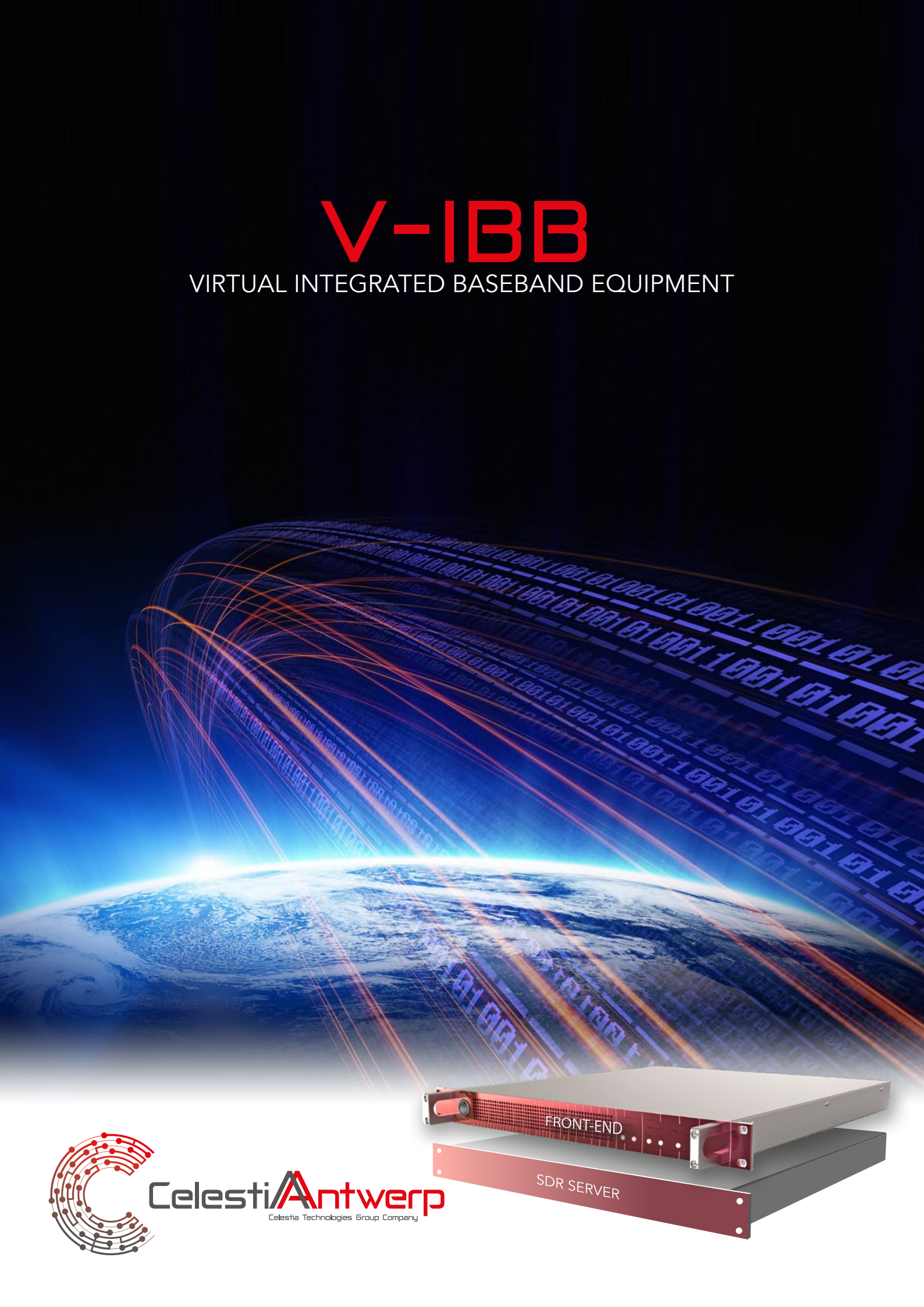
V-IBB

VIRTUAL INTEGRATED BASEBAND EQUIPMENT

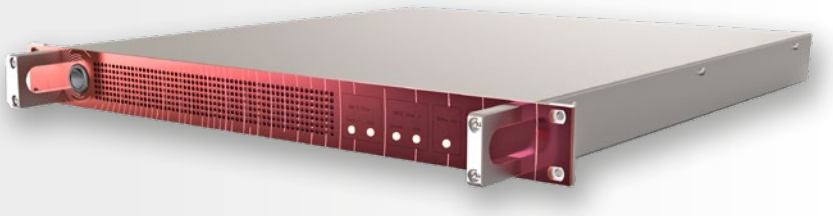


CelestiAntwerp
Celestia Technologies Group Company

V-IBB

The Virtual Integrated BaseBand (V-IBB) is a key component for Satellite Tracking, Telemetry and Telecommand (TT&C).

The V-IBB ensures reliable and flexible communication.



MAIN FUNCTIONALITY

- Carrier acquisition, tracking and demodulation
  - PM/PSK/PCM
  - FM/PSK/PCM
  - PM/PCM
  - FM/PCM
  - BPSK
  - QPSK
  - OQPSK
- Telemetry (TM) subcarrier demodulation and bit synchronization
- Processing of Telecommand (TC) data
- TC subcarrier generation and modulation
- Uplink carrier generation and modulation
  - PCM/PSK/PM
  - PCM/PSK/FM
  - PCM/PM
  - PCM/FM
  - BPSK
  - QPSK
  - OQPSK
- Generation and reception of ranging tones and associated delay measurement
- Processing of ranging data
- Doppler and Doppler rate measurements
- Data logging
- Local and remote monitoring and control
- Spectrum analyzer for real time analysis of the received input spectrum

APPLICATIONS

- Baseband equipment for reception of housekeeping & payload telemetry from GEO and LEO satellites, and transmission of telecommands to GEO and LEO satellites
- Ranging of GEO and LEO satellites
- Automated Satellite test, like TT&C SCOE, ATE, EGSE

KEY BENEFITS

- Extremely short acquisition time, even in challenging receiving conditions like low Signal/Noise, Doppler, ...
- Easy and flexible to use resulting in Reduced CAPEX and OPEX
  - Easy (re)configuration due to the modular software architecture and the intuitive graphical user interface.
  - Real-time built-in spectrum analyzer (Xspect)
  - Direct interface at 70MHz, L-band and/or S-band
  - Optional SLE interface
  - Optional EDEN interface
- Operational reliability resulting in Improved Total Cost Of Ownership (TCO)
  - Limited number of hardware elements
  - Most functions are software based, including modulation & demodulation
  - Linux based PC platform
- Field proven heritage (Globalstar, O3b, Proba, NAOS, MTSat,...)
  - Proven interoperability with the most common protocols for Satellite Control Centers, which allows for smooth integration in ground stations.
  - RF over IP concept allowing RF sampling very close to the Antenna and TT&C processing at a remote centralized location.

Carrier Acquisition and Demodulation

- Number of receivers: Standard 1 or 2 TM/TC chains (more chains available on request)
- Receiver input frequency: standard frequency range: 55 MHz – 2300 MHz
- Received carrier modulation: PM and FM
- Signal dynamic range: 80 dB (-100 dBm to -20 dBm)
- Input noise density:
  - Maximum: - 115 dBm/Hz
  - Typical: - 125 dBm/Hz

- AGC mode: Non coherent mode to optimize the ADC input loading and reducing signal degradation
- Input C/N_0 measurement accuracy: < 1 dB (starting from 60 dBHz down to threshold)
- Receiver IF bandwidth: ± 5 MHz

PM receiver characteristics

- Receiver acquisition range: ± 1500 kHz
- Acquisition and tracking threshold (C/N_0): down to 10 dBHz
- Maximum Doppler rate:
  - 100 Hz/s for C/N_0 = 25 dBHz
  - 10 kHz/s for C/N_0 = 35 dBHz
  - 40 kHz/s for C/N_0 = 38 dBHz
- Carrier acquisition time: < 0.5 s

FM test receiver characteristics

- Maximum deviation frequency in FM mode: ± 400 kHz
- Maximum AFC tracking range:± 300 kHz
- FM threshold: C/N minimum 10 dB in IF bandwidth

Subcarrier PSK Demodulation/BitSynchronizer

- Subcarrier demodulator per carrier: Standard 1 subcarrier (2 subcarriers on request)
- PCM format: NRZ-L/M/S, SP-L/M/S
- TM sub-carrier frequency (f_{sc}): integer multiple of symbol rate within the band
- TM sub-carrier waveform: sine/square
- PSK-symbol rate (Sr): 10 sym/s to 2 Msym/s, maximum depending on the number of Rx chains and the coding used
- TM modulation index: 0.1 rad -> 2.5 rad
- Threshold for TM reception (E_s/N_0): 1 dB
- Overall degradation (including PM demod): 0.5 dB typical

Suppressed Carrier Demodulation

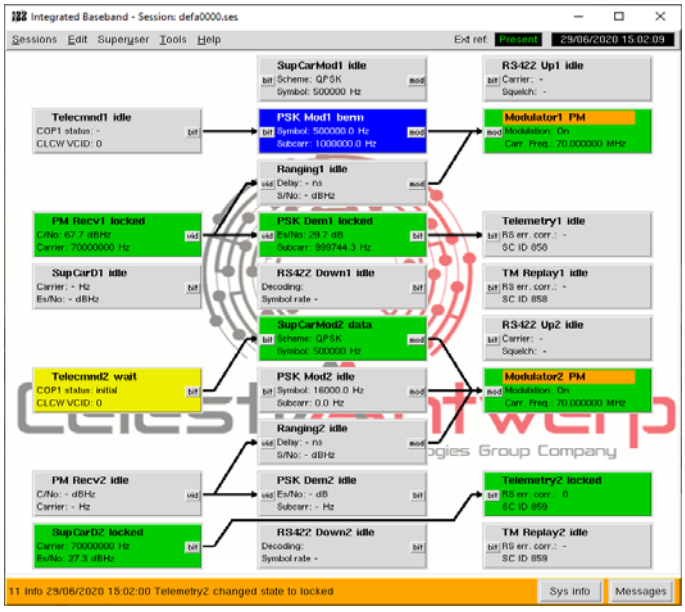
- Modulation types: BPSK, QPSK, optional OQPSK
- Symbol rate: up to 2 Msym/s
- Threshold for TM reception (E_b/N_0): 1 dB

Frame Synchronization

- Search for a configurable sync-word
- Invert data if the inverse sync-marker is found (user-settable)
- Search/verify/lock algorithm
  programmable (Turbo Code: 64 to 192 bits)
- Frame size: 1 to 2^{16}-1 bytes, or according to the Reed Solomon code length when Reed Solomon coding is used
- Synchronisation strategy parameters:
  - SYN (0 to 8 errors) depends on the synchronization word size
  - STL & LTS (0 to 8 frames)
  - Bit slip (0 to 7 bits)
- User-settable thresholds for frame sync lock/unlock
- Synchronization word size: 15 to 64 bits
- Frame descrambling
- Real time decommutation with graphical display
- Telemetry storage on hard disk: Time tagged frames or blocks

Telemetry Processing & Decoding

- Convolutional decoding (K = 7, R = ½)
- Reed Solomon decoding (255, 223)
- Turbo Decoding according to CCSDS 131.0-B-3 Code rates: 1/2, 1/3, 1/4, 1/6
- Info block length: 223, 223*2, 223*4, 223*5 bytes
- Interleaving factor automatically selected as function of the frame length
- Number of processing chains per carrier: standard 1 (2 processing chains on request)



RANGING

- Ranging tone waveform: sine wave
- Tone frequencies: fully programmable respecting the required mathematical relation between major and minor tones for ambiguity resolution.
- Ranging downlink modulation index: 0.1 rad -> 2.5 rad
- Min. S/N_0 on received major tone: 25 dBHz
- Min. S/N_0 on received minor tone: 15 dBHz
- Phase estimation based on first order or second order phase trajectory estimation.
- No phase (delay) measurement bias due to Doppler rate
- Allows for extremely long estimation time, not achievable with classic PLL's
- Different major tone modulation indices are programmable for ambiguity resolution and for the ranging measurement; switchover is automatic

- Max. measurement jitter due to thermal noise = 0.03 rad under the conditions:
  - S/N_0, max = 25 dBHz
  - Estimation time = 2 s
  - 100 kHz major tone
- Measurement accuracy: < 1 ns
- Measurement resolution: 1 ns
- Ambiguity Resolution Performance
  - Probability of ambiguity resolution error: up to 10^{-4}

TRANSMISSION OF SATELLITE TELECOMMAND DATA

Telecommand pre-processing

- Reception and acknowledgement of the Telecommand request messages.
- Generation and transfer of telecommand transaction messages.
- Telecommand check of the syntax of "TC request", spacecraft receiver lock status and uplink status and transmission.
- High and low priority TC queues.
- Idle pattern: Programmable length (1 to 16 bits) and content
- Local TC capability: based on customized database.

Sub-carrier modulation

- Modulation formats: PSK
- PCM format: NRZ-L/M/S, SP-L/M/S
- PSK sub-carrier frequency: integer multiple of the symbol rate
- PSK-symbol rate: 10 sym/s -> 2 Msym/s
- Priority switching between RNG and TC

Suppressed carrier modulation

- Modulation types: BPSK, QPSK, OQPSK
- Symbol rate: up to 5 Msym/s

Uplink carrier Generation

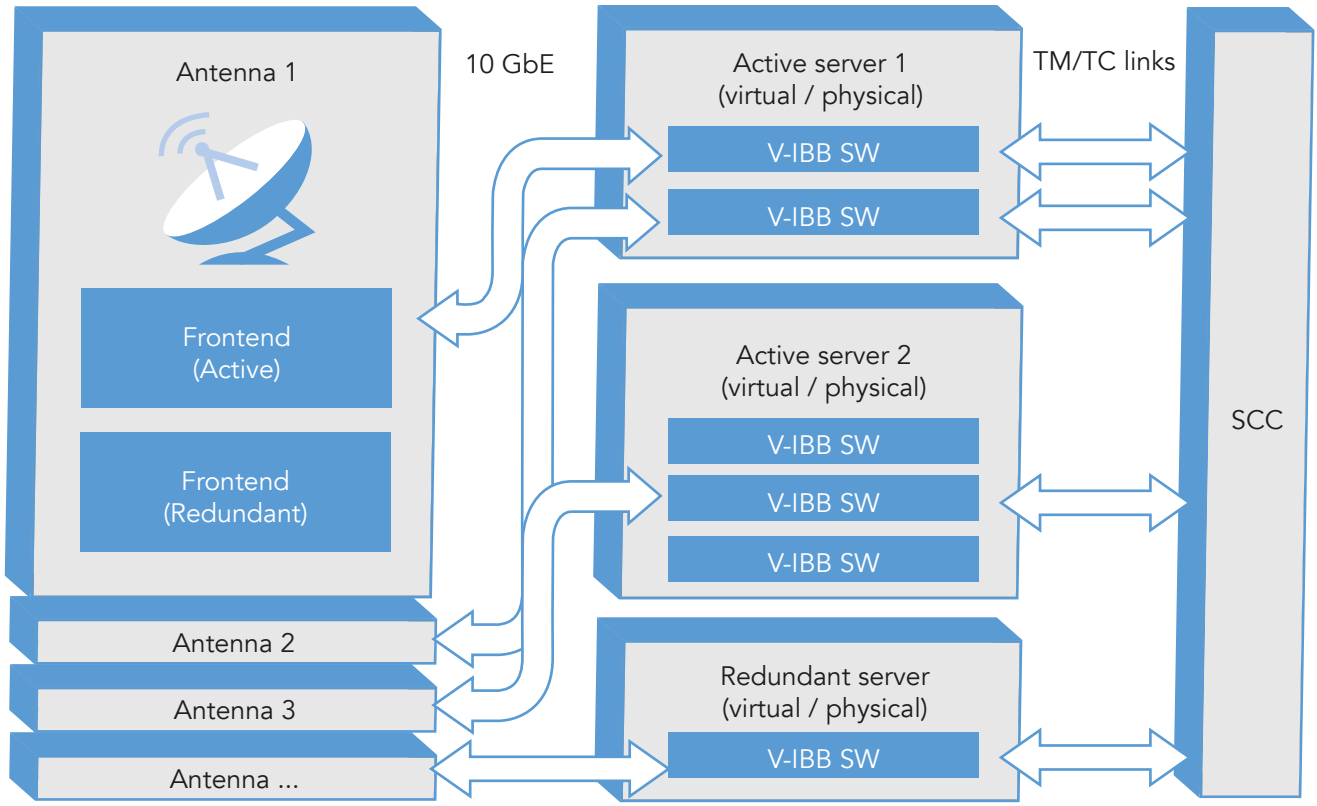
- Number of uplink chains: 1 or 2 (more chains available on request)
- Modulation format: FM/PM
- Output frequency: 55 - 2300 MHz
- Number of outputs: 2 (nominal + auxiliary)
- Output level range: - 64 dBm -> 0 dBm, in 1 dB steps
- Uplink sweep range: ± 500 kHz
- Uplink sweep rate: min 10 Hz/s -> max 1MHz/s
- Spurious, harmonies:
  - < - 60 dBc (not mains related)
  - < - 50 dBc (mains related)
- Max. modulating frequency: 200 kHz
- Phase noise (PM mode): - (51 dB + 10 logΔf) dBc/Hz
- IF phase noise integrated trom 10 Hz to 100 kHz: 0.7 degrees RMS

PM mode modulation characteristics

- Max. PM mode modulation level: 2.5 rad (TC and RNG combined)

FM mode modulation characteristics

- Max. FM mode freq. deviation: ± 500 kHz

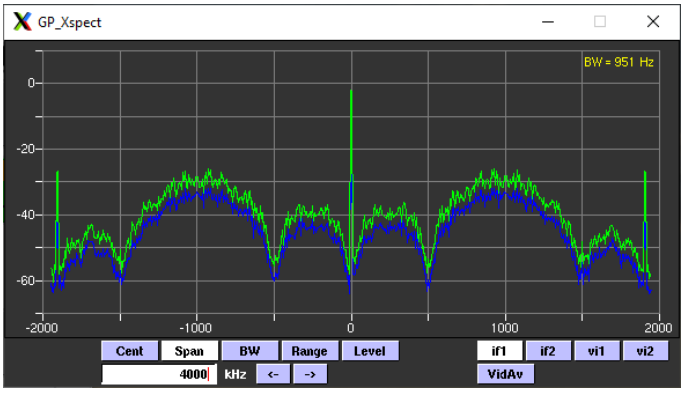


DOPPLER MEASUREMENT (PM MODE ONLY)

- Method: based on reconstruction of phase trajectory
- Accuracy: according to reference frequency (external or internal)
- Jitter:
  - 10 mHz at C/N_0 = 25 dBHz
  - 1 mHz at C/N_0 = 35 dBHz with 1s estimation time
- Rate: 1 per second
- Doppler logging according to CCSDS 503.0-B-1

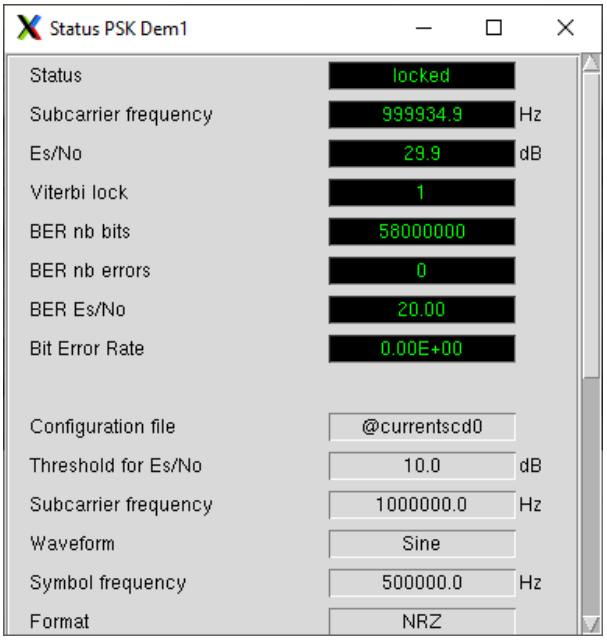
CALIBRATION AND TEST FEATURES

- Generation of a Telemetry sub-carrier for test purposes
- Generation of a pseudo-random bit pattern
- Emission of a fixed pattern TM frame
- Loop testing at IF for ranging calibration
- Loop testing of TM functions
- BER counting using the built-in pseudo random bit pattern generation
- Storage of test results in files



INTERFACES

- Exchange of TM data, TC data, RNG data and Doppler data with the SCC via an Ethernet interface using the TCP /IP protocol
- Optional SLE interface (RAF, RCF, ROCF, forward CLTU)
- Timing reference: Built-in IRIG-B decoder
- Frequency reference: 10 MHz, automatic switchover to external reference when present
- Optional RS422 interfaces for TM and TC (up to 10 Mbps)
- Optional EDEN interface for easy integration in satellite ground testing (SCOE/EGSE)
- Optional adaptation to proprietary interface
- Optional input for GPS antenna



MONITOR AND CONTROL FUNCTIONS

- Local Monitoring & Control by connecting screen, keyboard and mouse
- The communication link between the V-IBB workstation and the M&C computer is connection oriented (TCP/IP)
- Unlimited amount of dedicated configuration files for each functional block and global configuration files for the complete equipment can be built via the Graphical User Interface (GUI), stored and reloaded

ENVIRONMENTAL / POWER

- Operating temperature: + 10 °C to + 40 °C
- Storage temperature: - 20 °C to + 60 °C
- Relative humidity: 40 % to 90 % non condensing
- The equipment is CE compliant
- Power Supply: 90 - 265 V, 47 - 63 Hz

PHYSICAL DIMENSIONS

The IBB equipment consists of two components

- Server
  - 19”rack mountable, height 2U
  - dimensions (W x H x D): 43.7 x 8.8 x 56 cm
- Front End (Sampler)
  - 19” rack mountable, height 1U
  - dimensions (W x H x D): 43.7 x 4.4 x 47 cm (without handles)

RELATED PRODUCT

i2b2 is an inverse IBB, which allows to test the ground segment by simulating the satellite.

CelestiAntwerp
Celestia Technologies Group Company

Celestia Antwerp
Address: Roderveldlaan 1 (bus 3)
2600 Berchem
Belgium
Email: info@celestia-antwerp.be
Phone: +32 (0)3 303 94 50
Website: www.celestia-antwerp.be