WHOI Precision Timing Board User's Guide

Acoustic Communications Group

Woods Hole Oceanographic Institution

Version 0.1

Last modified 9/8/2015 9:42 AM

Hardware Interface

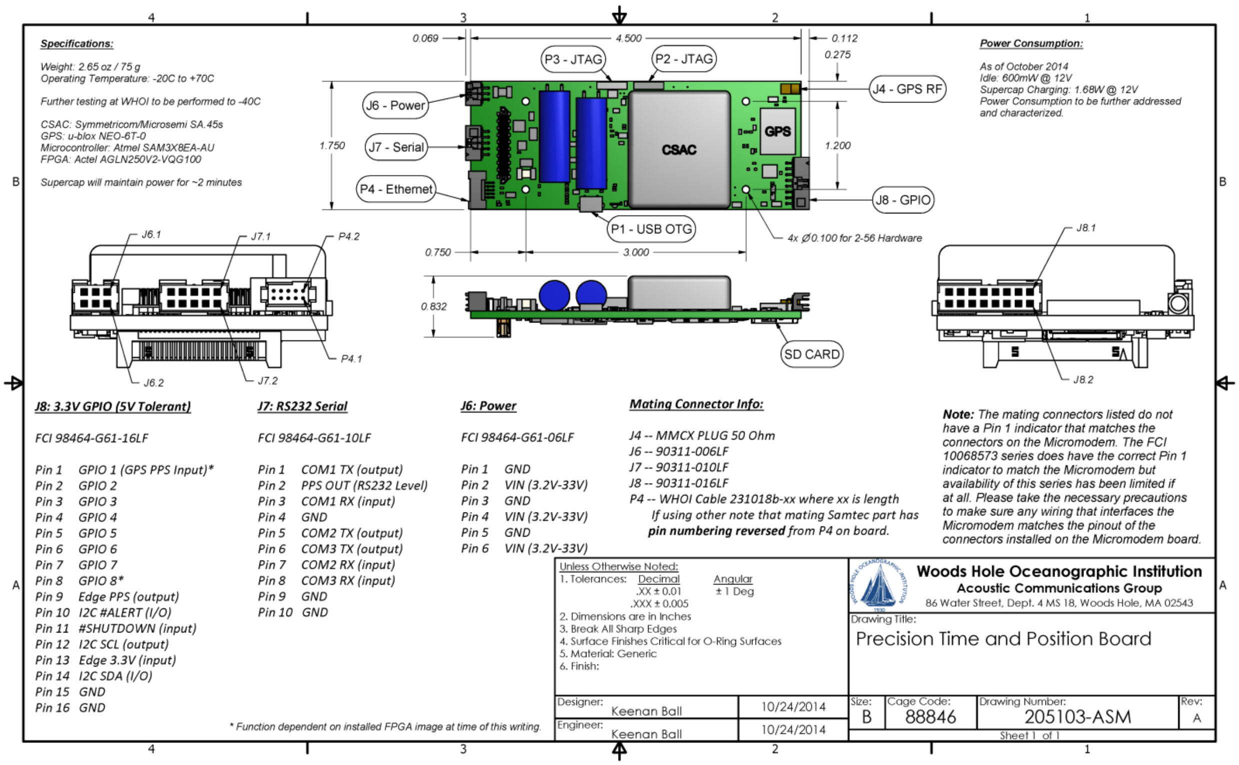

Figure 1: Precision Time and Position Board

Overview

The WHOI Precision Time and Position board (PTP, WHOI part number 205103A) is equipped with a Microsemi/Symmetricom SA.45s Chip-Scale Atomic Clock (CSAC) that can be synchronized to a GPS source to provide precision timing. The board has an internal u-blox NEO-6T-0 precision timing GPS receiver with low PPS jitter to allow disciplining the CSAC. Alternately, the PTP board can be connected to an external GPS for PPS synchronization.

Setting the time on a WHOI Micromodem-2 using the WHOI-PTP

Internal GPS configuration

This section describes how to synchronize the WHOI Micromodem-2 clock with the internal u-blox NEO-6T-0 GPS receiver on the PTP board.

1. Connect a GPS antenna cable to J4 (see Figure 1 for pinouts).
2. Do not connect J8.2. An internal pullup will select using the internal GPS.
3. Connect the serial output of the WHOI-PTP board on COM3 to a WHOI Micromodem-2 UART configured at 19200 baud, 8-N-1.
4. Connect the PTP board's PPS out pin (J8.9) to the Micromodem-2's EXTPPS pin (J3.11, see Micromodem-2 Users Guide)
5. Set the Micromodem-2's UART configuration parameters to process GPS messages on the appropriate UART and echo them on another. Set the Micromodem clock using GPS message string on the UART that is processing the incoming messages. In this example, the PTP board is connected to UART4 of the Micromodem using a baudrate of 19200, and the Micromodem output is monitored on UART2. The configuration parameters need to be set only once and will hold through a Micromodem power cycle.

```
$CCCFQ,uart4
$CACFG,uart4.parse_gps,1*37
$CACFG,uart4.show_gps,0*40
$CACFG,uart4.set_clk_GPS,1*3B
$CACFG,uart4.crc32,0*0B
$CACFG,uart4.rs485,0*40
$CACFG,uart4.bitrate,19200*0F
$CCCFQ,uart2
$CACFG,uart2.parse_gps,0*30
$CACFG,uart2.show_gps,1*47
$CACFG,uart2.set_clk_GPS,0*3C
$CACFG,uart2.crc32,0*0D
$CACFG,uart2.bitrate,19200*0
```

6. Power on the PTP board.

7. When the PTP board boots, the Micromodem-2 prints out the PTP board's boot message on Micromodem UART2 (the Micromodem-2 UART is hardcoded, so if Micromodem-2 UART2 is not being monitored, the user will not see this message):

```
$CAPST,2,0,0,0,0,,CSAC($Rev: 18173 $) INIT*00
```

8. A telemetry string from the CSAC will be printed every five minutes on Micromodem-2 UART2. This can be useful in monitoring clock drift and verifying that the CSAC heater power is not too high (which would indicate CSAC failure). See CSAC user guide for more information on each field.

```
$CAPST,2,0,0,0,0,,<Status,Alarm,SN,Mode,Contrast,LaserI,TCXO,HeatP,Sig,Temp,St
eer,ATune,Phase,DiscOK,TOD,LTime,Ver>
```

9. Once the Micromodem-2 sees a valid $GPRMC or $GPZDA sentence come from the PTP board, it will set its clock. Using the Micromodem-2's $CATMG or $CATMQ sentences, check to make sure that the Micromodem clock source is GPS and its PPS source is EXT. The Micromodem-2 will print a CATMG message upon change of clock status, or the user can query status using the CCTMQ command. Keep in mind that the PTP board only processes valid $GPRMC fixes. In addition, the internal GPS unit can take up to 12.5 minutes to acquire ephemeris data that is required for the $GPRMC UTC time field to be accurate with respect to leap seconds. $GPRMC strings are printed from the PTP board at a rate of once every 10 seconds.

```
$GPRMC,194010,A,4131.4776,N,07040.2588,W,000.0,000.0,051214,015.5,W*78
$CATMG,2014-12-05T19:40:11Z,GPS,EXT*7E
$CCTMQ,1
$CATMQ,2014-12-05T19:40:46Z,GPS,EXT*6A
```

10. At this point, it is safe to disconnect the GPS antenna. The PTP board will continue to supply the Micromodem-2 with a synchronized PPS along with a $GPZDA message once every 20 seconds. See $GPZDA message format for more information on each field.

```
$GPZDA,194010.00,051214,00,00*78
```

11. Super-capacitors on the PTP board will store enough energy to maintain the CSAC clock state through a power cycle up to approximately 1.5 minutes. If the Micromodem-2 reboots, the Micromodem will automatically re-synchronize its clock from the PTP board. If the PTP power is turned off for longer than this time, the PTP CSAC will have to be re-synchronized to GPS.

External GPS configuration

This section describes how to synchronize the WHOI Micromodem-2 clock with an external Garmin 18x GPS receiver connected to the PTP board.

1. Connect the GPS PPS output to J8.1 on the PTP board (0-3.3V, and 5V tolerant).
2. Connect J8.2 to ground to select using an external GPS.
3. Connect the serial output of the GPS unit at 9600 baud to PTP board COM2.
4. Follow the steps outlined in the previous section from Step 4 onwards to set the Micromodem-2's clock.

User control

Control of the CSAC can be passed from the microcontroller to the user by pulling GPIO4 (J8.4) to ground. In this mode, the user can query the CSAC and send it commands via COM1 at 57600 baud. The user can enter this mode after the PTP has achieved lock and synchronized its clock to the GPS clock. If the board is not synchronized, it will try and achieve synchronization after control is passed back from the user to the microcontroller.

LED behavior

There are two LEDs on the PTP board. The blue LED near P4, the ethernet port, is connected to the CSAC PPS and blinks at the rate of 1 Hz. The second LED, near P1, the USB/OTG port, has the following behavior:

LED color	CSAC state
Green	The microcontroller controls the CSAC, GPIO4 is high
Blue	The user controls the CSAC, GPIO4 is low
Red	The CSAC has not achieved lock

Initially, when the CSAC is powered up, the green and red leds will be lit, eventually as the CSAC achieves lock, the LED will turn pure green. If the CSAC control is transferred to the user, it will turn blue.

Appendix

CSAC product notification for operating temperature ranges:

January 2015

Product Notification

The Chip Scale Atomic Clocks ("CSAC") listed in the table below may fail to lock properly across the full operating temperature range, or after extended exposure to temperatures at the extremes of the storage temperature range. These products may experience other failures as well and at this time, we are unable to guarantee that these CSAC products will meet published specifications, including without limitation the following published specifications where we have seen numerous failures:

1) Storage temperature of -55°C to +90°C. We can only specify a range of -55°C to +40°C.
2) Operating temperature range of -10°C to +70°C (opt's 001, 003, 004, and 005). We can only specify a range of -10°C to +35°C.
3) Operating temperature range of -40°C to +85°C (opt 002). We can only specify a range of -10°C to +35°C.
4) Retrace of 5E-11. We can only specify 5E-10.
5) Aging of 3E-10/mo. and 1E-9/yr. We can only specify 9E-10/mo. and 1E-8/yr.

Products Affected: WOODS HOLE OCEANOGRAPHIC INST

Product Part Number	Description
090-00218-001	CHIP SCALE ATOMIC CLOCK (CSAC) OPT 001 -10 DEG C TO +70 DEG C
090-00218-002	CHIP SCALE ATOMIC CLOCK (CSAC) OPT 002 -40 DEG C TO +85 DEG C
090-00218-003	CHIP SCALE ATOMIC CLOCK (CSAC) 16.384MHZ -10 DEG C TO +70 DEG C
090-00218-004	CHIP SCALE ATOMIC CLOCK (CSAC) 10.24MHZ -10 DEG C TO +70 DEG C