Fully automated **D-Book RF testing** of DVB-T/DVB-T2 receivers

DTG Testing has approved the R&S®BTC broadcast test center together with the R&S®AVBrun D-Book test suite for precompliance testing in line with D-Book 7.3. When equipped with the R&S®BTC-KT3310 D-Book test suite option, the R&S®BTC broadcast test center enables users to fully automate all the tests specified in D-Book 7 Part A. chapters 9 and 10.

Your task

The D-Book¹⁾, a Digital TV Group (DTG) publication, is a recognized and widely used test specification for DVB-T/ DVB-T2 receivers. Chapters 9 and 10 of this test specification define a broad range of RF tests. The D-Book defines signal scenarios (an LTE interference signal scenario, for example) and the receive channels for different tests. It also establishes performance targets that vary depending

¹⁾ Current version: D-Book 7, Version 3.0,

on the specific test and on the configuration (option) of the wanted signal. Degradation criteria are evaluated in line with the D-Book using BER measurement, transport stream analysis or visual picture quality assessment.

To ensure repeatability of visual assessment results, the D-Book recommends three observation periods of 10 s each. The failure criterion for good signal guality is that no visible errors occur during two out of three observation periods.

When developing a new receiver, it is important to ensure that it can handle all kinds of different reception conditions in order to be competitive on the market. Manufacturers therefore have their receivers tested for D-Book conformance at DTG Testing, an independent test lab. To be deemed conformant, all requirements for all tests must be met. If that is not the case, the receiver must be improved until it is able to pass all tests in one continuous test run, a time-consuming and costly process.

Performing a complete precompliance test on the device under test (DUT) at the development lab minimizes the risk of not passing the compliance tests - if all tests performed in the development lab are properly executed and passed.

T&M solution

The R&S®AVBrun test suite software with the R&S®BTC-KT3310 D-Book test suite option is a costeffective solution for fully automatically and reproducibly performing all RF tests in versions 1.0 and 3.0 of D-Book 7 Part A, chapters 9 and 10.





To perform the tests, different RF signal scenarios are fed into the DUT. Thanks to the R&S®AVBrun test suite software, the configuration of the R&S®BTC and the entire test sequence are time optimized and run automatically.

The picture failure point is automatically determined based on failure criteria. This is done by feeding the A/V signal that is output at the DUT's existing A/V interfaces to the appropriate interface on the R&S[®]BTC, which automatically analyzes the signal. The R&S[®]BTC supports HDMI[™] and analog A/V interfaces.

For complete automation, it must be possible to switch the receive channels on the DUT as specified in the D-Book specifications. The test suite software does this by using a USB controlled infrared sensor.

Every test run generates a report with the overall result that includes detailed test configurations as well as information about the DUT and its individual test results. For documentation and archiving purposes, this report can be exported (e.g. as a PDF or XML file).

Despite the D-Book's complexity, all tests can be performed with a single T&M instrument, the R&S®BTC, which greatly simplifies the test setup. The R&S®BTC-KT3310 D-Book test suite can be configured intuitively and quickly. The terms and chapter numbers that are used correspond to the D-Book specifications. This fully automated solution ensures that the running of the tests is time optimized and that all tests are standard-compliant.

R&S®AVBrun test suite software D-Book configuration.

🏂 Test Properties 📃 🗶											
10	10.7 Basic RF Tests The D-Book 7 Part A Version 1										
General Compen- Setti		sation ng		Remote Control DUT		л сі	Channel List		Test Signal		
Te	est Case	Select All	10).7.1 8	Sensitivity (RF S	ensit	ivity)				
	10.7.1 Sensitivity			Test Arrangement Performance Target							
	10.7.2 C/N with AWGN			Channel Lowest RF Level (dBm)							
	10.7.3 PAL CCI Prote	ction		Ch	Freq		DVB-T				
				21	474		Option 1	-79.2	Option 3	-79.6	
	10.7.4 PAL ACI Protection			45	666 850		Ontion 2	-83.4	Option 7	N/A	
	10.7.5 PAL (N+9) Protection				000		Option 2	-05.4	opion 7		
	10.7.6 DVB-T/T2E A	CIProtection							Option 8	-78.1	
	10.7.7 DTT Non-ACI Protection						DVD TO				
	10.7.8 DTT (N+9) Pro	tection					Ortice 4	70.1	Online 6	76.0	
							Option 4	-70.1	Option 6	-70.3	
	10.7.9 Two DTT non-	-ACI Protection					Option 5	-78.2	Option 10	-76.3	
	10.7.10 LTE BS Prote	7.10 LTE BS Protection		V W	ith Offset Test		Option 9	-78.2	Option 11	N/A	
	10.7.11 LTE UE Prote	ection		-0 +0	ffset (-166670 Hz) Offset (+166670 Hz	z)			-,		
						1					
Test Method - Detailed Method				Video C					Juality Judgement - Auto		
Compensation Setting - CableTec.cr			omo	ip Test Si					a List - Minimum gnal DVB-T - 4 Signals		
Remote Control DUT - STB.seq									DVB-T2 -	5 Signals	
									ОК	Canc	el 📄

RF cabling

To achieve calibrated and reproducible measurements of the receiver under test, all used cablings and connections to the DUT must be calibrated out. For testing, the R&S°BTC RF output is connected to the DUT's RF input. Different impedances require a matching pad (50 Ω to 75 Ω , e.g. the R&S°FSH-Z38) to be connected to the DUT's RF input. The software automatically compensates for insertion loss; the matching pad's attenuation values only have to be entered into the software once. The D-Book recommends using an attenuator pad to increase the return loss. The R&S°FSH-Z38 matching pad satisfies this requirement without needing a separate attenuator pad.

To make sure that the frequency response of the cabling between the R&S®BTC and the matching pad does not falsify test results, the cabling is measured once. This measurement is performed automatically with R&S®AVBrun and the R&S®BTC using a power sensor (e.g. the R&S®NRP-Z11).

R&S®AVBrun stores the compensation data for the matching pad and cabling and ensures a precise measurement. The data can be reused or the user can regenerate it at any time, for instance when different cables are used.

Picture quality assessment

The picture quality (failure point) is automatically determined by the R&S[®]VT-K2111 A/V distortion analysis software option. The assessment is based on an analysis of the difference between the A/V signal to be tested and a reference signal (double-ended audio/video analysis). The deviation from the recorded reference, and not the absolute A/V quality, is assessed. Consequently, the reference recording must originate from the same video processing chain and the same A/V material. Transport streams (TS) with a time-limited A/V sequence (e.g. 20 s) are an integral part of the R&S[®]AVBrun test suite software. When the test starts, the software automatically records the A/V sequence of the selected TS as a reference. During the test, the A/V sequence is played back without interruption and assessed.

Errors that are to be considered visible errors are determined by setting two parameters. The structural similarity (SSIM) reflects the deviation between the signal to be tested and the reference signal. The duration determines the minimum amount of time that the value must remain below the SSIM limit before the human eye can perceive an error. 100 ms is the recommended value.

At the HDMI ports, a limit of typ. 0.988 is used for the SSIM. Interference-free reception has an SSIM of 1; reception subject to interference has an SSIM of < 0.988.

Due to noise influences, analog A/V interfaces have a lower SSIM value.

With digital transmissions such as DVB-T and DVB-T2, the picture quality transition from good to bad and vice versa is very clearly defined. This is referred to as the digital cliff-edge effect and it makes the assessment of A/V signals extremely reliable, reproducible, and automatable.

DUT remote control

To enable the software to switch channels automatically, the DUT is controlled using the RedRat3-II USB infrared sensor. With the help of this USB controlled sensor, R&S®AVBrun learns all remote keys of the DUT remote control (only necessary once per DUT). After this, a channel searching sequence is defined using R&S®AVBrun. This sequence contains a series of keystrokes and defined waiting periods. By using a placeholder (channel or frequency) in the sequence, users can scan for an individual channel. Alternatively, an automatic full scan channel search can be performed without a placeholder.

The NET8212 EPC IP power control is used to perform a selective reset or to respond to unexpected DUT behavior (e.g. a crash). The R&S®AVBrun test suite software uses the NET8212 to interrupt the power supply to the DUT and force a reset. This makes it possible to perform automated tests overnight or over the weekend.

The terms HDMI and HDMI High-Definition Multimedia Interface, and the HDMI Logo are trademarks or registered trademarks of HDMI Licensing LLC in the United States and other countries.

Product overview of options								
Designation	Туре							
D-Book Test Suite	R&S®BTC-KT3310							
A/V Distortion Test	R&S®VT-KT3360							
Broadcast Test Center	R&S®BTC							
RF Path A, 100 kHz to 3 GHz	R&S®BTC-B3103							
RF Path B, 100 kHz to 3 GHz ¹⁾	R&S®BTC-B3203							
Baseband Main Module, one I/Q path to RF	R&S®BTC-B11							
Baseband Main Module, two I/Q paths to RF $^{\mbox{\tiny 1)}}$	R&S®BTC-B12							
Baseband Generator, 1st channel	R&S®BTC-B1							
Baseband Generator, 2nd channel 1)	R&S®BTC-B2							
Fading Simulator (path A)	R&S®BTC-B1031							
Fading Simulator (path B) ¹⁾	R&S®BTC-B1032							
Interfaces for the R&S [®] BTC								
HDMI RX 225 MHz Analyzer ²⁾	R&S°VT-B2360							
HDMI RX 300 MHz Analyzer ²⁾	R&S°VT-B2361							
Analog A/V RX module ²⁾	R&S°VT-B2370							
Software options for the R&S®BTC								
DVB-T2 Coder ³⁾	R&S®BTC-K516							
DVB-T/DVB-H Coder ³⁾	R&S®BTC-K501							
Multi-ARB Waveform Generator	R&S®BTC-K35							

Flexibility

The default settings for the R&S®AVBrun test suite software allow users to perform all tests exactly as specified in the D-Book. The user can configure which tests are to be performed in a sequence. For fault analysis and additional testing, it is possible to deviate from the recommendations. The software offers the following configurations:

I User-specific signal configurations:

Execution of one or more tests with a user-specific signal configuration (option), channel and performance targets

- I The user can choose between two test modes:
 - Ouick test: pass/fail test
- Detailed test: limit search
- User-definable A/V sequence and observation interval: Selection of A/V sequence required for picture quality assessment; configuration of failure criteria
- Picture quality assessment:

Selection of SSIM or peak signal-to-noise ratio (PSNR) to reflect the deviation between the signal to be tested and the reference signal. At the HDMI ports, an interference-free reception has a PSNR of 100 dB; a limit of typ. 35 dB is used. At analog A/V interfaces, a lower PSNR value of approx. 45 dB is achieved; here a PSNR limit of typ. 25 dB is used

Subjective failure point:

Prompting the user to observe the A/V signal being output (on a TV set, for example); forwarding of any visible errors to the software at the press of a button

The test report that is generated immediately shows if all test configurations satisfy the D-Book requirements or if configurations were modified.

Product overview of options								
Designation	Туре							
AWGN after Fading	R&S®BTC-K1040							
Extended Noise Generator	R&S®BTC-K1043							
Power Meter	R&S®BTC-K2055							
Waveform Library	R&S®WV-K1114							
A/V Distortion Analysis	R&S°VT-K2111							
A/V Inspection ⁴⁾	R&S°VT-K2110							
Analog Signals	R&S®WV-K816							
Recommended accessories								
RedRat Infrared Remote Control Input/Output Device	RedRat3-II							
EPC IP Power Control	NET8212							
Matching Pad, 50 Ω /75 Ω	R&S®FSH-Z38							
Power sensors (example)								
Universal Power Sensor, 200 pW to 200 mW, 10 MHz to 8 GHz	R&S®NRP-Z11 5)							

¹⁾ Only required for diversity testing (chapter 10, section 10.10).

- ²⁾ Only one of these options is required, depending on the DUT interface.
- $^{\scriptscriptstyle 3)}$ $\,$ For diversity testing (chapter 10, section 10.10), this option is required twice.

⁴⁾ A/V distortion analysis requires A/V inspection.

⁵⁾ Any power sensor that the R&S[®]BTC supports can be used; see the R&S[®]BTC specifications (PD 3606.8550.22).

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The Rohde & Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcasting, secure communications, and radiomonitoring and radiolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries. The company is headquartered in Munich, Germany.

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- I Longevity and optimized total cost of ownership

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