TangerineSDR CKM GPS Module Configuration
Version: 2023-01-17

The ZED-F9T module has four serial I/O interfaces: USB, UART1, UART2, and I2C. UART1 can be configured as an SPI interface if desired.

In the factory reset configuration, the I2C, USB and UART1 interfaces output a set of NMEA messages. They can receive and send UBX protocol messages but by default none are enabled, so the only output will be the NMEA sentences. The UART default rate is 38400 N81. The I2C interface operates in slave mode only at a maximum bit rate of 400 kb/s. The TP1 and TP2 timepulse outputs are not enabled.

For operation in the CKM, the GPS module needs the following steps, which can all be done via the I2C interface:

0. Remember to write changes to RAM and BBRAM when finished!

1. Disable NMEA messages UART1, UART2, and I2C ports: UBX-CFG-NMEA. Leave enabled on USB so user can easily see the unit is functioning.

2. Confirm the receiver is there: UBX-CFG-MON-VER (will put up an ID screen with model, firmware version, etc.

3. Configure GNSS constellations to GPS only: UBX-CFG-GNSS set to enable GPS and QZSS and disable all other constellations. (The docs say to always turn on QZSS if GPS is turned on, even if it's not being used.) We can add an option to enable other constellations, but for timing purposes GPS-only is recommended.

4. Optional: set elevation mask: UBX-CFG-NAV5. Defaults in that message are usually OK.

5. Set to timing mode and either survey-in or enter user-provided LLH or ECEF location: UBX-CFG-TMODE2. For survey-in, use defaults for time and error for now but we may want to adjust those later.

6. Optional: set antenna cable delay: UBX-CFG-TP5

7. In UBX-CFG-TP5:
   a. set tpIdx to 0 for TP1
   b. set flag to enable TP1
   c. set TP1 as follows:
      1. freqPeriod to freq
      2. freqPeriod to 0 (no TP output when RX isn't locked)
      3. freqPeriodLock to 4192000 Hz (RF output on TP1 when locked)
      4. isLength 50 (percent duty cycle)
   d. set tpIdx to 1 for TP2

e. set flag to enable TP2
   f. set TP2 as follows:
      2. freqPeriod to 0 (no PPS output when RX isn't locked
      3. freqPeriodLock to 1 Hz (PPS output on TP2 when locked)
4. isLength to 10 (percent duty cycle; give 100 ms pulse)

   These settings configure the two TIMEPULSE outputs to be active only when the receiver is locked. Looking for TP transitions is about the only way to determine lock state without sending a polling message on one of the interfaces.

Those commands are sufficient to configure the ZED-F9T to drive the synthesizer and provide 1 PPS clock. The following are settings we will probably want in final version, but aren't necessary at this early stage:

8. Enable UBX-TIME-TP on I2C interface at 1 message per second to allow FPGA to do quantization error correction on PPS signal.

9. Enable UBX-NAV-HPPOSLLH and/or UBX-NAV-HPPOSECEF on I2C to provide high precision positioning info BUT – this won't mean anything when the receiver is in time mode (not navigating).

10. Enable UBX-RXM-RAWX and UBX-RXM-SFRBX messages on desired interface to output raw satellite data for TEC or post-processing. The original idea was to put this on UART1 by default as it's a lot of traffic and we don't want to swamp the I2C with data that's not necessary to process in real time.

There are certainly many other tweaks that we'll come up with, but these are a good V1.0 starting point.