

DVB-T/H Transmitter Measurements for Acceptance, Operation and Monitoring

Application Note

Products:

| R&S®ETL | R&S®DVSG

This application note describes how to perform acceptance, operational and monitoring measurements on a digital terrestrial television transmitter based on the Digital Video Broadcasting – Terrestrial / Handheld (DVB-T/H) standard.

As compared to analog television, digital television requires significantly fewer measurement parameters to evaluate the quality of the transmitter output signal. The most important parameters are:

- Transmitter output level
- Bit error ratio (BER)
- Modulation error ratio (MER)
- Shoulder attenuation

© 2009 Rohde & Schwarz GmbH & Co. KG
81671 Munich, Germany

Subject to change – Data without tolerance limits is not binding.
R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG.
Trade names are trademarks of the owners.

The following abbreviations are used throughout this document:
R&S®XYZ is abbreviated as R&S XYZ.

Table of Contents

1	Overview	2
2	Test Setup	3
3	Measurements	5
3.1	Transmitter Output Level	5
3.2	Bit Error Ratio	8
3.3	Modulation Error Ratio	10
3.4	I/Q Imbalance on the Modulator	11
3.5	Shoulder Attenuation	13
3.6	Out-of-Band Emissions	17
3.7	Crest Factor	19
3.8	Amplitude Frequency Response and Group Delay	21
3.9	Initial Carrier Frequency Tolerance	22
3.10	TPS	23
3.11	Constellation Diagram.....	25
4	Abbreviations	26
5	Literature	26
6	Additional Information	26
7	Ordering Information	27

1 Overview

This application note describes how to perform acceptance, operational and monitoring measurements on a digital terrestrial television transmitter based on the Digital Video Broadcasting – Terrestrial / Handheld (DVB-T/H) standard. As compared to analog television, digital television requires significantly fewer measurement parameters to evaluate the quality of the transmitter output signal. The most important parameters are:

- Transmitter output level
- Bit error ratio (BER)
- Modulation error ratio (MER)
- Shoulder attenuation

This document is structured as follows: Chapter 2 presents the test setup and its device requirements. Chapter 3 explains the particular measurements. Finally, ordering information is given.

2 Test Setup

The following measurement equipment is needed to perform measurements on the DVB-T/H transmitter:

- R&S DVSG MPEG-2 transport stream generator
- R&S ETL TV analyzer with the latest firmware
- Average power sensor; for example R&S NRP-Z91
- Dummy antenna
- GPS receiver with 10 MHz reference output and 1 pps output, for example R&S ED170
- Highpass filter to attenuate the wanted signal by 40 dB or more, for example MiniCircuits

The required device options are listed in Chapter 7.

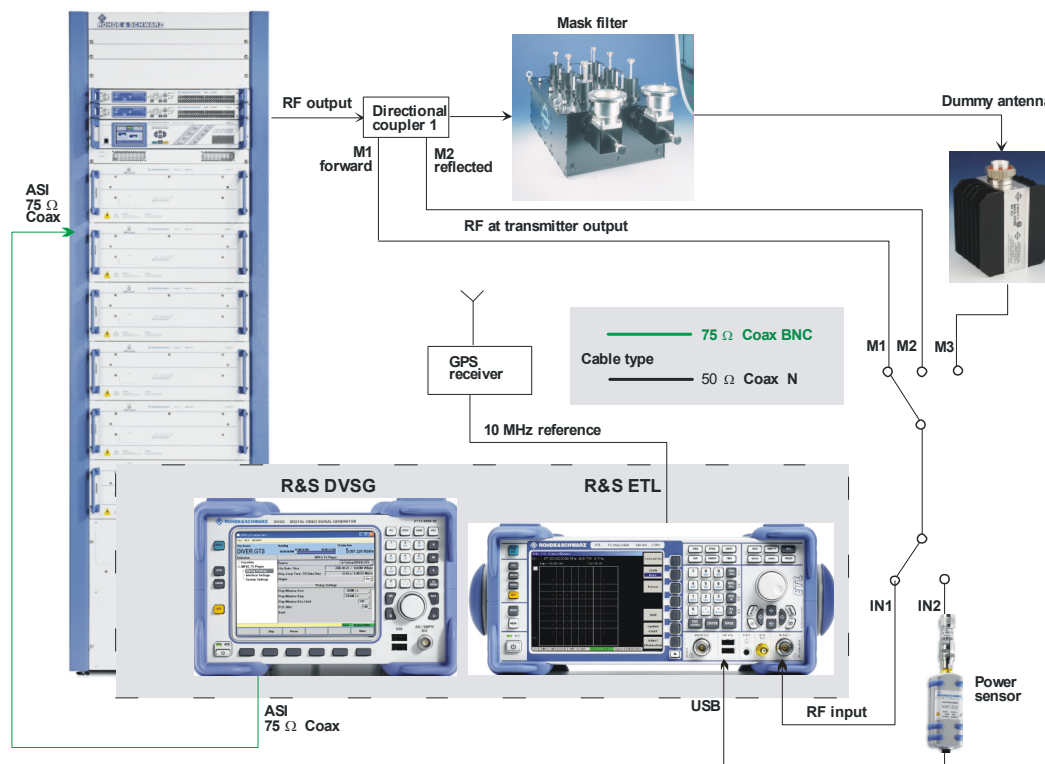


Fig. 2-1: Test setup

The R&S DVSG feeds the DVB-compliant MPEG-2 transport stream to the transport stream input on the DVB-T/H transmitter. The transmitter output is connected to a dummy antenna. If installed, the mask filter is located between the transmitter output and the dummy antenna. The RF input of the R&S ETL TV analyzer (IN1) or the power sensor (IN2) is connected as follows for the various measurements:

- to the test port on the transmitter output (M1 = forward, M2 = reflected)
- to the test port on the dummy antenna (M3)

The R&S ETL TV analyzer is connected to the power sensor using one of its USB ports and to the GPS receiver using its reference input.

Default settings on the R&S ETL TV analyzer

Unless specified otherwise in the individual sections, the following default settings are always used on the R&S ETL TV analyzer to perform TV transmitter measurements:

Reference frequency

Set R&S ETL SETUP:REFERENCE EXT to use the external 10 MHz reference frequency.

Spectrum Analyzer mode

- Center Frequency at mid-channel
- Span 15 MHz or 20 MHz
- Detector RMS (in the TRACE menu)
- RBW 30 kHz
- VBW 300 kHz
- Sweep Time 2 s

TV Analyzer/Receiver mode

- Digital TV Settings: OFDM DVB-T/H
- Bandwidth 6 MHz, 7 MHz, or 8 MHz, depending on standard
- Select RF depending on transmitter frequency
- Special Settings: System Opt. Slow/Laboratory
- Important: Always press MENU:ADJUST ATTENUATION before every measurement

3 Measurements

3.1 Transmitter Output Level

The definition of transmitter output level for digital television is different from its definition for analog television. DVB-T/H signals are noiselike signals, in contrast to vestigial sideband, AM-modulated analog TV signals. In the case of analog television, the synchronous pulse peak power is used as the power definition, while for digital television, the average power is measured versus the RMS value. The average power is constant for digital television, and not dependent on the picture contents, like it is in analog television. The transmitter output is followed by the mask filter, which can be implemented in either a critical or an uncritical mask. The filter itself has an attenuation of between 0.1 dB and 0.3 dB, depending on the technology used (coaxial or dual-mode waveguide). Therefore, the power has to be recorded both before and after the mask filter. The measurement itself takes place using a power sensor. This is connected to a calibrated test port on the transmitter output or on the dummy antenna. Measurements using the power sensor provide the greatest accuracy; alternatively, of course, the signal level can also be measured using the R&S ETL TV analyzer set to TV Analyzer/Receiver mode via the RF input on the R&S ETL.

Procedure:

1. Connect the power sensor (IN2) (connected to R&S ETL via USB) to the test port on the transmitter output (M1).
2. Switch transmitter on.
3. On the R&S ETL, press MENU:POWER METER.
4. Read the measured value from the R&S ETL.
5. Alternatively, feed a signal into the RF input on the R&S ETL (50 ohm, IN1) and read the level from the MEAS:OVERVIEW menu.
6. Add to that the correction value from the test port.
7. Connect the power sensor (IN2) (connected to R&S ETL via USB) to the test port on the dummy antenna (M3).
8. Read the measured value from the R&S ETL.
9. Alternatively, feed a signal into the RF input (50 Ohm, IN1) on the R&S ETL and read the level from the MEAS:OVERVIEW menu (first press ADJUST ATTENUATION).
10. Add to that the correction value from the test port.

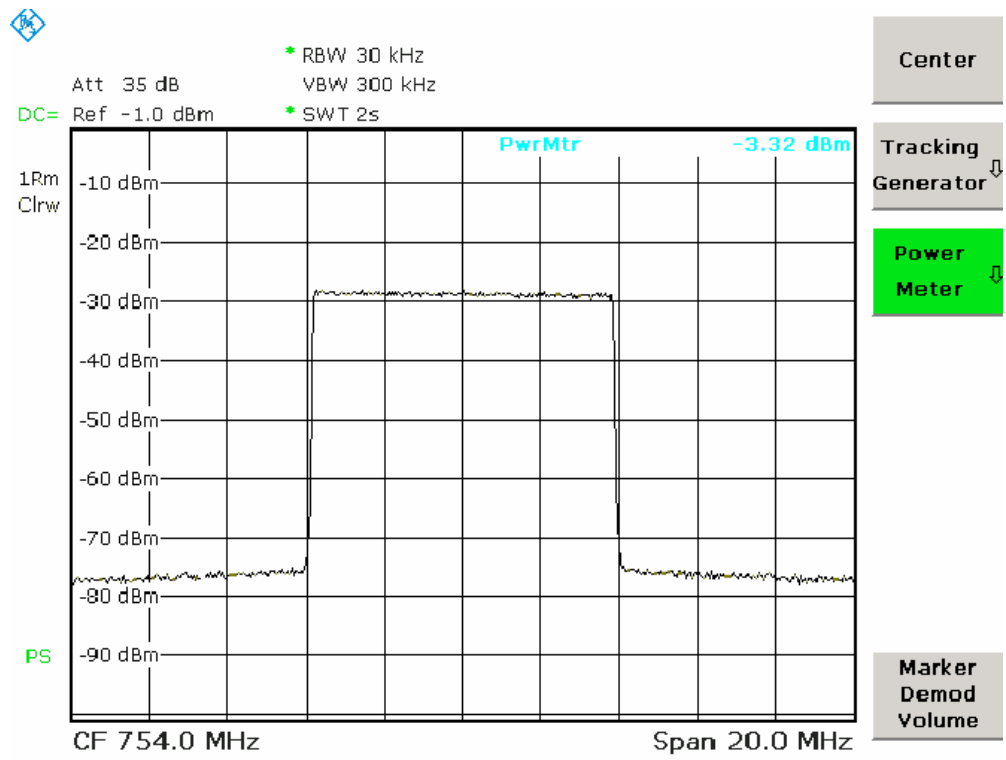


Fig. 3-1: DVB-T spectrum with integrated reading from the power sensor

Ch: --- RF 754.000000 MHz DVB-T/H 8 MHz

* Att 30 dB

DC= SigLvl -2.5 dBm

Level

-0.9 dBm

Fail	Limit	<	Results	<	Limit	Unit
Level	-60.0		-0.9		10.0	dBm
Constellation			16 QAM NH / normal			
MER (rms)	24.0	*	12.3		-----	dB
MER (peak)	10.0	*	3.7		-----	dB
EVM (rms)	-----	*	18.17		4.40	%
EVM (peak)	-----	*	62.93		22.00	%
BER before Viterbi			2.1e-2(10/10)		1.0e-2	
BER before RS			1.1e-4(10/10)		2.0e-4	
Packet Error Ratio			0.0e-5(75/100)		1.0e-8	
Packet Errors			0		1	/s
Carrier Freq Offset	-30000.0		-25.9		30000.0	Hz
Bit Rate Offset	-100.0		0.0		100.0	ppm
MPEG Ts Bitrate			14.929411			MBit/s

PS

16 QAM NH (16NH)	FFT 8k (8k)	GI 1/4 (1/4)	3/4,3/4 (3/4,3/4)	Cell ID 0
TPS Res. 0,0,0,0	INT N (N)	MPE FEC Off/Off	Time Sl. Off/Off	LI 1F

Lvl -0.9dBm | BER 1.1e-4 | MER 12.3dB DEMOD MPEG

Fig. 3-2: MEAS:OVERVIEW menu in TV Analyzer/Receiver mode on the R&S ETL with integrated level readings (zoom level, level result in the 2nd table row and along the bottom of the test screen)

Similarly, the power sensor (IN2) can also be used to measure the reflected power at measurement point M2 at the test port on the transmitter output.

3.2 Bit Error Ratio

DVB-T/H provides an outer and an inner error correction: RS (Reed-Solomon) block coding and convolutional coding. The counterparts at the receiver end are the Viterbi decoder and the Reed-Solomon decoder. As a result, the following three BERs (Bit Error Ratios) are available in the DVB-T/H receiver:

- Bit error ratio before Viterbi (BER before Viterbi)
- Bit error ratio after Viterbi or before Reed-Solomon (BER before RS)
- Bit error ratio after Reed-Solomon (BER after RS)

All interference on a DVB-T/H transmission path can be expressed as bit error ratios (BER). In the case of a functional DVB-T/H transmitter, only the BER before Viterbi can differ from null. It will lie in the range of 10^{-9} or less. With small BERs, it is necessary to select correspondingly long measurement times. For acceptance tests, these will be hours, while they will be minutes for monitoring tests.

Procedure:

1. Connect the R&S ETL TV analyzer to the test port on the transmitter output (M1) or the dummy antenna (M3).
2. Switch transmitter on.
3. On the R&S ETL, select OVERVIEW from the test menu.
4. Press MENU:ADJUST ATTENUATION.
5. On the R&S ETL, press BER reset.
6. Allow the test – lasting from several minutes to several hours – to run completely.
7. Read and document the BERs.

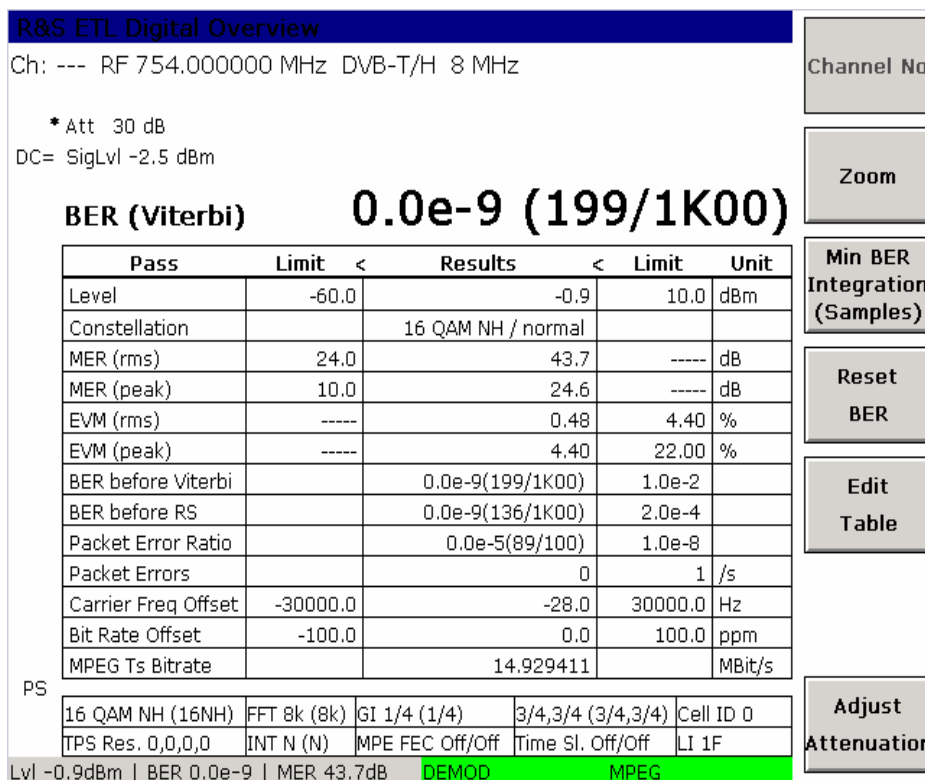


Fig. 3-3: R&S ETL test screen with zoomed BER before Viterbi, as well as BER before RS and packet errors after RS

3.3 Modulation Error Ratio

The modulation error ratio (MER) is a measure of the sum of all interference that affects a digital TV signal. It is typically expressed in dB as a logarithmic relationship between the RMS value of the signal amplitude and the MER. A high MER value indicates good signal quality. In practice, the MER lies in the range of 0 dB to 40 dB. A good DVB-T/H transmitter has a MER in the range of approximately 35 dB. When receiving DVB-T/H signals over a roof antenna with gain, a MER of 20 dB to 30 dB would be measurable at the antenna box. Values between 13 dB and 20 dB are expended for portable receivers with a room antenna. At the same time, the MER is the single most important quality parameter for a DVB-T/H transmitter. The MER can be expressed as an averaged value over all COFDM subcarriers or as MER(f) in a graph via the DVB-T/H channel.

Procedure:

1. Connect the R&S ETL TV analyzer (IN1) to the test port on the transmitter output (M1) or the dummy antenna (M3).
2. Switch transmitter on.
3. On the R&S ETL, select MEASURE:MODULATION ANALYSIS: MER(f).
4. Use the SPAN menu to select the carrier range FULL SPAN (0 to 6816 or 0 to 1705).
5. Important: SPEC SETTING:SYSTEM OPT:Slow/Laboratory
6. Select MENU:ADJUST ATTENUATION.
7. Use PRINT to print the test screen.

Ch: --- RF 754.000000 MHz DVB-T/H 8 MHz

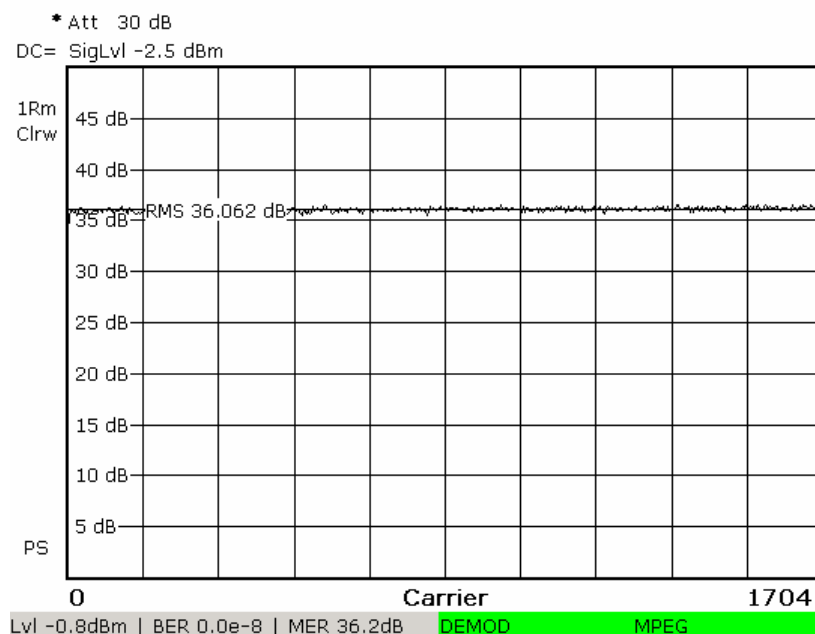


Fig. 3-4: MER as a function of the frequency, and integrations of the MER averaged over the channel

3.4 I/Q Imbalance on the Modulator

DVB-T/H modulators are essentially an IFFT signal processing block followed by an I/Q modulator. This I/Q modulator can be either digital or analog. If a DVB-T/H modulator uses direct modulation, then the I/Q modulator is analog. In this case, it must be aligned cleanly and must not exhibit any of the following:

- I/Q imbalance
- I/Q phase error, quadrature error
- Carrier leakage

Carrier leakage is recognizable directly in mid-band (around carrier number 3408 or 852) on MER(f) as a "notch" and results in a contorted and compressed constellation diagram in mid-band. I/Q imbalance and I/Q phase error negatively affect the MER of all COFDM carriers. The carriers above DVB-T/H mid-band relate to the carriers under mid-band and vice versa.

Procedure:

1. Connect the R&S ETL TV analyzer (IN1) to the test port on the transmitter output (M1) or the dummy antenna (M3).
2. Switch transmitter on.
3. On the R&S ETL, select MEAS:MODULATION ANALYSIS:MODULATION ERRORS from the menu.
4. Important: SPEC SETTING:SYSTEM OPT:Slow/Laboratory
5. Select MENU:ADJUST ATTENUATION.
6. Print the test screen or document the amplitude imbalance, quadrature error, and carrier leakage.

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

* Att 0 dB
SigLvl -32.5 dBm

Fail	Limit	<	Results	<	Limit	Unit
Level	-60.0		-34.0		10.0	dBm
Amplitude Imbalance	-2.00	*	-2.23		2.00	%
Quadrature Error	-2.00		1.94		2.00	deg
Carrier Suppression	10.0		17.0			dB
Carrier Phase			-164.8			deg
MER (rms)	24.0		31.0		-----	dB
MER (peak)	10.0		17.1		-----	dB
EVM (rms)	-----		1.85		4.40	%
EVM (peak)	-----		9.16		22.00	%

Lvl -34.0dBm | BER 0.0e-9 | MER 31.0dB DEMOD MPEG

Fig. 3-5: Modulation errors

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

* Att 0 dB
SigLvl -32.5 dBm

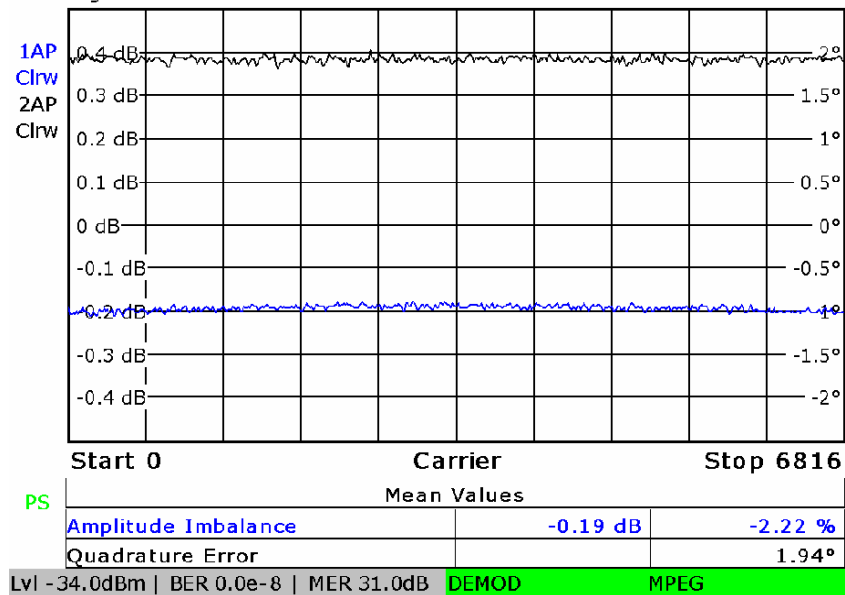


Fig. 3-6: I/Q imbalance and I/Q phase error

3.5 Shoulder Attenuation

DVB-T/H transmitters include very linear AB amplifiers. These are further linearized by a digital preliminary correction stage in the modulator. In spite of these, some residual nonlinearities remain. These cause intermodulation products to form from the many COFDM carriers. These intermodulation products are recognizable as "white noise" in the user channel and along the edges. These edges are called DVB-T/H signal shoulders. To further reduce the shoulders, mask filters can be used in a critical or uncritical mask. An important measurement parameter is the shoulder attenuation. It is determined either via cursor measurements using a spectrum analyzer or using the "tangent method" defined in the DVB measurement guidelines [1]. The R&S ETL TV analyzer supports both, i.e. the cursor method in Spectrum Analyzer mode and the tangent method in DVB-T/H Analyzer mode. Both methods have practical uses; however, because of their different definitions, they do not lead directly to the same result:

Procedure for method 1 (cursor method):

1. Connect the R&S ETL (IN1) to the corresponding test port M1 or M3.
2. Change the R&S ETL to Spectrum Analyzer mode.
3. Select the following settings on the spectrum analyzer:
 - a. Center Frequency at mid-band on the DVB-T/H channel
 - b. Span 15 MHz
 - c. Detector RMS
 - d. RBW 30 kHz
 - e. VBW 300 kHz
 - f. Sweep Time 2 s
 - g. Marker 1 at center
 - h. Marker 2 at + 4.2 MHz over center (8 MHz channel)
 - i. Marker 3 at -4.2 MHz under center (for 7 MHz channel use +/- 3.7 MHz)
 - j. Read the marker delta values.

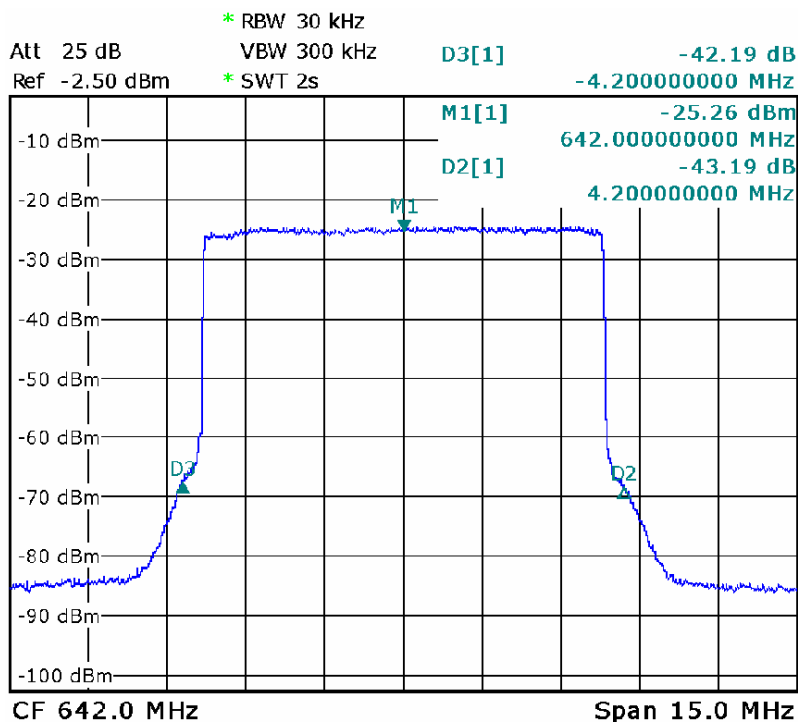


Fig. 3-7: Measuring the shoulder attenuation using the cursor method at +/- 4.2 MHz in the 8 MHz DVB-T channel

Procedure for method 2 (tangent method):

1. Connect the R&S ETL to the corresponding test port M1 or M3.
2. Change the R&S ETL to TV Analyzer/Receiver mode.
3. Press MENU:ADJUST ATTENUATION.
4. Select MEAS:SPECTRUM.
5. Set SHOULDER ON.
6. Print the test screen.

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

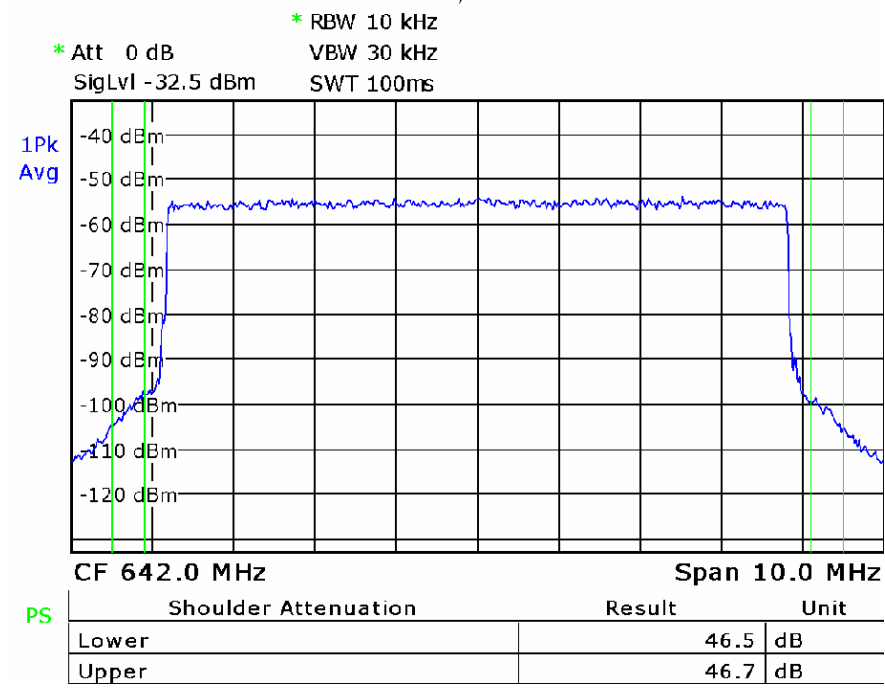


Fig. 3-8: Measuring the shoulder attenuation using the tangent method in accordance with the DVB measurement guidelines [1]

Table 3-1: Tolerance masks for shoulder attenuation using the uncritical mask:

f_{rel} [MHz] at 7 MHz channel bandwidth	f_{rel} [MHz] at 8 MHz chan- nel bandwidth	Attenuation [dB] as compared to total channel power at 4 kHz reference bandwidth	Attenuation [dB] at 7 MHz channel band- width	Attenuation [dB] at 8 MHz channel band- width
+/-3.4	+/-3.9	-32.2 (7 MHz) -32.8 (8 MHz)	0	0
+/-3.7	+/-4.2	-73	-40.8	-40.2
+/-5.25	+/-6.0	-85	-52.8	-52.2
+/-10.5	+/-12.0	-110	-77.8	-77.2
+/-13.85		-126	-93.8	

Table 3-2: Tolerance masks for shoulder attenuation using the critical mask:

f_{rel} [MHz] at 7 MHz channel bandwidth	f_{rel} [MHz] at 8 MHz chan- nel bandwidth	Attenuation [dB] com- pared to total channel power at 4 kHz refer- ence bandwidth	Attenuation [dB] at 7 MHz channel band- width	Attenuation [dB] at 8 MHz channel band- width
+/-3.4	+/-3.9	-32.2 (7 MHz) -32.8 (8 MHz)	0	0
+/-3.7	+/-4.2	-83	-50.8	-50.2
+/-5.25	+/-6.0	-95	-62.8	-62.2
+/-10.5	+/-12.0	-120	-87.8	-87.2
+/-13.85		-126	-93.8	

Adjacent channel transmissions farther away at over +/-10 MHz are more difficult to measure, because this requires an attenuation of over 80 dB as compared to the user channel. To measure these adjacent channel transmissions, the useful channel must be masked using a notch filter calibrated to the useful channel so that the spectrum analyzer can be used to conduct the measurement. It is also possible to measure the mask filter using the tracking generator in order to mathematically subtract the mask filter characteristics from the DVB-T/H spectrum before the mask filter and thus to simulate a measurement after the mask filter.

3.6 Out-of-Band Emissions

In addition to adjacent channel transmissions (shoulders), harmonics can also occur at multiples of the transmit frequency. A harmonics filter in the transmitter output ensures that these harmonics are suppressed. These out-of-band emissions can be measured using a spectrum analyzer or using the R&S ETL TV analyzer in Spectrum Analyzer mode. Because the mask filter does not suppress these harmonics, but rather affects only the channel near range, the harmonics can be measured at the test port on the transmitter output. However, this also requires that a suitable highpass filter be used to suppress the user channel by 40 dB or more. Notch filters have the disadvantage that they do not attenuate in just the useful band, but rather are "repeated" at multiples of the useful band.

Procedure:

1. Select a highpass filter and document using the R&S ETL tracking generator.
2. Connect the highpass filter to the test port on the transmitter (M1) and to the RF input on the R&S ETL (IN1).
3. Switch transmitter on.
4. Change the R&S ETL to Spectrum Analyzer mode.
5. Select Center 1.5 GHz and Span 3 GHz.
6. Search for the out-of-band emissions.
7. Pay special attention to the range around the multiples of the transmit frequency.

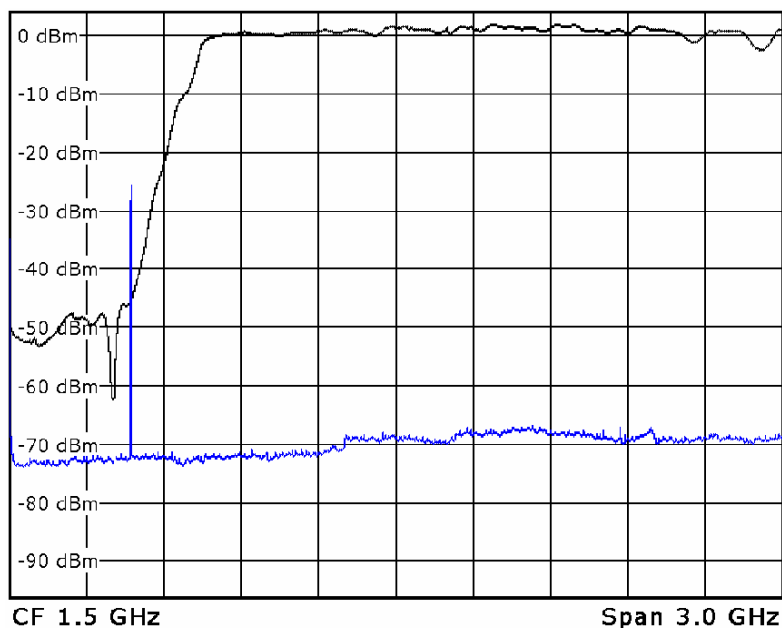


Fig. 3-9: Filter characteristics of a highpass filter compared to the useful channel

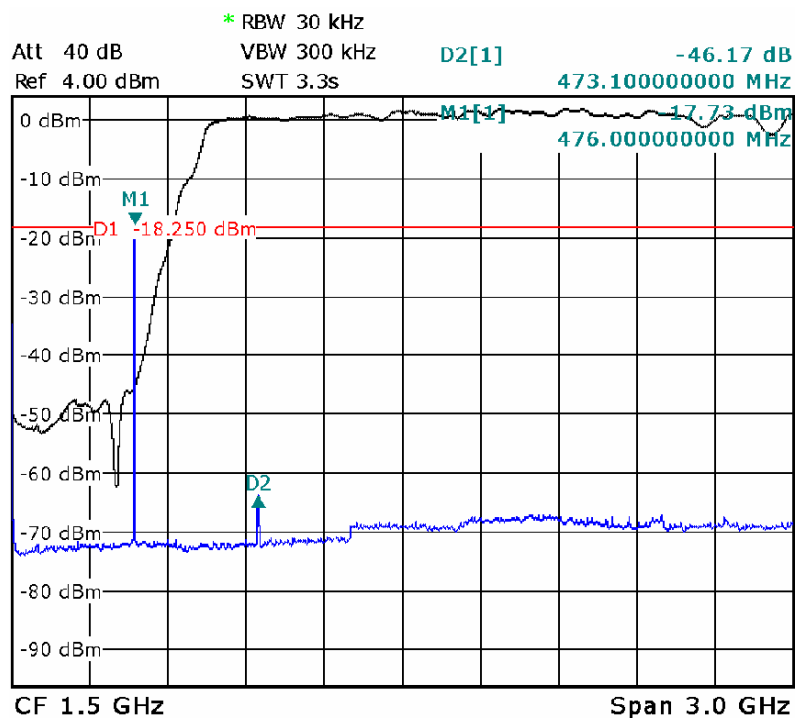


Fig. 3-10: Useful channel unattenuated compared to the first harmonic; the display line marks the level in the useful channel

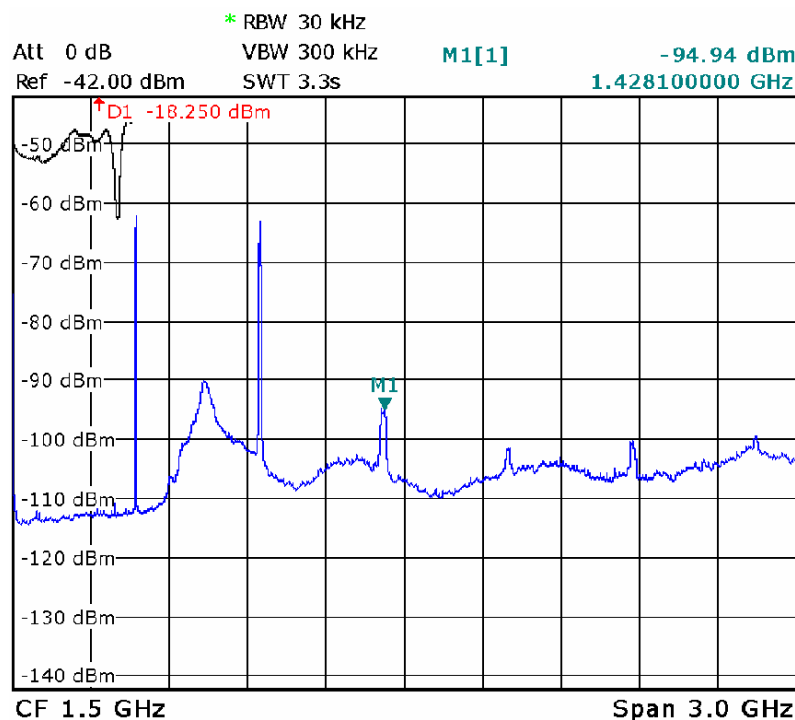


Fig. 3-11: Useful channel attenuated using the highpass filter; the display line marks the level in the useful channel; the figure shows the first and second harmonic and the attenuated useful channel (in this case: 474 MHz)

3.7 Crest Factor

The crest factor defines the relationship between the highest occurring signal amplitude and the RMS value of a signal. It is defined as:

$$Cf = 20 \cdot \log\left(\frac{U_{PEAK}}{U_{RMS}}\right)$$

OFDM signals exhibit a very high crest factor because essentially all carriers could be overlaid or even eliminated at any given moment. In the case of OFDM, the following relationship applies to the theoretical crest factor:

$$Cf_{OFDM} = 10 \cdot \log(2N), \text{ where } N = \text{number of carriers}$$

For DVB-T/H in 8K mode, it is theoretically over 40 dB. On transmitters, it is typically limited to about 13 dB. It is important to know the crest factor so that the components that follow the transmitter – such as the mask filter, the antenna splitter, the coaxial cable, and the antenna – can be adequately dimensioned. The crest factor is measured using the R&S ETL directly at the test port on the transmitter (M1).

Procedure:

1. Connect the R&S ETL to the test port on the transmitter (M1).
2. Switch transmitter on.
3. Select MEAS:MODULATON ANALYSIS:CCDF from the menu.
4. Press MENU:ADJUST ATTENUATION
5. Allow the test to run completely.
6. Read the measured value on the R&S ETL.
7. Add a correction value of 3 dB¹ and note the result.

¹ For measurements with a spectrum analyzer featuring CCDF (complementary cumulative distribution function) capability, it should be taken into account that an instrument of this type measures the peak envelope power (PEP) rather than the absolute voltage peaks that occur in the amplifier. The measured value, therefore, has to be corrected by a factor of $\sqrt{2}$ or 3.01 dB. [2]

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz
 RBW 8 MHz

* Att 0 dB
 SigLvl -32.5 dBm AQT 3.333s

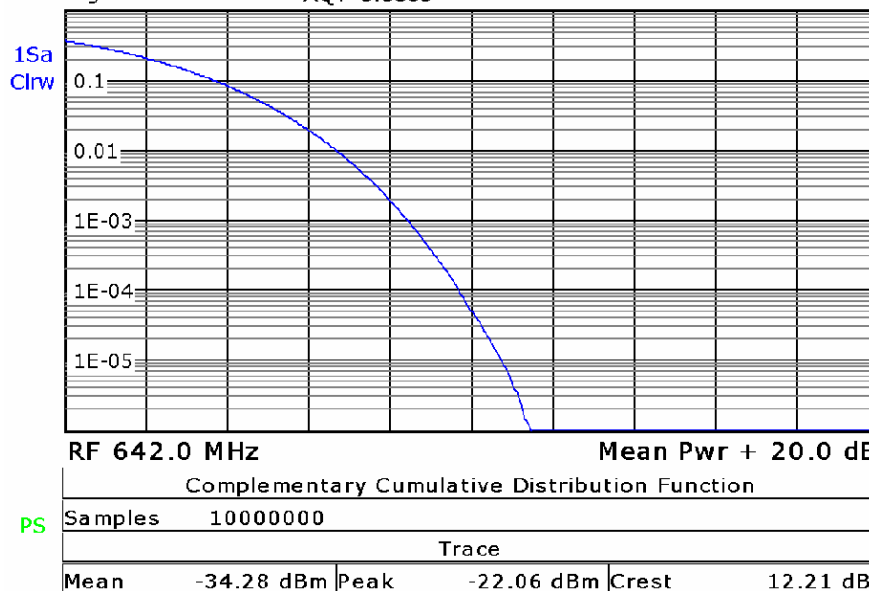


Fig. 3-12: CCDF function with crest factor reading

3.8 Amplitude Frequency Response and Group Delay

In analog televisions, amplitude frequency response and group delay were important parameters for a transmission path between the transmitter output and the receiver input. Because of the channel correction in the DVB-T/H receiver, significantly larger tolerances can now be permitted without noticeable reductions in quality. The mask filter and antenna combiners cause the linear distortions. These linear distortions can be compensated with the equalizer within the transmitter. As a result, however, the linear distortions reappear reversed directly at the transmitter output. Therefore, amplitude frequency response and group delay are measured at a test port in the antenna combiner.

Procedure:

1. Connect the R&S ETL to the test port.
2. Switch transmitter on.
3. Select MEAS:CHANNEL ANALYSIS:AMPLITUDE&GROUP DELAY from the menu.
4. Call MENU:ADJUST ATTENUATION.
5. Press AUTORANGE.
6. Print the test screen.

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

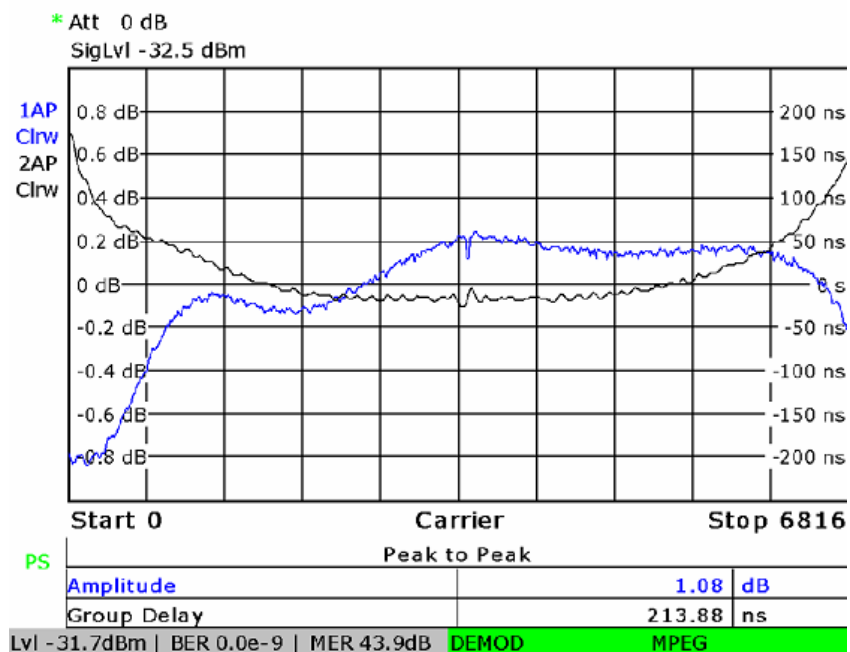


Fig. 3-13: Amplitude frequency response and group delay after an uncompensated mask filter, measured using the R&S ETL

3.9 Initial Carrier Frequency Tolerance

In single frequency networks (SFN), in particular, very stringent requirements are placed on the initial carrier frequency tolerance (ICFT) of a DVB-T/H transmitter of less than 10^{-9} . Due to the external 10 MHz reference from the GPS receiver, the ICFT of the transmitter can be measured using the R&S ETL TV analyzer operating in TV Analyzer/Receiver mode. The measurement can take place at the test port (M1) on the transmitter output.

Procedure:

1. Connect the R&S ETL to the test port on the transmitter output.
2. Switch transmitter on.
3. Select MEAS:OVERVIEW from the menu.
4. Press MENU:ADJUST ATTENUATION
5. Note the Carrier Freq Offset reading.

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

* Att 0 dB
SigLvl -32.5 dBm

Carr Freq Offset -300.0 mHz

	Pass	Limit	<	Results	<	Limit	Unit
		-60.0		-32.0		10.0	dBm
				64 QAM NH / normal			
		24.0		43.5		-----	dB
		10.0		18.9		-----	dB
		-----		0.44		4.40	%
Ext		-----		7.45		22.00	%
				0.0e-9(845/1K00)		1.0e-2	
				0.0e-9(583/1K00)		2.0e-4	
				0.0e-6(386/1K00)		1.0e-8	
				0		1	/s
		-30000.0		-0.3		30000.0	Hz
		-100.0		0.0		100.0	ppm
				22.394118			MBit/s
PS							
	64 QAM NH (64NH)	FFT 8k (8k)	GI 1/4 (1/4)	3/4,3/4 (3/4,3/4)		Cell ID 0	
	TPS Res. 0,0,0,0	INT N (N)	MPE FEC Off/Off	Time Sl. Off/Off		LI 1F	
Lvl -32.0dBm BER 0.0e-9 MER 43.5dB DEMOD MPEG							

Fig. 3-14: Measuring the initial carrier frequency tolerance (ICFT) of a DVB-T/H transmitter using the R&S ETL

3.10 TPS

In the case of DVB-T/H, the transmission parameter signaling (TPS) carrier transmits a total of 67 TPS bits in the four frames of a superframe. The TPS bits signal the currently selected transmission parameter. The 67 TPS bits can sometimes differ in the four frames of a superframe. They comprise the following:

- Initialization word
- Length indicator
- Data burst in line with DVB-T standard
- Reserved bits
- Error protection

In an SFN, it is important that all involved transmitters send out the correct TPS bits and that these bits are completely identical. This is why the transmitted TPS information must be checked. Some of the reserved bits are currently being used as follows:

- Cell ID
- DVB-H signaling

The TPS information is checked using an R&S ETL TV analyzer connected to the test port on the TV transmitter, in the MEAS:OVERVIEW menu.

Procedure:

1. Connect the R&S ETL to the test port on the transmitter output.
2. Switch transmitter on.
3. On the R&S ETL, select MEAS:OVERVIEW from the menu.
4. Print the test screen or take note of the final two lines.

Ch: --- RF 642.000000 MHz DVB-T/H 8 MHz

* Att 0 dB
SigLvl -32.5 dBm

Pass	Limit	<	Results	<	Limit	Unit
Level	-60.0		-34.0		10.0	dBm
Constellation			64 QAM NH / normal			
MER (rms)	24.0		43.9		-----	dB
MER (peak)	10.0		20.3		-----	dB
EVM (rms)	-----		0.42		4.40	%
EVM (peak)	-----		6.36		22.00	%
BER before Viterbi			0.0e-10(2K24/10K0)		1.0e-2	
BER before RS			0.0e-10(1K55/10K0)		2.0e-4	
Packet Error Ratio			0.0e-7(1K03/10K0)		1.0e-8	
Packet Errors			0		1	/s
Carrier Freq Offset	-30000.0		80.6		30000.0	Hz
Bit Rate Offset	-100.0		0.1		100.0	ppm
MPEG Ts Bitrate			22.394121			MBit/s

PS

64 QAM NH (64NH)	FFT 8k (8k)	GI 1/4 (1/4)	3/4,3/4 (3/4,3/4)	Cell ID 0
TPS Res. 0,0,0,0	INT N (N)	MPE FEC Off/Off	Time Sl. Off/Off	LI 1F
Lvl -34.0dBm BER 0.0e-10 MER 43.9dB DEMOD MPEG				

Fig. 3-15: OVERVIEW menu with TPS information in the bottom lines

3.11 Constellation Diagram

In addition to the measurements described above, the constellation diagram should also be documented. Any peculiarities will be immediately noticeable here. The constellation diagram is first printed in FULL SPAN, followed by the area around mid-band (carrier number 3408 in 8K mode or 852 in 2K mode). If the I/Q adjustment is not correct, this would be noticeable on the distorted constellation diagrams in mid-band.

Procedure:

1. Connect the R&S ETL (IN1) to the test port on the transmitter output (M1).
2. Switch transmitter on.
3. Change the R&S ETL to TV Analyzer/Receiver mode.
4. Select MENU:ADJUST ATTENUATION.
5. Select MEAS:MODULATION ANALYSIS:CONST DIAGRAM.
6. Print the constellation diagram.

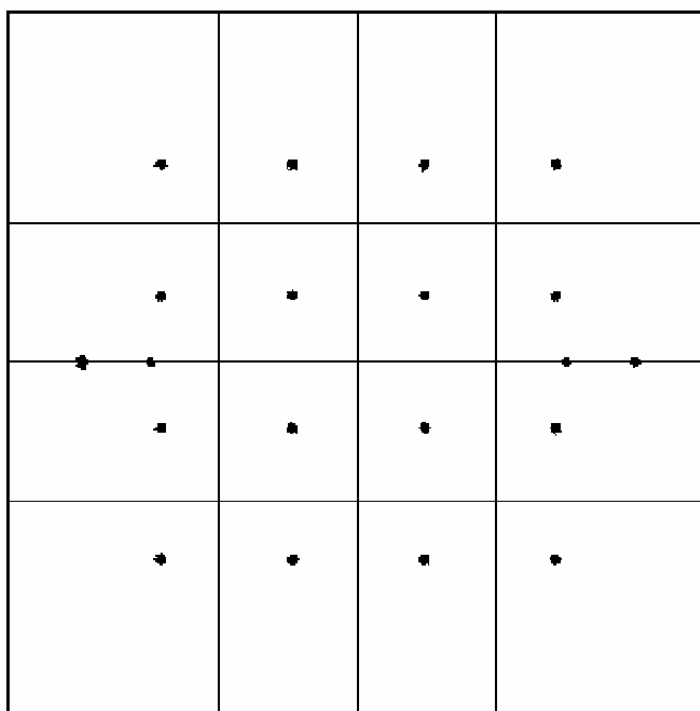


Fig. 3-16: Undistorted DVB-T constellation diagram (16QAM)

4 Abbreviations

BER	Bit error ratio
CCDF	Complementary cumulative distribution function
DVB-T/H	Digital Video Broadcasting - Terrestrial / Handheld
ICFT	Initial carrier frequency tolerance
MER	Modulation error ratio
PEP	Peak envelope power
RS	Reed Solomon
SFN	Single frequency network
TPS	Transmission parameter signalling

5 Literature

- [1] "Measurement guidelines for DVB systems",
ETSI TR 101 290

- [2] "CCDF determination – a comparison of two measurement methods",
Christoph Balz, News from Rohde & Schwarz, No. 172 (2001/III), pp 52 - 53

- [3] "Digital Video and Audio Broadcasting Technology",
Walter Fischer, Springer, 2008,
ISBN: 978-3-540-76357-4

6 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@rsd.rohde-schwarz.com.

7 Ordering Information

Instrument

Designation	Type	Order number
TV Analyzer, 500 kHz to 3 GHz, with tracking generator	R&S ETL	2112.0004.13
Digital Video Signal Generator	R&S DVSG	2113.0008.02
GPS Receiver	R&S ED170	2105.5856.02

Required options

Designation	Type	Order number
DVB-T/H Firmware	R&S ETL-K240	2112.0556.02
Power Sensor Support with R&S NRP	R&S FSL-K9	1301.9530.02
Average Power Sensor; 9 kHz to 6 GHz, 200 mW	R&S NRP-Z91	1168.8004.02
MPEG Processing Board	R&S ETL-B280	2112.0362.02
Measurement Log for DTV	R&S ETL-K208	2112.0579.02
80 Gbyte Hard Disk	R&S ETL-B209	2112.0291.02
TS Player and Recorder	R&S DVSG-K20	2113.0320.02

Recommended options

Designation	Type	Order number
<i>SFN Alignment</i>		
DVB-T/H SFN Frequency Offset	R&S ETL-K241	2112.0562.02
<i>Illustrations</i>		
Video and Audio Hardware Decoder	R&S ETL-B281	2112.0356.02
HDTV and Dolby Upgrade	R&S ETL-K281	2112.0604.02
<i>MPEG Analysis</i>		
MPEG Analysis / Monitoring	R&S ETL-K282	2112.0610.02
In-Depth Analysis	R&S ETL-K283	2112.0627.02
Data Broadcast Analysis	R&S ETL-K284	2112.0633.02
<i>Miscellaneous</i>		
DC Power Supply, 11 V to 18 V	R&S ETL-B230	2112.0256.02
Documentation of Calibration Values	R&S ETL-DCV	2082.0490.31

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Regional contact

Europe, Africa, Middle East

+49 1805 12 42 42* or +49 89 4129 137 74

customersupport@rohde-schwarz.com

North America

1-888-TEST-RSA (1-888-837-8772)

customer.support@rsa.rohde-schwarz.com

Latin America

+1-410-910-7988

customersupport.la@rohde-schwarz.com

Asia/Pacific

+65 65 13 04 88

customersupport.asia@rohde-schwarz.com

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

This document may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.

Rohde & Schwarz GmbH & Co. KG

Mühlendorfstraße 15 | D - 81671 München

Phone + 49 89 4129 - 0 | Fax + 49 89 4129 - 13777

www.rohde-schwarz.com