LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
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# Test procedure for the Clock, Gate, and DuoTone Signal Interface Advanced LIGO

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This is an internal working note
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| | |
|---|---|
| **Board document LIGO DCC #** | **080335** |
| **Board Revision** | **B** |
| **Board Serial #** | 0024 |
| **Board Type** | **DuoTone** |
| **Test Engineer** | Suresh Patel |
| **Test Date:** | 2/4/10 |

| | PASSED | FAILED |
|---|---|---|
| **Overall board testing:** | ☑ | ☐ |

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*The following Test Procedure is to test the functioning of the DuoTone board. Take a working Master -Slave board system. Place a DuoTone board on the Slave board. Load the FPGADuoTone_TEST program onto the Slave board (see Appendix).*

*Make sure the Master-Slave boards work correctly and have a synchronized 1PPS signal.*

*(Note: If the 1PPS signals are synchronized, the SYNCOUT LED on the Master (one of the green LEDs, labeled 1-16 on the front panel of the Master chassis, corresponding to the given output in use) and the and SYNCIN LED (DS1) on the Slave should blink with a rate of 1 sec on, 1 sec off. If the 1PPS signal is not synchronized but the boards are connected, the LEDs on both would blink significantly faster, with quarter sec on, quarter second off. If there is no 1PPS signal present, but the boards are connected, the LED is constantly ON.)*

*In this Test Procedure TP1 on the DuoTone board will be used for ground (GND).*

**1) Verify that the power supply rails are at the correct voltage.**

Measure the voltage at the following test points compared to GND (TP1). If any of the indicators of proper operation are not present the problem must be fixed before proceeding with the Test. A sign of proper operation is the three LEDs, labeled DS1, DS2 and DS3 on the DuoTone board. They should be on all the time if the power supply rails operate properly.

| | | | |
|---|---|---|---|
| TP2, | +12V (11.4 – 12.6)V | ☑ Pass | ☐ Fail |
| TP3, | +5V (4.75– 5.25)V | ☑ Pass | ☐ Fail |
| TP4, | -5V (-4.75 – (-5.25))V | ☑ Pass | ☐ Fail |
| TP5, | +3.3V (2.97– 3.63)V | ☑ Pass | ☐ Fail |
| DS1, DS2 and DS3 are on | | ☑ Pass | ☐ Fail |

*The following tests will include the measurement of different inputs and outputs. Please refer to figure 1 for the on board orientation and pin distribution of input and output connectors (P3-P8).*

**2) Verify that P3 (RS 485) works properly.**

**2 A** Measure the outputs of ports 3, 4, 5, 6, 9 and 10 on P3 with a Voltmeter.

| | | | |
|---|---|---|---|
| Ports 3, 4, 9, 10 | toggle HI (3.3V) - LOW (0V) every sec | ☑ Pass | ☐ Fail |
| Ports 5, 6 | GND | ☑ Pass | ☐ Fail |

Observe the toggling compared to DS1 LED on the slave board. Ports 4 and 10 should be high when DS1 is on (in-phase), while ports 3 and 9 should be off while DS1 is on (anti-phase).

☑ Pass ☐ Fail

**2 B** Connect port 1 with port 3, port 2 with port 4, port 7 with port 9 and port 8 with port 10. Turn on the digital I/O unit U_Test DuoTone in Altium Designer. The digital inputs RX0 and RX1 soft LEDS should be toggling every second.

☑ Pass ☐ Fail

RS485 (P3) works properly ☑ Yes ☐ No

Indicate faulty port, if any:

**3) Verify that P4 (DO) works properly.**

Measure each output ports with a Voltmeter.

| | | | |
|---|---|---|---|
| Ports 2, 4, 5, 6, 8, 10 | GND | ☑ Pass | ☐ Fail |
| Ports 1, 3, 7, 9 | toggle HI (3.3V) - LOW (0V) every sec | ☑ Pass | ☐ Fail |
| DO (P4) works properly | | ☑ Yes | ☐ No |

Indicate faulty ports, if any:

**4) Verify the proper operation of the header P6 (LCD).**

Measure the outputs of ports 1, 3, 4 and 5 with a Voltmeter.

| | | | |
|---|---|---|---|
| Port 1 | +5V | ☑ Pass | ☐ Fail |
| Port 3 | toggle HI (3.3V) - LOW (0V) every second | ☑ Pass | ☐ Fail |
| Ports 4, 5 | GND | ☑ Pass | ☐ Fail |

Connect ports 2 and 3. Turn on the digital I/O unit U_TEST_DuoTone in Altium Designer. The digital input soft LED, labeled LCD, should be toggling every second.

| | | |
|---|---|---|
| | ☑ Pass | ☐ Fail |
| LCD (P6) works properly | ☑ Yes | ☐ No |

**5) Verify the proper operation of the header P5.**

Measure the outputs of ports 2, 4, 6, 8, 9, 10, 12 and 14 with a Voltmeter. All should be GND.

☑ Pass ☐ Fail

Connect ports 1, 3, 5, 7, 11 and 13 with port 3 of P6 (LCD). Turn on the digital I/O unit U_TEST_Duotone in Altium Designer. The soft LEDs for digital inputs DI0, DI1, DI2, DI3, DI4 and DI5 should be toggling every second. (DI0-port 13, DI1-port 11, DI2-port 7, DI3- port 5, DI4-port 3, DI5-port 1)

| | | |
|---|---|---|
| | ☑ Pass | ☐ Fail |
| P5 works properly | ☑ Yes | ☐ No |

Indicate faulty port, if any:

**6) Verify the proper operation of the header P7 (Header 10X2).**

Connect the outputs to an oscilloscope and terminate the lines with 50 Ohm.

Connect port 19 from P7 (it is 3.3V) with port 13 of P5.
Measure the output of each port. Ports 1, 3, 5, 7, 9, 11, 13 and 15 should be toggling with 65,536 Hz (15.26 µs between upgoing edges). *Note: use 5µs/div and 1V/div.*

☑ Pass ☐ Fail

Ports 3, 7, 11 and 15 should be in anti-phase if put into CH2 of oscilloscope while port 1 is connected to CH1 and used as trigger. Ports 5, 9 and 13 should be in-phase.

☑ Pass ☐ Fail

All other ports should be GND ☑ Pass ☐ Fail

P7 works properly. ☑ Yes ☐ No

Indicate faulty port if any:

**7) Verify the proper operation of the header P8.**

Take an oscilloscope and measure the output of each port referenced to GND. Trigger on 1PPS output from the Timing Master.

Port 1 - constant +3.3V ☑ Pass ☐ Fail

Port 3, 5 - toggling with 16384 Hz (61.04 µs) ☑ Pass ☐ Fail
*Note: use 20µs/div and 1V/div.*

Ports 9, 11 - DuoTone signals (with 960 and 961 Hz components, see figure 2)
*Note: use 200ms/div and 500mV/div.* ☑ Pass ☐ Fail

Ports 2, 4, 6, 7, 8, 10, 12, 13, 14 – GND ☑ Pass ☐ Fail

P8 works properly. ☑ Yes ☐ No

Indicate faulty port if any:

**Notes:**

**FIGURES**

**Figure 1 DuoTone board attached to the Slave Board**
**Connectors on the DuoTone board (pin 1 is labeled with a red dot)**

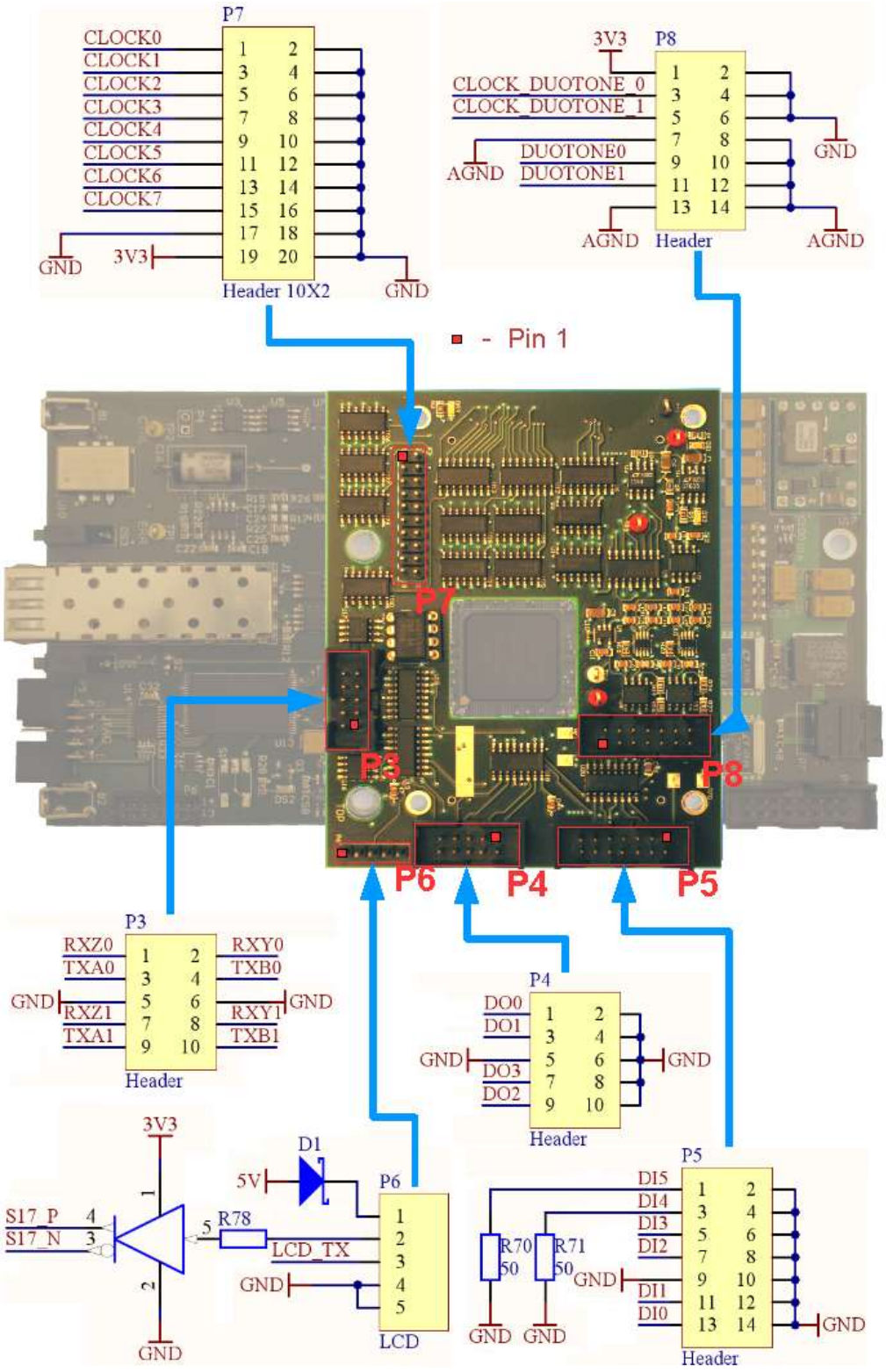
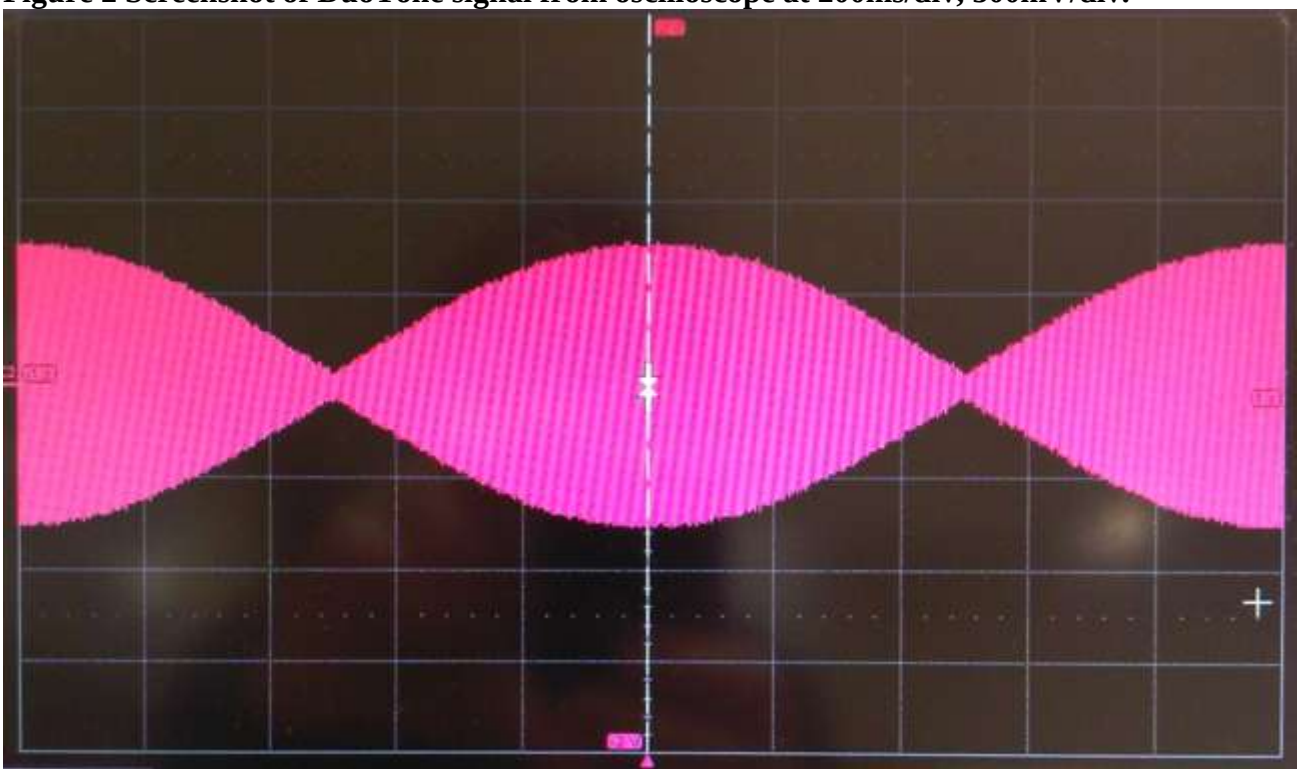


**Figure 2 Screenshot of DuoTone signal from oscilloscope at 200ms/div, 500mV/div.**



# APPENDIX. Programming FPGA Firmware onto Timing Module

*The following step by step instruction describes the programming of the FPGA chip and Flash PROM on a Timing Module, such as the Master, FanOut or Slave modules. The guideline assumes that one has the following done/ready prior to going through the steps:*
*- Computer with Altium Designer is installed on it.*
*- Xilinx ISE WebPACK installed on the same computer.*
*- Altium USB-JTAG adapter.*

1. Open Altium Designer.
2. Open 'My Account' from the 'DXP' menu bar (see Figure 1).
3. Press 'Sign In', provide your user name and password, then press 'Sign In' (see Figure 1).
4. Activate the product by clicking on the 'Activate' button (see Figure 1).

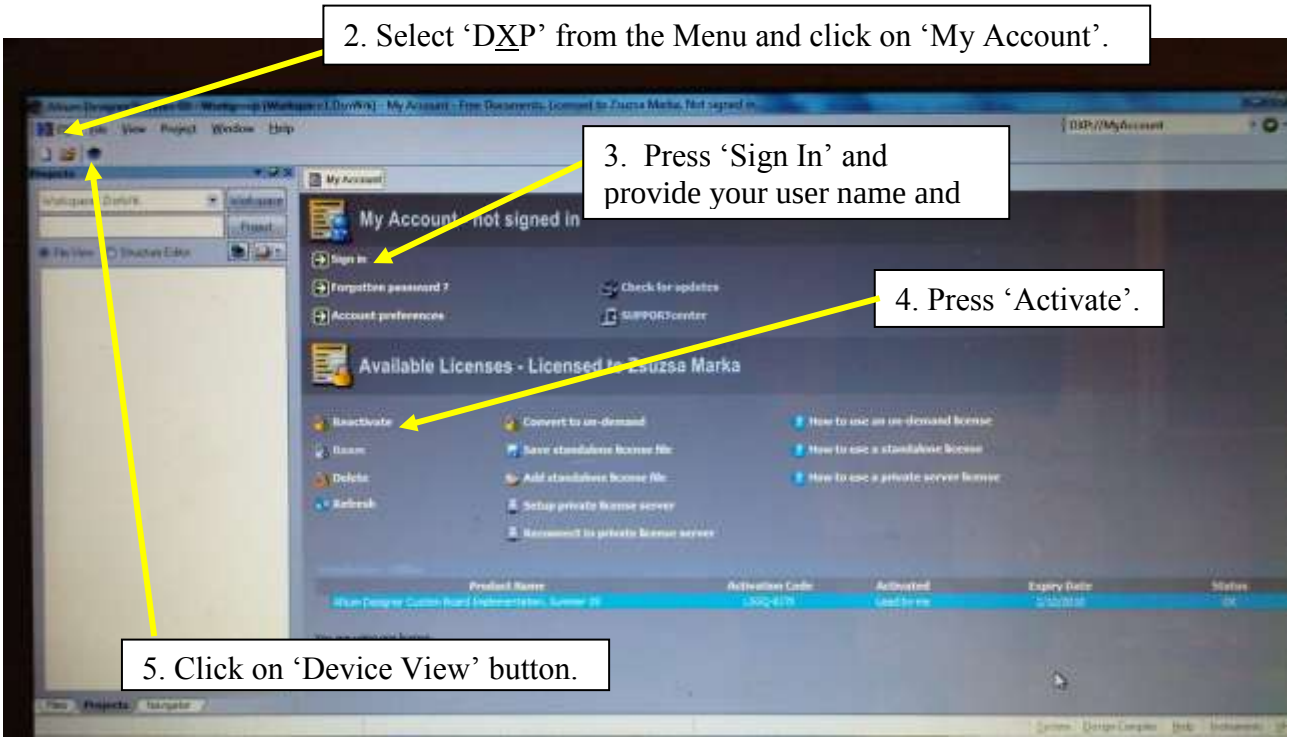



*Figure 1. My Account window. The steps of signing in and activating an account that allows the use of the software are indicated. We also indicated the position of the Device View icon that opens the window from where FPGA programming will be done.*

5. Click on 'Device View' button (see Figure 1).
6. Connect the computer to the desired board (Slave, Master or FanOut) using Altium USB-JTAG adapter.
7. Make sure that 'Live' is checked on the upper right corner of the 'Devices' screen in Altium Designer (see **Error! Reference source not found.**).

8. Make sure that 'Connected' is shown on the upper left corner of the screen (see **Error! Reference source not found.**).
9. Load Project. In the 'File' menu bar of Altium Designer, click on 'Open Project'. Select the the project you want to open and open it. Here, we give project locations for project one needs for testing:

   **SLAVE TEST:** C:\Timing\Slave_Test\FPGASlave.PrjFpg
   **DUOTONE TEST:** C:\Timing\DuoTone_Test\FPGADuoTone_TEST.PrjFpg

10. Reset Flash PROM. Right-click on Flash PROM icon as shown in **Error! Reference source not found.**. Click on 'Reset Hard Device'. Note that resetting can take up to a few minutes. Progress is indicated on the lower left corner of the screen.
11. Upload FPGA program to Flash PROM. Right-click on Flash PROM icon as in the previous step, and click on 'Choose File and Download…' (see **Error! Reference source not found.**).
    The files you need to select and download for testing are given below:

    **SLAVE TEST:**
    C:\Timing\Slave_Test\ProjectOutputs\Spartan3\fpgaslave.mcs
    **DUOTONE TEST:**
    C:\Timing\DuoTone_Test\ProjectOutputs\Spartan3\fpgaduotone_test.mcs

    Note that uploading the code can take up to a few minutes. Progress is indicated on the lower left corner of the screen.
12. Select project to program. From the menu below the FPGA chip icon, as indicated in **Error! Reference source not found.**, select the project you want to program. The project names for testing are:

    **SLAVE TEST:** FPGASlave / Spartan3
    **DUOTONE TEST:** FPGADuoTone_TEST / Spartan3

13. Program FPGA chip. Above the FPGA chip icon, click on 'Program FPGA', as indicated in **Error! Reference source not found.**.
14. For some tests you will need to use JTAG soft devices. These will appear after programming the board on the lower part of the 'Devices' screen, as indicated in **Error! Reference source not found.**. Note that soft devices work only if the board is connected to the computer with the Altium USB-JTAG adapter, it is programmed and the right project is selected below the FPGA icon that the board was programmed with.