

## SMU Software

The software environment includes support for C and ADA languages, using RTEMS open source Operating Systems as the scheduling engine.

Saab Ericsson Space normally delivers the SMU with a Basic Software package, providing the necessary platform for the customer's development of the Application Software.

The Basic Software package is available in two levels:

- A simple I/O driver library that is independent from the selected Operating System, but does not hide SMU details.
- A more advanced communication layer, where internal SMU hardware details are hidden from the application software designer. This layer uses interrupts and some RTEMS functions and it does not support the ADA language.

## Characteristics

### General Interfaces

- Digital inputs: 0/5 V, Relay contact sense, 16-bit serial
- Analog inputs: 0 - 5 V, -5 V to +5 V, thermistors
- Pulse commands: 28 V with programmable pulse width, 5 V CMOS, 16-bit serial

### AOCS Interfaces

- GPS Receiver
- Magnetorquer interfaces
- Magnetometer interfaces
- Gyro interfaces
- Reaction wheel interfaces
- Star tracker interfaces
- Thruster control interfaces
- Sun sensor interfaces

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## Specific Payload Interfaces

- 1553 Data buses
- 40 Mbps SpaceWire links
- 20 Mbps RS-422 Synchronous serial links
- 1.5 Mbaud UART links RS-422 or RS-485
- RS-422 Synch pulses fixed and programmable

## Typical properties

The data below refers to a typical All-in-One SMU configuration for a small satellite with approx. 700 I/Os in a LEO mission.

- Power consumption: <40 W average, < 60 W peak excluding external loads
- Mass: 18 kg
- Dimensions: 420 (L) x 270 (H) x 276 (D) mm including mounting feet
- Reliability:
  - >0,99 over a 3-year mission using class B components
  - >0,95 over a 15-year mission using class S components

## Extension capability

In addition to the above interfaces, the SMU can also be equipped with boards that handle:

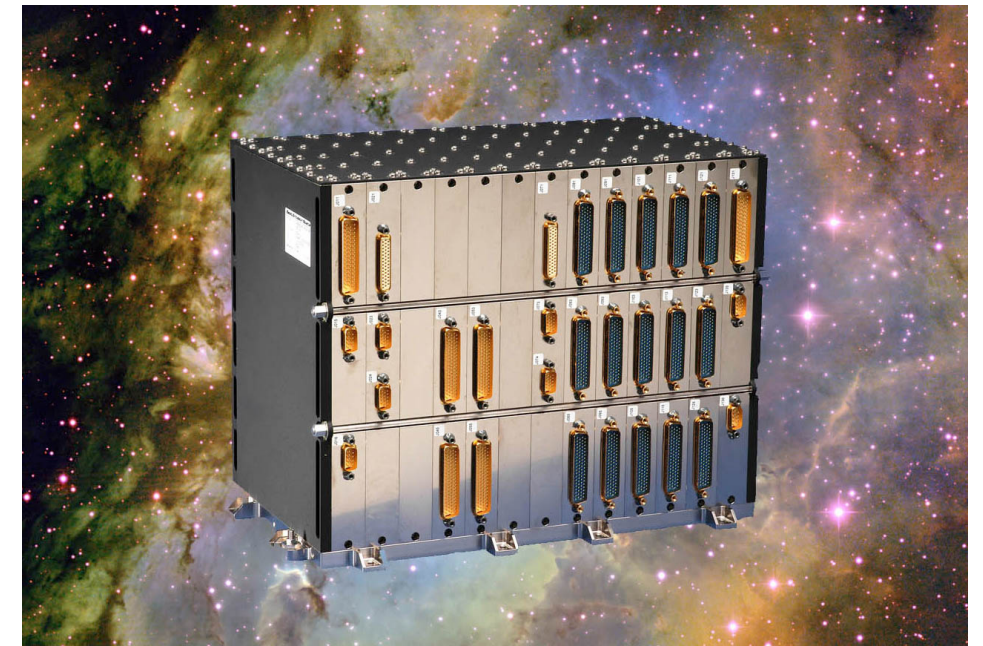
- Pyro activation: 1 ohm pyros
- Heaters: 50 W per line, > 500 W total
- Power distribution: secondary regulated and switched primary power (fused)
- Solar Array Drive Motor
- 32/64 Gbit mass memory boards without TM encoder.

## References

So far, the SMU has been applied in the following projects:

- Herschel
- Planck
- Pleiades
- Aeolus

# Spacecraft Management Unit



*The Herschel/Planck Spacecraft Management Unit is well prepared to meet the stars.*

The Saab Ericsson Space Spacecraft Management Unit, SMU benefits from the latest technology advances. Functionality is increased while mass, power consumption and volume decreases. In this process, overall reliability and performance is further improved and parts count reduced. The units handle all commonly used interfaces like reaction wheels, magnetorquers and thrusters as well as standardized analogue and digital interfaces and thermistors. The same basic design is applicable to LEO and GEO satellites and also to interplanetary missions.

## Features

- Everything you need for house-keeping and payload control in a single box
- Design scalable to platform size
- Highly reliable using internal redundancy and cross-strappings

- Advanced hardware support for autonomous missions
- Standardized interfaces:
  - Multiple MIL-STD-1553
  - SpaceWire
  - RS-422 UART
  - Synchronous serial links

## Functions

- On-board satellite telecommand functions such as decoding, validation, authentication and distribution of commands
- On-board satellite telemetry functions including telemetry data acquisition or generation, formatting, encoding and transmission to transponders
- Maintenance and distribution of on-board time and synchronization signals
- Processing resources for application software





- On-board surveillance and reconfiguration functions including the operation control modes of the unit
- Communication with the payload and other platform units through direct, standard interfaces and a MIL-STD-1553B bus
- Mass memory function for payload and housekeeping data

## SMU Core

The core of the SMU includes basic functionality needed for any on-board computer intended for both C&DH and AOCS purposes. The basic concept is to use the core together with a set of I/O boards to provide a combined C&DH and AOCS unit in a single box. Separate C&DH and AOCS units can, in some cases, be desirable. The core then serves both units, enabling the customer to re-use software components, reduce risk and save time and money.

## Failure-safe

The Spacecraft Management Unit is fully redundant, with its command and acquisition interfaces separated into failure-isolated blocks. It features two Reconfiguration Modules (RMs) that operate in a hot-redundant fail-silent configuration. The RMs monitor a number of external and internal alarm inputs and, upon active input, an automatic reconfiguration of the SMU is effected. The RMs can be programmed to carry out various reconfiguration actions for different alarm situations.

The SMU can be configured with a single RM if desired.

## Telecommand

The Spacecraft Management Unit receives telecommands (TC) from up to four independent receivers and performs decoding in compliance with the CCSDS-compatible ESA Packet Telecommand Standard.

High priority commands are directly output as pulse commands from the TC decoder, while other telecommands are routed to the Processor Module for further processing. The decoder supports Authentication of Telecommands.

## Telemetry

Telemetry (TM) is formatted in compliance with the CCSDS-compatible ESA Packet Telemetry Standard. Eight virtual channels are implemented with inputs coming from either the processor module, mass memory, TC decoder or external source.

The TM encoder provides for a wide range of downlink bit rates up to 8 Mbps. Reed-Solomon, Convolutional and Turbo codes are available as well as several modulation schemes and waveform outputs.

A dedicated essential TM function downlinks vital configuration status without software involvement.

## Processor Module

The Processor Module is built around a SPARC V7 processor, the TSC695F, and an in-house developed I/O ASIC.

Its processing performance is around 14 MIPS @ 20 MHz.

The Processor Module has a high degree of error protection. All memory has EDAC protection and the processor itself has error detection circuitry built in. All external buses use parity checks. The I/O ASIC supports the CPU with a wide range of serial interfaces towards other spacecraft units, as well as internal SMU functions. It also extends the CPU interrupt capability and provides advanced DMA support.

## Mass Memory

The SMU contains two independent mass memory modules, each with a capacity of 16 Gbits BOL. These can be operated in a cold-redundant configuration, each accessible from either processor module. If preferred, they can be used as one single unit of 32 Gbits capacity. The memory content is protected by a powerful Reed-Solomon CODEC and combined with continuous scrubbing, ensuring a very low bit-error rate. All memory management is handled by hardware, eliminating the need for specific software for that purpose. Data to the mass memory is received from the processor module via SpaceWire links. The mass memory has a direct interface to the TM encoder for downlinking the data and it can also be equipped with a separate TM Encoder with data rates up to 10 Mbps.

## SMU I/O

The Spacecraft Management Unit contains command and acquisition channels for standard TM/TC interfaces plus dedicated interfaces for AOCS and Propulsion Systems. These are implemented modularly with a standardized, internal, serial I/O bus for communicating with the processor module. This allows the Spacecraft Management Unit to be easily configured in accordance with customer needs in terms of redundancy, number and types of I/O-channels.

