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IZT
Innovationszentrum
Telekommunikationstechnik

IZT C6000
RF Link Emulator

- Bi-directional wideband solutions for up to 600 MHz bandwidth
- Simulation of complete satellite links including payload, uplink and downlink effects
- Simulation of RF stages and fading in terrestrial links

IZT C6000
RF Link Emulator

Modern communication systems adapt not only higher frequencies but also wider bandwidths. The IZT RF Link Emulator provides a cost effective and time-saving solution for testing the complete bi-directional transmission path of both terrestrial and satellite based communication links.

- Bi-directional wideband solutions for up to 600 MHz bandwidth
- Simulation of complete satellite links including payload, uplink and downlink effects
- Simulation of RF stages and fading in terrestrial links
- Continuous coverage of 8 / 7 GHz X band satellite communications systems
- Reproducible and complex scenarios
- Dynamic scenarios
- Real-time change of parameters
- Flexible and scalable architecture
- State-of-the-art Graphical User Interface
- Remote controllable
- Long-term support

FRONTPAGE SHOWS LARGE C6000 INSTALLATION. FULLY SYNCHRONOUS EMULATION OF FORWARD AND RETURN PATH WITH INTERFACES TO MORE THAN 300 VSAT TERMINALS.

Overview

The IZT C6000's optimized and scalable signal processing units offer real-time simulation of influences on the signal at the satellite (non linearity, IMUX / OMUX filter, phase noise, interference, antenna gain, Doppler shift) as well as on the transmission link (interference, rain fading, scintillation, reflections, thermal noise). The state-of-the-art Graphical User Interface allows changing all parameters of the setup easily. Remote control is possible through SCPI and SNMP.

With the IZT C6000 satellite based communication systems can be extensively simulated and tested prior to their realization. In addition, complex operational scenarios for equipment (receivers, transmitters, satellite phones) and satellite testing can be set up in a very cost-effective way.

The IZT C6000 is a scalable system based on individual hardware units that can be configured from uni-directional links to bi-directional links with hundreds of terminals.

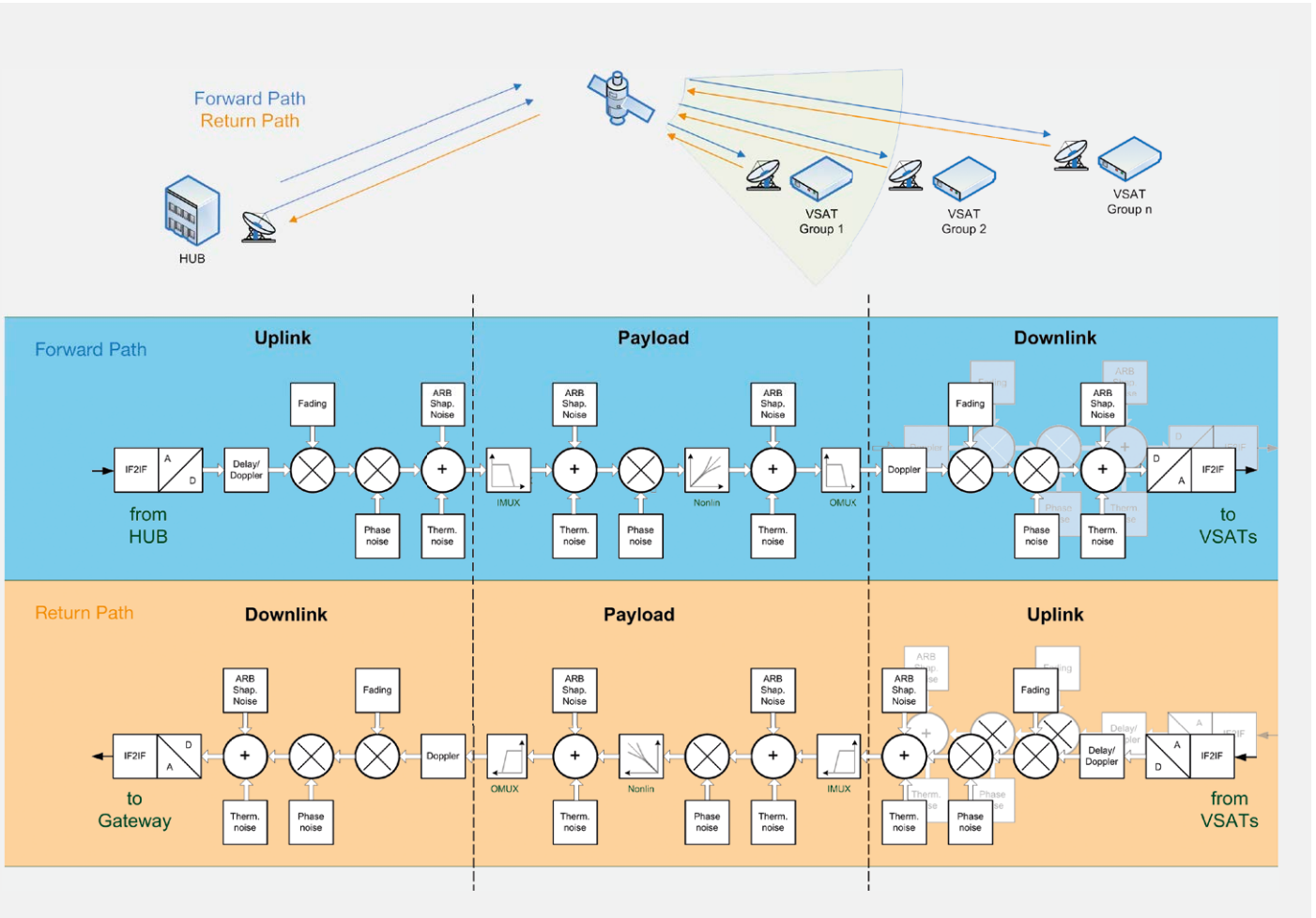

FIGURE 1: CHANNEL AND PAYLOAD MODELS OF IZT C6000

Channel Effects

DELAY

The IZT C6000 can simulate a variable link delay of up to 800 ms in each direction. Additionally, its variation is tied to the Doppler simulation of the link. It is continuously variable to simulate actual movement of the payload. Variations will resemble a linear change of distance between transmitter and receiver.

DOPPLER

The IZT C6000 provides the ability to simulate time-variant, phase continuous Doppler frequency profiles. The profiles can either be based on math functions or on time indexed orbit description (ECEF) and ground site descriptions for transmitters and receivers.
The Doppler simulation covers up to 24 hours of satellite movement.

RAIN FADE

To simulate rain fade, the IZT C6000 has the capability to apply time-varying attenuation profiles. Uplink Power Control (UPC) effects can be included in rain fade simulations by defining clear sky EIRP and maximum EIRP. The IZT C6000 provides a profile depth of up to 24 hours at a 1 millisecond time resolution.

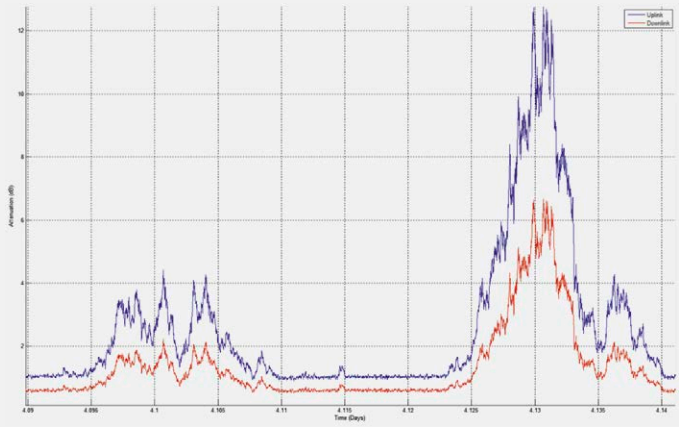

FIGURE 2: EXAMPLE OF A RAIN FADE PROFILE

FIXED ATTENUATION

Fixed offsets in attenuation representative of static clear sky conditions can be applied.

INTERFERENCE

The C6000 facilitates several instances of interference signal generators to emulate for example in-band adjacent beam co-channel interference.
The interference waveform generator supports AWGN, CW, and several types of PSK and QAM modes. Bandwidth and center frequency of the interference are variable and user controllable. The interference signal level is settable relative to the carrier signal level.
Every instance of the arbitrary waveform generator holds up to 3.5 GB of data.

THERMAL NOISE

AWGN generators in both uplink and downlink provide the means to emulate channel AWGN to reflect constant noise such as antenna and receiver noise temperature. The AWGN signal level is settable relative to the carrier signal level.

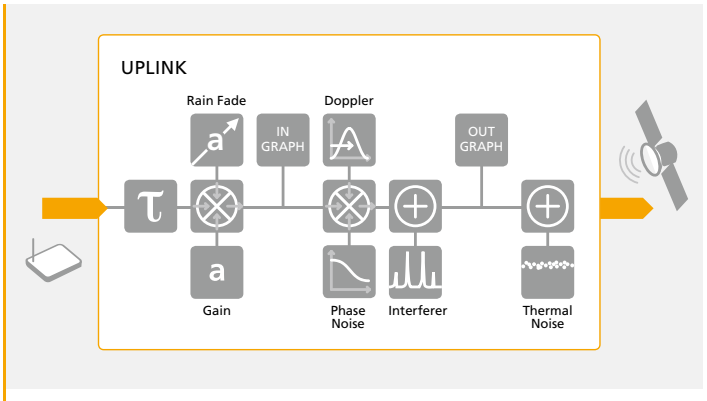

FIGURE 3: BLOCKDIAGRAM OF UPLINK EFFECTS

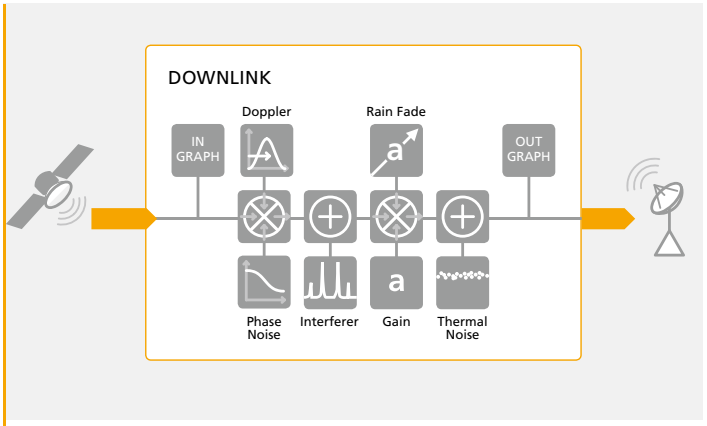

FIGURE 4: BLOCKDIAGRAM OF DOWNLINK EFFECTS

Satellite Payload Effects

LINEAR FILTER DISTORTION (IMUX/OMUX)

The IZT C6000 provides two digital filters on either end of the payload simulation to mimic the satellite's IMUX and OMUX filter amplitude and group delay response. The user may either specify the filter coefficients directly or provide a complex frequency response, which will be transformed into a FIR filter by the IZT C6000 control software. IMUX and OMUX filters are independent.

PHASE NOISE

The IZT C6000 supports an accurate phase noise simulation with up to 37.5 MHz bandwidth. The user can specify a desired frequency response or mask (noise power density versus frequency).
Phase noise can be emulated at various stages of the IZT C6000, representing transmitter, receiver and satellite phase noise performance.
As an example, the phase noise profile for "DVB-S2 typical" is shown in figure 5. The total (RMS) phase modulation is adjustable during the simulation. The exceptional underlying phase noise performance of the IZT C6000 allows simulating phase noise introduced by typical payload frequency conversion stages.

Specified phase noise mask:
-25 dBc/Hz@100 Hz; -50 dBc/Hz@1 kHz; -73 dBc/Hz@10 kHz;
-93 dBc/Hz@100 kHz; -103 dBc/Hz@ 1 MHz; -114 dBc/Hz@>10 MHz

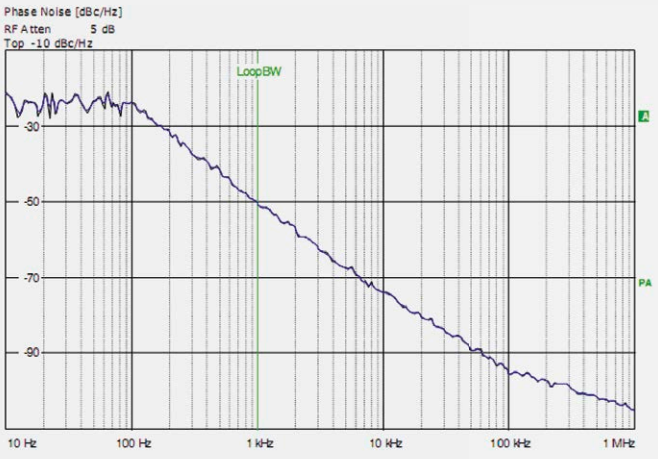

FIGURE 5: SIMULATED PHASE NOISE "DVB-S2 TYPICAL"

AUTOMATIC LEVEL CONTROL (ALC)

The IZT C6000 provides automatic level control (ALC) simulation. This is emulating the effect of additional payload noise due to the ALC loop increasing the forward payload gain to compensate for the decreased signal strength at the satellite's input for example caused by rain fade.

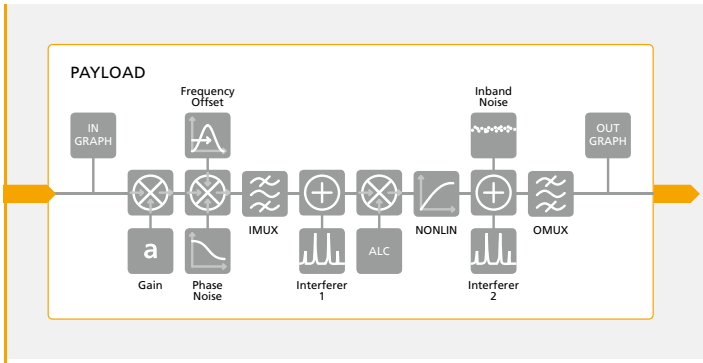

FIGURE 6: BLOCKDIAGRAM OF PAYLOAD EFFECTS

LTWTA NONLINEARITY

The IZT C6000 emulates the nonlinear response of the payload LTWTA by providing AM/AM and Phase versus IBO modeling. The user can either use any of the generic models or use his own actual measured AM/AM and Phase versus IBO data to emulate the LTWTA nonlinear response.
Real-time measurements of the signal amplitude statistics at the input and output of the nonlinearity simulation provide the user with valuable feedback about the current operating point of the nonlinearity.
The current operating point of the LTWTA is configured dynamically by setting the IBO via the Graphical User Interface.

THERMAL NOISE AND IN-BAND NOISE

Two AWGN generators provide the means to emulate thermal noise effects at the input of the payload and in-band noise to represent the LTWTA noise. The AWGN signal level is settable relative to the carrier signal level.

INTERFERENCE

Two independent interference signal generators provide the capability to add interference induced by transponder loading. The interferers can be added both before and after the LTWTA nonlinearity emulation.

OTHER EFFECTS

The IZT C6000 can emulate fixed frequency offsets representative of transponder frequency translation offsets and fixed attenuation offsets representative of static variations in payload gain.

PAYLOAD PRESET

The payload preset dialog allows the user to quickly configure the payload IMUX, OMUX, phase noise and nonlinearity based on the satellite channel in one single step.

Control Software

INTUITIVE LOCAL USER INTERFACE

IZT C6000's intuitive local Graphical User Interface allows the user to easily configure all settings and functions of the unit. The graphical user interface's (GUI) architecture is hierarchical from a top level system summary page down to subordinate pages showing system elements in increasing detail.
The GUI provides the capability to store and recall complex scenarios. A configuration database stores space segment information of multiple satellites, channels and interferers.
Status and time tagged log information provides valuable information about the IZT C6000's state of operation.

Optionally, the IZT C6000 can provide the capability to periodically backup data to a long term storage medium (NAS). Data retrieval can be specified by data type and/or time interval.

SPECTRUM DISPLAY

The spectrum display function calculates and plots the signal spectrum at various stages within the IZT C6000. This feature greatly increases the user's awareness and can even replace costly external test equipment.

NONLINEARITY DISPLAY

The IZT C6000 provides excellent guidance for the operator to configure the nonlinearity. Amplitude distribution and signal power are continuously measured at the input and output of the nonlinearity simulation. The result is then presented in the selected nonlinearity curve as output power and angle versus input power.

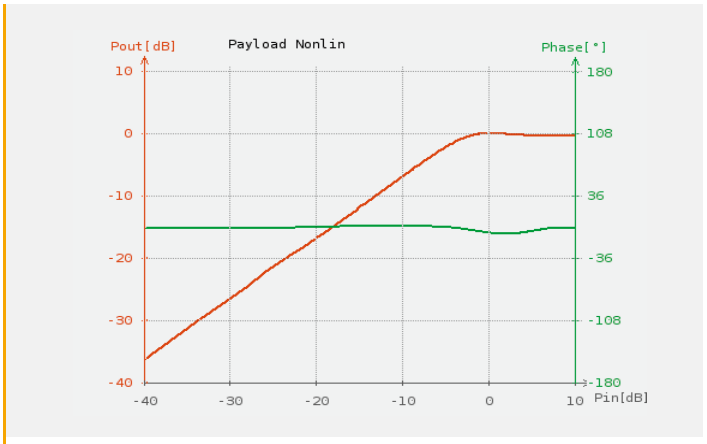

FIGURE 8: LTWTA CURVE: AM/AM AND PHASE VERSUS IBO DISTORTION

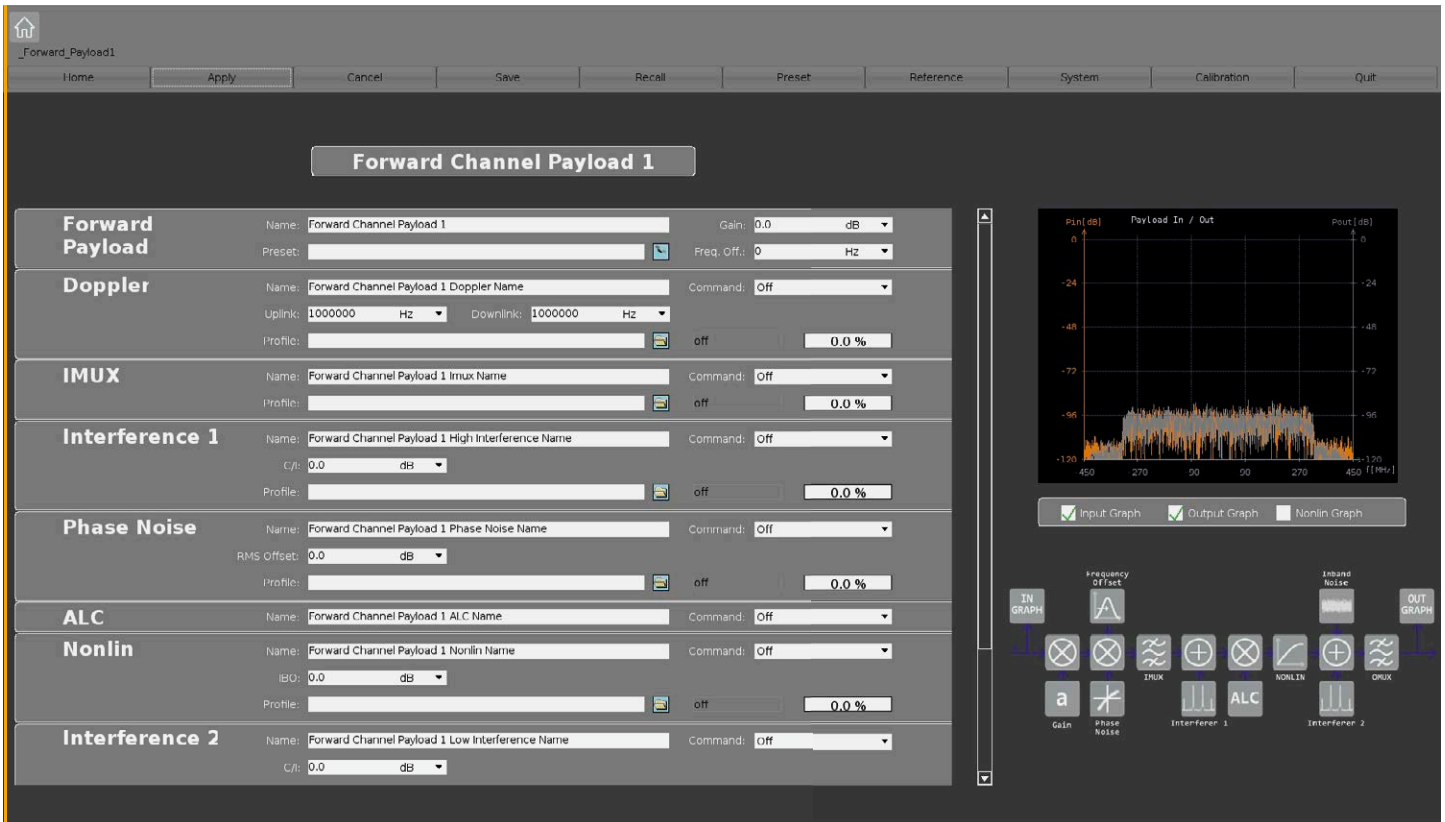

FIGURE 7: PAYLOAD CONFIGURATION

REMOTE CONTROL FUNCTIONALITY

All functions of the IZT C6000 can be controlled remotely with either SCPI or SNMP via LAN. Users of IZT Signal Generators or IZT Channel Simulators can quickly adapt their control software to the IZT C6000.

OFFLINE TOOLS

The IZT C6000 comes with helpful off-line tools intended to support the customer in generating complex simulation scenarios.

The interference generator is used by the operator to specify up to four carriers with individually, selectable modulation types (AWGN, CW, QPSK, 8PSK, 16QAM, 16APSK, or 32APSK).
Each carrier may have a different modulation type, carrier frequency and C/I ratio. The modulation type determines if the operator sets the bandwidth or symbol rate.
After specifying the interference parameters the waveform is calculated and the interference generator will signal completion of the calculation and plot the spectral waveform.
The spectral waveform plot can be used by the operator to visualize the interference waveform's spectral performance.

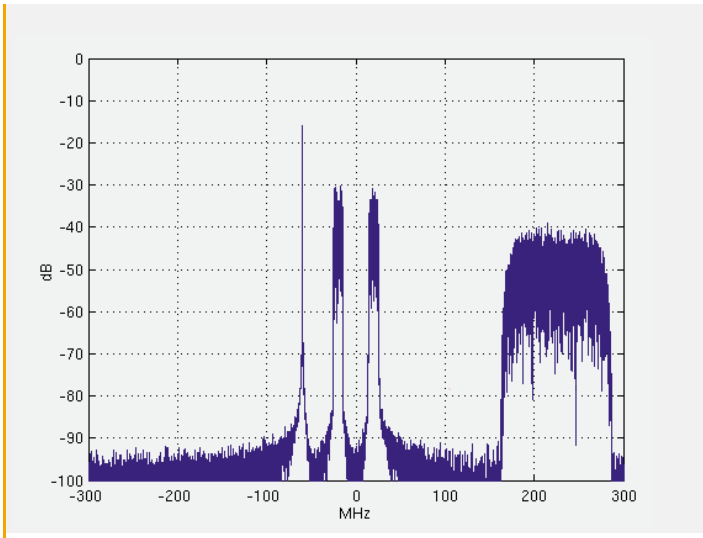

FIGURE 9: EXAMPLE OF AN INTERFERER SCENARIO

Architecture and System Scalability

Individual RF and signal processing units can be interconnected to scale the IZT C6000 to the customer specific application.

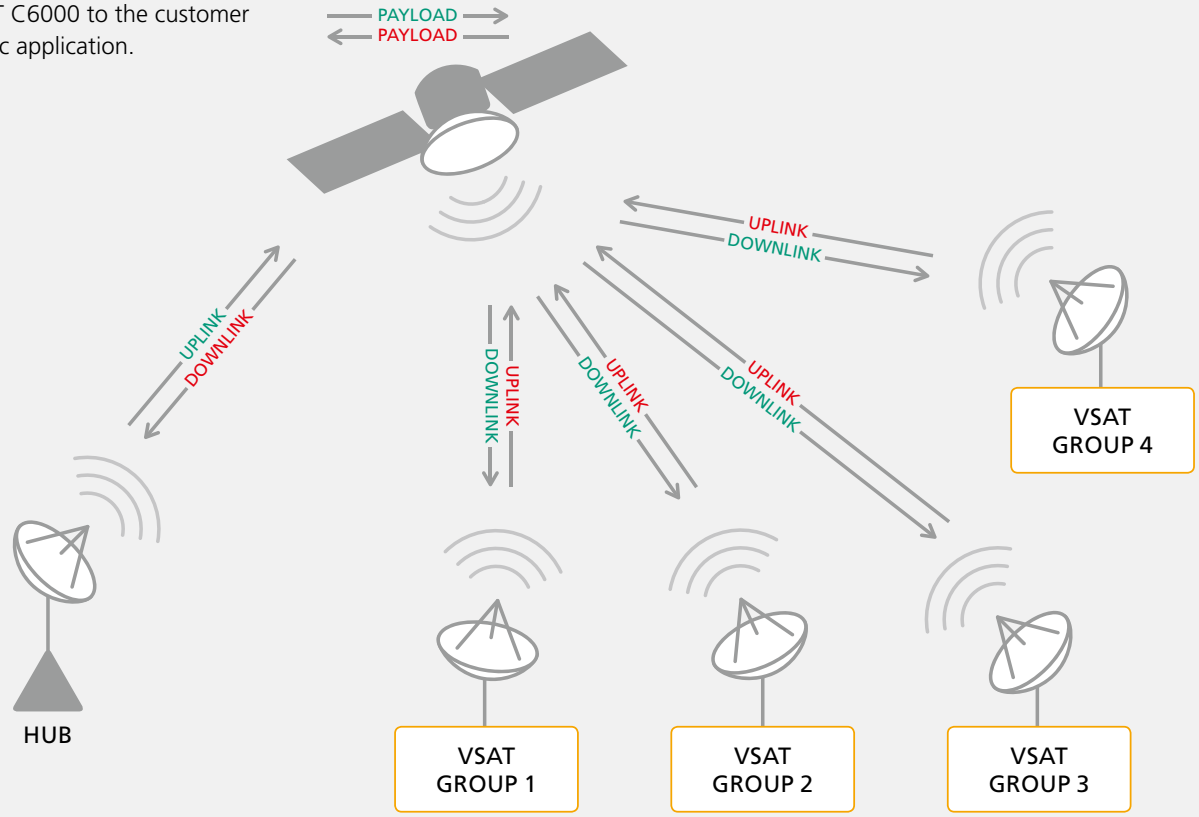

FIGURE 10: EXAMPLE BI-DIRECTIONAL SYSTEM

OPTION IZT C6000-UPL UPLINK

- Uplink unit: RF downconversion stages, A/D conversion and digital signal processing of the uplink path.
- Multiple independent uplink units can be combined to provide an aggregated signal to the payload.

OPTION IZT C6000-PLD PAYLOAD

- Payload unit: digital signal processing of payload effects.

OPTION IZT C6000-DNL DOWNLINK

- Downlink unit: digital signal processing, D/A conversion and RF upconversion of the downlink path.
- Multiple independent downlink units can be connected to the payload.

OPTION IZT C6000-CSU CENTRAL SYNCHRONIZATION UNIT

A central synchronization unit provides trigger and clock signals to all hardware units. This ensures sample synchronized data processing and coherent emulation of both forward and return paths.
The IZT C6000-CSU provides calibration for the complete IZT C6000 system, reducing required maintenance to a minimum.

OPTION IZT C6000-NAS NETWORK ATTACHED STORAGE

An optional Network Attached Storage (NAS) with 3 TB provides a long term data backup, for example for disaster recovery. All simulation relevant data such as configurations, profiles or interferer data is automatically stored on a regular basis for later retrieval.

OPTION IZT C6000-SVR SERVER

The monitor and control server hosts the Graphical User Interface, the remote control interface and configures the individual uplink, payload and downlink units.

OPTION IZT C6000-DSPL DISPLAY

An integrated high performance, 19 inch rackmount display and keyboard unit. The 17" TFT Wide LCD display provides a resolution of 1920 x 1200.

CONFIGURATION EXAMPLES

Example 1:

A basic uni-directional system can be configured by using one uplink (IZT C6000-UPL), one payload (IZT C6000-PLD) and one downlink (IZT C6000-DNL).

Example 2:

A bi-directional system with one hub, one payload and four independent VSAT terminal groups is emulated by using five uplink units (IZT C6000-UPL), two payload units (IZT C6000-PLD) and five downlink units (IZT C6000-DNL) as shown in figure 10.

FIGURE 11:
RACK INSTALLATION CONSISTING OF 11x UPLINKS, 12x DOWNLINKS AND 3x PAYLOADS

Specifications IZT C6000

Effects	
Delay range	10 µs to 800 ms
Delay resolution	1 ns
Delay accuracy	1 ns
Doppler shift range	±1 MHz (phase continuous)
Doppler shift resolution	1 Hz
Doppler shift accuracy	0.1 Hz
Doppler shift change rate	100 updates/s
Fixed frequency offset range	±1 MHz
Fixed frequency offset resolution	1 Hz
Fixed frequency offset accuracy	< 0.1 Hz
Fading attenuation range	70 dB
Fading attenuation resolution	0.1 dB
Fading attenuation accuracy	< 0.1 dB
Fading attenuation change rate	1000 updates/s
Fixed attenuation range	-10 to +10 dB
Fixed attenuation resolution	0.1 dB
Interferer type	CW, AWGN, QPSK, 8PSK, 16QAM, 16APSK, 32APSK (up to four interferers simultaneously)
Interferer bandwidth	Variable
Interferer center frequency	Variable within the 600 MHz system bandwidth
Interferer signal level	Adjustable relative to input carrier signal level (C/I)
Interferer accuracy	< ±0.5 dB from commanded level
Thermal noise signal level	Adjustable relative to input carrier signal level (C/N0)
Thermal noise resolution	0.1 dB
Thermal noise accuracy	< ±0.5 dB/Hz from commanded level
Phase noise	Emulates filter responses
Phase noise accuracy	< ±0.5 dB from commanded filter response
Linear filter distortion (IMUX, OMUX)	Up to 1024 complex FIR coefficients
Linear filter distortion amplitude accuracy	< ±0.5 dB amplitude ripple error
Linear filter distortion group delay accuracy	< 1 ns group delay error
Nonlinearity AM/AM distortion versus IBO	< ±0.1 dB
Nonlinearity phase distortion versus IBO	< ±0.5°
Nonlinearity dynamic range	60 dB

Ordering Guide

RF performance	
RF input frequency range	450 MHz or 1250 MHz IF (RF frequencies on request)
RF output frequency range	450 MHz or 1250 MHz IF (RF frequencies on request)
Amplitude response	< ±0.5 dB, typical
Group delay	< ±1 ns, typical
Bandwidth	600 MHz
RF input level	+10 dBm, max
RF output level	+10 dBm, max
Input VSWR	< 1.2 : 1
Output VSWR	< 1.2 : 1
Impedance	50 Ω

RF environmental	
Nominal operating temperature	18°C to 25°C
Max operating temperature	0°C to 40°C
Storage temperature	-10°C to +60°C
Humidity	10% to 90%, non condensing
Altitude	1000 m, AMSL
Power supply	100 V to 240 V (AC), 50 Hz to 60 Hz

IZT C6000 Hardware options	
IZT C6000-PLD	Payload emulation unit
IZT C6000-UPL	Uplink emulation unit
IZT C6000-DNL	Downlink emulation unit
IZT C6000-SVR	Monitor and control server, switch
IZT C6000-DSPL	Keyboard and display, 19 inch rackmount
IZT C6000-NAS	3 TB network attached storage for data backup
IZT C6000-CSU	Central synchronization unit

IZT C6000 Software options	
IZT C6000-101	Delay
IZT C6000-104P	IMUX/OMUX filter, payload
IZT C6000-106P	True Doppler simulation, up/downlink
IZT C6000-107U	Thermal noise, uplink
IZT C6000-107P	In-band noise, payload
IZT C6000-107D	Thermal noise, downlink
IZT C6000-109U	Phase noise simulation, uplink
IZT C6000-109P	Phase noise simulation, payload
IZT C6000-109D	Phase noise simulation, downlink
IZT C6000-110P	Nonlinearity simulation, payload
IZT C6000-111U	Rain fade (attenuation profiles), uplink
IZT C6000-111D	Rain fade (attenuation profiles), downlink
IZT C6000-112U	ARB incl interferer generator, uplink
IZT C6000-112P	ARB incl interferer generator, payload
IZT C6000-112D	ARB incl interferer generator, downlink
IZT C6000-114	Spectrum display

IZT C6000
RF Link Emulator

STUMPF.POOL-X.DE REV.3.0 08/2016

About IZT The Innovationszentrum fuer Telekommunikationstechnik GmbH IZT specializes in the most advanced digital signal processing and field programmable gate array (FPGA) designs in combination with high frequency and microwave technology.

The product portfolio includes equipment for signal generation, receivers for signal monitoring and recording, transmitters for digital broadcast, digital radio systems, and channel simulators. IZT offers powerful platforms and customized solutions for high signal bandwidth and real-time signal processing applications. The product and project business is managed from the principal office located in Erlangen/Germany. IZT distributes its products worldwide together with its international strategic partners.The IZT quality management system is ISO 9001:2000 certified.

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