IZT DCS 3020
Fading Channel Simulator

Innovationszentrum Telekommunikations-technik GmbH

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The IZT DCS 3020 is a wideband, digital channel simulator. It is especially designed for simulating satellite links. Its powerful signal processing also allows for use with terrestrial services and different fading channel models.

- slow fading simulation for handheld applications
- file streaming for repeatable testing of critical fading environments
- accurate and realistic carrier-to-noise and level profiles
- optional second module for the return path in two-way systems

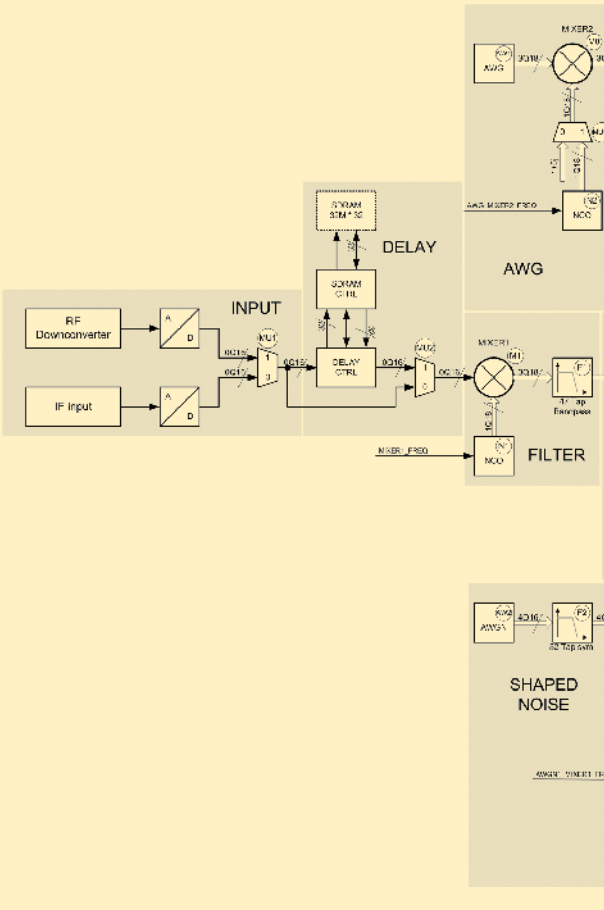


figure 1:

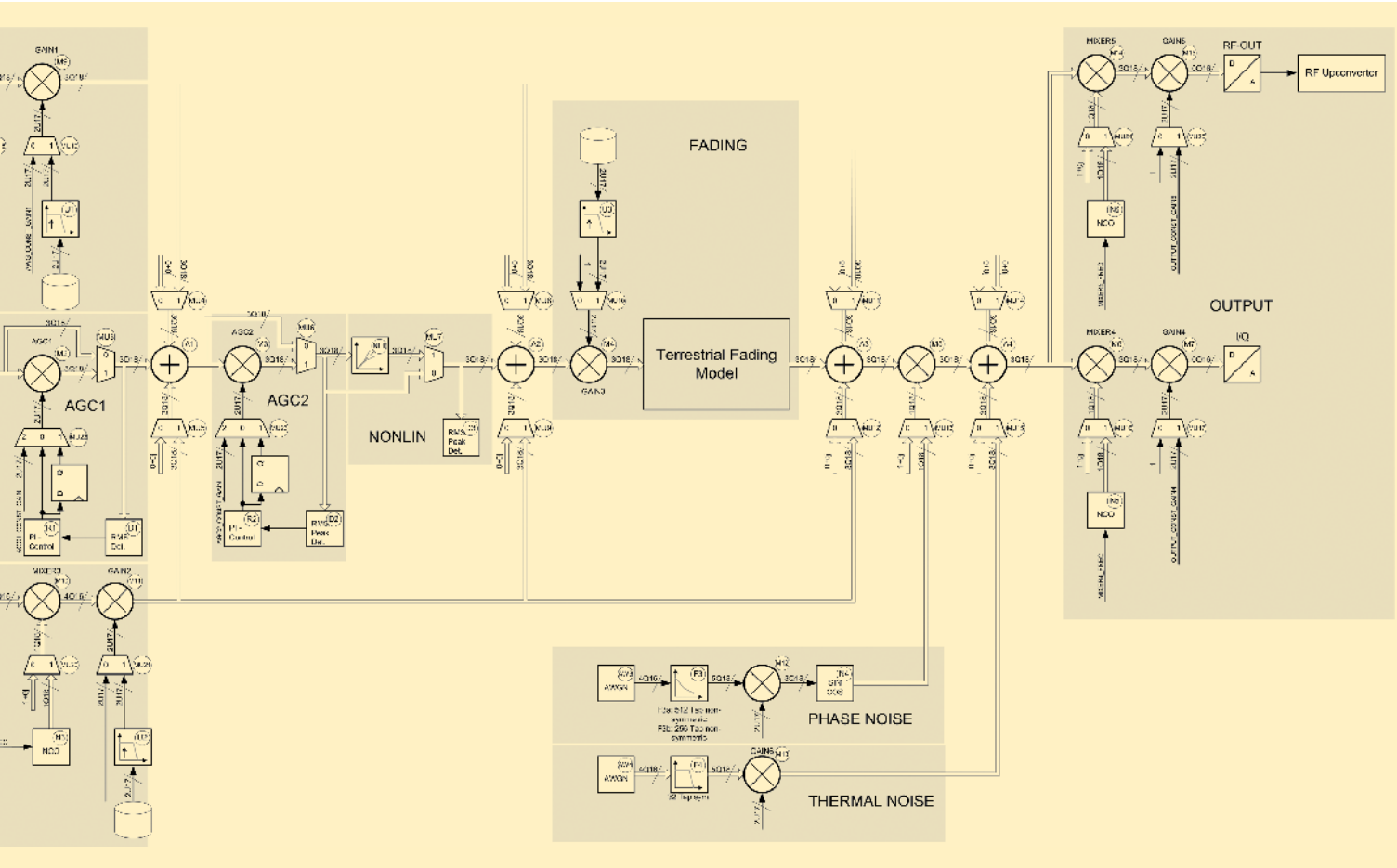
Satellite links for broadcast services or two-way communication subject the signals to various impairments, for example thermal noise, phase noise, non-linearity, interference, scintillation and fading. The DCS 3020 has the capability to simulate these effects for the forward and return link.

One typical example for a satellite link is the combination of DVB-S2 for the forward link and DVB-RCS for the return link.

The DCS 3020 can also be equipped with channel models to simulate terrestrial channels.

The DCS 3020 can simulate the following impairments:

- filters
- propagation delay
- automatic gain control
- shaped noise
- additive white Gaussian noise
- on-channel and/or adjacent channel interference
- phase-noise
- non-linear distortion
- flat fading
- frequency selective fading



Input Stage

The DCS 3020 supports a maximum input bandwidth of 34 MHz at an IF of 60MHz. A low frequency input (for example for shortwave) 0...30 MHz is possible as well.
An optional built-in down-converter supports input frequencies between 30 and 3000 MHz.

Propagation Delay

To simulate the propagation time, especially over satellite links, a delay block ranging from 25,6 usec to 838 msec can be switched into the signal path.

Automatic Gain Control

The DCS 3020 contains two automatic gain control stages. A first automatic gain control stage (AGC) is available directly after the input stage to normalize carrier-to-noise and/or carrier-to-interference levels.
It supports three different operating modes:

- constant gain
- constant power
- AGC freeze

A second AGC normalizes signal and noise power before the nonlinearity simulation in order to maintain a set operating point.

Noise and Interference

The DCS 3020 can add white Gaussian noise (AWGN) and user defined interference from an arbitrary waveform generator (AWG) at different stages in the signal chain:

- after the 1st AGC stage
- after the non-linearity simulation
- after the fading simulation

The AWGN is a white noise source of a well defined power spectral density. Its output can be filtered by pre-definded or programmable filter coefficients. Its center frequency can be adjusted within the signal bandwidth of the DCS 3020. The noise power can be amplitude modulated by a profile (1kSamples/s at 300 Hz bandwidth). Loading user-defined filter coefficients into the DCS 3020 modifies the power spectrum of the noise. The AGC of the DCS 3020 allows for accurate setting of a user-define C/N value.

The AWG contains up to 1 GSamples of complex baseband data which are sufficient for 13 seconds of signal before it repeats.
The center frequency of the AWG signal can be adjusted within the available signal bandwidth of the DCS 3020.
The output power of the AWG is also adjustable and can be amplitude modulated by a profile (1kSamples/s at 300Hz bandwidth).

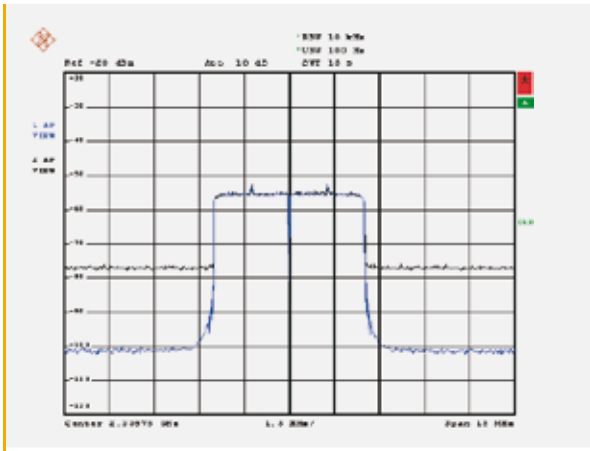


figure 2:

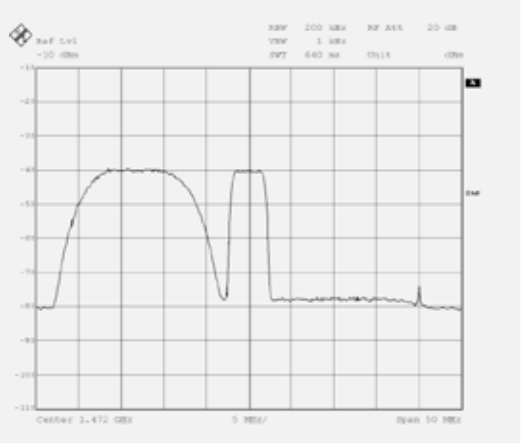


figure 3:

Nonlinearity Simulation

The power amplifier in a real system, for example a satellite or terrestrial transmitter, is modelled as a memoryless nonlinearity with AM/AM and AM/PM conversion. The AM/AM and AM/PM characteristics can be used-defined via a look-up table containing 1024 entries.
The nonlinearity simulation is complemented with digital detectors for accurate determination and control of the operating point in terms of input back-off (IBO) and/or output back-off (OBO).

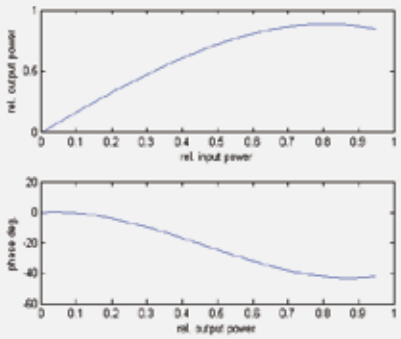


figure 4:
typical AM/AM and AM/PM

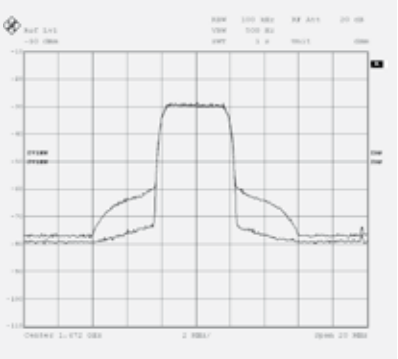


figure 5:
nonlinear distortion

Fading Simulation

The fading simulation supports satellite and terrestrial channels.

For satellite channels, the signal power is multiplied by a real time-variant attenuation factor, which is calculated either in real time or read from file. The sample rate is 1ksamples/sec., the maximum bandwidth is 300 Hz.

For terrestrial channels, WSSUS fading models up to three times eight paths with time-variant complex attenuation factors can be simulated. A realistic simulation of terrestrial single-frequency-networks is supported as well.

As a baseline, the model supports Raleigh, Rice and Lognormal fading. The complex channel weights can either be streamed from a file, allowing to reproduce difficult receiving scenarios or be calculated in real-time for quick user interaction.

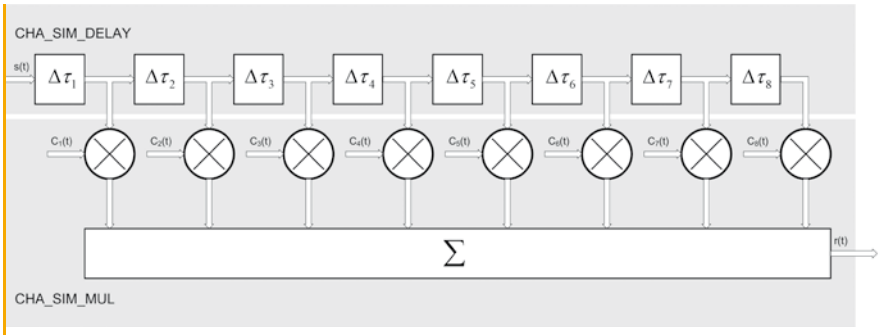


figure 6:

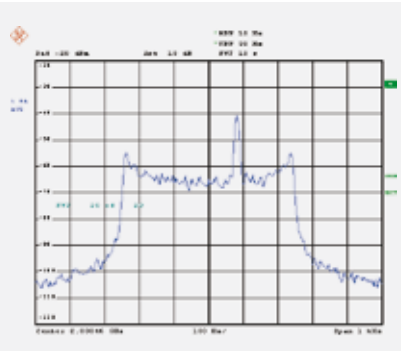


figure 7:
single path with Rice fading and

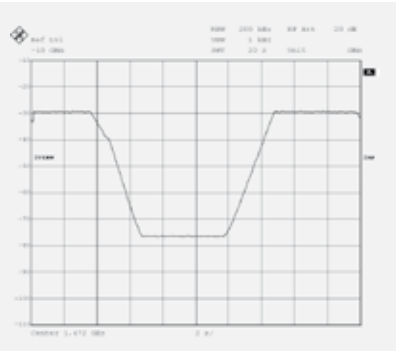


figure 8:
slow fading profile

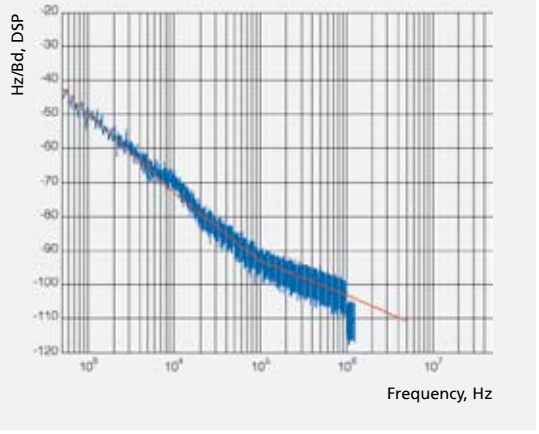


figure 9:

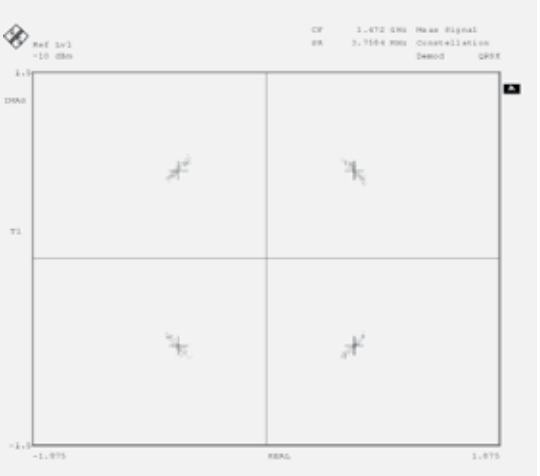


figure 10:
QPSK with phase noise simulation active

Phase Noise Simulation

The DCS 3020 has the capability to accurately simulate phase noise. The DCS 3020 comes with a number of phase noise profiles, for example DVB-S2 typical, DVB-S2 critical and DVB RCS. Phase noise simulation is performed by appropriate filtering of a digitally generated noise.

The user can generate additional phase noise profiles (up to 1 MHz BW) by loading different filter coefficients.

Output Stage

The maximum ouput signal bandwidth supported by the DCS 3020 is 54MHz. Two different outputs are available:

- I/Q baseband
- a wideband upconverter supporting the

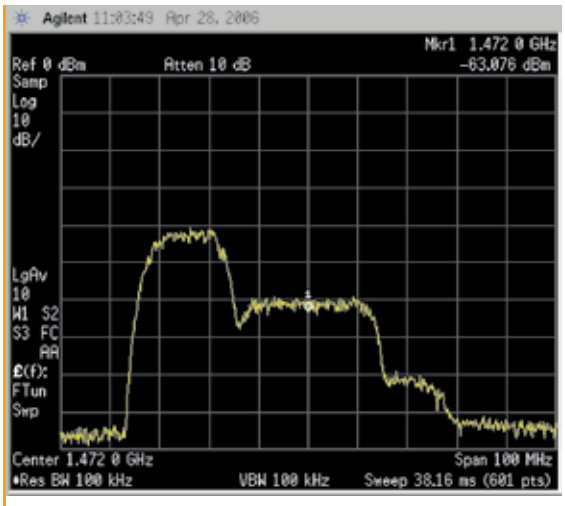


figure 11:
output signal: QPSK with thermal noise and adjacent

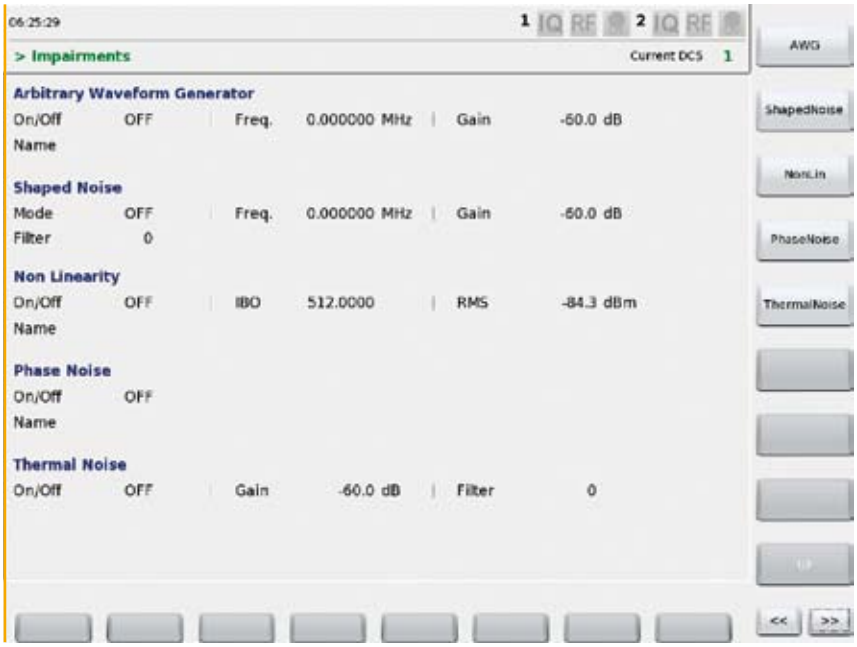


figure 12:
Screenshot of the

User Interface

The DCS 3020 has an intuitive graphical user interface, allowing access to all settings and functions. Soft keys on the front panel facilitate navigation between the different menus.
The DCS 3020 can also be fully remote controlled via a SCPI-like protocol. Standard interfaces are Ethernet on RS232. GPIB is available as

Ordering Information:

DCS 3020	baseline equipment
DCS 3020-RC	additional channel simulator module for simulating two-way systems
DCS 3020-WDC	wideband downconverter 30...3000 MHz for input signals
DCS 3020-TC	module for simulation of terrestrial channels and single frequency networks
DCS 3020-GPIB	GPIB-Interface for remote control

QUALITY MANAGEMENT
Certificate
Voluntary participation in regular monitoring according to ISO 9001:2000

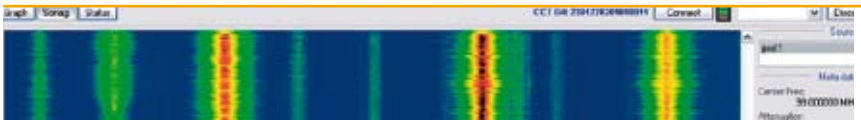
About IZT

The Innovationszentrum fuer Telekommunikationstechnik GmbH IZT is a spin-off of the "Fraunhofer Gesellschaft", a renowned organization for applied research in Germany. The company was founded in 1997.

IZT's major business fields are digital broadcast transmitters and repeaters, custom test equipment, special communication systems and spectrum monitoring receivers. The company is active in civilian and military markets.

IZT has a long history in customer specific test equipment, especially for modern hybrid satellite and terrestrial digital audio broadcast systems.

The company's products are marketed worldwide.



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