

Modular implementation

The IMBU is implemented in a fully modular way. Each of the main functions of the unit, including the power supplies, are implemented as single plug-in modules. This allows a modular configuration of the unit in accordance with the customer or system requirements.

The IMBU consists of two separate modules being the TM (demodulator) and TC (modulator) module, each having baseband and IF capabilities. Both modules provide coding and physical layer functions, which at the physical level consist of IF, sub-carrier and baseband electrical interfaces.

Since all modules can be removed from the back of the unit, in-the-field maintenance is highly simplified and module replacements can be performed quickly.

MBU models

Besides the Ground Segment-IMBU other types of IMBU units are implemented by Satellite Services B.V. For example the PSS-IMBU, which is specifically developed for Satellite simulation and ground station /segment testing and operator training. (see separate datasheet)

Due to the flexible and small-scale implementation, the IMBU is particularly suitable for multi-satellite link applications. (1 single module for each TM link.)

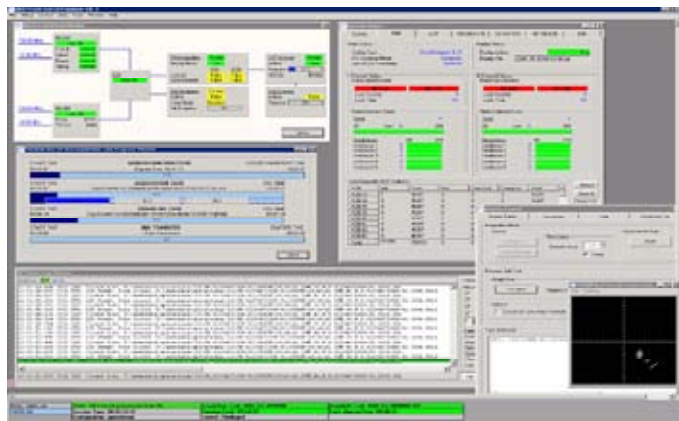
Software support

Since the IMBU enables direct software to physical link implementations, software applications can be developed on any platform supporting Ethernet-TCP/IP network connectivity.

The standard LAN interface protocol of the IMBU is based on binary message exchange which also readily supports multi-link/unit implementations where applicable. A full ICD and an interface library is available to aid in system integration.

Alternatively specific user protocols can be implemented as well. Support for the CCSDS Spacelink Extension Protocol (SLE) is being developed as an in-field upgradeable option.

For turn-key systems: the proven SSBV TM/TC baseband processing software and Control & Monitor Software (CMS), as deployed with TM/TC systems since 1996, is available under Windows™ 2000/XP-Pro/2003 Server™. This enables the user to create an AIT/Test or operational ground station Front-End, including frame/CLTU and packet layer support. This includes integrated archiving, logging and standard remote interface/gateway protocols.



For (autonomous) station implementations: the IMBU can also be supported by the SSBV FE-LZP software that offers TM ingestion and level-0 processing functionality. This can range from raw data ingestion to real-time TM processing, storing and forwarding.

Overall Environmental and Physical Specifications

<i>Characteristics</i>	
Dimensions HxWxD (mm)	133x448x443 mm
Weight	< 6 kg
Power	100-240V AC 50/60 Hz
Operating Temperature Range (°C)	5 – 35 °C
Storage Temperature	-20 °C to +60°C
Storage Relative Humidity	Up to 85 %

Experience

Building on over 20 years of experience related to TM/TC systems, Satellite Services B.V. has developed the Spacelink^{NGT} product range as a standardised range of complimentary products. These products fulfil the promise of true multi-purpose and multi-phase system deployments from simulation to operation.

With a 100% focus on space and space data communications as a prime application area, Satellite Services B.V. are fully aware of past, present and future standards and constantly work on improving its products.

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Spacelink^{NGT} Integrated Modem and Baseband Unit (IMBU)

The Spacelink^{NGT} Integrated Modem and Baseband Unit (IMBU) is one of the latest additions to the innovative Spacelink^{NGT} line of Multi-purpose modems and TM/TC equipment from Satellite Services B.V. of The Netherlands.

The IMBU supports real-time IF interfacing, (de)modulation, frame synchronisation, decoding / encoding and low-level processing of TM and TC streams. The IMBU offers IF, subcarrier and baseband interfaces as they are typically found in a ground station infrastructure. In addition, the IMBU is compatible with interfaces used for the Assembly Integration and Testing (AIT) of spacecraft and subsystems/payloads.

The IMBU combines TM and TC functions at 70/230 MHz IF, Video/Subcarrier as well as Baseband and LAN level using the latest technology. This has resulted in single-board implementations of a TM (receiver) and TC (transmitter) that operate fully independently. The overall IMBU is implemented as a compact 3U/19" rack-mountable unit which interfaces directly to a standard 10/100BaseT Ethernet LAN.

Each IMBU element supports either modulation or demodulation of TM and TC data at 70/230 MHz IF, as well as subcarrier/video level. The modem elements can either be used stand-alone or (in parallel) with the built-in baseband TM/TC processing functions.

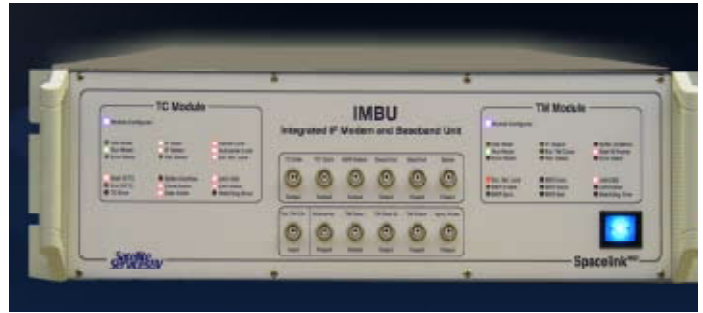
The TM and TC baseband functions of the IMBU provide Ground Segment TM and TC processing. The TM baseband processing receives Telemetry data from the demodulator or baseband interfaces. It performs different types of data decoding, TM Frame synchronisation, R/S-Convoluntional error correction/detection and frame annotation. The recovered TM information is then passed through baseband and Ethernet TCP/IP LAN interfaces. In addition to this, the TM baseband processing can also be used in a raw data acquisition mode.

Conversely, the TC baseband processing receives Telecommand data via the LAN interface and encodes/serialises the data for transmission via the baseband connections and/or via the IMBU modulator. In addition to TC data (CLTU/frames), raw or transparent datablock uplinks are also supported.

The modem and TM/TC baseband functions of the IMBU are implemented using (in-circuit programmable) FPGA technology and supports real-time data processing at bit rates varying from 7 bps to 24 Mbps (coding/modulation dependant). The baseband functions are compliant to the latest ECSS standards and CCSDS recommendations. In addition to the main TM/TC functions, the IMBU can also implement an Echo TC receiver and TM test data generator. This includes monitoring of TC data that is actually sent at baseband level.

The Ethernet LAN interface for remote control/status and TM/TC data exchange is implemented as a standard 10/100BaseT Ethernet interface. Reconfiguration of the modem and baseband firmware can be performed in the field without the need for the removal/exchange of hardware modules. As the IMBU modules can be used independently from one another, this allows different combinations of modules to be used such as multiple TM Receiver modules, i.e. the IMBU is also particularly suitable for multi-satellite link applications.

The IMBU utilises a low-noise internal oscillator, but also supports the use of either a 5 or 10MHz external clock to which signals are synchronised. The IMBU is supported by the proven range of TM/TC software from Satellite Services B.V. such as the TM/TC Control & Monitor Software (CMS). It can also be easily interfaced to third party systems.



Features

- Integrates IF modem, video, baseband processing and direct LAN interfacing into a single unit
- Allows operation either as a modem, baseband unit or both in parallel
- Supports the CCSDS/ECSS recommendations for modulation and coding
- Modular 3U/19" overall system implementation

Receiver module (i.e. Telemetry)

- Full digital implementation
- Single-board solution
- IF centred at 70 or 230 MHz +/- 4 MHz
- IF input level: -80 dBm to -30 dBm
- Doppler Rate +/- 52 kHz/sec
- Carrier demodulation: PM and BPSK, QPSK and OQPSK
- Sub-carrier demodulation: BPSK
- Doppler compensation 500 kHz at 230 MHz IF
- Data rates from 7.8125 bps to 24 Mbps (12Msps)
- 3-bit soft decision VITERBI decoder (nom. Rate 1/2 K=7)
- NRZ-L, NRZ-M and NRZ-S data formats
- Baseband Telemetry acquisition support of PCM, packet / AOS TM (ECSS/ESA/CCSDS) and other commercial and transparent data modes
- Supports RS error detection / correction (CCSDS IL=1 to 8 and Virtual Fill or other standards)
- Built-in test data generation
- Dedicated LAN interface for control/status and TM data exchange
- Optional IRIG-B / PPS inputs for integrated time tagging

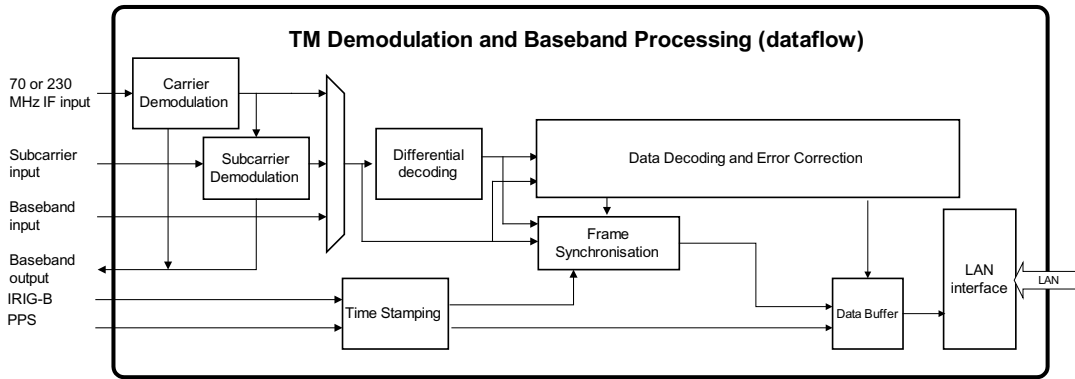
Transmitter module (i.e. Telecommand)

- Fully digital implementation
- Single board solution on a standard VME sized PCB
- IF Centre Frequency 70 or 230 MHz +/- 1.5 MHz (in 1 kHz steps)
- IF output level -50 dBm to +10 dBm in 0.25 dB steps
- Bit-rates from 7.8125 bps to 24 Mbps (12Msps)
- Carrier modulation: PM, BPSK, QPSK, OQPSK and GMSK
- Subcarrier modulation: BPSK (square and sine-wave)
- Baseband coding and serialisation
- Support for PCM and SCSS/CCSDS
- FEC supported: (punctured) Convolutional encoding
- Selectable QPSK/OQPSK differential encoding
- NRZ-L, NRZ-M and SPL data formats
- Built-in Echo TC Receiver
- Dedicated LAN interface for control/status and TM data exchange
- External Reference input (5/10 MHz)
- Optional IRIG-B / PPS inputs

Demodulation chain & Modulation chain Specifications

(TM) Demodulation chain		(TC) Modulation chain	
IF Centre Frequency	70 or 230 Mhz +/- 4 MHz (10 Hz steps) With a bandwidth of 25 MHz	IF Centre Frequency	Frequency 70 or 230 MHz +/- 1.5 MHz (in 1 kHz steps)
Input level range	-80 dBm to -30 dBm	IF Bandwith	20 MHz
Noise figure	<= 12 dB	IF Output Level	-50 dBm to +10 dBm in 0.25 dB steps
Input impedance	50Ω +/- 10%	IF Phase Noise	1Hz < f < 1 Mhz phase noise <= -60 -10 Log (f) dBc/Hz F> 1MHz phase noise <= -120 dBc/Hz
Carrier Demodulation Types	PM and BPSK, QPSK and OQPSK	IF Frequency Accuracy	+/- 10ppm (internal references)
Sub-carrier Demodulation	BPSK	Output Impedance	50Ω +/- 10%
Sub-carrier Frequencies	8kHz – 2 MHz	Carrier Modulation Types	PM, BPSK, QPSK, OQPSK and GMSK
Data formats	NRZ-L, NRZ-M, NRZ-S, SPL		
Decoding / coding	3-bit soft decision VITERBI decoder (Rate= ½ K=7) SPL decoder	PM Modulation Index	0.1 to 1.5 radians in 0.01 radian steps
Bit rates	8 bps – 24 Mbps	In/ out Bans spurious level	In band <= - 50 dBc Out band <= - 60 dBc
Doppler Compensation	+/- 500 kHz	Sub-carrier	Modulation Type: BPSK
Max Doppler rate	+/-52 kHz / sec		Frequency: 0.1 kHz – 6 MHz in 1 mHz steps
Implementation loss	0.7 - 1.0 dB typically @ 1.0E-6		Signal: Square / Sine
Data outputs	10/100BaseT Ethernet interface (TCP/IP) In parallel with Differential RS422/V11 baseband (I/Q/Clock) Data can be output from different parts of the demodulation/baseband processing chain including support for raw data acquisition.		Output level: 0 – 2.55 Vpp in steps of 10 mV Symbol rate ratio: 1 to 1024
External Reference input	5 / 10 MHz	Bit rates	8 bps to 24 Mbps (12Msps QPSK)
Error Detection	Supports RS error detection / correction (IL=1 to 8 and Virtual Fill)	Data Format/Coding	NRZ-L, NRZ-M and SPL Optional convolution encoding (rate ½ K=7)
Time Code	IRIG-B and PPS (Pulse Per Second) interfaces supported for TM time-tagging	External Reference input	5 / 10 MHz
		Data inputs	10/100BaseT Ethernet interface (TCP/IP) Or (user selectable) Differential RS422/V11 baseband (I/Q/Clock) External clock output supported
		Ranging	Ranging signal generator available as option (tone and PRN ranging)

TM module functional block diagram



TC module functional block diagram

