

# A-Series DOG-1 Multi-Mission Optical Modem



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The A-Series is a family of next generation satellite modem platforms built on versatile FPGA- and software-based architecture. The Digital Optical Groundstation (DOG) suite of products is designed for optical communication up to multi-GHz bandwidths, supporting the full variety of space missions from LEO to Deep Space. Exceptional analog and digital engineering provides teleport-grade devices with future-proof expandability.

Through an all-IP structure, the platform supports both native network operation as well as data streaming over IP. Built-in protocol stacks support an increasing number of space data formats as well as streaming of transparent baseband data and synchronized symbols for user-defined processing and integration into virtualized infrastructures.

## Key Features

- Multi-Mission support
- Hard-decision and soft-decision decoding
- Optical On-Off Keying (O3K)
- High-Photon-Efficiency (HPE) future upgradable extension
- CCSDS 141.0-B-x support
- CCSDS 142.0-B-x support
- O3K symbol rate up to 10 Gsp/s
- Internal storage for at least 2 LEO passes at maximum bandwidth
- Customizable processing infrastructure for easy integration into large communication systems
- Flexible software architecture for easy extension and future virtualization of functionality
- Teleport-grade M&C capabilities for seamless integration into professional ground station systems
- **3 years warranty**

The **DOG-1 Multi-Mission Optical Modem** is a modem dedicated to support the processing of optical links between space and Earth. It is designed for multi-mission support to enable effective ground station design. Optical On-Off-Keying (O3K) and High-Photon-Efficiency (HPE) transmissions can be processed via a common input that operates either based on hard-decision decoding or the processing of logarithmic-likelihood-ratios (LLR).

An additional front-end device (DOG-FE Optical Modem Front-End) is available for signal processing from symbol synchronization to LLR computation in combination with the DOG-1 for soft-decision input signals. That will also allow installations of the DOG-1 independently from the telescope location.

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## TX Signal Specifications

|  |  |   |
|--|--|---|
| <b>Signal output:</b>                                      | Optical transmission rates:<br>Connectors:<br>Data format on SFP+ TX pair:<br>Level on SFP+ TX pair: | 3.815 ksp/s for beacon<br>15.259 ksp/s for data transmission according to CCSDS 141.0-B-1<br><b>Contact factory for other rates.</b><br>1x QSFP+<br>4 output pairs of 2 SMA female each <i>w/ option SMAO</i><br>amplified and limited signal<br>1.7 Vpp            |
| <b>Modulation / Coding O3K:</b><br><i>w/ license O3KTX</i> | Modulation:<br>Coding:<br>CSM insertion:<br>PN spreading:<br>Channel interleaver:                    | On-Off-Keying<br>tbd<br>tbd<br>tbd<br>tbd<br>needs to be defined in CCSDS 142.0-B-x<br><b>Contact factory for specific modulations, codes, or formats.</b>  |
| <b>Modulation / Coding HPE:</b><br><i>w/ license HPETX</i> | Modulation:<br>Coding:<br>CSM insertion:<br>PN spreading:<br>Channel interleaver:                    | 2-PPM<br>LDPC 64/128, 256/512, 1024/2048<br>0xEB90 or 0x034776C7272895B0 according to LDPC code<br>1, 2, 4, 8, 16, 32, 64<br>Convolutional, max. values tbd<br>all according to CCSDS 142.0-B-x<br><b>Contact factory for other modulations, codes, or formats.</b> |

Specifications are subject to change

## RX Signal Specifications

|  |  |  |
|--|--|--|
| <b>Signal input O3K hard-decision:</b>                         | Optical transmission rates:<br>Connectors:<br>Data format:<br>Line rates:<br>Line rate tolerance:                          | 100 Msps<br>10 / 5 / 2.5 / 1.25 Gsp/s / 625 / 312.5 / 156.25 / 78.125 / 39.0625 Msps<br>8 / 4 / 2 / 1 Gsp/s / 500 / 250 / 125 / 62.5 / 31.25 Msps<br><b>Contact factory for other rates.</b><br>1x QSFP+<br>4 input pairs of 2 SMA female each, selectable input <i>w/ option SMAI</i><br>amplified and limited O3K signal<br>identical with optical transmission rate<br>± 800 ppm for ≤ 1 Gbps<br>± 200 ppm for > 1 Gbps |
| <b>Signal input LLR for soft-decision:</b>                     | Optical transmission rates:<br>Connector:<br>Data format:<br>Line rate:<br>Line rate tolerance:                            | depending on SDFE device<br>1x QSFP+<br>8-bit LLR values, frame synchronized, 64b/66b encoded<br>40 Gbps<br>± 200 ppm  |
| <b>Demodulation / Decoding O3K:</b>                            | Demodulation:<br>Decoding:<br>Synchronization marker:<br>Symbol repetition:<br>Symbol interleaver:<br>Channel interleaver: | O3K Reed-Solomon<br>Reed-Solomon 223/255<br>FSM<br>1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192<br>automatic detection<br>Depth=1, 2, 3, 4, 5, 8 according to CCSDS 131.0-B-3<br>Row/column block interleaver<br>N=1...2 <sup>23</sup><br>K=8...16320 (valid values depending on symbol interleaver)  |
| <b>Demodulation / Decoding HPE:</b><br><i>w/ license HPERX</i> | Demodulation:<br>Decoding:<br>Synchronization marker:<br>Channel interleaver:  | O3K LDPC <i>w/ license O3KRX</i><br>LDPC 1/2, (9/10 tbc)<br>PLFM, SPLFM, IPLFM<br>Row/column block interleaver<br>N=1...2 <sup>19</sup><br>K=1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024<br><br>all according to CCSDS 142.0-B-x<br><b>Contact factory for other modulations, codes, or formats.</b>   |
| <b>Demodulation / Decoding HPE:</b><br><i>w/ license HPERX</i> | Demodulation:<br>Decoding:   | 4-, 8-, 16-, 32-, 64-, 128-, 256-PPM<br>SCPPM 1/3, 1/2, 2/3<br><br>all according to CCSDS 142.0-B-x<br><b>Contact factory for details on availability.</b>   |

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# A-Series DOG-1 Multi-Mission Optical Modem

## Data Processing and Device Specifications

|   |   |  |
|---|---|--|
| <b>Device connectors:</b>               | Data network:<br>M&C network:   | 4x Ethernet RJ-45, 10/100/1000Base-T auto sensing<br>2x Ethernet RJ-45, 10GBase-T<br>2x SFP+ adapter slot for optical GbE or optical/copper 10GbE<br><b>Contact factory for available SFP+ modules.</b><br>1x Ethernet RJ-45, 10/100/1000Base-T auto sensing   |
| <b>Ranging:</b>                         | Ranging type:<br>Description:   | In-band ranging for O3K Reed-Solomon <i>w/ license RNG1</i><br>Transmission, reception, and processing of ranging packets according to CCSDS xxx.x-Y-x (yellow book not defined yet)   |
| <b>Storage:</b><br><i>w/ option SSD</i> | Capacity:<br>Access protocols:  | 1 TB high-speed SSD<br>tbd   |
| <b>Stream inputs:</b>                   | Interfaces:<br>Telecommand data:<br>Baseband data:  | 2x RTP/UDP/IP over Ethernet according to IETF RFC 2250<br>Multicast and IGMPv3 support<br>2 streams for direct input of TC data<br>data stream is sliced according to configured transfer frame length<br>generation of synchronization and fill patterns according to active waveform<br>configurable UDP/IP-based flow control<br>direct input of baseband data to various processing stages<br><i>w/ licenses tbd</i> |
| <b>Stream outputs:</b>                  | Interfaces:<br>Telemetry data:<br>Baseband data:  | 1x RTP/UDP/IP over Ethernet according to IETF RFC 2250<br>Transfer frame output including ASM<br>1 transfer frame per UDP packet<br>direct output of baseband data from various processing stages<br><i>w/ licenses tbd</i>  |
| <b>Frontpanel interface:</b>            | 7" IPS Touch Display 1024x600   |  |
| <b>Remote monitoring and control:</b>   | Protocol:<br>Connection:<br>Protocol:<br>Connection:  | SNMP<br>UDP/IP over Ethernet/RJ-45<br>HTTP web browser interface<br>TCP/IP over Ethernet/RJ-45   |
| <b>Temperature range:</b>               | Operating:<br>Storage:<br>Relative humidity:  | 0°C...50°C<br>-30°C...80°C<br>< 95% non condensing   |
| <b>Mains power:</b>                     | Input:<br>Consumption:<br>Connector:  | 100...240 V AC nominal, 90...264 V AC max, 50...60 Hz<br>300 VA / 300 W typical<br>IEC C14   |
| <b>Dimension and weight:</b>            | 483 x 134 x 505 mm <sup>3</sup> (WxHxD), 3 RU 19"<br>up to approx. 12 kg depending on device type |  |

Specifications are subject to change

### Order information:

**DOG-1** Multi-Mission Optical Modem

### Hardware options:

Hardware options have to be defined with the order and are not field-upgradable. Not all device types may support all combinations. Contact factory with specific requests.

**SSD** Internal disk storage  
**SMAO** O3K/HPE electrical output via SMA connectors  
**SMAI** O3K electrical input via SMA connectors

### License based functions:

License based functions are field-upgradable by uploading a license file to the device.

**O3KTX** O3K uplink processing  
**O3KRX** O3K downlink soft-decision processing  
**HPETX** HPE uplink processing  
**HPERX** HPE downlink processing  
**RNG1** Optical in-band ranging for O3K