TIMED Integrated Electronics Module (IEM)

1. Three spacecraft subsystems and supporting power-conditioning electronics, all implemented on nine plug-in cards, are integrated into a single chassis to form one IEM. (Two IEM's are used on the TIMED spacecraft for redundancy.) The three subsystems and supporting power-conditioning electronics are:

a. Command and Data Handling (C&DH)

- Processor and 1553 Bus Controller **(1 Card, A2)**
- Solid State Recorder (SSR) **(1Card, A3)**
- Command and Telemetry Interface **(1 Card, A6)**
- Downlink data formatter and PCI bus interface are implemented on the Downlink card
- Critical Command Decoder (CCD) is implemented on the Uplink card.

b. RF Communications

- Downlink S-Band channel consisting of Reed-Solomon, convolutional and CRC encoding, frequency synthesizer, vector modulator, and S-Band power amplifier **(1 Card, A7)**. (The downlink data formatter and PCI bus interface listed with the C&DH subsystem are also on this card.)
- Uplink S-Band channel consisting of a downconverter, frequency synthesizer, AGC control, command bit detector/synchronizer and an experimental non-coherent Doppler tracking system **(1 Card, A8)**. (The Critical Command Decoder (CCD) listed with the C&DH subsystem is also on this card.)

c. GPS[1] Navigation System (GNS)

- GNS Dual Processor, one processor for tracking the received GPS signals, the other for producing navigation results and other functions **(1 Card, A5)**.
- GPS Receiver and digital signal processing ASIC[2] that form 12 channels for tracking GPS signals **(1 Card, A4)**. (The tracking processor on the GNS dual processor card controls the ASIC.) A pre-amplifier, external to the IEM and located close to the GPS antenna, supplies the incoming GPS signals to the receiver.

d. Power Conditioning Electronics

- Power from the spacecraft's switched bus (unregulated), nominally +28 volts DC, is converted to regulated and filtered voltages for the C&DH and GNS cards within the IEM and for the Remote Interface Units (RIU's) external to the IEM **(1 Card, A1)**.
- Power from the spacecraft's switched and unswitched busses is converted to regulated and filtered voltages for the RF Communications subsystem **(1 Card, A9)**. Power for the uplink is derived from the unswitched bus and power for the downlink power amplifier is supplied from the switched bus.

Notes: 1. GPS = Global Positioning System
2. ASIC = Application Specific Integrated Circuit

2. Data flow both within the IEM and between the IEM and external spacecraft subsystems is performed based on industry standard architectures. Use of standard hardware interfaces for handling data permits ease of adapting the IEM for use on other space missions that require a different subsystem configuration. The methods for data transfer are implemented as follows:

a. Peripheral Component Interconnect (PCI) Bus

A modified version of this standard bus is used to control the flow of much of the data within the IEM. The modifications are operation at 5 MHz rather than 30 MHz and data are transferred in 16 rather than 32 bit parallel increments. Operation at 5 MHz is well within the requirements for TIMED data throughput and permits use of protection circuitry at the bus interfaces that limit the operating rate. The PCI bus is used to transfer data between the C&DH processor, Solid State Recorder, GNS navigation processor, Command and Telemetry Interface and the Downlink.

b. 1553 Bus

This is a redundant bus that is used to transfer data bit serially at a 1 MHz rate between the IEM, spacecraft instruments, Attitude Interface Units (AIU's), Power System Electronics (PSE) and the alternate IEM. A controller on the C&DH processor card implements the bus protocols.

c. Inter-Integrated Circuit (I^2C) Bus

This is a serial bus that is used to transfer spacecraft temperature data to the IEM from 6 Remote Interface Units (RIU's) located throughout the spacecraft. The data are received by the Command and Telemetry Interface card in the IEM and transferred to the C&DH processor via the PCI bus.

d. Relay Command Serial Interface

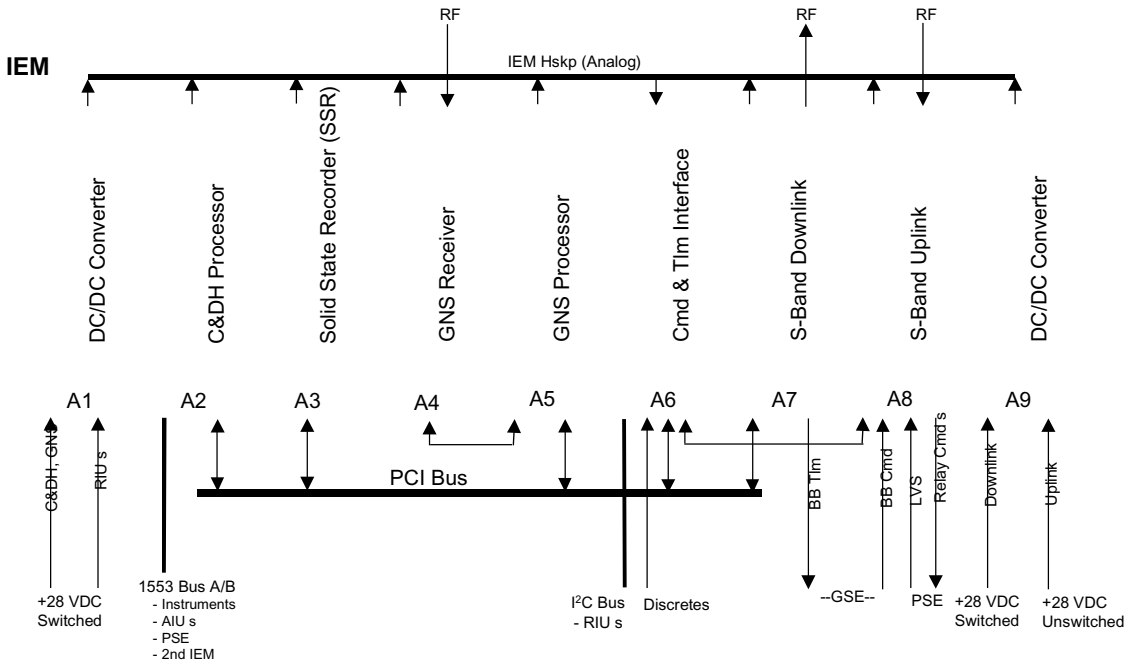
To control spacecraft relay states a serial, digital interface is provided between the IEM and the relay switching circuits in the Power Switching Electronics. The interface consists of Data, Clock, Enable and Gate signals. The Critical Command Decoder (CCD) on the Uplink card implements this interface in the IEM.

e. Baseband Command Interface

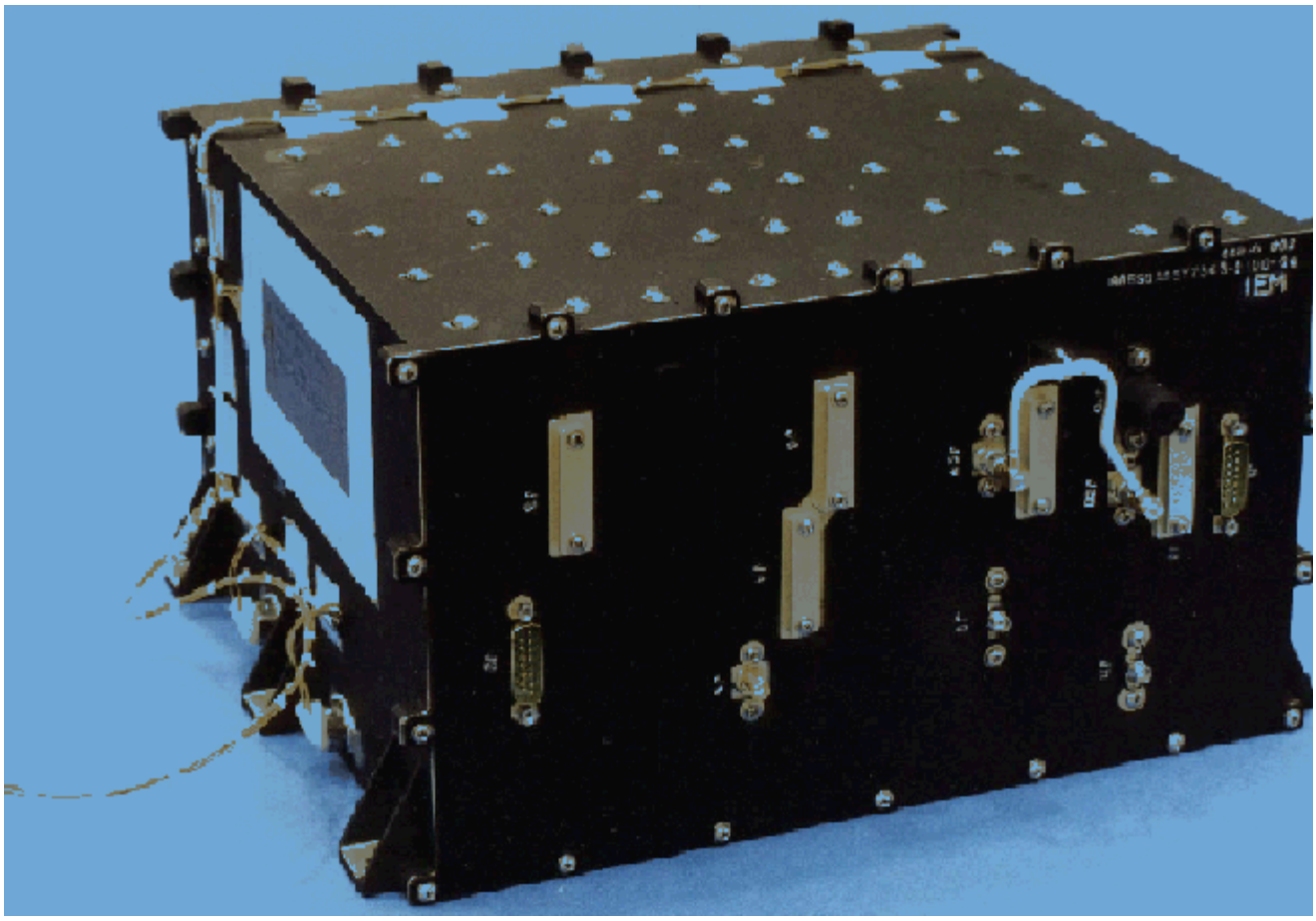
This is a digital interface that permits bypassing the RF uplink for commanding as required during pre-launch activities. It is implemented in the CCD on the Uplink card and consists of Data, Clock, Lock and Baseband Select signals.

f. Baseband Downlink Interface

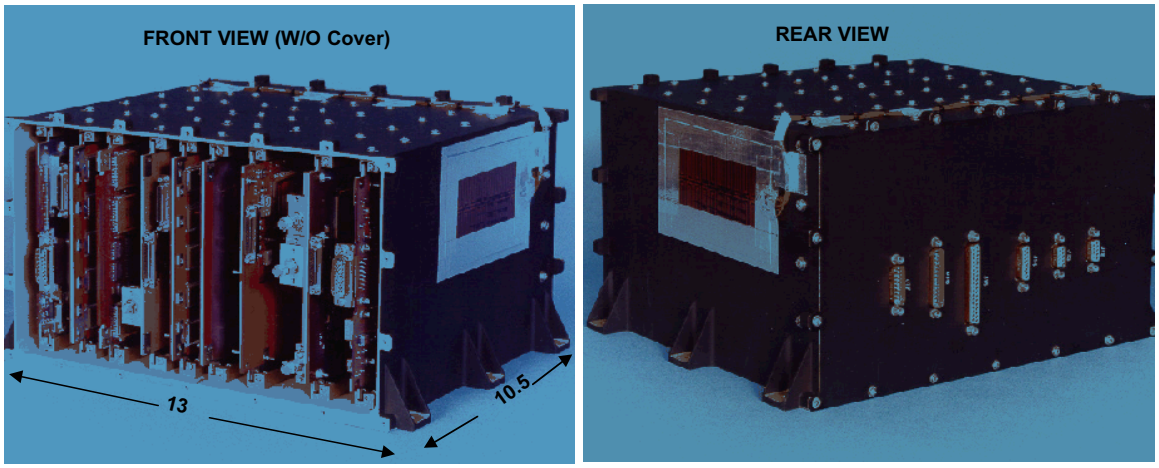
This digital interface is used to bypass the RF downlink to recover telemetry as needed during pre-launch activities. It is implemented on the Downlink card and consists of a Data signal.



IEM BLOCK DIAGRAM



TIMED IEM - FRONT VIEW



SIZE: 7.1x13x10.5 inches
WEIGHT: 25.2 lbs.
POWER: 53.3 Watts (Fully Powered)

TIMED IEM - OPEN FRONT and REAR VIEWS