Innovationszentrum Telekommunikations-
technik GmbH

IZT DSG2000

Signal Simulator for Sirius Satellite Radio and
XM Satellite Radio

The IZT DSG2000 is a versatile solution for developers and manufacturers of both US DARS* systems, Sirius Satellite Radio and XM Radio.
Its modular concept allows different configurations to generate either the Sirius or the XM signals or both.

Developers and manufacturers have different requirements for signal generation and test scenarios. While manufacturers are in need of a signal source to perform quick tests on each unit produced, developers need far more complex features.
The DSG2000 was developed to satisfy the requirements of both.

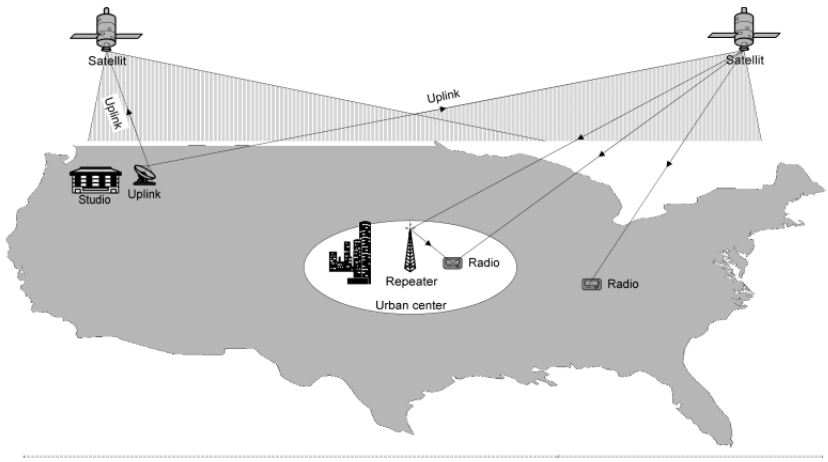
Dual Functionality in One Unit

The signal generator IZT DSG2000 excels by its modular concept. Sirius and XM signal generation take place in different components. The customer can decide if the device shall offer both functions or just one of them. Of course, the device can also be up-graded later on.
The advantage: increased functionality and performance, reduced costs and space.

Basic Features

The basic unit offers the composite signal of either the Sirius (option DSG2000-001) or the XM (option DSG2000-002) system (i.e: Sirius: satellite1, terrestrial, satellite2;
XM: satellite1 ensemble A and B, terrestrial ensemble A and B, satellite2 ensemble A and B).

The IZT DSG2000 can simulate any combination of the different carriers individually or simultaneously. Each carrier can be adjusted in frequency, delay and power level. As the Sirius satellites are not geostationary, the adjustment of delay and frequency can be used to reflect the generation of the signal at different time instants. The power level can be altered to test the radio's behavior with different power input levels.



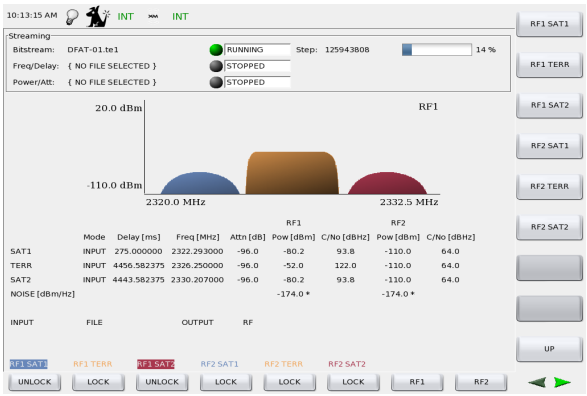
* Digital Audio Radio Service licensed in the US

Units with combined Sirius / XM functionality (i.e. including at least option DSG2000-001 + DSG2000-001H + DSG2000-001L or DSG2000-002 + DSG2000-002H + DSG2000-002L) allow to generate both signals simultaneously.

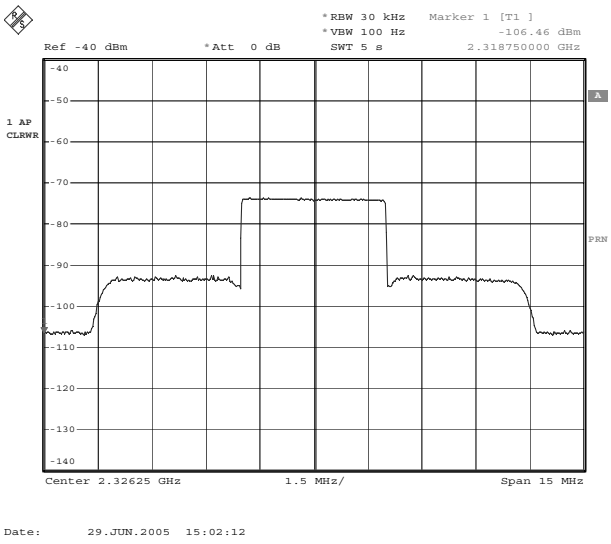
The data files required for simulation are incorporated in the product. Either unit can accomodate additional files as desired.The IZT DSG2000 performs the modulation in realtime. The bitstream data is stored on a 120GB harddisk, allowing to store more than ten hours of bitstreams.

All necessary hardware, software, and files are incorporated in a single unit.

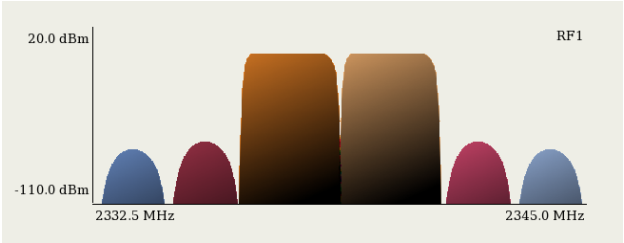
The use of a large LCD panel and a flexible menu driven interface provides a simple way of intuitively generating the desired output signal while minimizing any ambiguity in the settings of the generator.



Sirius signal - 2 QPSK, 1 COFDM

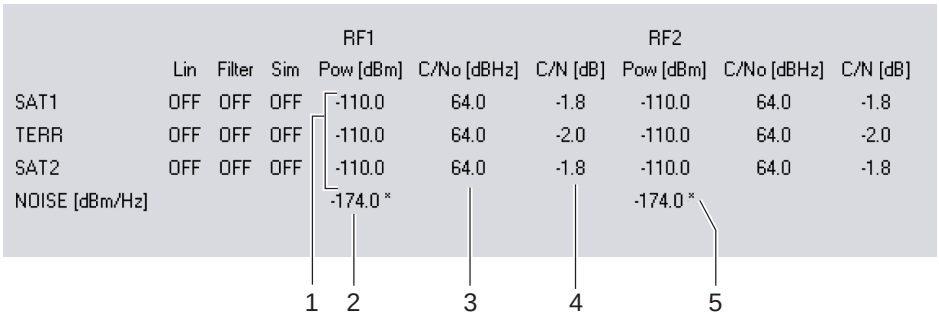


Linear Sirius signal at the spectrum analyzer; the IZT DSG2000 uses original studio files recorded by Sirius and XM.



XM signal - 4 QPSK, 2 MCM

Additive white Gaussian noise is included in the basic unit already. The noise can be configured as noise density or be locked to one carrier as C/N or C/No. In the latter case, the software automatically adjusts the noise density when the power level of the carrier is changed.



				RF1			RF2		
	Lin	Filter	Sim	Pow [dBm]	C/No [dBHz]	C/N [dB]	Pow [dBm]	C/No [dBHz]	C/N [dB]
SAT1	OFF	OFF	OFF	-110.0	64.0	-1.8	-110.0	64.0	-1.8
TERR	OFF	OFF	OFF	-110.0	64.0	-2.0	-110.0	64.0	-2.0
SAT2	OFF	OFF	OFF	-110.0	64.0	-1.8	-110.0	64.0	-1.8
NOISE [dBm/Hz]				-174.0 *			-174.0 *		

AWGN settings

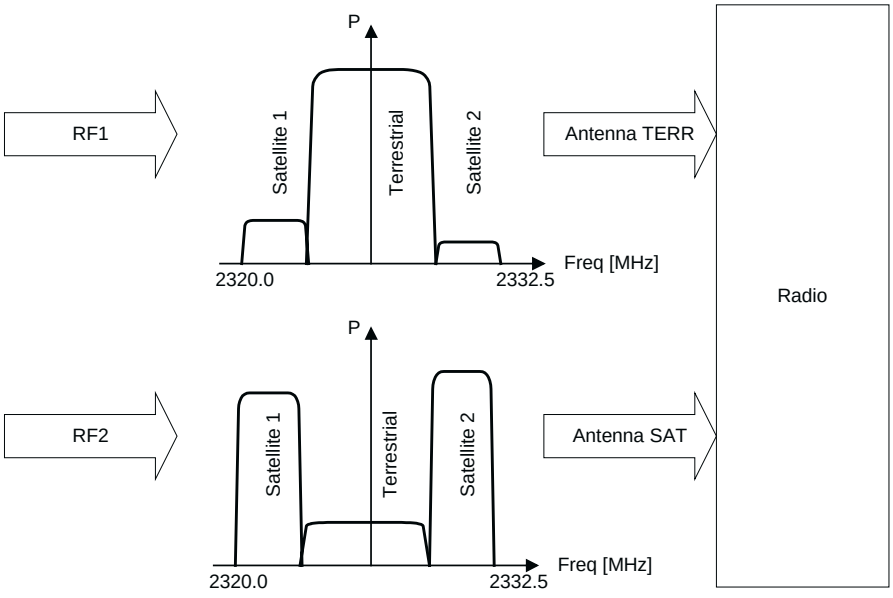
1 The carriers' power level

2 The RF output's noise density

3 The carriers' C/No

4 The carriers' C/N

5 Lock indicator



Verifying a radio with two antennae

2nd RF output

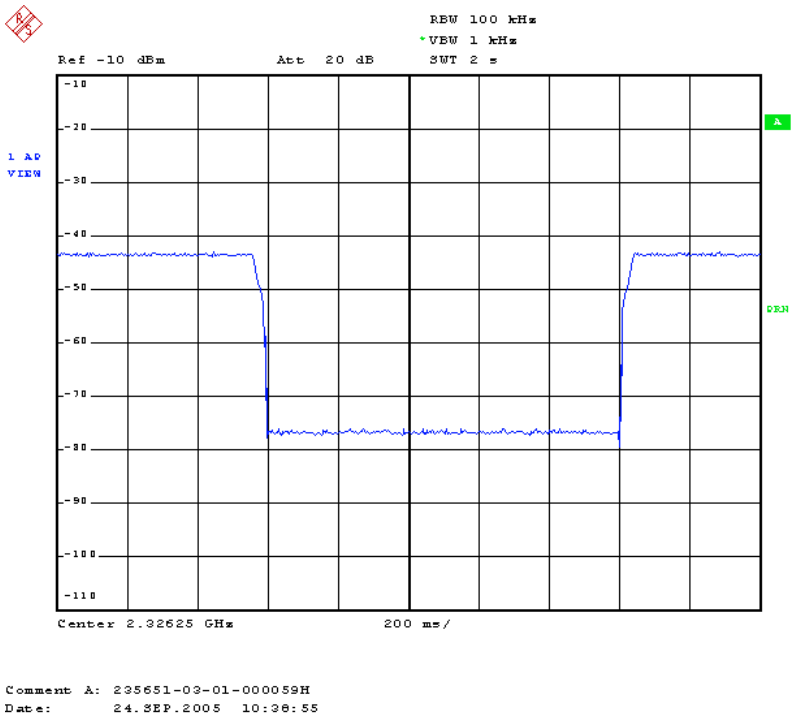
To generate the signal in the SDARS frequency range (Sirius: 2320.0-2332.5 MHz, XM: 2332.5-2345.0 MHz), each unit includes one RF output for each satellite system. An additional output (option DSG2000-001A for Sirius , option DSG2000-002A for XM) allows the user to verify radios supporting independent antennas for satellite and terrestrial reception. Both RF outputs refer to the same file, but can be individually set. For example, output one could output the terrestrial signal whereas output two could output the satellite signal.

Performance Testing Package

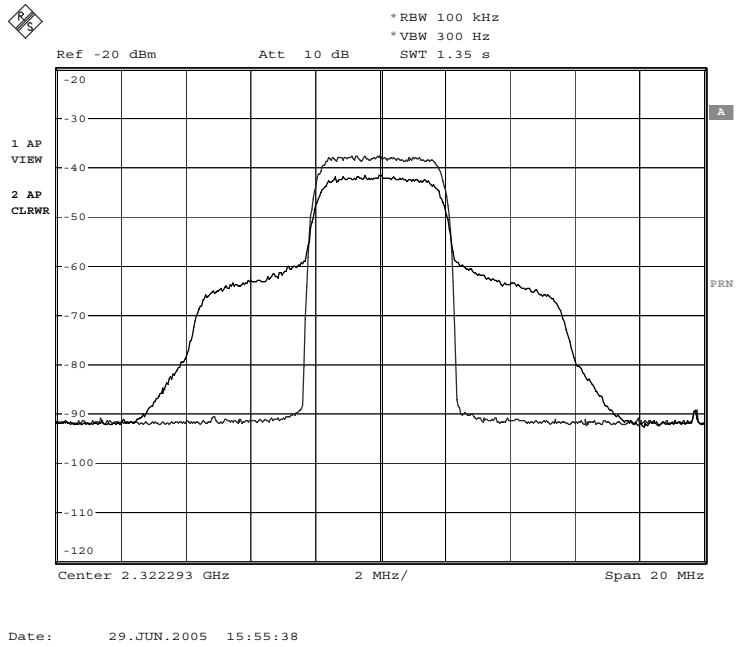
The performance testing option adds additional functionality to simulate impairments and conditions for development purposes. For the Sirius unit (option DSG2000-001G), the profile function supports time variant power level, delay, frequency and noise. With the XM unit (option DSG2000-002G), time variant power level is provided.

Profiles

“Profiles” can be used to simulate time continuous operation, for example the satellites’ movements or a vehicle in motion. The movement of the satellites can be reproduced by a frequency/ delay profile altering these two settings every 2 ms. The transition of a car under bridges, trees or through tunnels can be simulated by a power level profile. Power level profiles include a change in the power level for each carrier and simultaneously a change in the noise density.
By using an offline tool, developers can generate their own profiles. This tool converts the developer’s human readable text into files which will be copied to the IZT DSG2000.



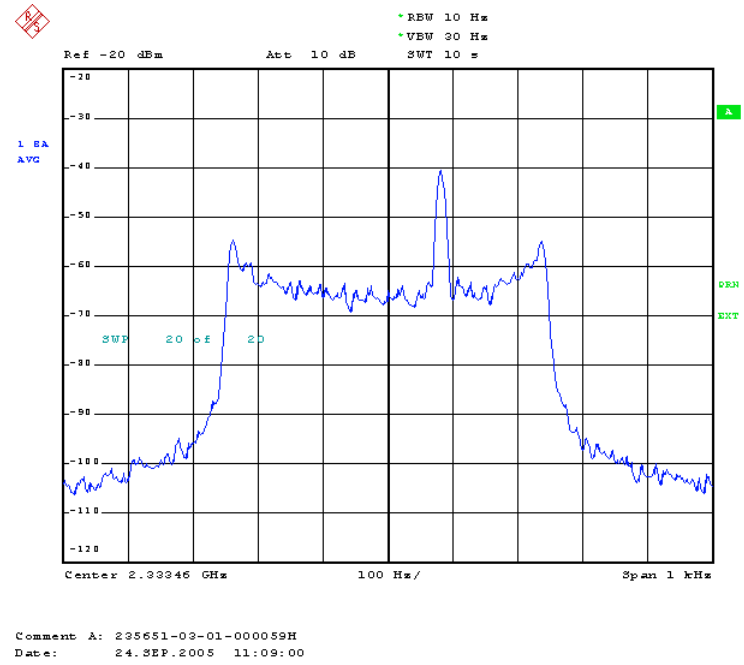
Power level profile



Non-linear signal at the spectrum analyzer

Non-linearities

The device supports non-linearities to simulate AM/AM and AM/PM conversion caused by the amplifiers in the satellite and the terretrial repeater.



Single path configured to Jakes with a 240Hz Doppler including LOS

Channel simulator

The performance of a digital radio system is limited by fading and multi-path caused by atmospheric scattering and rescattering or reflection from buildings etc. Different paths are received with different attenuation and delay and either add construcively or destructively to the overall reception signal. The built-in channel simulator allows the simulation of multipath propagation (eight paths for the terrestrial, two paths for the satellite signal). Each path can be configured in delay, doppler (alternatively: speed), loss and line-of-sight.

Output filter simulation

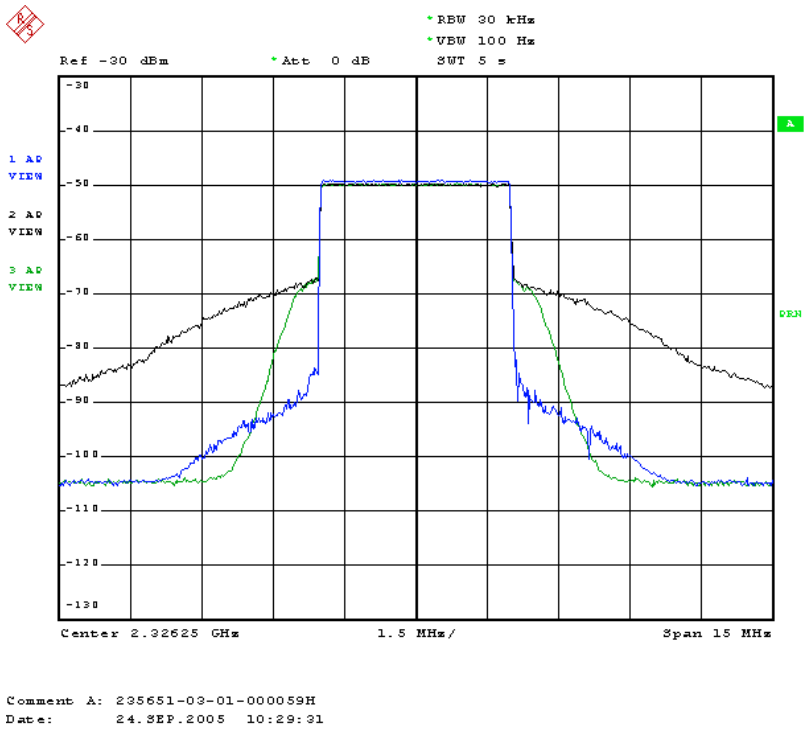
The shoulders created by the terrestrial repeaters would normally cover the satellite signals. Therefore in the repeaters an output filter is installed to reduce these non linearities. The DSG2000 supports an output filter simulation filtering the terrestrial signal with the characteristics of the real output filter installed in the repeaters.

External Output Filter

The performance of the internal output filter simulation is limited by the dynamic range of the RF sections (about 45dB). Therefore, when conducting tests with a strong terrestrial signal of one network (e.g. terrestrial signal of Sirius with 0dBm), the noise floor of the RF section would cover the satellite signal of the other network (e.g. satellite signal of XM with -90dBm) . In this case the external filter is used to address this situation: the outputs of both modulator cards are connected to the external output filter, the combined signal is available at this filter's output. Depending on which network shall be tested, IZT offers two different filters, a terrestrial XM filter (option DSG2000-001J; needed for tests with strong XM and low Sirius signal) and a terrestrial Sirius filter (option DSG2000-002J; needed for tests with strong Sirius and low XM signal).

Programming Option

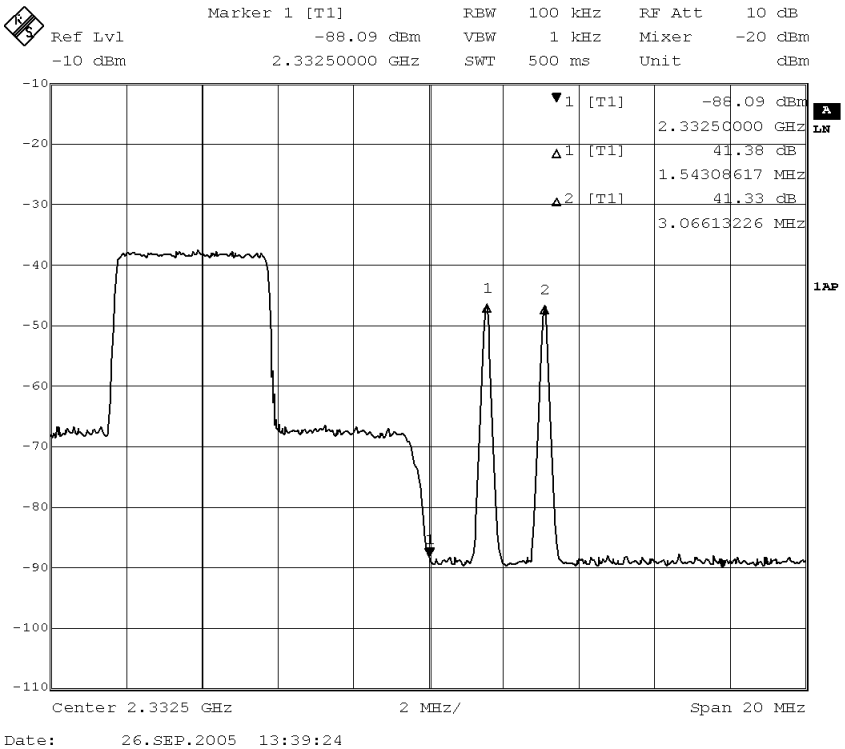
Settings stored by the user can be stringed together into scenarios. Once created, a scenario can be used by the tester to verify the device under test: The signal generator steps through this list of setting files.This option (DSG2000-003) also includes a labview driver.



Original terrestrial signal (blue), signal with strong non-linearity effects (black) and signal with output filter simulation (green)

Wideband Synthesizer / Arbitrary Waveform Generator

The standard RF sections allow the user to output a signal within the networks' frequency range. With the wideband synthesizer, the user can configure the frequency from 45MHZ to 3 GHz.
In combination with the arbitrary waveform generator, this can be used to generate signals for other standards (e.g. WLAN, Bluetooth) in Matlab. If used as an interferer, this signal can be superimposed to the Sirius or XM signal.
Once loadad into memory, a signal created in Matlab can still be changed in frequency and power level during runtime.



AWG: two tones generated in Matlab are superimposed to the Sirius signal.

This option is available for either units generating the Sirius signal (DSG2000-001K) or for those generating the XM signal (DSG2000-002K).

Interference Testing with the competingSatellite Radio System

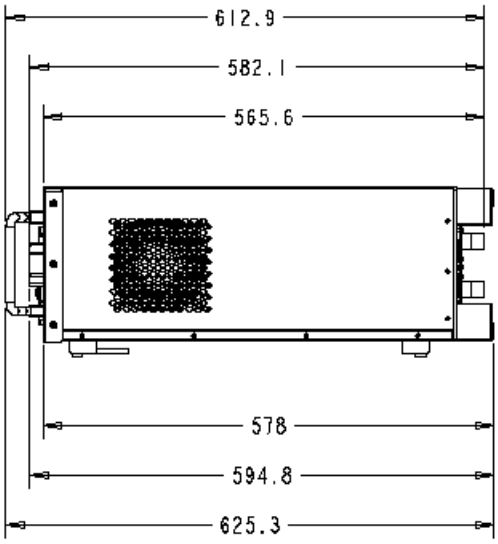
Users wanting to have an interfering Sirius or XM signal can add addtitional hardware (options DSG2000-002H and DSG2000-001H) to their signal generators that allows to generate a spectral representative signal of the system that is supposed to be the interferer.
The performance testing option already includes an internal output filter. For tests with big differences in signal strength external output filters are available (options DSG2000-001J and DSG2000-002J; see also p.7).

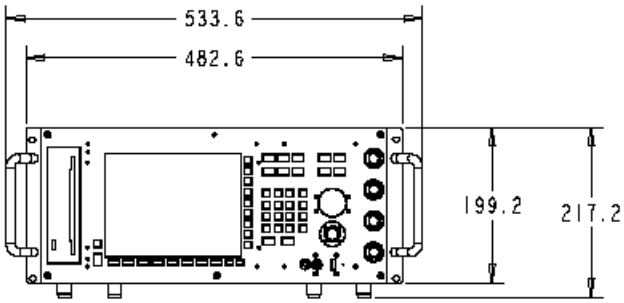
By buying additional software (option DSG2000-002L or DSG2000-001L) later on, the customer has the possibility to upgrade to a full Sirius or XM signal and therefore to a combined Sirius / XM unit.

General Specifications

Harddisk	120 GB
Power requirements	90 to 264 Vac, 47 to 63 Hz, 400 W maximum
Temperature range	0 to 40 ^{0}C
Weight	depending on equipment; approx. 25 kg

Dimensions





Side view and front view. Flanges and feet are removable.
Dimensions are indicated in millimeters.

Option DSG2000-001: Sirius Basic Unit

Signal	*2xQPSK*	2322.293 MHz / 2330.207 MHz
	COFDM	2326.25 MHz
	Frequency	Nominal frequencies +/-45kHz, stepsize 1 Hz
	Delay	SAT1: 228 to 322 ms TERR: fixed SAT2: 4397 to 4490ms
	Stability	$5x10^{-8}$ (OCXO)
Impairments	*AWGN*	Assignable in C/N, C/No and No
I/Q baseband output	*Channels*	2 (I and Q)
	Level	-6 dBm max
	Attenuation	0 to -96.0 dB, stepsize 0.1 dB
S-band output	*Output power*	-110 to 10 dBm, stepsize 0.1 dB
	Level uncertainity	Absolute < ± 0.5 dB
	Auto-calibration	User initiated auto-calibration
	QPSK/COFDM	Maximum output power difference between QPSK and COFDM: 35 dB
	QPSK/QPSK	Maximum difference between QPSK signals: 35 dB
Front panel connectors	*RF output*	One N-type output, impedance 50 Ohms
Rear panel connectors	*SAT 1 outputs, SAT 2 outputs, TERR outputs*	I and Q outputs Analog, BNC, impedance 50 Ohms
	1 PPS input	Accepts an 1 PPS reference (timebase) input; SMB, impedance 50 Ohms, TTL
	10 MHz input/output	Accepts an external reference (timebase) input; BNC, impedance 50 Ohms, 100 mV_{PP} - 5 $_{VPP}$
		Outputs int. or ext. reference signal. BNC, impedance 50 Ohms, 1 V_{PP}
	GPS input	GPS-Time information to synchronize timebase to GPS (RS232)
	Event output (1,2)	Outputs a pattern for triggering external equipment during large scale fading SMB, impedance 50 Ohms, 1 VPP
Remote access	*Remote programming*	Via LAN or RS-232

Option DSG2000-002: XM Basic Unit

Signal	*4xQPSK*	2333.465 MHz / 2335.305 MHz / 2342.205 MHz / 2344.045 MHz
	2xMCM	2337.490 MHz / 2340.020 MHz
	Frequency	Nominal frequencies +/-45kHz, stepsize of 1Hz
	Delay	SAT1,2: ±6 ms TERR: 10 to 30 ms processing delay
	Stability	$5x10^{-8}$ (OCXO)
Impairments	*AWGN*	Assignable in C/N, C/No and No
I/Q baseband output	*Channels*	2 (I and Q)
	Level	-6 dBm max
	Attenuation	0 to -96.0 dB, stepsize 0.1 dB
S-band output	*Output power*	-110 to 10 dBm, stepsize 0.1 dB
	Level uncertainity	Absolute < ± 0.5 dB
	Calibration	User initiated autocalibration
	QPSK/MCM	Maximum output power difference between QPSK and MCM: 35 dB
	QPSK/QPSK	Maximum difference between QPSK signals: 35 dB
Front panel connectors	*RF output*	One N-type, impedance 50 Ohms
Rear panel connectors	*SAT I output*	Outputs the "I" part of the satellites Analog, BNC, impedance 50 Ohms
	SAT Q output	Outputs the "Q" part of the satellites Analog, BNC, impedance 50 Ohms
	TERR I output	Outputs the "I" part of the terr. signal Analog, BNC, impedance 50 Ohms
	TERR Q output	Outputs the "Q" part of the terr. signal Analog, BNC, impedance 50 Ohms
	1 PPS input	Accepts an 1 PPS reference (timebase) input; SMB, impedance 50 Ohms, TTL
	10 MHz input/output	Accepts an external reference (timebase) input; BNC, impedance 50 Ohms, 100 mV_{PP} - 5 $_{VPP}$ Outputs int. or ext. reference signal BNC, impedance 50 Ohms, 1 V_{PP}
	GPS input	GPS-Time information to synchronize timebase to GPS (RS232)
	Event output (1,2)	Outputs a pattern for triggering external equipment during large scale fading SMB, impedance 50 Ohms, 1 VPP
Remote access	*Remote programming*	Via LAN or RS-232

Option DSG2000-001A: 2nd RF Sirius		
for i.e. antenna diversity testing; requires option DSG2000-001 or DSG2000-002H		RF output with power levels adjustable independently from first RF output for satellite and terrestrial signals
Option DSG2000-002A: 2nd RF XM		
for i.e. antenna diversity testing; requires option DSG2000-002 or DSG2000-001H		RF output with power levels adjustable independently from first RF output for satellite and terrestrial signals
Option DSG2000-001G: Performance Testing Package Sirius		
requires option DSG2000-001 or DSG2000-002H		
Improved performance	*Power level*	-110 to 20 dBm
	Frequency	2320.0 to 2332.5 MHz
Impairments	*Satellite non-linearity*	Memoryless distorter (Output back-off, non-linearity)
	Terrestrial non-linearity	Memoryless distorter (Output back-off, non-linearity)
	Terrestrial filter simuliation	Digital filter to simulate output filter
	Satellite channel simulator	Simulation with 2 paths
	Terrestrial channel simulator	Simulation with 8 paths
Profiles	*Level*	2 msec steps, individually settable for both RF outputs
	Delay + frequency	2 msecs steps
	Variable AWGN	2 msecs steps
Option DSG2000-002G: Performance Testing Package XM		
requires option DSG2000-002 or option DSG2000-001H		
Improved performance	*Power level*	-110 to 20 dBm
	Frequency	2332.5.0 to 2345.0 MHz
Impairments	*Satellite non-linearity*	Memoryless distorter (Output back-off, non-linearity)
	Terrestrial non-linearity	Memoryless distorter (Output back-off, non-linearity)
	Terrestrial filter simulation	Digital filter to simulate output filter
	Satellite channel simulator	
	Terrestrial channel simulator	
Profiles	*Level*	2 msecs steps, individually settable for both RF outputs
	Variable AWGN	2 msecs steps

Option DSG2000-001H: Spectral Representation of the XM signal for interference testing; requires option DSG2000-001	
Option DSG2000-002H: Spectral Representation of the Sirius signal for interference testing; requires option DSG2000-002	
Option DSG2000-001J: External output filter XM for interference testing; requires options DSG2000-001 + DSG2000-001H or DSG2000-002 + DSG2000-002H + DSG2000-002L	
Option DSG2000-002J: External output filter Sirius for interference testing; requires options DSG2000-002 + DSG2000-002H or DSG2000-001+ DSG2000-001H + DSG2000-001L;	
Option DSG2000-001K: Wideband Synthesizer, AWG for Sirius interference information on necessary hardware options on request	
Option DSG2000-002K: Wideband Synthesizer, AWG for XM interference information on necessary hardware options on request	
Option DSG2000-001L: Upgrade to real XM signal requires option DSG2000-001H	
Option DSG2000-002L: Upgrade to real Sirius signal requires option DSG2000-002H	
Option DSG2000-002N: Sirius Overlay requires option DSG2000-001 or options DSG2000-002H + DSG2000-002L	
Option DSG2000-003: Programming option requires option DSG2000-001or DSG2000-001	Step through scenario file, applying saved settings (local); Labview Driver
Option DSG2000-004: GPIB	Remote access

IZT is a spin-off of the “Fraunhofer Gesellschaft”, a renowned organization for applied research in Germany.

The company was founded in 1997. Since then, the company has grown at an average rate of 20 percent per year.

IZT’s major business fields are DAB transmitters and repeaters, custom test equipment, special communication systems and spectrum monitoring receivers.

The company has a long history in customer specific test equipment, especially for modern satellite based digital audio broadcast systems.

For the “WorldSpace” system IZT built the first signal generator, which served as reference for receiver development.

As a follow-on product, the “FLSTester” was developed, which can be used to verify both the ground stations and the receivers for the WorldSpace system. For XM Radio, one of the two US DARS satellite broadcasters, IZT developed and produced a signal generator (“SIGGEN”) for receiver development and verification.

The IZT DSG2000 – now for XM and Sirius – is based on the experience gained from this XM Signal Generator.

IZT has supplied to Sirius with equipment for terrestrial repeaters for years and also built customer specific test equipment for measurements of the network quality.

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