KU- AND KA-BAND

REPEATER RF TEST SYSTEM

Terma's RF Test System (RFTS) for Repeater/Telecommunication Payload

– is based on commercial off-the-shelf (COTS) instruments and designed for high-accuracy 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.

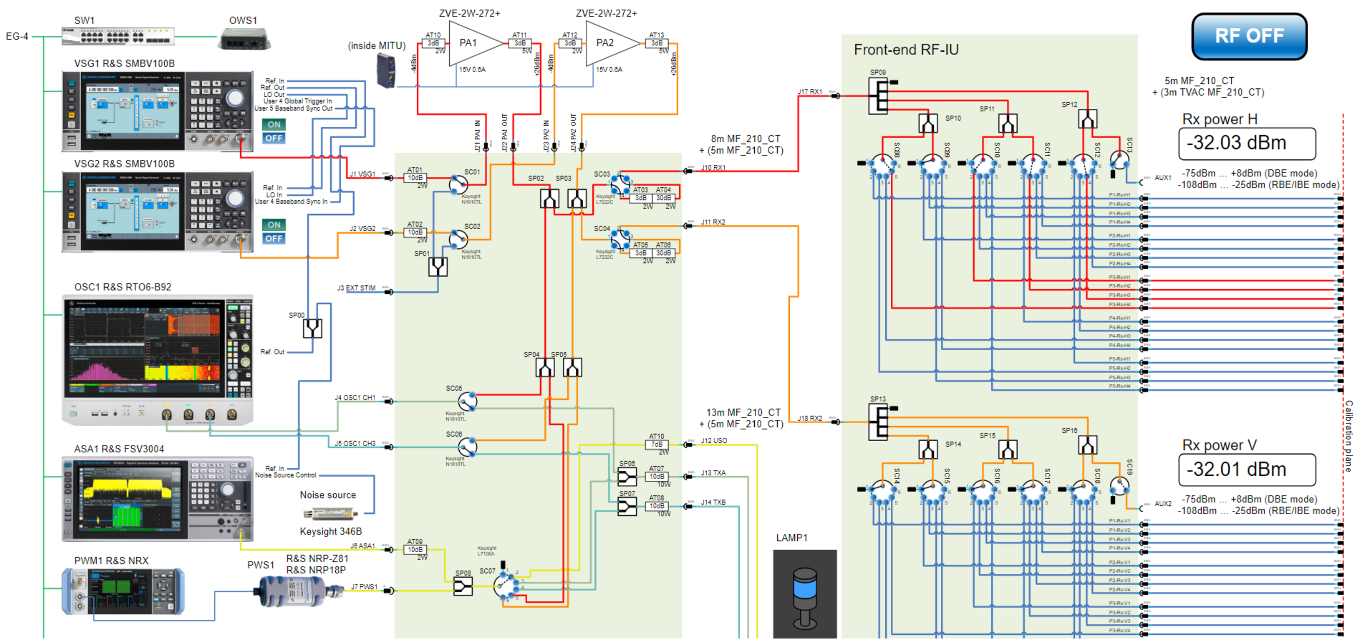
Terma's RF Test System (RFTS) can be upgraded to a full Telecommunication Payload Test System and connected to a Platform Service Module Simulator (SMS).

Similar to the Galileo Payload Test System, Terma can also provide the CCS and the SMS.

Product Description

- Special Check-Out Equipment (SCOE) for the radio frequency sub-system of satellites platform and payloads.
- Turnkey solution, based on a proven generic and mission-independent RF SCOE product, providing the following major benefits to the customer:
  - Low non-recurrent costs
  - Minimal risk
  - Optimized delivery schedule
- Fully-automated RF measurements on the satellite's TT&C subsystem section (S/X/Ka/Ku-band) and the Mission Communication Section/Payload (S/L/Ka/Ku/X and UHF- band) during assembly of the spacecraft/payload and during space environment testing at the test center facility.
- Modern state of the art MMI/GUI.

The RF device and path state can be traced and controlled by the interactive synoptic display:
(see example below for an L-Band Radar RF SCOE):



Typical Measurement Uncertainties

Measurement Type	Uncertainties (2σ)
Absolute power level	± 0.2 dB
Gain vs. frequency	± 0.3 dB
Phase vs. frequency	± 2.0 degrees
Group delay vs. frequency	± 0.5 ns
Gain slope, Gain ripple vs. frequency	± 0.1 dB
Gain vs. time	± 0.3 dB
Input power for saturation (IPS), saturated outputpower[1]	± 0.2 dB
Gain vs. power (AM/AM)	± 0.3 dB
Gain slope, Gain ripple vs. power	± 0.1 dB
Phase vs. power (AM/PM)	± 2.0 degrees
AM/PM conversion coefficient	± 0.3 degrees
Noise figure	± 0.5 dB
2-tone intermodulation	± 2.5 dB (abs. power), 1.0 dB (rel. power)
Frequency accuracy	± 1.5x10E-8 (abs. freq.)
Phase noise	± 2.0 dB (rel. power)
Spurious signals (in-band)	± 2.5 dB (abs. power), ± 1.0 dB (rel. power)
Harmonics	± 3.0 dB (abs. power), ± 1.5 dB (rel. power)
Out-of-band response rejection	± 3.0 dB (abs. power), ± 1.5 dB (rel. power)

[1] for TWTA

Additionally supported measurements: Input/Output dynamic range, TWTA noise shape, Gain control range, LO leakage, multipath crosstalk, RF isolation/repeater isolation.

Stimulus Power Level Uncertainties

Stimulus	Uncertainties (2σ)
Single CW carrier	± 0.2 dB (abs. power)
Multiple CW carriers	± 0.5 dB (abs. power)
Multicarrier	± 0.5 dB (abs. power)[2]
Frequency chirp	± 0.5 dB (abs. power)[2]
Amplitude (Power) sweep (fast amplitude CW sweep)	± 0.5 dB (abs. power)

[2] Total effective power level accuracy of complete stimulus signal (all carriers).

Typical Measurement Times

Measurements	Comment	Time [seconds]
Absolute power	Using power meter3	3
Absolute power	Using spectrum analyzer	7
Gain, phase, and group delay vs. frequency	Span 40 MHz, carrier spacing 100 kHz	10
Gain vs. power (AM/AM), phase vs. power (AM/PM) IPS, Saturated output power	Stimulus sweep level range -50 dBm to -25 dBm	12
Noise figure		6
2-tone intermodulation		10
Frequency accuracy	12 measurements	17
Phase noise	7 offset points	24
Spurious	Span 10 GHz, resolution BW 10 kHz	24

[3] Power meter measurement duration depends on power level

Stimulus Setup Times

Stimulus	Time [seconds]
Single CW carrier	4
Multiple CW carriers	10
Multicarrier	10
Frequency chirp	10
Amplitude (Power) sweep (fast amplitude CW sweep)	9

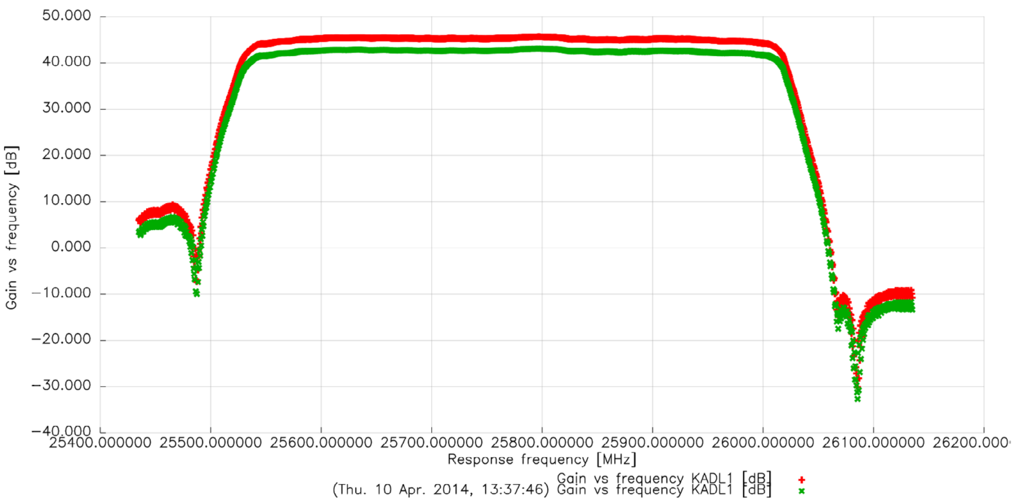
Test Sequence

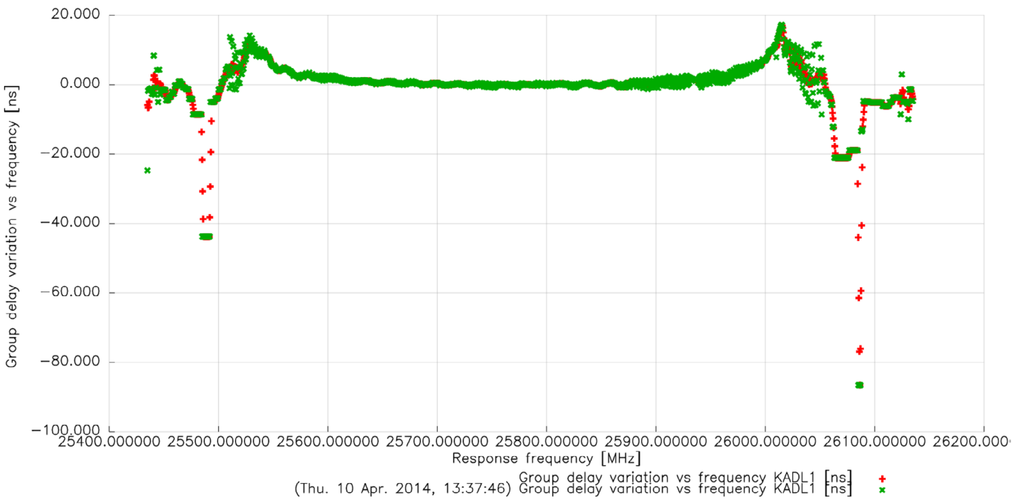
Measurement Type	Test Sequence
RF-Power	MEAS_POWER
Absolute power	
RF-Power vs. time	
Gain vs. time	
Saturated output power	MEAS_AMCONV
Input power for saturation	
Gain vs. frequency, gain slope, gain ripple	MEAS_MCARRIER
Noise shape	MEAS_SPURIOUS
Gain vs. power (AM/AM)	± 0.1 dB
Gain transfer	MEAS_AMCONV
AM/PM conversion coefficient	
Gain control range	MEAS_POWER
Gain step delta/gain adjustment	
Input/Output dynamic range	MEAS_AMCONV
Phase vs. frequency	MEAS_MCARRIER
Input section gain vs. frequency/group delay	MEAS_MCARRIER
Output section gain vs. frequency/group delay	
Group delay vs. frequency	
Phase vs. power (AM/PM)	MEAS_AMCONV
AM to PM conversion, AM/PM conv. factor, AM/PM conv. coeffic.	
Spurious signals	MEAS_SPURIOUS
In-band spurious	
Spurious modulation	MEAS_SPURMOD
2-tone intermodulation (Dynamic range)	MEAS_2TONE
Input section amplitude linearity	
NPR (Multi-Tone IMD)	n.a.
Noise figure	MEAS_NOISEFIG
Phase noise	MEAS_PNOISE
Input return loss	n.a.
Output return loss	
Frequency accuracy	MEAS_FREQ
OoB-Response	MEAS_POWER, MEAS_SPURIOUS
Harmonics	MEAS_POWER, MEAS_SPURIOUS
Passive Inter-Mod.	n.a.
Image rejection	n.a.
LO leakage	MEAS_POWER, MEAS_SPURIOUS
RF Isolation/Repeater isolation	MEAS_POWER, MEAS_SPURIOUS
Multipath	MEAS_POWER, MEAS_SPURIOUS

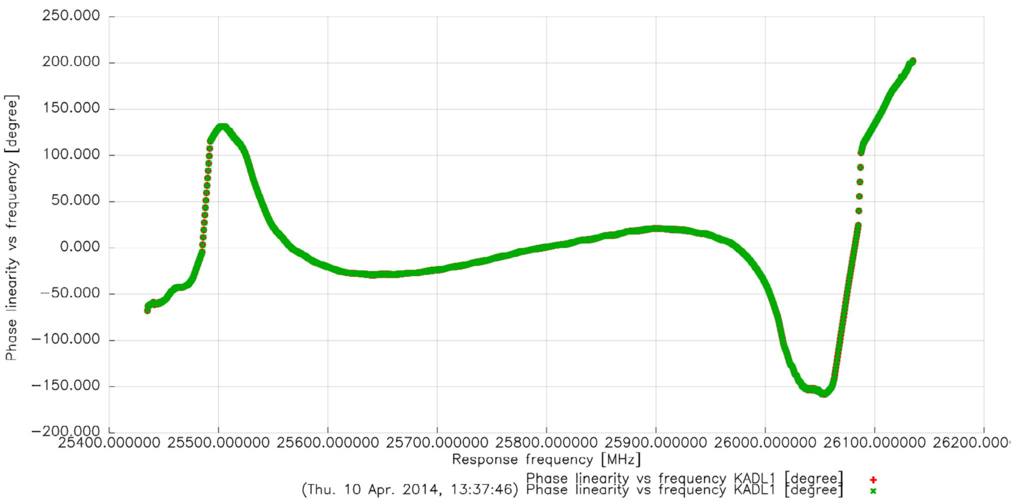
Software Components

In addition to the remote-control functionality via CCS and GUI control, the SW package also provides the "internal logic" functionality of self-test, calibration, measurement, and status/ measurement reports.

Measurement Results







Typical Hardware Configuration

Hardware	Description
Controller	Fujitsu Primergy / DELL PowerEdge Server with RAID1
RF Matching & Switching Unit (RF-MU)	Terma G97000-A7200-A1 custom-built (Ku & Ka-Band)
Turnaround Converter (TAC)	Terma G97000-A7200-A12 custom-built (Ku & Ka-Band)
Switch/Attenuator Mainframe and modules	Keysight 34980A Opt001, Modules: 34945A
Power meter/power sensors	R&S NRX base unit, USB or LAN Power Sensors: NRP33S/N, NRP40S/N
Spectrum/Signal analyzers (up to Ka-Band)	R&S FSW43, 2Hz to 43.5GHz, with Options FSW-B320-K7-K17-K40-K70
Vector Signal generators (up to Ka-Band)	R&S SMW200A, 100kHz to 31.8GHz, with options SM200A-B1031-B2031-B709-B719-B94L-B13XT-2xB9-K527-2xK525-K444-K416
Reference clock	Rubidium frequency standard Standford Resarch FS725

The headquarter for RF/TTC Test System Business is at Terma Techologies 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.