

## 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 for a modular configuration of the unit in accordance with the customer or system requirements.

The IMBU consists of two separate modules being the TM (modulator) and TC (demodulator) 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.

## Different types

Besides the PSS-IMBU other types of IMBU's are implemented by Satellite Services B.V. to support ground station and earth terminal applications. (See also GS-IMBU datasheet)

Due to the flexible and small-scale implementation, the IMBU is also particularly suitable for hybrid and multi-satellite link applications.

## 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 that 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™ to create an AIT/Test or operational ground station simulation Front-End including frame/CLTU and packet layer support; integrated archiving, logging and standard remote interface/gateway protocols.

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A separate software simulation framework (PSSmk3) that supports the IMBU has been developed by the European Space Agency (ESA). More details are available on request.

## Overall Environmental and Physical Specifications

Characteristics	
Dimensions HxWxD (mm)	133x448x443 mm
Weight	< 6 kg
Power	100-240 V 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 almost 20 years of experience related to TM/TC systems; Satellite Services B.V. has developed the Spacelink<sup>NGT</sup> product line as a standardised range of complimentary products which 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 works on improving its products.

## Contact information

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# Spacelink<sup>NGT</sup> Portable Satellite Simulator Integrated Modem and Baseband Unit (PSS IMBU)

The Spacelink<sup>NGT</sup> Integrated Modem and Baseband Unit (IMBU) is one of the latest additions to the innovative Spacelink<sup>NGT</sup> product line of TTC & TM/TC products from Satellite Services B.V. A specific variant of the IMBU was implemented for the latest generation of Portable Satellite Simulators (PSS) of the European Space Agency (ESA).

The PSS-IMBU supports the real-time interfacing, (de)coding and low-level processing of a wide range of different spacecraft/ground station TM/TC interfaces and data processing based on the latest CCSDS recommendations and ECSS standards.

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

The PSS-IMBU modem elements support the modulation and demodulation of TM and TC data at 70/230 MHz IF and subcarrier / video level and 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 PSS-IMBU are specifically developed for Portable Satellite Simulation (PSS) applications. In this context, TM and TC data at packet/frame level are exchanged with the IMBU through a standard Ethernet TCP/IP LAN interface. All subsequent coding/decoding and (de)modulation functions, as required at lower layers, are implemented within the IMBU hardware.

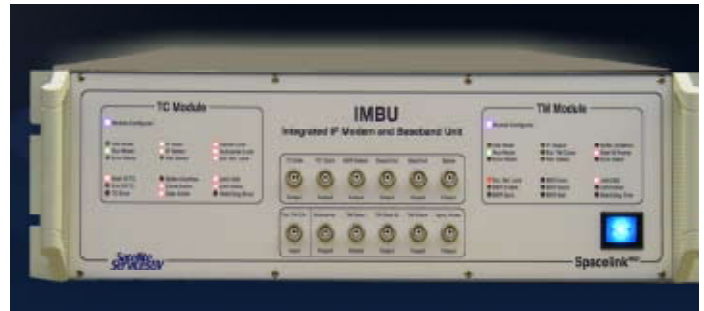
The modem and TM/TC baseband functions of the PSS-IMBU are implemented using (in-circuit programmable) FPGA technology and support real-time data processing at bit rates varying from 7 bps to 24 Mbps. (coding/modulation dependant)

The 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.

Besides using the IMBU as an Integrated Modem and Baseband Unit, all main functions of the unit can also be used independently of one another. This allows backward compatibility with existing ground station interfaces and traditional front-end chains.

In addition to the main TM/TC functions, the PSS-IMBU also implements specific test functions, such as a user programmable repetitive frame generator and a BER tester that can operate using normal spacecraft TM data (even when coded). The PSS-IMBU utilises a low-noise internal oscillator, but it also supports the use of either a 5 or 10MHz external clock to which signals are synchronised.

Currently supported FEC encoding schemes include: Reed-Solomon, (punctured) Convolutional or concatenated coding as well as turbo encoding. All encoding schemes are CCSDS compliant. Supported data coding formats include pseudo Randomisation, NRZ-L, NRZ-M, SPL encoding and QPSK/OQPSK differential encoding.



## Features

- Integrated IF modem, video, baseband processing and direct LAN interfacing into a single unit
- Supports the latest CCSDS/ECSS recommendations for modulation and coding
- Highly modular and suitable for different application area
- Modular and compact 3U/19" implementation

### TC Demodulation chain

- Full digital implementation
- Single-board solution
- Direct IF conversion into LAN and back
- IF centred at 230 MHz +/- 4 MHz
- IF input level: -80 dBm to -30 dBm
- Doppler Rate +/- 52 kHz/sec
- Carrier demodulation: PM and BPSK
- Sub-carrier demodulation: BPSK
- Doppler compensation 500 kHz at 230 MHz IF
- Data rates from 7.8125 bps to 1 Mbps
- Optional VITERBI decoder (Rate 1/2 K=7)
- NRZ-L, NRZ-M and NRZ-S decoding
- Baseband Telecommand acquisition support of PCM, TC packet (ESA and CCSDS) and transparent modes
- Supports PCM hamming and TC packet BCH error detection / correction
- Optional IRIG-B and PPS inputs

### TM Modulation chain

- Fully digital implementation
- Single board solution
- External Reference input (5/10 MHz)
- IF Centre Frequency 70 MHz in 1 kHz steps
- Bit-rates from 8 bps to 12 Mbps
- Supports Reed-Solomon coding, Turbo coding, Convolutional encoding and Pseudo Randomization (CCSDS)
- Built-in BER tester
- Error Injection Mechanism
- NRZ-L, NRZ-M and SPL encoding
- Symbol Rates 5sps – 6 Msps
- Optional IRIG-B and PPS inputs

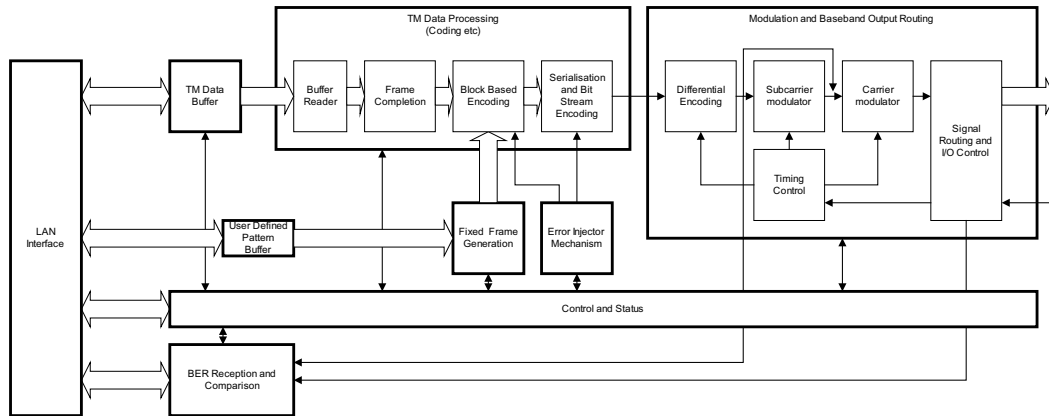
### Control/Status interface (for each module)

- Telnet like remote control/status interface
- TCP/IP - Ethernet (10/100BaseT)

## Demodulation chain & Modulation chain Specifications

TC Demodulation chain		TM Modulation chain	
<b>IF Centre Frequency</b>	230 Mhz +/- 4 MHz (10 Hz steps)  With a bandwidth of 25 MHz	<b>IF Centre Frequency</b>	70 MHz +/- 1.5 MHz (1 kHz steps)
<b>Input level range</b>	-10 dBm to -80 dBm	<b>IF Bandwidth</b>	20 MHz
<b>Noise figure</b>	<= 12 dB	<b>IF Output Level</b>	-50 dBm to +10 dBm in 0.25 dB steps
<b>Input impedance</b>	50 $\square$ +/- 10%	<b>IF Phase Noise</b>	1Hz < f < 1 Mhz phase noise <= -60 -10 Log (f) dBc/Hz F > 1MHz phase noise <= -120 dBc/Hz
<b>Carrier Demodulation Types</b>	PM and BPSK	<b>IF Frequency Accuracy</b>	+/- 10ppm (internal references)
<b>Sub-carrier Demodulation</b>	BPSK	<b>Output Impedance</b>	50 $\square$ +/- 10%
<b>Sub-carrier Frequencies</b>	8kHz – 2 MHz	<b>Carrier Modulation Types</b>	PM, BPSK, QPSK and GMSK
<b>Data formats</b>	NRZ-L, NRZ-M, NRZ-S, SPL		
<b>Decoding / coding</b>	Optional VITERBI decoder (Rate= $\frac{1}{2}$ K=7)  SPL coder	<b>PM Modulation Index</b>	0.1 to 1.5 radians in 0.1 radian steps
<b>Bit rates</b>	7.8125 bps – 1 Mbps	<b>In/ out Bans spurious level</b>	In band <= - 50 dBc Out band <= - 60 dBc
<b>Doppler Compensation</b>	+/- 500 kHz at 230 MHz IF	<b>Sub-carrier</b>	Modulation Type: BPSK
<b>Max Doppler rate</b>	+/-52 kHz / sec		Frequency: 0.1 kHz – 6 MHz in 1 mHz steps
<b>Implementation loss</b>	0.7 - 1.0 dB typically @ 1.0E-6		Signal: Square / Sine
<b>Configuration</b>	Multiple satellites within nominal specification range can be supported through user selection. (No limit on no. of missions stored, other than Non-Volatile storage media)  Configurations can normally be loaded and become operational in less than 30 seconds.		Output level: 0 – 2.55 Vpp in steps of 10 mV  Symbol rate ratio: 1 to 1024
<b>Data outputs</b>	Differential RS422/V11 baseband outputs.	<b>Bit rates</b>	10 bps – 24 Mbps (12Msps QPSK)
<b>External Reference input</b>	5 / 10 MHz	<b>Data Format</b>	NRZ-L/M/S
		<b>External Reference input</b>	5 / 10 MHz

### TC module functional block diagram



### TM module functional block diagram

