High Rate Demodulator & Front End Processor

The MEOS™ Capture HRDFEP is a high performance, fully programmable data receiver, acquisition and data processing system for the most demanding professional users. Developed to bring all your data safely home, always. This mission statement translates into the key properties of all MEOS™ Capture products: Performance, Reliability and Flexibility.

PERFORMANCE
- Low implementation loss: 0.1 – 1 dB, typically <0.5 dB
- Conventional modulations and coding
- SCCC
- DVB-S2

<table>
<thead>
<tr>
<th>Bit Rate (Mbps) conventional</th>
<th>100</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPSK</td>
<td>0.15</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>QPSK</td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8PSK</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>16QAM</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>SCCC</td>
<td>&lt;1 dB</td>
<td>&lt;1 dB</td>
<td>&lt;1 dB</td>
<td>&lt;1 dB</td>
<td>&lt;1 dB</td>
</tr>
</tbody>
</table>

Implementation loss at BER 10^-6

RELIABILITY
Reduce your operations cost by automated operations
- Fully automated operations
- Automatic recovery in case of network problems
- Automated storage management, using RAID,
- Hot swap disks
- Dual power supplies, hot swappable
- Monitoring of HW resources
- Stable Linux system, supporting 24/7 operations without operator intervention
- Robust server computer and data processing boards

FLEXIBILITY & MODULARITY
Keep your system continuously updated simply by downloading new software.
- State of the art FPGA based hardware re-programmable and in-field upgradable. New versions and updates are provided as files
Demodulator (HRD)
- Fully programmable wideband digital demodulator for BPSK, xQPSK, 8PSK, 16QAM, SCCC**, DVB-S2**
- Dual input ports – female SMA connectors
- 720, 1200MHz (tunable within 700 MHz bandwidth)
- Input impedance: 50 ohms
- VSWR: < 1.5
- AGC range: -5 dBm to –50 dBm
- AGC output level: 0 – 10V - female SMA connector
- Demodulation type:
  - BPSK, CBPSK, QPSK, OQPSK, 1/2 UQPSK, 1/4 UQPSK,
  - 1/8 UQPSK, 8PSK, 16QAM, SCCC*, DVB-S2*
- Matched filters: SRRC, Integrate & Dump
- Adaptive Equalizer
- Spectrum inversion correction
- Fast, wideband carrier acquisition (up to +/- 100 MHz range)
- Doppler on Carrier: 1500 kHz
- Max Carrier Doppler rate: 100 kHz/s max
- Reference oscillator input 10 MHz

Front-End Processor (FEP)
- Two channels (FEPs) per demodulator - fully independent I/Q processing

Frame Processing
- Frame synchronization, de-randomization, error correction and time tagging
- Automatic data ambiguity resolution
- Advanced frame synchronization:
  - Sync options: CCSDS AOS/PT, TDM
  - Fixed length, variable length, adaptive modes
  - Frame length: Up to 64 kBytes
  - Sync pattern: Up to 64 bits
  - Bit error tolerance: Up to 31 bit errors
  - Search-Check-Lock-Flywheel strategy: 0 to 15 frames thresholds
  - Bit slips: Up to ± 7 bits

Data PN de-randomization: Any pattern supported

CRC checking:
- CCSDS polynomial: g(x) = x16 + x12 + x5 + 1
- Programmable offsets

Decoding:
- Modulo 4 Differential Decoding
- Modulo 2 Differential Decoding (PCM):
  - NRZ-M, NRZ-S, NRZ-L
  - Trellis Decoding 4D-TCM:
    - Rate: 8/12, 5/6 (10/12), 9/12
  - Viterbi decoding:
    - CCSDS compliant Viterbi polynomial
    - Rate 1/2, 3/4, 2/3, 5/6, 7/8
    - 7 bits constraint length
    - Viterbi BER estimation

Forward Error Correction and Detection:
- R-S (10, 6), R-S (255, 259), R-S (255, 223)
- Codeword interleaving: 1 to 16
- Codeword length: 33 to 255
- Filtering of uncorrectable frames
- LDPC 7/8
- LDPC DVB-S2**
- SCCC Turbo codes**
  - optional compact
  - optional Max

Quality and Time Appending Frame sync status:
- Up to 4 bytes appended to the frames
- Reed-Solomon status:
- Up to 32 bytes appended to the frames (including frame counter, error status, and user defined fields)

Time-stamping - 8 bytes time field:
- Day: millisecond of day; microsec. of millisecond

Processing
- Splitting and sorting of VCDUs
- Instrument Source Packet (ISP) service processing
- Supports part of the CCSDS AOS Path, Internet and Encapsulation services

Baseband Data Inputs**
- Two serial clock/data inputs per demodulator channel – separate or merged (I+Q) data
- Data rates: Up to 1 Gbps per channel
- Data polarity: - Normal/Inverted
- Clock input phases - Small step phase adjustments
- Electrical standard: Differential ECL
- LVDS: Specify on order
- 8 bit parallel: LVDS (option)
- All serial: female SMA connectors, Parallel (TBD)

Baseband Data Output**
- Playback of stored data (real or synthetic) (serial or parallel)
- Two serial clock/data outputs per demodulator channel – separate or merged (I+Q) data
- Data polarity: Normal/Inverted
- Adjustable data polarity and clock/data phasing
- Clock duty cycle: - 50% ± 10%
- External clock input
- Electrical standard: Differential ECL [standard].
- LVDS, 8 bit parallell (option)
- All female SMA connectors serial/ TBD Parallel
- Gigabit Ethernet (optional 100bit)

Distribution
- Near Real Time (NRT) distribution via TCP socket with rate control. Supports compression, encryption, XML meta data and checksums
- Post-pass file transfer protocols: FTP, SFTP
- SLE: CCSDS Space Link Extension, RAF, RCF and FTPS
- CFDP: Class 1 and Class 2

Special Features
- BER tester: four selectable standard polynomials
- Frame data pattern generator
- PN generator: four selectable standard polynomials
- Status report file generation

Automatic Storage Management
- Oldest data stored on disk will automatically be purged if space is needed
- Important data can be manually locked
# TECHNICAL SPECIFICATIONS

## MEOS™ CAPTURE HRDFEP V5

### Measurements performed with Arbitrary Waveform Generator (AWG) transmitter: BER vs SNR

### External Interface
- TCP socket and XML based
- external interface with minimal bandwidth usage
- Access authentication
- MEOS™ Connect ready

### Reporting
- Historical view of qualitative and quantitative status information for previous activities, based on satellite and orbit. Both as numeric values and graphs
- Automatic generation of WEB reports, including quality and quantitative status information, plots, events and data analysis. Available through standard WEB browser

### MEOS™ CAPTURE HRDFEP is available in two versions:
- **MEOS™ CAPTURE HRDFEP V5 Compact**: 2 U unit that supports up to two channels conventional modes
- **MEOS™ CAPTURE HRDFEP V5 - SCCC**: 5 U unit that supports up to two channels conventional modes, SCC and DVB-S2

### Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>V5 Compact</th>
<th>V5 MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel LVDS input</td>
<td>N.A</td>
<td>Option</td>
</tr>
<tr>
<td>MODULATOR</td>
<td>N.A</td>
<td>Option</td>
</tr>
<tr>
<td>DVB-S2</td>
<td>N.A</td>
<td>Option</td>
</tr>
<tr>
<td>SCC</td>
<td>N.A</td>
<td>Standard</td>
</tr>
<tr>
<td>CCSDS ISP reconstruction</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>SLE</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>CFDP</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>BERT</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>Max symbol rate/channel Msymb/s</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Data storage (Tbytes)</td>
<td>2,4</td>
<td>6</td>
</tr>
<tr>
<td>10 Gbits network</td>
<td>Option</td>
<td>Option</td>
</tr>
<tr>
<td>Moving Window Display</td>
<td>Option</td>
<td>Option</td>
</tr>
<tr>
<td>WEB reports</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>Preconfigured missions</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>LDPC 7/8</td>
<td>Standard</td>
<td>Standard</td>
</tr>
</tbody>
</table>

## MEOS™ CAPTURE HRDFEP V5 Compact:
2 U unit that supports up to two channels conventional modes

## MEOS™ CAPTURE HRDFEP V5 MAX
Compact:
2 U unit that supports up to two channels conventional modes

## MEOS™ CAPTURE HRDFEP V5 - SCCC:
5 U unit that supports up to two channels conventional modes, SCC and DVB-S2
FEATURES

- Real-time acquisition, processing and distribution
- Fast lock-in times: 0.01 – 0.1 sec. typically
- Data rates from 200 kbps to 2.7 Gbps per channel
- Up to 4 Front-End Processors
- Receiver implementation loss typically less than 0,5 dB
- Receiver adaptive equalizer compensates bandwidth mismatch, group delay, ISI, spectrum tilt and multipath
- Real-time and offline status and plots available in GUI and remotely
- WEB and PDF quality reports
- CFDP (CCSDS File Delivery Protocol), Class 1 and 2.
- CCSDS AOS Instrument Source Packets reconstruction
- Real-time buffered distribution, automatic recovery
- SUSE Enterprise Linux, redundant power and SAS RAID disks
- Automatic operation and scheduling
- High rate Space Link Extension (SLE) support
- GUI is displayable on computers in LAN/WAN

MEOS™ CAPTURE HRDFEP V5

Automatic Commanding
This feature is based on orbit prediction for user selected missions. Candidate list of satellite missions to receive and process is generated automatically. The list is editable by the operator.

Data driven operations
The HRDFEP detects the satellite mission automatically from the input (IF) spectrum characteristics and from analysis of the spacecraft ID in the received data. Reception, processing and distribution configuration are reconfigured permission and applied automatically.

This configuration supports two independent IF and ECL input channels, four independent front-end processors (two per channel) and four independent reconstructions (two per channel) of Instrument Source Packets (ISPs). It also supports two independent online distribution channels and three independent offline distribution channels. This configuration also supports two ECL output channels.

Specifications subject to change without any further notice.

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Graphical User Interface
- Programmable (XML definition), Java based GUI.
- Stand alone or through a web browser, using Java web start technology.
- Real-time visualization of quality/quantity status
- Real time vector and Spectrum plots
- Real-time visualization of acquired data from optical satellite instruments (Moving Window Display)