

Version  
04.00January/  
June 2004

## DTV Recorder Generator R&S® DVRG

Recording, replay and generation of digital video streams

- ◆ Data rates up to 214 Mbit/s (TS)
- ◆ Data rates up to 270 Mbit/s (SDI)
- ◆ Hard disk memory up to 144 Gbyte
- ◆ Endless and seamless generation of MPEG-2 transport streams
- ◆ Large selection of test signals (DVG-compatible)
- ◆ Compatibility with ATSC and DVB
- ◆ Triggered recording for error analysis (with pretrigger)
- ◆ Optional recording and replay of SDI video streams
- ◆ Cutting function via front panel
- ◆ File transfer via network and CD
- ◆ Easy and self-explanatory operation
- ◆ Compact design (2 HU)
- ◆ Remote-control capability with support of SCPI commands
- ◆ Convenient remote-control software included in base unit



**ROHDE & SCHWARZ**

# The universal processing platform for digital video streams

## Introduction

The R&S® DVRG is a universal processing platform for digital video streams. It enables recording and replay of MPEG-2 transport streams. For error analysis, recording can be controlled by means of an external trigger signal. The stored signal includes time sections of different lengths both before and after the trigger event. For multifaceted tests of STBs, decoders and D/A converters, the R&S® DVRG offers a comprehensive library of transport streams.

As a standalone unit, the R&S® DVRG is operated via the keys and the LC display on the front panel. The R&S® DVRG includes a complete PC platform running under the WindowsNT Embedded operating system, which can be fully utilized after connecting a VGA monitor, keyboard and mouse. This makes it possible, for example, to install and use further software packages for analyzing or generating transport streams. Moreover, the R&S® DVRG can easily be networked via the standard Ethernet 100BaseT interface for remote control and transmission of transport stream files.

As an option, the R&S® DVRG also enables recording and replay of uncompressed digital video streams in SDI format at a data rate of 270 Mbit/s.

Its versatility and configurability make the R&S® DVRG the most flexible platform available for anyone who works with digital video signals to MPEG-2, DVB and ATSC or SDI standard.

## Operating modes

The R&S® DVRG has two operating modes: standalone and workstation. In standalone mode, the hard disk is write-protected for system security. The instrument can thus be switched off at any time and is safeguarded against faults even in the event of a power failure. This feature is of great advantage especially in production. Operation is via the keyboard, rollkey and the LC display on the front panel of the instrument.

The workstation mode makes it possible to use the R&S® DVRG with an external monitor, keyboard and mouse, and provides access to the WindowsNT Embedded operating system. This considerably expands the functional scope, enabling users to perform such tasks as:

- ◆ Burning CDs (R&S® DVRG-B5 option)
- ◆ Accessing external network drives
- ◆ Generating transport streams from elementary streams (R&S® DVG-B1 Stream Combiner™ software)
- ◆ Using other programs released by Rohde&Schwarz, e.g. for offline analysis





### Generation of seamless and endless transport streams

The R&S® DVRG can be used to generate endless and seamless transport streams at the press of a button. For this purpose, an extensive collection of transport streams in Rohde&Schwarz GTS format is available in the R&S® DVRG. The generated transport streams fulfill all the conditions listed in the section entitled "How is a transport stream generated in a seamless endless loop?" (see grey box).

In addition, the following features are available:

- ◆ Jitter of PCR values (adjustable waveform, frequency and amplitude)
- ◆ Selectable data rate (up to 214 Mbit/s by inserting null packets)
- ◆ Generation of transport streams in GTS format with application-specific contents (both elementary-stream and PSI/SI/PSIP contents; in workstation mode: Stream Combiner™, option R&S® DVG-B1)

### How is a transport stream generated in a seamless endless loop?

For seamless generation of a transport stream in an endless loop (GTS mode), two conditions must be fulfilled:

- ◆ All available time stamps (PCR, PTS, DTS values and entries in the TDT, TOT and STT tables) in the transport stream must be updated in realtime.
- ◆ The individual elementary streams must be computed/cut in such a way that they end with a complete GOP (video) or an entire frame (audio), so that no errors occur in the decoder. In addition, all elementary streams must be computed in such a way that the average buffer fill level over a loop time is constant, so that no overflows or underflows of the buffer occur during continuous replay in an endless loop.

If these conditions are met, the transport stream appears to be continuously generated in realtime directly from a multiplexer and a number of encoders connected to it, although the video, audio and data contents occur repeatedly.



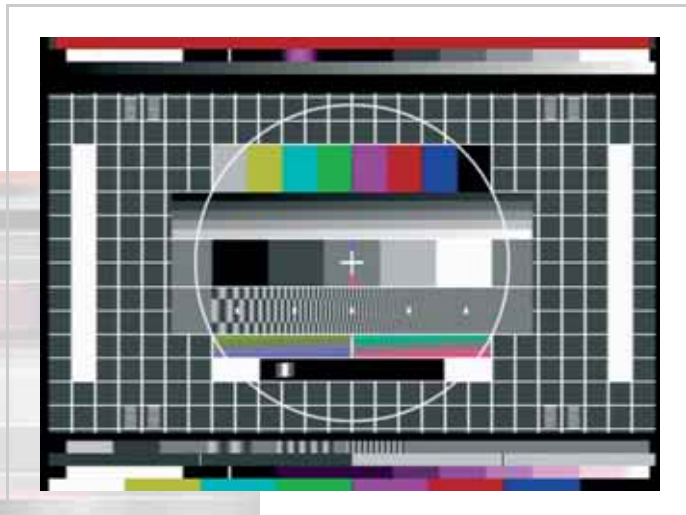
## Test signals

The R&S® DVRG provides many different preconfigured MPEG-2 transport streams to ATSC and DVB standards at the press of a button. The transport streams are comprised of several elementary streams and contain video, audio and other data (e.g. teletext or PRBS). Video streams with different data rates, formats, frequencies and contents are available.

The signal set comprises sequences with moving picture contents as well as some static test patterns. The latter include, for example, colour bars, zone plate, CCIR17/18/331, ITS1 to ITS4, etc, and the Rohde&Schwarz Codec test pattern. Due to integrated test lines in the upper and lower picture area of this test pattern, a suitable video analyzer such as the R&S® VSA can be used to measure the analog outputs of a set-top box (or IRD) within seconds. In addition, integrated moving picture elements allow visual checking of the decoder functionality.

Audio data streams with different sampling rates, encoded according to MPEG-1 layer 2 or Dolby AC-3, contain the accompanying sound for the video sequences as well as special audio test signals. Of course, the transport streams include all program information, service and system tables (PSIP or SI) required by MPEG-2 and ATSC or DVB as stipulated by the selected standard.

Further options enable HDTV signals and other special test signals to be added to this large collection (see R&S® DV-HDTV and R&S® DV-TCM options, page 7).



*Sample signal: universal Rohde & Schwarz Codec 4:3 test pattern*

## Recording

The R&S® DVRG enables recording of transport streams at data rates up to 214 Mbit/s. Exchanging transport streams with other systems does not pose a problem, as the stored files contain the transport stream packets in consecutive order and without additional headers.

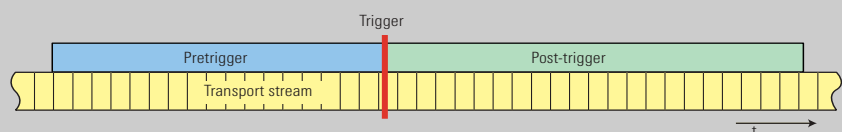
As a special SPI feature, the R&S® DVRG also allows interface-specific data to be recorded simultaneously with transport stream data (8 bits). Thus, the bit signalling the start of the packet (PSYNC) and the bit signalling the validity of the data (DVALID) are also recorded so that a total of 10 bits are stored for 8 data bits.

As the R&S® DVRG records transparently, it can record non-DTV-compliant signals and even signals of other applications via its interfaces.

In addition to these versatile functions, the R&S® DVRG optionally supports the recording of SDI signals at a data rate of 270 Mbit/s. As this process is also transparent, all ancillary data and embedded audio signals are recorded. Furthermore, SDTI signals can be recorded (for more details, see option R&S® DVRG-B4, page 6).

Recording of all signals can be controlled via the trigger input of the R&S® DVRG. For this purpose, the applied signal is continuously buffered. If a trigger event occurs, the signal segments following the event (post-trigger) and preceding the event (pretrigger) can be stored. The length of the post- and pretrigger can be set. This makes it possible to determine where in the stored signal the event should be located. This function is particularly important for error analysis.

*The length of the pre- and post-trigger can be set on the R&S® DVRG for triggered recording*



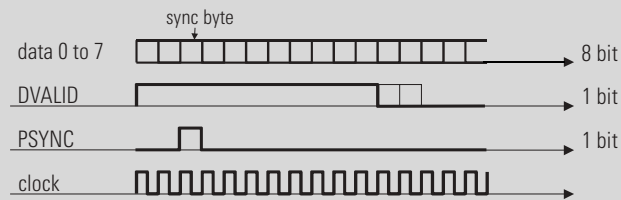
## How is data transmitted via the SPI?

This interface transmits 8 bits of the transport stream in parallel. In addition to these 8 bits, the following information is transmitted:

- ◆ Common clock for all parallel lines (clock)
- ◆ Start of a transport stream packet (PSYNC)
- ◆ Validity of the transmitted data (DVALID)

By way of the "data valid" signal, it is possible to transport no valid data for a specific period of time and thus interrupt the transport stream.

This transport stream can be used by instruments internally, for example, for parallel data transmission (e.g. in STB).



10-bit SPI signalling

## Overview: hard disk recording times

Signal type	Data rate (Mbit/s)	Memory space (factor K=1024)		
		140 Gbyte	70 Gbyte	CD <sup>1)</sup> 0.65 Gbyte
		Time (min)		
TRP 8 bit	5	4008.6	2004.3	18.6
	10	2004.3	1002.2	9.3
	19.4	1033.2	516.6	4.8
	38	527.5	263.7	2.5
	38.8	516.6	258.3	2.4
	80	250.5	125.3	1.2
	120	167.0	–	0.8
SDI 8 bit	160	125.3	–	0.6
	216	92.8	–	0.4
SDI 10 bit	270	69.6	–	0.3

<sup>1)</sup> For data transfer only.

## Replay of recorded signals

Replayed signals are applied to all interfaces simultaneously. However, the SDI interface is used exclusively for SDI signals, whereas other 10-bit-wide signals are only replayed via the SPI interface.

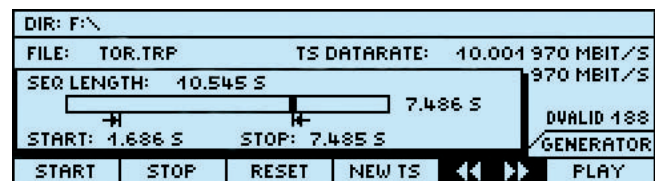
The signals are replayed in an endless loop in such a way that the transition from the end to the beginning of the recording always coincides with the packet or frame (transport stream or SDI signal).

Flawless decoding of the video and audio sequences in the replayed transport stream is ensured only if the original data rate of the recording is used. For this reason, the R&S®DVRG automatically recognizes the data rate of transport streams on the basis of the PCR values in the transport stream. Independent of this automatic recognition, the data rate can also be set by the user (up to 214 Mbit/s).

Furthermore, the interfaces can be configured for replay. It is thus possible to choose between the "packet" and "continuous" operating modes for the ASI interface. This feature is important primarily for testing routers.

For the SPI interface, the signals can be set via the "data valid" line. This flexibility allows versatile tests to be performed and offers maximum compatibility to other instruments.

A special feature of the R&S®DVRG is its cutting function for recorded transport streams and SDI signals. Via the front panel, these signals can be easily cut to the exact packet or frame. This makes it possible to automatically replay interesting segments of long recordings in a loop or store them on hard disk for further analysis or a simple transfer to other units.



Cutting function via front panel



### **R&S® DVRG-B5: CD read/write drive**

The basic configuration of the R&S® DVRG includes a read-only drive for conventional data CD-ROMs and DVD-ROMs. Software can thus be updated and new transport streams stored. Option R&S® DVRG-B5 offers a read/write drive for CD-Rs for storing recorded transport streams, replacing the existing read-only drive. Like the base unit, it can also be used to read data DVDs.

The R&S® DVRG contains the Nero software for burning data to CD. This software is used in workstation mode and requires the connection of an external monitor, keyboard and mouse.

### **R&S® DVRG-B6: SMPTE-310M interface**

The synchronous serial transport stream interface SMPTE-310M provides an additional input/output (BNC) on the rear panel of the R&S® DVRG. It is usually used for 8-VSB modulation with ATSC.

### **R&S® DV-HDTV: HDTV sequences**

The R&S® DV-HDTV option provides an extensive transport stream library containing high-resolution video signals. To generate individual transport streams, the option also includes these video signals in the form of elementary streams. The transport stream data is already stored in the base unit. It can be unblocked by loading a software key. A separate data sheet specifying the details of this option is available on request (PD 0757.6979).

### **R&S® DV-TCM: Test Card M streams**

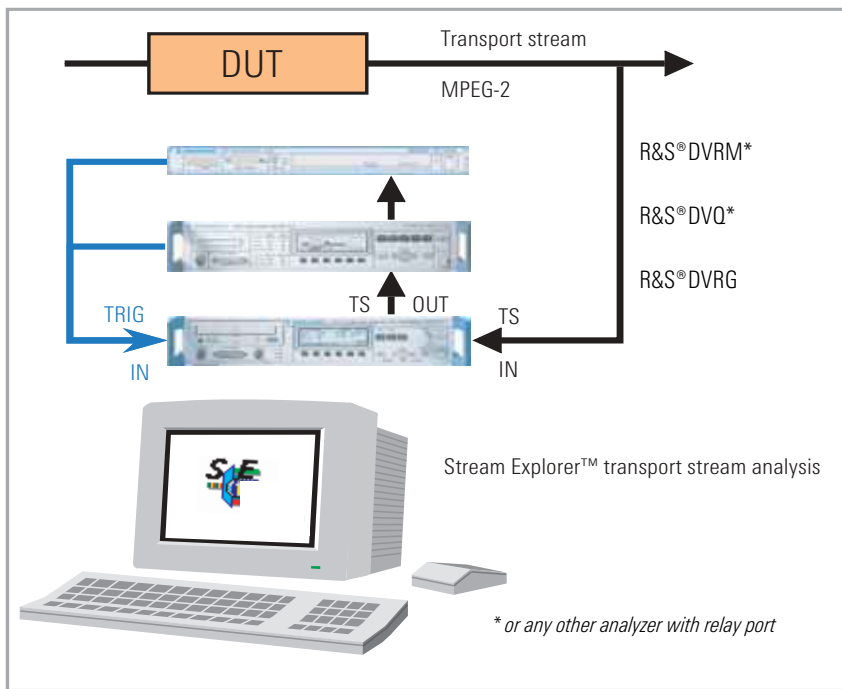
This option supports the replay of a specific collection of transport streams that was developed by the company Snell & Wilcox and is called Test Card M. The transport stream data is already stored in the base unit. It can be unblocked by loading a software key. A separate data sheet specifying the details of this option is available on request (PD 0757.7369).

### **R&S® DVG-B1: Stream Combiner™**

Stream Combiner™ makes it possible to generate new transport streams from supplied or recorded elementary streams in addition to the transport streams stored in the R&S® DVRG. Used as an offline multiplexer, it automatically integrates all program information, service and system tables (PSI/SI/PSIP) required in accordance with MPEG-2 and the selected standard (ATSC or DVB). In addition, Stream Combiner™ makes it possible to edit, add to or remove all table contents – even in noncompliance with standards – in order to generate test signals for specialized tasks. The transport-stream files can be generated in GTS or TRP format. A separate data sheet is available for this option (PD 0757.3611).

## Abbreviations

<b>ATSC</b>	Advanced Television Systems Committee
<b>BAT</b>	Bouquet Association Table
<b>CAT</b>	Conditional Access Table
<b>CETT</b>	Channel Extended Text Table
<b>CVCT</b>	Cable Virtual Channel Table
<b>DIT</b>	Discontinuity Information Table
<b>DTS</b>	Decoding Time Stamp
<b>DVB</b>	Digital Video Broadcast
<b>EIT</b>	Event Information Table
<b>EPG</b>	Electronic Program Guide
<b>ETT</b>	Extended Text Table
<b>GOP</b>	Group of Pictures
<b>HDTV</b>	High Definition Television
<b>IRD</b>	Integrated Receiver Decoder
<b>MGT</b>	Master Guide Table
<b>MPEG</b>	Motion Picture Experts Group
<b>NIT</b>	Network Information Table
<b>PAT</b>	Program Association Table
<b>PCR</b>	Program Clock Reference
<b>PES</b>	Packetized Elementary Stream
<b>PID</b>	Packet Identification
<b>PIT</b>	Program Identification Table
<b>PMT</b>	Program Map Table
<b>PSI</b>	Program Specific Information
<b>PSIP</b>	Program and System Information Protocol
<b>PT</b>	Private Table
<b>PTS</b>	Presentation Time Stamp
<b>RRT</b>	Rating Region Table
<b>RST</b>	Running Status Table
<b>SDI</b>	Serial Digital Interface
<b>SDT</b>	Service Description Table
<b>SDTI</b>	Serial Digital Transport Stream Interface
<b>SI</b>	Service Information
<b>SIT</b>	Selection Information Table
<b>SPI</b>	Synchronous Parallel Interface
<b>SSI</b>	Synchronous Serial Interface
<b>ST</b>	Stuffing Table
<b>STB</b>	Set-Top Box
<b>STT</b>	System Time Table
<b>TDT</b>	Time and Date Table
<b>TOT</b>	Time Offset Table
<b>TS</b>	Transport Stream
<b>TVCT</b>	Terrestrial Virtual Channel Table



**Error analysis with the R&S® DVRG and realtime analyzers**

## Applications

Its versatility, flexibility and numerous options make the R&S® DVRG the ideal platform for a variety of different applications.

### Development

In the development of set-top boxes and other instruments that process digital TV signals according to the MPEG-2 standard, the R&S® DVRG is optimally suited as a signal source for a wide range of tests due to its extensive collection of transport streams. Stream Combiner™ makes it possible to quickly and easily create customized transport streams to expand the set of existing streams.

### Quality assurance

Test signals of the R&S® DVRG are always replayed in the same way and thus serve as reference standards for quality assurance tests. Diverse tests are possible due to the extensive collection of signals. Using the optional Test Card M Streams R&S® DV-TCM, it is easy to add special signals to the collection.

### Production

Device software and configurations can be downloaded via customer-specific transport streams to the STB or any other instrument.

### Substitution signal generator

If the signal supply line to the playout center, the cable headend, or the satellite uplink or downlink fails, the R&S® DVRG functions as a substitution signal source and provides an endless and seamless transport stream. Due to the hard disk's high storage capacity, the R&S® DVRG can replay even very long sequences.

### Monitoring and error analysis

The R&S® DVRG's trigger function makes it an ideal tool for simplifying error analysis and for effective monitoring. Any signal segments before and after the trigger signal can be automatically stored for detailed analysis. The trigger signal can be activated from any device that has a relay port. The MPEG-2 Measurement Decoder R&S® DVMD, the MPEG-2 Realtime Monitor R&S® DVRM, the

### MPEG-2 Monitoring System

R&S® DVM 100/120 and the Digital Video Quality Analyzer R&S® DVQ are all equipped with these ports (R&S® DVMD with option R&S® DVMD-B5).

The "multiple" function mode of the trigger function is particularly worth mentioning, as it can be used to automatically and continuously record signals for a number of trigger signals over a long period of time (overnight, for example).

### From SDI recording to MPEG-2 transport stream

A special application of the R&S® DVRG makes it possible to combine SDI recording and transport stream replaying. With these functions, uncompressed signals can be recorded, encoded, integrated into a transport stream and replayed using a single instrument.

Encoding and multiplexing also take place in the R&S® DVRG. Encoding is performed by means of third-party standard encoding software, and multiplexing runs via Stream Combiner™.



## Specifications

### Signal inputs

MPEG-2 transport stream	
Asynchronous serial interface (ASI) acc. to EN 50083-9	BNC connector (75 Ω) on front <b>and</b> rear panel
Data rate	270 Mbit/s
Mode	packet or continuous
Synchronous parallel interface (SPI) acc. to EN 50083-9	25-pin connector on rear panel
Clock	LVDS
Mode	84.375 kHz to 20 MHz TRP, 8 bit (8 bits data) T10, 10 bit (8 bits data, 1 bit DVALID, 1 bit PSYNC)
Synchronous serial interface (SSI) acc. to SMPTE-310M	BNC connector (75 Ω) on rear panel only with option R&S® DVRG-B6
Data rate	19.392658 Mbit/s
Video serial digital 270 Mbit/s	
SDI acc. to ITU-R B.T.601/656 or SMPTE 259M	BNC on rear panel, 800 mV ( $V_{pp}$ ), 75 Ω, only with option R&S® DVRG-B4

### Signal outputs

Input signals are applied to outputs of the same type if the Record menu on the R&S® DVRG has been selected.

MPEG-2 transport stream	
Asynchronous serial interface (ASI) acc. to EN 50083-9	BNC connector (75 Ω) on front <b>and</b> rear panel, plus loop-through output of ASI input on rear panel
Data rate	270 Mbit/s
Mode	packet or continuous, selectable
Synchronous parallel interface (SPI) acc. to EN 50083-9	25-pin connector on rear panel
Clock	84.375 kHz to 20 MHz
Mode	TRP, 8 bit (8 bits data) 1 bit PSYNC automatically generated and 1 bit DVALID configurable: – exactly 188 bytes active – constantly active with packet length of 204 or 208 bytes T10, 10 bit as recorded (8 bits data, 1 bit DVALID, 1 bit PSYNC)
Synchronous serial interface (SSI) acc. to SMPTE-310M	BNC connector (75 Ω) on rear panel only with option R&S® DVRG-B6
Data rate	19.392658 Mbit/s
Video serial digital 270 Mbit/s	
SDI acc. to ITU-R B.T.601/656 or SMPTE 259M	BNC connector on rear panel, 800 mV ( $V_{pp}$ ), 75 Ω, only with option R&S® DVRG-B4

### Signal characteristics

<b>GTS generator</b>	for generating transport streams acc. to ISO/IEC 1-13818
Interfaces	outputs: ASI, SPI and SSI
Length of transport stream packets	ATSC: 188/208 bytes (selectable) DVB: 188/204 bytes (selectable)

Sequence length	endless and seamless generation with repetition of video, audio and data contents
Data rate	675 kbit/s to 214 Mbit/s (including null packets)
Net data rate	max. 90 Mbit/s
Data volume	max. 80 Mbyte payload
Number of programs	max. 10
Number of elements per program	max. 10
PCR jitter	configurable (only GTS mode)
Form	sine, rectangle and triangle
Frequency	1 mHz to 100 kHz
Amplitude	0 ms to 1 ms, increment 0.1 μs
Signal set	moving picture sequences and test patterns with test tones, for 625 and 525 lines DVB/ATSC systems, additional signals via options (R&S® DV-HDTV, R&S® DV-TCM)
<b>TRP generator and recorder (8 bit)</b>	for recording and replaying signals of any content
Interfaces	inputs and outputs: ASI, SPI and SSI
Max. data rate	214 Mbit/s from memory or hard disk if two hard disks are installed 90 Mbit/s if one hard disk is installed
Min. data rate	675 kbit/s
Max. data volume	limited only by size of hard disk
Replay data rate	automatic data rate recognition for MPEG-2-compliant transport streams on the basis of PCR values; can be modified by user
Endless replay	packet-exact cut at transition from end of file to beginning of file
<b>T10 generator and recorder (10 bit)</b>	for recording and replaying signals of any content
Interfaces	inputs and outputs: SPI
Max. data rate	214 Mbit/s from memory or hard disk if two hard disks are installed 90 Mbit/s if one hard disk is installed
Min. data rate	675 kbit/s
Max. data volume	limited only by size of hard disk
<b>SDI generator and recorder</b>	for recording and replaying signals of uncompressed serial video signals acc. to ITU-R B.T. 601/656 or SMPTE 259M and SDTI signals
Interfaces	inputs and outputs: SDI
Data rate	270 Mbit/s
Max. data volume	limited only by size of hard disk
Formats	8-bit SDI 10-bit SDI including all ancillary data and embedded audio SDTI
Endless replay	seamless (frame-exact cut at transition from end of file to beginning of file)

## Functions

Replay	
Types	transport stream seamless and endless (GTS); transport stream 8/10 bit (TRP, T10), endless; SDI 8/10 bit, seamless and endless (SDI, S10)
Replay and storage of signal segments	
TRP/T10 signals	
Min. length	1 s
Increment	100 ms, packet-exact
SDI/S10 signals	
Min. length	1 frame
Increment	1 frame
Replay using external clock	84.375 kHz to 20 MHz via SPI input (clock)
Recording	
Types	transport stream 8/10 bit (TRP, T10) SDI 8/10 bit (SDI, S10)
Externally controlled recording via separate trigger input on rear panel	
Function modes	
Single	single automatic storage after trigger signal repeated storage of individual segments for more than one trigger signal; as many as 128 files/trigger events can be automatically recorded
Multiple	
Parameter	
File size	8 Mbyte up to hard disk capacity (recording to RAM up to 80 Mbyte file size)
Post-trigger/stop delay	0% to 100% of file size

## PC platform

Operating system	Windows NT Embedded, Service Pack 5
Main memory (RAM)	256 Mbyte (80 Mbyte reserved as data buffer)
System hard disk	IDE $\geq$ 20 Gbyte
DVD drive	read: CD-ROM and DVD-ROM
CD-R/RW drive (option R&S®DVRG-B5)	CD-ROM read and write, DVD-ROM read
Software	only for software released for R&S®DVRG by Rohde&Schwarz
Interfaces (rear panel)	
VGA	15-pin sub-D connector, for SVGA or TFT monitor
PS/2	PS/2 connector, combined for mouse and keyboard
Serial interface	9-pin sub-D connector, RS-232-C, 9.6 kbaud to 115 kbaud, connection to other devices and remote control (SCPI)
Parallel interface	25-pin sub-D connector, printer output
Network	RJ-45 connector, Ethernet 100BaseT for 100 Mbit/s, TCP/IP, remote control (SPCI) and system integration

## Operation

From instrument	keys, rollkey and LC display on front panel or via external keyboard, mouse and monitor (display and operation of LC display of R&S®DVRG or R&S®DVRG Commander)
Remote control	SCPI commands via TCP/IP (Ethernet 100BaseT) or via serial interface (RS-232-C) with R&S®DVRG remote software (conversion of SCPI commands to TCP/IP interface received via RS-232-C interface of R&S®DVRG) R&S®DVRG Commander software

## R&S®DVRG Commander software

System requirements	
Operating system	Windows95/98/2000/NT and XP
Processor	Pentium I, 200 MHz
Memory	32 Mbyte
Hard disk	4 Mbyte
Ethernet	TCP/IP
Functions	
	remote control of all basic functions of R&S®DVRG

## General data

Operating temperature range	+5°C to +40°C
Permissible temperature range	+5°C to +40°C
Storage temperature range	-40°C to +70°C
Mechanical resistance	
Vibration, sinusoidal	5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const., meets DIN EN 60068-2-6, DIN EN 61000-1 and MIL-T-28800D class 5
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (rms)
Shock	40 g shock spectrum, meets MIL-STD-810D and MIL-T-28800D class 3 and 5
Climatic resistance	95% rel. humidity, cyclic test at +25°C/ +40°C, meets DIN EN 60068-2-30
Electromagnetic compatibility	meets EN 50081-1 and 50082-2 (EMC directive of EU)
Power supply	88 V to 264 V/47 Hz to 63 Hz
Dimensions (W × H × D)	427 mm × 88 mm × 450 mm
Weight (without options)	9.7 kg

## Ordering information

Designation	Type	Order No.
DTV Recorder Generator	R&S®DVRG	2083.1302.02

### Hardware options

Additional Hard Disk for recording and replaying	R&S®DVRG-B2	2083.1919.04
SDI Recording and Replaying	R&S®DVRG-B4	2083.1931.02
CD Read/Write Drive <i>with DVD read-only</i>	R&S®DVRG-B5	2083.1948.02
SMPT-310M Interface	R&S®DVRG-B6	2083.1954.02

### Software options

Test Card M Streams	R&S®DV-TCM	2085.7708.02
HDTV Sequences	R&S®DV-HDTV	2085.7650.02
Stream Combiner™	R&S®DVG-B1	2068.9835.02

### Recommended extras

Documentation of Calibration Values	R&S®DRG-DCV	2082.0409.21
19" Adapter (2 HU) for installation with handles (rackmount without handles on request)	R&S®ZZA-211	1096.3260.00
Service manual		2083.1360.24





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