Broadcast Test System: R&S®SFU, Test Transmitter: R&S®SFE100

Creating Test Scenarios in Accordance with IEC 62002 Ed. 2.0 (MBRAI) Using the R&S®SFU

Application Note

The International Electrotechnical Commission (IEC) created the MBRAI specifications, which call for strict conformance tests that ensure the proper functionality of mobile receiver terminals for DVB-T/H transmissions. MBRAI is a common abbreviation of the IEC 62002 standard and stands for "mobile and portable DVB-T/H radio access interface".

This Application Note describes how the Broadcast Test System R&S®SFU provides all functions to generate MBRAI-compliant test signals. Only two special measurements require additional sources. For this purpose, the Test Transmitter R&S®SFE100 is used.

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1   Overview

Developers and manufacturers of mobile phones nowadays are faced with DVB-H mobile TV broadcasting technology. This requires test equipment and test procedures that are different from those required for mobile radio communications.

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2   Some Basic Information About IEC 62002

The IEC 62002 standard defines specifications for mobile, portable and hand-held portable devices for DVB-T/H signals. The standard covers specifications for four different terminal categories:

- Integrated car terminals (a)
- Portable digital TV sets (b1)
- Pocketable digital TV receivers (b2)
- Handheld convergence terminals (c)

IEC 62002 consists of two parts:

- Part 1: Interface specifications
- Part 2: Interface conformance testing

Part 2 "Interface conformance testing" specifies practicable test procedures for DVB-T/H receivers. This document provides a testing guideline in order to meet the requirements of Part 1 "Interface specifications".

3 Test Principles

General test setup
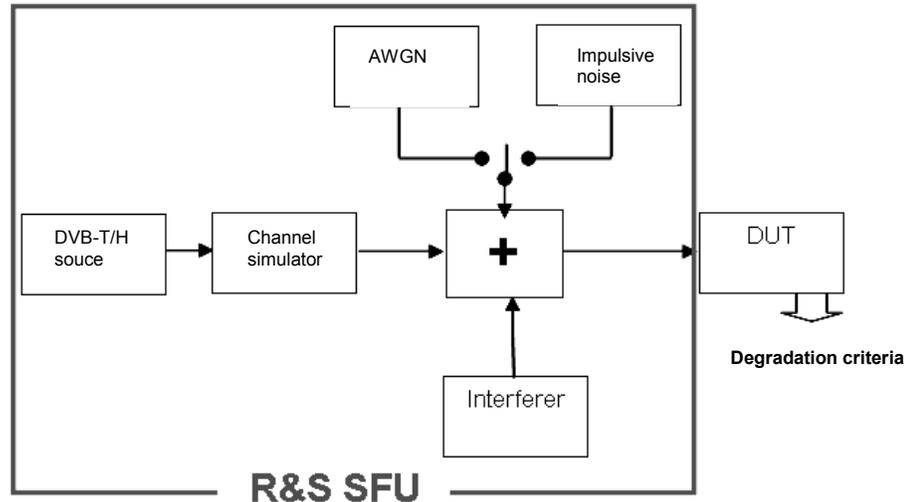
Fig. 1: Test setup for conformance tests in accordance with IEC 62002

As shown in the above schematic, a DVB-T/H signal source is affected by various interferences. The influence of these interferences on the receiver terminal is determined by means of various degradation criteria.

As previously mentioned, the MBRAI standard specifies different terminal categories. Depending on the category, one or more of the following criteria are used as reference values.

Degradation criteria

Degradation criteria are used to indicate whether a test case is processed successfully:

BER: bit error rate

Common definition: $BER = \dfrac{erroneous\_bits}{Total\_number\_of\_bits}$

Reference BER = 2 × 10^{-4} after Viterbi decoding. The quasi error-free (QEF) criterion defined by the DVB-T standard corresponds to the reference BER.

The bit error rate can also be determined by using the R&S®SFU. Please refer to the Application Note for the R&S®SFU "Measuring Bit Error Rate using the R&S®SFU-K60 Option" [3].
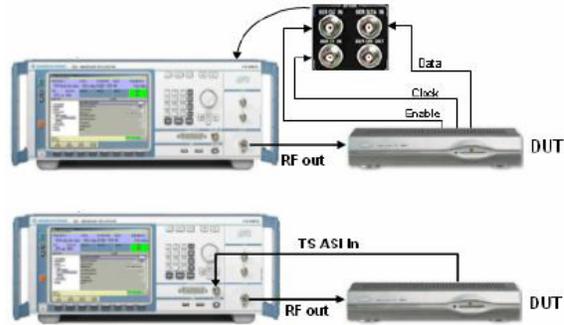
Fig. 2: BER test setup, using the R&S®SFU

PFP: picture failure point

The PFP criterion is the C/N or C/I value, where first picture errors appear on the display.

The criterion is met when more than one out of three consecutive 10-second periods of visual observation show an error. The PFP criterion can also be derived from the QEF criterion. Please refer to the MBRAI document for more information.

SFP: subjective failure point in mobile reception

The SFP criterion has been introduced for mobile reception environments.

It is defined as not more than one erroneous second in a visual observation period of 20 seconds. The SFP criterion can also be determined by measuring the packet error rate. Please refer to the MBRAI document for more details.

DVB-H error criterion

The degradation criterion in case of DVB-H is the MPE-FEC frame error rate (MFER). An MPE-FEC frame consists of MPE (IP payload data) and MPE-FEC sections (Reed Solomon data). Due to the Reed Solomon data, a fix of a certain number of errors in the MPE section can be applied.

The MFER is the percentage of erroneous frames after error correction:

$$MFER = \frac{Number\_of\_erroneous\_frames}{Total\_number\_of\_frames} x100\ \%$$

To ensure a meaningful value, at least 100 frames need to be captured. The degradation criterion is a 5 % MFER value.

In order to determine the degradation criterion, Rohde & Schwarz offers the R&S®DVM family for in-depth DVB-H analysis on the transport stream layer.

Please refer to the Application Note "DVB-H Measurements with the R&S®DVM" [4] for a more detailed information.
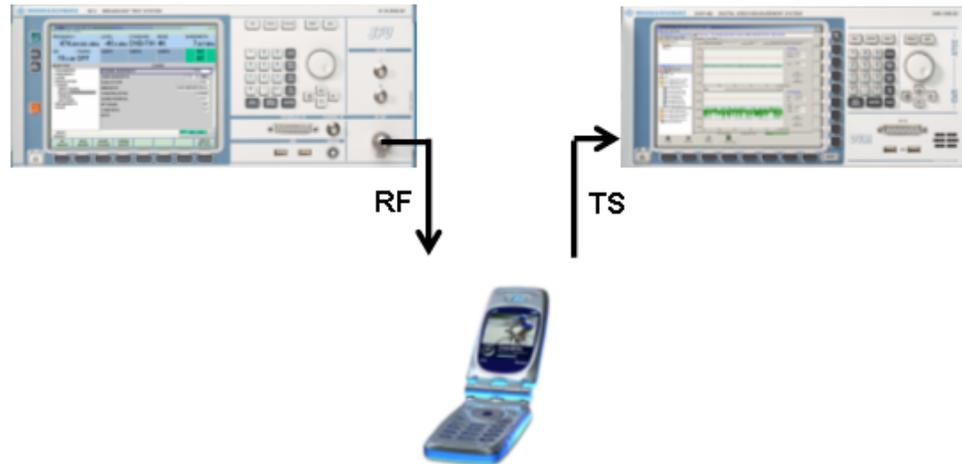
Fig. 3: Test setup for MBRAI-compliant DVB-H receivers

As the SFP and the MFER criterion are correlated according to MBRAI (ESR$_5$), a qualitative estimation of the MFER value is possible, using the SFP criterion. That is helpful in cases, where the TS is not provided through the DUT.

4   Overview of Test Cases

The test cases of the MBRAI standard can be divided into nine parts: C/N performance, input signal levels, immunity to analog and/or digital signals in other channels, immunity to co-channel interference, multipath reception within the guard interval, multipath reception outside the guard interval, impulsive noise, GSM900 TX signal blocking and mobile SFN channel.

C/N performance (Chapter 5 of IEC 62002-2)

The purpose of this scenario is to determine the carrier-to-noise level when the failure point criterion is met.

In order to find out the C/N performance of the DUT, different channel types are used:

• Gaussian: ideal channel conditions

• Portable: multipath channel without direct path

• Portable indoor (PI) and portable outdoor (PO)

• Mobile: terminal is moving in a car

Fig. 4: C/N test schematic

Receiver minimum and maximum input signal levels (Chapter 6 of IEC 62002-2)

This test determines the minimum and maximum input levels of the DUT.

For this purpose, MBRAI contains input level tests for different channels.

Fig. 5: Input level test schematic

Immunity to analog and/or digital signals in other channels (Chapter 7 of IEC 62002-2)

This scenario determines the performance of a receiver device in the presence of analog and/or digital signals in adjacent channels.

Five different test scenarios are specified. Two, the S1 and S2 patterns, contain only one analog or digital interferer. The test patterns L1, L2, L3 and L4 show two interferer signals (analog; digital).

Immunity to co-channel interference from analog TV signals (Chapter 8 of IEC 62002-2)

The co-channel interference test simulates an analog TV signal interfering with the actual useful signal in the same channel.

PAL I1, B/G, D1 and SECAM signals (depending on the area of operation) are overlaid to the useful signal.
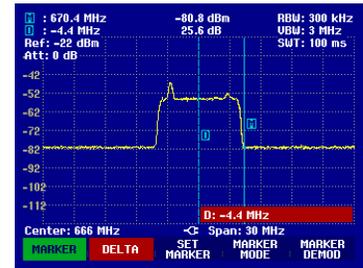
Fig. 6: Co-channel interference schematic

Guard interval utilization: echoes within the guard interval (Chapter 9 of IEC 62002-2)

The performance of a receiver is determined while echoes within the guard interval occur.

The receiver should be able to handle two static echo paths in the channel. The test ensures that the echoes, having certain attenuation, still allow proper reception.
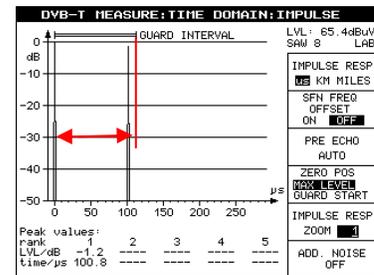
Fig. 7: Guard interval utilization (within guard interval) schematic

Guard interval utilization: echoes outside the guard interval (Chapter 10 of IEC 62002-2)

The performance of a receiver is determined while echoes outside the guard interval occur.

During the test, various delayed echoes are applied to the useful signal. The possible attenuation of the echoes is the parameter that needs to be adjusted.
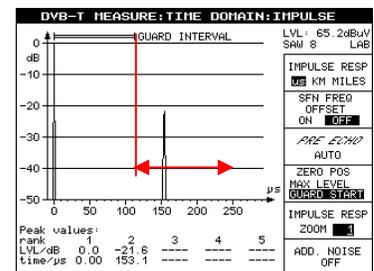
Fig. 8: Guard interval utilization (outside guard interval) schematic

Tolerance to impulse interference (Chapter 11 of IEC 62002-2)

This test determines the performance of receivers when impulsive noise interference is present.

The carrier-to-noise value for the impulsive interference is decreased for various noise conditions in one channel.

Fig. 9: Impulsive noise schematic

GSM900 TX signal blocking test (Chapter 12 of IEC 62002-2)

The blocking test should verify that the receiver sensitivity does not degrade too heavily when a GSM900 TX blocking signal is present at the receiver input.
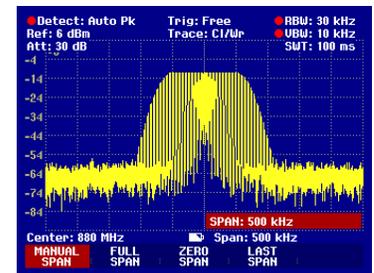
Fig. 10: GSM900 TX blocking signal

Mobile SFN channel test (Chapter 13 of IEC 62002-2)

In order to ensure that the receiver synchronization works correctly in mobile SFN networks and a sufficient mobile performance is ensured, the Mobile SFN channel test is processed.
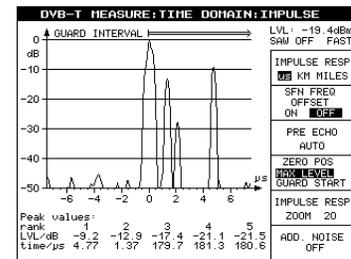
Fig. 11: Mobile SFN channel test schematic

5 R&S®SFU/SFE100 Configuration Depending on the Test Cases

Depending on the specific test case, different options for the R&S®SFU are required. The options also depend on the terminal category. Please pay attention to the below table, showing which R&S®SFU options are needed for the different test cases.

	Device options									
Test cases	TS Generator (R&S®SFU-K20) or TRP Player (R&S®SFU-K22)	DVB-T/H coder (R&S®SFU-K1)	Noise Generator AWGN (R&S®SFU-K40)	Impulsive noise (R&S®SFU-K42)	Fading simulator, 20 paths (R&S®SFU-B30)	Interferer Management (R&S®SFU-K37)	Arbitrary generator (R&S®SFU-K35)	Memory Extension (R&S®SFU-B3)	DTV interferer (R&S®SFU-K354)	Multi ATV predefined (R&S®SFU-K199)
C/N performance	X	X	X		X (C)					
Input signal levels	X	X								
Immunity to other signals (other channel)	X	X				X	X	X	X	X
Immunity to co-channel interferers	X	X				X	X	X		X
Multipath reception (within guard interval)	X	X	X		X					
Multipath reception (outside guard interval)	X	X			X					
Impulsive noise	X	X		X						
GSM900 TX signal blocking	X	X								
Mobile SFN channel test	X	X			X					

Table 1: R&S®SFU options for MBRAI tests (c = handheld convergence terminals)

Most of the test cases can be carried out with one R&S®SFU, used as shown below.

SFU 1: DVB-H signal
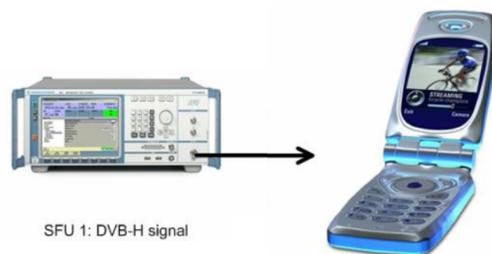
Fig. 12: Test setup for MBRAI-compliant DVB-H receivers with only one R&S®SFU

Additional signal sources are required in two test cases:

- GSM900 TX signal blocking.

  The setup of the GSM900 TX signal blocking test requires a separate CW source. In the example below, a R&S®SFE100 is used to generate this signal, using its arbitrary waveform generator (ARB) and the waveform library "DTV Interferer" R&S®SFU-K354. Both units are interconnected with

the first R&S®SFU over a highpass filter using a combiner. The resulting signal is fed to the device under test (DUT).
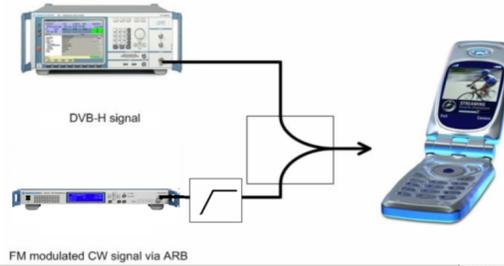
Fig. 13: Test setup for MBRAI-compliant DVB-H receivers

A possible solution is a R&S®SFE100 unit with the following options:

- o Arbitrary generator (R&S®SFE100-K35)
- o Memory extension (R&S®SFE100-B3)
- o DTV interferer (R&S®SFU-K354)

- Immunity to other signals (other channel) in case of pattern L4:

In case of test pattern L4, two additional signal generator units are required, as the frequency spacings between the interferer and the useful signal exceed the IQ bandwidth of the R&S®SFU. The possible setup could look as follows: A combiner is used to feed the three signals (R&S®SFU + 2 x R&S®SFE100) to the DUT.
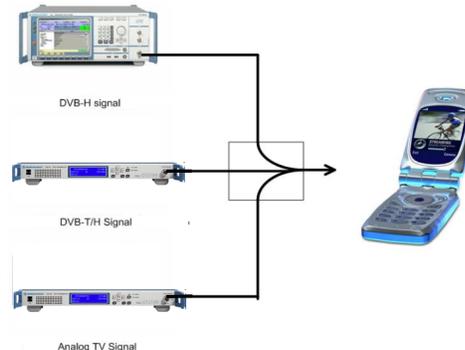
Fig. 14: Test setup for MBRAI-compliant DVB-H receivers

- o One R&S®SFE100 for the analog interferer signal unit containing the following:
    - ATV-x (R&S®SFE100-K19x)
    - Video generator (R&S®SFE100-K23)
- o One R&S®SFE100 for the digital interferer signal
    - Arbitrary generator (R&S®SFE100-K35)
    - Memory extension (R&S®SFE100-B3)
    - DTV/MBRAI interferer (R&S®SFU-K354)

6 General R&S®SFU Settings

Every initial setup of a test case requires a configuration of some basic device settings such as transmission mode, modulation parameters, center frequency and output level.

Since the basic settings are the same for all tests, this procedure is shown only once below. The test cases each contain only the test-case-specific steps.

General TX settings

1. Preset the R&S®SFU.

2. Set the DVB-T/H transmission mode.
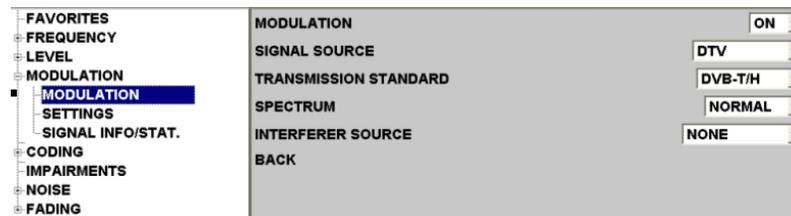
3. Enter the center frequency (in this case, 666 MHz).
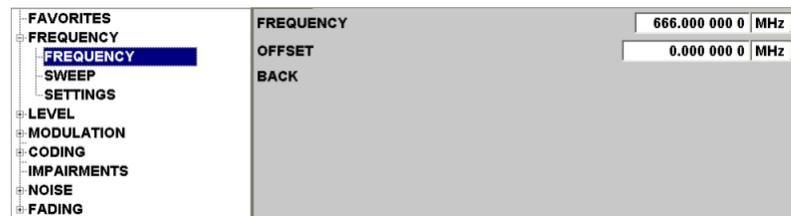
4. Configure the DVB-T/H transmission standard (in this case, 8 MHz channel BW, QPSK modulation and code rate ½).
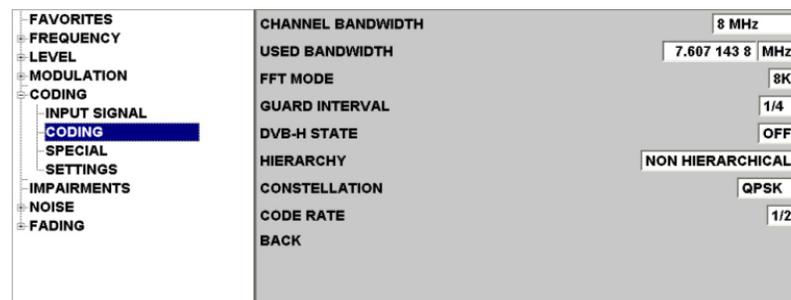
5. Set the desired input signal: Set the source to TS PLAYER. In case of DVB-H, set stuffing to OFF.
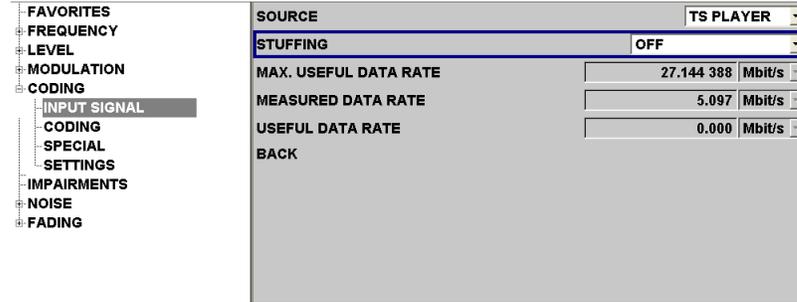
General TSGEN settings

1. Change to TSGEN using the <APPL> key and menu or softkeys:
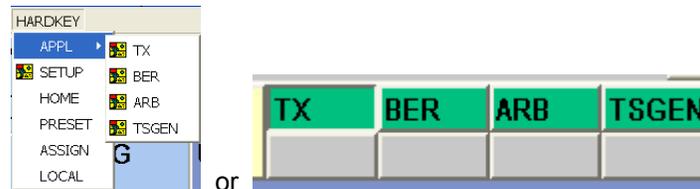
2. Select your desired *.GTS or *.TRP file and your desired TS data rate:
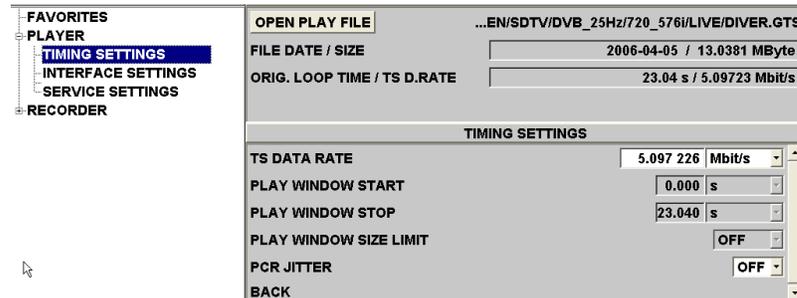
Note: In case of DVB-H signal generation, special transport streams (TS) fitting to the different settings (CodeRate Viterbi, CodeRate MPE-FEC, Burst Length, PID, Destination IP address) are required.

3. Start the chosen TS file using the PLAY button:

7 Test Case Examples Using the R&S®SFU/SFE100

As previously mentioned, the IEC 62002-1/2 standard defines seven basic test scenarios. This chapter shows an example for every scenario, using the R&S®SFU.

7.1 C/N Performance

Details of the test case example

Determines the point TP4 (characterization point for C/N versus Doppler) in IEC 62002-1 for DVB-H receivers. Item 3 of table 6:

- Frequency: 666 MHz

- Level: -50 dBm

- FFT: 8k; constellation: 16QAM; guard interval: 1/4; code rate: 1/2; MPE-FEC CR: ¾; Doppler Shift: 10 Hz

Settings on the R&S®SFU

1. Switch on fading.
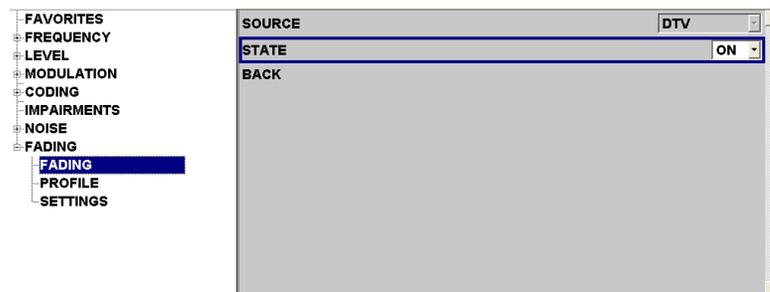
2. Change to profile menu.

3. Configure fading path 1 (10 Hz Doppler shift).

	1 - 1
STATE	ON
PROFILE	PURE DOPPLER
PATH LOSS [dB]	0.00
BASIC DELAY [us]	0.00
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	0.000
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	8.95
FREQ RATIO	0.48
RES DOPPLER SHIFT [Hz]	10.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

4. Switch on noise.
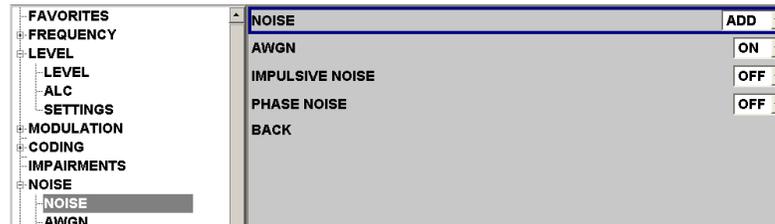
5. Adjust the C/N value to determine TP4 of the MBRAI standard.
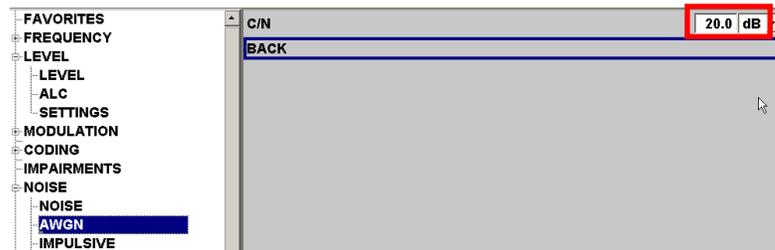
7.2 Receiver Minimum and Maximum Input Signal Levels

Details of the test case example

In case of QPSK modulated signals (DVB-T) with code rate ½ in a 8 MHz channel (channel 45), the following requirements need to be met:

- Minimum input level: -94.6 dBm

- Maximum input level (terminal category b, c): -28 dBm or higher

Settings on the R&S®SFU

Adjust the level value in order to determine MBRAI compliance.

Creating Test Scenarios in Accordance with IEC 62002 Ed. 2.0
(MBRAI) Using the R&S®SFU
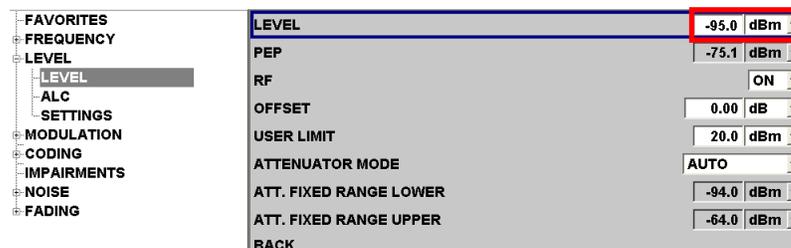
7.3 Immunity to Analog and/or Digital Signals in Other Channels

Details of the test case example

As part of this example, test pattern L1 includes an analog and a digital interferer signal with the following characteristics:
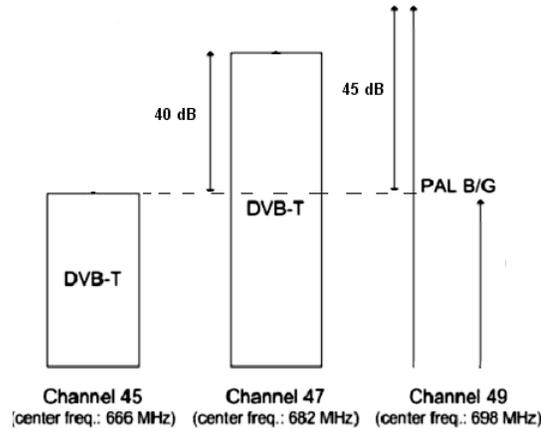
The useful DVB- H signal in the example above in channel 45 has the following characteristics:

- FFT: 8k

- Constellation: 16QAM

- Code rate = 2/3

- Guard interval = 1/8

The DVB-T interferer signal needs to be compliant with ETSI EN 300 744. The analog PAL B/G interferer needs to meet following requirement:

- Modulating signals: 75 % color bar, 1 kHz FM sound with +/- 50 Hz deviation, any NICAM modulation

- Level ratio vision carrier / FM carrier: 13 dB

- Level ratio vision carrier / NICAM carrier: 20 dB

- Filter roll off factor: 40 %

Settings on the R&S®SFU

In order to specify the analog and digital interferers on the R&S®SFU, apply the following settings:

1. Select "ATV PREDEF." as the interferer source.

2. Choose the desired kind of interferer signals: You can choose between single and multiple interferer in accordance with the MBRAI specifications. For the L1 scenario, select "DVB-T + PAL G (MBRAI)".

3. In order to generate the useful signal at 666 MHz, a special frequency configuration is required. Due to the default alignment of the interferer signal, a frequency shift to the set output frequency is necessary. Set the INTERFERER FREQUENCY OFFSET to 24.0 MHz (3 x 8 MHz, due to channel spacing).
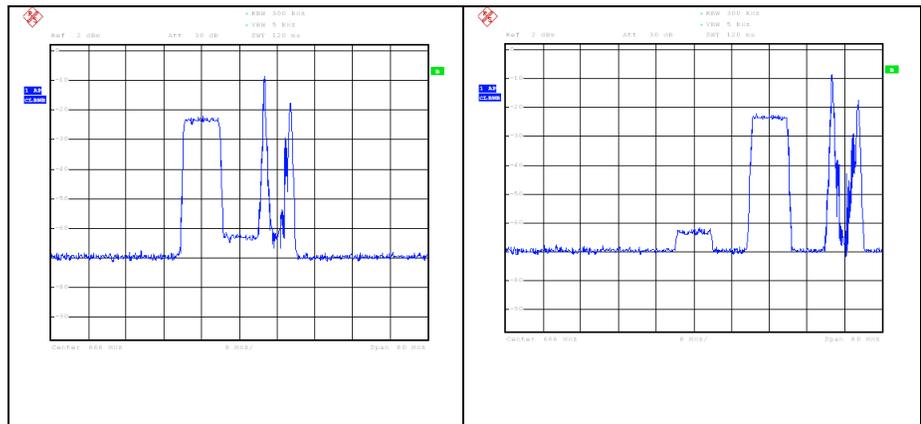
Fig. 15: Interferer frequency offset = 0 MHz and 24 MHz

4. In order to avoid any negative influences of the residual carrier, it is advisable to use a configuration which ensures that the residual carrier is not part of the useful signal.

    Therefore the set output frequency of the R&S®SFU needs to be outside the tested signal.

    For this purpose, the item SIGNAL FREQUENCY OFFSET has been introduced. It allows a frequency offset from the residual carrier, which exists at the set output frequency of the R&S®SFU.

    To generate a realtime modulated signal at 666 MHz without any residual carrier influence, apply the following settings:

    - Set the actual R&S®SFU output frequency to 674 MHz

    - Apply an INTERFERER FREQUENCY OFFSET of 16 MHz and a SIGNAL FREQUENCY OFFSET of -8 MHz, as shown in the picture on page 15.

5. In this case, it is advisable to calibrate the vector modulator. To do this, select the SETUP key:

    Select SETUP from the menu:

    In the window which appears, go to ADJUSTMENT and execute the VECTOR MODULATION LOCAL function:
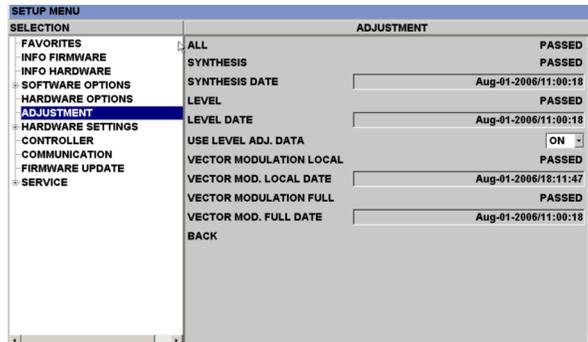
6. To activate interferer addition, select the desired interferer addition mode. If no noise is active, "after noise" and "before noise" addition are equal.

7. Finally, adjust interferer attenuation in order to determine the MBRAI compliance (marked in red in the picture on page 15).

For further details regarding the interferer function of the R&S®SFU, please refer to the Rohde & Schwarz Application Note 7BM50 [5].

7.4 Immunity to Co-Channel Interference from Analog TV Signals

Details of the test case example

Useful digital signal:

- DVB-T signal at channel 45 (center frequency = 666 MHz; bandwidth = 8 MHz)
- Level: -50 dBm
- FFT: 8k; constellation: 64QAM; code rate = 2/3; guard interval = 1/8

Interferer signal:

- PAL B/G
- C/I = 4 dB

Settings on the R&S®SFU

Access the modulation menu, and specify the interferer settings as shown:
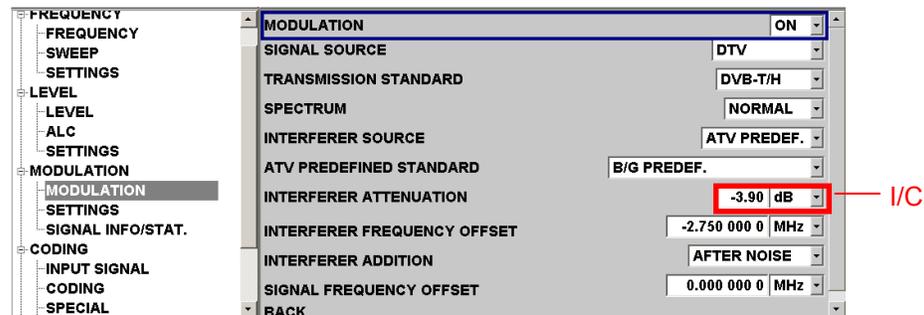
1. Select "ATV PREDEF." as the interferer source.

2. Choose the desired kind of interferer signals: You can choose between single and multiple interferer in accordance with the MBRAI specification. For this scenario, select "PAL B/G PREDEF."

3. With INTERFERER FREQUENCY OFFSET set to 0 MHz, the vision carrier frequency of the analog interferer equals the set output frequency. In order to generate a co-channel interference for standard G, in this case apply an offset of -2.75 MHz (UHF, in VHF apply -2.25 MHz) so that the analog interferer channel and the realtime coded digital channel correspond.

4. To activate the interferer addition, select the desired interferer addition mode. If no noise is active, "after noise" and "before noise" addition are equal.

5. Finally, adjust interferer attenuation in order to determine the MBRAI compliance (marked in red in the picture on page 17).

For further details regarding the interferer function of the R&S®SFU, please refer to the Rohde & Schwarz Application Note 7BM50 [5].

7.5 Guard Interval Utilization: Echoes Within the Guard Interval

Details of the test case example

The following parameters are used for the test:

- Channel 45 (666 MHz)

- Level: -40 dBm

- FFT: 8k; constellation: 64QAM; code rate = 2/3; guard interval = 1/8

- C/N = 26.2 dB

Echoes:

- Path 1: Attenuation = 0 dB, delay = 0 s

- Path 2: Attenuation = 0 dB, delay = 100.8 µs

- Path 3: Attenuation = -1 dB, delay = 100.8 µs, Doppler shift = 0.2 Hz

Settings on the R&S®SFU

1. Switch on noise.
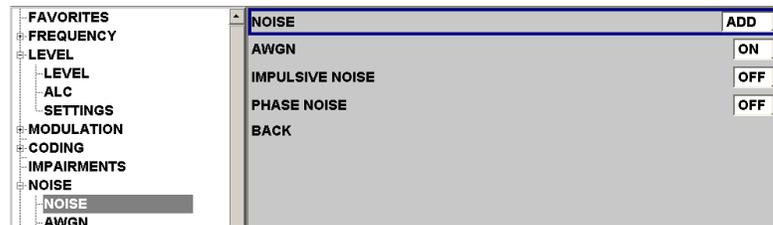
2. Set the C/N value.

3. Switch on fading.

FAVORITES	SOURCE	DTV
FREQUENCY	STATE	ON
LEVEL	BACK	
MODULATION		
CODING		
IMPAIRMENTS		
NOISE		
FADING		
FADING		
PROFILE		
SETTINGS		

4. Change to profile menu.

FADING
  FADING
  PROFILE
  SETTINGS

5. Configure fading path 1.

	1 - 1
STATE	ON
PROFILE	STATIC PATH
PATH LOSS [dB]	1.00
BASIC DELAY [us]	0.00
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	0.000
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	0.00
FREQ RATIO	0.00
RES DOPPLER SHIFT [Hz]	0.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

6. Configure fading path 2.

	2 - 1
STATE	ON
PROFILE	STATIC PATH
PATH LOSS [dB]	1.00
BASIC DELAY [us]	100.80
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	100.800
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	0.00
FREQ RATIO	0.00
RES DOPPLER SHIFT [Hz]	0.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

7. Configure fading path 3.

	2 - 2
STATE	ON
PROFILE	PURE DOPPLER
PATH LOSS [dB]	0.00
BASIC DELAY [us]	100.80
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	100.800
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [km/h]	0.61
FREQ RATIO	0.10
RES DOPPLER SHIFT [Hz]	0.20
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

7.6 Guard Interval Utilization: Echoes Outside the Guard Interval

Details of the test case example

Produce the echo with the delay time Tc, which is outside the guard interval. Now the echo level needs to be adjusted until the QEF criterion is met.

The following parameters are used for the test:

- Channel 45 (666 MHz)

- Level: -40 dBm

- FFT: 8k; constellation: 64QAM; code rate = 2/3; guard interval = 1/8

Echoes:

- Path 1: Attenuation = 0 dB, delay = 0s

- Path 2: Attenuation = variable, delay = 145.6 µs

Settings on the R&S®SFU

1. Switch on fading.

SOURCE	DTV
STATE	ON
BACK	

FAVORITES
FREQUENCY
LEVEL
MODULATION
CODING
IMPAIRMENTS
NOISE
FADING
 FADING
 PROFILE
 SETTINGS

2. Change to profile menu.

FADING
 FADING
 PROFILE
 SETTINGS

3. Configure fading path 1.

	1 - 1
STATE	ON
PROFILE	STATIC PATH
PATH LOSS [dB]	0.00
BASIC DELAY [us]	0.00
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	0.000
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	0.00
FREQ RATIO	0.00
RES DOPPLER SHIFT [Hz]	0.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

4. Configure fading path 2, where the path attenuation is varied:

	2 - 1
STATE	ON
PROFILE	STATIC PATH
PATH LOSS [dB]	0.00
BASIC DELAY [us]	145.60
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	145.600
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	0.00
FREQ RATIO	0.00
RES DOPPLER SHIFT [Hz]	0.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0
PHASE [Deg]	0.00

7.7 Tolerance to Impulse Interference

Details of the test case example

The following scenario shows how to apply one impulsive noise test model to a DVB-T/H signal in accordance with IEC 62002-2.

The following parameters are used for the test:

- Channel 45 (666 MHz)

- Level: -60 dBm

- FFT: 8k; constellation: 64QAM; code rate = 2/3; guard interval = 1/8

For this example, test number 5 is used:

- Pulses per burst: 20

- Effective burst duration: 5 µs

- Min. pulse spacing: 1 µs

- Max. pulse spacing: 2 µs

- Range of actual burst durations: 19.25 µs to 38.25 µs

- 64QAM modulation and code rate 2/3

Settings on the R&S®SFU

1. Activate impulsive noise.
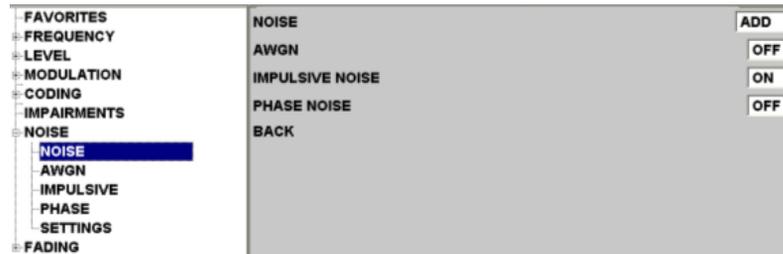
2. Set following impulsive noise configuration, and vary the C/I value to determine MBRAI compliance.
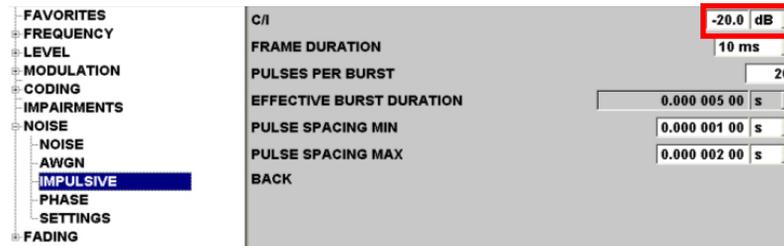
Note: The meaning of the configuration values for the impulsive noise is explained in this schematic.
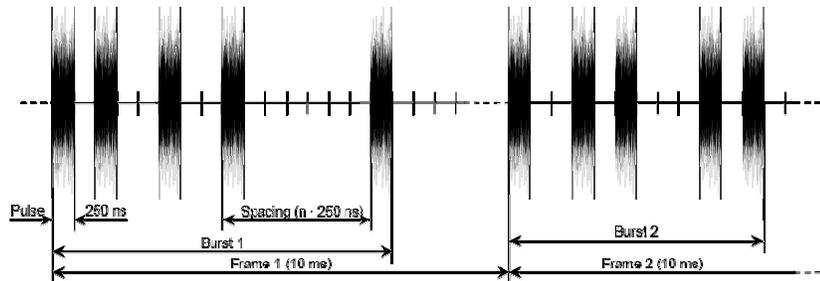
- The effective burst duration is computed from the frame duration and the number of pulses per burst.

- The actual burst duration is an automatic R&S®SFU setting.

7.8 GSM900 TX signal blocking test

Details of the test case example

The described test case verifies whether the R&S DVB-H receiver supports interoperability with a GSM900 transmitter (blocking signal).

The useful DVB-H signal needs to show following characteristics:

- Channel 55: 746 MHz

- FFT: 8K; constellation: QPSK; code rate = ½; guard interval = ¼; MPE-FEC = ¾;

- Level < -94.1 dBm

The GSM interferer signal simulated by a FM spectrum is defined as follows:

- CW carrier with +/- 50 kHz deviation and 1 kHz frequency

- CW signal level at least 18 dBm

- CW frequency: 880 MHz (lowest available GSM900 TX channel)

Settings on the R&S®SFU/SFE100

The first R&S®SFU, generating the useful signal, is configured as described in chapter 6 "General R&S®SFU Settings". Divergent from this section of the document, the second signal source R&S®SFE100 generating the CW interferer is required to be run with "ARB" as signal source instead of "DTV":
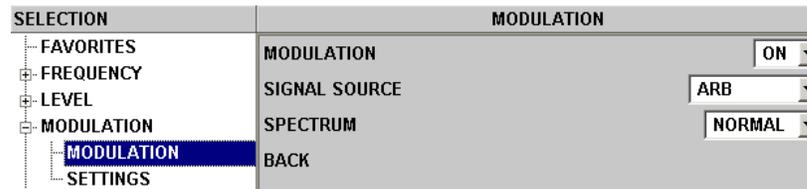
or
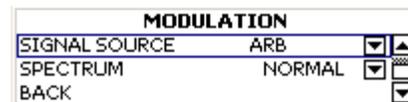
Configuration of the ARB signal

1. Change to ARB using the <APPL> key and menu or softkeys:
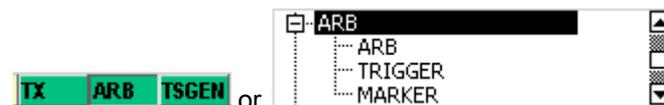
 or

2. In the window that appears, go to the "ARB" menu item, switch ARB to "ON", and click "Load Waveform".
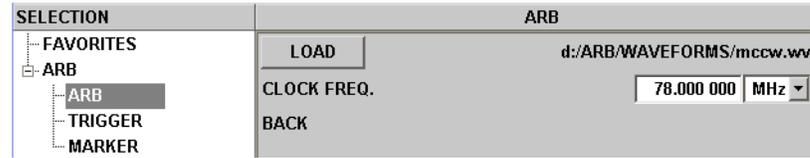
or
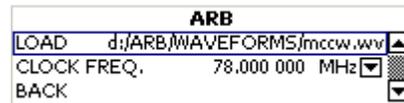
3. Select "FM_JAMER_50kHz.wv" from the folder "DTV_INTERFERERS".
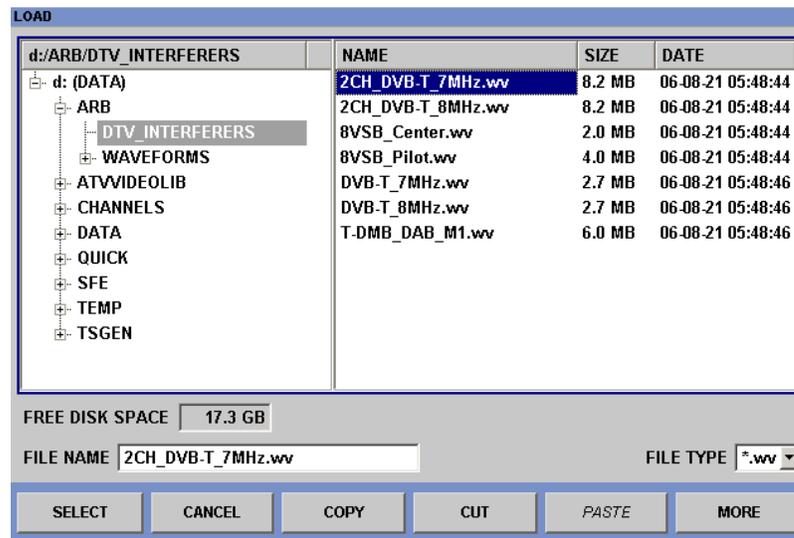
or

7.9 Mobile SFN channel test

Details of the test case example

In order to ensure that the receiver synchronization also works correctly in a mobile SFN environment, three mobile SFN channel models (weak long echo, strong long echo, strong short echo) are checked.

The useful DVB-H signal needs to show following characteristics:

- Channel 45: 666 MHz

- FFT: 8K; constellation: 16QAM; code rate = ½; guard interval = ¼; MPE-FEC = ¾;

For this example, the weak long echo channel is chosen. There are twelve Rayleigh paths, defined as follows (Delay/us, Power/dB): (0.0/-3), (0.2/0), (0.5/-2), (1.6/-6), (2.3/-8), (5.0/-10), (179.2/-13.6), (179.4/-10.6), (179.9/-12.6), (180.8/-16.6), (181.5/-18.6), (184.2/-20.6).

Additionally apply a Doppler shift of 10 Hz at the primary path. With this setting, the C/N value can be varied until C/N$_{min}$ is met. With this value, one is able to vary the Doppler shift setting in order to check for MBRAI compliance.

Settings on the R&S®SFU

1. Switch on fading.
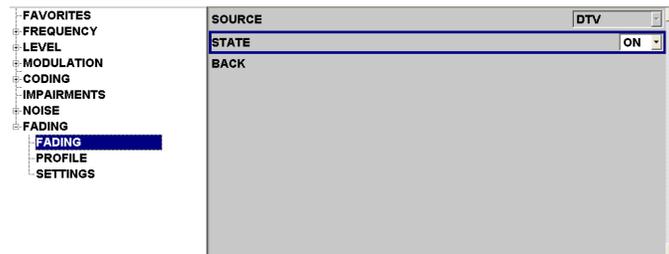
2. Change to profile menu.

3. Configure the fading paths.

STATE	ON
PROFILE	RAYLEIGH
PATH LOSS [dB]	3.00
BASIC DELAY [us]	0.00
ADDIT. DELAY [us]	0.00
RESULTING DELAY [us]	0.00
POWER RATIO [dB]	0.00
CONST PHASE [Deg]	0.0
SPEED [m/s]	16.20
FREQ RATIO	1.00
RES DOPPLER SHIFT [Hz]	10.00
CORRELATION PATH	OFF
COEFFICIENT [%]	0

For all twelve fading paths, set the profile entry to "Rayleigh" and switch the state to on.

For fading taps 1 to 6, use R&S®SFU fading paths 1-1 to 2-1. Enter the corresponding path delay and path attenuation in entries "Path Loss" and "Additional Delay". Additionally apply a Doppler shift of 10 Hz in the first path. For fading taps 7 to 12, use R&S®SFU fading paths 3-1 to 4-1. Enter the basic delay of 179.2 µs. Specifically enter the additional delay to meet the specified overall delays.

4. Switch on noise.
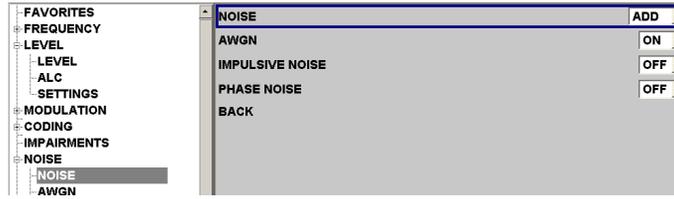
5. Adjust the C/N value to determine C/N$_{min}$.
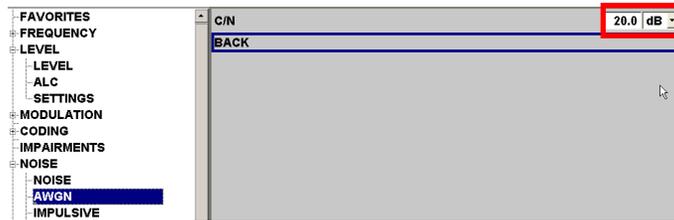
6. With the specified C/N$_{min}$ vary the Doppler shift setting in the fading section.

8 References

[1] International Electrotechnical Commission (Ed.) (2005). International Standard IEC 62002-1. Mobile and portable DVB-T/H radio access – Part 1: Interface specification. International Electrotechnical Commission.

Or:

European Information & Communications Technology Industry Association (Ed.) (2007). Mobile and portable DVB-T/H radio access – Part 1: Interface specification. Brussels: EICTA website: http://www.eicta.org .

[2] International Electrotechnical Commission (Ed.) (2005). International Standard IEC 62002-2. Mobile and portable DVB-T/H radio access – Part 2: Interface conformance testing. International Electrotechnical Commission.

Or:

European Information & Communications Technology Industry Association (Ed.) (2007). Mobile and portable DVB-T/H radio access – Part 2 Interface conformance testing. Brussels: EICTA website: http://www.eicta.org .

[3] Tan, C K (2005). Application Note 7BM51. Measuring Bit Error Rate using the R&S®SFU-K60 Option. Munich: Rohde & Schwarz GmbH & Co. KG website: http://www.rohde-schwarz.com.

[4] Gsoedl, Harald (2006). Application Note 7BM60. DVB-H Measurements with the R&S®DVM. Munich: Rohde & Schwarz GmbH & Co. KG website: http://www.rohde-schwarz.com.

[5] Tan, C K (2005). Application Note 7BM50. Generating Interference Signals using the R&S® SFU-K37 Option. Munich: Rohde & Schwarz GmbH & Co. KG website: http://www.rohde-schwarz.com.

9 Additional Information

Our Application Notes are regularly revised and updated. Check for any changes at http://www.rohde-schwarz.com.

Please send any comments or suggestions about this Application Note to

Broadcasting-TM-Applications@rohde-schwarz.com.

10 Ordering Information

R&S®SFU

Type	Designation	Order no.
R&S SFU	Broadcast Test System	2110.2500.02
R&S SFU-B1	Coder Extension 1	2110.7424.02
R&S SFU-B10	Coder Extension 10	2110.7747.02
R&S SFU-B11	ETI Input/Output	2110.7553.03
R&S SFU-B30	Fading Simulator	2110.7530.02
R&S SFU-B31	Fading Simulator Extension to 40 Paths	2110.7547.02
R&S SFU-B4	Memory Extension 2	2110.7453.02
R&S SFU-B5	User I/O	2110.7460.02
R&S SFU-B6	Additional Hard Disk	2110.7501.02/03
R&S SFU-B90	High Power and Overvoltage Protection	2110.8008.02
R&S SFU-K1	DVB-T/H Coder	2110.7301.02
R&S SFU-K10	MediaFLO Coder	2110.7524.02
R&S SFU-K108	AMC Coder	only on request
R&S SFU-K11	T-DMB/DAB Coder	2110.7518.02
R&S SFU-K120	DMB-TH Coder	2110.7760.02
R&S SFU-K190	ATV Standard B/G Coder	2110.8050.02
R&S SFU-K191	ATV Standard D/K Coder	2110.8037.02
R&S SFU-K192	ATV Standard I	2110.8043.02
R&S SFU-K193	ATV Standard M/N Coder	2110.8066.02
R&S SFU-K194	ATV Standard L Coder	2110.8072.02
R&S SFU-K199	Multi ATV Predefined	2110.8089.02
R&S SFU-K2	DVB-C Coder	2110.7324.02
R&S SFU-K20	TS Generator	2110.7476.02
R&S SFU-K21	TS Recorder	2110.7482.02
R&S SFU-K22	TRP Player	2110.7499.02
R&S SFU-K221	T-DMB/DAB Streams	2110.4348.02
R&S SFU-K23	Video Generator	2110.7799.02
R&S SFU-K3	DVB-S/DSNG Coder	2110.7330.02
R&S SFU-K30	Enhanced Fading	2110.7560.02
R&S SFU-K32	DAB Gaussian Fading	2110.7630.02
R&S SFU-K35	ARB Generator	2110.7601.02
R&S SFU-K351	T-DMB/DAB Waveforms	2110.4277.02
R&S SFU-K352	DVB-H Waveforms	2110.4425.02
R&S SFU-K353	DRM Waveforms	2110.4554.02
R&S SFU-K354	DTV Interferers	2110.4690.02
R&S SFU-K356	Cable Interferers	2110.3212.02
R&S SFU-K4	ATSC/8VSB Coder	2110.7353.02
R&S SFU-K37	Interferer Management	2110.7647.02
R&S SFU-K40	Noise AWGN	2110.7653.02
R&S SFU-K41	Phase Noise	2110.7660.02
R&S SFU-K42	Impulsive Noise	2110.7676.02
R&S SFU-K43	Multinoise Use	2110.7682.02
R&S SFU-K5	J.83/B Coder	2110.7360.02
R&S SFU-K6	ISDB-T Coder	2110.7376.02
R&S SFU-K60	BER Measurements	2110.7782.02
R&S SFU-K7	DMB-T Coder	2110.7382.02
R&S SFU-K8	DVB-S2 Coder	2110.7399.02
R&S SFU-K80	Extended I/Q	2110.7953.02
R&S SFU-K81	Realtime Disabled	2110.7960.02
R&S SFU-K82	Realtime Enabled	2110.7976.02
R&S SFU-K9	DIRECTV	2110.7401.02
R&S SFU-U43	Upgrade Kit for R&S SFU-K43	2110.7699.02
R&S DV-DVBH	DVB-H Stream Library	2085.8704.02
R&S DV-H264	H.264 Stream Library	2085.7650.02
R&S DV-HDTV	HDTV Sequences	2085.7650.02
R&S DV-ISDBT	ISDB-T Stream Library	2085.9146.02
R&S DV-TCM	Test Card M Streams	2085.7708.02

R&S®SFE100

Type	Designation	Order no.
R&S SFE100	Test Transmitter	2112.4100.02 / 2112.4100.03
R&S SFE100-K1	DVB-T/H	2113.4003.02
R&S SFE100-K2	DVB-C	2113.4026.02
R&S SFE100-K3	DVB-S/DSNG	2113.4049.02
R&S SFE100-K4	ATSC/8VSB	2113.4061.02
R&S SFE100-K5	J.83/B	2113.4084.02
R&S SFE100-K6	ISDB-T/ISDB-Tsb	2113.4103.02
R&S SFE100-K8	DVB-S2	2113.4126.02
R&S SFE100-K9	DirecTV	2113.4149.02
R&S SFE100-K10	MediaFLO™	2113.4161.02
R&S SFE100-K11	T-DMB/DAB	2113.4184.02
R&S SFE100-K12	DTMB	2113.4203.02
R&S SFE100-K190	ATV-B/G	2113.4649.02
R&S SFE100-K191	ATV-D/K	2113.4661.02
R&S SFE100-K192	ATV-I	2113.4684.02
R&S SFE100-K193	ATV-M/N	2113.4703.02
R&S SFE100-K194	ATV-L	2113.4726.02
R&S SFE100-K20	TS Generator, includes SDTV stream library	2113.4861.02
R&S DV-DVBH	DVB-H Stream Library	2085.8704.02
R&S DV-TCM	Test Card M-Streams	2085.7708.02
R&S DV-HDTV	HDTV Sequences	2085.7650.02
R&S DV-H264	H.264 Stream Library	2085.9052.02
R&S DV-ISDBT	ISDB-T Stream Library	2085.9146.02
R&S SFU-K221	T-DMB/DAB Streams	2113.4348.02
R&S SFE100-K22	TRP Player	2113.5268.02
R&S SFE100-K23	Video Generator	2113.4884.02
R&S SFE100-K35	ARB Generator model	2113.4926.02
R&S SFU-K351	T-DMB/DAB Waveforms	2110.4277.02
R&S SFU-K352	DVB-H Waveforms	2110.4425.02
R&S SFU-K353	DRM Waveforms	2110.4554.02
R&S SFU-K354	DTV Interferer Waveforms	2110.4690.02
R&S SFU-K355	MediaFLO™ Waveforms	2110.2974.02
R&S SFU-K356	Cable Interferer Waveforms	2110.3212.02
R&S SFE100-K80	Extended I/Q Input	2113.5245.02
R&S SFE100-B90	Power Amplifier	2112.4900.02
R&S SFE100-B3	Memory Extension	2112.4400.02

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