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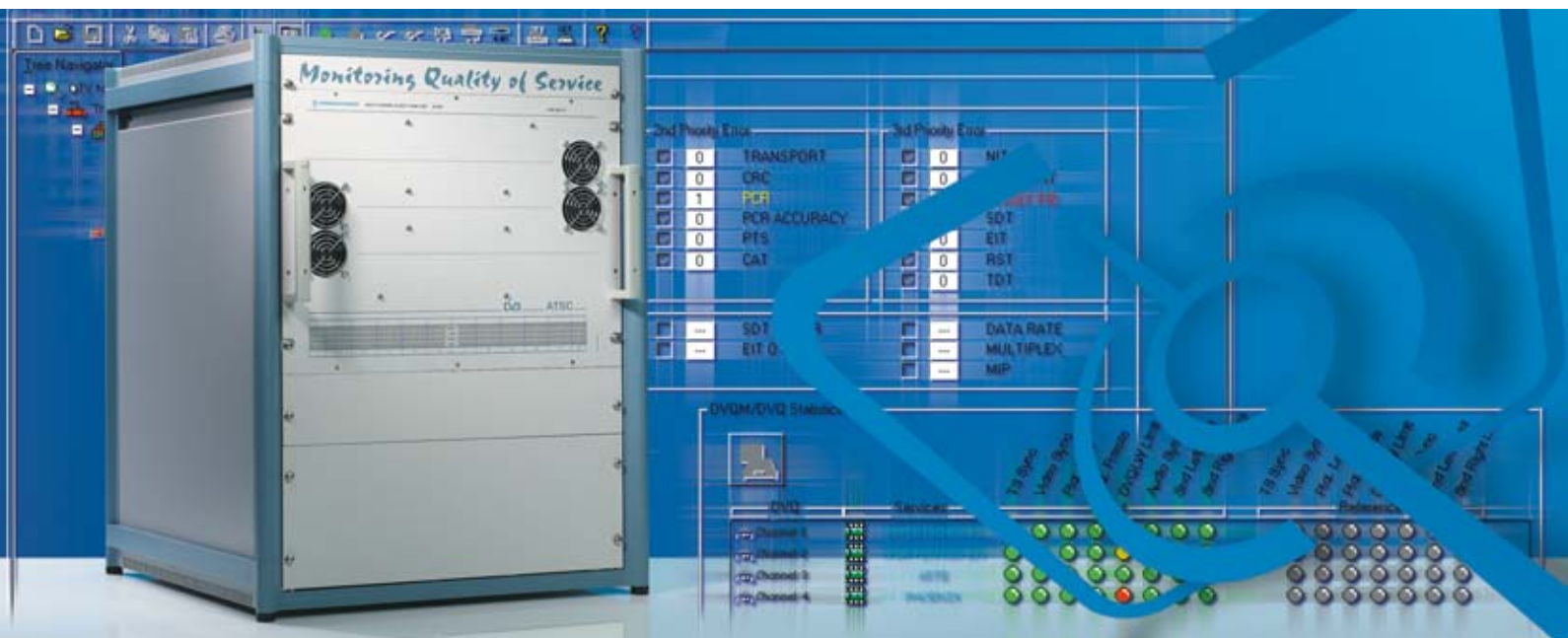


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# Multichannel Digital Video Quality Analyzer DVQM

Always in the picture about picture quality in all channels

- ◆ Simultaneous monitoring of up to 12 channels
- ◆ Optional monitoring of video quality with SSCQE scaling of quality levels
- ◆ No reference signal required
- ◆ 12 programmable alarm relay contacts per channel
- ◆ Selectable alarm thresholds
- ◆ SDI interface
- ◆ Video outputs: SDI and CCVS
- ◆ Compatible with DVB and ATSC
- ◆ Ethernet interface (TCP/IP-SNMP)
- ◆ MS Windows software for remote control
- ◆ Internal event and error report and statistics
- ◆ Optional decoding of CA programs



**ROHDE & SCHWARZ**



*In 2000, Rohde & Schwarz won an EMMY award for the DVQ – the single-channel version of the DVQM – in the category "Pioneering development of equipment to provide objective measurement of perceptible picture quality in digital television systems"*



*The DVQM received the "Broadcast Engineering Pick Hit" award at the NAB 2001*

The DVQM is the multichannel version of the successful Digital Video Quality Analyzer DVQ from Rohde&Schwarz. The DVQM can combine the performance of up to twelve DVQs. The resulting large variety of configurations allows the DVQM to be optimally adapted to different requirement profiles.

For configuration of the individual analyzer boards and for readout of the measurement results, the DVQM comes with the DTV NetView PC software running under MS Windows. This software ena-

bles remote communication with all instruments via the Ethernet interface where the instruments are not used at the same place or there are major distances between the measuring instruments and the PC.

The software can be individually adapted to different instrument configurations and provides a fast overview of the analysis results of all the instruments.

Video quality analysis is optionally available (DVQM-B4) for the individual analyzer boards of the DVQM.

Using the Video Quality Analysis Option DVQM-B4, the assessment of picture quality according to subjective criteria becomes an objective realtime measurement method. Picture quality is assessed from artefacts produced by digital compression. The method is based on the analysis of video data and can thus also be used where no reference video material is available. For complete display and analysis of all coding data as well as convenient remote control of the DVQM and display of the recorded quality data, the Elementary Stream Analyzer PC Software DVQ-B1 can be used in addition.

The increasing use of digital, data-compressed TV signals calls for monitoring and assessment of the picture quality. Picture quality assessment is very strongly influenced by the subjective perception of the human eye.

The DVQM is a tool that ideally satisfies both requirements. It optionally determines the picture quality in relation to digital compression and evaluates the results according to the subjective criteria of visual perception.



*The DVQM mounted in a 19" rack*

## Characteristics

The basic unit of the DVQM comes with two analyzer boards. The instrument can accommodate another 10 boards. These may be analyzer boards for simultaneous monitoring of 12 channels, or descrambling boards for decoding of pay TV programs. Up to six scrambled programs can be monitored simultaneously (6 descrambling boards and 6 analyzer boards).

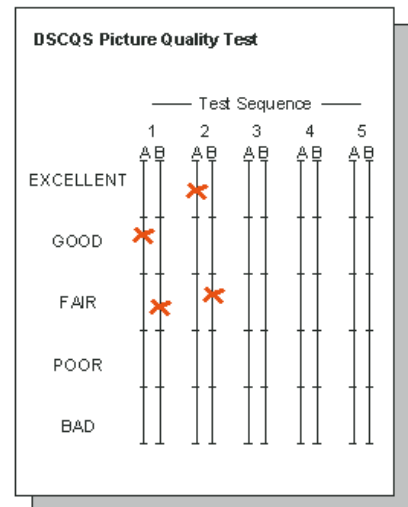
## Video quality analysis (DVQM-B4)

The method adopted for determining the quality is based on the analysis of DCT-coded video data applied to the DVQM in an MPEG-2 transport stream. The additional SDI input also allows evaluation of decompressed video data.

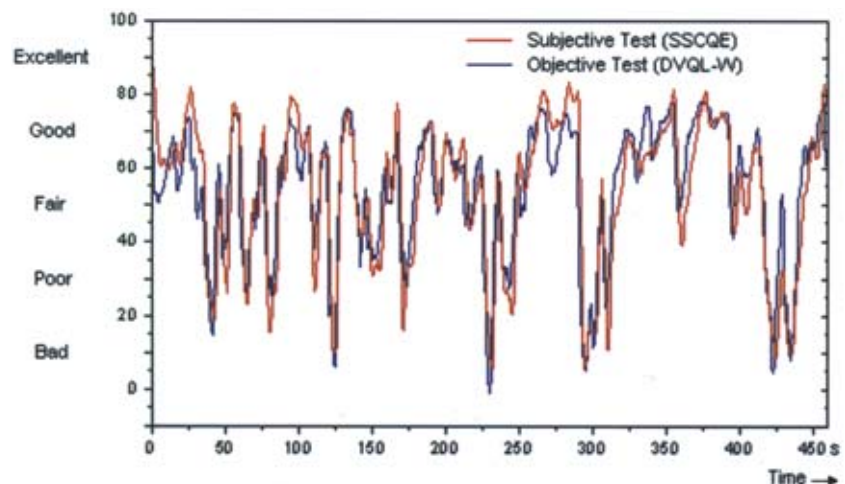
Quality analysis is performed in realtime so that any potential quality degradation can immediately be recognized and remedied. This method allows long-term recording, monitoring and evaluation of picture quality.

Picture quality is determined by the DVQM in two steps. The first step is based on the analysis of blocking contained in the video stream – the most frequent cause of picture errors in MPEG-2-coded video signals – and the calculation of the spatial and temporal activities. These parameters are continuously determined for the video stream monitored.

Spatial activity is the structural intensity of an individual picture; temporal activity describes the degree of picture content variation between two pictures. The intensity of blocking is calculated separately for the luminance signal and the two chrominance signals. The unweighted quality levels (DVQL-U) are obtained from these parameters.



**Quality scale for comparative (DSCQS) and absolute (SSCQE) subjective assessment of picture sequences**



**Comparison of objective test results (DVQL-W) and subjective quality assessments (SSCQE) for a 480 s sample sequence**

In the second step, the parameters determined are used to calculate the weighted quality level (DVQL-W) with the aid of a patented algorithm. This value represents the picture quality perceived by the human eye. The masking effects of the eye are thus taken into account. Rohde & Schwarz developed the algorithm in cooperation with the Institute for Communications Technology of the Technical University of Braunschweig. Comparisons with the quality assessments of individual video sequences by a group of test persons have shown an agreement of over 80% with the results obtained with the aid of the algorithm developed.

The unique combination of realtime capability, independence from a reference signal and weighted picture quality calculation make the DVQM an indispensable tool in the quality assessment of digital, DCT-coded video sequences.



## Signalling on the instrument

The DVQM has four LEDs for each slot for signalling the most important device states:

- ◆ READY: slot is fitted with analyzer board and ready for operation
- ◆ REMOTE: board is controlled via RS-232-C or Ethernet
- ◆ ALARM: signal error is detected
- ◆ SIGNAL: signal is present (no failure of transport stream, video or audiot)

If the slot is not occupied or a descrambling board is installed, the LEDs for the slot concerned have no function.

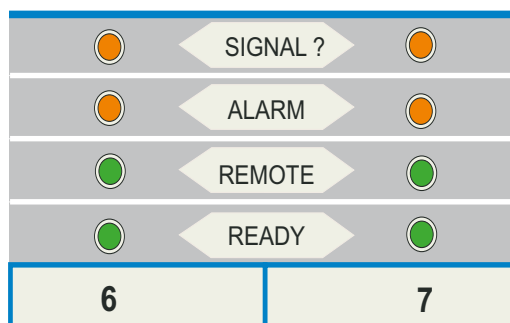
## Possible configurations

The analyzer boards can be inserted into any of the 12 slots, whereas the descrambling boards are subject to the following condition: they must be inserted into the slot immediately following the associated analyzer board. This means that slot 1 may not contain a descrambling board.

Analyzer boards with and without associated descrambling boards may be combined as desired. Altogether, up to 12 unscrambled or 6 scrambled programs can be analyzed simultaneously.

To make subjective quality ratings comparable, ITU (International Telecommunication Union) has specified two main test methods: the DSCQS (double stimulus continuous quality scale) method is exclusively used for comparative quality assessments. The SSCQE (single stimulus continuous quality evaluation) method is based on a single observation of the sequence to be assessed.

During the presentation, the test person moves a slider on a scale from 0 (bad) to 100 (excellent) according to his/her subjective impression of picture quality. This method can be used when no original sequence is available as a reference and corresponds better to the real-life situation of the TV viewer who cannot see the picture recorded in the studio, and to the measurement method implemented in the DVQM.



*Signalling on the DVQM for each slot (here slots 6 and 7)*

## Analyzer board characteristics

### Test parameters

Each analyzer board can be used to monitor all the relevant parameters of the video and audio elementary streams of the selected program. Moreover, they determine whether a valid transport stream is present or whether there are failures. The hysteresis for the detection of transport streams or failures can be set by the user.

The video stream is checked for picture freeze and picture loss. The check is made using the threshold values for spatial and temporal activities as well as the period for which the threshold values have not been adhered to. All threshold values for the determination of picture freeze and picture loss can be set by the user. The audio stream, if available (audio sync), is checked for its volume separately for the right and left channels. If the volume is below a certain threshold for a defined

period, this indicates a sound loss. Minimum volume and maximum period can be set by the user. AC-3-coded audio streams are also monitored in this way. For this purpose, the audio signal is downconverted to a stereo signal according to a method especially specified by Dolby so that this signal can be monitored in the described way. The DVQM-B4 option allows additional continuous monitoring of the picture quality.

### Decoder

In addition to the analysis unit, each analyzer board also has a built-in MPEG-2 decoder for audio and video data in the format Main Profile @ MainLevel and 4:2:2 Profile @ MainLevel. The program being analyzed is decoded and can simultaneously be viewed on a connected video monitor (CCVS or ITU-R 601 or SMPTE259M formats). The audio signals are available at the connectors in both analog and digital form (AES/EBU).

### On-screen display

For the analysis of an MPEG-2 transport stream, an on-screen display (OSD) can be switched on for each channel. The OSD is output together with the decoded picture via the CCVS or SDI output. Different views with a variety of information are available. The OSD is not available for measurements on SDI signals.

### Alarm outputs

Altogether 12 relay contacts, which can be allocated to one or several (ORed) events, are fitted as standard. The switching mode (active when open or closed) can be set for the electrically isolated relays.

### Scan mode for several programs

An MPEG-2 transport stream usually contains several programs made up of video and audio data streams. The advantage of the DVQM is its multichannel capabil-

ity allowing several programs of a single transport stream or of various transport streams to be simultaneously monitored in realtime. Where continuous monitoring is not required, the scan mode allows all or selected programs of a transport stream to be successively analyzed for picture quality and interference over a selectable period of time. The threshold values for the detection of picture freeze, picture loss and sound loss as well as the minimum value for picture quality can be set separately for each program in the scan mode. In addition, the user can select – for each of these tests and separately for each program – after how many scans with consecutive errors a given error is to be recorded and signalled. Thanks to these two setting facilities, monitoring can be optimally adapted to the specific characteristics of each program transmitted. The scan mode can be individually selected for each analyzer

board, and it can be configured so that upon detection of an error, monitoring of the program is continued until the error is remedied.

### Reference measurement

For comparative quality measurements, the quality analysis can simultaneously be carried out on two different signals.

Quality analysis is carried out completely independently for each signal and the final result is formed from the differences found. There is no pixel comparison of two video data sources in this mode, but the difference is formed on the basis of reduced video data according to the weighting algorithm. The reference signal is applied either as an uncompressed SDI video stream (to ITU-R 601/656 or SMPTE259M) or as a transport stream (ASI or SPI) to the DVQM input that is not occupied by the signal to be analyzed. The DVQM automatically detects and compensates for any delay of up to  $\pm 5$  s between the reference and the test signal.



*Clearly visible blocking effects on digitally coded TV picture and – by comparison – picture without blocking*

## Applications

The unique combination of realtime capability and independence from a reference signal opens up a wide field of applications for the DVQM. Long-term recording and evaluation of the quality parameters allows a quality assessment that is closer to reality than that of short standardized test sequences.

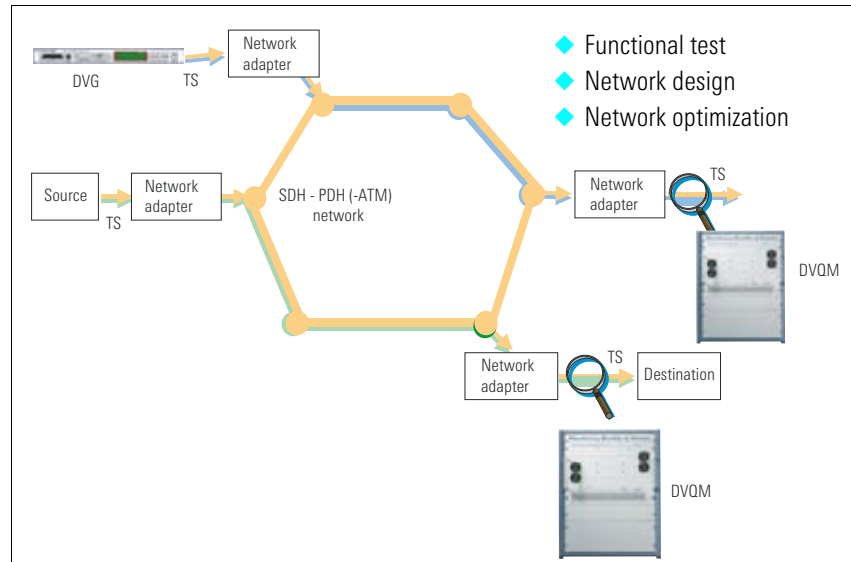
### Quality monitoring in distribution networks

The DVQM allows the picture quality to be monitored during program transmission and in realtime. Degradations in quality and failures can be recognized at an early stage so that remedial measures can be taken in time. Since the analysis method employed does not require any reference signals, the DVQM is suitable for use wherever MPEG-2-coded video data is transmitted or received.

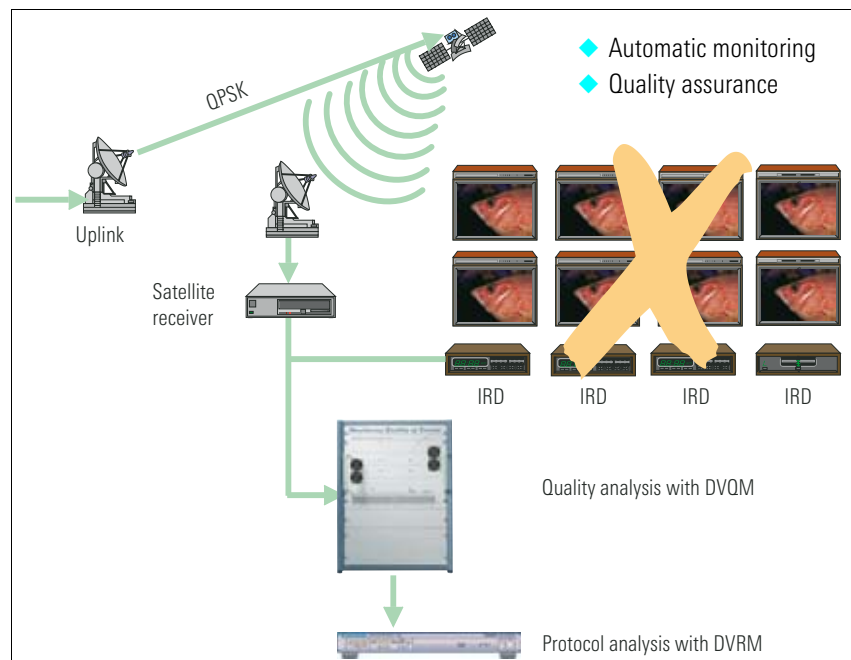
The DVQM can be used to document the picture quality versus time at the gateway between two different networks. This can, for example, be used as an evidence for the contractual performance of services.

The network compatibility of the DVQM ensures optimum integration into monitoring systems.

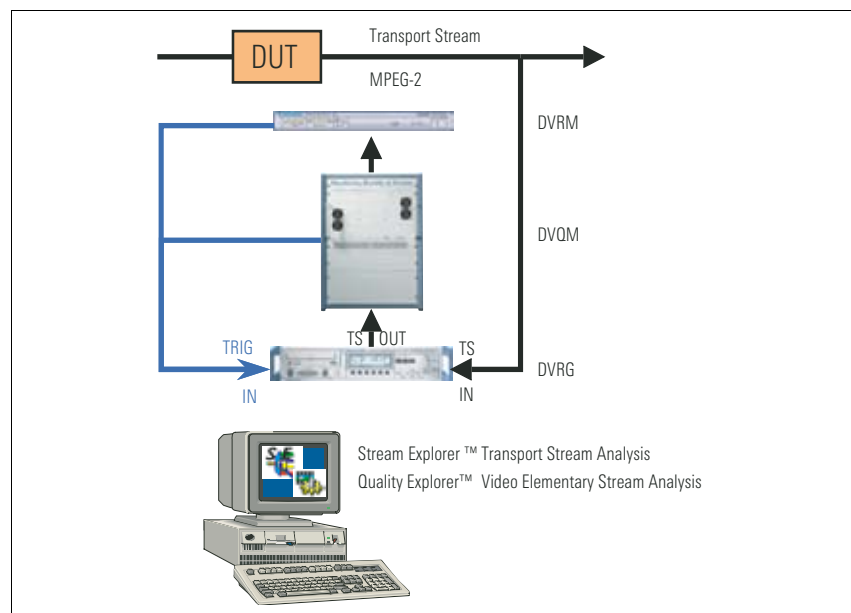
The DVQM in conjunction with the DTV Recorder Generator DVRG (see DVRG data sheet PD 757.5708) and, optionally, the Realtime Monitor DVRM (see DVRM data sheet PD 757.5566) forms a complete monitoring system with recording capability even for very rare disturbances. The relay outputs of the DVQM and the DVRM are connected to the trigger input of the DVRG, whose elaborate trigger characteristics make it possible to save a transport stream section of arbitrary length before and after an error event for subsequent detailed analysis.



**Network monitoring**



**Satellite uplink**



**Error analyses using DVRG and realtime analyzers**

### Program quality assessment

Again, it is a benefit that the measurement method is based on the analysis of video data and does not need reference pictures. Instead of lengthy observations carried out by a test person, unknown program material can automatically be checked for its picture quality (e.g. satellite uplink).

## Options

### Analyzer Board DVQM-B2

An additional Analyzer Board DVQM-B2 can be ordered for monitoring a further channel. It corresponds to the two analyzer boards contained in the basic DVQM model. The video quality analysis for this board is activated – same as for the boards contained in the basic unit – via the DVQM-B4 option.

### Video Quality Analysis DVQM-B4

Video quality analysis of the individual DVQM analyzer boards is optionally available. The measurement functions of the analyzer board are enhanced by this option to include determination of the picture quality. The option allows continuous analysis of the video quality of a video elementary stream according to a patented weighting algorithm, which takes into account the masking effects of the eye and thus furnishes measurement results that are adapted to the human perception. If the result is below a defined quality level, an alarm message and a report entry are generated.

### Descrambling Options DVQMB1x

As a rule, pay TV programs are transmitted in scrambled form to protect them against unauthorized access. Different CA systems are used, and the programs have to be descrambled accordingly in order to analyze, decode and display the picture and sound contents.

The DVQM comes with options for the most common CA systems. The options include a card reader, the slot for which is provided on the rear of the DVQM. It takes up the smart card that is issued by the program broadcaster and serves as the subscriber's identity card. The smart card is not included in the DVQMB1x options.

A descrambling option can be installed for each analyzer board. The descrambling board is internally wired with the analyzer board and takes up one slot. The transport stream is externally applied to the board (ASI) so that the program contained therein can be descrambled. The transport stream with the descrambled program is taken via an ASI output of the descrambling board to the analyzer board. The descrambling board is internally controlled via the analyzer board (program selection).

Only one descrambling board can be used per analyzer board and can descramble only one program at a time. Descrambling is necessary in any case, even if the option for determining the picture quality has not been ordered for the program in question.

CA system	Option
Conax	DVQMB10
Nagravision	DVQMB10
Viaccess	DVQMB10
Irdeto	DVQMB11
SECA-Mediaguard	DVQMB12
NDS-Videoguard (BSkyB)	DVQMB15
Betacrypt BetaDigital DTAG ORF	DVQMB16
Cryptoworks	DVQMB17
Other systems on request	

### Quality Explorer™ DVQ-B1

The optional software package is installed on an external Pentium II PC and connected to the DVQM via the serial or Ethernet interface. It allows in-depth display, analysis and decoding of the video data in MPEG-2 format down to the bit and byte level.

The following display modes are possible:

- ◆ Header and extension data at sequence, group and picture level
- ◆ Information at picture, slice and macroblock level
- ◆ Type, DC value and motion vectors per macroblock
- ◆ Macroblock statistics and decoding of each individual macroblock



## Software

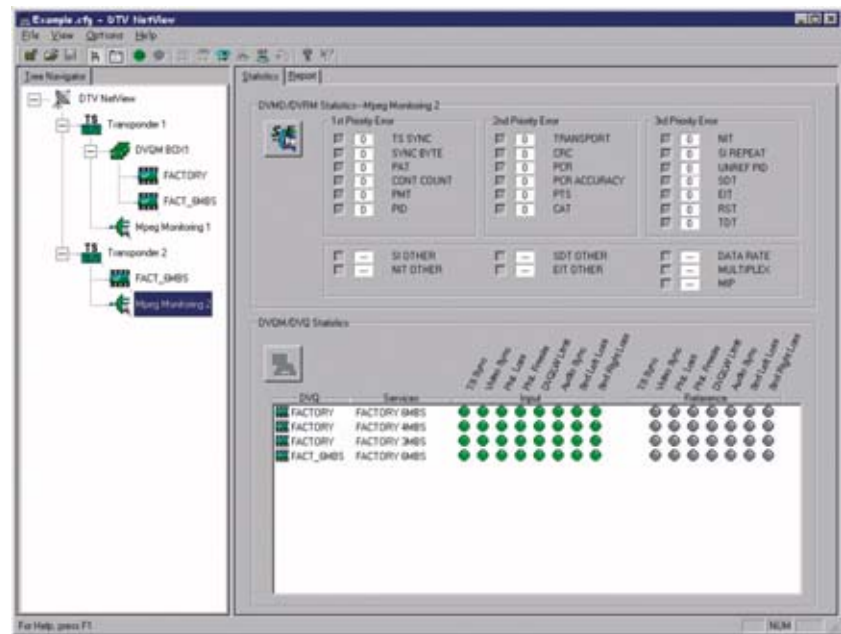
The DVQM functions are considerably enhanced by several software packages. The DTV NetView software comes with the DVQM for easy detection and clear display of the errors detected by the DVQM, as well as for easy configuration of all devices connected.

The Quality Monitor, which also comes with the DVQM, allows continuous display and recording of the measurement results of an analyzer board and can conveniently be started from DTV NetView for individual analyzer boards.

The Elementary Stream Analyzer allows in-depth analysis of an MPEG-2 video elementary stream monitored by an analyzer board (option DVQ-B1).

### DTV NetView

One of the assets of DTV NetView is its high flexibility allowing it to be adapted to quite different monitoring system configurations. The adaptation is made with the aid of a special file reflecting the configuration of the monitoring system. Several DVQMs and

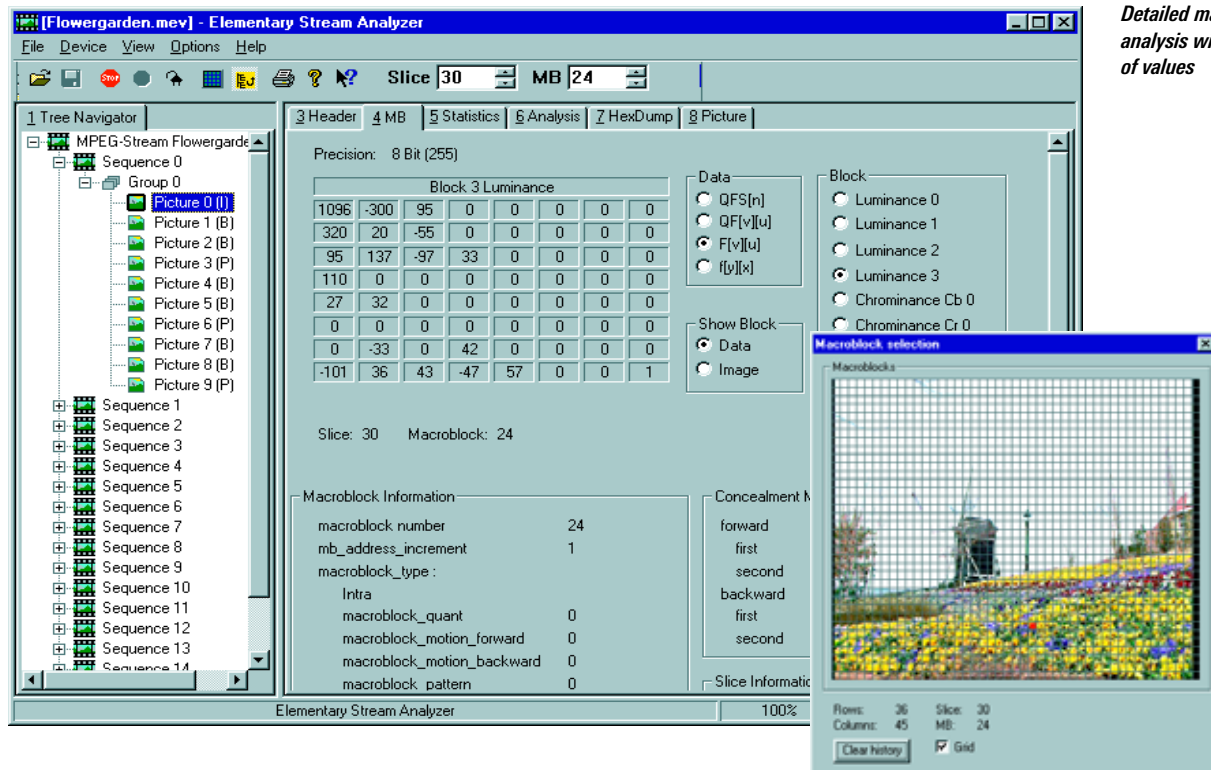


**DTV NetView**

DVQs can be integrated. DTV NetView also allows the integration of the DVRM and the DVMD; these are Rohde&Schwarz instruments for monitoring and analyzing of the transport stream syntax.

After opening the configuration file via DTV NetView, all devices mentioned above are initialized and the structure

read is displayed as a tree structure in the program window to provide a good overview of all the devices contained in the system. This tree structure also serves for selecting individual devices in order to start further programs (Quality Monitor or Stream Explorer), to configure these devices, or to display the status information for selected devices only.



**Detailed macroblock analysis with decoding of values**

DTV NetView provides two different views, the Statistics and the Report view, for displaying the errors which have occurred.

The Statistics view provides a quick overview of the current states of the programs monitored by the DVQ/DVQM. Symbolized LEDs indicate the status of each monitored parameter by a colour code. For a selected DVRM/DVDM, the Statistics view also shows how often each monitored parameter is out of the defined tolerances. A clear overview of the results of transport stream monitoring is thus obtained.

The Report view shows a list of all events and errors. The information is read by all instruments integrated in the system and displayed according to time. Each entry in the list is provided with date and time. The instrument to which the entry refers is also shown. Any further information available,

for example the program that has caused the error, is also displayed.

The report can be continuously stored by DTV NetView in a file or a new file can automatically be selected for every day. Convenient and automated documentation of all events and errors is thus possible.

### Quality Monitor

This software, which is also ideal for use with a DVQ, allows remote control of each analyzer board (DVQM-B2) in the same way as the DTV NetView software. In addition, it allows easy and continuous reading of the measured values: spatial and temporal activities, data rate and DVQL-W quality levels.

The Quality Monitor can be installed on an external PC with MS Windows 95, 98 or NT 4.0 operating system. The connection

to the DVQM is established via an RS-232-C or Ethernet interface. Using a compatible interchange format (CSV), the measured values can be continuously stored in a data memory and graphically displayed. An automatic, user-definable save function allows convenient storage of measurement results over any period of time.

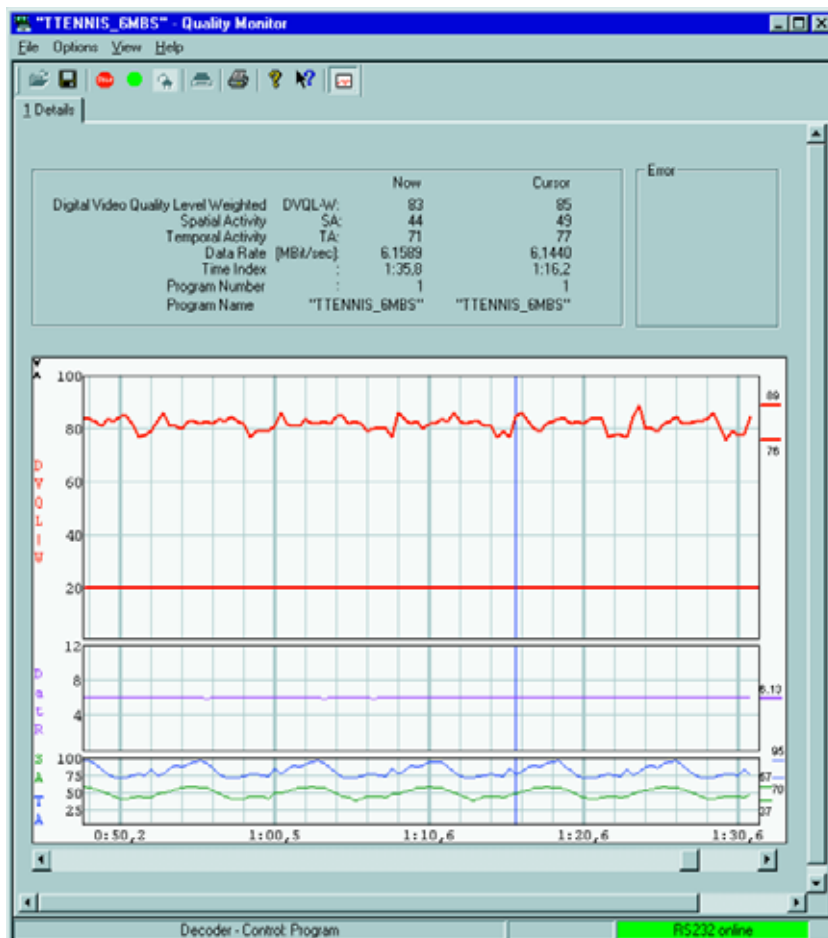
### Elementary Stream Analyzer

The Elementary Stream Analyzer is part of the Quality Explorer™ DVQ-B1 software package and can be ordered as an option. The software option is enabled by a dongle at the parallel interface of the PC.

The Elementary Stream Analyzer is installed on an external PC and connected to the analyzer board via the RS-232-C or Ethernet interface. It allows in-depth display, analysis and decoding of coded video data in MPEG-2 format down to the bit and byte level.

The following display modes are possible:

- ◆ Header and extension data at sequence, group and picture level
- ◆ Information at picture, slice and macroblock level
- ◆ Type, DC value and motion vectors per macroblock
- ◆ Macroblock statistics and decoding of each individual macroblock



Measured values displayed by Quality Monitor

## Specifications

### Analyzer board

#### Signal inputs

MPEG-2 transport stream	to ISO/IEC 13818-1
Length of data packets	188/204 byte
Asynchronous serial 270 Mbit/s (ASI, to DVB-A010)	BNC connector on rear panel 200 mV to 1 V ( $V_{pp}$ ), 75 $\Omega$
Data rate	up to 70 Mbit/s
Video serial digital 270 Mbit/s (SDI, to ITU-R 601/656 or SMPTE259M)	BNC connector on rear panel to SMPTE259M
Audio serial digital (AES/EBU)	LEMO Triax connectors on rear panel 400 mV to 12 V ( $V_{pp}$ ), 110 $\Omega$

#### Signal outputs

MPEG-2 transport stream	to ISO/IEC 13818-1
Asynchronous serial 270 Mbit/s (ASI, to DVB-A010)	BNC connector on rear panel looped through from input
Video CCVS (PAL, SECAM, NTSC, MPEG-2 transport stream)	BNC connector on rear panel 1 V $\pm$ 1% ( $V_{pp}$ ), 75 $\Omega$
C/L gain	$\pm$ 2% (measured on 20T signal)
C/L delay	$\pm$ 30 ns (measured on 20T signal)
Return loss (0 MHz to 6 MHz)	>34 dB
Frequency response (typical values, measured with multiburst signal)	
0 MHz to 3 MHz	+2% / -2%
<4 MHz	+2% / -5%
<5 MHz	+2% / -15%
Video serial digital 270 Mbit/s (SDI, to ITU-R 601/656 or SMPTE259M)	BNC connector on rear panel 800 mV ( $V_{pp}$ ), 75 $\Omega$
Audio	unbalanced, not floating
Level (full scale)	6/9/12/15 dBu $\pm$ 0.5 dB
Frequency response (60 Hz to 15 kHz)	$\pm$ 0.5 dB relative to 1 kHz, into 600 $\Omega$
S/N ratio	>70 dB, unweighted
THD	>70 dB
Audio left, audio right	LEMO Triax connectors on rear panel <50 $\Omega$
Audio serial digital (AES/EBU)	LEMO Triax connectors on rear panel 4 V ( $V_{pp}$ ), 110 $\Omega$

#### Interfaces

Serial interface	9-pin sub-D connector on rear panel RS-232-C, 9600 baud to 115 000 baud, remote control, SCPI commands
Parallel interface	25-pin sub-D connector on rear panel, printer output
Network	RJ45 connector on rear panel, Ethernet 10BaseT, 10 Mbit/s remote control, system integration
Protocols	TCP/IP, SNMP
Relay outputs	15-pin VGA connector on rear panel
Number	12 with any allocation to events, ORed in case of allocation to several events
Active state	selectable (open or closed)

#### Test parameters

TS sync	duration and hysteresis
Video sync	duration
Audio sync	duration
Picture freeze	duration and temporal activity
Picture loss	duration, spatial activity and picture freeze
Quality below threshold	threshold value (only with option DVQM-B4)
Sound loss left	duration and volume
Sound loss right	duration and volume

Before they are analyzed, AC-3-coded audio streams are downconverted to a stereo signal by means of the downmix method specified by Dolby.

#### Display

##### On-screen display with selectable parameters:

Statistics	error seconds of events according to type, display selectable according to type
Report	listing of the last four events according to time optional filtering according to type display per entry: time, duration, PID, type
Program	display of the first 4 programs of a TS
Measure details	4 views for display of quality level: Numeric, Bargraph, Histogram and Long Time (up to 5 hours)
LEDs	4 LEDs for each slot for signalling: <i>Signal</i> is present (no failure of transport stream, video or audio), <i>Alarm</i> signal error is detected, <i>Remote</i> , board is remotely controlled, and <i>Ready</i> , analyzer board is inserted into slot and ready for operation

#### Reference measurement

Signal inputs	SDI and MPEG-TS
Delay	$\pm$ 5 s max., automatically detected

### Descrambling board

for descrambling of a program

#### Signal input

MPEG-2 transport stream	to ISO/IEC 13818-1
Asynchronous serial 270 Mbit/s (ASI, to DVB-A010)	BNC connector on rear panel 200 mV to 1 V ( $V_{pp}$ ), 75 $\Omega$
Data rate	up to 50 Mbit/s

#### Signal output

MPEG-2 transport stream	to ISO/IEC 13818-1
Asynchronous serial 270 Mbit/s (ASI, to DVB-A010)	BNC connector on rear panel 800 mV ( $V_{pp}$ ), 75 $\Omega$
Data rate	same as input data rate

## DTV NetView

### System requirements

IBM-compatible PC or laptop with Pentium II processor	recommended clock frequency min. 200 MHz, recommended graphics resolution 1024 x 768 pixels
RAM	Windows95/98 min. 16 Mbyte Windows2000 min. 32 Mbyte WindowsNT min. 32 Mbyte
Free hard disk memory	approx. 5 Mbyte, further space for saving reports
Interfaces	1 free Ethernet interface (10BaseT)
Drive	CD-ROM drive
Operating system	Windows95/98, 2000 or WindowsNT 4.0

### Measurement system configuration

Instrument types	DVQM, DVQ, DVRM and DVMD (DVRM and DVMD for monitoring transport stream syntax)
Designation	user-selectable names for all defined devices and transport streams
Device configuration	creation of a hierarchy by combining devices and assigning them to the defined transport streams and by assigning the analyzer boards to the DVQM
Storage	test file with extension .cfg

### Display

Tree navigator	tree structure of configured devices (assignment to transport streams)
Statistics view	signalling of measurement results (DVQM and DVQ) by means of colour codes: <i>red</i> : error currently detected <i>yellow</i> : at least one error detected, but no error at the moment <i>green</i> : there is and was no error number of errors occurred (DVRM/DVMD)
Report view	list of all report entries of all configured devices (max. 2000)

### Storage of measurement results

Data	report entries of all configured devices
Max. file size	user-defined
Automatic storage	continuous saving of data on hard disk (interval user-configurable), new file name for each day (optional)

## General data

Modular design	12 slots for accommodating analyzer boards or descrambling boards (2 analyzer boards supplied with basic unit)
Dimensions (W x H x D) in mm (inch)	427 x 88 x 450 (16.6 x 3.5 x 17.7) for mounting in 19" rack, 8HU
Weight	16 kg (without options) 31 kg (fully equipped)
Rated temperature range	+5 °C to +40 °C
Operating temperature range	0 °C to +45 °C
Storage temperature range	−40 °C to +70 °C
Power supply	100 V to 240 V AC / 50 Hz to 60 Hz / 425 VA max.
Electromagnetic compatibility	meets EN 50081-1 and 50082-2 (EMC Directive of EU)
Electrical safety	meets EN 61010-1

## Ordering information

<b>Multichannel Digital Video Quality Analyzer</b>	DVQM	2088.0004.02
Basic unit with two analyzer boards (DVQM-B2) plus DTV NetView remote-control software		

### Options

<b>Additional Analyzer Board</b>	DVQM-B2	2088.0027.02
max. 10 optional DVQM-B2 per DVQM		

<b>Video Quality Analysis for DVQM-B2</b>	DVQM-B4	2088.0062.02
Activates digital video quality determination for an Analyzer Board DVQM-B2		

### CA systems

One slot required per system (max. 6 per DVQM)

Conax, Nagravision or Viaccess	DVQMB10	2088.0491.02
Irdeto	DVQMB11	2088.0504.02
Mediaguard	DVQMB12	2088.0510.02
NDS-VideoGuard BSKyB	DVQMB15	2088.0540.02
BetaCrypt		
BetaDigital	DVQMB16	2088.0556.02
DTAG	DVQMB16	2088.0556.03
ORF	DVQMB16	2088.0556.04
Cryptoworks	DVQMB17	2088.0562.02

<b>Quality Explorer™</b>	DVQ-B1	2079.7151.02
Only one license required for several analyzer boards		

## Recommended extras

Calibration Data Documentation	DVQM-DCV	2082.0409.27
Service Manual		2079.7951.24







**ROHDE & SCHWARZ**

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