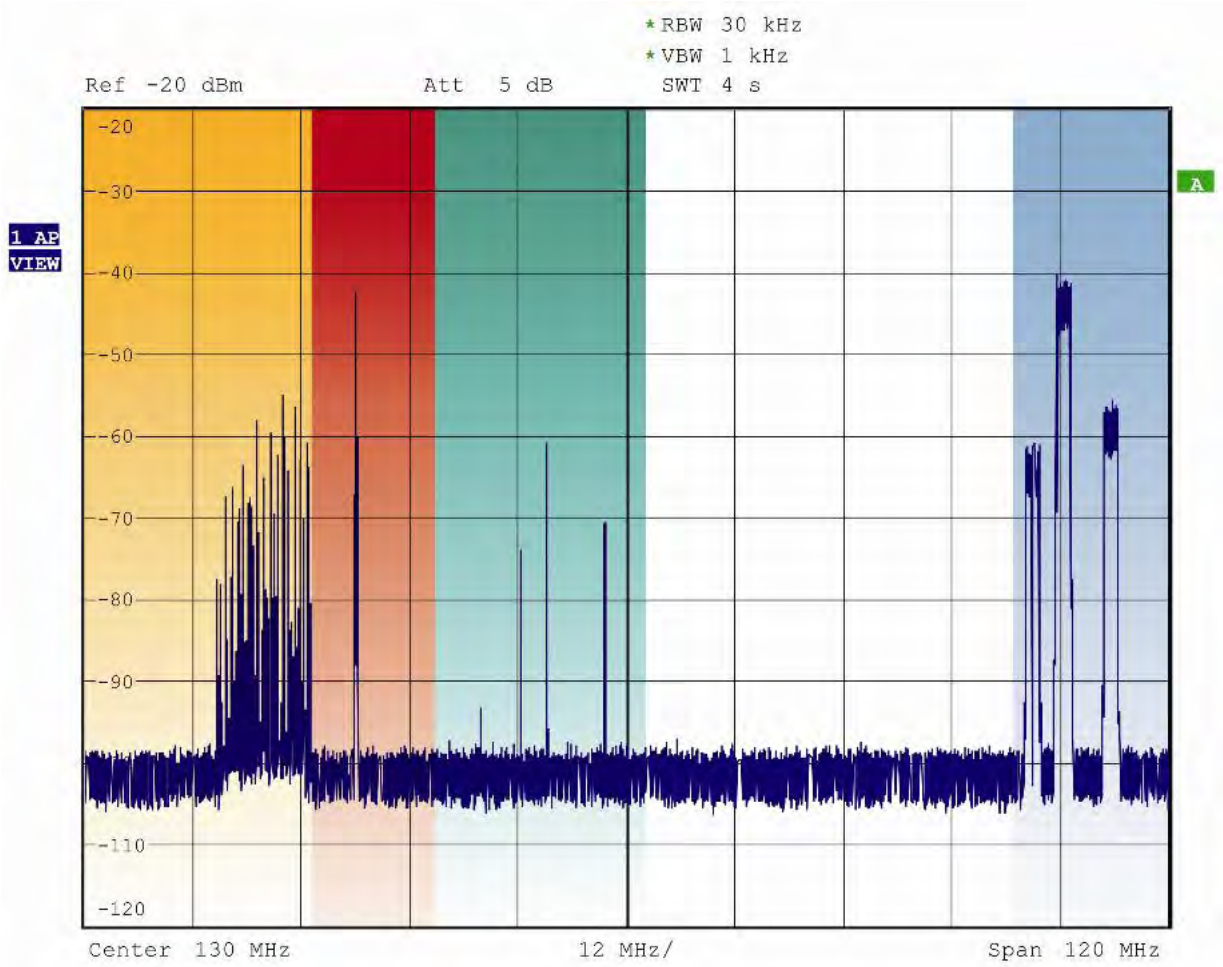


IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	



IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

1. Introduction

The S1000 with its revolutionary architecture and IZT's patented signal processing algorithm enables the user to consolidate multiple conventional RF generators into one compact, cost effective, easy-to-use and most flexible RF test source.

Modern radio receivers no longer gather information from a single modulated carrier, but often from multiple sources simultaneously: more than one antenna, multiple independent carriers and even signals of different modulation formats.

To achieve acceptable test coverage, a shelf full of costly RF generators is necessary. The S1000 combines the required functionality into a single piece of test equipment. (figure 1).

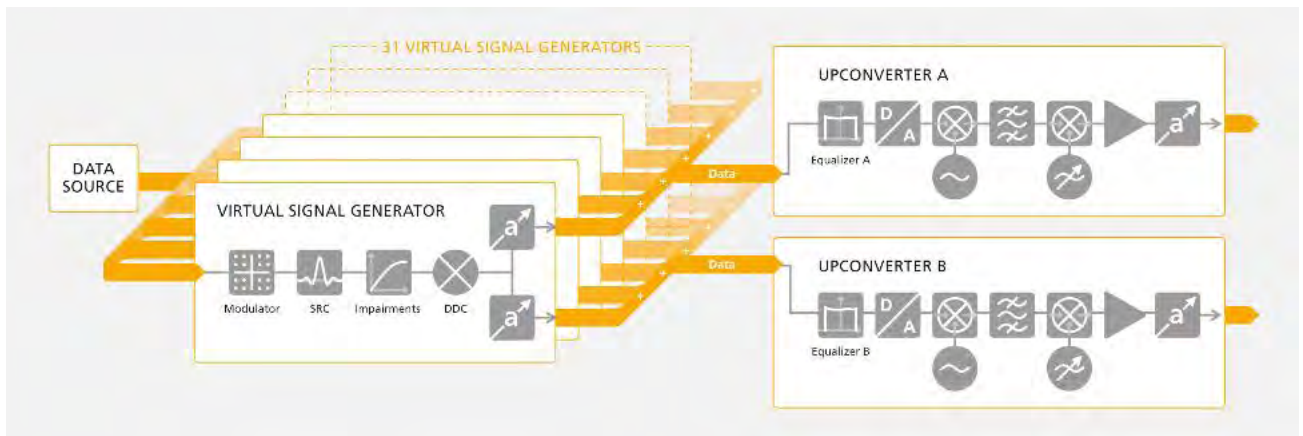


figure 1: IZT S1000 Concept

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

2. Multichannel ARB operation

The S1000 generates a composite signal out of a maximum of 31 virtual signal generators (VSG, channels) in two 120 MHz wide blocks anywhere in the frequency range up to 3 GHz.

For each virtual signal generator, the user can assign:

- § content
- § real-time modulation or plain I/Q data for ARB channels
- § interpolation rate
- § launch delay
- § profiles
- § impairments
- § center frequency
- § RF power

The S1000 can be configured with up to 31 virtual signal generators (VSG) with a total sampling rate of 320 MSps corresponding to a total signal bandwidth of ~260MHz. These 31 VSGs work simultaneously.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

3. Hardware

3.1. Front Panel

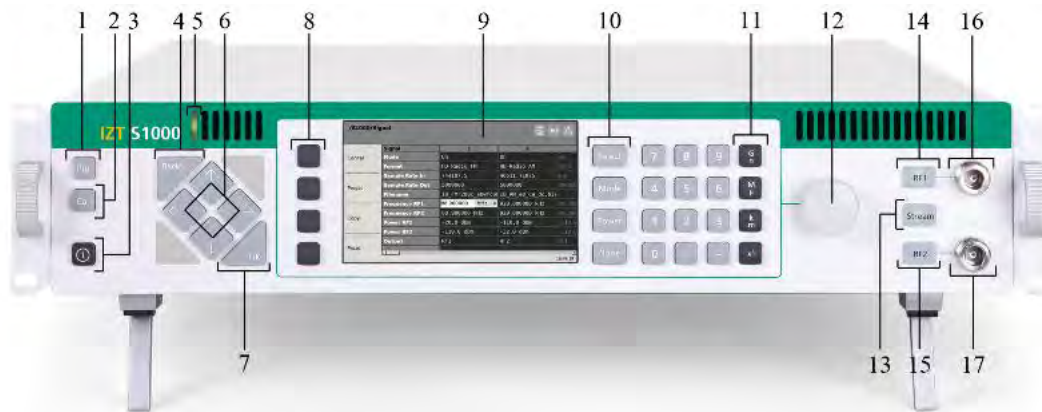


figure 2: IZT S1000 Frontpanel

- | | |
|--|---|
| <ul style="list-style-type: none"> [1] Preset / Save / Recall [2] Autocalibration [3] Power On/Off [4] Back [5] Status LED [6] Navigation Keys [7] Ok / Enter Key [8] Softkeys – Function changing in different views [9] Display | <ul style="list-style-type: none"> [10] Special Keys:
Select / Mode /
Power / Noise [11] Unit Keys [12] Jog Dial [13] Stream Start /
Stop [14] RF1 On/Off [15] RF2 On/Off [16] RF1 Connector [17] RF2 Connector |
|--|---|

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

3.2. Rear Panel



figure 3: IZT S1000 rear panel

- | | |
|---|---|
| [1] 10MHz REF IN/OUT | [11] Power connection
100-240V AC |
| [2] Digital Clock IN/OUT | [12] Power Switch |
| [3] Trigger Input | [13] Serial Number |
| [4] Local Oscillator
Distribution (Optional) | [14] GPIB Connection |
| [5] IQ Connections
(Optional) | [15] VGA Connection |
| [6] Local Oscillator
Distribution
part2(Optional) | [16] Digital controllable
and monitorable
Outputs and Inputs,
variable DC output |
| [7] ASI inputs (Optional) | [17] RS232 |
| [8] IQ Connections
(Optional) | [18] USB2.0 |
| [9] Synchronisation input
PPS | [19] High Speed LAN2 |
| [10] ESATA Connection
(Optional) | [20] High Speed LAN1 |
| | [21] LAN Connection for
Remote Interface
and Server |

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

3.3. Analog Processing

3.3.1. *RF Outputs*

The S1000 can be equipped with single or dual RF outputs. Each output has an instantaneous bandwidth of up to 120 MHz and can be set to any center frequency up to 3000 MHz.

If the S1000 is equipped with dual synthesizers, the center frequencies can be chosen independently. If fully coherent operation is required, one of the two synthesizers drives both RF outputs.

3.3.2. *Synchronization*

The S1000 is a fully synchronous design. All digital and analog oscillators and time bases are derived from a common clock source.

Using optional clock distribution equipment, multiple S1000 can be combined to a fully phase coherent source with eight or more RF outputs.

3.4. Digital Processing Stages

A VSG can contain the following stages from a common resource pool.

3.4.1. *Real-time Modulator*

At present, the S1000 contains FPGA code for generation of up to nine downlinks signals of SiriusXM, a civilian hybrid satellite broadcasting system at S-Band.

3.4.2. *Variable Interpolation*

A continuously variable sample rate converter adapts any user selected sample rate between 5 ksp/s and 40 MSps of the I/Q data to the fixed sample rate required by the Processing Unit (5/10/20/40 MSps).

The maximum signal bandwidth utilization is 0.86 times the complex sample rate of the IQ data entering the variable interpolation stage.

3.4.3. *Profiles*

Center frequency, power and delay of each VSG can be continuously altered by so-called profiles which are defined by the user or generated by offline software tools.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

3.4.3.1 Delay Profile

The continuously variable (launch) delay of a VSG simulates variable (line-of-sight) distance between transmitter and receiver in a mobile environment or a moving path in a fading channel situation.

The maximum update rate is 156.250 kHz.

The delay profile is also heavily used in the simulation of receive antenna patterns.

3.4.3.2 Frequency Profile

The center frequency of each VSG can be continuously changed within the 120MHz instantaneous bandwidth of the S1000. Minimum time resolution is 25 microseconds. This so-called Frequency Profile is used for simulation of time-variant Doppler shift. It is also extremely effective for generating frequency hopping signals with large spreads from a narrow band IQ-file.

3.4.3.3 Level Profile.

The power level of every VSG can also be continuously changed. Minimum time resolution is 25 microseconds. This feature is useful for simulating time-variant loss on the propagation path.

In a hopper simulation it is used for muting the transmit signal while the hopper is moving to a new frequency.

3.4.3.4 Complex Gain

Each VSG can be multiplied with a complex gain factor as part of a fading channel simulation.

3.4.4. Impairments

For a subset of VSGs additional powerful impairment simulations are available.

3.4.4.1 Amplifier Nonlinearity

Amplifier Nonlinearity is an important feature for realistic simulation of OFDM transmitters, satellite downlinks and pulsed systems, where nonlinear amplifiers are subject to complex waveforms.

For simulation of the transmitter power amplifier AM/AM and AM/PM conversion, four look-up tables with 1k complex entries are provided. Each VSG can be assigned to one of the tables with individually settable input back-off.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

3.4.4.2 Output Filter Simulation

Each VSG can be sent through its individual 10 pole IIR filter. This simulates the narrow bandpass filter usually placed at the output of a high power transmitter.

3.4.5. Additive Noise

A single common white Gaussian noise source is available, providing adjustable, frequency independent noise density from -174 dBm/Hz to -70 dBm/Hz on either RF1 or RF2 over the full 120 MHz bandwidth.

The user can set a lower bandwidth and select an appropriate center frequency for the AWGN.

For the simulation of scenarios where the noise power density is not constant, the S1000 can produce a wide variety of shaped noise, controlled by a user-supplied description file

3.4.6. Processing Unit

Final stage is the Processing Unit, It performs final interpolation to 160 MSps and digital mixing to the final center frequency assigned to the VSG. The result can be routed to only RF1, only RF2 or both outputs at different levels. Understanding the resources available in the Processing Unit is important for assessing the feasibility of a certain simulation scenario on the S1000.

The S1000 signal processing is organized in processing units (PUs). There are 8 PUs which can handle up to 40 MSps each. Each of the 8 PUs can be organized in 40 MSps, 2 x 20 MSps, 4 x 10 MSps or 8 x 5MSps. This results in a maximum number of 64 possible sub-processing units (SPUs). Each SPU can be assigned to an available VSG or to a channel simulator path. The following figures show three possible configurations. This will clarify how many SPUs are available. For the sake of clarity only 4 of 8 available PUs are illustrated in the examples.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

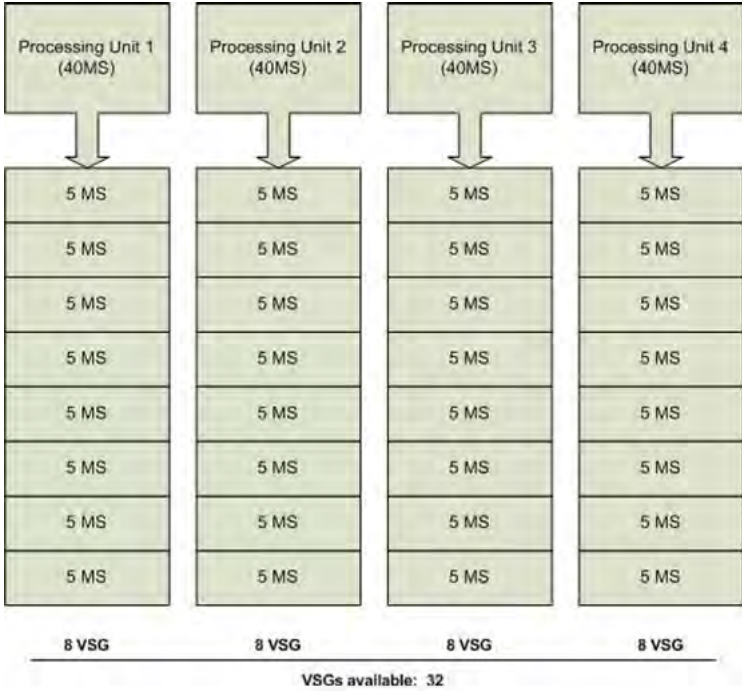


figure 4: SPU Combination of 32 x 5MSps

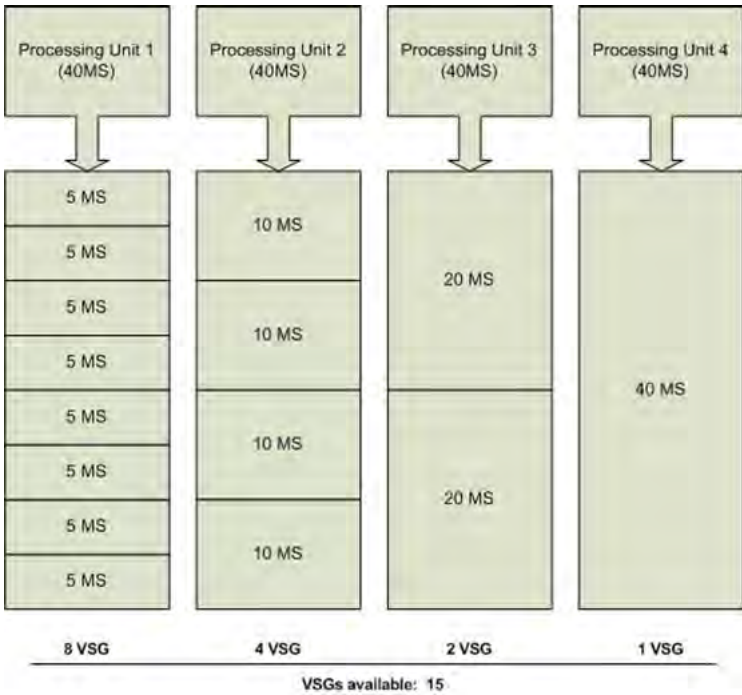


figure 5: SPU Combination of 8 x 5 MSps, 4 x 10 MSps, 2 x 20 MSps, 1 x 40 MSps

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

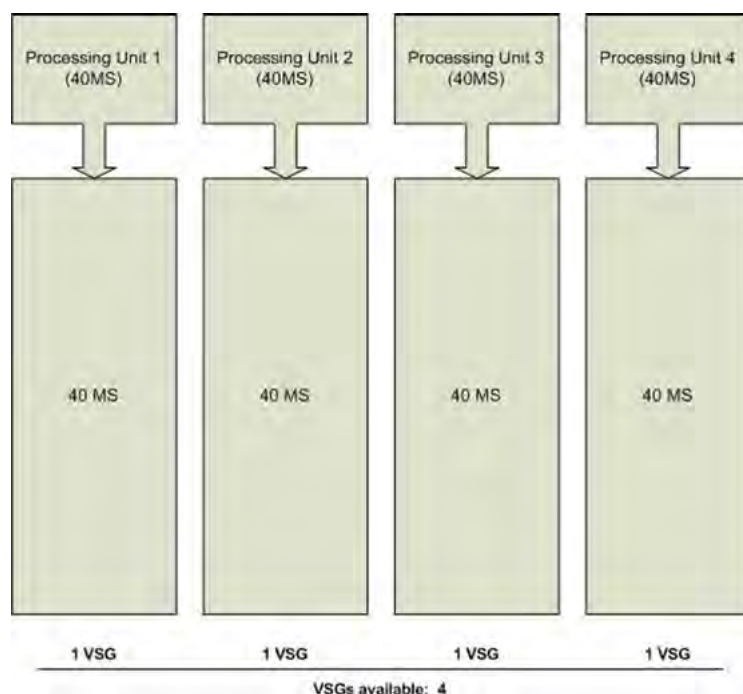


figure 6: SPU Combination of 4 x 40MSps

3.4.7. Data Sources

Signals going into the VSGs can be taken from any combination of three data sources.

3.4.8. Internal RAM

The S1000 has 4 or 8 GBytes of internal memory available for storing IQ-data for the VSGs. The assignment is completely flexible, i.e. very short test signals for one VSG can be combined with long test signals for another VSG. The memory depths below refer to samples before interpolation, which is important when comparing the S1000 with a conventional ARB.

If the S1000 is equipped with a 4 Gbyte Module the available memory for one VSG can be as large as 875.000.000 IQ samples.

If the unit is equipped with a 8Gbyte Module the available memory for one VSG can be as large as 1.750.000.000 IQ samples

The internal RAM is loaded either by the built-in controller from internal or external HDD or by an external server before the signal generation is started.

3.4.9. Streaming operation

The S1000 accepts continuously streamed signals from the internal harddrive or from and external server via dual Gbit LAN.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

Up to 10 MB/sec can be streamed directly from the internal harddisk or an external drive connected via ESATA, in cases where no sensitive data is supposed to remain on the device.

The S1000 is capable of receiving over 200 MBytes/sec. of data from dual GBit LAN (HSL) going directly to the FPGA.

Using the high performance P1100/P1200/P1300 server platform allows streaming of IQ Data with up to 2x24 MSPS Data which equals to 2x20.5 MHz real-time bandwidth.

Typically, the streamed signals are generated by a RF recorder like the IZT R3301. In this case, the S1000 can be set to follow the AGC settings of the R3301 recorder.

figure 7 shows a setup for playing two diversity signals with a maximum bandwidth of 120MHz. The setup can be expanded to a system with up to four or more diversity channels by combining multiple external synchronized IZT S1000 signal generators.

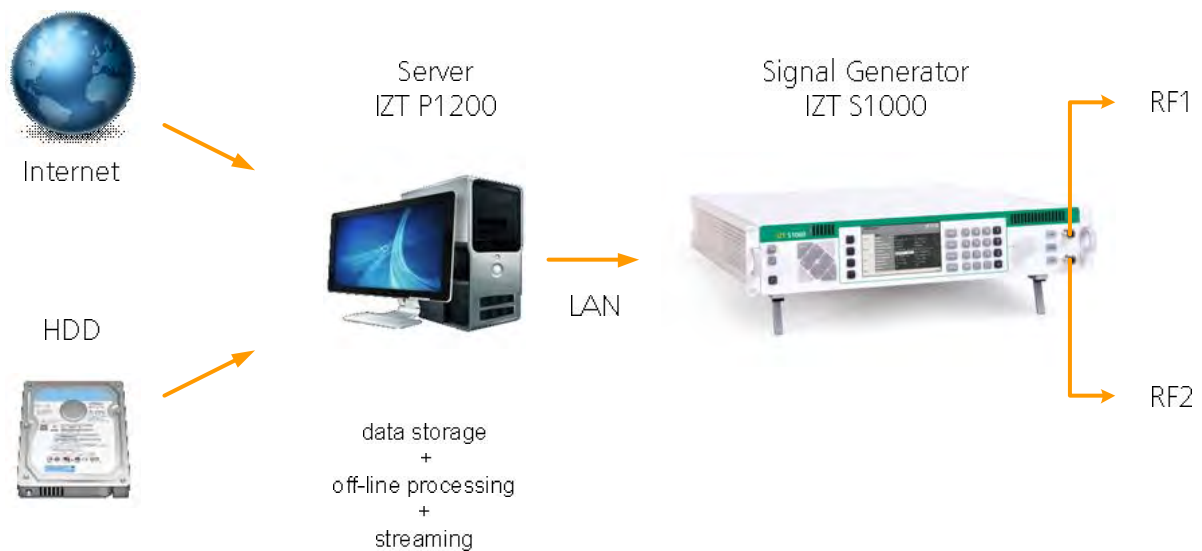


figure 7: Player for diversity signals, using a single IZT S1000 with two rf outputs

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

4. External Tools

For the different markets, IZT is offering different tools for generating test files and controlling the S1000.

4.1. Analog Modulation and Broadcast

The offline IZT IQ Generator Toolbox generates test files for all major broadcast standards:

- § FM-RDS
- § AM
- § DAB / DAB+
- § DVB-T
- § DMB
- § DRM/ DRM+
- § HDRadio

Input data can be a full multiplex or raw content material.

4.2. Real-time Modulation

Real-time modulation has been implemented for SiriusXM Satellite Radio, generating six QPSK and two COFDM modulated signal simultaneously.

4.3. Communication Standards

For applications in COMINT/SIGINT, typical communication signals are supported:

- § ASKn,
- § PSKn (single and multi channel),
- § QAMn (single and multi channel),
- § ASKnPSKm (single and multi channel)
- § NCPFSKn
- § FSKn (single and multi channel)

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

- § MSK (single and multi channel)
- § GMSK (single and multi channel)
- § F7B
- § TFM3
- § TFM5
- § AM, NFM, SSB (from .wav files)

Signal parameters can be selected by the user:

- § Attenuation
- § Center Frequencies
- § Baud Rates
- § Degree / subtypes /version
- § Pulse shapes (RC, RC/RRC, Gauss)
- § Burst Parameters

Different coding schemes are available:

- § Binary, Baudot, ASCII, HC ARQ, ITA2
- § Differential/absolute coding
- § Convolutional encoding
- § CCITT standards V.17...V.33
- § variable bit stream, bit order, parity
- § various scrambling algorithms

4.4. Frequency Hopping Module

The Frequency Hopping Module utilizes the profile functionality of the S1000 to generate hopping networks in a very efficient manner. The content is supplied by the user as narrow band IQ data.

- § Spread: up to 120/240MHz

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

- § Hop rate: >2000 hops/sec.
- § Channel spacing: user settable
- § Pattern: regular or random within user-defined channel list or sequence of channels / frequencies defined by user
- § Number of hoppers: up to 31. One hopper requires one VSG (two VSGs with 240MHz spread).
- § Content: IQ-data, generated by Analogue Modulation Tool or user-supplied content

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

5. Specifications

5.1. Power supply input

Input voltage range	100 VAC ... 240 VAC
Maximum input current	4.0 A (100V)
AC supply frequency	46 Hz to 60Hz
Input current in standby operation	0.1 A (100V)

Table 1 – Power supply input specifications

5.2. RF specifications

Frequency range	9 kHz to 3 GHz
Frequency resolution	0.001 Hz
Instantaneous BW 9 kHz to 30 MHz	30 MHz
Instantaneous BW 90 MHz to 2940 MHz	120 MHz
Reference Oscillator	OCXO aging $\pm 5 \cdot 10^{-8}$ per year temperature stability $< \pm 1 \cdot 10^{-8}$ warm-up time 10 min
RF outputs	N-type 50 ohms Return loss typ (dB) -18 (f<30MHz, Pout < -10dBm) -10 (otherwise)

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

	AC-coupled with maximum permissible DC Voltages 10V at >30MHz 5V at <30MHz
RF output power	maximum power +20 dBm (peak, typ.) resolution 0.1 dB uncertainty ±0.5 dB
Spectral purity	< -30 dBc at +10 dBm < -70 dBc (typ., at full scale)
Noise density typ@ 0dB backoff (dBm/Hz)	-134 (f<30MHz, Pout > -10dBm) -150 (f<30MHz, Pout = -10dBm) -134 (f>30MHz, Pout = 5dBm) -138 (f>30MHz, Pout = 0dBm) -144 (f>30MHz, Pout = -10dBm)
SSB phase noise	-120dBc/Hz @ 10kHz (typ.)
LO switching speed	> 1 msec.
Dynamic range measured at 100kHz RBW, CW @ 1500MHz,	0dBm

Table 2 – RF specifications

5.3. Digital Processing

Number of Virtual Signal Generators	up to 31
Input sample rates	5kSps...40 MSps
Maximum signal bandwidth per VSG	34MHz
Internal memory depth	1.750.000.000 IQ samples
Maximum data rate for external streaming	~220MByte/sec.

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

Cumulative Processing Power of all VSGs	320MSps
DAC Resolution	16 Bits
Supported File Formats	12 bit I/Q 16 bit I/Q IZT R3000 iBiquity's HD Radio™ files in E0 and E1 format
Continuously variable parameters (profiles)	power, delay, frequency, complex gain
Update rates complex gain	156.25 / 78.25 / 38 /19/9.7 / 4.88 / 2.44k frames per second
Update rates (power, delay, frequency amplitude)	78.25 / 38 /19/9.7 / 4.88 / 2.44k frames per second

5.4. Mechanical characteristics

Width	482 mm
Depth	569 mm
Height	88 mm
Weight	12 kg

Table 3 – Mechanical characteristics

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

5.5. Specification IZT P1100

OS	OpenSuSE 11.1 64Bit
RAM	4 GBytes
Storage HDD	2*4Tbyte Raid0 System
System HDD	250GBtes
CPU	AMD Dualcore x240
LAN	4*Gbit High Speed
Interfaces	2* ESATA (Raidcontroller) 8*USB2.0
Optical	DVD-ROM
Display	17"TFT
Input	USB Keyboard, USB Mouse
Width	295 mm
Depth	390 mm
Height	240 mm
Weight	13,5 kg (incl TFT and keyboard)

Table 4 – Specification IZT P1100

5.6. Specification IZT P1200

OS	Windows Ultimate 7 64Bit
RAM	12 GB
Storage HDD	2* 6 TB Raid0 System

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

	1* 1 TB Raid0 System (2*Tray)
System HDD	320GB
CPU	Intel Core I7-960
LAN	4*Gbit High Speed
Interfaces	2* ESATA 2* USB 3.0 4* USB 2.0 2* IEEE 1394
Graphic Interface	NVIDIA GTS 250
Display	24" TFT
Input	USB Keyboard, USB Mouse
Width	426 mm (+52 mm for mounts)
Depth	510 mm (+20 mm incl grips)
Height	178 mm
Weight	25,6 kg

Table 5 – Specification IZT P1200

5.7. System Specification of P1300

OS	Windows Ultimate 7 64Bit
RAM	12 GB
Storage HDD	1* 14 TB Raid5 System 1* 4 TB Raid0 System 2* 1 TB Raid0 System (4*Tray)

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

System HDD	320 GB
CPU	Intel Core I7-960
LAN	4*Gbit High Speed
Interfaces	2* ESATA 2* USB 3.0 4* USB 2.0 2* IEEE 1394
Graphic Interface	NVIDIA GTS 250
Display	24" TFT
Input	USB Keyboard, USB Mouse
Width	426 mm (+52 mm for mounts)
Depth	510 mm (+20 mm incl grips)
Height	178 mm
Weight	28.0 kg

Table 6 – System Specification of P1300

5.8. Environmental specifications

Ambient temperature range Operation	0 °C ... 50 °C
Ambient temperature range Storage	-40 °C ... 70 °C
Humidity	operation: 5 % ... 95 % non-condensing storage: 5 % ... 99 % non-condensing

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

Altitude range (m)	S1000: 2000 m
Operation	P1100: 2000 m
	P1200: 2000 m
	P1300: 2000 m

Table 7 – Environmental specifications

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

6. Revision History

Date	Version	Description	Author
2010-03-15	1.01	Initial version	pth
2011-04-15	1.02	SiriusXM added; minor clarifications	pth

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000_Description.doc by Rainer Perthold	

IZT S1000	Version: 1.02
Description	Date : 2011-04-15
S1000 Description.doc by Rainer Perthold	

7. Content

1.	Introduction.....	3
2.	Multichannel ARB operation.....	4
3.	Hardware.....	5
3.1.	Front Panel.....	5
3.2.	Rear Panel.....	6
3.3.	Analog Processing.....	7
3.3.1.	RF Outputs.....	7
3.3.2.	Synchronization.....	7
3.4.	Digital Processing Stages.....	7
3.4.1.	Real-time Modulator.....	7
3.4.2.	Variable Interpolation.....	7
3.4.3.	Profiles.....	7
3.4.4.	Impairments.....	8
3.4.5.	Additive Noise.....	9
3.4.6.	Processing Unit.....	9
3.4.7.	Data Sources.....	11
3.4.8.	Internal RAM.....	11
3.4.9.	Streaming operation.....	11
4.	External Tools.....	13
4.1.	Analog Modulation and Broadcast.....	13
4.2.	Real-time Modulation.....	13
4.3.	Communication Standards.....	13
4.4.	Frequency Hopping Module.....	14
5.	Specifications.....	16
5.1.	Power supply input.....	16
5.2.	RF specifications.....	16
5.3.	Digital Processing.....	17
5.4.	Mechanical characteristics.....	18
5.5.	Specification IZT P1100.....	19
5.6.	Specification IZT P1200.....	19
5.7.	System Specification of P1300.....	20
5.8.	Environmental specifications.....	21
6.	Revision History.....	23
7.	Content.....	25