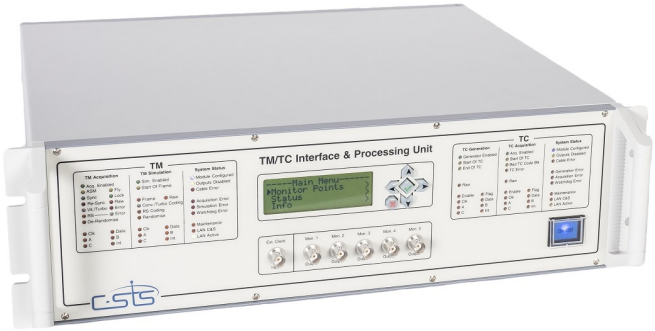
TM/TC Front-End

The TM/TC Front End provides direct control of spacecraft using baseband interfaces during spacecraft design, development, AIT and pre-launch.

The TM/TC Front End can be used for a wide variety of standard (CCSDS/ ECSS) TM/TC baseband solutions as well as customer specific applications.

The TM/TC Front End typically connects to the spacecraft On-Board Computer (OBC) or Central Data Management Unit (CDMU) via the direct Bypass Interfaces or via an RF SCOE. Additional interfaces can be used for NDIU, Closed Loop connections as well as RF Suitcase applications.



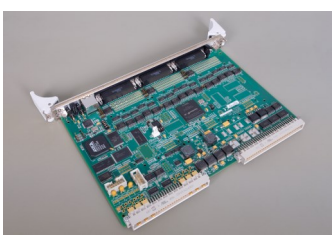
The TM/TC Front End provides four main functions:

- **TM Acquisition** - physical layers, frame synchronization, frame annotation (time stamping etc), VC and packet extraction. Selectable serial decoding, error correction and de-randomisation. Idle Frame, VC filtering, reception analysis (counter continuities, FECW, packet CRCs etc). CLCW extraction
- **TC Generation** - support at Packet, Segment, Frame, CLTU levels. CLTU serialization with PLOP mode and external or internal clocking.
- **TM Simulation** - Packet, Frame and Phyiscal layer generation for closed loop testing including Transponder/CDMU testing, RF Suitcases and stand-alone operation.
- **TC Acquisition** - Physical, CLTU and Segment/Packet support for Echo TC processing, Transponder/CDMU testing, RF Suitcases and stand-alone operation.

The TM/TC Front End is a combination of a standard 3U/19" Unit (TM/TC Interface and Processing Unit or IPU) and the TM/TC Application Software (Control and Monitor Software or CMS) that runs on a Windows™ computer or User Workstation. The TM/TC IPU is connected to the User Workstation via LAN thus allowing the two parts to be co-located or the IPU placed close to the spacecraft while the workstation is (for example) placed outside the cleanroom. The architecture allows the units to be rack mounted or used as stand-alone table top systems.

The CMS itself can be used directly through the local user graphical user interface or remotely by systems such as Central Checkout Systems (CCS) or RF Suitcase controllers.

The main TM/TC Front End low level processing is implemented based on a single (VME form-factor) module that requires no connection other than DC power for operation. The system has been designed specifically for connection directly to flight equipment where FMEA and isolation are key.



60 galvanically isolated LVDS/422 pairs are routed via an FPGA to the core processing. A standard configuration supports typical AIT setups however the architecture allows the system to be configured for specific spacecraft test configurations or system applications if required.

The TM/TC IPU also supports the mounting of up to 4 daughter board modules for customer specific applications and future expansion. Examples are: IRIG-B/-G/PPS timecode interfaces, subcarrier modulator / demodulator, discrete interfaces and high-speed data transfer interfaces.

The TM/TC IPU is connected to the user workstation via a single LAN connection through which it is controlled, configured, monitored and data exchanged with sustained rates of up to 10 Mbps. For high-speed applications, an optional 1G LAN module can be used to pass data to/from the workstation.

The standard TM/TC IPU 3U/19" unit includes one interface module but also has sufficient space reserved to allow the unit to be expanded with either daughterboard modules or more TM/TC IPU Modules. The external interfaces and power are supported in the TM/TC IPU as removable modules at the back of the unit while the LCD, LED and monitoring points are located on the front panel.

All I/O lines are galvanically isolated directly after the interfacing circuitry. This makes the TM/TC IPU highly suitable for controlled Simulation and Test environments as typically found in the spacecraft Assembly, Integration & Test domain. The galvanic isolation can also be useful with interface adaptation, fault propagation prevention and during spacecraft EMC testing.

Technical Specifications

Features

- Single-board, modular implementation
- Integrates baseband processing and direct LAN interfacing into a single unit
- Maximum of 60 differential I/O lines (3x HD44)
- RS-422 and LVDS standard (or mixture)
- All I/O lines can be galvanically isolated
- All I/O routed directly to on-board FPGA
- FPGA based interfacing/routing/processing
- Selectable error correction coding schemes incl. Viterbi/Reed-Solomon/Turbo decoders for TM and BCH for TC
- Selectable serial and parallel processing schemes incl. NRZ-M, SPL, Randomisation
- TC Authentication/Encryption support (option)
- Standard support with TM to 10Msps and TC to 2Msps. Higher data rates available on request.
- On-Board Ethernet interface for baseband <>LAN data routing as well as control/status
- Front-panel LCD and LED status
- Front-panel monitoring points (firmware selectable)
- Daughterboard expansion slots (e.g. CCSDS Turbo codec)
- Compact 3U/19" overall system implementation
- Customised Front-panel lay-out / labeling
- FMEA Report Available

Sample applications (C-STS application software may be required)

- TM/TC Front-End
- TM/TC Baseband Spacecraft Simulator
- Network Data Interfacing (NDIU)
- Raw Data acquisition/routing
- SLE Gateway
- RS-422/LVDS to/from Ethernet conversion
- Bit Error Rate Testing
- Interface Conversion

Upgrades

- Hardware/firmware is in-system re-programmable

TM/TC Applications

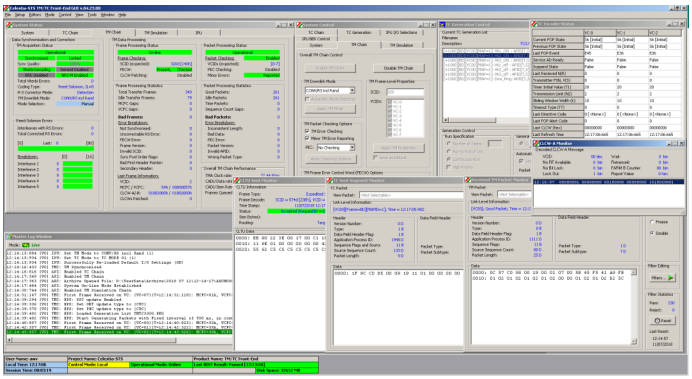
The TM/TC IPU can be configured for a number of TM/TC application scenarios. One of the most common and readily available configurations is that of a TM/TC Front-End.

Within this configuration, for TM the hardware performs all baseband functions from interfacing to frame synchronisation, de-scrambling, Convolutional and/or Reed-Solomon decoding / correction and or Turbo Decoding, time/quality tagging and frame level transfer via the LAN interface. For TC, the hardware receives CLTUs from the application software (via LAN) and performs the required PLOP interfacing, buffering and emission/serialisation of the bitstream.

Added functions include the capability to perform TC echo reception/ decoding from the outgoing bitstream (or a dedicated input) as well as TM simulation and Bit Error Rate Testing.

For these cases the baseband optimised architecture of the TM/TC IPU offers additional advantages due to its large I/O interfacing / routing and galvanic isolation capabilities.

When used in raw data acquisition/serialisation mode, the TM/TC IPU is also compatible with other C-STS software processing products that are able to provide real-time data processing and simulation.



Software support

As part of turn-key systems, the proven C-STS TM/TC baseband processing software and Control & Monitor Software (CMS) as deployed with TM/TC systems since 1996 is available under the latest Windows™ Operation systems, both as workstation and Server platform operation systems. The CMS allows the system to be used both locally through the GUI or remotely as part of a larger AIT configuration through a CCS.

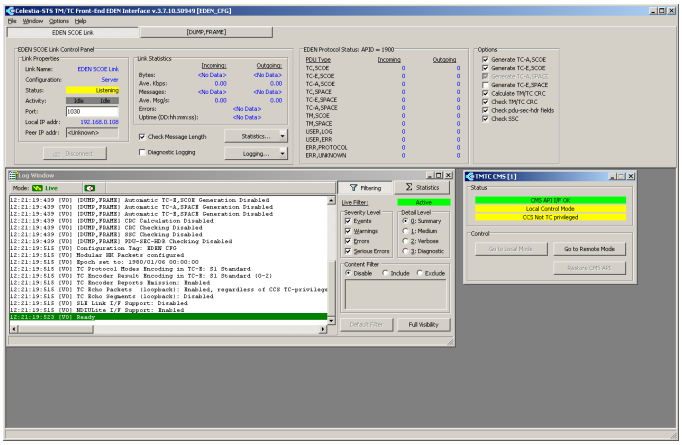
The CMS includes processing layers for AIT/Test or operational ground station Front-End including frame/CLTU and packet layer support; integrated archiving, logging and standard remote interface/gateway protocols (such as SLE).

Dedicated functions are included in the CMS for TM and TC statistics and troubleshooting such as frame and packet counter consistency checks, idle frame extraction, frame monitors with advanced trigger/snapshot functions, CLCW monitors, APID statistics etc.

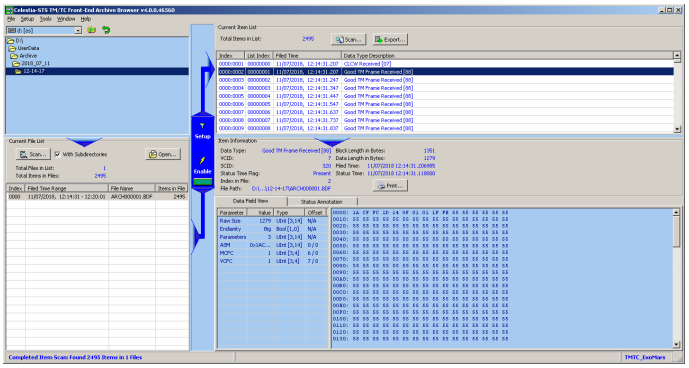
A number of standard remote interface protocols are supported such as EDEN, C&C and PFLP allowing the system to be rapidly integrated into CCS configurations. The modular software architecture allows the remote interface to be adapted as needed to meet specific customer needs.

TM/TC Application Examples

Remote Interface (CCS) example extension application:



C-STS Archive Browser Application:



Environmental and Physical Specifications

Dimensions H x W x D	133 x 448 x 443 mm
Weight	< 6 kg
Input Power Range	100-240VAC 50-60Hz
Operating Temperature Range	+10°C to +40°C
Operating Humidity	30% to 85% (non-condensing)
Storage Temperature	-10°C to +60°C
Storage Humidity	Up to 85% (non-condensing)

Experience

Building on over 30 years of experience in spacecraft EGSE systems; C-STS provides innovative high-tech solutions for ground-based systems in the domains of spacecraft simulation and testing as well as modem (spacecraft communication) and data processing systems. Supporting all phases of the spacecraft lifetime, from integration to flight and all phases in between.

Contact Details

For further information, contact us at:

Celestia Satellite Test & Simulation B.V.
Huygensstraat 44
2201 DK, Noordwijk ZH
The Netherlands

T: +31 - 71 - 751 51 00
E: info@celestia-sts.com

www.celestia-sts.com