
AltOS Companion Port

Protocol Definitions

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1. Companion Port

Many Altus Metrum products come with an eight pin Micro MaTch connector, called the Companion Port. This is often used to program devices using a programming cable. However, it can also be used to connect TeleMetrum to external companion boards (hence the name).

The Companion Port provides two different functions:

- Power. Both battery-level and 3.3V regulated power are available. Note that the amount of regulated power is not huge; TeleMetrum contains a 150mA regulator and uses, at peak, about 120mA or so. For applications needing more than a few dozen mA, placing a separate regulator on them and using the battery for power is probably a good idea.
- SPI. The flight computer operates as a SPI master, using a protocol defined in this document. Companion boards provide a matching SPI slave implementation which supplies telemetry information for the radio downlink during flight

2. Companion SPI Protocol

The flight computer implements a SPI master communications channel over the companion port, and uses this to get information about a connected companion board and then to get telemetry data for transmission during flight.

At startup time, the flight computer sends a setup request packet, and the companion board returns a board identifier, the desired telemetry update period and the number of data channels provided. The

flight computer doesn't interpret the telemetry data at all, simply packing it up and sending it over the link. Telemetry packets are 32 bytes long, and companion packets use 8 bytes as a header leaving room for a maximum of 12 16-bit data values.

Because of the limits of the AVR processors used in the first two companion boards, the SPI data rate is set to 187.5kbaud.

3. SPI Message Formats

This section first defines the command message format sent from the flight computer to the companion board, and then the various reply message formats for each type of command message.

Table 1. Companion Command Message

| Offset | Data Type | Name | Description |
|--------|-----------|--------------|--|
| 0 | uint8_t | command | Command identifier |
| 1 | uint8_t | flight_state | Current flight computer state |
| 2 | uint16_t | tick | Flight computer clock (100 ticks/second) |
| 4 | uint16_t | serial | Flight computer serial number |
| 6 | uint16_t | flight | Flight number |
| 8 | | | |

Table 2. Companion Command Identifiers

| Value | Name | Description |
|-------|--------|---|
| 1 | SETUP | Supply the flight computer with companion information |
| 2 | FETCH | Return telemetry information |
| 3 | NOTIFY | Tell companion board when flight state changes |

The flight computer will send a SETUP message shortly after power-up and will then send FETCH messages no more often than the rate specified in the SETUP reply. NOTIFY messages will be sent whenever the flight state changes.

flight_state records the current state of the flight, whether on the pad, under power, coasting to apogee or descending on the drogue or main chute.

tick provides the current flight computer clock, which be used to synchronize data recorded on the flight computer with that recorded on the companion board in post-flight analysis.

serial is the product serial number of the flight computer, *flight* is the flight sequence number. Together, these two uniquely identify the flight and can be recorded with any companion board data logging to associate the companion data with the proper flight.

NOTIFY commands require no reply at all, they are used solely to inform the companion board when the state of the flight, as computed by the flight computer, changes. Companion boards can use this to change data collection parameters, disabling data logging until the flight starts and terminating it when the flight ends.

3.1. SETUP reply message

Table 3. SETUP reply contents

| Offset | Data Type | Name | Description |
|--------|-----------|------------------|--|
| 0 | uint16_t | board_id | Board identifier |
| 2 | uint16_t | board_id_inverse | \sim board_id—used to tell if a board is present |
| 4 | uint8_t | update_period | Minimum time (in 100Hz ticks) between FETCH commands |
| 5 | uint8_t | channels | Number of data channels to retrieve in FETCH command |
| 6 | | | |

The SETUP reply contains enough information to uniquely identify the companion board to the end user as well as for the flight computer to know how many data values to expect in reply to a FETCH command, and how often to fetch that data.

To detect the presence of a companion board, the flight computer checks to make sure that `board_id_inverse` is the bit-wise inverse of `board_id`. Current companion boards use USB product ID as the `board_id`, but the flight computer does not interpret this data and so it can be any value.

3.2. FETCH reply message

Table 4. FETCH reply contents

| Offset | Data Type | Name | Description |
|--------|-----------|-------|---------------|
| 0 | uint16_t | data0 | 0th data item |
| 2 | uint16_t | data1 | 1st data item |
| ... | | | |

The FETCH reply contains arbitrary data to be reported over the flight computer telemetry link. The number of 16-bit data items must match the *channels* value provided in the SETUP reply message.

4. History and Motivation

To allow cross-programming, the original TeleMetrum and TeleDongle designs needed to include some kind of connector. With that in place, adding the ability to connect external cards to TeleMetrum was fairly simple. We set the software piece of this puzzle aside until we had a companion board to use.

The first companion board was TeleScience. Designed to collect temperature data from the nose and fin of the airframe, the main requirement for the companion port was that it be able to report telemetry data during flight as a back-up in case the TeleScience on-board data was lost.

The second companion board, TelePyro, provides 8 additional channels for deployment, staging or other activities. To avoid re-programming the TeleMetrum to use TelePyro, we decided to provide enough information over the companion link for it to independently control those channels.

Providing a standard, constant interface between the flight computer and companion boards allows for the base flight computer firmware to include support for companion boards.