R&S® HMO1002
Digital Oscilloscope
50/70/100 MHz Bandwidth
**Bandwidth**
50 MHz, 70 MHz or 100 MHz

**Sampling Rate**
1 Gsample, 512 Msample per channel

**Memory Depth**
1 Msample, 512 Ksample per channel

**FFT**
The easy way to analyze the signal spectrum

**QuickView**
Key results at the push of a button

**Auto Measurement**
Versatile measurement functions and fast results

**Voltmeter**
Voltmeter measurements on both analog channels simultaneously

**Acquire**
High acquisition rate to identify signal faults

**Channels**
High vertical sensitivity down to 1 mV/div

**Serial Bus Analysis**
Hardware-based triggering and decoding

**Function Generator**
Common waveforms up to 50 kHz

**MSO**
Mixed signal function as standard

**Pattern Generator**
4 bit wide patterns with up to 2 KBit length and 50 Mbit/s
At a glance

High sensitivity, multifunctionality and a great price – that is what makes the R&S®HMO1002 digital oscilloscope so special. From embedded developers to service technicians to educators – with its wide range of functions, the R&S®HMO1002 addresses a broad group of users. Advanced, powerful technology in a fanless design meets the high requirements of today’s customers. The R&S®HMO1002 digital oscilloscope includes a wide range of upgrade options, providing true investment protection for the future.

The R&S®HMO1002 digital oscilloscope from the Rohde & Schwarz Value Instruments product range features a high waveform update rate and high vertical sensitivity, and is available with bandwidths of 50 MHz, 70 MHz and 100 MHz. The fanless instrument offers a sampling rate of 1 Gsample/s and a memory depth of 1 Msample.

Like all R&S®HMO oscilloscopes, the R&S®HMO1002 includes the mixed signal function as standard. The separately available R&S®HO3508 logic probe is not coupled to a specific instrument and can be used with all R&S®HMO oscilloscopes.

For communications between embedded systems and the environment, the R&S®HMO1002 includes hardware-based signal triggering and decoding for all common protocols (I²C, SPI, UART, CAN and LIN). This option can be activated with an upgrade voucher at any time.

The integrated pattern generator for generating protocol messages at up to 50 Mbit/s is ideal for embedded users. In addition to using predefined messages, developers can program their own signal patterns for supported serial protocols. The integrated three-digit digital voltmeter enables service technicians to simultaneously perform voltage measurements on both analog channels with two values each.

The function generator that generates different types of signals with frequencies up to 50 kHz is useful in educational settings. Trainees and students can use the R&S®HMO1002 to learn basic measurement tasks. In education mode, the convenience functions can be switched off.

Thanks to 128K test points and analysis functions in the frequency domain, the R&S®HMO1002 keeps pace with significantly larger oscilloscopes. The time domain signal, measurement window, FFT analysis range and measurement result are displayed on a single screen, which makes it easier to measure the spectra.

The R&S®HMO1002 offers time domain, logic, protocol and frequency analysis in a single instrument and is a member of the Rohde & Schwarz family of scope-of-the-art oscilloscopes.
Key facts

Superior hardware-based acquisition for precise measurement results
- 1 Gsample/s sampling rate, 1 Msample memory depth
- High vertical sensitivity down to 1 mV/div
- Low-noise measurement due to state-of-the-art A/D converter
- High acquisition rate to identify signal faults

Versatile measurement functions and fast results
- Wide selection of automatic measurement functions
- QuickView: key results at the push of a button
- Mask test: a new mask can be easily created with just a few keystrokes
- FFT: the easy way to analyze the signal spectrum

Logic analysis with the MSO option
- Mixed signal function as standard
- Precise triggering on signal events
- Straightforward display of digital signals
- Low test point loading due to active probe solution

Serial bus analysis: hardware-based triggering and decoding
- Versatile trigger options for isolating specific data packets
- Color-coded display of decoded bus signals
- Direct export of analyzed data to USB flash drive
- Simultaneous decoding of two buses in realtime

The right waveform for each application
- The right signal at hand: pattern generator up to 50 Mbit/s and function generator up to 50 kHz
- Pattern generator with standard bus signals, arb editor and counter
- Function generator with all common waveforms

Voltmeter measurements using an oscilloscope
- Three-digit display for precise voltage measurements
- Simultaneous measurement of primary and secondary voltage value per channel

Future-ready investment and scalability
- Free firmware updates
- Bandwidth upgrades as required
- Serial bus analysis options via software licenses

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50 MHz, 70 MHz or 100 MHz

Depending on your requirements, the standard R&S®HMO1002 bandwidth can be upgraded from 50 MHz to 70 MHz or 100 MHz. This is done with upgrade vouchers which can be purchased at the dealer either together with the instrument or anytime thereafter.

- The upgrade voucher HV572 allows the basic 50 MHz instrument to be upgraded to a bandwidth of 70 MHz.
- Voucher HV512 increases the bandwidth from 50 MHz to 100 MHz.
- If an instrument has initially been upgraded to 70 MHz, the voucher HV712 enables you to upgrade it at any time to 100 MHz.

Voucher for bandwidth upgrades or serial bus analysis options are available at the dealer. The individual voucher number and the serial number of the instrument to be upgraded is entered at http://voucher.hameg.com. The customer immediately receives the respective licence key. By loading this key via USB interface on the instrument, a 50 MHz oscilloscope is upgraded to a bandwidth of 70 MHz or 100 MHz in no time.
Always a MSO

Although it is unusual for this instrument class, the standard R&S®HMO1002 model is equipped with a mixed signal functionality with no software option necessary to unlock it. Analog and digital signals can be measured and analyzed simultaneously. A real life example is the integration of ADCs (analog digital converter) or DACs (digital analog converter). In this case, the mixed signal technology allows users to determine latency periods by means of a simple cursor measurement. Therefore a MSO allows developers to devote their full attention to the circuit without having to waste energy on the measurement setup.

The active logic probe R&S®HO3508 is available separately and is not linked to a specific instrument. It can be used with all R&S®HMO oscilloscopes.

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Serial Bus Analysis

I²C, SPI, CAN or LIN – in terms of interaction with the outside world for embedded systems, it is safe to say that these are the most commonly used communication protocols. The R&S®HMO1002 oscilloscopes offer you hardware-accelerated signal triggering and decoding for all of these protocols. You can upgrade your instrument via software licence keys with those functions required to develop your application:

- HV110: Analysis of I²C, SPI and UART/RS-232 signals on analog and logic channels
- HV111: Analysis of I²C and UART/RS-232 signals on all analog channels
- HV112: Analysis of CAN and LIN signals on analog and logic channels

Serial bus trigger types:
- I²C: Start, Stop, ACK, nACK, Address/Data
- SPI: Start, End, Serial Pattern (32Bit)
- UART/RS-232: Startbit, Frame Start, Symbol, Pattern
- LIN: Frame Start, Wake Up, Identifier, Data, Error
- CAN: Frame Start, Frame End, Identifier, Data, Error

SPI bus signal, MISO / MOSI decoded
HEX decoded CAN bus signal
I²C bus signal in zoom view
Pattern Generator

Are you working on a distributed project, the interface definition has been completed but the prototype hardware has yet to be implemented? The R&S®HMO1002 pattern generator includes a tool for freely programmable 4-bit wide bus signals which allows you to emulate a sensor signal, for instance, to continue your work.

- Generate protocol telegrams at speeds of up to 50 Mbit/s
- Use predefined signal patterns: I2C, SPI, UART, CAN, LIN
- Create your own patterns tailored to your needs
- Use the pattern generator as counter: a clock for your circuit with up to 25 MHz
Digital Voltmeter (DVM)

The three-digit digital voltmeter is also a standard feature which makes the work of service technicians in particular easier. Voltage measurements can be performed simultaneously for both analog channels. Integrated into a single compact device it allows you to keep your workplace tidy.

- Perform measurements simultaneously on both analog channels, with two freely definable parameters each
- These options are available: DC, DC
  rms, AC
  rms, Crest Factor, Vpp, Vp+, Vp-.
- You decide about the position of the values on the screen

Component Tester

Our time proven component tester will also be at your side. Two measuring frequencies with 50 Hz or 200 Hz are provided to support your potentially tedious search for faulty components. And since a picture truly does say more than a thousand words, or rather individual values, you will be able to tell at a glance if your error analysis is on track.

Function Generator

Select the signal type suitable for your scope of application. The various basic types with frequencies of up to 50 kHz not only assist trainees and students with their measuring tasks, they also support technicians in the audio field with their assessments of filters and passes.

- The function generator offers all common basic waveforms up to 50 kHz
- Available waveforms: Sine, square wave, pulse, triangle and ramp
- In tandem with the education mode which allows you to deactivate the automatic measuring functions for instruction and demonstration purposes, this will get you a powerful all-in-one instrument
Frequency Analysis

Due to the outstanding FFT functionality of the R&S®HMO series oscilloscopes signals can also be analysed in the frequency domain with up to 128 Kpoints. Additional practical tools such as cursor measurement as well as peak-detect-functions are also available. They allow engineers to complete their analysis significantly faster, also in the frequency domain.

Easy analysis in frequency domain

Quite often the distortion of input signals cannot be detected with the naked eye. For instance, the sine wave signal displayed in figure 1 appears to be undistorted. Only the frequency spectrum (figure 2) - available with just one touch of a button - clearly displays additional harmonics that occur as harmonic oscillations for multiples of the basic frequency.

For non-periodic input signals most instruments offer the option to trigger the spectrum at just the right moment to then check it in “STOP” mode at a later time. However, at that point, many oscilloscopes with FFT functionality calculate the spectrum only once and store the result in the memory. The base time signal will no longer be used for the calculation. Consequently, an investigation of all parts of the signal will no longer be possible.

R&S®HMO series oscilloscopes work differently: Since FFT is also active for previously stored signals, it is possible to subsequently analyze any sections of those signals captured in single shot mode or stop mode with an adjustable window width. Figure 3 shows a sine burst signal in the time domain. Pushing the FFT button will switch the oscilloscope into the frequency domain. Users can choose
between various measurement windows like the „rectangular“ type that has been used in figure 4. Although this window type captures frequencies at a high degree of accuracy, it is also accompanied by more noise. In order to suppress this disturbing interference users can for instance choose the Hanning window. The impact on the spectrum is visible in figure 5 (see device screen).
R&S® HMO1002
50/70/100MHz 2-channel mixed signal oscilloscopes

All data valid at 23°C after 30 minute warm-up.

Display
- Display: 16.5 cm (6.5") VGA Color Display
- Resolution: 640 (H) x 480 (V) Pixel
- Backlight: 400 cd/m² (LED)

Display range in horizontal direction
- without menu bar: 12 Div (600 Pixel)
- with menu bar: 10 Div (500 Pixel)

Display range in vertical direction
- with Virtual Screen usage: 20 Div
- without menu bar: 8 Div (400 Pixel)
  - with menu bar: 10 Div (500 Pixel)

Color depth: 256 colors
Levels of trace brightness: 32
Trace display: pseudo-color, inverse brightness

Vertical System
- DSO Mode: CH1, CH2
- MSO Mode: CH1, POD (with Logic Probe HO3508)

Analog channels
- Y-bandwidth (-3dB)
  - (1 mV, 2 mV)/Div: 50 MHz
  - (5 mV to 10 V)/Div: 150 MHz
- Lower AC bandwidth: 2 Hz
- Bandwidth limitation (switchable): about 20 MHz
- Rise time (calculated, 10%-90%)
  - 50 MHz (basic unit): <7 ns
  - 70 MHz (with HO5672/HV572 option): <6 ns
  - 100 MHz (with HO512/HV512 or HO0712/HV712 option): <4.5 ns
- DC gain accuracy (all ranges): 3% of full scale
- Input sensitivity range
  - all analog channels: 1 mV/Div to 10 V/Div
  - coarse stepping: 13 calibrated steps, 1-2-5 sequence
  - variable stepping: freely between calibrated steps
- Impedance: 1 MΩ || 16 pF ±2 pF
- Coupling: DC, AC, GND

Max. input voltage: 200 V, (derates at 20 db/decade to 5 V above 100 kHz)
Position range: ±5 Div (from center of screen)
Channel isolation: 35 dB from DC to specified bandwidth (same V/Div range)
XY mode: CH1, CH2
Inversion: selectively all analog channels

Logic channels (with logic probe HO3508)
- Thresholds: TTL, CMOS, ECL, user-defined (-2 V to +8 V)
- Impedance: 100 kΩ || 4 pF
- Coupling: DC
- Max. input voltage: 40 Vp

Trigger system
- Trigger mode:
  - Auto: Triggers automatically also without any specific trigger event
  - Normal: Triggers only on specific trigger events
  - Single: Triggers once on a trigger event
- Trigger indicator:
  - Screen and panel (LED)
- Trigger sensitivity
  - up to 5 mV/Div: 1.5 Div
  - from 5 mV/Div: 0.8 Div
- Trigger level setting
  - with auto level: adjustable between peak values of a signal
  - without auto level: ±5 Div (from center of screen)
- Trigger coupling
  - AC: <5 mV/Div: 10 Hz to 65 MHz
  - >5 mV/Div: 10 Hz to 65/90/130 MHz
  - DC: <5 mV/Div: DC to 65 MHz
  - >5 mV/Div: DC to 65/90/130 MHz
  - HF: <5 mV/Div: 30 kHz to 65 MHz
  - >5 mV/Div: 30 kHz to 65/90/130 MHz
- selectable filters
  - LF (low pass): DC to 5 kHz (-3db), selectable in DC and auto level mode
- Noise rejection: min. level: 1.5 Div (> 5 mV/Div)
- selectable with AC, DC and HF coupling
- Trigger hold-off: auto, 50 ns to 10 s
- External trigger input (BNC)
  - Impedance: 1 MΩ || 16 pF ±2 pF
  - Trigger level: 0.3 Vp to 10 Vp
  - Max. input voltage: 100 Vp
- Coupling: DC, AC
- Trigger output
  - via AUX OUT (BNC)
- Functions:
  - Pulse output for every acquisition trigger event, error output on mask violation
- Output level: 3 V
- Pulse polarity: positive
- Pulse width: >150 ns (trigger event), >0.5 µs (mask violation)

Trigger types
- Edge
  - Direction: rising, falling, both
  - Trigger coupling:
    - auto level AC, DC, HF
- Switchable filters
  - LF, noise rejection
  - Sources:
    - all analog and digital channels, AC line, external (AC, DC)
- Pulse width
  - Polarity: positive, negative
  - Functions:
    - equal, not equal, lower, higher, within/without a range
  - Pulse duration: 16 ns to 10 s, resolution min. 2 ns
  - Sources: all analog channels
- Logic
  - Functions:
    - Boolean operators: AND, OR, TRUE, FALSE
    - time based operators: equal, not equal, lower, higher, within/without a time range, timeout
  - Duration: 16 ns to 10 s, resolution min. 2 ns
  - States: H, L, X
  - Sources: all logic channels
Video
Sync. pulse polarity: positive, negative
supported standards: NTSC, SECAM, PAL, PAL-M, SDTV 576i, HDTV 720p, HDTV 1080i, HDTV 1080p
Field: even/odd, either
Line: line number selectable, all
Sources: all analog channels, external (AC, DC)

Serial Busses
Bus representation: Up to two busses can be analyzed at the same time. Color-coded display of decoded data in ASCII, binary, decimal and hexadecimal format.

Option code
HOO10: Analysis of I2C, SPI, UART/RS-232 signals on analog and logic channels
HOO11: Analysis of I2C, SPI, UART/RS-232 signals on all analog channels
HOO12: Analysis of CAN and LIN signals on analog and logic channels

Trigger types by protocols
I2C: Start, Stop, ACK, NACK, Address/Data
SPI: Start, End, Serial Pattern (32 Bit)
UART/RS-232: Startbit, Frame Start, Symbol, Pattern
LIN: Frame Start, Wake Up, Identifier, Data, Error
CAN: Frame Start, Frame End, Identifier, Data, Error

Horizontal System
Display
Time domain (Yt): main screen, time domain and zoom window
Frequency domain (FFT): time domain and frequency domain window (FFT)
XY mode: voltage (XY)
VirtualScreen: virtual display of ±10 Div for all math, logic, bus, reference signals
Component tester: voltage (X), current (Y)
Reference signals: up to 4 references
Channel deskew: ±32 ns, step size 2 ns

Memory Zoom: up to 50.000:1
Time base: 50.0 x 10⁶
Accuracy: 10.0 x 10⁶ per year

Operation Modes
REFRESH: 2ns/Div to 50 s/Div
ROLL: 50 ms/Div to 50 s/Div

Acquisition System
real-time sampling rate: 2 x 500 MSa/s or 1 x 1 GSa/s
Logic channels: 8 x 500 MSa/s
Memory depth: 2 x 500kPts or 1 x 1 MPts
Resolution: 8 Bit, (HiRes up to 16Bit)
Waveform arithmetics: refresh, roll (loose/triggered), average (up to 1024), envelope, peak detect (2ns), filter (low-pass, adjustable), high resolution (up to 16 bit)
Record modes: automatic, max. sampling rate, max. waveform rate

Interpolation
all analog channels: sin(x)/x, linear, sample-hold
logic channels: pulse
Delay
pre-trigger: 0 to 500,000 Sa x (1/sample rate), multiplied by 2 in interlaced mode
post-trigger: 0 to 8 x 10⁶ Sa x (1/sample rate)
Waveform update rate: up to 10,000 Wfm/s
Waveform display: dots, vectors, persistence afterglow
Persistence afterglow: min. 50 ms

Waveform measurements and Operation
Operation: menu-driven (multilingual), auto-set, help functions (multilingual)
Automatic measurements: voltage (Vpp, Vp+, Vp-, Vrms, Vavg), amplitude, phase, frequency, period, rise/fall time (80%, 90%), pulse width (pos/neg), burst width, duty cycle (pos/neg), standard deviation, delay, crest factor, overshoot (pos/neg), edge/pulse count (pos/neg), trigger period, trigger frequency

Cursor measurements: voltage (V1, V2, ∆V), time (t1, t2, ∆t, 1/∆t), ratio X, ratio Y, pulse and edge count (pos/neg), peak values (Vpp, Vp+, Vp-), mean/RMS/standard deviation, duty cycle (pos/neg), rise/fall time (80%, 90%), ratio marker, crest factor
Quick measurements: (QUICKVIEW) voltage (Vpp, Vp+, Vp-, Vmean, Vrms, ∆Vmean, rise/fall time, frequency, period plus 6 additional measurement functions (see automatic measurement functions, freely selectable)
Marker: up to 8 freely positionable markers for easy navigation

Frequency counter (hardware based)
Resolution: 5 digit
Frequency range: 0.5 Hz to 100 MHz
Accuracy: 50.0 x 10⁻⁶
Aging: ±10.0 x 10⁻⁶ per year

Mask Testing
Functions: Pass/Fail comparison with an user-defined mask performed on waveforms
Sources: all analog channels
Mask definition: Mask enclosing acquired waveform with user-defined tolerance
Actions
on mask violations: beep, acquisition stop, screenshot, trigger pulse, automatically saving trace data
during acquisition: Statistics: number of completed tests, number of passes / failed acquisitions (absolute and in percent), test duration

Waveform maths
Quickmath
Functions: addition, substraction, multiplication, division
Sources: CH1, CH2
Frequency Analysis (FFT)
Parameters: frequency span, center frequency, vertical scale, vertical position
FFT length: 2 Kpts, 4 Kpts, 8 Kpts, 16 Kpts, 32 Kpts, 64 Kpts, 128 Kpts
**Digital Voltmeter**

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<tr>
<td>Sources</td>
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**Component Tester**

| Parameters: | voltage (X), current (Y) |
| Testing frequency: | 50 Hz, 200 Hz |
| Voltage: | 10 V_	ext{pp} (open) |
| Current: | 10 mA (short) |
| Reference potential: | Ground (PE) |

**Interfaces**

- for mass storage (FAT16/32): 1 x USB-Host (Typ A), max. 500 mA
- for remote control: Ethernet (RJ45), USB Device (Typ B)

### General Data

- Application memory: 3 MB for references and device settings
- Save/Recall device settings: on internal file system or external USB memory, available file formats: SCP, HDS
- reference waveforms: on internal file system or external USB memory, available file formats: BIN (MSB/LSB), FLT (MSB/LSB), CSV, TXT, HDR
- traces: on external USB memory, available file formats: BIN (MSB/LSB), FLT (MSB/LSB), CSV, TXT
- data: display or acquisition data
- sources: single or all analog channels
- screenshots: on external USB memory, available file formats: BMP, GIF, PNG
- Realtime Clock (RTC): date and time
- Power supply: AC supply: 100 V to 240 V, 50 Hz to 60 Hz, CAT-II

### Function Generator

| Waveform modes: | DC, sine, square, triangle/ramp, pulse |
| Sine: | frequency range: 0.1 Hz to 50 kHz, flatness: ±0.5 dB relative to 1 kHz |
| Square: | frequency range: 0.1 Hz to 50 kHz, rise time: <4 µs |
| Triangle/ramp: | frequency range: 0.1 Hz bis 10 kHz |
| Pulse: | frequency range: 0.1 Hz to 10 kHz, duty cycle: 10% to 90% |
| Sampling rate: | 978 kSa/s |
| Frequency accuracy: | 50.0 x 10^{-6} |
| Aging: | ±10.0 x 10^{-6} per year |
| Amplitude: | high impedance load: 60 mV_	ext{pp} to 6 V_	ext{pp} |
| 50 Ω load: | 30 mV_	ext{pp} to 3 V_	ext{pp} |
| Accuracy: | ±3% |
| DC offset: | ±3 V |

### Window

- Hanning, Hamming, Rectangular, Blackman

### Scale

- dBm, dBV, V_	ext{pp}

### Waveformarithmetics

- refresh, envelope, average (up to 512)

### Cursor measurement

- 2 horizontal cursors, previous/next peak search

### Sources

- all analog channels

### Pattern Generator

| Functions: | square wave / probe adjust, bus signal source, counter, programmable pattern |
| Square wave (Probe ADJ output): | frequency range: 1 Hz to 500 kHz, level: 2.5 V_	ext{pp} (ts < 4 ms), polarity: normal, invert, duty cycle: 1% to 99% |
| Bus Signal Source (4 Bit): | I2C (100 kBit/s, 400 kBit/s, 1 MBit/s), SPI (100 kBit/s, 250 kBit/s, 1 MBit/s), UART (9600 kBit/s, 115.2 kBit/s, 1 MBit/s), CAN (up to 50 MBits/s), LIN (up to 50 MBits/s) |
| Counter (4 Bit): | frequency: 1 MHz to 25 MHz, direction: incrementing, decrementing |
| Programmable pattern (4 Bit): | sampling time: 20 ns to 42 s, memory depth: 2048 sa, pattern idle time: 20 ns to 42 s |

### Safety

- in line with IEC 61010-1 (ed. 3), IEC 61010-2-30 (ed. 1), EN 61010-1, EN 61010-2-030, CAN/CSA-C22.2 No. 61010-1-12, UL Std. No. 61010-1 (3rd Edition), UL61010-2-030

### Operating temperature range:

- +5 °C to +40 °C

### Storage temperature range:

- -20 °C to +70 °C

### Rel. humidity:

- 5% to 80% (without condensation)

### Mechanical Data

- Dimensions (W x H x D): 285 mm x 175 mm x 140 mm
- Net weight: 2.5 kg

### Accessories included:

- Line cord, printed operating manual, 2 probes: HZ154 (100 MHz, 10:1/1:1 switchable), HZ20 adapter BNC plug / 4 mm banana socket, software-CD

### Printed operating manual

- software-CD

### HZ154

10/100 MHz passive probe

### HZ20

Adapter BNC plug / 4 mm banana socket
Recommended Accessories

**HZO50**
AC/DC Current Probe 30 A, DC to 100kHz

**HZO51**
AC/DC Current Probe 100/1000 A, DC to 20kHz

**HZO20**
High voltage probe 1000:1 (400 MHz, 1000 V_{rms})

**HZO30**
1 GHz active probe (0.9 pF, 1 MΩ)

**HZ115**
Differential Probe 100:1/1000:1

**HO3508**
8 channel logic probe (350 MHz, 4pF)

**HZ51**
150 MHz passive probe 10:1 (12 pF, 10 MΩ)

**HZ52**
250 MHz passive probe 10:1 (10 pF, 10 MΩ)

**HZ53**
100 MHz passive probe 100:1 (4.5 pF, 100 MΩ)

**HZO40**
Active differential probe 200 MHz (10:1, 3.5 pF, 1 MΩ)

**HZO41**
Active differential probe 800 MHz (10:1, 1 pF, 200 kΩ)

**HZO90**
Carrying case for protection and transport

**HZO91**
4 RU 19” rackmount kit