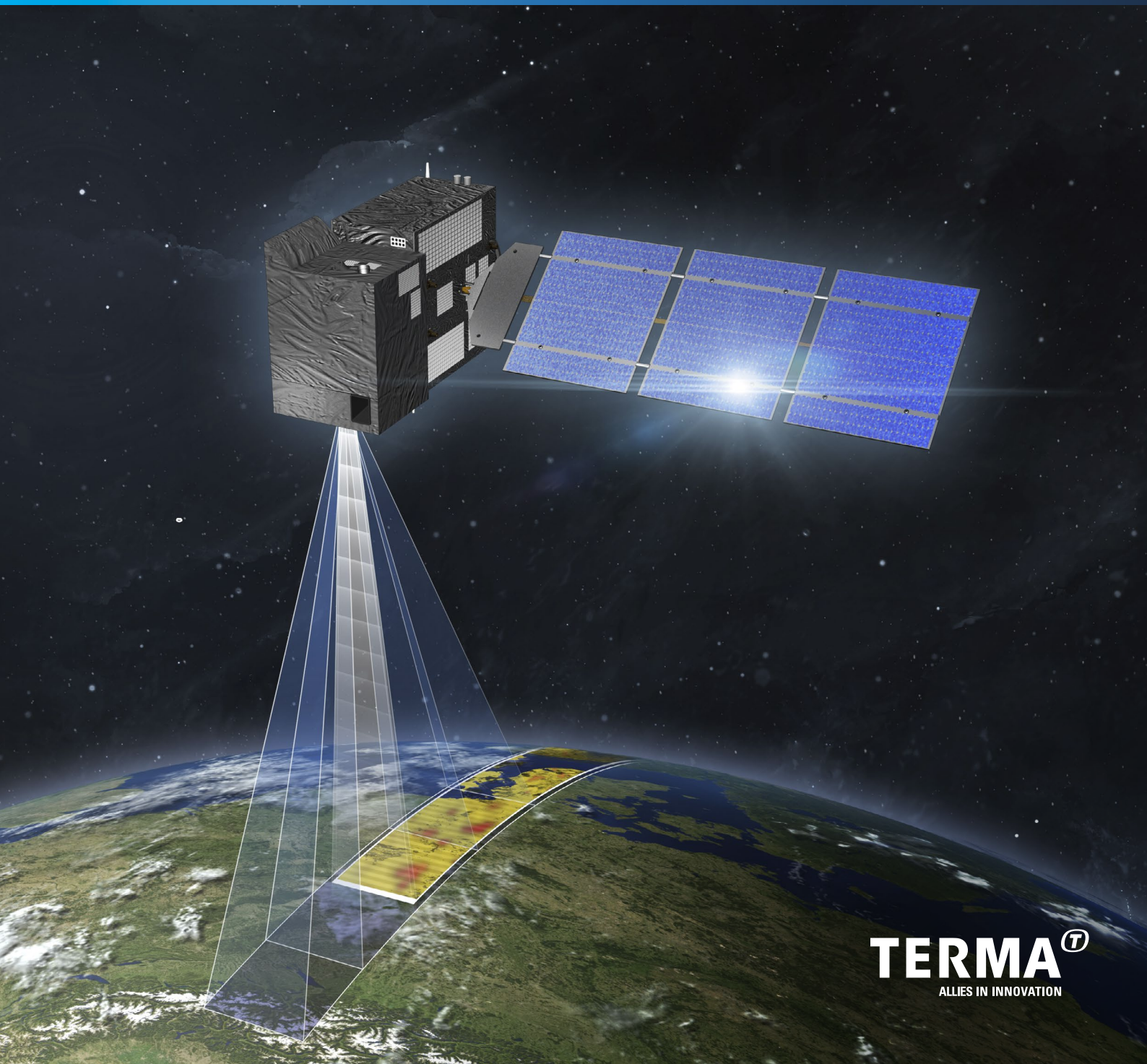
REMOTE TERMINAL UNITS

FOR ALL TYPES OF SATELLITES



Remote Terminal Units

For all types of satellites

Remote Terminal Unit Function

The Terma developed RTU concept is targeted to cover the classical satellite need for interfaces for commanding, measuring and other interaction functions. Customized RTUs can be composed of a variety of available functional modules, in units comprising from three up to 16 modules.

Due to its modularity and low mass and volume compared to the high degree of functionality, the concept allows a customization of a distributed RTU concept that can provide the following features:

- Significant reduction of harness in large spacecraft systems
- Functional segregation at satellite level
- Increased satellite integration efficiency

The selected configuration can adapt to any bus voltage between 20V and 100V. Dual MIL-STD-1553 RTI provides access to functional commanding, measurement reading and housekeeping telemetry of all important parameters. Optionally, CAN Bus can be implemented in the RTU concept on customer request.

Full redundancy can be obtained by a dual set of modules, either build in one unit integrated into the same backplane module or build as two separate units that can be operated in cold or hot redundancy.

To optimize failure robustness and functional segregation, each module provides to the extent possible an autonomous function itself that shares only a few transparent interfaces distributed along the integrated modules via a backplane module.

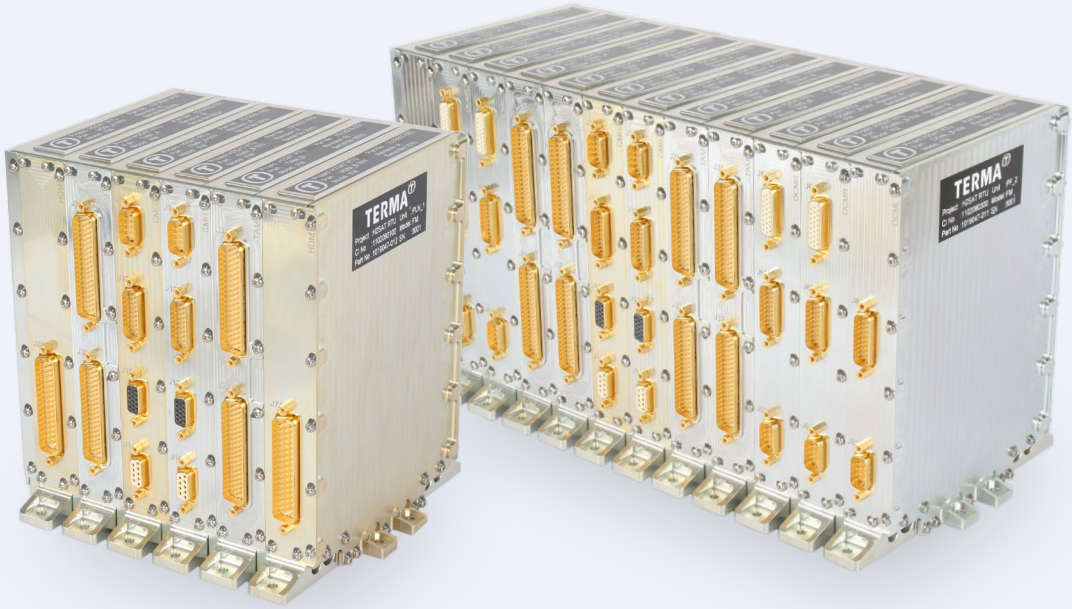
Technology

Terma has developed a unique implementation technology that provides superior cost, mass, and volume versus performance ratio for remote terminal units compared to competitors. Each module has its own mechanical structure that ensures sufficient unit mechanical strength when integrated, to sustain the mission mechanical load profile. A direct module thermal contact area to satellite structure ensures thermal segregation and proper temperature balance in the unit during all electrical load combinations.

The concept provides a great flexibility during spacecraft integration, that allows to add, remove, or replace modules without unit dismounting during integration phase. High ESD tolerance on all external interfaces (>4 kV) ensures robustness to the integration phase.

Module functions

To cover the need of interfaces for commanding, measuring and other interaction functions, Terma has developed a variety of module functions targeted to classical satellite needs. New module functions can be added if non existing specific interface functions are needed.



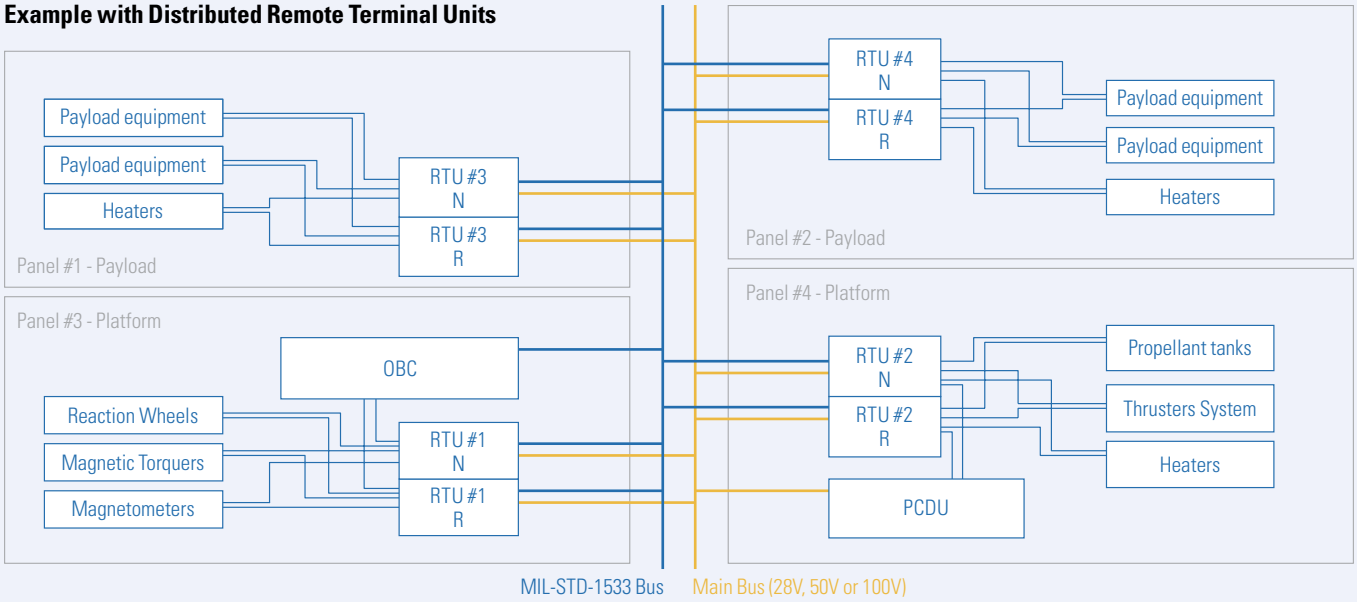
Background

Terma has participated in European space missions for more than four decades and has pioneered several power system electronics technology and mission specific electronics developments. Based on these technologies and competences Terma has, in close corporation with satellite integrator OHB System, developed a new generation of Remote Terminal Units (RTU) applied in ESA missions and military satellites:

Mission	Launch	Equipment	Features	Status
Classified	2023	2 x 3 x RTU	28V MB, 1553, AC, HPC, OC, SDI, TA, VD	Flying in-orbit
H2SAT	2023	1 x 9 x RTU	50V MB, 1553, AC, HPC, OC, TA, TSW, VD	Flying in-orbit
Electra	202?	1 x 10 x RTU	100V MB, 1553, HPC, TA, TSW, VD	Delivered for integration
NAOS	2024	1 x 2 x RTU	28V MB, 1553, AC, HPC, OC, TA, VD	Delivered for integration
Classified	2025	3 x 2 x RTU	28V MB, 1553, AC, HPC, OC, SDI, TA, VD	Delivered for integration
HERA	2024	1 x 2 x RTU	28V MB, 1553, AC, HPC, OC, TA, VD	Flying in-orbit
CO2M	2025	2 x 3 x RTU	28V MB, 1553, AC, HPC, OC, SDI, TA, VD	Delivered for integration
Comet-I	2029	1 x 2 x RTU	28V MB, 1553, AC, HPC, OC, TA	In production
ExoMars	2028	1 x 4 x RTU	28V MB, 1553, HPC, SDI, TA	In production
Harmony	2029	2 x 3 x RTU	28V MB, 1553, AC, HPC, OC, SDI, TA	In production

AC: Attitude Control, HPC: High Power Commands, OC: Orbit Control, SDI: Serial Data Interface,
TA: Telemetry Acquisition, TSW: Transistor Switch, VD: Valve Drive

Example with Distributed Remote Terminal Units



Core Module (CMH and CMS)

The CMH/S module serves via MIL-STD-1553 Bus interface as RTU core module and can be combined with any types of interface modules. The module connects to interface module types via a local Command/Telemetry bus distributed by a backplane module and can set command-able functions and read the telemetry of interface modules.

In CMH version it provides in addition High-Power Commands while in CMS it provides Serial Data Interfaces (SDI), implemented as RS422 transceiver interfaces.

Attitude Control Module (ACM)

The ACM interface provides common drives for spacecraft attitude control. The module serves as a slave module to an upstream core module via a local Command/Telemetry bus distributed by the backplane module.

The module provides functions for common applied spacecraft attitude control functions like reaction wheels, magnetic torquers, and associated telemetry readings. The module functions can be switched on/off by external dual High-Power Commands (HPC) while external digital status lines report the present on/off status.

Heater Distribution Module (HDM)

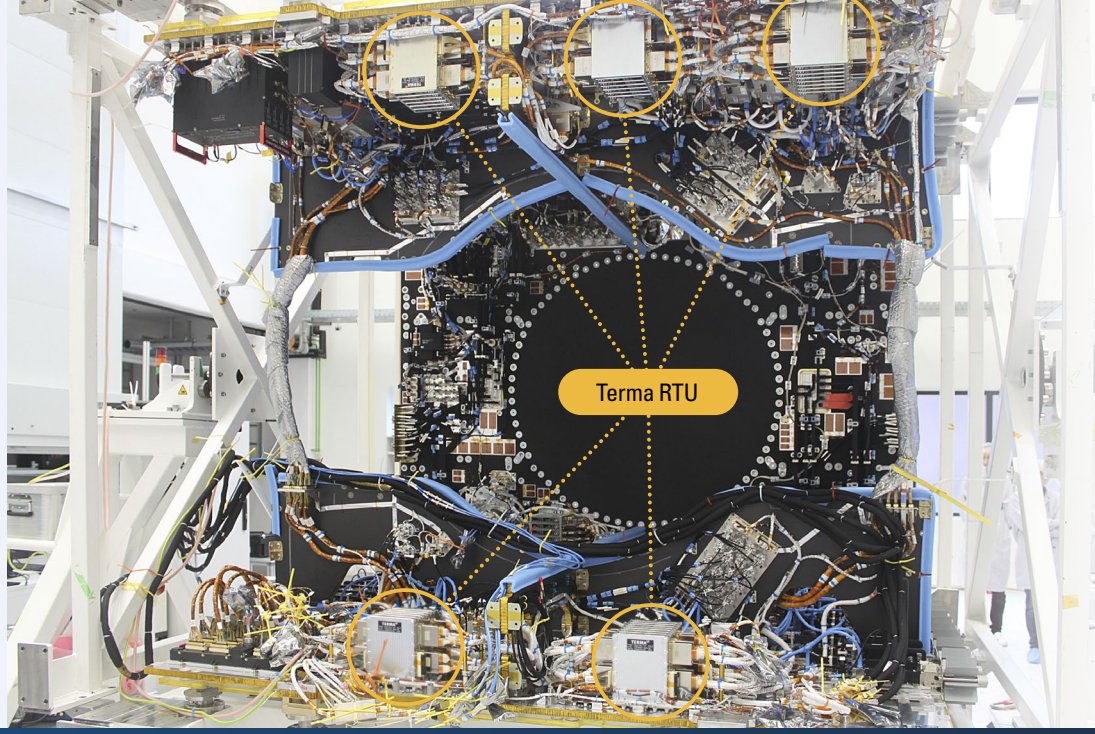
The HDM interface provides switchable power interfaces for spacecraft heaters. The module serves as a slave module to an upstream core module via a local Command/Telemetry bus distributed by the backplane module.

The HDM is designed to distribute power from the spacecraft regulated or unregulated main bus and into resistive load such as heaters.

Orbit Control Module (OCML and OCMR)

The OCM interface provides common drives for spacecraft orbit control and serves as a slave module to an upstream core module via a local Command/Telemetry bus distributed by the backplane module.

The module provide functions for common applied spacecraft orbit control functions like latch valves drives, flow control valve drives, and associated telemetry readings.



DLR Heinrich Hertz Satellite in OHB, Bremen integration

Telemetry Acquisition Module (TAM)

The TAM interface provides interfaces to monitor spacecraft analogue and digital spacecraft housekeeping signals and serves as a slave module to an upstream core module via a local Command/Telemetry bus distributed by the backplane module.

The TAM module is designed to adapt to classical spacecraft sensor types, to assist the on-board data handling system to collect and report typical all spacecraft housekeeping telemetry. The TAM module works as an interface module type for the upstream core module.

Qualification and Flight Heritage

The RTU modules are all TRL8, having gone through full qualification. First flight of the RTU is expected in 2022 when four satellites, using a total of 16 RTUs, are scheduled for launch. The intended orbits are low Earth orbit and geo-stationary orbit. Development of new functionality continues, and at present, we are developing a passivation function for the attitude control function, the Bi-stable Relay Module (BRM) and one more Orbit Control Module, the OCMB. Both modules are slated for qualification in the spring of 2022.

Remote Terminal Unit Modules Summary:

Module	Catagory	Functionality	Heritage
CMH	Core	1553, 64 x HPC	Q / 24MY
CMS	Core	1553, 8 x SDI	Q / 4MY
ACM	Interface	5 x 28V, 2 x +/-16V, 4 x RW, 3 x MTQ	Q / 6MY
ACMB	Interface	8 x BSM, 2 x +/-16V, 4 x RW, 3 x MTQ	Q / -
BRM	Interface	6N + 6R MTQ Shunt	Q / -
HDM	Interface	12 x TSW	Q / 12MY
OCMB	Interface	3 x 26V, 5 x VD	Q / -
OCML	Interface	13 x VD	Q / 4MY
OCMR	Interface	5 x 28V, 9 x VD	Q / 10MY
TAM	Interface	132 x ATM, 4 x 5V	Q / 44MY

Note 1: Q = Qualified, MY = Module years in flight

Operating in the aerospace, defense, and security sector, Terma supports customers and partners all over the world. With more than 1,700 committed employees globally, we develop and manufacture mission-critical products and solutions that meet rigorous customer requirements.

At Terma, we believe in the premise that creating customer value is not just about strong engineering and manufacturing skills. It is also about being able to apply these skills in the context of our customers' specific needs. Only through close collaboration and dialog can we deliver a level of partnership and integration unmatched in the industry.

Our business activities, products, and systems include: command and control systems; radar systems; self-protection systems for ships and aircraft; space technology; and advanced aerostructures for the aircraft industry.

Terma has decades of hands-on know-how in supporting and maintaining mission-critical systems in some of the world's most hostile areas. Terma Support & Services offers through-life support of all our products to maximize operational availability, enhance platform lifetime, and ensure the best possible cost of ownership.

Headquartered in Aarhus, Denmark, Terma has subsidiaries and operations across Europe, in the Middle East, in Asia Pacific as well as a wholly-owned U.S. subsidiary, Terma Inc., with offices in Washington D.C., Georgia and Texas.

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