

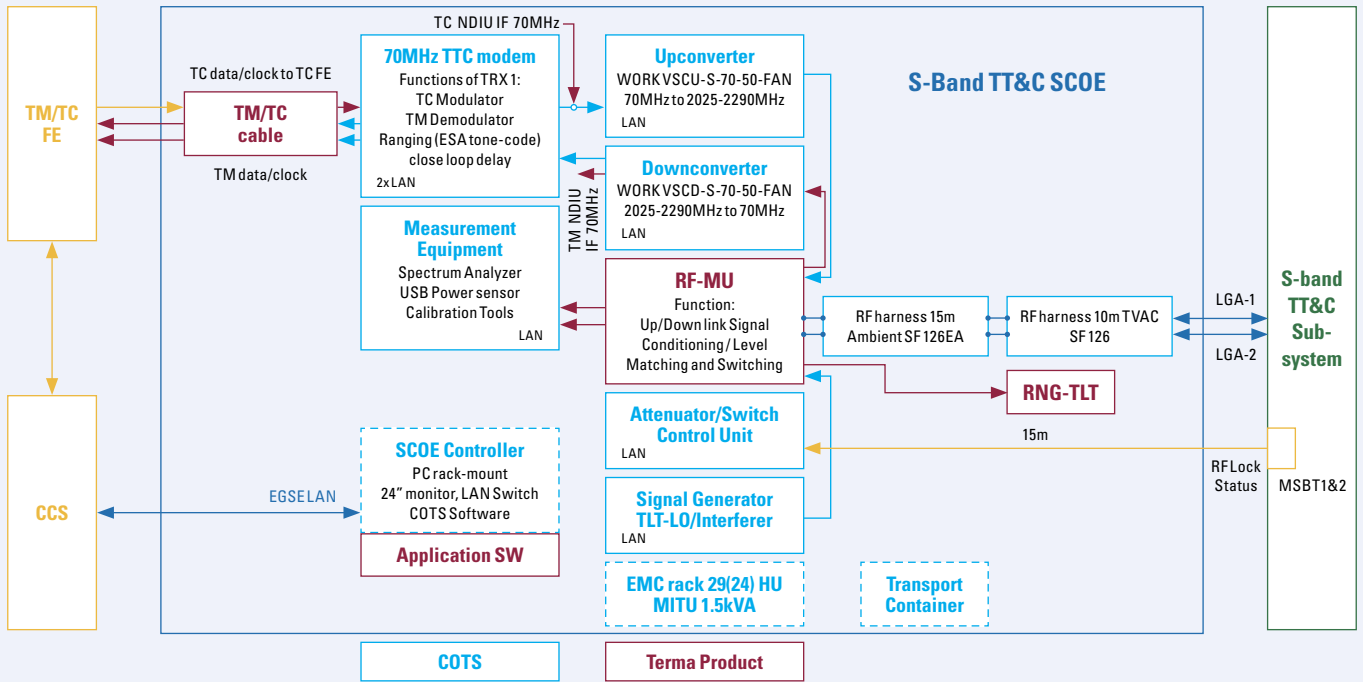


TT&C SCOE (TCR TESTER)

TELEMETRY, TRACKING & CONTROL-SPECIFIC
CHECK-OUT EQUIPMENT



TERMA[®]
ALLIES IN INNOVATION



Terma's TT&C SCOE (Telemetry, Tracking & Control-Specific Check-Out Equipment) for testing the satellite platform TT&C subsystem or, at unit level, the transponder (comprising a Telecommand Receiver and Telemetry Transmitter) is based on commercial off-the-shelf (COTS) instruments and a 70 MHz IF TTC modem (IMBU: IF Modem and Baseband Unit), and has been designed for highly-accurate automated measurements.

It includes a comprehensive software package, supporting remote control through the standard Central Check-out System (CCS) interface,

as well as full access to test results and calibration data via database access and web interface, thus allowing for the highest degree of accessibility and scalability.

The TT&C SCOE can be ordered with additional features, for example supporting an X- or Ka-Band Downlink input to the measurement equipment only or to a high data rate modem, or with a Service Module Simulator Part (Power, Discrete TM/TC, CAN-Bus for TC and TM, etc.) for a standalone Transponder / Integrated Communication Unit Test Bench.

Typical Hardware Configurations

Hardware	Description
Controller	Fujitsu Primergy / DELL PowerEdge Server with RAID1 configuration
RF Matching Unit (RF-IU)	Terma custom-built models for S-Band, X-Band, X-Band & Ka-Band, Ku-Band
Switch/Attenuator Mainframe and modules	Keysight 34980A /Opt001, modules: 34945A, 34959A, 34952A, 34950A, 34925A
Power meter/power sensor	R&S NRX base unit USB or LAN Power Sensors: R&S NRP8S/N, NRP18S/N, NRP33S/N, NRP40S/N
Spectrum/Signal analyzers	R&S FSV3007/3013/3030/3044 or R&S FSVA3030/3044, Options FSV3-B4-B24-K7-K40-K70, R&S FPL1003/1007 Options FPL1-B4-K7-K40; R&S FSWP8, R&S FSW26/43 Options FSW-B4-B24-B160-K7-K40-K70
Counter	Keysight 53230A
Oscilloscope	R&S RTB2004, R&S RTO64 (for Radar Application)
TTC Modem types (IF 70 MHz)	Celestia TTC-IMBU: TC: STD PM; TM: ESA STD PM, OQPSK, GMSK; Ranging delay: ESA PM tone code, PN ranging for deep-space applications), 1Hz step size, linear and rectangular sweep Safran Cortex CRT-Q: Dual Mode as for ESA STD and Spread Spectrum in G2G (TC: ESA STD PM, Spread Spectrum; TM: STD PM, OQPSK, GMSK, Spread Spectrum; Ranging delay: ESA PM tone code, ESA-like 100kHz, spread spectrum), 1Hz step size, linear and rectangular sweep
Signal generator (Interferer / Spur calibration / TLT-LO Signal)	R&S SMCV100B / R&S SMB100B and opti
Up converter	S-Band: WORK Microwave VSCU-S-70-50-FAN: IF-Input: 70+/-20 MHz, RF-Output:2025-2290 MHz, 100Hz step size Alternative: Safran SM01026637A X-Band: WORK Microwave VSCU-X1-70-50-LB-FAN-S00884: 70+/-20MHz to 7145-7235 MHz and 8400-8500 MHz, 100Hz step size Ku-Band: WORK Microwave VSCU-Ku-70-50-FAN, 70+/-20MHz to 12.75-14.50 GHz, 100Hz step size Ka-Band: WORK Microwave VSCU-Ka21-70-50-FAN, 70+/-20MHz Hz to 25-28 GHz, 100Hz step size
Down converter	S-band: WORK Microwave VSCD-S-70-50-FAN: IF-output: 70+/-20 MHz, RF-input:2025-2290 MHz, 100Hz step size Alternative: Safran SM01026636A X-band: WORK Microwave VSCD-X1-70-50-FAN, 8400-8500MHz to 70 MHz, 100Hz step size Ku-Band: WORK Microwave VSCD-Ku-70-50-FAN, 10.70-2.75 GHz to 70+/-20MHz, 100Hz step size Ka-Band: WORK Microwave VSCD-Ka-70-50-FAN, 18.1-21.2 GHz to 70+/-20MHz, 100Hz step size
Reference clock	Spectrum Analyzer OCXO (FSV3-B4 / FSW-B4), or Rubidium reference SR FS725

RF Harness

The RFTS comes with proven high-performance microwave coaxial cable assemblies, ruggedized for use outside a thermal vacuum chamber and good amplitude and phase stability vs. flexure and temperature, as well as superior shielding.

Software Components

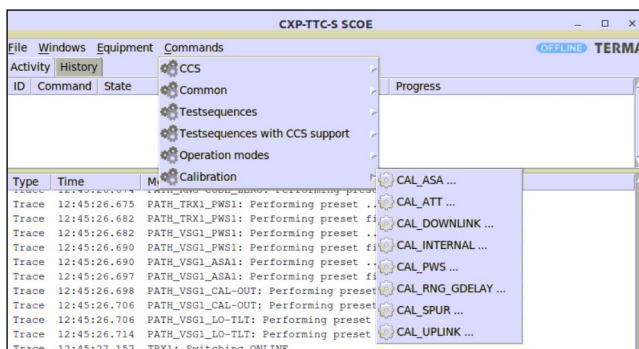
In addition to the remote-control functionality via the CCS and GUI control, the SW package provides the “internal logic” functionality of self-test, calibration, measurement and status/measurement reports. The following illustration shows a chart of historical measurement results obtained via web access. The data can be exported in pdf, csv, and jpg format. The RF device and path state can be traced and controlled by the interactive synoptic display.

Typical Measurement Uncertainties

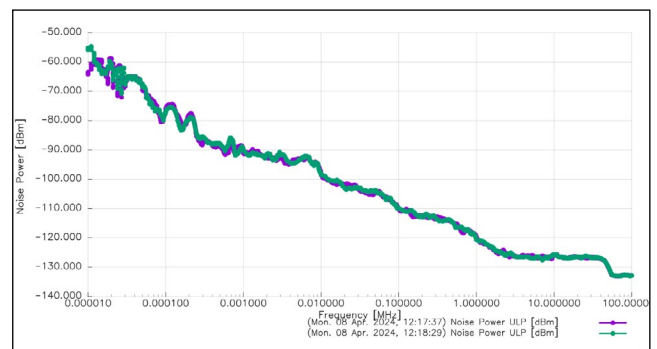
Measurement type	Uncertainties (2σ)
TC Operation: active interface is provided with uplink power setting, frequency sweeping, measurement of PM modulation index	No test Uplink power ±0.3dB (down to -130dBm)
TM Operation: the TM path is switched to the Modem receiver which is switched to the TM mode as configured for demodulation	No test
Frequency accuracy and stability	with Spectrum Analyzer in Counter Mode: resolution is 0.1Hz, Accuracy given by OCXO With R&S FSV3-B4 (OCXO) < ±1x10 ⁻⁷ per year < ±1x10 ⁻⁹ per day < ±5x10 ⁻⁸ initial calibration
Absolute power level/stability	Uplink down to -130dBm: <±0.3dB Downlink: <±0.2dB with PWS Stability: ±0.05dB
Power spectrum and spurious	±0.05 dB
Modulation index TC and TM	≤ 2% (referred to MI of 1.0rad), i.e. ≤0.02 rad
Uplink TC execution threshold	≤ ±0.3dB
Uplink carrier acquisition threshold and lock maintenance	≤ ±0.3dB
Receiver AGC verification	≤ ±0.3dB
ESA Ranging tone-code delay and group delay response vs. frequency (100kHz to 1.5MHz)	≤ ±3ns
Ranging Channel Amplitude Response vs. frequency and 3dB bandwidth	≤ ±0.3dB
SSB phase noise	±0.2 deg rms repeatability, accuracy given by residual noise of spectrum analyzer
Measurement of in- and out-band-spurious (unwanted emissions)	≤ 1 dB (can be calibrated over signal source frequency range, for higher frequencies a loss vs. frequency table can be stored)

Some example GUIs:

Calibration Overview



Phase noise measurement (comparison)



The headquarter for RF/TTC Test System Business is at Terma Technologies GmbH in Austria.



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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