# DVB-C Solutions

Product Overview

HP 8594Q QAM Analyzer

**The first choice for field
testing of DVB-C signals
on your cable TV system**

All cable TV network operators
planning the introduction of
DVB-C (Digital Video Broadcast
via Cable) services have
increasing competitive pressure
to install these new services—
quickly. Aggressive activation
schedules require test equipment
capable of verifying your quality
of service—fast. The HP 8594Q
QAM[1] analyzer is a compre-
hensive and powerful test
solution for installation and
maintenance test on European
DVB-C systems. Supporting 8, 4
and 2 MHz channel bandwidths,
the HP 8594Q QAM analyzer
makes both qualitative and
quantitative measurements on
the transmitted 64 QAM signal.
It gives engineers the measure-
ment capability required to
accurately verify the quality of
service delivered to subscribers.
All measurements are presented
in a user friendly manner so the
engineer can focus on the job at
hand, not on operating the test
equipment.
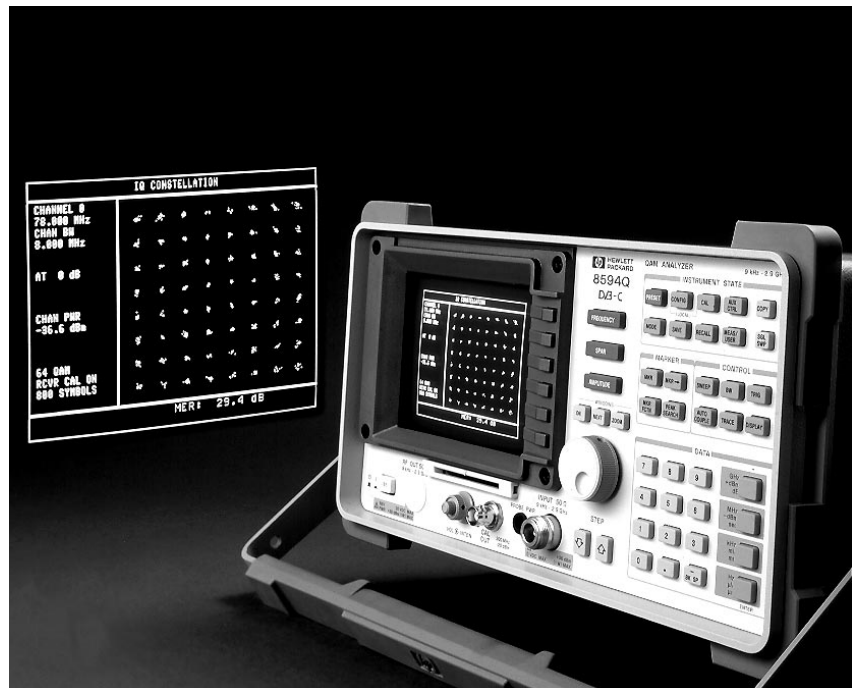
The HP 8594Q QAM analyzer can help you during:

• Headend equipment installation and maintenance
• System verification
• Field installation and maintenance
• Modulator manufacturing test

The HP 8594Q QAM analyzer demodulates and accurately measures
the QAM signals carried through the DVB-C system. It provides new
measurement metrics necessary to characterize these signals and
troubleshoot problems. The HP 8594Q QAM analyzer's clear user
interface and one-button measurement capability will make the
transition from analog to digital testing easy for cable TV engineers.

[1] QAM - Quadrature Amplitude Modulation

Verify *your* **quality** *of service*

Activate your DVB-C services faster

To help you activate your DVB-C services faster, test equipment must provide a comprehensive suite of measurements. The ability to analyze the signals on the system in detail will help you to quickly identify and troubleshoot problems. With the new challenge of testing digital signals it is important that your test equipment is easy to use. With the HP 8594Q QAM analyzer's one button measurement capability, engineers will be able to concentrate on getting measurement results, not finding the right menu. The portable, rugged HP 8594Q QAM analyzer is ideal for testing from the headend through the network to the subscriber drop.

This combination of powerful measurements and usability will ease your transition from analog to DVB-C testing.
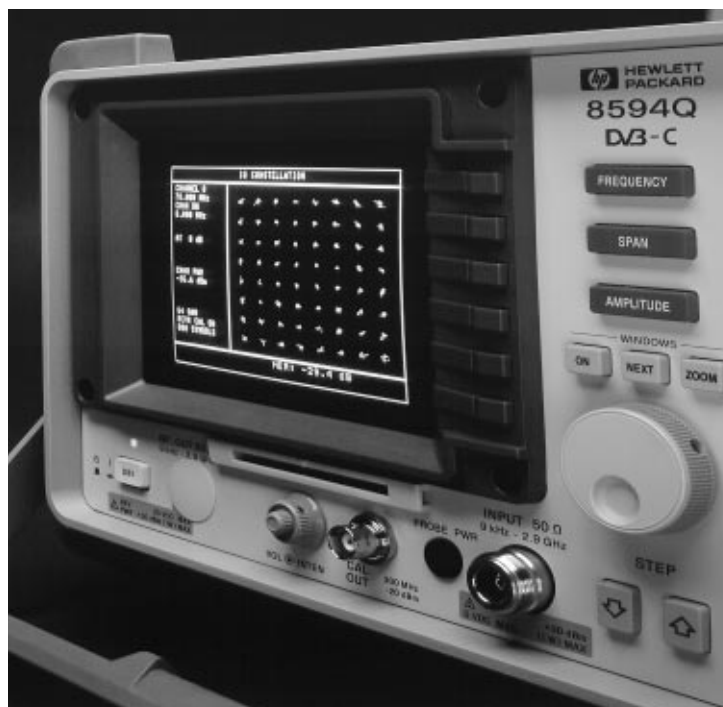
Digital video measurement overview

The shift from analog to digital technology brings many new measurement challenges. Analog system measurements which would have indicated a high quality of service are no longer appropriate. Where analog signals degrade slowly as impairments become worse, digital signals will provide excellent picture quality then degrade very rapidly upon reaching the threshold. Analyzing these digital signals in detail is crucial to determining the real quality of service being delivered to your customer.

## *Headend* *to* *subscriber drop* *testing*

Comprehensive RF *and* modulation quality *measurements*

Comprehensive measurement capability

To accurately verify your quality of service the following measurements are important:

Average channel power

Channel power is the most basic measurement of digital signals on your DVB-C system. The HP 8594Q QAM analyzer gives a real-time display of the average power across the channel being measured. The sensitivity of the HP 8594Q QAM analyzer allows measurements throughout the system, from the headend to the low level signals at the subscriber drop.
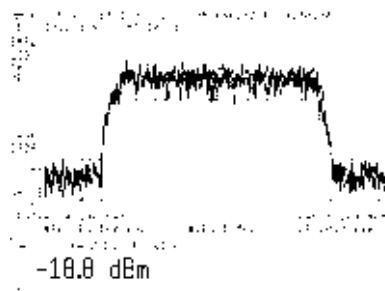
Average channel power measured on an HP 8594Q QAM analyzer

Adjacent channel power

Adjacent channel power provides a measure of how much a transmission is 'leaking' into the immediately adjacent channels. Measurements are carried out across the transmission channel as well as two adjacent channels. The power level is presented for each channel.
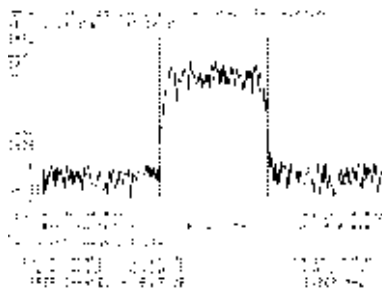
Adjacent channel power measured on an HP 8594Q QAM analyzer

Constellation display

The constellation display gives a graphical view of the demodulated 64 QAM signal. This allows quick identification of impairments such as gain compression or IQ imbalance. The information from the visual appearance of the constellation display can be used to isolate and troubleshoot problems.
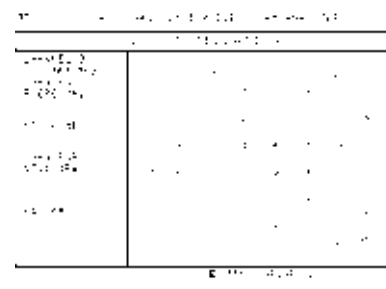
The HP 8594Q QAM analyzer constellation display of a signal with gain compression
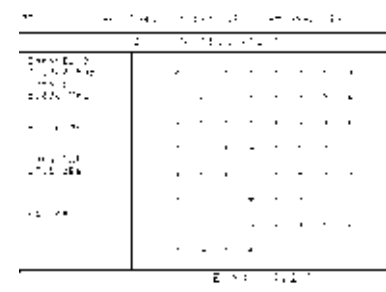
The HP 8594Q QAM analyzer constellation display of a signal with IQ imbalance

MER (modulation error ratio) and EVM (error vector magnitude and origin offset)
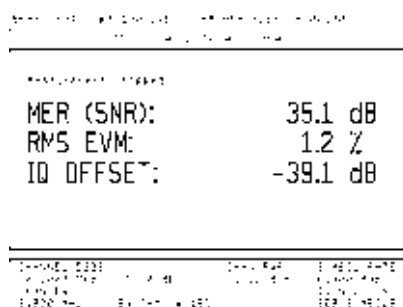MER and EVM give a metric measurement of the modulation quality. The measurement results can be displayed in real-time alongside the graphical constellation. Alternatively, ten average, maximum, minimum and standard deviation measurements can be captured and analyzed for trends.
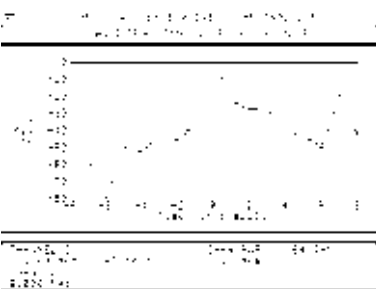

The HP 8594Q QAM analyzer display of MER, EVM and IQ offset

Built-in equalizer response
The built-in adaptive equalizer in the HP 8594Q QAM analyzer displays both impulse and frequency response. The impulse response allows identification of micro-reflections in the transmission plant while the frequency response shows any tilt across the channel.
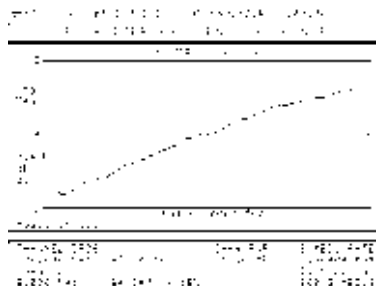
The HP 8594Q QAM analyzer display of the built-in equalizer frequency response

The HP 8594Q QAM analyzer display of the built-in equalizer impulse response

Estimated SER (symbol error ratio) versus carrier to noise
The estimated SER versus carrier-to-noise ratio measurement shows the current operating point of the cable TV system. A calculation is carried out for each measured constellation point to determine its probability of being misinterpreted. This point is then plotted against the current carrier-to-noise ratio. An operating curve can then be traced out by adding an external noise source to decrease the carrier-to-noise ratio.
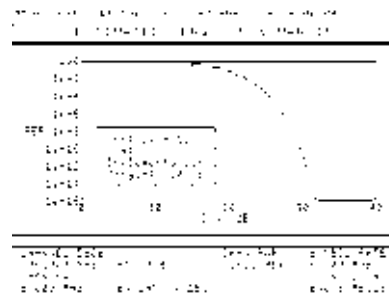
The HP 8594Q QAM analyzer display of SER versus carrier to noise

Spectrum analysis
In addition to these specific DVB-C measurements, the HP 8594Q QAM analyzer provides a fully featured 2.9 GHz spectrum analyzer.
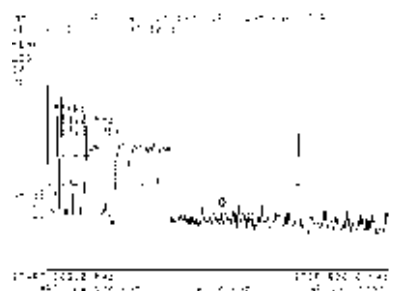
The HP 8594Q QAM analyzer showing a sweep of several analog and digital channels

Full spectrum

analysis **capability**

Data *analysis* **option**

Check data integrity

Add Option 195 to the HP 8594Q QAM analyzer to verify that the MPEG data has been correctly decoded, and check transport stream content. The option also proves a real-time output (both ASI and parallel), to allow access to the data stream for further comprehensive analysis.

Reed-Solomon error

Examining the statistics from the forward error correction (FEC) system gives information about the transmission margin of the RF channel. The FEC process adds information to each packet in the transport stream, to enable the correction of transmission errors. The HP 8594Q Option 195 includes a real-time FEC decoder. By monitoring the activity of the FEC decoder, analysis of byte and packet errors is provided. Since this analysis can be made on live data, this is the method recommended for non-intrusive in-service bit error ratio estimation.

```
             REED-SOLOMON RESULTS

    Byte Errors
            Count    186924
            Ratio    4.338E-04

    Packet Errors
            Count    72
            Ratio    3.408E-05

CHANNEL USER │ TIME:       00d 00h 01m 23s
723.125 MHz  │ RESULTS: [ Cumulative ]
   41.25 Mb/s│
Measurement Stopped
```

Reed-Solomon byte and packet error count displayed on an HP 8594Q Option 195 QAM analyzer

PID statistics

The program identifier (PID) statistics provide two critical pieces of information about the MPEG transport stream. First, they list the individual data streams which make up the transport stream, along with the data rate associated with each one. An operator can check the video, audio and data content of the stream, and check for "illegal" PIDs. The number of "null" packets (added to bring the overall data rate up to the rate used for the channel) determines how much more information could be added to the stream. Second, they allow identification of any PID which has suffered uncorrectable packet errors during transmission. Packet errors cause glitches or blocking effects on the picture.

```
/hp
  188.28385         PID STATISTICS
 ┌─PID─┬─TEI─┐           Last PID: 37        Net Kb/s
 10│02D0│00001│█████████████████             4066
  9│0212│00000│█                              136
  8│0140│00002│████████████                  4082
  7│00DC│00000│████████████                  4066
  6│0078│00002│█████████████                 4090
  5│0398│00001│████████████                  4066
  4│026C│00001│████████████                  4066
  3│0208│00001│████████████                  4074
  2│01A4│00002│██████████████████████        6159
  1│0032│00000│                                32

  NULL Packet Min. Rate:1446  Kb/s    Total 38015
  NULL Packet Max. Rate:2197  Kb/s
  NULL Packet Mean Rate:1976  Kb/s    Averages: Off

CHANNEL USER │ TIME:       00d 00h 02m 57s
723.125 MHz  │ RESULTS: Real Time
   41.25 Mb/s │
Measuring...
```

The PID statistics of a transport stream displayed on an HP 8594Q Option 195 QAM analyzer

Bit error ratio testing

For out-of-service testing of a digital channel, the recommended quality metric is bit error ratio (BER). Typical headend modulators can be set to transmit a standard continuous $2^{23}-1$ pseudo-random binary sequence (PRBS). The HP 8594Q QAM analyzer data analysis option allows the instrument to function as a BER receiver, providing analysis and display of true bit error ratio measurements during installation of new channels or during system troubleshooting.

```
            Count    14
            Ratio    1.765E-08
```

The HP 8594Q Option 195 QAM analyzer makes the key out-of-service test of bit error ratio

Solutions *from* baseband *to* RF...

HP Digital Video Test Solutions

HP provides a comprehensive range of test equipment for DVB-C analysis, generation and MPEG analysis.

RF Testing

HP 8594Q DVB-C QAM Analyzer

- Field testing solution for the European DVB-C standard
- Comprehensive RF and data quality testing
- Test from the headend to the subscriber drop

**HP 8591C
Cable TV Analyzer**

- Includes digital carrier power measurement
- In service analog RF and video measurements

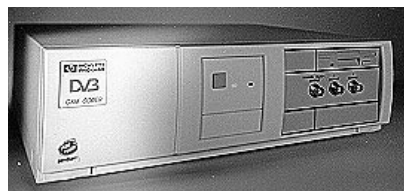**HP 89441A Option AYH Digital Video Modulation Analysis**

- Provides highest quality QAM and VSB analysis capabilities
- Measures key modulation metrics
- Ideal for R&D use

**HP CaLan 3010R/H
Sweep/Ingress Analyzer**

- Return sweep and ingress detection
- Includes digital carrier power measurements
- Identify, troubleshoot and eliminate ingress

HP E4441A DVB QAM Coder

- Fully compliant with DVB-C specifications
- Flexible real-time encoding
- Built-in calibrated impairments simplifies receiver characterization

MPEG Testing

E6277A MPEGScope Plus

- Verify or troubleshoot MPEG-2/DVB/ATSC implementations
- Generate and capture MPEG-2 streams up to 60 Mb/s
- Live monitoring and analysis of MPEG-2 transport streams
- Complete MPEG-2, DVB and ATSC protocol decode

**HP E6271A MPEGScope
ATM Test Application**

- Comprehensive MPEG-2 testing for the HP E4200B/4210B Broad-band Series Test System - the ATM industry standard tester
- Real-time MPEG-2 transport stream analysis for ATM systems
- Implements key measurements including PCR jitter
- Supports most ATM standard interfaces from DS1 to OC-3DVB-C channel bandwidths

...and back again.

HP 8594Q QAM Analyzer Specifications

This section contains specifications and characteristics for the HP 8594Q QAM Analyzer. The distinction between specifications and characteristics is described as follows.

Specifications describe warranted performance over the temperature range 0 °C to +55 °C (unless otherwise noted). The analyzer will meet its specifications under the following conditions: 0 °C to +50 °C with Option 015 or Option 016 operating/carrying case; the instrument is within the one year calibration cycle; two hours of storage at a constant temperature within the operating temperature range; thirty minutes after the analyzer is turned on; after the CAL frequency, and CAL amplitude routines have been run.

Characteristics provide useful, but nonwarranted information about the functions and performance of the analyzer. Characteristics are specifically identified. Typical performance, where listed, is not warranted, but indicates performance that most units will exhibit. Nominal value indicates the expected, but not warranted, value of the parameter.

Spectrum Analyzer Specifications

When used as a spectrum analyzer, the HP 8594Q QAM analyzer conforms to all specifications described in the HP 8590E-Series Portable Spectrum Analyzers, Technical Specifications. Literature number 5963-6909E.

Specifications for DVB measurement capability

DVB-C channel bandwidths	8 MHz, 4 MHz and 2 MHz

Supported symbol rates (Characteristics)

Channel Bandwidth	**8 MHz**	**4 MHz**	**2 MHz**
Symbol Rate	6.9 MSymbol/s	3.45 MSymbol/s	1.725 MSymbol/s
	6.89 MSymbol/s	3.445 MSymbol/s	1.72 MSymbol/s
	6.875 MSymbol/s	3.4375 MSymbol/s	1.71875 MSymbol/s
	6.872 MSymbol/s	3.436 MSymbol/s	1.718 MSymbol/s

Channel Selection
Standard Tuning Ranges

DVB-C D channel 31 - 41, 330 - 445
CCIR VHF S channels 21 - 41
CCIR UHF U channels 21 - 69

User defined channel tuning	10 MHz - 2.9 GHz
	10 MHz - 1 GHz (with internal pre-amplifier)

Testing at the headend
Conditions   Single input signal

Average power measurement
Minimum average power at input

without preamp	**8 MHz**	**4 MHz**	**2 MHz**
	-60 dBm	-63 dBm	-66 dBm
	-62 dBm typical	-65 dBm typical	-68 dBm typical
with preamp[1]	-81 dBm	-84 dBm	-87 dBm
	-83 dBm typical	-87 dBm typical	-90 dBm typical

Average power accuracy	± 2.8 dB, ± 1 dB typical

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[1] Gain error of internal pre-amp not included.

HP 8594Q QAM Analyzer Specifications (continued)

Residual EVM/MER	EVM	MER
	1.47 %	33 dB
	1.16 % typical	35 dB typical

Reflects mean residual EVM/MER of 50 individual measurements
All measurements using 800 symbols
Typical value is at 20-30 °C (room) temperature

Minimum power input for
EVM/MER measurements   -55 dBm (Using internal pre-amplifier)

Testing at the subscriber drop

Conditions
Multiple input signals
Total incident power at 50 ohm <+17 dBm
Without external pad

Average power measurement

Minimum average power at input	8 MHz	4 MHz	2 MHz
without preamp	-40 dBm	-43 dBm	-46 dBm
	-42 dBm typical	-45 dBm typical	-48 dBm typical
with preamp[1]	-41 dBm	-44 dBm	-47 dBm
	-43 dBm typical	-47 dBm typical	-50 dBm typical

Average power accuracy   ± 2.8 dB, ±1 dB typical

Residual EVM/MER	EVM	MER
(For total incident power	2.07 %	30 dB
at input < +20 dBm)	1.74 % dB typical	31.5 dB typical

Reflects mean residual EVM/MER of 50 individual measurements
All measurements using 800 symbols
Typical value is at 20-30 °C (room) temperature

Minimum power input for
EVM/MER measurements   -55 dBm (Using internal pre-amplifier)

Characteristics

Demodulator Characteristics

Supported digital demodulation format   64 Quadrature Amplitude Modulation
Nyquist Filter Alpha   0.15 time DFE/FFE Adaptive Equalizer

ACP dynamic range   58 dB without internal pre-amplifier

Maximum total incident input power   + 30 dBm without internal pre-amplifier
+ 5 dBm with internal pre-amplifier

Pre-amp typical specifications
Maximum safe input level   -5 dB (average or peak power)
Gain   +23 dB ±3 dB
Frequency range   1 MHz to 1 GHz
Flatness   ±0.5 dB
Noise figure   4 dB maximum
TOI   +14 dBm

HP 8594Q QAM Analyzer Specifications (continued)

Front and rear panel interfaces

Front Panel

RF Input	50 ohms Type-N
Calibration Output	50 ohms BNC, -20 dBm, 300 MHz
Probe Power	+15Vdc, -12.6Vdc, and Gnd 150 mA each

Rear Panel

Keyboard (Standard or Option 043)	5-Pin mini-DIN, compatible with HP C1405B and most IBM/AT keyboards
External Trigger Input	BNC, TTL levels, positive edge trigger
HPIB and Parallel	SH1, AH1, T6, L4, ST1, RL1, PPO, DC1, C1 C2, C3, & C28 and 25 Pin subminiature D-shell female or parallel
RS-232 and Parallel (Option 043)	9-Pin subminiature D-shell female and 25 Pin subminiature D-shell female for parallel
External Ref Input	50 ohms BNC, 10 MHz, -2 to +10 dBm
10 MHz Ref Output	50 ohms BNC, 10 MHz, 0 dBm
Monitor Out	50 ohms BNC, Selectable Format NTSC, 15.75 kHz, 60 Hz PAL, 15.625 kHz, 50 Hz
DVB Parallel interface (Option 195)	25-Pin subminiature D-shell female. Compliant with DVB-PI specification, 188 or 204 byte mode user-selectable
DVB ASI serial interface (Option 195)	75 ohms BNC. Compliant with DVB-ASI specification, 188 or 204-byte mode, user-selectable

Data Measurements (Option 195)

PID statistics measurement

Maximum number of PID's analyzed simultaneously	64
Transport stream net data rate accuracy	1% without averaging
PID net data rate accuracy	1% without averaging
Transport stream gross data rate accuracy	1% without averaging

Multiplex overview measurement

Maximum number of PIDs detected in transport stream	5000
Maximum number of PIDs analyzed simultaneously	10
Transport stream net data rate accuracy	1% without averaging
PID net data rate accuracy	1% without averaging
Transport stream gross data rate accuracy	1% without averaging

Reed-Solomon error statistics measurement

Measurement displays:	Byte error count
	Byte error ratio
	Packet error count
	Packet error ratio
	Estimated bit error ratio

Bit error ratio measurement

|	
Measurement stimulus types:	2^{23}-1 continuous PRBS
	Sync (47hex, no inversion) + 203-byte 2^{23}-1 PRBS *
	R-S encoded packet with payload of 187 bytes of 2^{23}-1 PRBS *
	R-S encoded packet with user-definable PID and payload of 184 bytes of 2^{23}-1 PRBS *
	R-S encoded packet with null PID value and payload of 184 bytes of 0000
	*Note: PRBS sequence paused during header and Reed-Solomon bytes

HP 8594Q QAM Analyzer Specifications (continued)

Dimensions

Without handle, feet, or cover	163 mm (H) x 325 mm (W) x 427 mm (D)
Overall	184 mm (H) x 373 mm (W) X 461 mm (D)

Weight

Net	16.4 kg (36 lb)
Shipping	19.1 kg (42 lb)
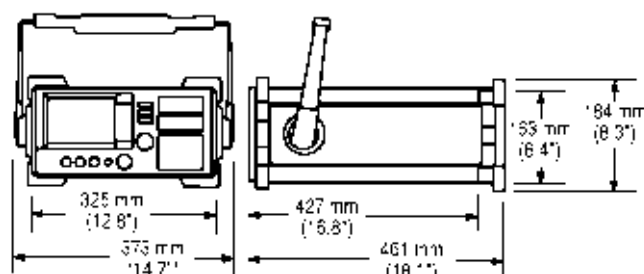
General Specification

Temperature Range	Operating 0 °C to +55 °C
	Storage -40 °C to +75 °C
EMI Compatibility	Conducted and radiated interference CISPR Pub. 11 and Messempfaenger Postverfuegung 526/527/79
Audible Noise	<37.5 dBa pressure and <5.0 Bels power (ISODP7779)
Power Requirements	
ON (Line 1)	90 to 132 V rms, 47 to 440 Hz,195 to 250 V rms, 47 to 66 Hz
	Power consumption <500 VA; <180W
Standby (Line 0)	Power consumption <7 W
User Program Memory	289 Kbytes non-volatile RAM
Data Storage (nominal)	Internal 24 traces or 32 states

Ordering Information

HP 8594Q QAM Analyzer

Option 190[1]   DVB-C RF and modulation quality measurements
               (includes DVB-C measurement software, precision frequency reference, HP-IB/parallel interface)
Option 195   Data measurements
Option 016   Soft yellow operating/carrying case
Option 040   Front panel protective cover w/storage
Option 042   Protective soft carrying case
Option 043   Replace HP-IB/parallel interface with RS232/parallel interface
Option 908   Rack mount kit without handles
Option 909   Rack mount with handles
Option 910   Additional manual set

Related Test Equipment

HP E4441A DVB QAM Coder
HP E443xA Series digital signal generators
HP 89441A 2.65 GHz vector signal analyzer
Option AYA   Vector modulation analysis
Option AYH   Digital video modulation analysis
Option UFG   4 Mbytes extended RAM and additional I/O

HP 8591C Cable TV Analyzer, 1.8-GHz, 75-ohm input
 (includes digital carrier power measurement)
HP CaLan 3010R/H Sweep/Ingress Analyzer
 (includes digital carrier power measurement)
HP E6277A MPEGScope DVB Plus

Recommended HP Accessories

HP 85702A 128K RAM card
HP 85704A 256K RAM card
HP 85705A 512K RAM card
HP 85901A Portable AC power source
HP 24542U RS-232 9-pin cable (analyzer to PC)
HP 24542G RS-232 9-pin to 25-pin cable (analyzer to PC)
HP C2950A Parallel 36-pin to 25-pin cable (analyzer to printer)
HP 10833A HP-IB (GP-IB) cable (1 m)

For further information on the HP 8594Q QAM Analyzer the following literature may be ordered:
5965-3210E   HP 8594Q QAM Analyzer photo card
5965-4991E   HP 8594Q QAM Analyzer product note
Visit the interactive demo page on the WorldWideWeb at http://www.hp.com/info/HP8594Q_demo

For further information on associated test equipment the following literature may be ordered:
5965-4722E   HP E4441A DVB QAM Coder product information
5964-0244E   HP Calan 8591C Cable TV Analyzer
5965-1108E   HP CaLan 3010R/H Sweep/Ingress Analyzer
5964-3403E   HP 89440A Option AYH Vector Signal Analyzer product information
5965-8194E   MPEGScope DVB Plus product information

[1] Required option.

HEWLETT PACKARD

For more information on Hewlett-Packard Test and Measurement products, applications, or services, please call your local Hewlett-Packard sales office. A current listing is available via the World-wide Web through AccessHP at http://www.hp.com. If you do not have access to the Internet, please contact one of the HP centers listed below and they will direct you to your nearest HP representative.

United States:
Hewlett-Packard Company
Test and Measurement Organization
5301 Stevens Creek Blvd.
Bldg. 51L-SC
Santa Clara, CA 95052-8059
1 800 452 4844

Canada:
Hewlett-Packard Canada Ltd.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
(905) 206 4725

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