IZT COMINT and DF Simulator

Real-Time RF Environment
Simulation System

Innovationszentrum Telekommunikations-
technik GmbH

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The IZT COMINT Simulator is a unique digital signal source platform for simulating time variant, complex and realistic RF signals. It can be efficiently employed whenever multiple and accurately synchronized RF test signals are required.

It stores and replays artificial and real world signals as elements of a complex, time-variant RF environment simulation.

The IZT COMINT Simulator is intended for test and validation of COMINT and DF systems as well as operator training.

Development and test of COMINT receive systems together with subsequent operator training require a repeatable and well controlled representation of the realistic RF environment in which the system will have to operate in.
If the COMINT system has a DF component, multiple receive inputs have to be fed. For this application the COMINT Simulator provides:

- a very large number of emissions at an excellent signal quality
- stationary and moving emitters in different positions relative to the COMINT system under test
- emissions with realistic content
- simulation of receive antenna patterns

Overview

The IZT COMINT Simulator assumes the place of the receive antenna and its output signals are directly fed into the receive inputs of the COMINT system. In the control software of the COMINT Simulator the user defines time variant "scenarios":

- type and content of the emissions
- power
- distance
- relative bearing between receive antenna and each emitter.

The emissions are simulated as if they were received from the actual antenna system of the COMINT receiver. Phase, amplitude and delay of each individual emission are time variant and matched to the current receive scenario.

Each element of the virtual receive antenna is described by means of a complex gain and delay function of azimuth, elevation and frequency.

The COMINT or DF system can then be operated freely within its frequency range as if it were in a real world scenario.

Operator Training

The IZT COMINT Simulator is a cost effective platform that facilitates the training of military Signal Intelligence (SIGINT) personnel in Communications Intelligence (COMINT) related disciplines.

The realistic representation of today's radio frequency spectrum combined with the possibility to simulate up to fourteen receive antennas makes it possible to replicate the use of expensive naval, airborne or ground equipment when training operators.

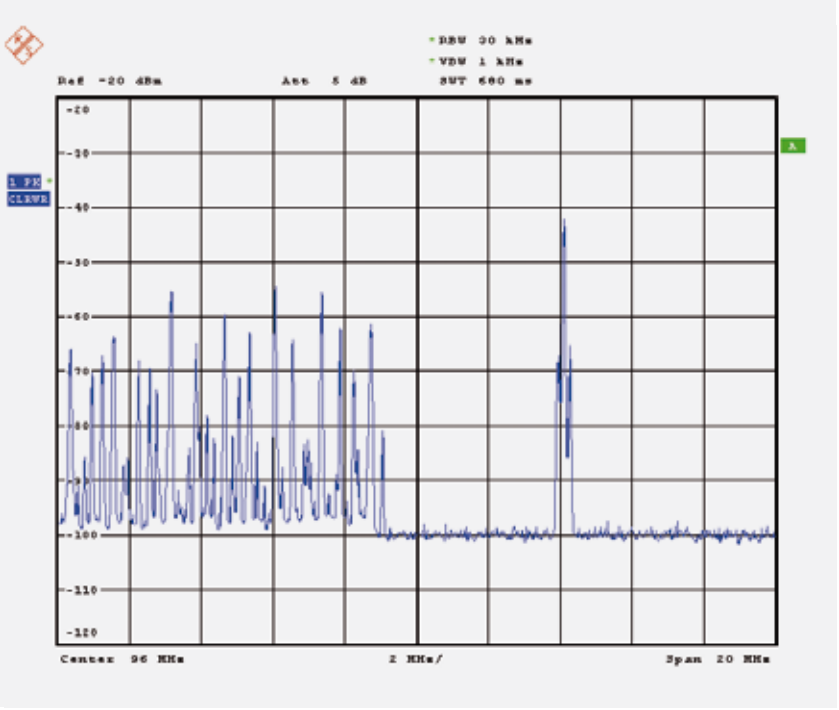

figure 1: Synthesizing a 120 MHz wide spectrum with the IZT S5000

System Verification and Validation

The IZT COMINT Simulator is the ideal means when it comes to generating reproducible complex real world scenarios. Covering the bandwidth of 20 MHz to 3 GHz in standard configuration it is able to generate thousands of emitters on up to fourteen synchronized antenna outputs.

It is the perfect instrument to develop modern digital wideband sensors, direction finders and jammers.

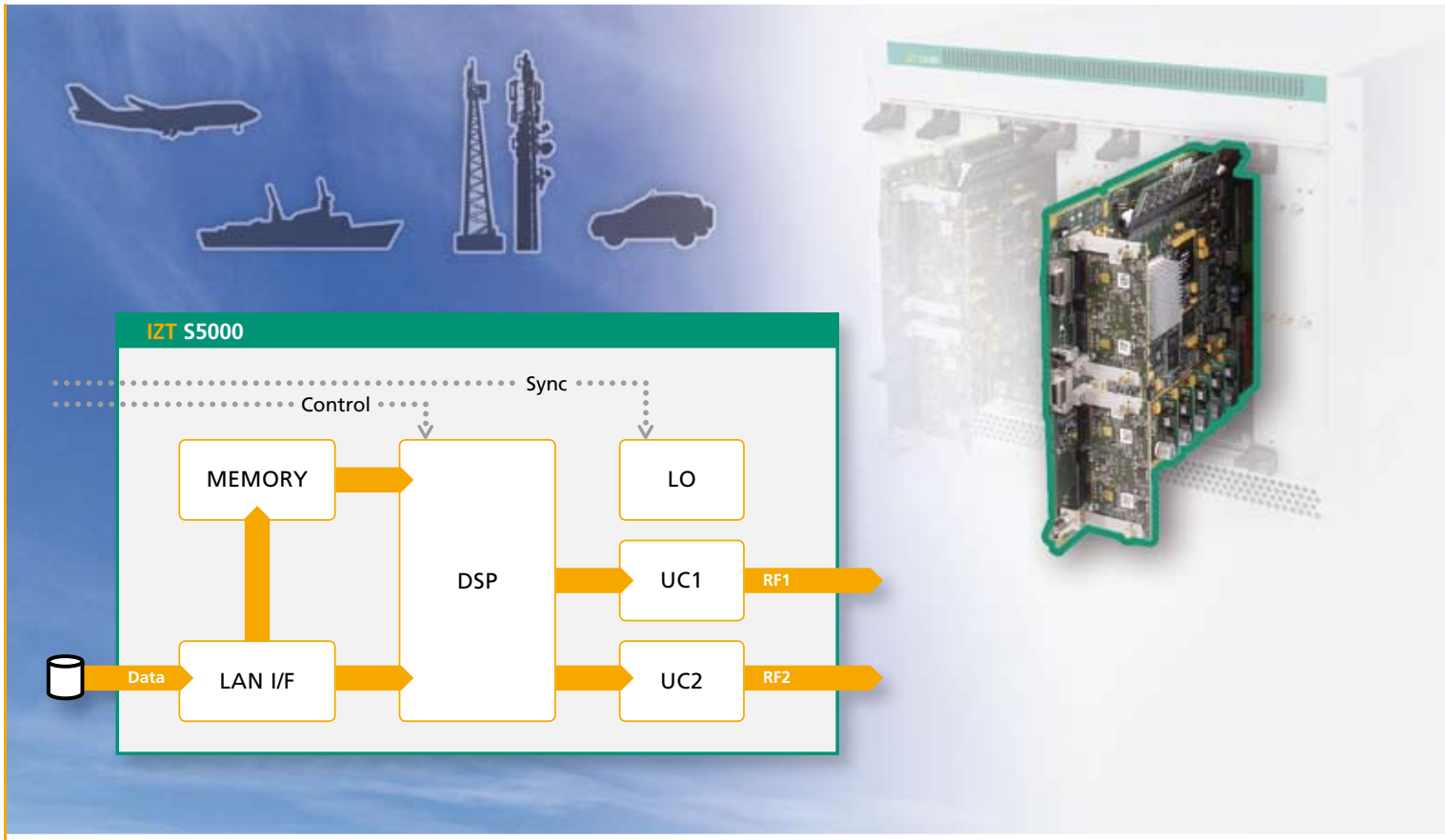

figure 2: IZT S5000 signal generator, simplified representation of single slot

Scalability

The IZT COMINT Stimulator is a flexible and scalable system based on the IZT S5000 signal generator. With 120 MHz of instantaneous bandwidth and up to fourteen RF outputs a single IZT S5000 provides the basis for COMINT environment simulations.

Multiple IZT S5000 generators can be combined for instantaneous coverage of more than 120 MHz bandwidth. In its full configuration, the COMINT Simulator comprises twenty-six IZT S5000 signal generators to continuously cover the frequency range from 20 MHz to 3000 MHz and generates several thousand emissions available on up to fourteen synchronized antenna outputs.

An IZT S5000 generator can be assembled with up to seven signal processing cards referred to as DSV2. The DSV2 card is the core of the IZT S5000.

figure 3:
IZT S5000 in a large installation for COMINT stimulation

It contains powerful FPGA based signal processing, RF or IQ-output modules and can generate two synchronized RF outputs.

Unlike standard arbitrary waveform generators, the IZT S5000 offers proprietary and highly efficient signal processing. This patented technology allows the generation of a large number of independent channels ("emitters") in real time. Their relative delay, frequency and amplitude can be varied seamlessly in real time. On a single card up to 127 individual signals can be processed with a cumulative bandwidth of up to 250 MHz.

The IZT S5000 accurately sets power, delay, phase and frequency of each emitter in real time based on external control data. The IZT S5000 can be synchronized in time and phase from a central clock source. This includes all local oscillator signals allowing phase stable operation.

Emitter

The RF signals are stored in a scalable file system as I/Q data sampled at the minimum required data rate. This allows for many hours of continuous content to be stored and streamed in real-time.

The emitter data is streamed from servers via GBit LAN or stored in 4 GByte on-board memory.

For emissions streamed directly from the data servers, a total data rate of up to 200 MByte/sec is supported which is sufficient for a total signal bandwidth up to 50 MHz.

With storage space of one terabyte, signals would loop only once per hour on average. The remaining bandwidth can be filled with up to four gigabytes of emission data stored in the RAM.

The following table shows possible emitter bandwidths and their data source

emitter bandwidth	source
16 MHz	DDRRAM
8 MHz	DDRRAM / Streaming
4 MHz	DDRRAM / Streaming
2 MHz	DDRRAM / Streaming
1 MHz	DDRRAM / Streaming
500 kHz	DDRRAM / Streaming
250 kHz	DDRRAM / Streaming
125 kHz	DDRRAM / Streaming
62.5 kHz	DDRRAM / Streaming
31.25 kHz	DDRRAM / Streaming
15.625 kHz	DDRRAM / Streaming

Antenna Simulation

The COMINT Stimulator has the capability to apply antenna patterns to any emitter generated. These antenna patterns replace the necessity of receiver antennas and complex field test setups when using antenna-related sensors, like in a direction finder system.

The antenna simulation performs scenario dependent variation of gain and delay with respect to azimuth, elevation, frequency and polarization.

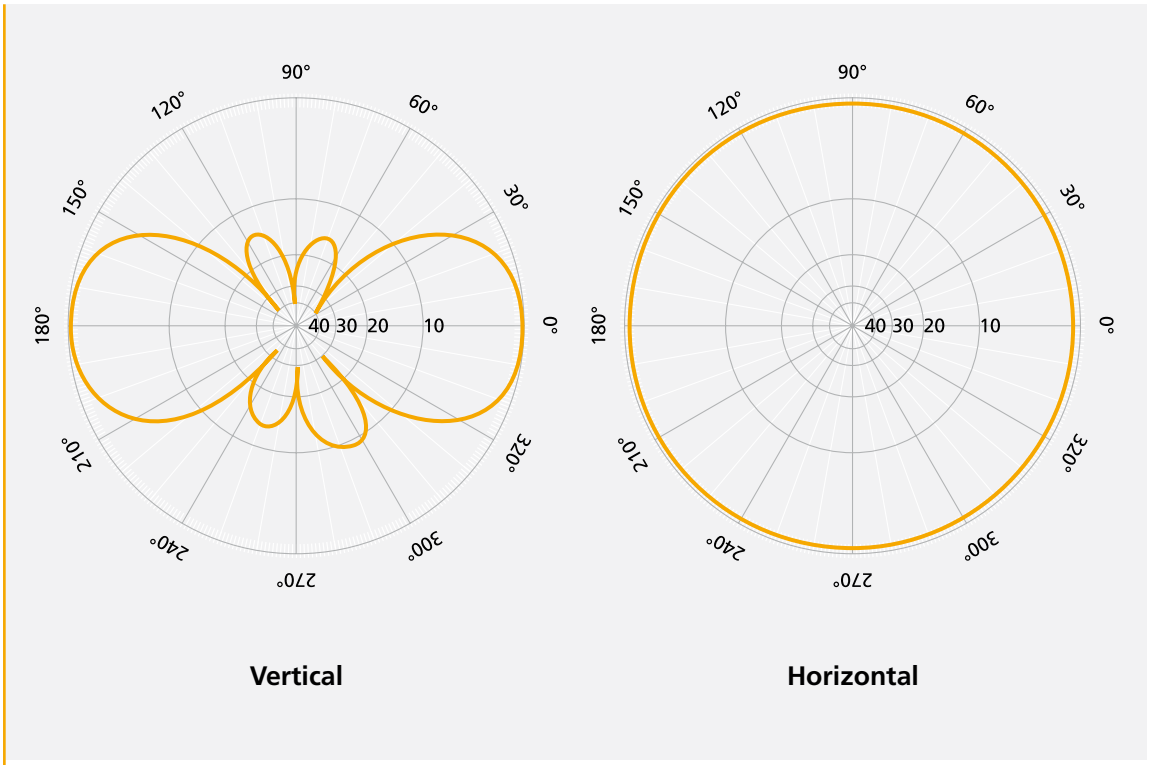

figure 4: Simulated example antenna pattern of omnidirectional antenna

Specifications		
Frequency	Range	20 MHz to 3 GHz
	Resolution	1 Hz
	Accuracy	≤ 1 x 10-7
	Input for external reference	10 MHz, 50 Ω
Level	Output signal level	-120 dBm to -25 dBm
	Level resolution	0.1 dB
	Level uncertainty	< 1 dB
	Relative uncertainty between antenna outputs	< 0.5 dB
	Phase uncertainty between antenna outputs	≤ 3°

Spectral Purity	Harmonic spurious	< -40 dBc
	Non-harmonic spurious	< -70 dBc at full scale
	Dynamic range	> 70 dB
Emitter	Single emitter bandwidth	16 MHz (DDR RAM only)
		8 MHz, 4 MHz, 2 MHz, 1 MHz, 500 kHz, 250 kHz, 125 kHz, 62.5 kHz, 31.25 kHz, 15.625 kHz (all continuous streaming from LAN and DDR RAM)
	Maximum number of active emitters	3302
	Maximum number of administrable emitters	100 000
	Maximum number of active emitters within 120 MHz bandwidth	127
	Maximum number of administrable emitters within 120 MHz bandwidth	5 000
	Emitter storage system	up to 26 data servers each with: 1 Terabyte RAID 5 6 removable hard disks
Emitter Streaming	Real time streaming from external server	up to 50 MByte/sec per 120 MHz bandwidth
	Real time streaming from internal DDR RAM	up to 1080 MByte/sec per 120 MHz bandwidth
Simulation of Antenna Types	Antenna array	Matrix containing attenuation and delay with respect to azimuth, elevation and frequency
	Omni-directional antenna	Attenuation and delay with respect to azimuth, elevation, frequency and polarisation
	Spinning antenna	Attenuation and delay with respect to azimuth, elevation, frequency and polarization
	Antenna parameter resolution	attenuation: 0.1 dB
		delay: 0.1 ps
		azimuth: 0.5°
		elevation: 0.5°
		frequency: 10 MHz
Inputs / Outputs	RF output	up to 14 RF outputs, N-female, 50 Ω
	External reference input	10 MHz, 50 Ω
		Trigger Input
		1PPS Input
	External reference output	10 MHz, 50 Ω
	Control interface	Gigabit LAN
General Data	Operating temperature range	+15 °C to +30 °C
	Operating temperature range for full compliance with signal specifications	+22 °C +/- 2 °C
	Storage temperature range	-10 °C to +55 °C
	Humidity	20% to 75%, non condensing
	EMC	EN 55022, lower emissions optional
	Mechanical	dependent on configuration
	Power supply	dependent on configuration

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REV.1.0 03/2010 DESIGN@POOL-X.DE

Ordering Guide

Hardware options	**IZT S5000-FRAME**	Framework for one IZT S5000: Chassis with room for seven DSV2 cards, clock generation, supporting IT and GUI-Software.
	IZT S5000-DSV2	Signal Processor Card: Signal Processor Card with dual upconverters. Generates two channels (up to seven DSV2 per chassis); supports a single emitter.
	IZT S5000-CPLR	Signal Coupler: Combines up to four S5000 systems. 56-port to 14-port with harmonic filters.
	IZT S5000-CAL	Calibration Kit: Calibration coupler and receiver necessary to align amplitude and phase of the emitters.
Software options	**IZT S5000-100**	Four Emitters: Enables one S5000-DSV2 for four emitters
	IZT S5000-110	Increase to 31 Emitters: Increases the number from four to 31
	IZT S5000-120	Increase to 127 Emitters: Increases the number from 31 to 127
Service	**IZT S5000-WE2**	Warranty Extension to 2 Years
	IZT S5000-WE3	Warranty Extension to 3 Years

Example Configurations

	Very small system	**Small system**	**Large system**	**Very large system**
	1x IZT S5000	2x IZT S5000	10x IZT S5000	26x IZT S5000
	120 MHz bandwidth	240 MHz bandwidth	1200 MHz bandwidth	3120 MHz bandwidth
	2 RF channels	5 RF channels	12 RF channels	14 RF channels
	4 emitters	31 emitters	127 emitters	127 emitters
IZT S5000-FRAME	1	2	10	26
IZT S5000-DSV2	2	6	60	182
IZT S5000-CPLR		1	4	10
IZT S5000-CAL	1	1	1	1
IZT S5000-100	1	6	60	182
IZT S5000-110		6	60	182
IZT S5000-120			60	182

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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 customers are civil companies, governmental agencies and armed forces.

The IZT quality management system is ISO 9001:2000 certified.