

## C Avionics Hardware Design (SS)

### C.1 Avionics Board Interfaces

It is essential to identify the interfaces in order to ensure a complete and functioning Avionics/electronics subsystem. The primary role of the Avionics subsystem is to integrate all hardware and software of the system; therefore, the Avionics hardware must interface with all other subsystems.

Central to the Avionics subsystem is the Tattletale Model 8 computer. The Avionics team has chosen to utilize the Tattletale Model 8 computer (TT8), with Motorola CPU (Central Processing Unit) and TPU (Time Processing Unit), because it both suits project processing needs and is readily available in the Space System Laboratory. This computer interfaces directly with four other pieces of hardware: The Metrology computer, the voltage regulator, the Communications board, and a series of mosfets used for power amplification purposes. This hardware conceptual layout is depicted in Figure C.1-A.

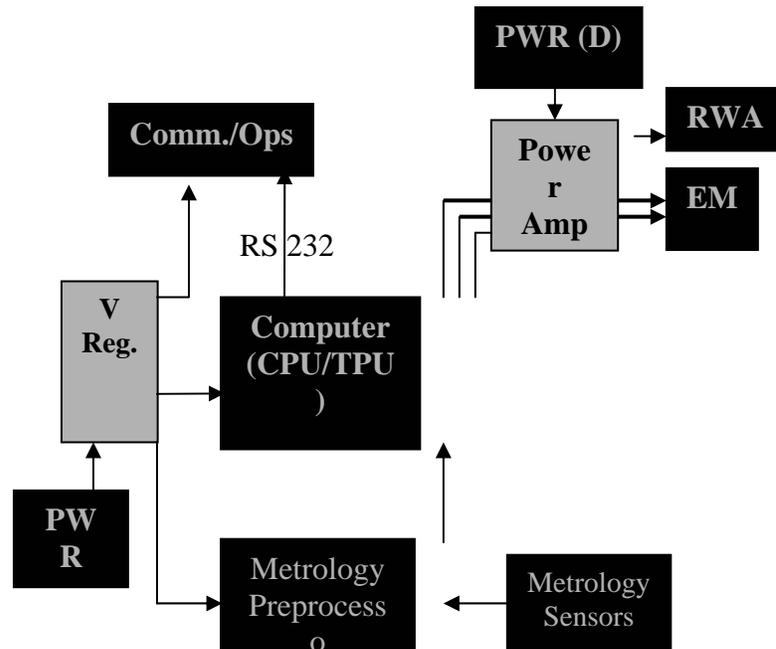


Figure C.1-A: Avionics Hardware Interfaces

Each hardware interface is necessary and vital to each EMFFORCE vehicle. The necessity for these interfaces is explained as follows:

- The Metrology computer is another Tattletale Model 8 computer. The Avionics subsystem must allow for the sending of Primary Vehicle Array (PVA) updates through a serial channel from the Metrology TT8 to the main Avionics TT8 computer.

- The Power team is responsible for the voltage regulator. However, the Avionics team is responsible for the interfacing between the voltage regulator and the rest of the system. The voltage regulator allows for a steady 5V power to come from the AA batteries to the Tattletale computers and the Avionics board. The Power and Operations teams shall address any other power concerns and notify the Avionics team in a timely manner such that any new concerns can be addressed properly in the system design.
- The communications/operations hardware is the hardware that allows for the sending and receipt of all data being transmitted and received from the immediate vehicle system to the Avionics TT8 and vice versa. The Communications board interfaces with the Avionics TT8 through a serial RS232 cable connection.
- A circuit design of mosfets, like the voltage regulator, is the responsibility of the Power team. However, the intergration of the mosfets into the vehicle system is the responsibility of the Avionics team. These mosfets shall ensure that the power derived from the D-cell main batteries supply the necessary level of current needed to drive the Reaction Wheel Assembly and the Electromagnets.

## **C.2 Avionics Board Wiring and Schematic**

The Metrology and Avionics Tattletale computers shall be attached to the Avionics board via one TSW-116-07-SS connector and one TSW-120-07-SS connector per Tattletale computer. The two Tattletales communicate via one Tx line and one Rx line. Four RS-232 jacks, (corresponding to the Serial1 and Serial2 lines for each computer) shall be placed on the board, in a manner such that code loading can easily occur. The Digital Ground (DGND), -MCLR, and -IRQ3 lines shall have male connectors such that a female connector can be used to load programs (DGND must be paired with either -MCLR and -IRQ3 to load either FLASH or ROM).

The Communications board shall be connected to the main Avionics board via another RS-232 cable. This connection requires from Avionics a transmit, a receive, and a digital ground line. Three Ultrasonic (US) signals shall all be inputs to the Metrology TT8 while the three Infrared (IR) signals shall converge through an OR gate before metrology computer processing. This single IR signal shall also be sent to the Avionics TT8 for time synchronization purposes.

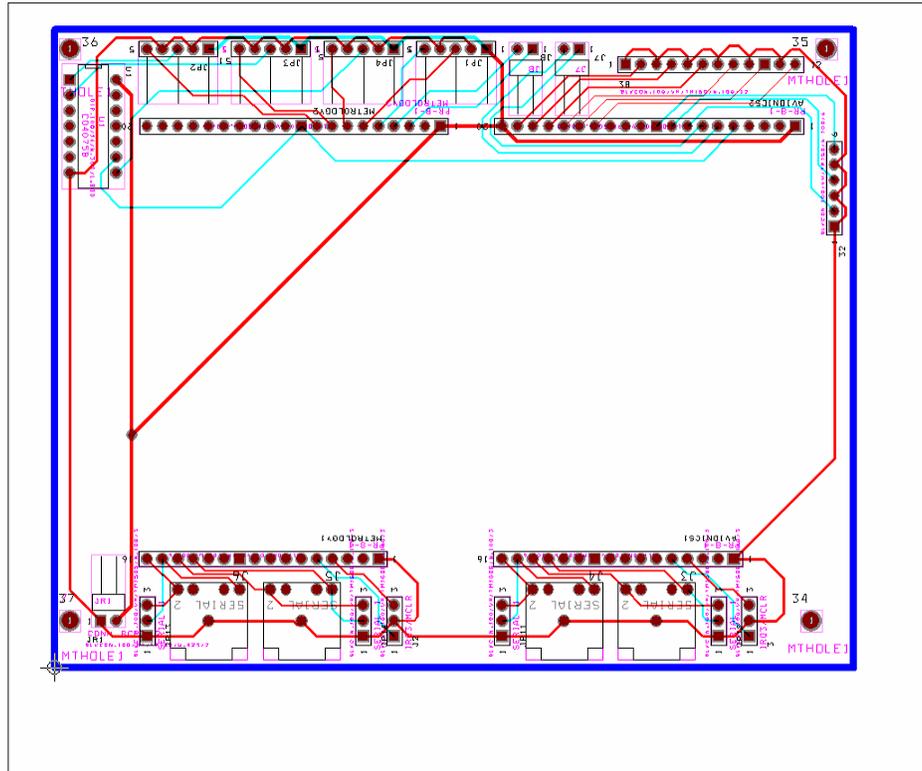


Figure C.2-A: Avionics Board Wiring Schematic

### C.3 TT8/Avionics Board Pin Allocations

The Avionics team established the following input/output pin allocations so that every subsystem can transmit and receive data when necessary. The following pins have been allocated for the following functions on the Metrology and Avionics TT8 computers. The “TP” prefix refers to a TPU channel, and the “AD” pin and channel prefix refers to a pin connected to the TT8’s internal A/D converter. A pin on the Avionics board or on the Metrology board is signified, respectively, by an “A” or an “M” appended to either the “TP” or “AD” prefix. Table 0-A lists the Avionics computer TT8 pins, their functions, and whether it is for an input or an output signal from the Avionics computer while lists the same for the Metrology computer. Loading of software code shall occur via serial port. TT8-to-TT8 and TT8-to-Communications Board communication shall occur via serial lines made by the Avionics team. Two TPU pins and the ground pin are necessary for each of these serial lines.

**Table C.3-A: Avionics IO Pin Allocations**

<b>Channel/Pin</b>	<b>Purpose</b>	<b>Input or Output?</b>
TPA0	Actuation 1, Electromagnet	Output
TPA1	Actuation 2, Electromagnet	Output
TPA2	Reaction Wheel	Output
TPA3	TT8-to-TT8 Communication, Tx	Output
TPA4	TT8-to-TT8 Communication, Rx	Input
TPA5	IR	(input from met.)
TPA6 (not needed yet)	Actuator Stop	Output
TPA7	Small Control Loop	Input?
TPA8	PWM	Output
Serial1	Used for loading of code	Input
Serial2	TT8-to-Comm. Board	Input and Output
AA1	Ground line	Input
AA4	-MCLR	Output
AA5	-IRQ3	Output
ADA1	EM Amperage	Input
ADA2	EM Amperage	Input

**Table C.3-B: Metrology I/O Pin Allocations**

<b>Channel/Pin</b>	<b>Purpose</b>	<b>Input or Output?</b>
TPM0	Infrared	Input
TPM1	Ultrasonic 1	Input
TPM2	Ultrasonic 2	Input
TPM3	Ultrasonic 3	Input
TPM4	Infrared	Output
TPM5	Ultrasonic	Output
SerialM1	Used for loading of code	Input
SerialM2	Used for loading of code	Input
TPM6	TT8-to-TT8 Communication, Tx	Output
TPM7	TT8-to-TT8 Communication, Rx	Input
AM1	Ground line	Input
AM4	-MCLR	Output
AM5	-IRQ3	Output

### C.4 Avionics Board Capture Drawing

The following schematic (please refer to Figure C.4-A) was developed utilizing OrCAD Capture and shows the individual parts and connections to be included for the avionics board design.

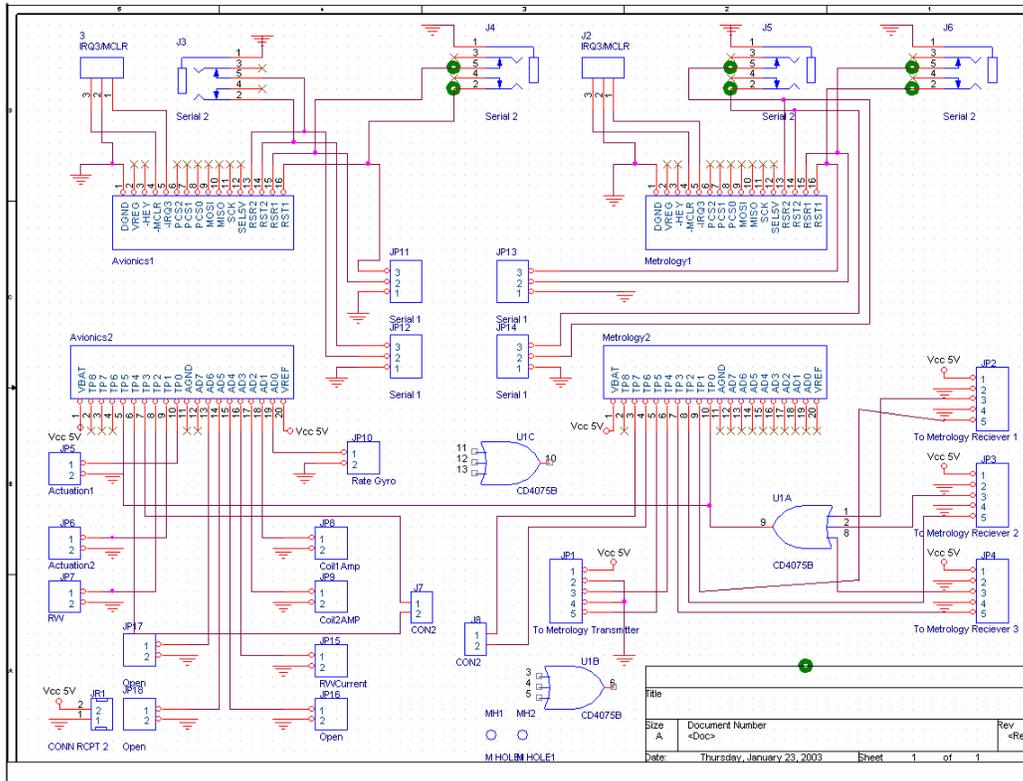


Figure C.4-A: Avionics Board OrCAD Capture

## C.5 Avionics Hardware Testing

Integration has been completed in a series of steps. The following different tests and projects were performed to ensure proper avionics hardware design, integration, and compatibility with the vehicle as a whole. The dates that these stages occurred are also noted.

- Dec2002 – May2003: A prototype board and design concept for the actual Avionics board is designed and used. At this point, tests shall be conducted to ensure proper coding and board design theory as well as to verify correct design of the various subsystems. The prototype “board” includes 2 IO-8 prototyping boards manufactured by Onset Computers, 1 prototyping breadboard with metrology OR gate chip for IR signal timing transmission, RS-232 cables used for both TT8-to-TT8 communication and TT8-to-Communication board communication, and all wiring of signals from each I/O channel. This prototype system is currently still being used on Vehicle 1, and has allowed successful completion of tests 1A and 1B.
- Apr2003: The manufactured boards were first compared to the OrCAD Layout and Capture drawings to ensure that they were manufactured to our specifications, and then tested with a scope to ensure proper connections. These assurance tests were completed successfully.
- 24Apr2003: Two avionics electronics boards are populated according to to-date specifications. Metrology software and hardware were integrated into the system without fault.
- 29Apr2003: It was determined that the current design of the avionics software needed 5 more digital channels for functionality. The manufactured board design only included 5 excess A/D channels and no extra digital channels. Therefore, the two boards were hardwired to meet the needs of the software.
- 01May2003: Software integration with the Avionics electronics board commenced. The Metrology TT8 and the Avionics TT8 were not communicating; bypassing the OR-gate solved this issue.
- 08May2003: Hardware/electronics integration on Vehicle 2 begins.

## **C.6 Avionics Circuit Board Part Information**

Each Avionics circuit board includes the following parts:

- Main avionics circuit board: The board is a prototype board manufactured by Advanced Circuits, Inc. (see [www.4PCB.com](http://www.4PCB.com) for more information).
- Motorola TT8C Computers: Each board has 2 of these.
- CD4075: This is the Or-gate chip necessary for IR processing. It is a “dip” chip. For part specification, see C-7.
- Screw terminals: four 5-terminal screw blocks, 1 12-terminal screw block, 1 6-terminal screw block are needed per board. For the part specification, see C-8.
- Headers: The TT8 is connected to the board with one 16-pin and one 20-pin header per computer.

## **C.7 Part Specification for Screw Terminals**