IBB
Integrated Baseband Equipment for TT&C Stations
HW-00035

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Product Description

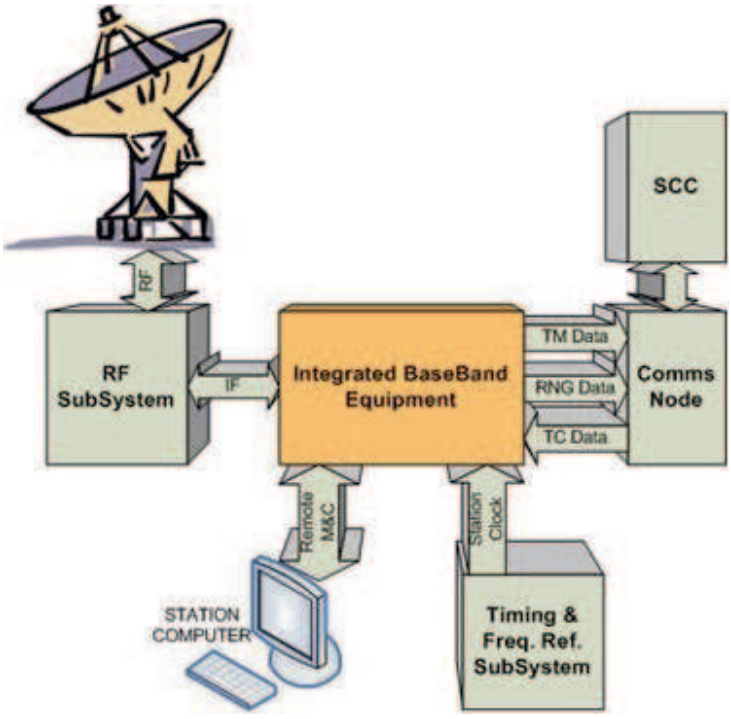
Antwerp Space's Integrated BaseBand system (IBB) is a key component in ground stations for satellite Telemetry, Telecommand and Ranging.
The IBB ensures reliable and flexible communication between the Satellite Control Centre (SCC) and -via the station RF section- the satellite.

Main Functionality

- Carrier acquisition, tracking and demodulation
  - PM/PSK/PCM
  - FM/PSK/PCM
  - PM/PCM
  - FM/PCM
- TM subcarier demodulation/bit synchronization
- Processing of TC data
- TC subcarrier generation and modulation
- Uplink carrier generation and modulation
  - PCM/PSK/PM
  - PCM/PSK/FM
  - PCM/PM
  - PCM/FM
- Generation and reception of ranging tones
- Ranging delay measurement
- Processing of ranging data
- Doppler and doppler rate measurements
- Data logging
- Local and remote monitoring and control
- Real time spectrum analyzer of the received input spectrum

Key Benefits

- Extremely short acquisition time
  - Even in challenging receiving conditions: Signal/Noise, Doppler, ...
- Easy and flexible to use
  - Easy (re)configuration thanks to the modular software architecture and the intuitive graphical user interface.
  - Real-time built-in spectrum analyzer (Xspect)
- Operational reliability
  - Limited number of hardware elements
  - Most functions are software based, including modulation and demodulation
  - Linux based industrial PC platform



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Reception of Satellite Telemetry Data

Carrier Acquisition And Demodulation

- Number of receivers:
  Standard 1 or 2 RX chains
  (more chains available on request)
- Receiver input frequency:
  65 - 75MHz
  (other frequencies on request)
- Received carrier modulation: PM/FM
- Signal dynamic range: 80dB
- Receiver signal input level:
  -100dBm → -20dBm
- Maximum input noise density:
  115dBm/Hz
- AGC mode:
  Non coherent mode to optimize the ADC input loading and reducing signal degradation
- Input C/N0 measurement accuracy:
  <1dB (starting from 60dBHz down to treshold)
- Receiver IF bandwidth: ±450kHz

PM receiver characteristics

- Receiver acquisition range: ±300kHz
- Acquisition and tracking treshold (C/N0):
  down to 10 dBHz is possible
- Maximum doppler rate:
  100Hz/s for C/N_0 = 25dBHz
  10kHz/s for C/N_0 = 35dBHz
  40kHz/s for C/N0 = 38dBHz
- Carrier acquisition time: <0.5s

FM receiver characteristics

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

Subcarrier PSK Demodulation / Bit Synchronizer

- Standard 1 subcarrier demodulator per carrier
- Up to 2 subcarrier demodulators per carrier upon special request
- PCM format: MRZ-L/M/S, SPL-L/M/S
- TM sub-carrier frequency (f_{sc}): 2kHz 150kHz
- TM sub-carrier waveform: sine/square
- Bit/symbol rate (f_b):
  300bit/s → 64kbit/s, maximum depending on the number of RX chains and the coding used
- TM modulation index: 0.1rad → 1.5rad
- Threshold for TM reception (E_b/N_0): 2dB
- Overall degradation (including PM demod): <0.5dB typical

Telemetry Processing Decoding

- Convolutional decoding (K=7, R=½)
- Reed Solomon decoding (255, 223)
- Interleaf factor automatically selected as function of the frame length
- Number of processing chains per carrier:
  standard 1, 2 processing chains on request

Frame Synchronization

- Search for a configurable sync-word
- Allow 0 to 2 bit errors
- Invert data if the inverse sync-marker was found (user-settable)
- Search/verify/lock algorithm
- User-settable thresholds for frame cync lock/unlock
- Synchronization word size: 8 to 64 bits (programmable)
- Frame size: 1 to 2^{16}-1 bytes, when Reed Solomon coding is used, according the Reed Solomon code length from length
- Synchronization strategy:
  SYN (0 to 8 errors) depends on the synchronization word size STL & LTS (0 to7 frames)
  Bit slip (0 to 7 bits)
- Frame scrambling
- Real time deco mutation with graphical display
- Telemetry storage on hard disk: Time-tagged frames or blocks

Transmission of Satellite Telecommand Data

Telecommand pre-processing

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

Sub-carrier modulation

- Modulation formats: FSK, PSK.
- PCM format: NRZ-L/M/S, SPL-L/M/S, RZ.
- PSK sub-carrier frequency (f_{sc}): 2kHz...150kHz.
- PSK-Bit/symbol rate (f_b): 300bit/s...64kbit/s.
- PSK-Ratio (f_{sc}/f_b): 2...1024 (integer).
- Priority switching between RNG and TC.

Transmission of Satellite Telecommand Data Cont'd

Uplink carrier Generation

- Number of uplink chains: 1 or 2
  (more chains available on request)
- Modulation format: FM/PM
- Output frequency: 65...75MHz
  (others on request)
- Number of outputs: 2 (nominal + auxilary)
- Output level range: -30...0dBm, 0.1dB steps
- Uplink sweep range: ±150kHz
- Uplink sweep rate: 50Hz/s...30 kHz/s
- Spurious, harmonics:
  < -60dBc (not mains related)
  < -50dBc (mains related)
- Max. modulating frequency: 200kHz
- Phase noise (PM mode):
  -(51dB + 10log(Δf)) dBc/Hz
- IF phase noise integrated from 10Hz to 100kHz: <0.7 degrees RMS

PM mode modulation characteristics

- Max. PM mode modulations:
  Combination TC+RNG: max. 2.5rad

FM mode modulation characteristics

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

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: 0.1rad...1.5rad
- Min. S/N_0 on received major tone: 25dBHz
- Min. S/N_0 on received minor tone: 15dBHz
- Phase estimation based on 1st order or 2nd order phase trajectory estimation
- No phase (delay) measurement bias due to doppler rate
- Allows for extremely long estimation time, not acheivable 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=0.03rad under the conditions:
  $S/N_{0,ma}$ = 25dBHz
  Estimation time = 2s
  -100kHz major tone
- Measurement resolution: <1nsec
- Ranging measurement timing accuracy: 1µs

Ambiguity Resolution Performance

- Probablility of ambiguity resolution error: 10-4 under the conditions:
  ESA ranging tones
  S/N0,ma = 25dBHz
  S/No,mi = 15dBHz
  Total integration time = 12s
- Doppler Measurement (PM mode only)
- Method: Baded on reconstruction of phase trajectory
- Estimation time: 1s
- Doppler measurement resolution: Floating point calculation
  Doppler measurement accuracy: according to reference frequency (external or internal)
- Doppler jitter:
  10mHz at C/N0 = 25dBHz
  1mHz at C/N0 = 35dBHz
  with 1s estimation time
- Doppler measurement rate: 1 measurement per second

Calibration and Test Features

- Generation of a Telemetry sub-carrier for test purposes
- Generation of a pseude-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-patern generation
- Store 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
- Timing reference: Built-in IRIG decoder
- Frequency reference: 10MHz, automatic switch to its internal reference cin case of external reference missing

Monitor and Control Functions

- Local Monitor & Control via Front Panel mounted TFT screen, keyboard and mouse pad
- The communication link between the IBB workstation and the M&C computer is connection-oriented (TCP/IP)
- Dedicated configuration files for each functional block and global configuration files for the complete equipment can be buildt via hte Graphical User Interface (GUI) and stored

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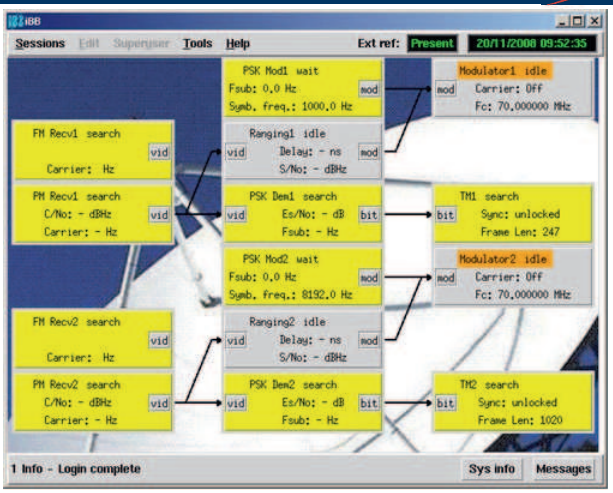
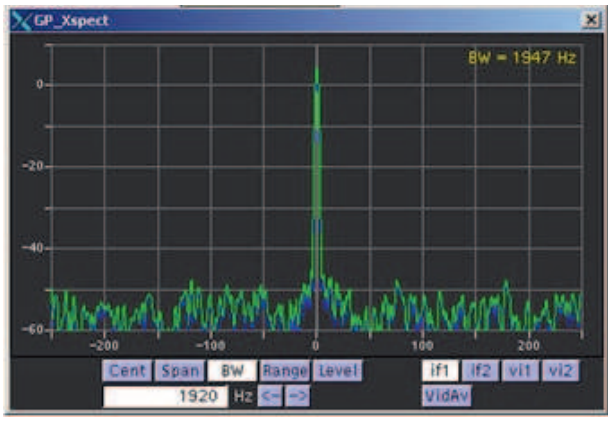
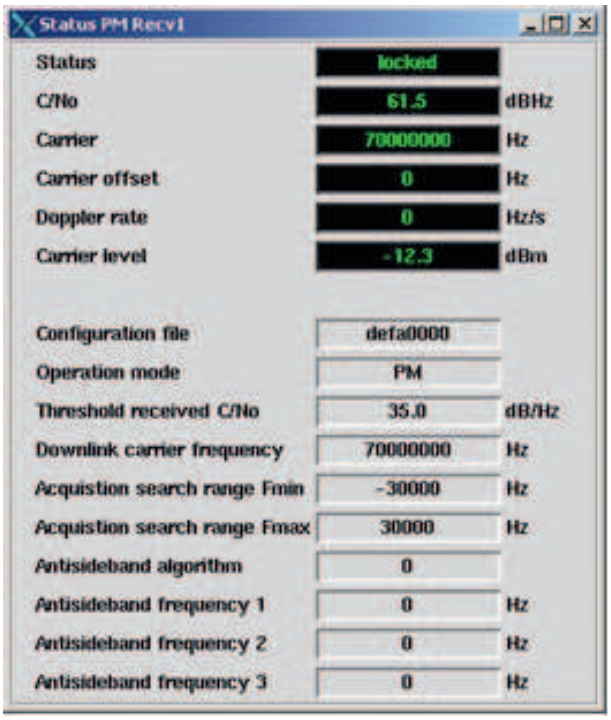
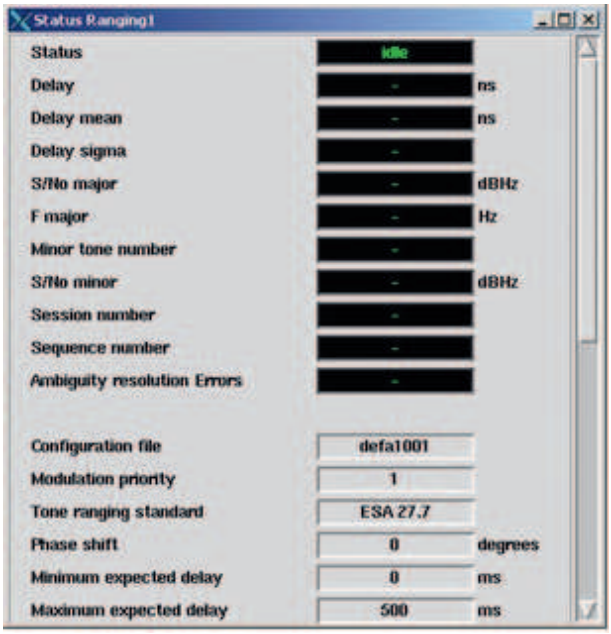
Screenshots









Physical Dimensions

- The IBB is housed in a 4U heigh, 14-slot rackmount industrial PC with a 6.4" LCD display, built-in slim keyboard and touch pad drawer
- Dimensions: 17.5 x 44.9 x 65.0 cm

Environmental

- Signal Operating temperature: +10°C...+40°C
- Storage temperature: -20°C...+60°C
- Relative humidity: 40%...90% non condensing
- The equipment is CE compliant

  Non coherent mode to optimize the ADC input loading and reducing signal degradation
- Input C/N0 measurement accuracy:

  <1dB (starting from 60dBHz down to treshold)
- Receiver IF bandwidth: 450kHz

Ordering Information

HW-Number	Description	Option
HW-00035BLAB	IBB Equipment	IF 70MHz
HW-00035BKAB	IBB Equipment	L-Band Frequency Converters
HW-00035BNAB	IBB Equipment	S-Band Frequency Converters

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