICS8422002I-01

General Description



The ICS8422002I-01 is a 2 output LVHSTL Synthesizer optimized to generate Ethernet reference clock frequencies and is a member of the HiPerClocks™ family of high performance clock solutions from IDT. Using a 25MHz 18pF parallel resonant crystal, the following frequencies can be generated based on the 2 frequency select pins (F_SEL[1:0]): 156.25MHz, 125MHz and 62.5MHz. The ICS8422002I-01 uses IDT's 3rd generation low phase noise VCO technology and can achieve 1ps or lower typical rms phase jitter, easily meeting Ethernet jitter requirements. The ICS8422002I-01 is packaged in a small 20-pin TSSOP package.

Features

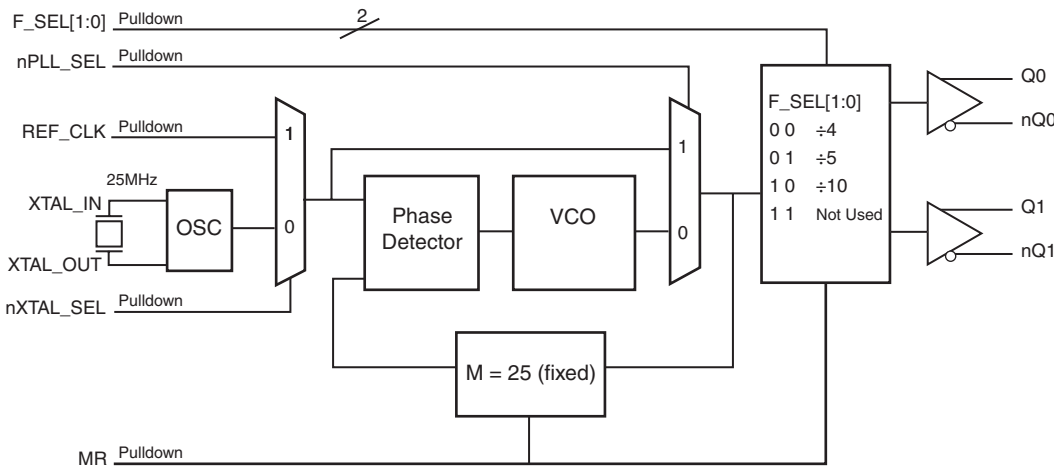
- Two LVHSTL outputs ($V_{OHmax} = 1.2V$)
- Selectable crystal oscillator interface or LVCMOS/LVTTL single-ended input
- Supports the following output frequencies: 156.25MHz, 125MHz, 62.5MHz
- VCO range: 560MHz - 680MHz
- RMS phase jitter @ 156.25MHz, using a 25MHz crystal (1.875MHz - 20MHz): 0.44ps (typical)
- Power supply modes:
Core/Output
3.3V/1.8V
2.5V/1.8V
- -40°C to 85°C ambient operating temperature
- Available in both standard (RoHS 5) and lead-free (RoHS 6) packages

Pin Assignment

| | | | |
|----------|----|----|-----------|
| nc | 1 | 20 | VDDO |
| VDDO | 2 | 19 | Q1 |
| Q0 | 3 | 18 | nQ1 |
| nQ0 | 4 | 17 | GND |
| MR | 5 | 16 | VDD |
| nPLL_SEL | 6 | 15 | nXTAL_SEL |
| nc | 7 | 14 | REF_CLK |
| VDDA | 8 | 13 | XTAL_IN |
| F_SEL0 | 9 | 12 | XTAL_OUT |
| VDD | 10 | 11 | F_SEL1 |

ICS422002I-01
20-Lead TSSOP
6.5mm x 4.4mm x 0.925mm package body
G Package
Top View

Block Diagram



The Preliminary Information presented herein represents a product in pre-production. The noted characteristics are based on initial product characterization and/or qualification. Integrated Device Technology, Incorporated (IDT) reserves the right to change any circuitry or specifications without notice.

Table 1. Pin Descriptions

| Number | Name | Type | | Description |
|--------|----------------------|--------|----------|---|
| 1, 7 | nc | Unused | | No connect. |
| 2, 20 | V _{DDO} | Power | | Output supply pins. |
| 3, 4 | Q0, nQ0 | Output | | Differential output pair. LVHSTL interface levels. |
| 5 | MR | Input | Pulldown | Active HIGH Master Reset. When logic HIGH, the internal dividers are reset causing the true outputs Qx to go low and the inverted outputs nQx to go high. When logic LOW, the internal dividers and the outputs are enabled. LVCMOS/LVTTL interface levels. |
| 6 | nPLL_SEL | Input | Pulldown | Selects between the PLL and REF_CLK as input to the dividers. When LOW, selects PLL (PLL Enable). When HIGH, deselects the reference clock (PLL Bypass). LVCMOS/LVTTL interface levels. |
| 8 | V _{DDA} | Power | | Analog supply pin. |
| 9, 11 | F_SEL0, F_SEL1 | Input | Pulldown | Frequency select pins. LVCMOS/LVTTL interface levels. |
| 10, 16 | V _{DD} | Power | | Core supply pins. |
| 12, 13 | XTAL_OUT, XTAL_IN | Input | | Parallel resonant crystal interface. XTAL_OUT is the output, XTAL_IN is the input. |
| 14 | REF_CLK | Input | Pulldown | Single-ended reference clock input. LVCMOS/LVTTL interface levels. |
| 15 | nXTAL_SEL | Input | Pulldown | Selects between crystal or REF_CLK inputs as the PLL Reference source. Selects XTAL inputs when LOW. Selects REF_CLK when HIGH. LVCMOS/LVTTL interface levels. |
| 17 | GND | Power | | Power supply ground. |
| 18, 19 | nQ1, Q1 | Output | | Differential output pair. LVHSTL interface levels. |

NOTE: *Pullup and Pulldown* refer 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 | -0.5V to $V_{DD} + 0.5V$ |
| Outputs, I_O Continuous Current Surge Current | 50mA 100mA |
| Package Thermal Impedance, θ_{JA} | 73.2°C/W (0 lfp/m) |
| Storage Temperature, T_{STG} | -65°C to 150°C |

DC Electrical Characteristics

Table 3A. Power Supply DC Characteristics, $V_{DD} = V_{DDA} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ\text{C}$ to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| V_{DD} | Core Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{DDA} | Analog Supply Voltage | | 3.135 | 3.3 | 3.465 | V |
| V_{DDO} | Output Supply Voltage | | 1.6 | 1.8 | 2.0 | V |
| I_{DD} | Core Supply Current | | | 90 | | mA |
| I_{DDA} | Analog Supply Current | | | 10 | | mA |
| I_{DDO} | Output Supply Current | | | 0 | | mA |

Table 3B. Power Supply DC Characteristics, $V_{DD} = V_{DDA} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ\text{C}$ to 85°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 | | 2.375 | 2.5 | 2.625 | V |
| V_{DDO} | Output Supply Voltage | | 1.6 | 1.8 | 2.0 | V |
| I_{DD} | Core Supply Current | | | 80 | | mA |
| I_{DDA} | Analog Supply Current | | | 10 | | mA |
| I_{DDO} | Output Supply Current | | | 0 | | mA |

Table 3C. LVCMOS/LVTTL DC Characteristics, $T_A = -40^{\circ}\text{C}$ to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|----------|--------------------|---|---------|---------|----------------|---------------|
| V_{IH} | Input High Voltage | $V_{DD} = 3.3\text{V}$ | 2 | | $V_{DD} + 0.3$ | V |
| | | $V_{DD} = 2.5\text{V}$ | 1.7 | | $V_{DD} + 0.3$ | V |
| V_{IL} | Input Low Voltage | $V_{DD} = 3.3\text{V}$ | -0.3 | | 0.8 | V |
| | | $V_{DD} = 2.5\text{V}$ | -0.3 | | 0.7 | V |
| I_{IH} | Input High Current | REF_CLK, MR, F_SEL[0:1], nPLL_SEL, nXTAL_SEL $V_{DD} = V_{IN} = 3.465\text{V}$ or 2.625V | | | 150 | μA |
| I_{IL} | Input Low Current | REF_CLK, MR, F_SEL[0:1], nPLL_SEL, nXTAL_SEL $V_{DD} = 3.465\text{V}$ or 2.625V , $V_{IN} = 0\text{V}$ | -5 | | | μA |

Table 3D. LVHSTL DC Characteristics, $V_{DD} = V_{DDA} = 3.3\text{V} \pm 5\%$, $V_{DDO} = 1.8\text{V} \pm 0.2\text{V}$, $T_A = -40^{\circ}\text{C}$ to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|---------|---------|---------|-------|
| V_{OH} | Output High Current; NOTE 1 | | 1.0 | | 1.2 | V |
| V_{OL} | Output Low Current; NOTE 1 | | 0 | | 0.4 | V |
| V_{OX} | Output Crossover Voltage; NOTE 2 | | 40 | | 60 | % |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | 0.6 | | 1.1 | V |

NOTE 1: Outputs termination with 50Ω to ground.

NOTE 2: Defined with respect to output voltage swing at a given condition.

Table 3E. LVHSTL DC Characteristics, $V_{DD} = V_{DDA} = 2.5\text{V} \pm 5\%$, $V_{DDO} = 1.8\text{V} \pm 0.2\text{V}$, $T_A = -40^{\circ}\text{C}$ to 85°C

| Symbol | Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|-----------------------------------|-----------------|---------|---------|---------|-------|
| V_{OH} | Output High Current; NOTE 1 | | 1.0 | | 1.2 | V |
| V_{OL} | Output Low Current; NOTE 1 | | | 0.235 | | V |
| V_{OX} | Output Crossover Voltage; NOTE 2 | | 40 | | 60 | % |
| V_{SWING} | Peak-to-Peak Output Voltage Swing | | | 0.9 | | V |

NOTE 1: Outputs termination with 50Ω to ground.

NOTE 2: Defined with respect to output voltage swing at a given condition.

Table 4. Crystal Characteristics

| Parameter | Test Conditions | Minimum | Typical | Maximum | Units |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation | | Fundamental | | | |
| Frequency | | 22.4 | 25 | 27.2 | MHz |
| Equivalent Series Resistance (ESR) | | | | 50 | Ω |
| Shunt Capacitance | | | | 7 | pF |
| Drive Level | | | | 1 | mW |

AC Electrical Characteristics

Table 5A. AC Characteristics, $V_{DD} = V_{DDA} = 3.3V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ\text{C}$ to 85°C

| Parameter | Symbol | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|--------------------------------------|-------------------------------|---------|---------|---------|-------|
| f_{OUT} | Output Frequency | F_SEL[1:0] = 00 | 140 | | 170 | MHz |
| | | F_SEL[1:0] = 01 | 112 | | 136 | MHz |
| | | F_SEL[1:0] = 10 | 56 | | 68 | MHz |
| $t_{sk(o)}$ | Output Skew; NOTE 1, 2 | | | TBD | | ps |
| $f_{jit()}$ | RMS Phase Jitter (Random); NOTE 3 | 156.25MHz, (1.875MHz – 20MHz) | | 0.44 | | ps |
| | | 125MHz, (1.875MHz – 20MHz) | | 0.48 | | ps |
| | | 62.5MHz, (1.875MHz – 20MHz) | | 0.49 | | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | | 410 | | ps |
| odc | Output Duty Cycle | | | 50 | | % |

NOTE 1: Defined as skew between outputs at the same supply voltages and with equal load conditions. Measured at $V_{DDO}/2$.

NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 3: Please refer to the Phase Noise Plot.

Table 5B. AC Characteristics, $V_{DD} = V_{DDA} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = -40^\circ\text{C}$ to 85°C

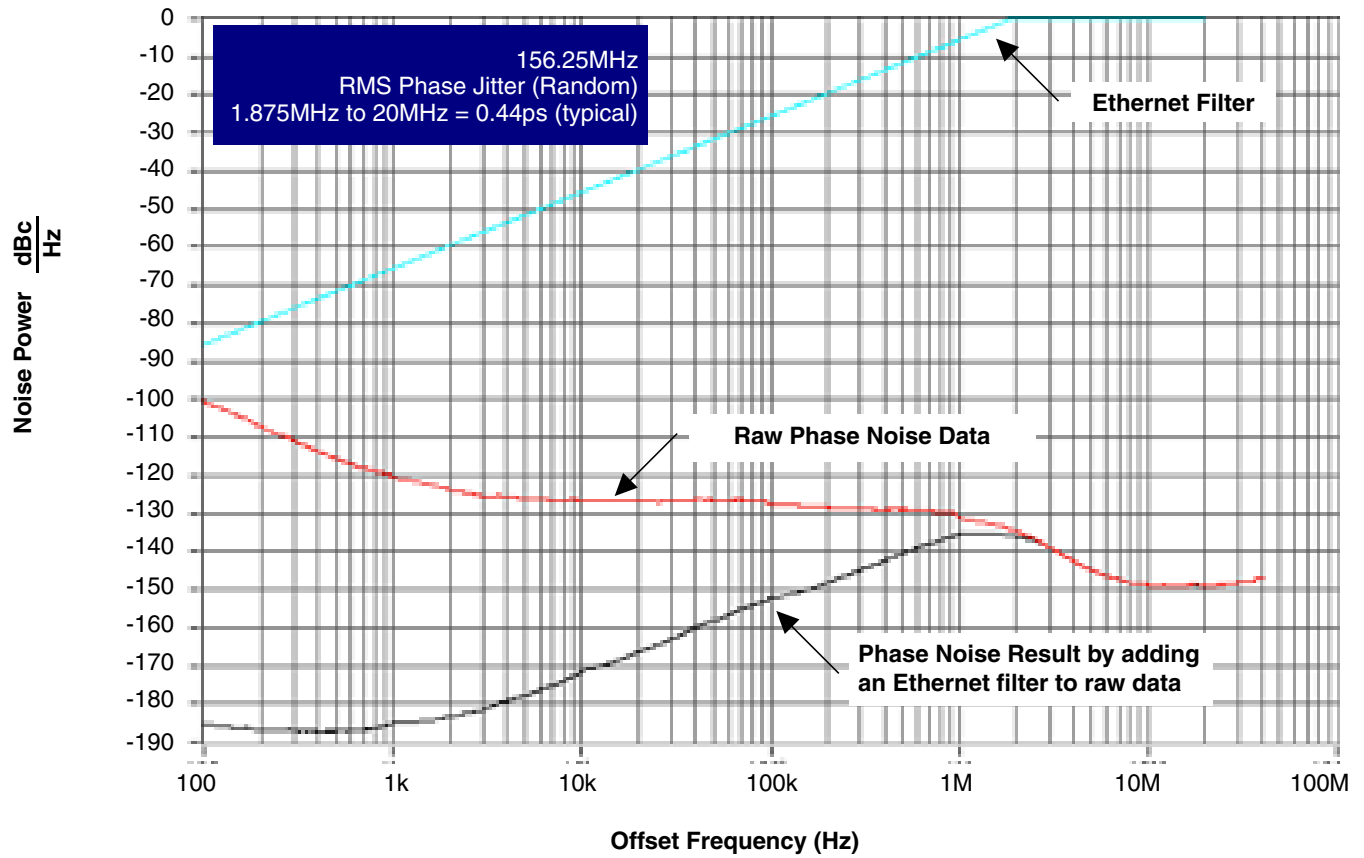
| Parameter | Symbol | Test Conditions | Minimum | Typical | Maximum | Units |
|-------------|--------------------------------------|-------------------------------|---------|---------|---------|-------|
| f_{OUT} | Output Frequency | F_SEL[1:0] = 00 | 140 | | 170 | MHz |
| | | F_SEL[1:0] = 01 | 112 | | 136 | MHz |
| | | F_SEL[1:0] = 10 | 56 | | 68 | MHz |
| $t_{sk(o)}$ | Output Skew; NOTE 1, 2 | | | TBD | | ps |
| $f_{jit()}$ | RMS Phase Jitter (Random); NOTE 3 | 156.25MHz, (1.875MHz – 20MHz) | | 0.41 | | ps |
| | | 125MHz, (1.875MHz – 20MHz) | | 0.49 | | ps |
| | | 62.5MHz, (1.875MHz – 20MHz) | | 0.50 | | ps |
| t_R / t_F | Output Rise/Fall Time | 20% to 80% | | 380 | | ps |
| odc | Output Duty Cycle | | | 50 | | % |

NOTE 1: Defined as skew between outputs at the same supply voltages and with equal load conditions. Measured at $V_{DDO}/2$.

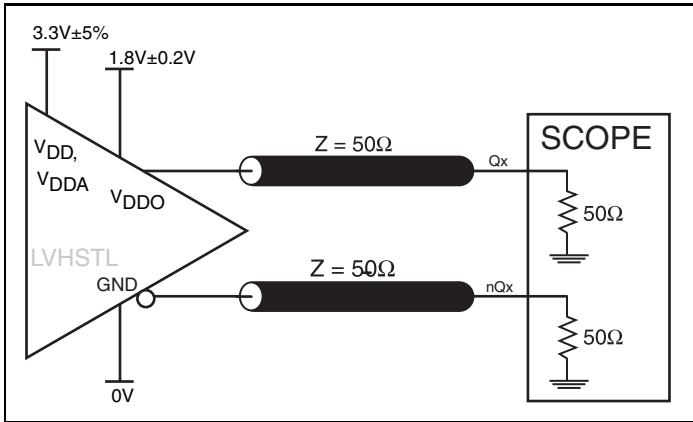
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 3: Please refer to the Phase Noise Plot.

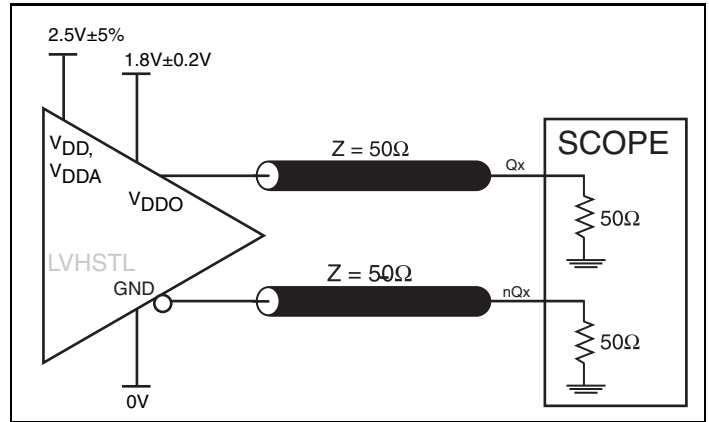
Typical Phase Noise at 156.25MHz



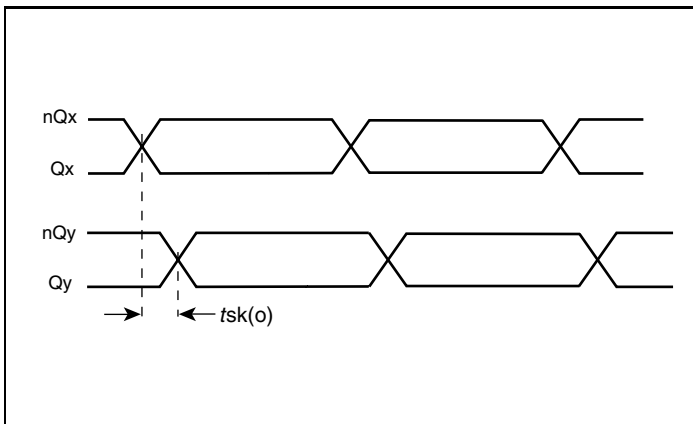
Parameter Measurement Information



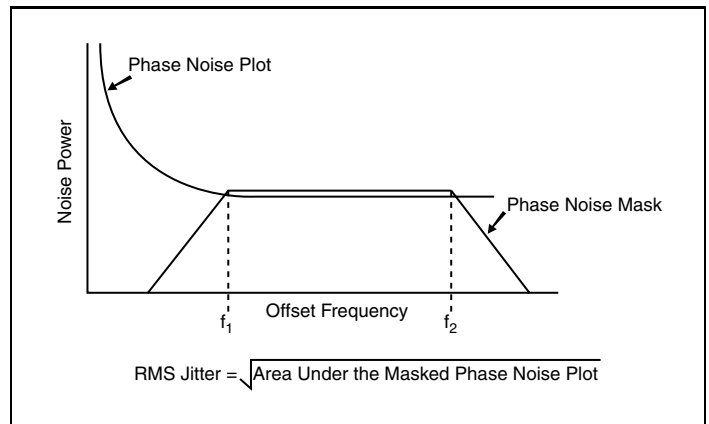
3.3V/1.8V Output Load AC Test Circuit



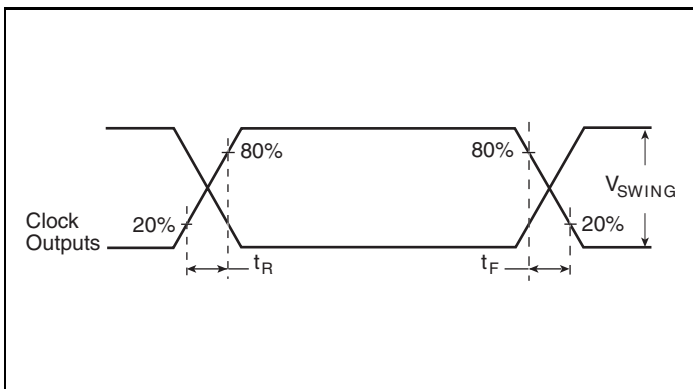
2.5V/1.8V Output Load AC Test Circuit



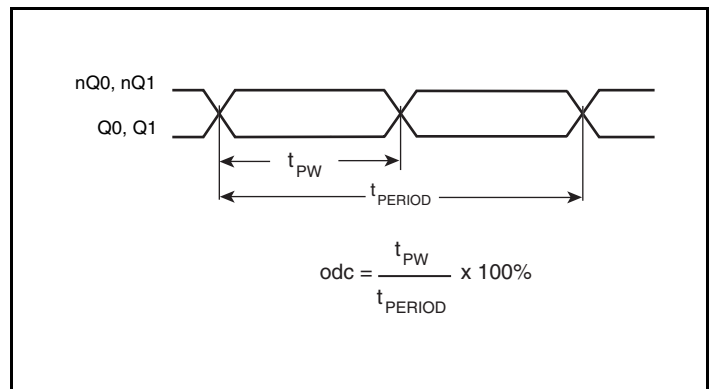
Output Skew



RMS Phase Jitter



Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period

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 ICS8422002I-01 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL. V_{DD} , V_{DDA} and V_{DDO} 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_{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.

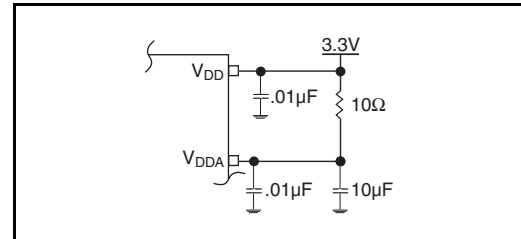


Figure 1. Power Supply Filtering

Recommendations for Unused Input and Output Pins

Inputs:

LVC MOS Control Pins

All control pins have internal pull-ups or pull-downs; additional resistance is not required but can be added for additional protection. A $1\text{k}\Omega$ resistor can be used.

Crystal INPUTS

For applications not requiring the use of the crystal oscillator input, both XTAL_IN and XTAL_OUT can be left floating. Though not required, but for additional protection, a $1\text{k}\Omega$ resistor can be tied from XTAL_IN to ground.

REF_CLK INPUT

For applications not requiring the use of the reference clock, it can be left floating. Though not required, but for additional protection, a $1\text{k}\Omega$ resistor can be tied from the REF_CLK to ground.

Outputs:

LVHSTL Outputs

All unused LVHSTL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

Crystal Input Interface

The ICS8422002I-01 has been characterized with 18pF parallel resonant crystals. The capacitor values shown in *Figure 2* below

were determined using a 25MHz 18pF parallel resonant crystal and were chosen to minimize the ppm error.

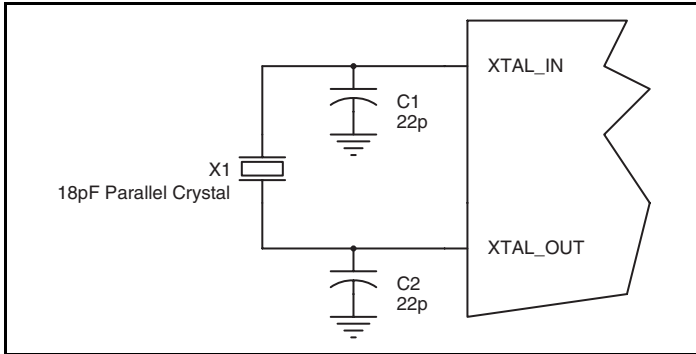


Figure 2. Crystal Input Interface

LVCMOS to 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 3*. The XTAL_OUT pin can be left floating. The input edge rate can be as slow as 10ns. For LVCMOS inputs, it is recommended that the amplitude be reduced from full swing to half swing in order to prevent signal interference with the power rail and to reduce noise. 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, 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 making R_2 50Ω.

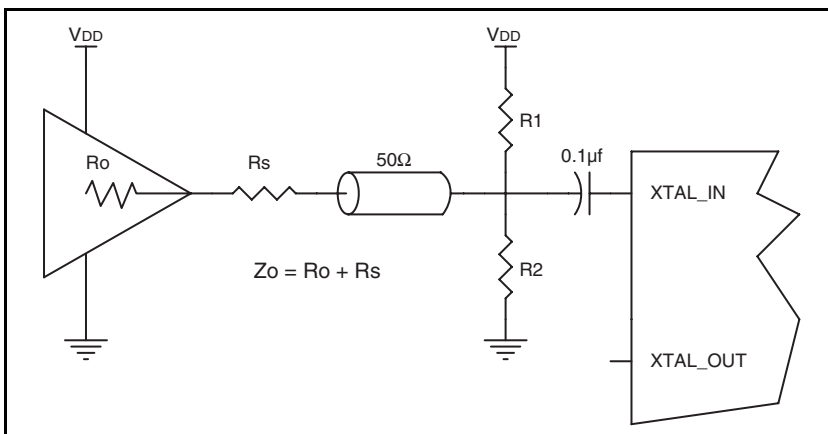


Figure 3. General Diagram for LVCMOS Driver to XTAL Input Interface

Schematic Example

Figure 4 shows an example of ICS8422002I-01 application schematic. In this example, the device is operated at $V_{DD} = 3.3V$. Both input options are shown. The device can either be driven using a quartz crystal or a 3.3V LVCMOS signal. The $C1 = 22pF$ and $C2 = 22pF$ are recommended for frequency accuracy. For

different board layout, the $C1$ and $C2$ may be slightly adjusted for optimizing frequency accuracy. The LVHSTL output driver termination examples are shown in this schematic. The decoupling capacitor should be located as close as possible to the power pin.

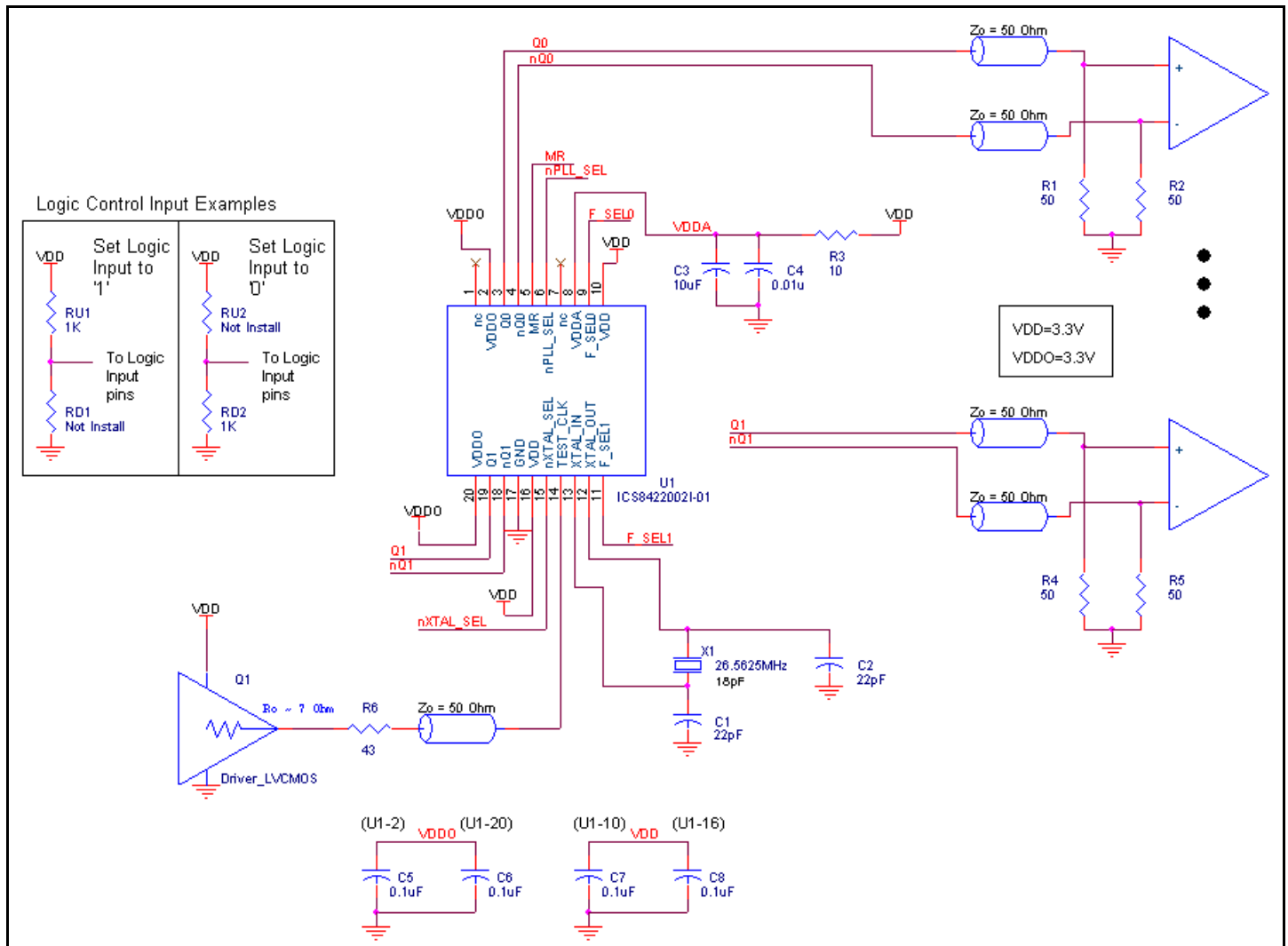


Figure 4. ICS8422002I-01 Schematic Example

Power Considerations

This section provides information on power dissipation and junction temperature for the ICS8422002I-01. Equations and example calculations are also provided.

1. Power Dissipation.

The total power dissipation for the ICS8422002I-01 is the sum of the core power plus the power dissipated in the load(s). The following is the power dissipation for $V_{DD} = 3.3V + 5\% = 3.465V$, which gives worst case results.

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

- Power (core)_{MAX} = $V_{DD_MAX} * I_{DD_MAX} = 3.465V * 100mA = \mathbf{346.5mW}$
- Power (outputs)_{MAX} = **32.8mW/Loaded Output pair**
If all outputs are loaded, the total power is $2 * 32.8mW = \mathbf{65.6mW}$

Total Power_{MAX} (3.465V, with all outputs switching) = $346.5mW + 65.6mW = \mathbf{412.1mW}$

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 200 linear feet per minute and a multi-layer board, the appropriate value is 66.6°C/W per Table 6 below.

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

$$85^\circ\text{C} + 0.412\text{W} * 66.6^\circ\text{C/W} = 112.4^\circ\text{C}. \text{ This is well below the limit of } 125^\circ\text{C}.$$

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 6. Thermal Resistance θ_{JA} for 20 Lead TSSOP, Forced Convection

| Linear Feet per Minute | θ_{JA} by Velocity | | |
|--|---------------------------|----------|----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 114.5°C/W | 98.0°C/W | 88.0°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 73.2°C/W | 66.6°C/W | 63.5°C/W |

3. Calculations and Equations.

The purpose of this section is to derive the power dissipated into the load.

LVHSTL output driver circuit and termination are shown in *Figure 5*.

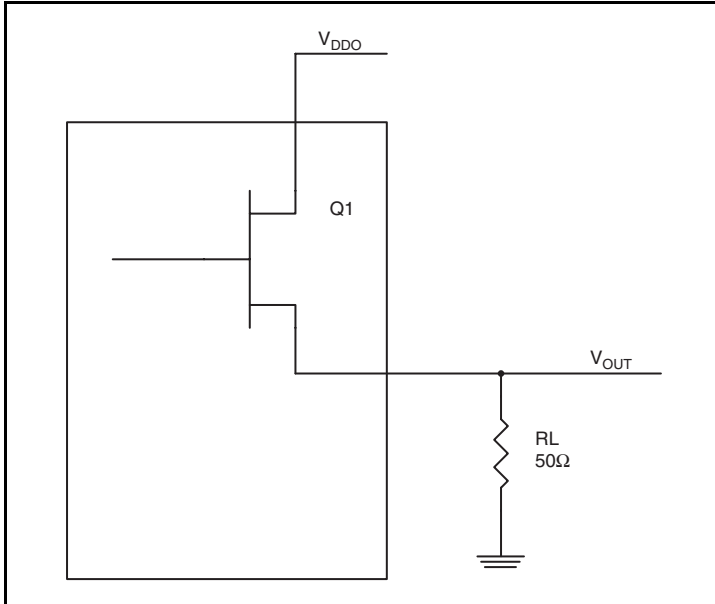


Figure 5. LVHSTL Driver Circuit and Termination

To calculate worst case power dissipation into the load, use the following equations which assume a 50Ω load.

Pd_H is power dissipation when the output drives high.

Pd_L is the power dissipation when the output drives low.

$$Pd_H = (V_{OH_MAX} / R_L) * (V_{DDO_MAX} - V_{OH_MAX})$$

$$Pd_L = (V_{OL_MAX} / R_L) * (V_{DDO_MAX} - V_{OL_MAX})$$

$$Pd_H = (1.0V / 50\Omega) * (2V - 1.0V) = \mathbf{20mW}$$

$$Pd_L = (0.4V / 50\Omega) * (2V - 0.4V) = \mathbf{12.8mW}$$

$$\text{Total Power Dissipation per output pair} = Pd_H + Pd_L = \mathbf{32.8mW}$$

Reliability Information

Table 7. θ_{JA} vs. Air Flow Table for a 20 Lead TSSOP

| Linear Feet per Minute | θ_{JA} by Velocity | | |
|--|---------------------------|----------|----------|
| | 0 | 200 | 500 |
| Single-Layer PCB, JEDEC Standard Test Boards | 114.5°C/W | 98.0°C/W | 88.0°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards | 73.2°C/W | 66.6°C/W | 63.5°C/W |

Transistor Count

The transistor count for ICS8422002I-01 is: 2951

Package Outline and Package Dimension

Package Outline - G Suffix for 20 Lead TSSOP

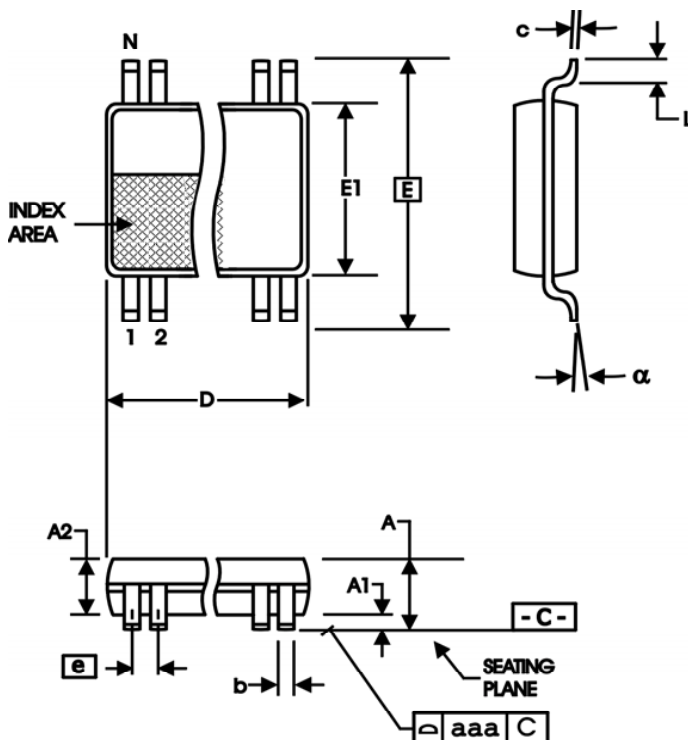


Table 8. Package Dimensions

| All Dimensions in Millimeters | | |
|-------------------------------|------------|---------|
| Symbol | Minimum | Maximum |
| N | 20 | |
| A | | 1.20 |
| A1 | 0.05 | 0.15 |
| A2 | 0.80 | 1.05 |
| b | 0.19 | 0.30 |
| c | 0.09 | 0.20 |
| D | 6.40 | 6.60 |
| 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 |
|-------------------|--------------|---------------------------|--------------------|---------------|
| 8422002AGI-01 | ICS22002AI01 | 20 Lead TSSOP | Tube | -40°C to 85°C |
| 8422002AGI-01T | ICS22002AI01 | 20 Lead TSSOP | 2500 Tape & Reel | -40°C to 85°C |
| 8422002AGI-01LF | TBD | "Lead-Free" 20 Lead TSSOP | Tube | -40°C to 85°C |
| 8422002AGI-01LFT | TBD | "Lead-Free" 20 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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Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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