Quartz Crystal Oscillator Implementation with PolarPro and Eclipse II

QuickLogic® Application Note 95

Introduction

This application note provides relevant information for designers who want to compare the performance of quartz crystal oscillators to self-contained oscillators when implementing their designs on PolarPro and Eclipse II devices. All data presented has been verified using a QuickLogic internal test board. A PCB layout is included as a crucial part in correct oscillator design.

The quartz crystal oscillator implementation is selected with the intent to reduce manufacturing costs and to save board space.

Quartz Crystal Oscillator Circuit

The suggested configuration to support the quartz crystals is illustrated in **Figure 1**. This method is recommended for frequencies less than 30 MHz.

Table 1 shows the optimal value of components for various frequencies. Note that Rd is only dependant variable listed. All measurments are taken at Vcc= ±3.3V.

Figure 1: Crystal Oscillator Schematic

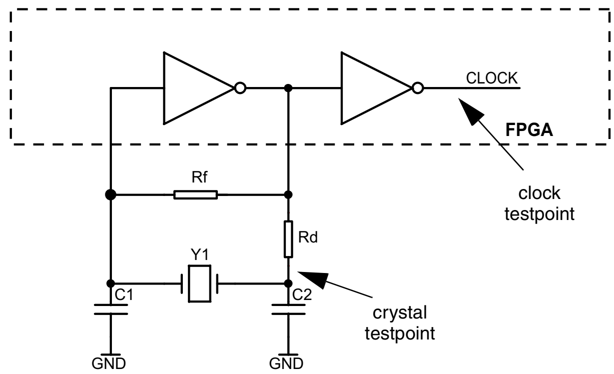


Table 1: Quartz Crystal Oscillator Frequencies—Fundamental Mode

Frequency	Device	Crystal	C1,C2	Rf	Rd
12 MHz	QL8150	Y1	15 pF	1 M	1.8 K
13 MHz	QL1P100-144	Y1	15 pF	1 M	1.8 K
14 MHz	QL8150	Y1	15 pF	1 M	1 K
16 MHz	QL1P100-144	Y1	15 pF	1 M	1 K
18 MHz	QL1P100-144	Y1	15 pF	1 M	1 K
25 MHz	QL8150	Y1	15 pF	1 M	560
27 MHz	QL1P100-144	Y1	15 pF	1 M	560

Test Results

Crystal Components

QuickLogic testing was done on quartz crystals from different manufacturers. For results shown in this application note the ECS Inc. HC-49USX quartz crystals were used. Crsytals with a frequency range between 4 MHz to 30 MHz (in fundamental mode) were selected.

Waveform Results

Figure 2 shows 16 MHz and 25 MHz waveforms measured with a 1 GHz Tektronix TDS580D oscilloscope. The signal is measured near C2, see **Figure 1**.

Figure 2: Crystal Waveforms

16 MHz 25 MHz

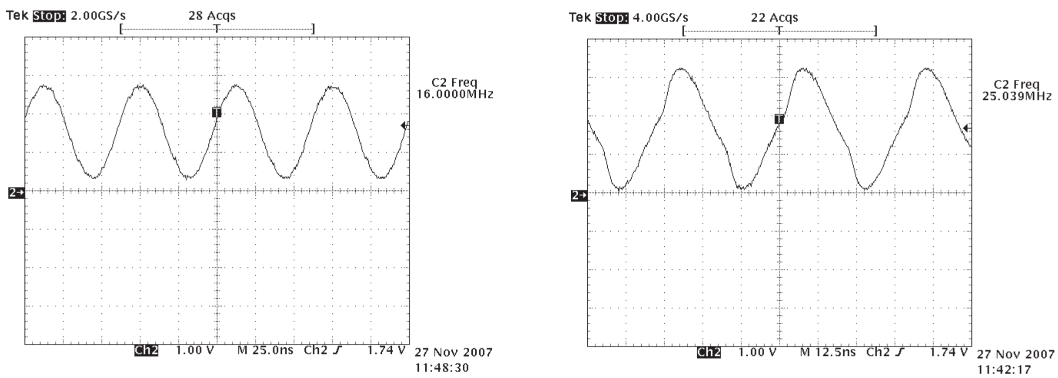
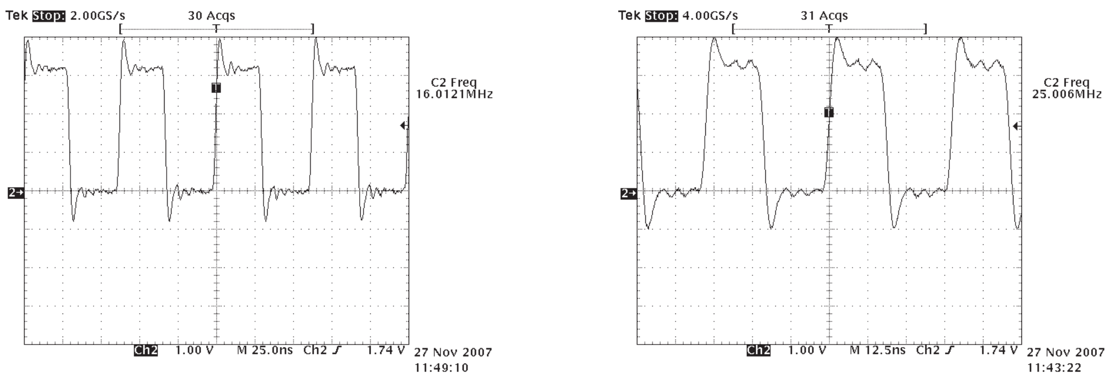


Figure 3 shows the same 16 MHz and 25 MHz clock signals on the output by the oscillator circuit. The signals are stable with low jitter and good swing. The overshooting and undershooting peaks are the result of imperfect line termination.

Figure 3: .Device Output Signals

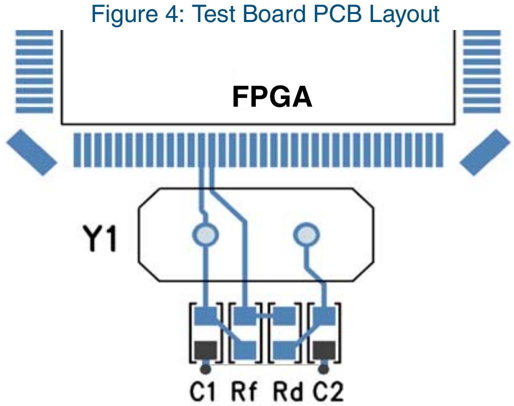
16 MHz 25 MHz



Crystal PCB Layout Recommendations

Figure 4 shows the reference PCB layout.

Figure 4: Test Board PCB Layout



The following tips help with PCB layout design. Careful routing and placement of components are required for a successful layout.

- First place the crystal component as close as possible to the FPGA on the same side of the PCB.
- Second place the coupling capacitors and termination resistors as close as possiible to the crystal, see **Figure 4**.
- Reduce noise by placing a ground plane under the crystal circuit. Adding a ground ring around the oscillator components is preferable.
- Provide good power decoupling as close as possible to the FPGA.
- Do not cross any clock traces on nearby layers.
- Avoid routing high speed, high noise and high power signals near the crystal oscillator circuit.

Additional Design Support

Getting Information About Quartz Crystal Selection

This application note assumes a basic understanding of the behavior and operation of quartz crystals and their design considerations. When using quartz crystal oscillators in an application it is important to be aware of the ASIC and crystal characteristics, and the circuit design requirements when selecting a crystal. For example, details such as input and output resistances, the mode of operation, typical crystal aging and so forth will have different effects in the application.

NOTE: For more information about the characteristics affected for each area of consideration see the Abracon Quartz Crystals Application Note located at www.abracon.com/Support/quartz crystals.pdf.

Getting Answers to Quartz Crystal Oscillator-Related Questions

This application note assumes that you are familiar with crystal oscillators. For more information about crystal resonator theory, oscillator operation theory, oscillator design considerations and examples of some common frequencies supported by these oscillators, visit the Texas Instruments website and read the TI Application Report located at http://focus.ti.com/lit/an/spra054/spra054.pdf.

Conclusion

It is possible to use the crystal oscillator circuits described in this application note with PolarPro and Eclipse II devices in any application where high precision frequency and low signal jitter are not required. Designers are strongly advised to follow correct PCB and component selection guidelines. Using these crystal components in the BOM reduces cost and saves board space.

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Revision History

Revision	Date	Originator and Comments
A	November 2007	First release

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