4.4.1 Theoretical DVB-T Spectrum

Looking at the theoretical DVB-T spectrum in Fig. 16, you see a flat trace with a ripple of about 3 dB in the useful region, this ripple depending on the guard interval used.

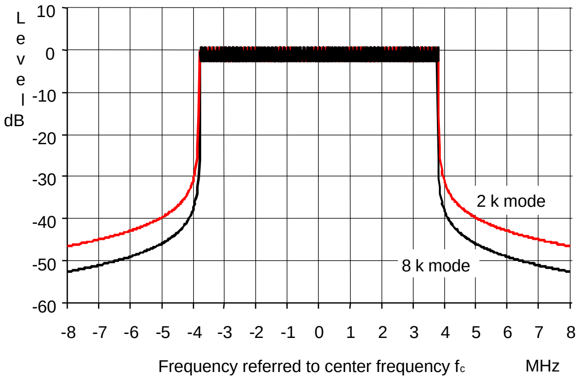


Fig. 4.16 DVB-T spectrum for 2k and 8k mode with guard interval $\tau = 1/4$

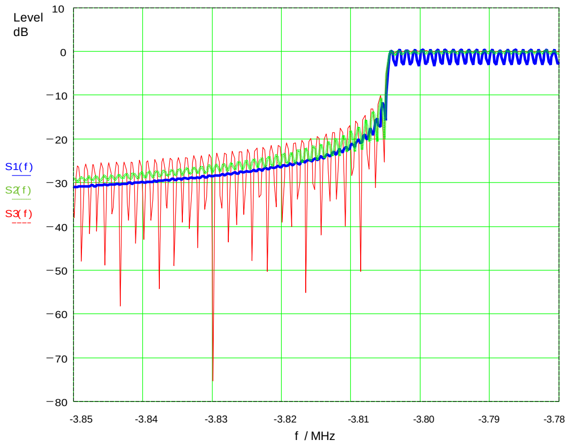


Fig. 4.17 Detail of spectrum with different guard intervals: $\tau = 1/4$ S1(f)
$\tau = 1/32$ S2(f)
$\tau = 0$ S3(f)

At the band limits, the signal drops sharply over the width of a carrier spacing, then the trace is relatively flat again. In 2k mode the knee is located about 10 dB higher than in 8k mode.

With higher frequency resolution, the inserted guard intervals are clearly discernible. Fig. 4.17 shows the range from -3.85 MHz to -3.78 MHz in 8k mode, where the single carriers can be recognized.

The blue curve shows the signal characteristic for $\tau = 1/4$. In the useful band the single carriers are distinguishable, even though the dips between them are just about 3 dB. By contrast, the out-of-band components are markedly flatter.

The green curve is the signal characteristic for $\tau = 1/32$. In the useful band the single carriers can hardly be distinguished, the dips between them are less than 1 dB. The out-of-band components in this case have much more pronounced ripple.

The red curve shows the characteristic for $\tau = 0$, i.e. without any guard intervals. In the useful band the spectrum is absolutely smooth, whereas the out-of-band components are characterized by deep dips at carrier spacing.

Fig. 4.17 illustrates that orthogonality between the single carriers exists only for $\tau = 0$. As soon as the guard interval is added, this condition is no longer fulfilled. The guard interval is blanked in the receiver, thus restoring orthogonality.

Figs 4.16 and 4.17 demonstrate a basic problem in DVB-T spectrum measurement: in the useful region there is always a certain amount of ripple as a function of the guard interval.
How, then, do you measure the useful spectrum?

And there is another problem: the out-of-band components always have a basic ripple as well as a steep decline by about 15 dB at a spacing of one carrier from the last useful carrier. Then the out-of-band spectrum is relatively flat and, with a guard interval of $\tau = 1/32$, has up to 10 dB deep dips at carrier spacing.
Where do you measure the shoulder distance?

SPECTRUM ANALYZER FSP

Condensed data of FSP

Frequency range (FSP 3/7/13/30)	9 kHz to 3/7/13/30 GHz
Amplitude measurement range	-140 dBm to +30 dBm
Amplitude display range	10 dB to 200 dB in steps of 10 dB, linear
Amplitude measurement error	<0.5 dB up to 3 GHz <2.0 dB from 3 GHz to 13 GHz <2.5 dB from 13 GHz to 20 GHz
Resolution bandwidths	1 Hz to 30 kHz (FFT filters) 10 Hz to 10 MHz in 1, 3 sequence; EMI bandwidths: 200 Hz, 9 kHz, 120 kHz
Detectors	Max Peak, Min Peak Auto Peak, Quasi-Peak, Sample, Average, RMS
Display	21 cm (8.4") TFT LC colour display, VGA resolution
Remote control	IEC 625-2/IEEE 488.2 (SCPI 1997.0) or RS232C
Dimensions (W x H x D)	412 mm x 197 mm x 417 mm
Weight (FSP 3/7/13/30)	10.5/11.3/12/12 kg

SPECTRUM ANALYZER FSEx

Condensed data of FSEA/FSEB

Frequency range	20 Hz/9 kHz to 3.5 GHz/7 GHz
Amplitude measurement range	-155/-145 dBm to +30 dBm
Amplitude display range	10 dB to 200 dB in steps of 10 dB
Amplitude measurement error	<1 dB up to 1 GHz <1.5 dB above 1 GHz
Resolution bandwidths	1 Hz /10 Hz to 10 MHz in 1, 2, 3, 5 sequence
Calibration	amplitude, bandwidth
Display	24 cm (9.5") TFT LC colour or monochrome display, VGA resolution
Remote control	IEC 625-2/IEEE 488.2 (SCPI 1997.0) or RS232C
Dimensions (W x H x D)	4127 mm x 236 mm x 460 mm
Weight	21.5/23 kg

4.4.2 Useful Spectrum

Modern spectrum analyzers provide the answer to the above problems: with resolution bandwidth much wider than the carrier spacing, the dips of the useful spectrum are averaged to obtain a smooth characteristic. In this way, satisfactory results are achieved even with a medium-priced analyzer. However, it must be remembered that the reference for all measurements is the positive envelope of the spectrum; so the analyzer must have a peak detector.
State-of-the-art spectrum analyzers like FSP and FSEx from Rohde & Schwarz fully meet the requirements for transmitter measurements.

They feature both a peak and an rms detector. The dynamic range exceeds the values stipulated in all the subsequent spectrum measurements. Even the most favourably priced model offers ample frequency range for LO (local oscillator) harmonics measurement.
Just as with analog transmitters, measurement of the second harmonic and determining LO phase noise are musts with DVB-T transmitters too.

4.4.3 Measurement of Phase Noise

A spectrum analyzer should be available at each transmitter site of an SFN so that the above measurements can be performed and LO phase noise determined unambiguously. These purposes call for a high-end analyzer. FSP and FSEx meet the stipulated requirements. The standards proposed by the European VALIDATE work group are very restrictive; see draft standard AC106 for phase noise in 2k mode illustrated by Fig. 4.18.

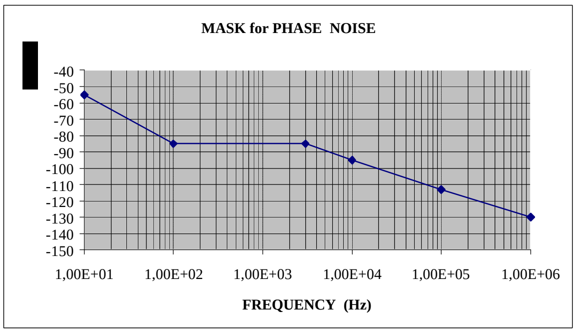


Fig. 4.18 VALIDATE draft standard AC106 for phase noise measurement in 2k mode

It shows that phase noise suppression as low as -55 dB/Hz is demanded just 10 Hz from the LO frequency. So the RBW (resolution bandwidth) must be much smaller than 10 Hz, the preferred value being 1 Hz.
Phase noise at a spacing of one carrier from the LO frequency is already defined as ENF (equivalent noise floor).

There are two types of phase noise in COFDM modulation:

- CPE (common phase error):
  signal distortions that are common to all carriers. This error can (partly) be suppressed by channel estimation using the continual pilots.
- ICI (inter-carrier interference):
  non-correlated noise superimposed on all carriers. This type of signal degradation cannot be corrected.

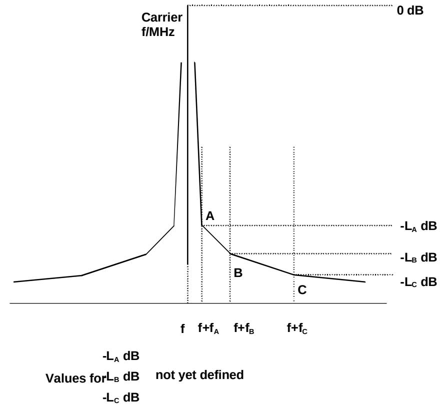


Fig. 4.19 Mask for phase noise

The frequencies for measuring ICI are defined by ETR290. However, the levels at points A, B and C of the mask are not yet defined. The frequencies are n times the carrier spacing in each case.

COFDM mode	f_A kHz	f_B kHz	f_C kHz
2k	4.464	8.928	13.392
8k	1.116	2.232	3.348

Table 4.7 Frequencies for measuring ICI

4.4.4 Mask for Out-of-Band Components (Minimum Shoulder Distance)

During the transition from analog to digital transmission, the protection channels between the present analog channels are used to start with DVB-T operation. Especially in Central Europe, there are hardly any other frequencies available.
Fig. 4.20 shows a possible spectral configuration during the transition from analog TV to DVB.

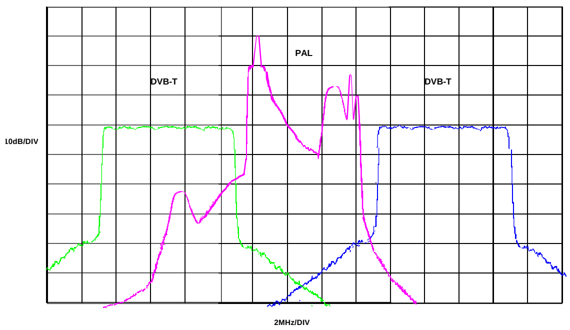


Fig. 4.20 Adjacent channel occupation, DVB-T and PAL

The DVB-T spectrum in the upper adjacent channel will have only little effect on the PAL signal if the PAL vision carrier frequency and the DVB-T center frequency conform to the standard. At most, the DVB-T shoulder in the lower adjacent channel may impair the second sound carrier of the B/G PAL signal, whereas in the upper adjacent channel it superimposes on the vestigial sideband like noise.
To prevent any interference to adjacent analog TV channels, EN 300 744 defines masks for the DVB-T spectrum. These are tables listing levels in the range ±12 MHz from the center frequency of the DVB-T channel when the upper and the lower adjacent channel are occupied by analog RF signals (G/PAL/A2 or G/PAL/NICAM or I/PAL/NICAM or K/L/SECAM/NICAM or K/PAL) emitted by co-sited UHF transmitters.

The tables in EN 300 744 specify levels versus frequency. The selected levels and frequencies orient on important points within the analog channels. Fig. 4.21 and Table 8, for example, show the values of the DVB-T mask when the upper and the lower adjacent channel are occupied by a G/PAL/A2 signal.

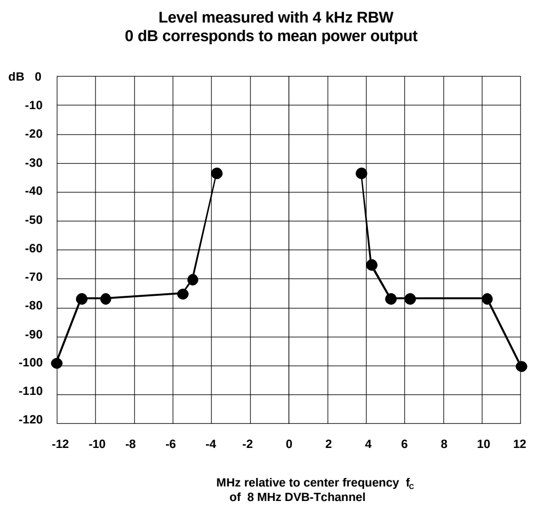


Fig. 4.21 Mask for out-of-band components

DVB-T out-of-band spectrum mask with standard G/PAL/A2 signals in the adjacent channels		
Frequency relative to center of DVB-T channel in MHz	Explanation of frequency	Level in dB[1])
-12.00	Lower end of lower adjacent channel	-100
-10.75	Vision carrier in lower adjacent channel	-76.9
-9.75	Vision carrier +1 MHz in lower adjacent channel	-76.9
-5.75	Upper end of (upper) sideband of lower adjacent channel	-74.2
-5.185	Upper end of RF bandwidth of first sound carrier in lower adjacent channel	[2])
-4.94	Upper end of RF bandwidth of second sound carrier (IRT A2) in lower adjacent channel	-69.9
-3.90	Lower end of RF bandwidth of DVB-T signal	-32.8
+3.90	Upper end of RF bandwidth of DVB-T signal	-32.8
+4.25	Vision carrier –1 MHz; lower end of vestigial sideband in upper adjacent channel	-64.9
+ 5.25	Vision carrier in upper adjacent channel	-76.9
+ 6.25	Vision carrier +1 MHz in upper adjacent channel	-76.9
+10.25	Upper end of (upper) sideband in upper adjacent channel	-76.9
+12.00	Upper end of upper adjacent channel	-100

[1]) Measured with 4 kHz RBW
[2]) Has no influence on shape of spectrum mask

Table 4.8

In critical cases, for example where channels adjacent to DVB-T channels operate in special modes like low-power analog TV transmission, a spectrum mask with higher out-of-channel attenuation of the DVB-T signal may be needed. For such cases a critical mask is defined by EN 300 744 (see Fig. 4.22 and Table 4.9).

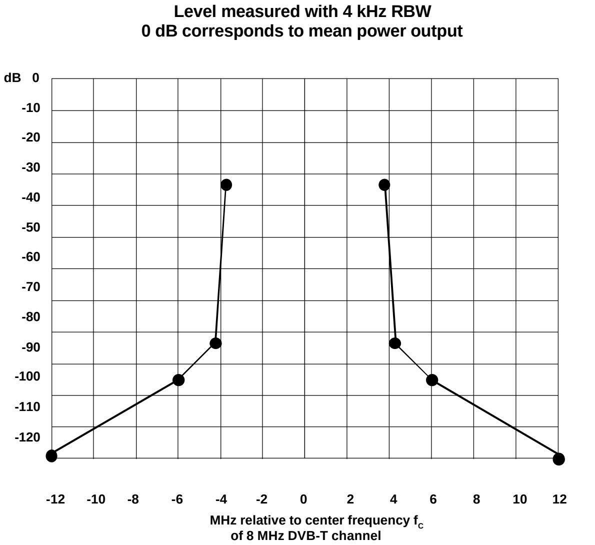


Fig. 4.22 Spectrum mask for critical cases

The breakpoints for the critical mask are likewise defined in a table:

Breakpoints for critical mask (UHF)	
Frequency relative to center of DVB-T channel (MHz)	Level (dB) *)
±12.0	-120
±6.0	-95
±4.2	-83
±3.8	-32.8

*) Measured with 4 kHz RBW

Table 4.9

4.4.5 Center Frequencies of UHF Channels

In contrast to analog TV which, at 8 MHz bandwidth in the UHF range, uses odd-numbered vision carrier frequencies offset by 250 kHz relative to the next integer MHz (e.g. 210.250 MHz for channel 10), even-numbered center frequencies are used in DVB-T. The UHF range starts at 470 MHz. From this frequency, the center frequencies f_{center} for DVB-T are calculated by:

UHF band IV/V

$$f_{center} = 470 + 4 + n \times 8 \text{ MHz}$$

$$n = 0, 1, 2, 3...49$$

So, the first channel in the UHF range has the center frequency f_{center} = 474 MHz and the last channel f_{center} = 866 MHz. This allocation is given by EN 300 744 for the UHF range only. Although no allocation is made for DVB-T for VHF with 7 MHz channel bandwidth, DVB-T is transmitted in the VHF range too. The above formula can therefore be used in a slightly modified form:

VHF band III

$$f_{center} = 174 + 3.5 + n \times 7 \text{ MHz}$$

$$n = 0, 1, 2, 3...7$$

So, the first channel in the VHF band III has the center frequency f_{center} = 177.5 MHz and the last channel f_{center} = 226.5 MHz.
For DVB-T transmission, special allocations of VHF channels used in some countries should be modified to match the above scheme.

4.4.6 Increasing Shoulder Distance

From 4.4.1, "Theoretical DVB-T Spectrum", it follows that the spectrum has to be bandpass-filtered to meet the requirements defined in the out-of-band spectrum masks. For the normal mask a 6-cavity filter is sufficient, whereas for the critical mask at least eight cavities are required.

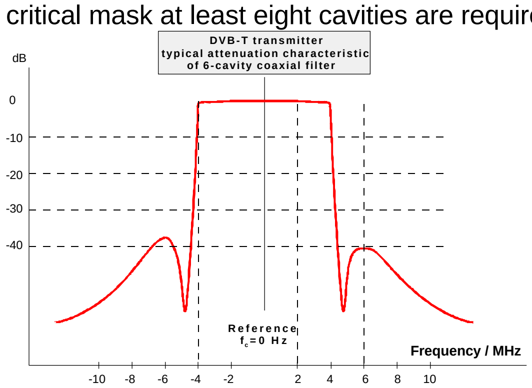


Fig. 4.23 Bandpass filter

The filter is connected between the transmitter power output and the antenna. With the bandpass filter the required shoulder distance is achieved. The output signal of the exciter of the DVB-T transmitter has a shoulder distance of about 50 dB. But this is reduced to values of near 30 dB by intermodulation products resulting from nonlinearity of the transmitter amplifiers. The effect is in part compensated by the exciter's digital linearity precorrector, producing intermodulation suppression of about 40 dB in the useful spectrum.
From Fig. 4.17 it can be seen that the DVB-T spectrum has to be additionally bandpass-filtered to attain the stipulated value of >36 dB.
This corresponds to the difference of 69.9 dB – 32.8 dB = 37.1 dB required at frequencies ±4.94 MHz and ±3.90 MHz in the normal mask. For the critical mask, the required shoulder

distance is correspondingly higher, i.e. 83.0 dB – 32.8 dB = 50.2 dB.

Very stringent demands are made for the out-of-band components of COFDM signals for DVB-T, which can be seen from the limit values of the relevant mask. As mentioned above, the shoulder distance at the transmitter output is not sufficient and so it is increased by bandpass filters. Filter attenuation rises especially close to the limits of the passband. The very steep attenuation characteristic in the stopband causes a correspondingly steep increase of group delay. The amplitude frequency response and the group delay shown are largely compensated by the digital precorrectors of the exciter.
Depending on the degree of suppression in the stopband of the bandpass filter, an extra filter may be required to suppress local oscillator harmonics.

In the absence of detailed specifications from official standardization bodies regarding permissible residual deviation from the ideal filter, preliminary values were laid down in 1998 in Great Britain for the installation of an MFN. These can be seen in Fig. 4.24.

Suitable measuring instruments:
Spectrum Analyzers FSEx and FSP (for data see page 19)

andDVB-T Test Receiver EFA model 40 or 43 (for data see page 23)

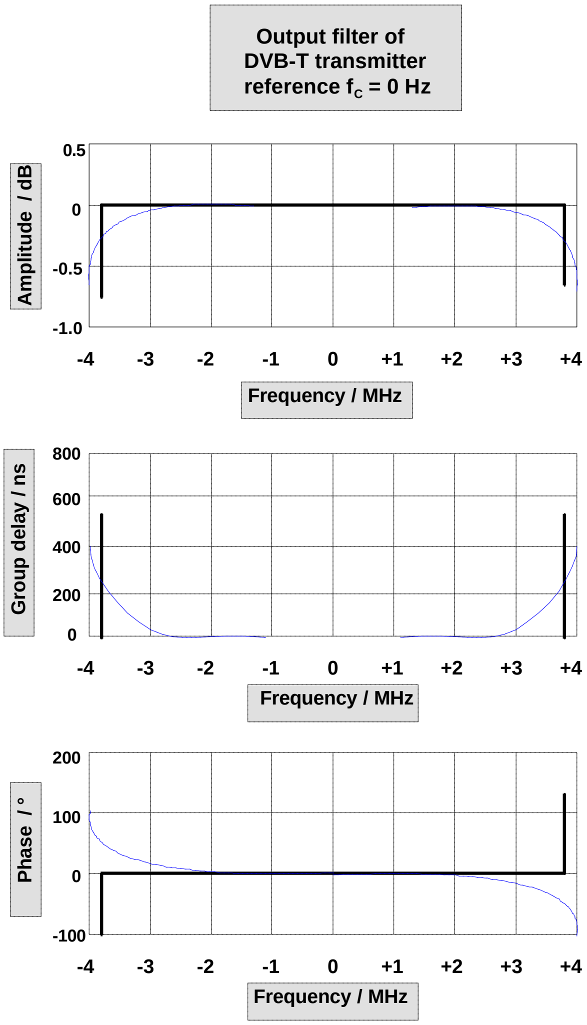


Fig. 4.24 Proposal for bandpass characteristic

Corrected amplitude frequency response with ripple ≤ 0.3 dB and group delay ≤ 250 ns (!)

Condensed data of EFA models 40/43

Frequency range	45 MHz to 1000 MHz, 5 MHz to 1000 MHz with RF preselection option (EFA-B3)
Input level range	-47 dBm to +14 dBm; -84 dBm to +14 dBm (low noise) with RF preselection option (EFA-B3)
Bandwidth	6/7/8 MHz
FFT mode	2k/8k
Modulation	QPSK, 16QAM, 64QAM; hierarchical/ non-hierarchical
Guard interval	1/4, 1/8, 1/16, 1/32
Puncturing rate	1/2, 2/3, 3/4, 5/6, 7/8
BER analysis	before Viterbi, before and after Reed Solomon
Measurement functions/ graphic display	level, BER, MER, carrier suppression, quadrature error, phase jitter, amplitude imbalance, FFT spectrum, constellation diagram, MER (f), I/Q (f), spectrum
Output signals	MPEG2 TS: ASI, SPI
Options	MPEG2 decoder, RF preselection

4.4.7 Measuring Shoulder Distance with DVB-T Test Receiver EFA

The FREQUENCY DOMAIN/FFT function of Test Receiver EFA makes it easy to determine the shoulder distance. For an 8 MHz DVB-T channel with frequency range –4.48 MHz (start frequency) to +4.48 MHz (stop frequency), for example, the shoulder distance can immediately be read from the spectrum displayed. EFA 40/43 determines the shoulder distance automatically and objectively in conformance with the ETR290 standard, which describes all test methods and parameters.

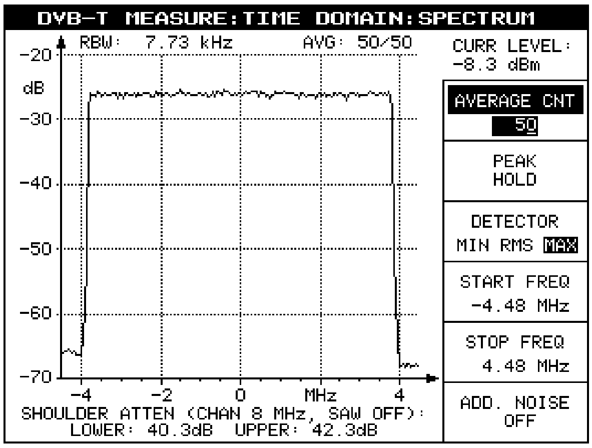


Fig. 4.25 Shoulder distance of COFDM signal

According to European Technical Report ETR290, the shoulder distance is to be measured between the maxima of the useful spectrum (approx. –26 dB in Fig. 4.25) and the (weighted) maxima of the out-of-band components at 300 kHz to 700 kHz from the last useful carrier (approx. –66 dB or –68 dB in Fig. 4.25). The MAX DETECTOR function greatly facilitates determining this value.
Measuring the suppression of local oscillator harmonics calls for a spectrum analyzer in addition.

4.4.8 Determining Shoulder Distance to ETR290

ETR290 describes a method for determining the shoulder distance that is rather time-consuming. Test Receiver EFA 40/43 delivers identical values provided that out-of-band components starting 300 kHz from the last COFDM carrier have a flat characteristic. This is almost always the case in COFDM.

Measurement to ETR290 works as follows (illustrated in Fig. 4.26):

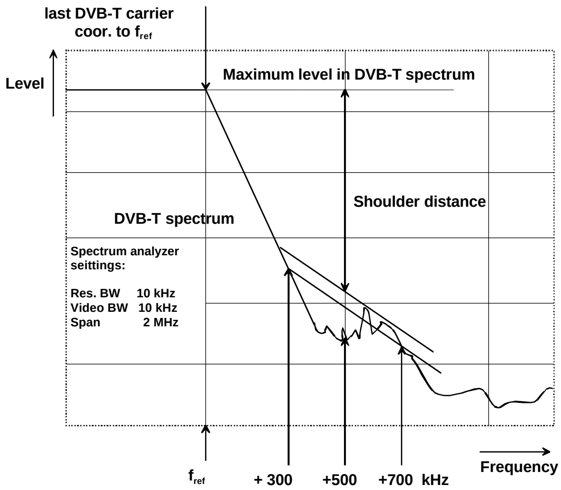


Fig. 4.26 Measurement of shoulder distance to ETR290

1. Determine the maximum level of the DVB-T spectrum (Max Hold).

2. Draw a line between the level value of the spectrum 300 kHz above (below) the frequency of the last (first) carrier in the DVB-T spectrum and the level value of the spectrum 700 kHz above (below) the frequency of the last (first) carrier in the DVB-T spectrum.

3. Draw a parallel to the above line that goes through the maximum of the DVB-T spectrum in the range 300 kHz to 700 kHz above (below) the frequency of the last (first) carrier in the DVB-T spectrum.

4. Measure the difference between the maximum level of the DVB-T spectrum and the level of the parallel line at 500 kHz above (below) the frequency of the last (first) carrier in the DVB-T spectrum. The lower of the two values is the shoulder distance.

This method requires a hardcopy of the spectrum as well as a protractor and a ruler, so its use will tend to be the exception. Deviations between this method and direct measurement with EFA 40/43 will rarely occur, i.e. where strong interference is superimposed on the out-of-band components. But even then, Test Receiver EFA supplies sufficiently accurate results because the FFT frequency range of -4.48 MHz to +4.48 MHz about the channel center frequency exactly corresponds to the range specified by ETR290.

4.4.9 Linearity Precorrector and Shoulder Distance

	Output signal	
Input signal	In-phase	Quadrature
0000	0.000	0.000
0.300	0.295	0.013
0.500	0.492	0.015
1.000	1.000	0.000
1.500	1.500	-0.070
3.000	2.300	-0.900
Crest factor 7.235 /dB (calculated from peak power)		

Table 10 Amplifier characteristic

Table 10 shows the linearity relationship of a typical power amplifier as used in a DVB-T transmitter. In the beginning there is a linear correlation between the input signal and the output signal, whereas at higher input levels there is a strong limitation of the output signal. The phase response can be determined from the in-phase and the quadrature component. A normalized output level up to 2.3 is possible referred to the normalized nominal value of 1. Higher output levels are limited. From the amplitude distribution and the limitation at 2.3 the crest factor in dB can be calculated.

4.4.10 How Is Crest Factor Defined?

The crest factor expresses a voltage ratio. The quotient of the peak voltage value (V_p) and the root-mean-square voltage value (V_{rms}) is formed and expressed as a logarithmic ratio (K_{CREST}):

$$K_{CREST} = 20 \times \log(V_p/V_{rms})\ \text{dB}$$

The linearity measurements, whose results are shown in Table 10, were made with a Spectrum Analyzer FSP using the CCDF (complementary cumulative distribution function). This function measures peak envelope power (PEP) rather than absolute peak voltage that occurs in the amplifier. So, with different weighting applied to the signal, the values stated in Table 10 have to be corrected by a factor of $\sqrt{2}$ or 3.01 dB. The actual crest factor is, therefore, 10.245 dB. When referring to the crest factor K_{CREST} in the following, this is understood to mean the value derived from the absolute peak voltage. The various types of signal weighting are discussed in Annex 4A.

The (typical) nonlinear characteristic of power amplifiers always leads to intermodulation products. Without filtering, these reduce the shoulder distance at the transmitter output to about 34 dB.

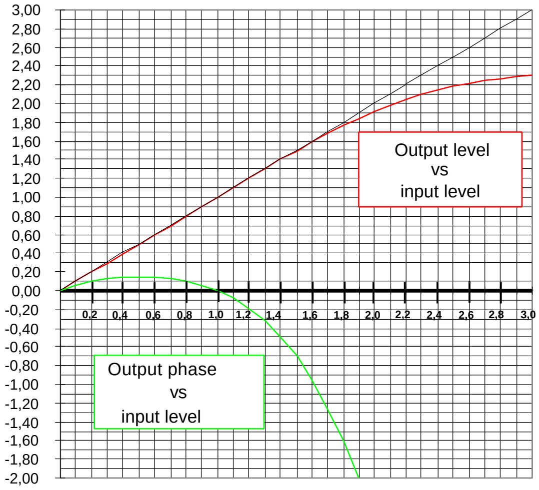


Fig. 4.27 Amplifier characteristic

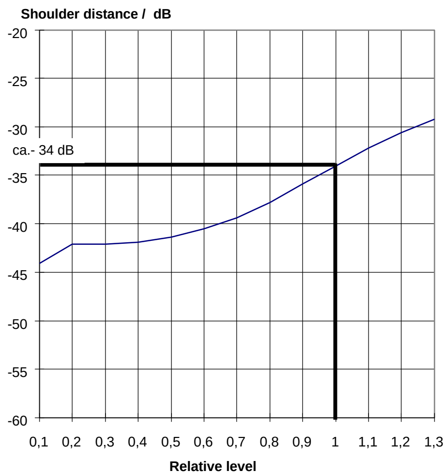


Fig. 4.28 Shoulder distance versus nominal input level

The digital precorrectors in the exciter make for optimal linearization not only of amplitude frequency response and group delay but also of the amplifier characteristic.

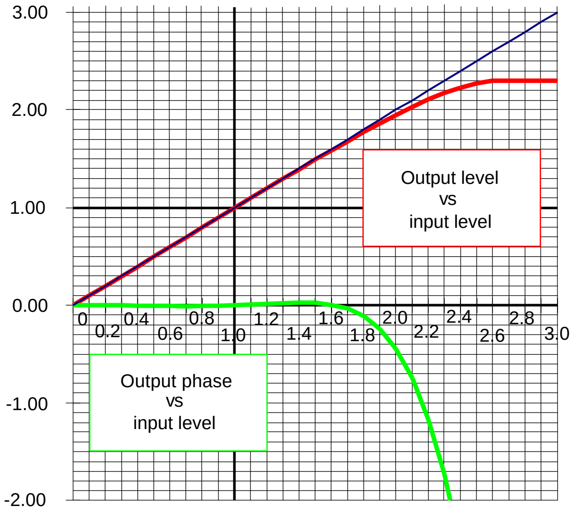


Fig. 4.29 Typical gain and phase characteristics of corrected amplifier

An amplifier with this typical characteristic (i.e. going into saturation at normalized output level of 2.3, and with corrected phase = 0 up to normalized input level of 1, then assuming negative values) attains a shoulder distance of approx. 42 dB at nominal input level.

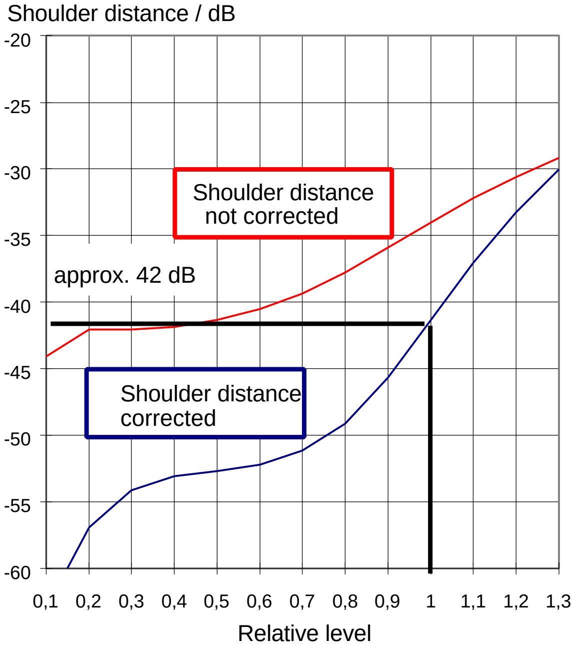


Fig. 4.30 Shoulder distance obtained with corrected/non-corrected amplifier

4.4.11 Crest Factor and Level Limiting in DVB-T Transmitter

For the theoretical case that all carriers of the COFDM time-domain signal, which is very similar to white noise, attain their maximum or minimum at the same time, all carrier amplitudes add up to give the maximum possible peak amplitude $V_{P\,MAX}$. In 8k mode this peak amplitude yields a crest factor of

$K_{CREST\,MAX}$ = 10 x log(6817)
= 38.3 dB

and in 2k mode

$K_{CREST\,MAX}$ = 10 x log(1705)
= 32.3 dB

These peak values will, however, not occur in practice. So, a realistic value of

K_{CREST} ≥15 dB

is assumed with a probability of 1×10^{-7} for both modes.

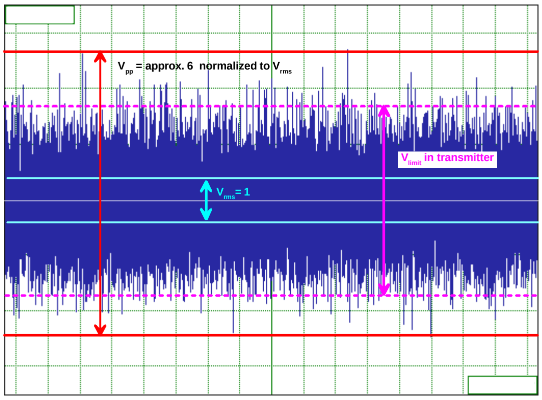


Fig. 4.31 Time-domain signal in DVB-T

This corresponds to a V_p / V_{rms} ratio of about 6. For the transmitter power this means that peak power 36 times that of the mean power must be provided as a safety margin. Using such a factor, all signal components would be transmitted, with favourable effect on the BER. This is not acceptable in terms of efficiency however. Investigations have shown that with a crest factor of K_{CREST} ~ 13 dB there will be no appreciable impairment of BER. But a safety margin of nine times the mean transmitter power is in any case economically impractical. For this reason the crest factor is limited to K_{CREST} = 10 dB...11 dB for all DVB-T transmitters, corresponding to a safety margin of about 7 dB.
This, however, does mean an appreciable degradation of BER. With channel filtering for boosting shoulder distance, a BER (before Viterbi) of 1×10^{-5} to 1×10^{-6} is in this case obtained at the transmit antenna.

The new solid-state amplifier generation employs high-linearity LDMOS transistors. This means that demands on digital precorrectors are less stringent than with predecessors using bipolar or MOS technology. To protect the transistors, the crest factor is limited to K_{CREST} = 10 dB. This prevents high voltage peaks from damaging the transistors.
Determining the crest factor at the transmitter output is, therefore, indispensable as it is crucial for power transistor lifetime. This measurement too can be performed with DVB-T Test Receiver EFA 40/43.

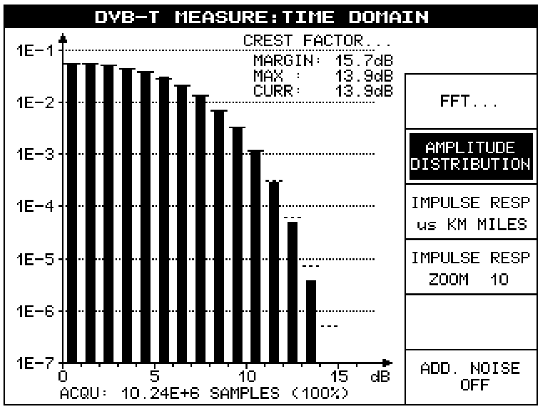


Fig. 4.32 Crest factor measurement with DVB-T Test Receiver EFA model 40 or 43

EFA calculates the crest factor based on the amplitude distribution or CCDF (complementary cumulative distribution function). The display indicates the current crest factor during the measurement (10.24×10^{-6} samples), the maximum crest factor since the beginning of the measurement, and the margin acive for the test configuration.

Note:
As set forth in 4.4.10, measurement of the crest factor with a spectrum analyzer (e.g. FSP) yields a value lower by 3 dB since in this case the peak power of the envelope is measured (see also Annex 4A).

4.5 Power Measurement on DVB-T Transmitters

Mean power measurement

In the case of analog transmitters, signal power is determined by measuring the peak power of the sync pulse floor of the modulated CCVS signal. The sync pulse floor is always the reference in analog TV because this signal component must be transmitted without compression or distortion.
In DVB this is different. The "*Sync 1 Inversion and Randomization*" block of the DVB modulator (see EN 300 421, EN 300 429 or EN 300 744) ensures constant mean power of the transmitter signal.
In DVB, therefore, it is not the peak power that is measured, based on the crest factor, but the mean output power. Three methods are available today:

a Mean power measurement with Power Meter NRVS and thermal power sensor

Condensed data of Power Meter NRVS with Thermal Power Sensor NRV-Z51

NRVS	
Frequency range	DC to 40 GHz
Level range	100 pW to 30 W (depending on sensor)
Readout	
Absolute	W, dBm, V, dBmV
Relative	dB, % W or % V referred to a stored reference value
Remote control	IEC 625-2/IEEE 488.2 interface
Max. input voltage	50 V
NRV-Z51	
Power sensor	thermal
Impedance	50 O
Connector	N type
Frequency range	DC to 18 GHz
Level range	1 µW to 100 mW

Thermal power sensors supply the most accurate results if there is only one TV channel in the overall spectrum. Plus, they can easily be calibrated by performing a highly accurate DC voltage measurement, provided the sensor is capable of DC measurement.

b Mean power measurement with Spectrum Analyzer FSEx or FSP

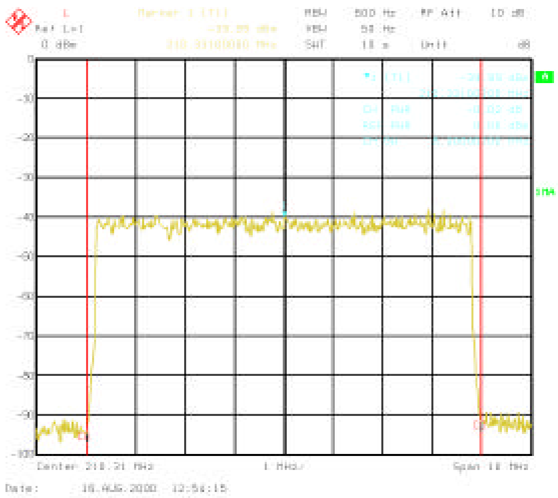


Fig. 4.33 Power measurement with frequency cursor

A frequency cursor is placed on the lower and another on the upper frequency of the DVB channel. The spectrum analyzer calculates the power for the band between the cursors. The method provides sufficient accuracy as in DVB-T normally no signals are put on the air in the adjacent channels.

c Mean power measurement with Test Receiver EFA

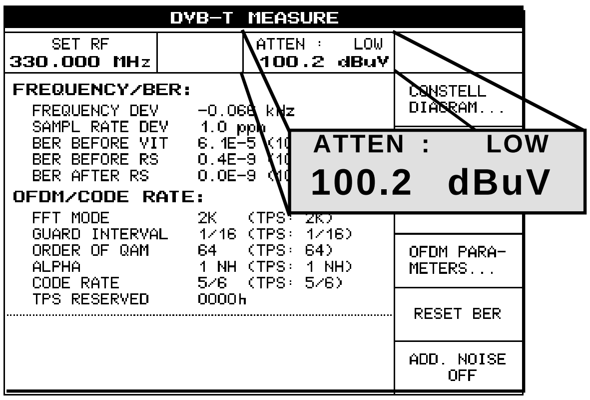


Fig. 4.34 Measurement menu of Test Receiver EFA model 40 or 43

EFA displays all important signal parameters in a status line. The righthand upper status field indicates mean power in various switchable units. Investigations on channel spectra revealing pronounced frequency response have shown the high accuracy of the displayed level. A comparison of the levels obtained with EFA and NRVS with thermal power sensor yielded a maximum difference of less than 1 dB – the comparison being performed with various EFA models at different channel frequencies and on different, non-flat spectra. Thanks to EFA's built-in SAW filters of 6 MHz, 7 MHz and 8 MHz bandwidth for the IF range, highly accurate results are obtained even if the adjacent channels are occupied.

The following example describes a measurement used in the above comparison.

An echo with 250 ns delay and 2 dB attenuation is generated by means of TV Test Transmitter SFQ with Fading Simulator option. This echo, plus the signal sent via the direct path, produces the channel spectrum shown in Fig. 4.35 with pronounced dips resulting from frequency response.

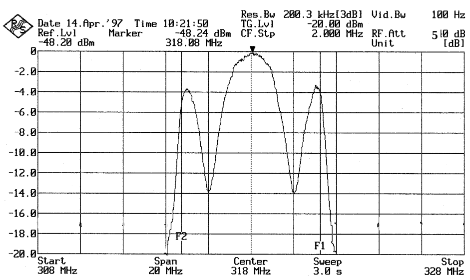


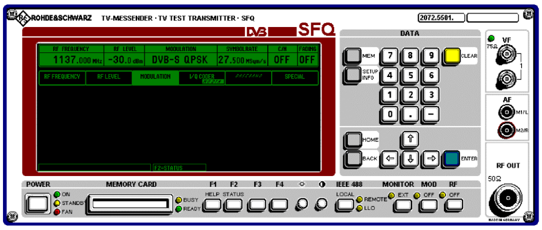
Fig. 4.35 Fading spectrum

Table 4.11 gives the results where the maximum difference between EFA and NRVS has occurred.

Level measurement with	NRVS	EFA
	-33.79 dBm	-33.0 dBm

Table 4.11 Comparison of results

Note:
The results of the level measurements are specified in detail in Application Note 7MGAN15E (see also Annex 4B).



Condensed data of TV Test Transmitter SFQ

Frequency range	0.3 MHz to 3.3 GHz
Level range	+4 dBm to -99 dBm
MPEG2 inputs	ASI SPI TS PARALLEL
Error simulation	
I/Q amplitude imbalance	±25 %
I/Q phase error	±10°
Residual carrier	0 % to 50 %
Special functions	scrambler, Reed-Solomon, all interleavers can be switched off
DVB-C	
Modulation	16, 32, 64, 128, 256QAM
DVB-S	
Modulation	QPSK
Puncturing	1/2, 2/3, 3/4, 5/6, 7/8
DVB-T	
Modulation	QPSK, 16QAM, 64QAM, non-hierarchical, hierarchical
FFT mode	8k and 2k
Bandwidth	6 MHz, 7 MHz, 8 MHz
Puncturing	1/2, 2/3, 3/4, 5/6, 7/8
ATSC	
Modulation	8VSB
Bandwidth	6 MHz
Data rate	19.392658 Mbit/s ±10 %
Symbol rate	10.762 Msymbol/s ±10 %
Internal test signals	NULL TS PACKETS NULL PRBS PACKETS PRBS (2^{23} -1 and 2^{15} -1)
Options	fading simulator, noise generator, input interface, BER measurement