# *TIMED*

*Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics*

## GUIDANCE and CONTROL SYSTEM PRESENTATIONS

| | |
|---|---|
| **SYSTEM** | **WADE RADFORD** |
| **I&T HARDWARE** | **STEVE HUTCHINSON** |
| **SOFTWARE** | **SHANE HUTTON** |
| **ANALYSIS** | **WAYNE DELLINGER** |

## CHANGES SINCE PDR

- SUN SENSORS ARE CROSS STRAPPED
- MAGNETOMETERS ARE CROSS STRAPPED
- 4 SENSOR HRG REPLACED WITH REDUNDANT 3 SENSOR RLG

# TIMED G&C Functional Requirements

- Operational Mode
  - Commanded Attitude: ± X to Ram
    + Z to Nadir
    Sun on - Y
  - Implies: 1 RPO pitch rate
    0 roll and yaw rates
- Control Accuracy: 0.5 ◦ each axis, 3σ
  - Requires full 3-axis active control
- YAW Maneuver every 60 days

# TIMED G&C Functional Requirements

(cont'd.)

- Attitude Knowledge: 0.03 ◦ each axis, 3σ
- Knowledge of G&C Fiducial Frame, mapped to SC coordinates

- Jitter/Stability
  - G&C Controls Low Frequencies
  - Higher frequencies met by structural rigidity

# G&C Modes: SAFE

- NADIR Pointing Mode
    - Same as Operational Configuration but with very loose constraints
- SAFE Mode:
    - Stabilize the Spacecraft Attitude
    - Maintain Adequate Power, Thermal Protection

# G&C Modes : Operational

- Operational Mode:
  - Nominal Commanded Attitude: ± X to Ram
    + Z to Nadir
    Sun on - Y
  - Requires IRU, Star Tracker and Orbit Data
  - Stars, orbit may be stale within uploaded tolerances
    - Integrate orbit forward
    - Fly on gyros from last stellar reference
  - Yaw Maneuver and Solar Panel Rotation
  - Notify of impending operation(via C&DH 1553)
  - Perform operation
  - Notify when operation safely completed

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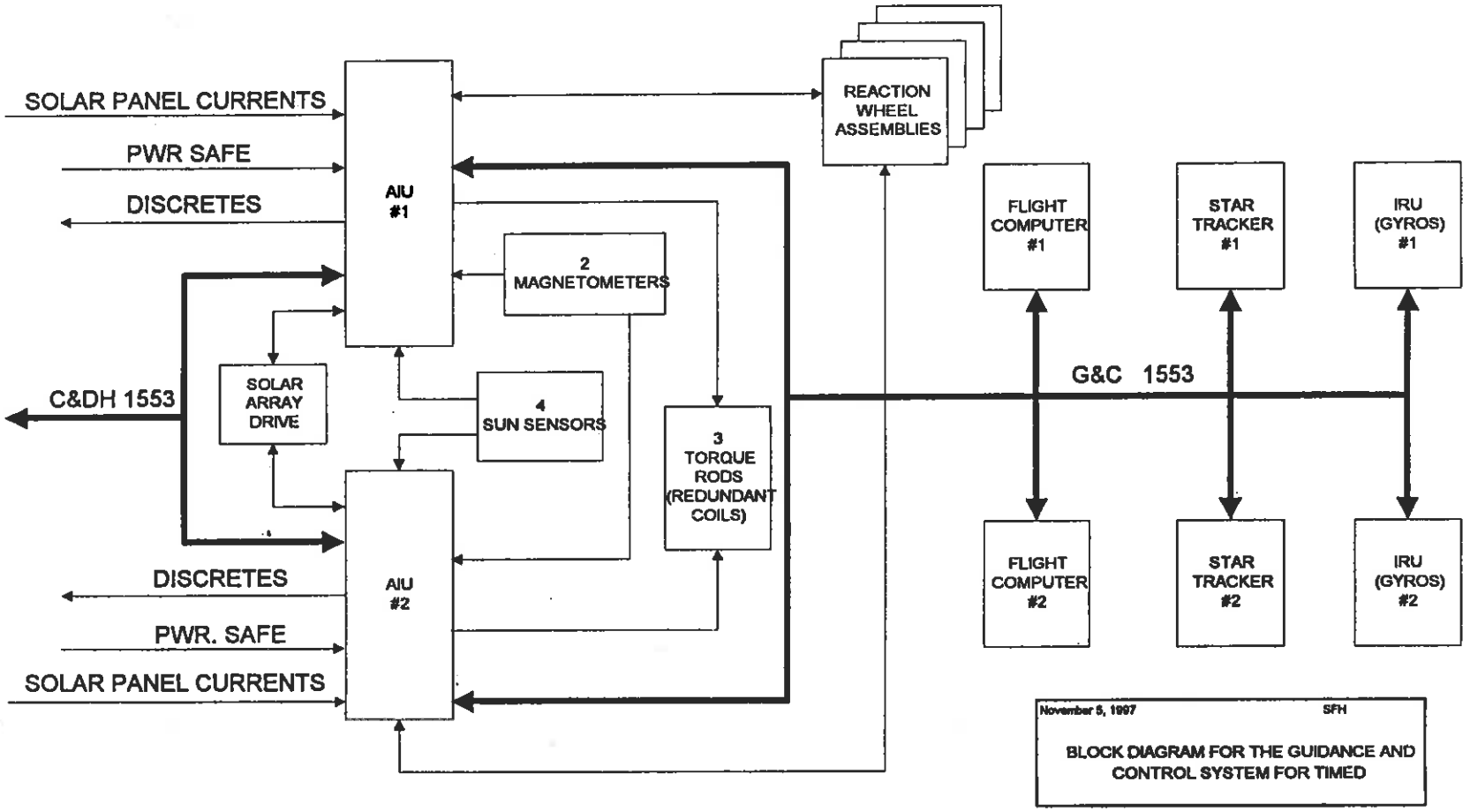
## BLOCK DIAGRAM

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## GUIDANCE and CONTROL SYSTEM PROCUREMENTS

| | |
|---|---|
| **Star Trackers:** | **2** |
| **Inertial Reference Units:** | **2** |
| **Reaction Wheel Assemblies:** | **4** |
| **Torque Rods** (redundant) | **3** |
| **Magnetometers:** | **2** |
| **Solar Panel Drives** | **2** |

## Meet mission requirements in accordance with TIMED Documents:

| | |
|---|---|
| **Component Environmental Specification** | **JHU/APL 7363-9010** |
| **Procurement Product Assurance Requirements** | **JHU/APL 7363-9029a** |
| **Contamination Control Plan** | **JHU/APL 7363-9031** |
| **EMC Control Plan and Performance Specification** | **JHU/APL 7363-9038** |

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## GUIDANCE and CONTROL SYSTEM

### Procurement Decision Basis

- **Minimize costs with "Off the shelf" purchase**

- **If changes/modifications required, consideration given only to existing/available options (No development costs)**

- **Delivery to comply with ambitious schedule**

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## GUIDANCE and CONTROL SYSTEM

### Autonomous Star Tracker (AST) (2 required)
### Lockheed Martin AST-201

**Star Availability:** (7 to 48; Average 27)

**Star Database:** 6,400 for star ID and initial attitude determination
10,000 supplemental to maximize attitude accuracy

| | | |
|---|---|---|
| **Accuracy:** | **Pitch, Yaw:** | **2.7 arcseconds** |
| | **Roll:** | **31.9 arcseconds** |
| **Stray Light Rejection:** | **> 20 degrees off boresight** | |
| **Interface:** | **Redundant 1553B** | |
| **Sample rate:** | **5 Hz.** | |
| **Power:** | **< 15 W each** | |
| **Voltage:** | **28±7 V** | |
| **Weight:** | **4.4 Kg Each** | |
| **Delivery:** | **September 1998** | **WER-10** |

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## GUIDANCE and CONTROL SYSTEM

### Inertial Reference Unit (IRU) (2 required)
### Honeywell YG9666XX IRU

**Three axis Ring Laser Gyro including the Soft Start/Current Limit, 1553B Interface and Pressure Transducer Options.**

- **Bias** — **0.036 deg/hr over 24 hours**
- **ARW (1 sigma)** — **0.008 deg/ rt.hr.**

| | |
|---|---|
| **Power (Steady State):** | **21.5 W each** |
| **Voltage:** | **28±7 V** |
| **Weight:** | **4.2 Kg each** |
| **Delivery:** | **September 1998** |

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## GUIDANCE and CONTROL SYSTEM

### Reaction Wheel Assembly (RWA) (4 required)
### Ithaco Inc. Type B

| | |
|---|---|
| **Angular Momentum Capacity:** | **16.6 N-m-s** |
| **Maximum reaction Torque:** | **40 mN-m** |
| **Speed:** | **0 to ± 5100 rpm** |
| **Power: steady state** | **5.5 W @ 200 RPM** |
| **steady state** | **17 W @ 5100 RPM** |
| **peak** | **50W @ 5100 RPM** |
| **Voltage:** | **28±7 V** |
| **Weight (including integrated electronics):** | **5.86 Kg each** |
| **Delivery:** | **July 1998 WER-12** |

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## GUIDANCE and CONTROL SYSTEM

### Torque Rods (3 required)
### Ithaco Inc. TR100UPR

**Dipole Moments (absolute Values):**

| | | | |
|---|---|---|---|
| **Linear:** | **110 $Am^2$** | **@** | **20.0 V, 122 mA** |
| **Saturation:** | **130 $Am^2$** | **@** | **24.6 V, 150 mA** |
| **Residual:** | **1.0 $Am^2$** | | |

**Dimensions:** 33.2 in. long X 0.9 in. diameter

**Power:** 3.7 W each (when powered)

**Weight:** 2.1 Kg each

**Delivery:** January 1998

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## GUIDANCE and CONTROL SYSTEM

### Magnetometers (2 required)
### Science Applications International Corporation (SAIC)
### NT-600S Quadraxial Fluxgate

| | |
|---|---|
| **Sensor:** | **Ring Core Fluxgate** |
| **Sensitive Axis:** | **X, Y, Z and R** |
| **Dynamic range:** | **±60,000nT (±600mG)** |
| **Frequency response:** | **0 - 30 HZ** |
| **Power:** | **300 mW each** |
| **Voltage:** | **28 ±7 V** |
| **Weight:** | **0.45 Kg each** |
| **Delivery:** | **January 1998** |

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## GUIDANCE and CONTROL SYSTEM

## TIMED SOLAR ARRAY DRIVE ACTUATOR

- Purchase Specification (7363-9316) for the Solar Array Drive Actuator for the TIMED Spacecraft was written May 1997.
- Purchase Contract was awarded to Schaeffer Magnetics Inc. on June 17,1997 and Contract was signed on August 26, 1997.
- Two modified Type 3 Harmonic Drive Actuators and a four-channel Electronic Control Unit are being procured.
    - Drive rotation will be over a 110° range.
    - Position telemetry will be 0 to 5 volts over a 160° pot range.
- Critical Design Review was held November 13, 1997.
- Delivery of Flight Hardware scheduled for August 15, 1998.

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## GUIDANCE and CONTROL SYSTEM

**Attitude Interface Unit** (Made At APL/ NEAR Heritage)

- **POWER 11 WATTS EACH UNIT**
- **WEIGHT 6.6 Kg TOTAL**
- **RTX2010 PROCESSOR; 12 MHz CLOCK**
  - **64K WORDS RAM**
  - **64K WORDS EEPROM**
  - **8K WORDS PROM**
- **1553 BUS INTERFACES**
  - **G&C 32K WORDS RAM BUFFER**
  - **C&DH 32K WORDS RAM BUFFER**

- ANALOG INPUTS/OUTPUTS
  - MAGNETOMETERS
  - SUN SENSORS
  - REACTION WHEELS
  - SOLAR ARRAY CURRENT
  - SOLAR ARRAY POSITION

- DIGITAL INPUTS/OUTPUTS
  - IEM DISCRETES
  - POWER SYSTEM DISCRETES
  - SOLAR ARRAY DRIVE

- POWER SWITCHING INTERNAL TO AIU
  - TORQUE RODS (ON/OFF & POLARITY)
  - SOLAR ARRAY DRIVE
  - IRU

- TWO INDEPENDENT UNITS IN ONE CHASSIS

- **RELAYS CONTROLLED BY THE IEM DETERMINES WHICH UNIT IS IN CONTROL OF THE WHEELS, TORQUE RODS AND POWER SWITCHING**

- **EXTERNAL CROSS STRAPPING**
  - **REACTION WHEEL SPEEDS**
  - **SOLAR ARRAY CURRENT**
  - **IEM DISCRETES**
  - **POWER SYSTEM DISCRETES**

- **TOTALLY REDUNDANT**
  - **SOLAR ARRAY POSITION**
  - **SOLAR ARRAY DRIVE**

- **INTERNAL CROSS STRAPPING**
  - **4 SUN SENSORS**
  - **2 MAGNETOMETERS**
  - **3 TORQUE RODS**

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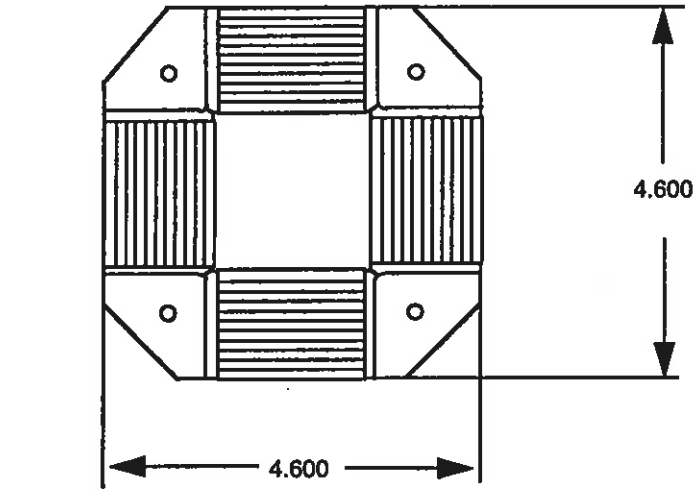


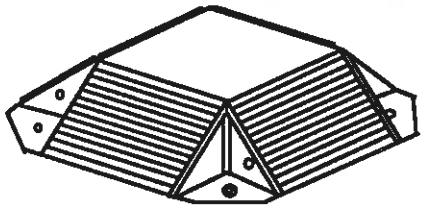

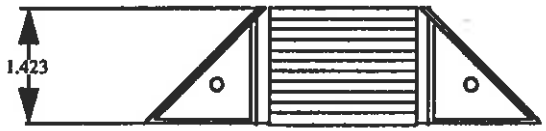


Sun Sensor

## Launch Sequence of Events

- Launch With Both AIUs ON
- Separate From Booster— Turn Both Magnetometers ON
- Dump Tip Off Rates with Torque Rods and Magnetometers
- Power Wheels and IRU
- Null Rates in Sun Safe Mode and Point +Z Axis Close to the Sun
- Wait for ground command

## STATUS SUMMARY

- AIU IN APL SHOPS: NEAR Heritage: The design is completed and the drawings are mostly complete. The chassis drawings are completed.

- PROCUREMENTS: All contracts are in place and parts procurements are in process. All contracts are on schedule.

- SUN SENSOR: The design is progressing at APL. The solar cell vendor has agreed to supply, mount and test the cells on the pyramid.