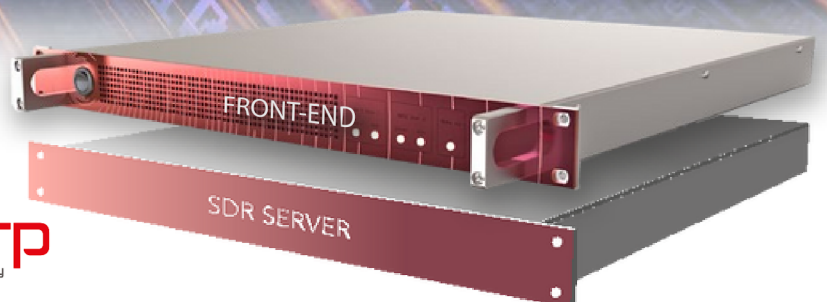


# V-IBB

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<sub>sc</sub>): integer multiple of symbol rate within the band

TM sub-carrier waveform: sine/square

PSK-symbol rate (S<sub>r</sub>): 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<sub>0</sub>): 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<sub>0</sub>): 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 216 -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)

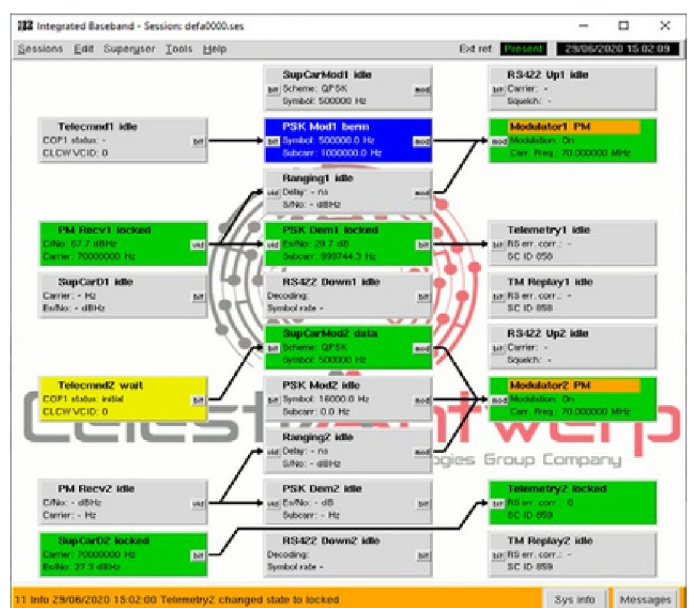
Turbo Decoding according to CCSDS 131.0-B-3

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<sup>-4</sup>

## 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, harmonics:

- < - 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 from 10 Hz to 100 kHz:

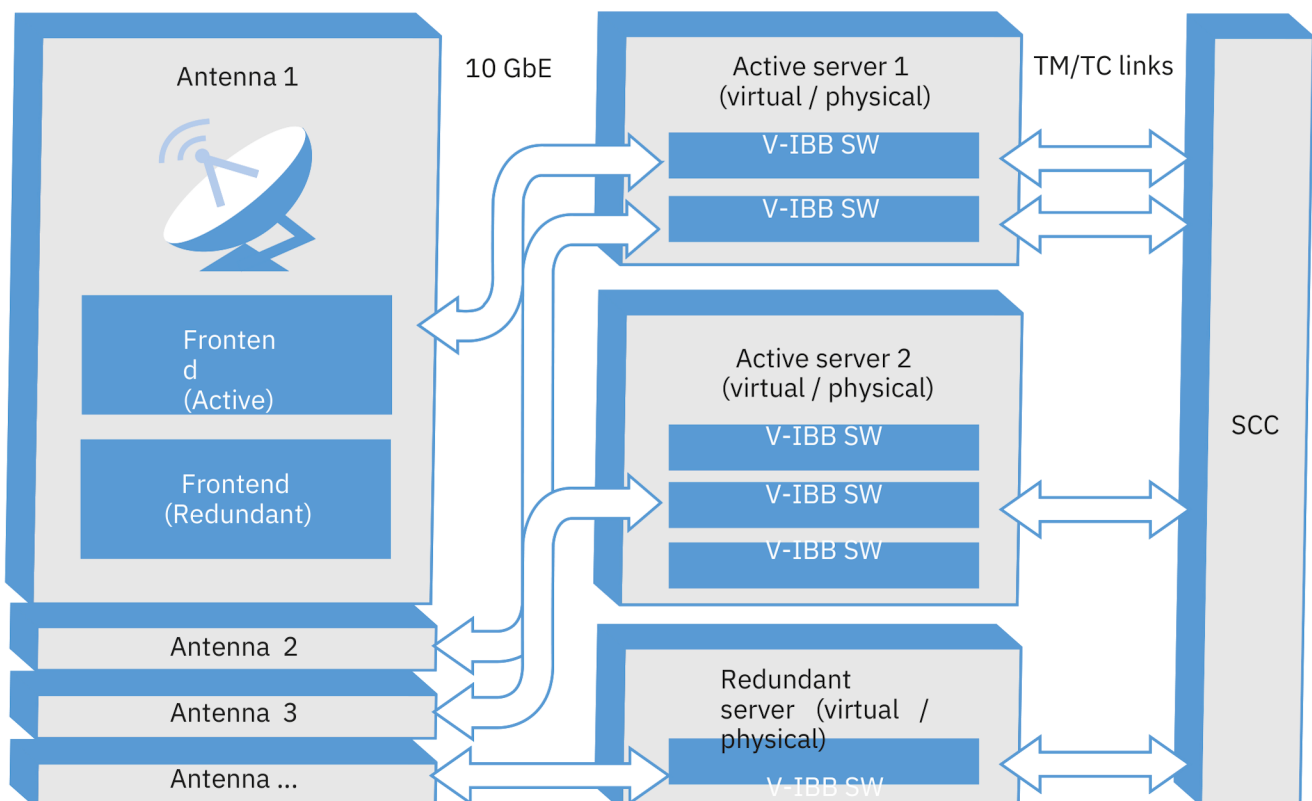
0.7 degrees RMS

### 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

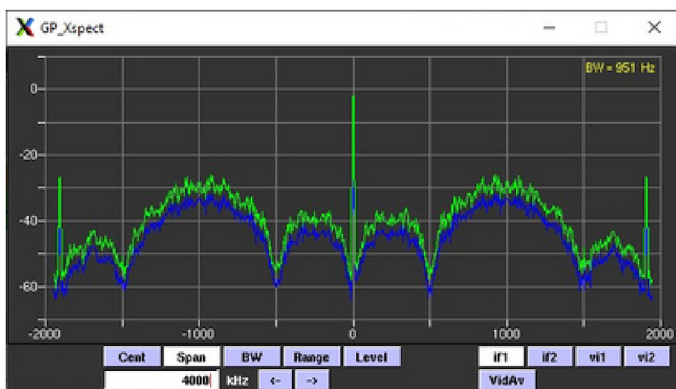
Emission of a fixed pattern TM frame

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

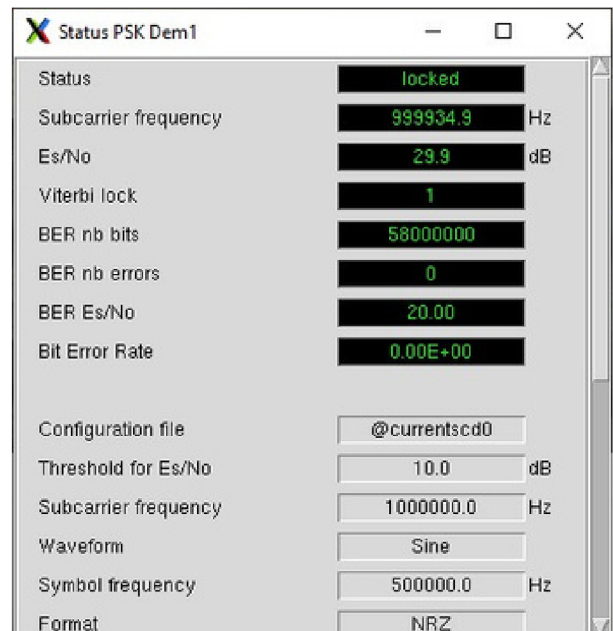
Frequency reference: 10 MHz, automatic switchover to external reference when present

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.



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