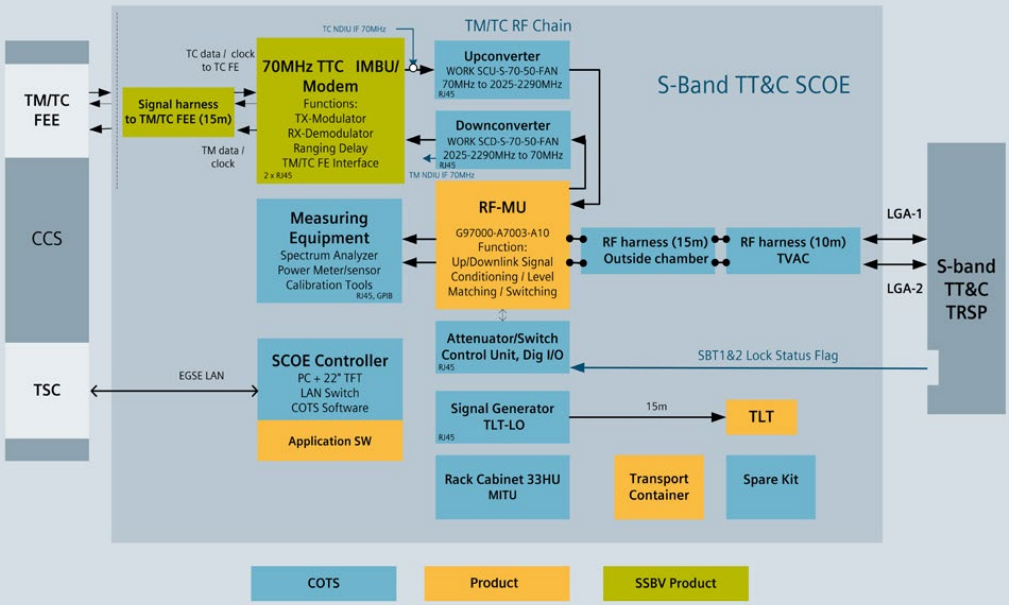
TT&C SCOE (TCR TESTER)

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 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 upgraded with a Platform Simulator Module.

Typical Hardware Configurations

Hardware	Description
Controller	Fujitsu Primergy Server with RAID or CELSIUS with RAID
RF Matching Unit (RF-IU)	Terma G97000-x700x-A10, model for S-band, X-band, X-band & Ka-band, Ku-band
Switch/Attenuator Mainframe and modules	Agilent 34980A Opt001, modules: 34945A/EXT or L4445A
Power meter/power sensor	R&S NRP-Z11/Z21/Z31 operated on R&S Spectrum Analyzer or Agilent N1913A and sensor E930xA / U200xA
Spectrum/Signal analyzers	Middle class: R&S FSV 3/7/13/30/40, Opt B4-K9-K7 Top class: R&S FSW/8/13, FSUP26/50
Counter	Agilent 53131A or successor
Oscilloscope	Agilent DSO5014A or successor
TTC Modem types (IF 70 MHz)	Single mode (STD PM): SSBV TTC-IMBU including ranging delay (ESA PM tone code / 100K-tone / new PN ranging for deep-space applications)
	Alternative option: CORTEX CRT-Q (ranging ESA-like)
	Dual mode: STD PM and Direct Sequence Spread Spectrum (DSSS):
	- SSBV Galileo TTCF-IMBU
Signal generator (Interferer / Spur calibration / TLT-LO Signal)	R&S SMC100A-B103 or SMB100A-B103/106, or SGS100A-B106 or Agilent MXG
Up converter	S-band: WORK SCU-S-70-50: IF-Input: 70 +/-20 MHz, RF-Output:2025-2290 MHz
	X-band: WORK HCU-X1-70-50-0001: 70 MHz to 7145-7235 MHz and 8400-8500 MHz
Down converter	SS-band: WORK SCD-S-70-50: IF-output: 70 +/-20 MHz, RF-input:2025-2290 MHz X-band: WORK HCD-X1-70-50-0001, 8400-8500MHz to 70 MHz
Reference clock	Spectrum Analyzer OCXO (FSV Opt B4), or alternatively, up converter internal OCXO, or Rubidium reference SR FS725
Mains unit	Trafo Schneider Mains Isolation Transformer Unit (MITU) or, alternatively, Rack power distribution Unit

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

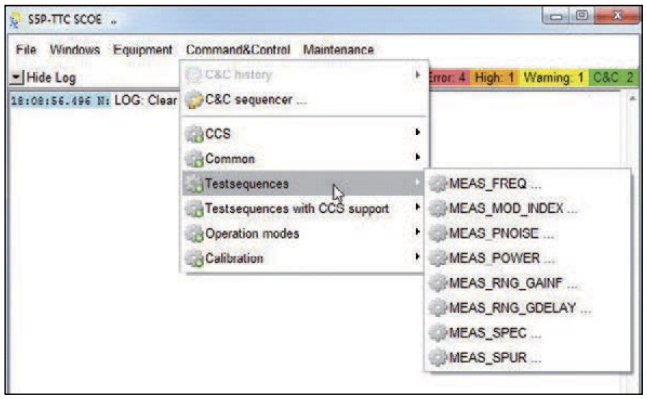
Measurement type	Uncertainties (2σ)
Frequency accuracy and stability	with Spectrum Analyzer in Counter Mode: Stability:< ±10 Hz for meas. over 24h, Accuracy: given by OCXO
Absolute power level/stability	±0.3 dB / ±0.05 dB
Power spectrum and spurious	±0.05 dB
Modulation index TC and TM	
TC execution threshold	±0.03 dB
Uplink carrier acquisition threshold and lock maintenance	±0.03 dB
Receiver AGC verification	±0.03 dB
ESA Ranging tone-code delay and group delay response vs. frequency (100kHz to 1.5MHz)	±3 ns
Ranging Channel Amplitude Response vs. frequency and bandwidth	±0.3 dB (1 kHz to 2 MHz)
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

Operation modes

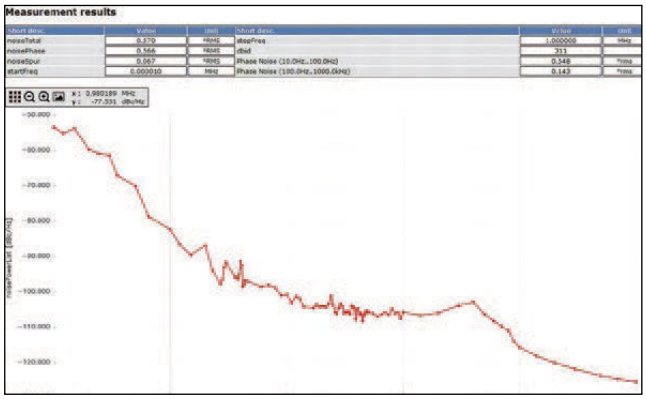
Measurement type	Uncertainties (2σ)
TC operations mode	±0.03 dB
TM operations mode	n.a.

Some example GUIs:

Test execution from local



Phase Noise Measurement



Operating in the aerospace, defense, and security sector, Terma supports customers and partners all over the world. With more than 1,600 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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