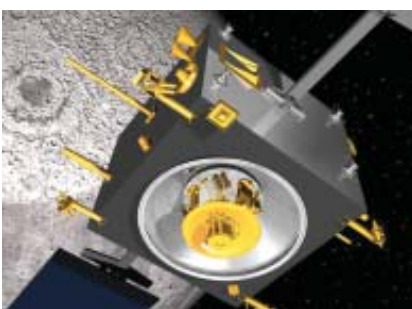
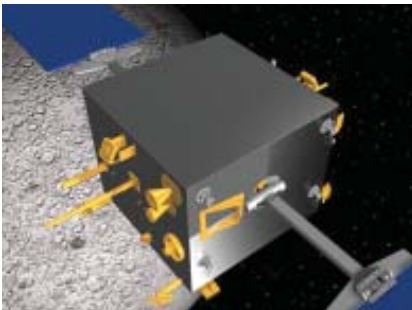


# Spacecraft System Unit

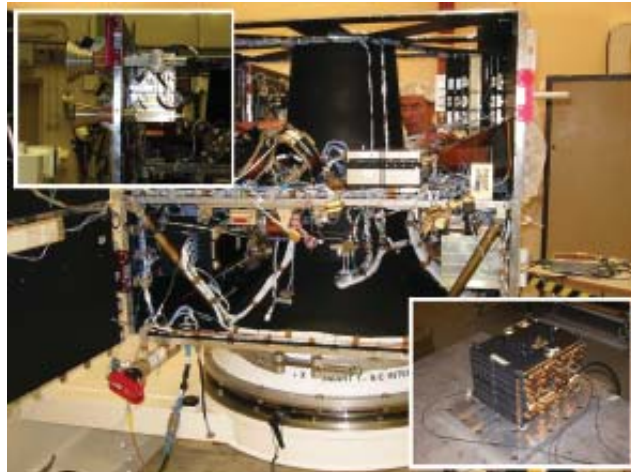


## GENERAL DESCRIPTION

The Spacecraft System Unit has been specifically developed by SSC for the SMART-1 mission. Due to its flexibility, cost-effectiveness, radiation tolerance, CCSDS compatibility, absence of single failure points and ease of interfacing it is well suited for many other types of space missions.

The spacecraft controller board is a combination of the main processor and a mass memory board. The spacecraft controller connects the two spacecraft buses, the system bus and the payload bus. The two buses are based on the CAN (Controller Area Network) protocol which is extensively used in the automotive industry. The spacecraft platform units are connected to the system CAN bus and the payload (scientific instruments) are connected to the payload CAN bus. The system CAN bus has a bit rate of 1Mbit/s and the payload CAN bus has a bit rate of 500kBit/s.

The system unit consists of 8 cards, a 20 MHz microprocessor (single-chip SPARC compatible ERC-32), 512 MByte DRAM mass memory, TM/TC, Pyro control and four Remote Terminal Units. The remote terminal units are interfaces to platform devices that do not have an integrated CAN bus connection, i.e. reaction wheels/gyros, hydrazine thruster system, star trackers/sun sensors/BAPTA, thermal control system and the electric propulsion system. The RTU:s are completely self contained but are placed inside the main system unit cabinet.



## SYSTEM UNIT FUNCTIONS

### Telecommand handling:

- Reception of telecommands according to CCSDS standard from TT&C system
- HW decoding and distribution of pulse telecommands as defined in the CCSDS standard
- Distribution and execution of commands directed to the spacecraft platform
- Distribution of telecommands directed to the scientific payload to the payload bus for further decoding by the addressed payload
- Switching payloads on and off as requested by telecommands

### Telemetry handling:

- Acquisition of platform data
- Storage and transmission to ground of essential housekeeping data obtained from the power system. This function is not dependent on processor assistance.
- Storage, coding and transmission of platform data to ground
- Acquisition of payload data (only stored in the mass memory for subsequent transmission to ground)
- Transfer of coded telemetry according to CCSDS to the TT&C system
- Handling of spacecraft platform sensors and actuators
- Acquire sensor data to determine spacecraft status (thermal sensors, sun sensors, gyros, star trackers)
- Onboard time keeping and distribution to onboard units and to ground according to CCSDS standard

### Other functions:

- Powerful 32 bit SPARC compatible processor
- VxWorks operating system and board support package complete with all device drivers, ready for application programming
- Failure detection and autonomous reconfiguration of platform devices
- Software upload to spacecraft controllers

## SYSTEM UNIT SPECIFICATIONS

### Physical and environmental

- Radiation tolerance: 30kRad
- Mass: 13 kg
- Dimensions: base plate 230\*280 mm, height 292 mm
- Vibration and chock: meets Ariane 5 launch requirements
- Thermal environment: -20 to +50°C on base plate
- Power I/F: 50V DC supply feeds each sub unit separately
- Total power consumption: in normal operation 28W



Smart-1 System Unit



Vacuum test of Smart-1 system unit.

### Onboard computer

- Processor: Atmel TSC695F, single chip SPARC 32 bit architecture, 20 MHz system clock
- Memory: 2Mbyte EEPROM, EDAC protected, HW controlled write protection. 3Mbyte static RAM, EDAC protected. 512 Mbyte Mass Memory, EDAC protected, HW refresh and scrubbing.
- Peripherals: 2 serial ports RS422 full duplex asynchronous up to 625 kbit/s CAN bus 1 Mbit/s with 1kByte receiver path FIFO nominal and redundant bus i/f:s CAN bus 500 kBit/s with 1kByte receiver path FIFO nominal and redundant bus i/f:s 5 general purpose event inputs (switch closure) 2 second external watchdog timer JTAG interface for checkout and EEPROM loading
- Operating system: VxWorks
- Pulse TC inputs: Processor reset Watchdog enable/disable CAN bus nominal/redundant select
- Parallel outputs: To control unit for thermal knives and pyros
- Power: 45-51V / 8W



### Telemetry and telecommand

- Telemetry:
  - TM downlink: CCSDS compatible. User bitrate switchable 65kBit/s and 2 kBit/s before encoding Reed Solomon and Viterbi coding (two switchable rates up to 1 Mbit/s can be selected when ordering)
  - Virtual channels: VC0 with 3 wire serial input for essential HK VC7 connected to the CAN bus
  - Telecommands:
    - TC uplink: Any speed up to 50 kBit/s Input for nominal and redundant command receivers
    - Pulse commands: On board pulse command decoding and distribution. 12 are distributed via separate RS422 i/f:s of which 2 are hazardous (arm+fire with timer supervision) 14 are current limited relay drive outputs 48V max 100mA





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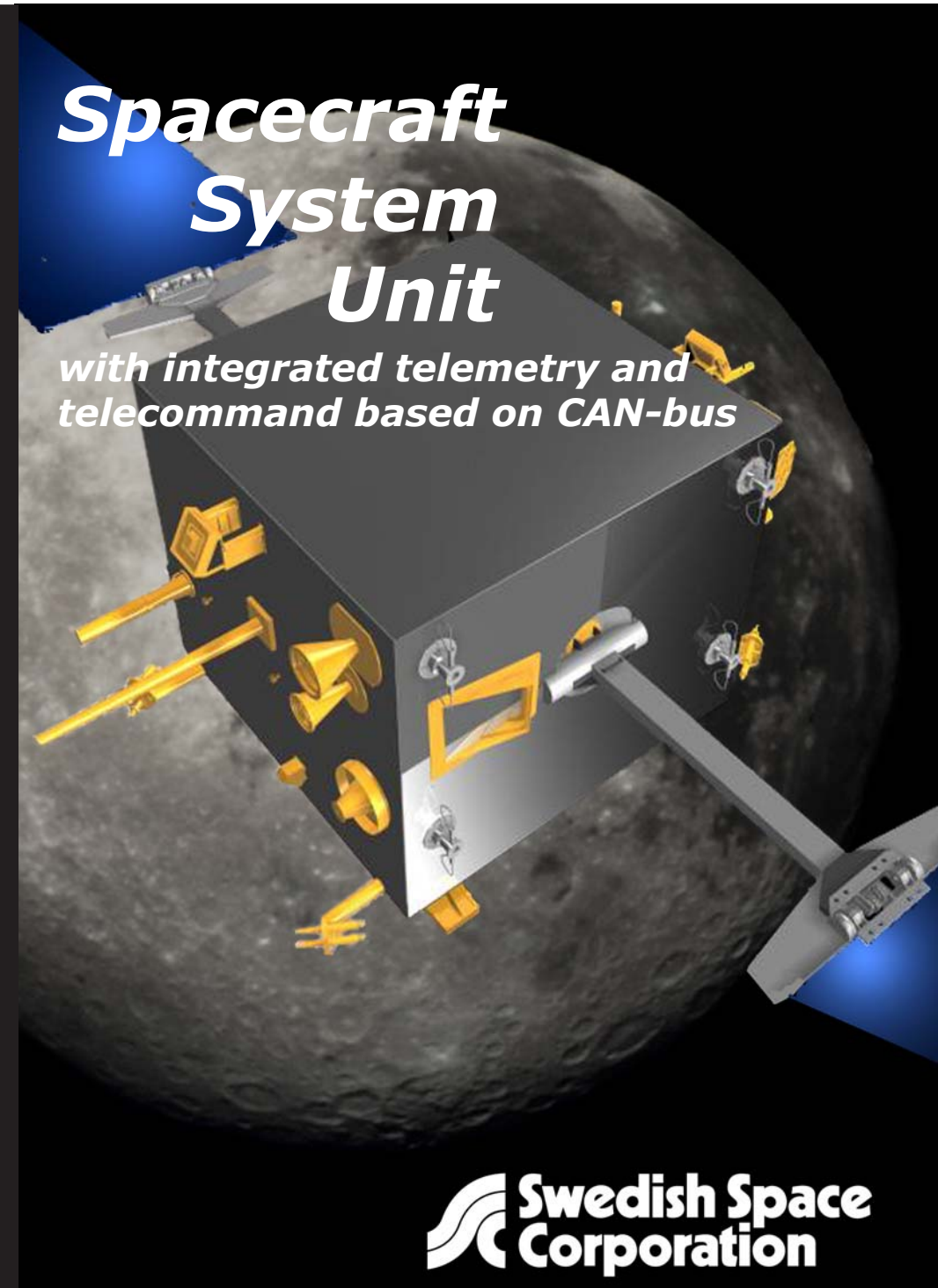
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# Spacecraft System Unit

*with integrated telemetry and telecommand based on CAN-bus*



## Time keeping

SCET: Spacecraft elapsed timer function. Operates with externally mounted 5MHz Oven Controlled Crystal Oscillators (nominal & redundant). Two second pulse RS422 outputs. SCET transferred to ground according to CCSDS standard.

## Communication with rest of system unit

CAN bus: 1 Mbit/s for reception of data for TM Virtual Channel 7 and for telecommand distribution, when not pulse telecommands

Virtual channel 0 i/f: 3 \* RS422 clock, data and data valid up to 1 Mbit/s

## Power

50V/ 3.5W automatic restart function.

## Remote terminal units

All remote terminal units operate with 1Mbit CAN bus with nominal and redundant bus interfaces. All are supplied by a 45-51V power source.

GRWRTU: Interfaces 5 rate sensors (Systron Donner QRS11) and 4 reaction wheels (Ithaco) Nominal & redundant unit on same board. Power 5W per unit (nominal, redundant)

STSSBRTU: Interfaces 3 sun sensors (12 current sources 0-40mA) One star Tracker (RS422 / 38400 bit/s) Two solar array stepping motor drives Nominal & redundant unit on same board. Power 3W per unit (nominal, redundant)

HTRTU: Interfaces 4 hydrazine thrusters (Primex) and 4 thermocouples Power 4W

TCRTU: Interfaces 18 heaters and 58 thermistors. Power 4W

## Control unit for thermal knives and quick nuts

Has parallel isolated interface directly to processor board. Interfaces 8 thermal knives (20V/1A/70s firing) and 3 quick-nuts (16V/4A/100ms firing) Nominal and redundant units built on same board. Power 2\* 2W nominal and redundant (idle consumption).

