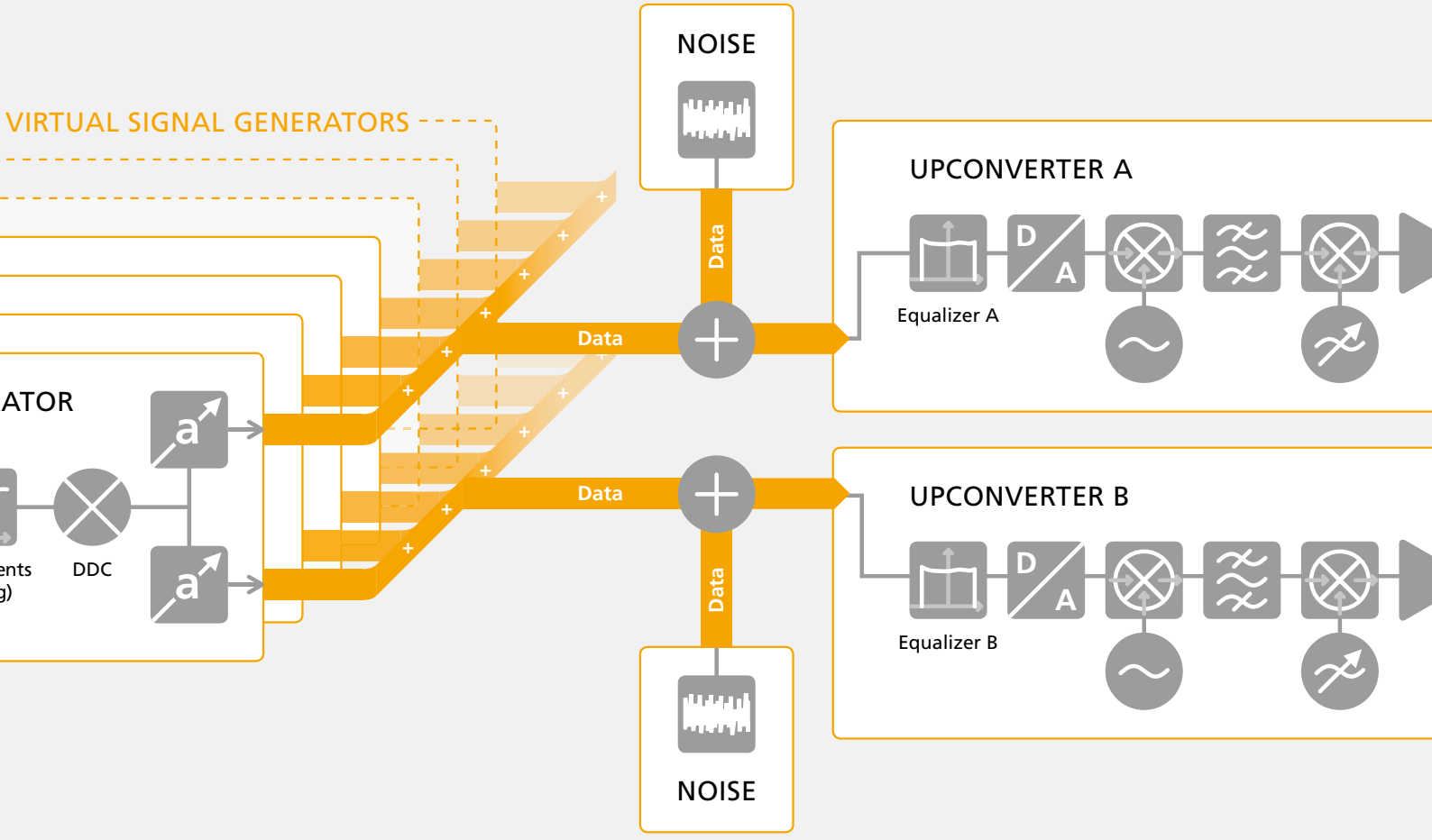
IZT S1000
Maximum Ratio Combining Tests

Application Note

- Antenna diversity
- HD Radio
- DAB/DAB+
- DVB-T



IZT S1000: Maximum Ratio Combining Tests

Maximum Ratio Combining (MRC) is a variant of diversity combining, that is a method to combine two or more received signals in order to improve the quality of the resulting signal from more antennas. MRC can be used to improve the reception quality for wireless communications and a variety of broadcasting standards such as DVB-T, DAB and HD Radio.

TECHNICAL BACKGROUND

Different kinds of diversity can be used to improve the quality of a received signal. Common diversity schemes include:

- Time diversity (FM diversity)
- Frequency diversity: different frequencies are used for transmission to overcome frequency-selective fading, for example combining the two HD Radio OFDM+ sidebands or spread spectrum
- Space diversity: several propagation paths, for example by using antenna diversity (multiple transmission or reception antennas)

The MRC technique can be used to make use of antenna diversity at the receiver to increase the overall received signal-to-noise ratio to improve performance during fading and nonuniform interference. This is achieved by calculating a weighted sum of all input channels where the gain of each channel is proportional to the RMS level and inversely proportional to the mean square noise in the respective channel.

ANTENNA DIVERSITY SIMULATION

To simulate antenna diversity, it is required to simulate the transmission paths of each channel. This includes the simulation of fading effects and incoherent noise generators for each channel. The output signal from each transmission path needs to be fed to a separate RF output of a signal generator.

CONVENTIONAL APPROACH

Conventional signal generators usually contain only one RF output. In consequence, one separate device is required for each simulated transmission path. They share the same data source as common input. Each device applies fading effects and noise to the respective transmission signals. The devices need to be synchronized to achieve a controlled phase relation among the signal generators.
Figure 1 shows a conventional setup consisting of two synchronized signal generators.

ANTENNA DIVERSITY SIMULATION WITH THE IZT S1000 SIGNAL GENERATOR

The IZT S1000 not only includes 31 Virtual Signal Generators, but also provides two independent RF outputs for diversity testing (Figure 2). With the built-in incoherent noise sources for each RF output and the flexible independent fading generator a very compact setup can be achieved.

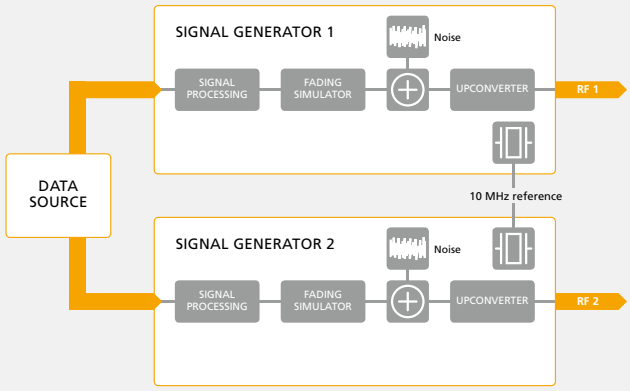


FIGURE 1: BLOCK DIAGRAM OF A CONVENTIONAL APPROACH TO MRC

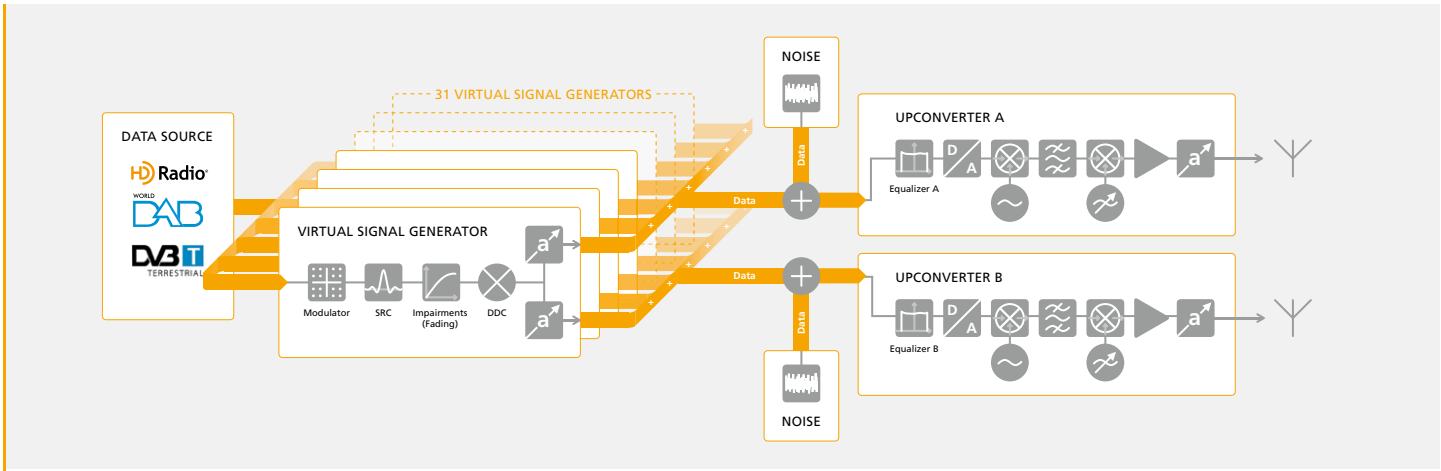


FIGURE 2: BLOCK DIAGRAM OF A SINGLE IZT S1000 WITH TWO RF OUTPUTS FOR MRC – (REQUIRED EQUIPMENT: S1000, OPTIONAL MEMORY EXTENSION)

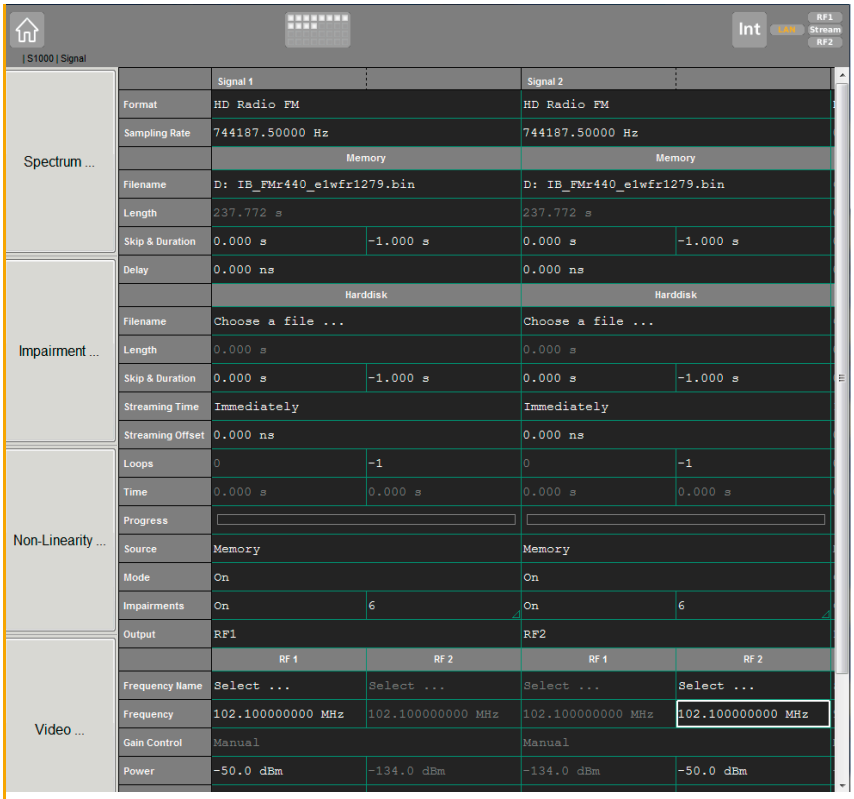


FIGURE 3: SIGNAL CONFIGURATION USING TWO SIGNALS ON RF1 AND RF2

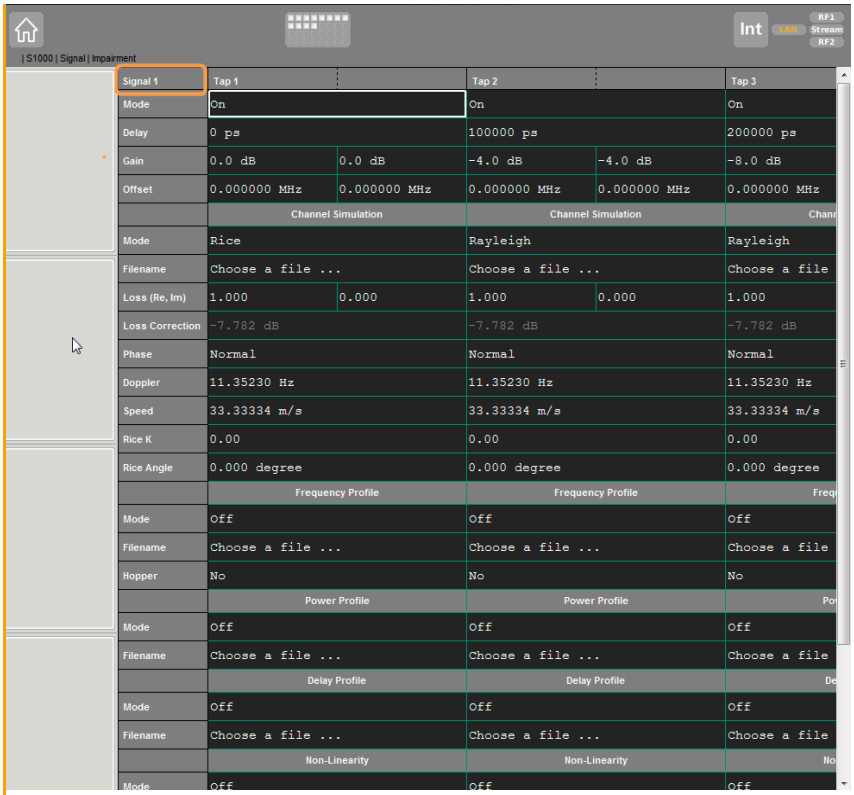


FIGURE 4: ACTIVATE MULTIPATH FADING ON RF1

HOW TO CONFIGURE THE IZT S1000

1. Configure two signals using the same test vector or signal (e.g. HD Radio)
2. Configure first signal on RF1 output and second signal on RF2 output
3. Simulate fading effects with channel simulator, e.g. TU6 Profile for both outputs
4. Effects will be simulated independently for both RF outputs
5. Activate incoherent noise for both RF outputs
6. Configure effective bandwidth and C/N for each signal

IZT S1000: Maximum Ratio Combining Tests

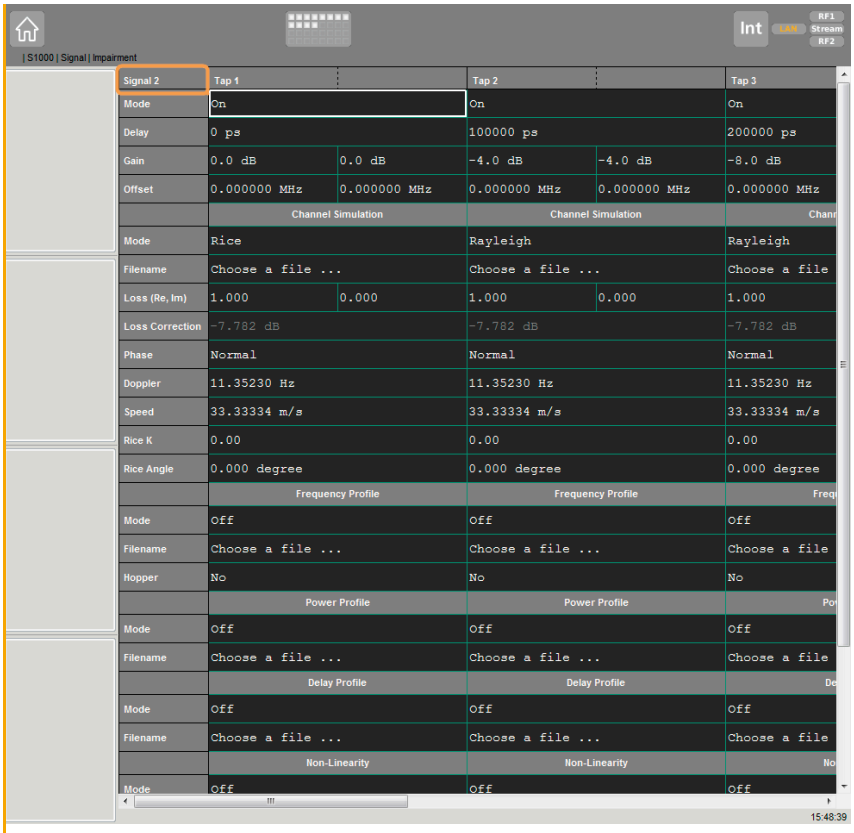


FIGURE 5: ACTIVATE MULTIPATH FADING ON RF2

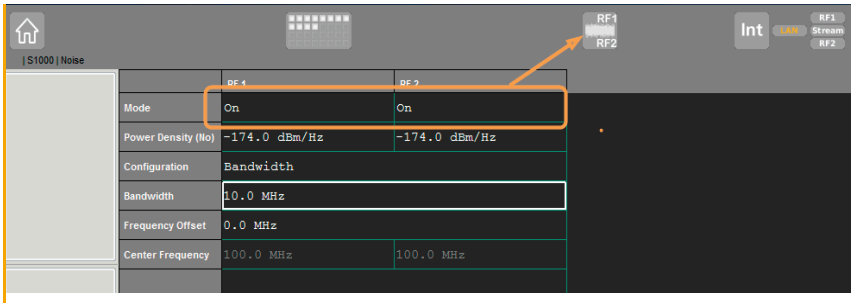


FIGURE 6: USE INCOHERENT NOISE SOURCE FOR RF1 AND RF2

Power	-50.0 dBm	-134.0 dBm	-134.0 dBm	-50.0 dBm
Gain	0.0 dB	0.0 dB	0.0 dB	0.0 dB
Eff. Bandwidth	396.80400000 kHz		396.80400000 kHz	
C/N	68.0 dB	-16.0 dB	-16.0 dB	68.0 dB
C/No	124.0 dBHz	40.0 dBHz	40.0 dBHz	124.0 dBHz

FIGURE 7: C/N CAN BE CONFIGURED TO ADAPT THE NOISE LEVEL

REQUIRED HARDWARE AND SOFTWARE CONFIGURATION

- 2 RF outputs
  [option IZT S1000-RF3]
- Fading generator (channel simulator)
  [option IZT S1000-304]
- HD Radio
  [option IZT S1000-220]
- DAB/DVB-T
  [option IZT S1000-403 / IZT S1000-408]
- Memory Extension for live streaming of test vectors
  [option IZT S1000 Memory Extension]
- High speed LAN streaming (needed with IZT S1000 Memory Extension)
  [option IZT S1000-120]

CONCLUSIONS

Antenna diversity can greatly improve performance under multipath fading conditions. To ensure maximum performance of receivers the use of the diversity is an essential technical feature which has to be tested thoroughly and this comes with some efforts.

Compared to conventional approaches, the IZT S1000 Signal Generator provides two independent RF outputs for diversity testing. This leads to a very compact, cost-effective stand-alone solution. In addition, the IZT S1000 Signal Generator can be easily configured and used in automated test setups.

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