

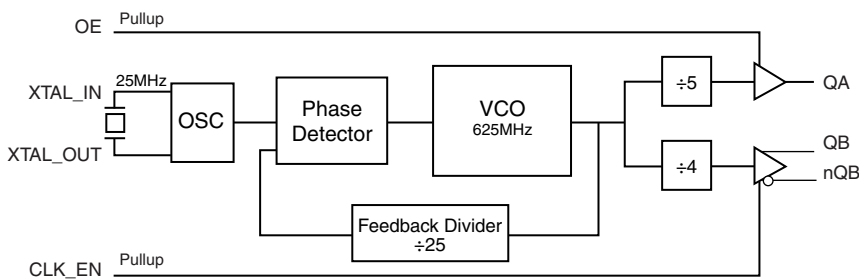
### GENERAL DESCRIPTION

The 8430252-45 is a 2 output LVPECL and LVCMOS/LVTTL Synthesizer optimized to generate Ethernet reference clock frequencies. Using a 25MHz, 18pF parallel resonant crystal, the following frequencies can be generated: 156.25MHz LVPECL output and, 125MHz LVCMOS output. The 8430252-45 uses IDT's 3<sup>rd</sup> generation low phase noise VCO technology and can achieve 1ps or lower typical rms phase jitter, easily meeting Ethernet jitter requirements. The 8430252-45 is packaged in a small 16-pin TSSOP package.

### FEATURES

- One differential 3.3V LVPECL output and One LVCMOS/LVTTL output
- Crystal oscillator interface designed for a 25MHz, 18pF parallel resonant crystal
- A 25MHz crystal generates both an output frequency of 156.25MHz (LVPECL) and 125MHz (LVCMOS)
- VCO frequency: 625MHz
- RMS phase jitter @ 156.25MHz (1.875MHz - 20MHz) using a 25MHz crystal: 0.39ps (typical)
- Full 3.3V supply mode
- 0°C to 70°C ambient operating temperature
- Available in lead-free (RoHS 6) package

### BLOCK DIAGRAM



### PIN ASSIGNMENT

|        |   |    |          |
|--------|---|----|----------|
| OE     | 1 | 16 | CLK_EN   |
| VEE    | 2 | 15 | VEE      |
| QA     | 3 | 14 | QB       |
| Vcco_A | 4 | 13 | nQB      |
| nc     | 5 | 12 | Vcco_B   |
| nc     | 6 | 11 | XTAL_IN  |
| VCCA   | 7 | 10 | XTAL_OUT |
| Vcc    | 8 | 9  | VEE      |

**8430252-45**  
**16-Lead TSSOP**  
 4.4mm x 5.0mm x 0.92mm  
 package body  
**G Package**  
 Top View

**TABLE 1. PIN DESCRIPTIONS**

| Number   | Name                 | Type   |        | Description  |
|----------|----------------------|--------|--------|--|
| 1        | OE                   | Input  | Pullup | Output enable pin. LVCMOS/LVTTL interface levels. See Table 3A Function Table. |
| 2, 9, 15 | V <sub>EE</sub>      | Power  |        | Negative supply pin.   |
| 3        | QA                   | Output |        | LVCMOS/LVTTL clock output.   |
| 4        | V <sub>CCO,A</sub>   | Power  |        | Output supply pin for QA output.   |
| 5, 6     | nc                   | Unused |        | No connect.  |
| 7        | V <sub>CCA</sub>     | Power  |        | Analog supply pin.   |
| 8        | V <sub>CC</sub>      | Power  |        | Core supply pin.   |
| 10, 11   | XTAL_OUT,<br>XTAL_IN | Input  |        | Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.    |
| 12       | V <sub>CCO,B</sub>   | Power  |        | Output supply pin for QB, nQB outputs.   |
| 13, 14   | nQB, QB              | Output |        | Differential clock outputs. LVPECL interface levels.                           |
| 16       | CLK_EN               | Input  | Pullup | Clock enable pin. LVCMOS/LVTTL interface levels. See Table 3B Function Table.  |

**TABLE 2. PIN CHARACTERISTICS**

| Symbol              | Parameter                     | Test Conditions   | Minimum                   | Typical | Maximum | Units |
|---------------------|-------------------------------|---|---------------------------|---------|---------|-------|
| C <sub>IN</sub>     | Input Capacitance             |   |                           | 4       |         | pF    |
| C <sub>PD</sub>     | Power Dissipation Capacitance | V <sub>CC</sub> , V <sub>CCA</sub> , V <sub>CCO,A</sub> , V <sub>CCO,B</sub> = 3.465V |                           | 18      |         | pF    |
| R <sub>PULLUP</sub> | Input Pullup Resistor         |   |                           | 51      |         | kΩ    |
| R <sub>OUT</sub>    | Output Impedance              | QA  | V <sub>CCO,A</sub> = 3.3V | 20      |         | Ω     |

**TABLE 3A. OE SELECT FUNCTION TABLE**

| Input | Output |
|-------|--------|
| OE    | QA     |
| 0     | Hi-Z   |
| 1     | Active |

**TABLE 3B. CLK\_EN SELECT FUNCTION TABLE**

| Input  | Outputs |        |
|--------|---------|--------|
| CLK_EN | QB      | nQB    |
| 0      | Low     | High   |
| 1      | Active  | Active |

### 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, $\theta_{JA}$ | 89°C/W (0 lfpm)          |
| 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 4A. POWER SUPPLY DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO,A} = V_{CCO,B} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

| 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 |                 | $V_{CC} - 0.10$ | 3.3     | $V_{CC}$ | V     |
| $V_{CCO,A}$ $V_{CCO,B}$ | Output Supply Voltage |                 | 3.135           | 3.3     | 3.465    | V     |
| $I_{EE}$                | Power Supply Current  |                 |                 |         | 95       | mA    |
| $I_{CCA}$               | Analog Supply Current |                 |                 |         | 10       | mA    |

**TABLE 4B. LVCMOS / LVTTTL DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO,A} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

| 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          | OE, CLK_EN<br>$V_{CC} = V_{IN} = 3.465V$     |         |         | 5              |       |
| $I_{IL}$ | Input Low Current           | OE, CLK_EN<br>$V_{CC} = 3.465V, V_{IN} = 0V$ | -150    |         |                |       |
| $V_{OH}$ | Output High Voltage; NOTE 1 |  | 2.6     |         |                | V     |
| $V_{OL}$ | Output Low Voltage; NOTE 1  |  |         |         | 0.5            | V     |

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{CCO,A} / 2$ . See Parameter Measurement Information Section, "3.3V Output Load Test Circuit".

**TABLE 4C. LVPECL DC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO,B} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$**

| Symbol      | Parameter                         | Test Conditions | Minimum           | Typical | Maximum           | Units |
|-------------|-----------------------------------|-----------------|-------------------|---------|-------------------|-------|
| $V_{OH}$    | Output High Voltage; NOTE 1       |                 | $V_{CCO,B} - 1.4$ |         | $V_{CCO,B} - 0.9$ | V     |
| $V_{OL}$    | Output Low Voltage; NOTE 1        |                 | $V_{CCO,B} - 2.0$ |         | $V_{CCO,B} - 1.7$ | V     |
| $V_{SWING}$ | Peak-to-Peak Output Voltage Swing |                 | 0.6               |         | 1.0               | V     |

NOTE 1: Outputs terminated with 50 to  $V_{CCO,B} - 2V$ .

**TABLE 5. CRYSTAL CHARACTERISTICS**

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

NOTE: Characterized using an 18pF parallel resonant crystal.

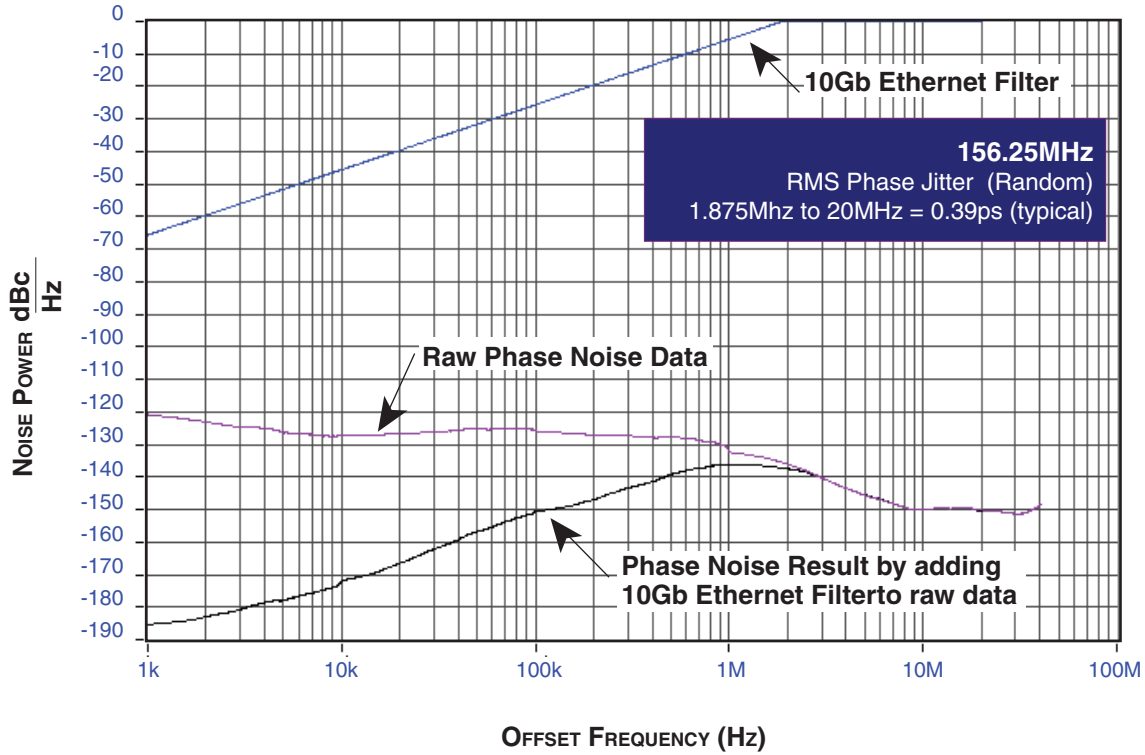
**TABLE 6. AC CHARACTERISTICS,  $V_{CC} = V_{CCA} = V_{CCO,A} = V_{CCO,B} = 3.3V \pm 5\%$ ,  $T_A = 0^\circ C$  TO  $70^\circ C$** 

| Symbol               | Parameter                         | Test Conditions | Minimum                      | Typical | Maximum | Units |
|----------------------|-----------------------------------|-----------------|------------------------------|---------|---------|-------|
| $f_{OUT}$            | Output Frequency Range            |                 |                              | 156.25  |         | MHz   |
|                      |                                   |                 |                              | 125     |         | MHz   |
| $t_{jit}(\emptyset)$ | RMS Phase Jitter (Random); NOTE 1 | QA              | 125MHz (1.875MHz - 20MHz)    |         | 0.41    | ps    |
|                      |                                   | QB, nQB         | 156.25MHz (1.875MHz - 20MHz) |         | 0.39    | ps    |
| $t_R / t_F$          | Output Rise/Fall Time             | QA              | 20% to 80%                   | 500     | 1200    | ps    |
|                      |                                   | QB, nQB         |                              | 300     | 700     | ps    |
| odc                  | Output Duty Cycle                 | QA              | 47                           |         | 53      | %     |
|                      |                                   | QB, nQB         | 48                           |         | 52      | %     |

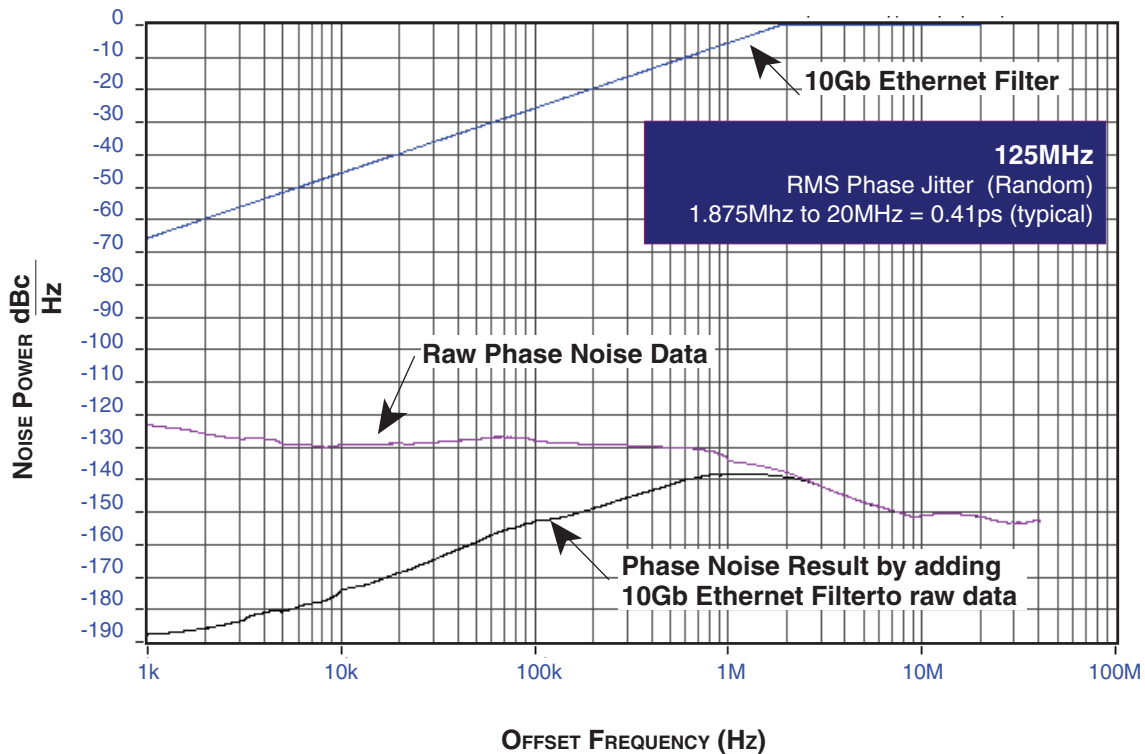
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfm. The device will meet specifications after thermal equilibrium has been reached under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

NOTE 1: Please refer to the Phase Noise Plots.

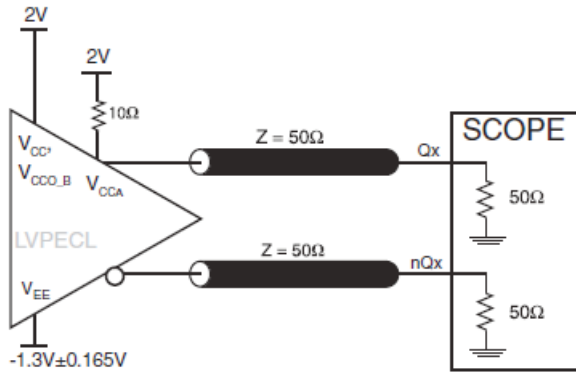
### TYPICAL PHASE NOISE AT 156.25MHz



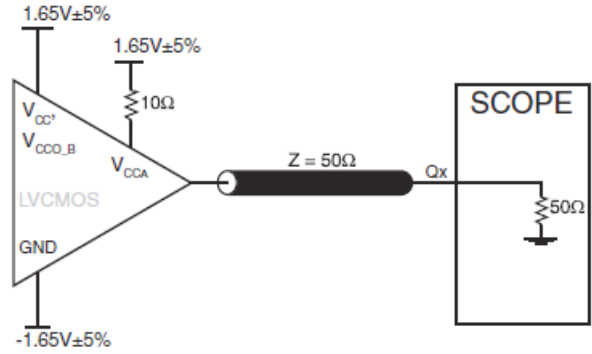
### TYPICAL PHASE NOISE AT 125MHz



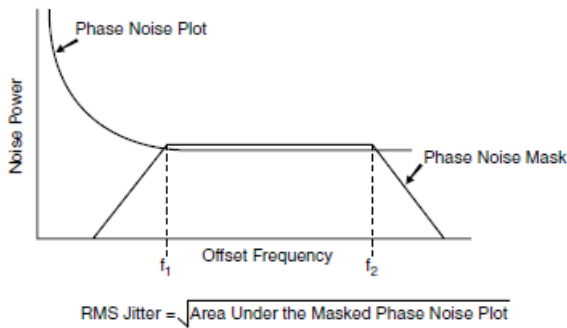
## PARAMETER MEASUREMENT INFORMATION



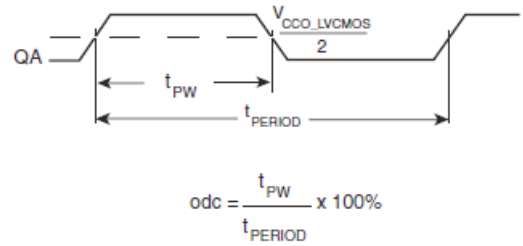
3.3V CORE/3.3V LVPECL OUTPUT LOAD AC TEST CIRCUIT



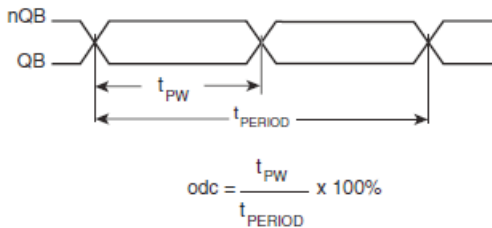
3.3V CORE/3.3V LVCMOS OUTPUT LOAD AC TEST CIRCUIT



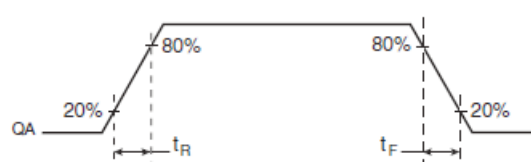
RMS PHASE JITTER



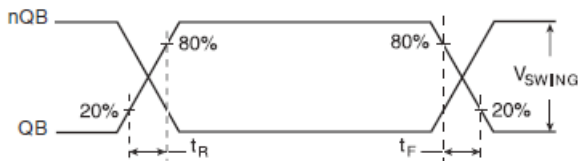
LVCMOS OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



LVPECL OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



LVCMOS OUTPUT RISE/FALL TIME



LVPECL 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 8430252-45 provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL.  $V_{CC}$ ,  $V_{CCA}$ , and  $V_{CCX}$  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  $10\Omega$  resistor along with a  $10\mu\text{F}$  and a  $.01\mu\text{F}$  bypass capacitor should be connected to each  $V_{CCA}$  pin.

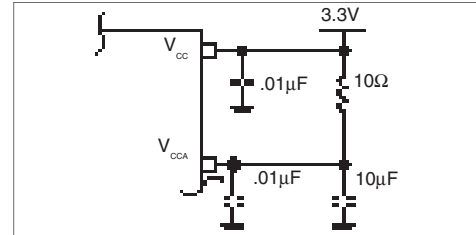


FIGURE 1. POWER SUPPLY FILTERING

### RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

#### INPUTS:

##### SELECT PINS:

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

#### OUTPUTS:

##### LVC MOS OUTPUT:

All unused LVC MOS output can be left floating. We recommend that there is no trace attached.

##### LVPECL OUTPUT

All unused LVPECL 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 8430252-45 has been characterized with  $18\text{pF}$  parallel resonant crystals. The capacitor values shown in

*Figure 2* below were determined using a  $25\text{MHz}$ ,  $18\text{pF}$  parallel resonant crystal and were chosen to minimize the ppm error.

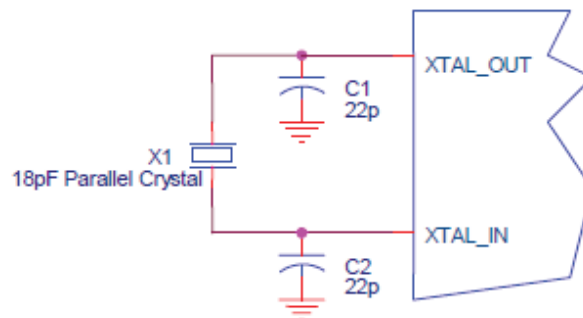


Figure 2. CRYSTAL INPUT INTERFACE

### OVER-DRIVING THE CRYSTAL INTERFACE

The XTAL\_IN input can be overdriven by an LVCMOS driver or by one side of a differential driver through an AC coupling capacitor. The XTAL\_OUT pin can be left floating. The amplitude of the input signal should be between 500mV and 1.8V and the slew rate should not be less than 2V/nS. For 3.3V LVCMOS inputs, the amplitude must be reduced from full swing to at least half the swing in order to prevent signal interference with the power rail and to reduce internal noise. *Figure 3A* shows an example of the interface diagram for a high speed 3.3V LVCMOS driver. This configuration requires that the sum of the output impedance of the driver ( $R_o$ ) and 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 changing  $R_2$  to 50Ω. The values of the resistors can be increased to reduce the loading for slower and weaker LVCMOS driver. *Figure 3B* shows an example of the interface diagram for an LVPECL driver. This is a standard LVPECL termination with one side of the driver feeding the XTAL\_IN input. It is recommended that all components in the schematics be placed in the layout. Though some components might not be used, they can be utilized for debugging purposes. The datasheet specifications are characterized and guaranteed by using a quartz crystal as the input.

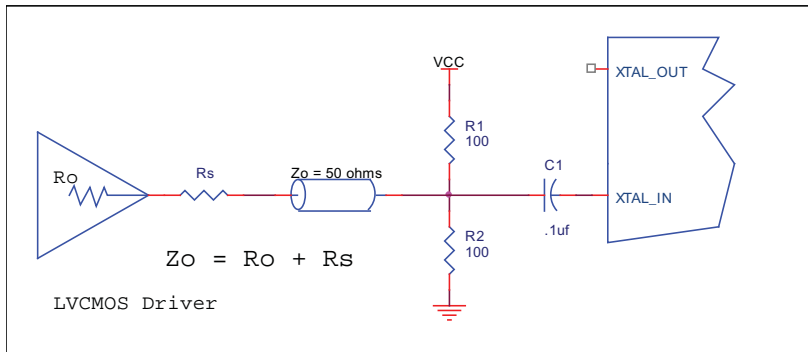


FIGURE 3A. GENERAL DIAGRAM FOR LVCMOS DRIVER TO XTAL INPUT INTERFACE

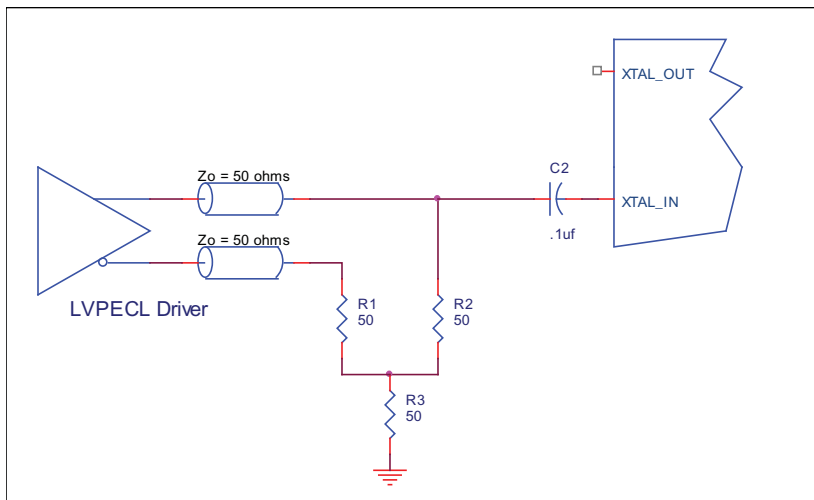


FIGURE 3B. GENERAL DIAGRAM FOR LVPECL DRIVER TO XTAL INPUT INTERFACE



### 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.

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.

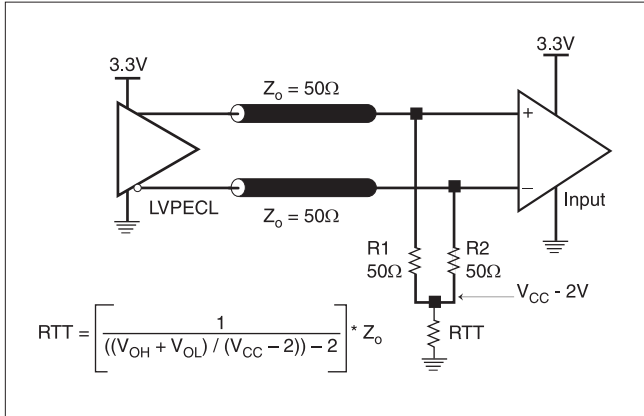


FIGURE 4A. LVPECL OUTPUT TERMINATION

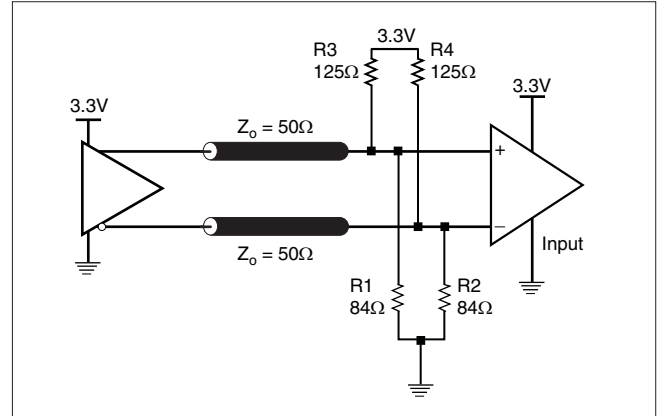


FIGURE 4B. LVPECL OUTPUT TERMINATION

LAYOUT GUIDELINE

Figure 5 shows an example of 8430252-45 application schematic. In this example, the device is operated at VCC=3.3V. The 18pF parallel resonant 25MHz crystal is used. 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. Two examples of LVPECL and one example of LVCMOS terminations are shown in this schematic. Additional termination approaches are shown in the LVPECL Termination Application Note.

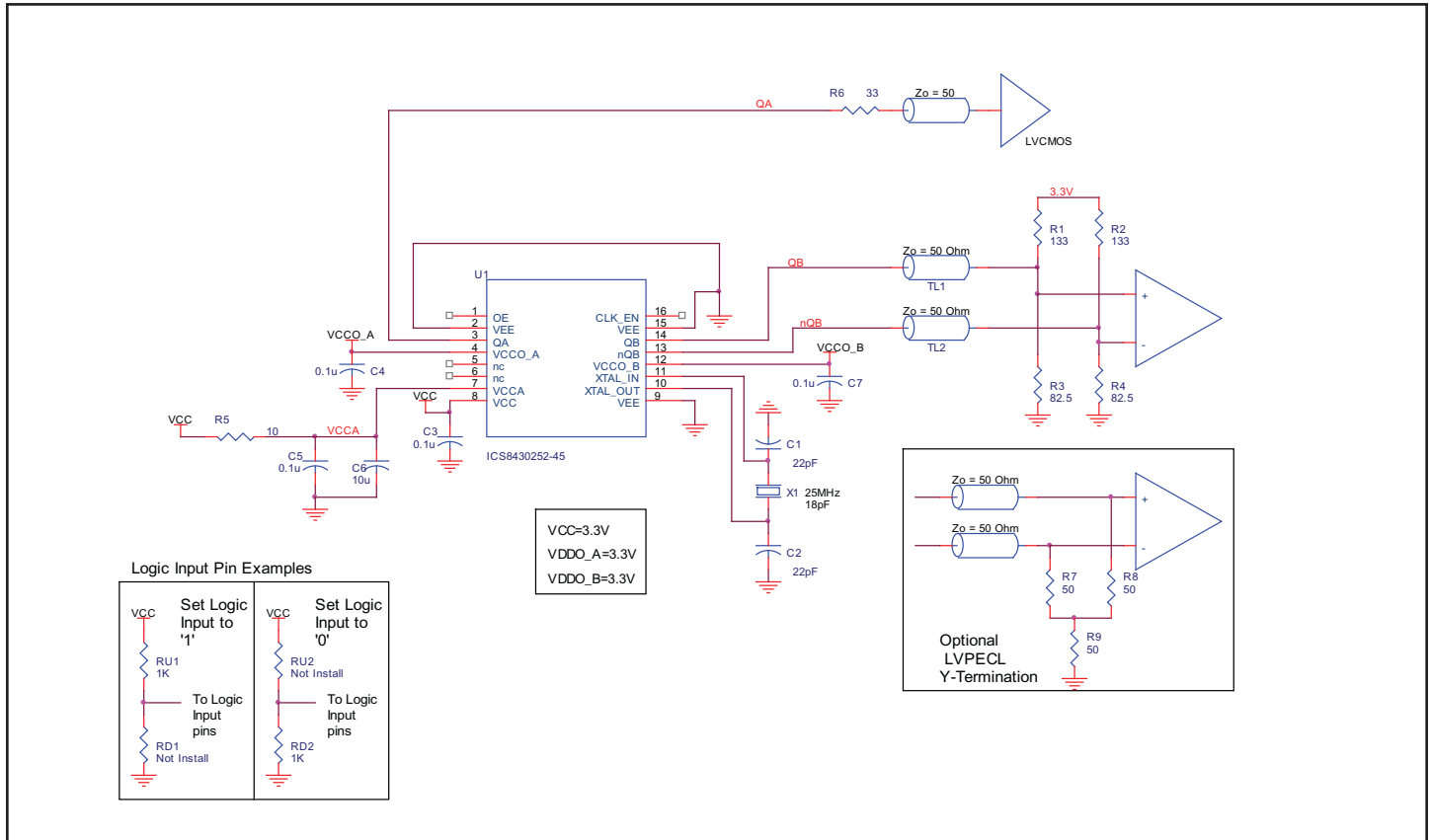


FIGURE 5. 8430252-45 SCHEMATIC EXAMPLE

## POWER CONSIDERATIONS

This section provides information on power dissipation and junction temperature for the 8430252-45. Equations and example calculations are also provided.

### 1. Power Dissipation.

The total power dissipation for the 8430252-45 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)<sub>MAX</sub> =  $V_{CC\_MAX} * I_{EE\_MAX} = 3.465V * 95mA = 329.17mW$   
(95mA includes the LVCMOS output terminated with 50Ω to  $V_{CC}/2$  at 125MHz)
- Power (outputs)<sub>MAX</sub> = **30mW/Loaded Output pair**

**Total Power**<sub>MAX</sub> (3.465V, with all outputs switching) = 329.17mW + 30mW = **359.17mW**

### 2. Junction Temperature.

Junction 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<sub>j</sub>, to 125°C ensures that the bond wire and bond pad temperature remains below 125°C.

The equation for T<sub>j</sub> is as follows:  $T_j = \theta_{JA} * Pd\_total + T_A$

T<sub>j</sub> = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

Pd<sub>total</sub> = Total Device Power Dissipation (example calculation is in section 1 above)

T<sub>A</sub> = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming a moderate air flow of 200 linear feet per minute and a multi-layer board, the appropriate value is 81.8°C/W per Table 7 below.

Therefore, T<sub>j</sub> for an ambient temperature of 70°C with all outputs switching is:

$$70^\circ C + 0.359W * 81.8^\circ C/W = 99.4^\circ C. \text{ This is well below the limit of } 125^\circ C.$$

This calculation is only an example. T<sub>j</sub> 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  $\theta_{JA}$  FOR 16-PIN TSSOP, FORCED CONVECTION**

|  | $\theta_{JA}$ by Velocity (Linear Feet per Minute) |           |           |
|--|--|-----------|-----------|
|  | 0  | 200       | 500       |
| Single-Layer PCB, JEDEC Standard Test Boards | 137.1°C/W  | 118.2°C/W | 106.8°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards  | 89.0°C/W   | 81.8°C/W  | 78.1°C/W  |

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

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.

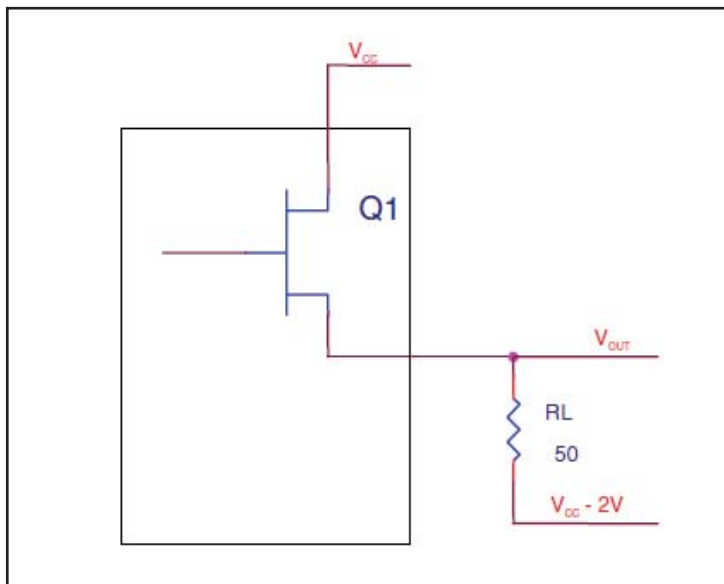


FIGURE 6. LVPECL DRIVER CIRCUIT AND TERMINATION

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,  $V_{OUT} = V_{OL\_MAX} = V_{CC\_MAX} - 1.7V$

$$(V_{CC\_MAX} - V_{OL\_MAX}) = 1.7V$$

$Pd\_H$  is power dissipation when the output drives high.

$Pd\_L$  is the power dissipation when the output drives low.

$$Pd\_H = [(V_{OH\_MAX} - (V_{CC\_MAX} - 2V))/R_L] * (V_{CC\_MAX} - V_{OH\_MAX}) = [(2V - (V_{CC\_MAX} - V_{OH\_MAX}))/R_L] * (V_{CC\_MAX} - V_{OH\_MAX}) = [(2V - 0.9V)/50\Omega] * 0.9V = 19.8mW$$

$$Pd\_L = [(V_{OL\_MAX} - (V_{CC\_MAX} - 2V))/R_L] * (V_{CC\_MAX} - V_{OL\_MAX}) = [(2V - (V_{CC\_MAX} - V_{OL\_MAX}))/R_L] * (V_{CC\_MAX} - V_{OL\_MAX}) = [(2V - 1.7V)/50\Omega] * 1.7V = 10.2mW$$

$$\text{Total Power Dissipation per output pair} = Pd\_H + Pd\_L = 30mW$$

## RELIABILITY INFORMATION

**TABLE 8.  $\theta_{JA}$  VS. AIR FLOW TABLE FOR 16 LEAD TSSOP**

| $\theta_{JA}$ by Velocity (Linear Feet per Minute) |           |            |            |
|--|-----------|------------|------------|
|  | <b>0</b>  | <b>200</b> | <b>500</b> |
| Single-Layer PCB, JEDEC Standard Test Boards       | 137.1°C/W | 118.2°C/W  | 106.8°C/W  |
| Multi-Layer PCB, JEDEC Standard Test Boards        | 89.0°C/W  | 81.8°C/W   | 78.1°C/W   |

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

### TRANSISTOR COUNT

The transistor count for 8430252-45 is: 2070

PACKAGE OUTLINE - G SUFFIX FOR 16 LEAD TSSOP

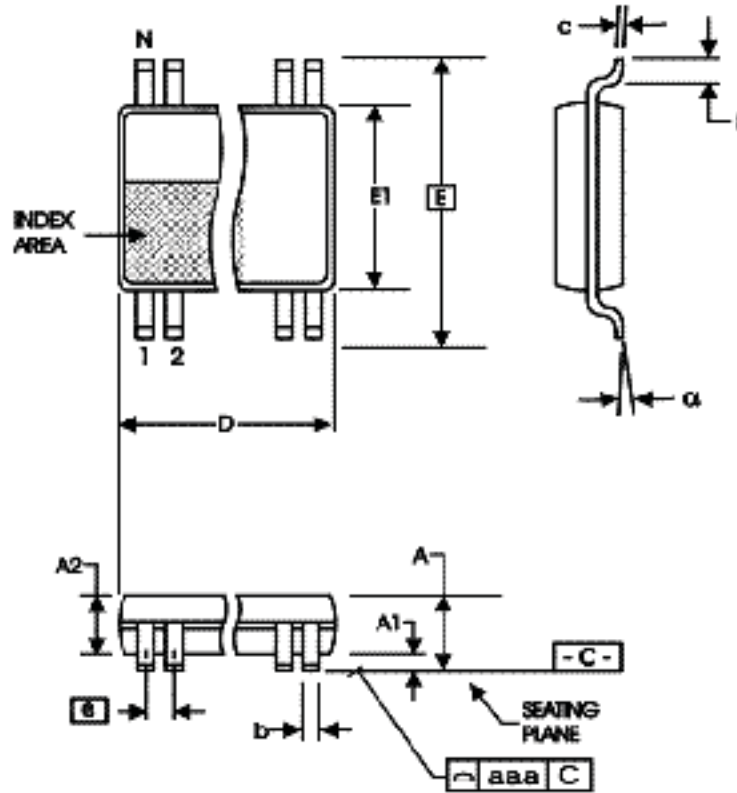


TABLE 9. PACKAGE DIMENSIONS

| SYMBOL | Millimeters |         |
|--------|-------------|---------|
|        | Minimum     | Maximum |
| N      | 16          |         |
| A      | --          | 1.20    |
| A1     | 0.05        | 0.15    |
| A2     | 0.80        | 1.05    |
| b      | 0.19        | 0.30    |
| c      | 0.09        | 0.20    |
| D      | 4.90        | 5.10    |
| 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 |
|-------------------|----------|---------------------------|--------------------|-------------|
| 8430252CG-45LF    | 0252C45L | 16 Lead "Lead-Free" TSSOP | tube               | 0°C to 70°C |
| 8430252CG-45LFT   | 0252C45L | 16 Lead "Lead-Free" TSSOP | 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.

REVISION HISTORY SHEET

| Rev | Table     | Page                   | Description of Change  | Date    |
|-----|-----------|------------------------|--|---------|
| A   |           | 9                      | Added Schematic Layout and Guideline.  | 10/4/06 |
| A   | T6<br>T10 | 1<br>4<br>8<br>9<br>15 | General Description - deleted HiperClocks logo and text reference.<br>AC Characteristics Table - added thermal note.<br>Updated Over-Driving the Crystal Interface section.<br>Termination for 3.3V LVPECL Outputs - updated Figures 4A and 4B.<br>Ordering Information Table - deleted ICS prefix in Part/Order column. And deleted tape & reel count in Shipping Packaging column. | 2/19/14 |
| A   | T10       | 15                     | Updated data sheet format.<br>Ordering Information - removed leaded devices.   | 5/27/15 |





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