MXO 4 Series
OSCILLOSCOPE

Specifications



Specifications
Version 21.00

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CONTENTS

Definitions **3**

Base unit **4**

Vertical system: analog channels 4

Horizontal system 5

Acquisition system 6

High definition mode 6

Trigger system 7

Spectrum analysis 8

RF characteristics 9

Waveform measurements 9

Waveform math 10

Digital voltmeter 10

Display characteristics 10

History and segmented memory 11

Mask testing 12

R&S®ScopeSync 12

Miscellaneous 12

Input and output 13

General data **14**

Options **16**

R&S®MXO4-B1 mixed signal option 16

R&S®MXO4-B6 arbitrary waveform generator 16

R&S®MXO4-B108 memory upgrade to option, 800 Mpoints on 2 channels 18

R&S®MXO4-K12 basic jitter analysis 18

R&S®MXO4-K31 power analysis 19

R&S®MXO4-K36 frequency response analysis 19

R&S®MXO4-K333 3-phase power analysis 20

R&S®MXO4-K337 impedance analysis 20

R&S®MXO4-K360 motor drive analysis 21

R&S®MXO4-K500 bus analysis 21

R&S®MXO4-K510 low speed serial buses 22

R&S®MXO4-K520 automotive protocols 29

R&S®MXO4-K530 aerospace protocols 33

R&S®MXO4-K550 MIPI low speed protocols 35

R&S®MXO4-K560 automotive Ethernet protocols 39

R&S®MXO4-K570 USB protocols 40

Ordering information **42**

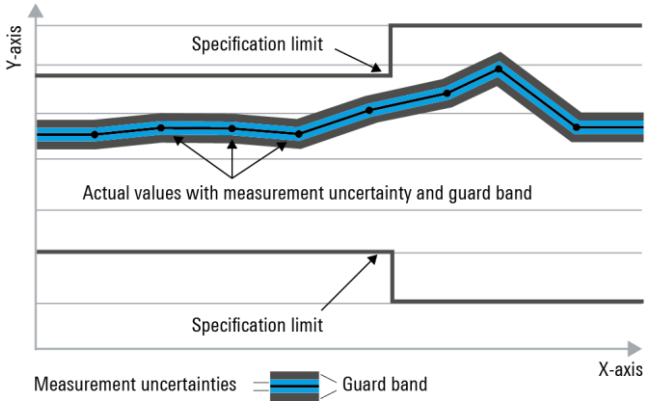
Warranty and service **43**

Definitions

General
Product data applies under the following conditions:

- Three hours of storage at ambient temperature followed by 30 minutes of warm-up operation
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

Specifications with limits
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ± or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Non-traceable specifications with limits (n. trc.)
Represent product performance that is specified and tested as described under “Specifications with limits” above. However, product performance in this case cannot be warranted due to the lack of measuring equipment traceable to national metrology standards. In this case, measurements are referenced to standards used in the Rohde & Schwarz laboratories.

Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value, e.g. dimensions or resolution of a setting parameter. Compliance is ensured by design.

Typical data (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter, e.g. nominal impedance. In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are designated with the format “parameter: value”.

Non-traceable specifications with limits, typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

In line with the 3GPP standard, chip rates are specified in million chips per second (Mcps), whereas bit rates and symbol rates are specified in billion bit per second (Gbps), million bit per second (Mbps), thousand bit per second (kbps), million symbols per second (Msps) or thousand symbols per second (ksps), and sample rates are specified in million samples per second (Msample/s). Gbps, Mcps, Mbps, Msps, kbps, ksps and Msample/s are not SI units.

Base unit

Vertical system: analog channels

Input channels		4 channels
Input impedance		50 Ω ± 1.5 %, 1 MΩ ± 1 % || 12 pF (meas.)
Analog bandwidth (–3 dB)	at 50 Ω input impedance	
	MXO 4	≥ 200 MHz
	MXO 4 with -B243 option	≥ 350 MHz
	MXO 4 with -B245 option	≥ 500 MHz
	MXO 4 with -B2410 option	≥ 1 GHz
	MXO 4 with -B2415 option	≥ 1.5 GHz [1]
	at 1 MΩ input impedance	
	MXO 4	≥ 200 MHz (meas.)
	MXO 4 with -B243 option	≥ 350 MHz (meas.)
	MXO 4 with -B245 option	≥ 500 MHz (meas.)
	MXO 4 with -B2410 option	≥ 700 MHz (meas.) [2]
	MXO 4 with -B2415 option	≥ 700 MHz (meas.) [2]
Additional bandwidth filters available up to instrument bandwidth		1 GHz, 500/350/200/100/50/20 MHz (meas.)
Rise/fall time (calculated)	10 % to 90 % at 50 Ω	
	MXO 4	< 1.75 ns
	MXO 4 with -B243 option	< 1 ns
	MXO 4 with -B245 option	< 700 ps
	MXO 4 with -B2410 option	< 350 ps
	MXO 4 with -B2415 option	< 234 ps
Vertical resolution		12 bit, up to 18 bit for high definition mode
Effective number of bits (meas.)	at 50 Ω, 50 mV/div, with HD-mode and digital filters, 10 MHz sine signal with 80 % full-scale	
	10 MHz	10.1
	20 MHz	9.6
	100 MHz	8.7
	200 MHz	8.4
	300 MHz	8.2
	500 MHz	7.9
	1 GHz	7.3
Input sensitivity	at 50 Ω	0.5 mV/div to 1 V/div, entire analog bandwidth supported for all input sensitivities
	at 1 MΩ	0.5 mV/div to 10 V/div, entire analog bandwidth supported for all input sensitivities
DC gain accuracy	offset and position set to 0 V, after self-alignment	
	input sensitivity > 5 mV/div	±1 % full scale
	input sensitivity ≤ 5 mV/div to ≥ 1 mV/div	±1.5 % full scale
	input sensitivity < 1 mV/div	±2.5 % full scale
Input coupling	at 50 Ω	DC
	at 1 MΩ	DC, AC (> 7 Hz)
Maximum input voltage	at 50 Ω	5 V (RMS), 30 V (V_p)
	at 1 MΩ	300 V (RMS), 400 V (V_p), derates at 20 dB/decade to 5 V (RMS) above 250 kHz
	at 1 MΩ with R&S®RT-ZP11 passive probe	400 V (RMS), 1650 V (V_p), 300 V (RMS) CAT II; for derating and details, see R&S®RT-Zxx Standard Probes specifications (PD 3607.3851.22)
Position range		±5 div

[1] 1.5 GHz analog bandwidth in interleave mode with 5 Gsample/s real-time sampling rate.

[2] With R&S®RT-ZP11 passive probe.

Offset range at 50 Ω	input sensitivity	
	100 mV/div to 1 V/div	±20 V
	0.5 mV/div to < 100 mV/div	±5 V
Offset range at 1 MΩ	input sensitivity	
	800 mV/div to 10 V/div	±200 V
	80 mV/div to < 800 mV/div	±50 V
	0.5 mV/div to < 80 mV/div	±(5 V – input sensitivity × position)
Offset accuracy		±(0.35 % × |net offset| + 0.5 mV + 0.1 div × input sensitivity) (net offset = offset – position × input sensitivity)
DC measurement accuracy	after adequate suppression of measurement noise using high definition (HD) mode or waveform averaging or a combination of both	±(DC gain accuracy × |reading – net offset| + offset accuracy)
Channel-to-channel isolation (each channel with same input sensitivity)	input frequency within instrument bandwidth	> 60 dB (1:1000)

RMS noise floor [3]						
At 50 Ω (meas.)	Input sensitivity	Analog bandwidth (–3 dB)				
		20 MHz	200 MHz	350 MHz	500 MHz	1 GHz
	0.5 mV/div	20 µV	43 µV	47 µV	50 µV	98 µV
	1 mV/div	22 µV	45 µV	50 µV	54 µV	104 µV
	2 mV/div	25 µV	52 µV	56 µV	61 µV	116 µV
	5 mV/div	43 µV	72 µV	77 µV	84 µV	152 µV
	10 mV/div	76 µV	118 µV	120 µV	131 µV	238 µV
	20 mV/div	148 µV	219 µV	219 µV	241 µV	436 µV
	50 mV/div	360 µV	508 µV	492 µV	543 µV	1.01 mV
	100 mV/div	747 µV	1.17 mV	1.19 mV	1.30 mV	2.47 mV
	200 mV/div	1.40 mV	2.13 mV	2.14 mV	2.34 mV	4.43 mV
	500 mV/div	3.47 mV	4.91 mV	4.80 mV	5.27 mV	10.13 mV
	1 V/div	6.88 mV	9.71 mV	9.47 mV	10.41 mV	19.96 mV
At 1 MΩ (meas.)	Input sensitivity	Analog bandwidth (–3 dB)				
		20 MHz	100 MHz	200 MHz	350 MHz	500 MHz
	0.5 mV/div	28 µV	40 µV	42 µV	47 µV	51 µV
	1 mV/div	28 µV	40 µV	46 µV	50 µV	53 µV
	2 mV/div	30 µV	43 µV	49 µV	54 µV	58 µV
	5 mV/div	44 µV	58 µV	67 µV	71 µV	78 µV
	10 mV/div	73 µV	92 µV	109 µV	109 µV	120 µV
	20 mV/div	138 µV	169 µV	199 µV	198 µV	218 µV
	50 mV/div	344 µV	442 µV	525 µV	529 µV	586 µV
	100 mV/div	739 µV	959 µV	1.13 mV	1.14 mV	1.24 mV
	200 mV/div	1.40 mV	1.74 mV	2.06 mV	2.07 mV	2.27 mV
	500 mV/div	3.47 mV	4.43 mV	5.22 mV	5.28 mV	5.75 mV
	1 V/div	7.11 mV	8.92 mV	10.44 mV	10.53 mV	11.49 mV
	2 V/div	13.83 mV	16.9 mV	19.87 mV	19.56 mV	21.38 mV
	5 V/div	34.84 mV	44.32 mV	52.43 mV	53.39 mV	57.97 mV
	10 V/div	57.16 mV	68.58 mV	80.66 mV	78.53 mV	85.46 mV

Horizontal system

Timebase range		selectable between 200 ps/div and 10 000 s/div, time per div settable to any value within range
Deskew range (channel deskew)	between analog channels	±20 ms
	between digital channels	±100 ns
Reference position		0 % to 100 % of measurement display area
Horizontal position range (trigger offset range)	max.	50000 s
	min.	–50000 s

[3] HD mode active for bandwidth ≤ 500 MHz.

Modes		normal, roll
Channel-to-channel skew	between analog channels	< 100 ps (meas.)
	between digital channels	< 500 ps (meas.)
Timebase accuracy	after delivery/calibration, at +23 °C	±0.2 ppm
	during calibration interval	±1 ppm
Delta time accuracy	corresponds to time error between two edges on same acquisition and channel; signal amplitude greater than 5 divisions, measurement threshold set to 50 %, vertical gain 10 mV/div or greater; rise time lower than four sample periods; waveform acquired in real-time mode	±(0.20/real-time sampling rate + timebase accuracy × |reading|) (peak) (meas.)

Acquisition system

Sampling rate	analog channels (real time)	max. 5 Gsample/s on 2 channels, max. 2.5 Gsample/s on 4 channels
	analog channels (interpolated)	max. 5 Tsample/s
	digital channels	max. 5 Gsample/s on each channel
Waveform acquisition rate	max.	> 4 500 000 waveforms/s
Trigger rearm time	min.	< 21 ns
Memory depth [4]	standard	400 Mpoints with 4 active channels (single capture), 400 Mpoints with 2 active channels (run continuous)
	R&S®MXO4-B108 option	800 Mpoints with 2 active channels (single capture), 800 Mpoints with 1 active channel (run continuous)
Acquisition modes	sample	middle sample in decimation interval
	peak detect	largest and smallest sample in decimation interval
	average	average of acquired waveforms
	number of averaged waveforms	2 to 16 777 215
	envelope	envelope of acquired waveforms
Sampling modes	real-time mode	max. sampling rate set by digitizer
	interpolated time	enhancement of sampling resolution by interpolation; max. sampling rate is 5 Tsample/s
Interpolation modes		linear, sin(x)/x, sample & hold
Fast segmentation mode	continuous recording of waveforms in acquisition memory without interruption due to visualization	
	max. real-time waveform acquisition rate	> 4 600 000 waveforms/s
	min. blind time between consecutive acquisitions	< 21 ns

High definition mode

General description	The high definition mode increases the bit resolution of the waveform signal by using digital filtering, leading to reduced noise. Because of the digital trigger concept of the MXO 4, signals with increased numeric resolution are used as the input for triggering.	
Numeric resolution	bandwidth, at 5 Gsample/s	bit resolution
	1 kHz to 10 MHz	18 bit
	100 MHz	16 bit
	200 MHz	15 bit
	500 MHz	14 bit
Real-time sampling rate	all models	max. 5 Gsample/s on 2 channels, max. 2.5 Gsample/s on 4 channels

[4] The maximum available memory depth depends on the bit depth of the acquired data and, therefore, on the settings of the acquisition system, such as decimation mode, waveform math or high definition mode.

Trigger system

Trigger sources		analog channels (C1 to C4), digital channels (D0 to D15), external trigger input, line trigger, serial bus
Trigger level range		±5 div from center of screen
Trigger modes		auto, normal, single, n single
Trigger sensitivity		0.0001 div, from DC to instrument bandwidth for all vertical scales
Trigger jitter	full-scale sine wave of frequency set to –3 dB bandwidth	< 1 ps (RMS) (meas.)
Coupling mode	standard	same as selected channel
	HF reject	cutoff frequency selectable from 1 kHz to 500 MHz
	LF reject	attenuates frequencies < 50 kHz
Trigger hysteresis	modes	auto (default setting) or manual
	adjustment resolution	0.0001 div, from DC to instrument bandwidth for all vertical scales
Holdoff range	time	100 ns to 10 s, fixed and random

Main trigger modes		
Edge	triggers on specified edge (positive, negative or either) and level	
Glitch	triggers on glitches of positive, negative or either polarity that are shorter or longer than specified width	
	glitch width	200 ps to 1000 s
Width	triggers on positive or negative pulse of specified width; width can be shorter, longer, inside or outside a specified range	
	pulse width	200 ps to 1000 s
Runt	triggers on pulse of positive, negative or either polarity that crosses one threshold but fails to cross a second threshold before crossing the first one again; runt pulse width can be arbitrary, shorter, longer, inside or outside a specified range	
	runt pulse width	200 ps to 1000 s
Window	triggers when signal enters or exits a specified voltage range; triggers also when signal stays inside or outside the voltage range for a specified period of time	
Timeout	triggers when signal stays high, low or unchanged for a specified period of time	
	timeout	0 ps to 1000 s
Interval	triggers when time between two consecutive edges of same slope (positive or negative) is shorter, longer, inside or outside a specified range	
	interval time	200 ps to 1000 s
Slew rate	triggers when the time required by a signal edge to toggle between user-defined upper and lower voltage levels is shorter, longer, inside or outside a specified range; edge slope may be positive, negative or either	
	toggle time	0 ps to 1000 s
Setup & hold	triggers on setup time and hold time violations between clock and data present on any two input channels; monitored time interval may be specified by the user in the range from –100 s to 100 s around a clock edge and must be at least 200 ps wide	
Pattern	triggers when a logical combination (and, nand, or, nor) of the input channels stays true for a period of time shorter, longer, inside or outside a specified range	
State	triggers when a logical combination (and, nand, or, nor) of the input channels stays true at a slope (positive, negative or either) in one selected channel	

Advanced trigger modes		
Zone trigger	triggers on user-defined zones drawn on the display	
	source	acquired waveforms (input channels), math waveforms (including power analysis waveforms), spectrum waveforms, XY plots
	number of zones/areas	up to 4 zones with up to 8 areas each
	area shapes	polygons with up to 16 points
	area types	must intersect, must not intersect
	combination of zones	logical combination of zones of multiple sources using Boolean expressions
	trigger compatibility	requires sequence trigger A -> zone trigger where primary A condition can be: edge, glitch, width, runt, window, timeout, interval, slew rate, setup & hold, state, pattern
Sequence trigger (A/B/R trigger)	triggers on B event after occurrence of A event; delay condition after A event specified as time interval; an optional R event resets the trigger sequence to A	
	A event	edge, glitch, width, runt, window, timeout, interval, slew rate
	B event	edge, glitch, width, runt, window, timeout, interval, slew rate
	R event	edge, glitch, width, runt, window, timeout, interval, slew rate
Serial bus trigger	optional	see dedicated triggering and decoding options
External trigger input	input impedance	50 Ω (meas.) or 1 MΩ (meas.) || 11 pF (meas.)
	max. input voltage at 50 Ω	30 V (V_p)
	max. input voltage at 1 MΩ	300 V (RMS), 400 V (V_p), derates at 20 dB/decade to 5 V (RMS) above 250 kHz
	trigger level	±5 V
	sensitivity	
	input frequency ≤ 500 MHz	300 mV (V_{pp}) (meas.)
	input coupling	AC, DC (50 Ω and 1 MΩ)
	trigger filter	HF reject (attenuates > 50 kHz), LF reject (attenuates < 50 kHz), noise reject
	trigger modes	edge (positive, negative or either)
Trigger output	functionality	A pulse is generated for each event triggering signal acquisition.
	output voltage	0 V to 5 V (nom.) at high impedance; 0 V to 2.5 V (nom.) at 50 Ω
	pulse width	selectable between 16 ns and 50 ms
	pulse polarity	low active or high active
	output delay	depends on trigger settings

Spectrum analysis

General description	Spectrum analysis allows signal analysis in the frequency domain.	
Spectrum	sources	channel 1 to channel 4, math waveforms, reference waveforms
	setup parameters	center frequency, frequency span, resolution bandwidth (automatic or manual), gate position, gate width, vertical scaling, vertical position
	scaling	dBm, dBV, dBµV, V (RMS)
	span	1 Hz to 1.8 GHz [5]
	resolution bandwidth (RBW)	span/4 ≥ RBW ≥ span/6000
	windows	flat top, Hanning, Hamming, Blackman, rectangular, Kaiser Bessel, Gaussian
	trace types	normal, max. hold, min. hold, average
	max. real-time waveform acquisition rate	> 40 000 waveforms/s

[5] The stop frequency depends on the analog bandwidth of the instrument.

Gate	delimits the display region used for spectrum analysis
Peak list	The values in the peak list are also shown in the diagram to allow easy correlation.

RF characteristics

Sensitivity/noise density	at 1 GHz (measurement of the power spectral density at 1 GHz at input sensitivity 2 mV/div, corresponding to –30 dBm input range of the oscilloscope, using spectrum analysis with center frequency 1 GHz, span 500 kHz, RBW 3 kHz)	–160 dBm (1 Hz) (meas.)
Noise figure	at 1 GHz (calculated based on the noise power density above)	14 dB (meas.)
Dynamic range	measured for a 1 GHz input carrier with level –3 dBm at input of oscilloscope, using spectrum analysis with center frequency 1 GHz, span 2 MHz, RBW 400 Hz at +20 MHz from center frequency	106 dB (meas.)
Absolute amplitude accuracy	0 Hz to 1.2 GHz	±1 dB (meas.)
Spurious-free dynamic range (excluding harmonics)	measured for a 250 MHz input carrier and level –3 dBm at input sensitivity 50 mV/div, using spectrum analysis with center frequency 900 MHz, span 1.8 GHz, RBW 300 kHz	65 dBc (meas.)
Second harmonic distortion	measured for a 250 MHz input carrier and level –3 dBm at input sensitivity 50 mV/div, using spectrum analysis with center frequency 900 MHz, span 1.8 GHz, RBW 300 kHz	–60 dBc (meas.)
Third harmonic distortion	measured for a 250 MHz input carrier and level –3 dBm at input sensitivity 50 mV/div, using spectrum analysis with center frequency 900 MHz, span 1.8 GHz, RBW 300 kHz	–59 dBc (meas.)

Waveform measurements

Automatic measurements	measurements on acquired waveforms (input channels), math waveforms, reference waveforms	amplitude, high, low, maximum, minimum, peak-to-peak, mean, RMS, sigma, positive overshoot, negative overshoot, area, rise time, fall time, positive pulse width, negative pulse width, period, frequency, positive duty cycle, negative duty cycle, delay, phase, burst width, pulse count, edge count, pulse train, positive switching, negative switching, cycle area, cycle mean, cycle RMS, cycle sigma, setup, hold, setup/hold time, setup/hold ratio, slew rate rising, slew rate falling, delay to trigger
	gate	delimits the display region evaluated for automatic measurements
	reference levels	user-configurable vertical levels define support structures for automatic measurements
	statistics	displays maximum, minimum, mean, standard deviation and measurement count for each automatic measurement
	track	measurement results are displayed as a continuous trace that is time-correlated to the measurement source

	limit check	measurements tested against user-defined limits; pass or fail conditions may trigger automatic response: beep, stop acquisition, save waveform, save results, screenshot, trigger output pulse
	number of active measurements	16
	result line annotation	
Cursor measurements	available cursors	up to two cursor sets on screen, each set with two horizontal and two vertical cursors
	target waveforms	acquired waveforms (input channels), math waveforms, reference waveforms, XY diagrams
	operating modes	vertical measurements, horizontal measurements, or both; vertical cursors either set manually or locked to waveform
	source mode	single source, use second source, multiple sources (multi-channel cursor)
	multiple sources mode selection	acquired waveforms (input channels), math waveforms, reference waveforms
Waveform histogram	number of diagrams	up to 8
	sources	acquired waveforms (input channels), math waveforms, reference waveforms
	mode	vertical, horizontal
	windowing	user-defined

Waveform math

General features	number of math equations	up to 5
	number of reference waveforms	up to 4
	sources	channel 1, channel 2, channel 3, channel 4, math waveforms 1 to 4, reference waveforms 1 to 4
Functions	operators	add, subtract, multiply, divide, absolute value, square, square root, integrate, differentiate, $\log_{10}$, $\log_e$, $\log_2$, reciprocal, invert, low pass, high pass, rescale (a * x+b)
	filter	low pass, high pass
	filter types	Gaussian, rectangular
	gate	delimits the display region used for waveform math

Digital voltmeter

Accuracy		related to channel settings of voltmeter source
Measurements		DC, DC RMS, AC RMS
Sources		C1, C2, C3, C4
Number of measurements		up to 4
Resolution		up to 6 digits
Bandwidth		up to 20 MHz

Display characteristics

Diagram types	Yt, XY, zoom, spectrum
Display configuration (waveform layout)	The display area can be split into separate diagram areas by dragging and dropping signal icons. Each diagram area can hold any number of signals. Diagrams can be stacked on top of each other and later accessed via dynamic tabs (Tab 1, etc.).
Signal icons	Each active waveform is represented by a signal icon on the signal bar; the signal icon displays the individual vertical and acquisition settings.
Toolbar	Enables quick access to important tools; allows to set the most common parameters directly in a simple menu and gives access to more detailed parameters in the main menu; User-defined selection of tools in the toolbar.
Upper menu bar	Display trigger, horizontal and acquisition system settings; allows quick access to these settings.
Main menu	Provides access to all instrument settings in a compact menu structure.

Axis label	The x-axis and y-axis are labeled with values and physical unit.
Diagram label	Diagrams can be individually labeled with a descriptive, user-defined name.
Diagram layout	The grid, crosshair, axis labeling and diagram labeling can be switched on and off separately.
Persistence	50 ms to 50 s, or infinite
Zoom	vertical and horizontal; touch interface simplifies resize and drag operations on zoom window
	display of several zoomed signals: overlapping, stacked on top of each other or lined up next to each other
Signal colors(waveform coding)	predefined or user-defined color tables for persistence display

History and segmented memory

Acquisition memory	automatic	automatic setting of segment size and sample rate	
	manual	user-defined setting of segment size and sample rate	
Memory segmentation	function	memory segments for the acquisition	
	number of segments	record length	segments [6] (up to)
		1 kpoints	1 048 575
		2 kpoints	524 287
		5 kpoints	262 143
		10 kpoints	131 071
		20 kpoints	65 535
		50 kpoints	32 767
		100 kpoints	16 383
		200 kpoints	9 361
		500 kpoints	4 095
		1 Mpoints	2 113
		2 Mpoints	1 056
		5 Mpoints	427
		10 Mpoints	213
		20 Mpoints	106
		50 Mpoints	41
		100 Mpoints	20
		200 Mpoints	9
		400 Mpoints	4
		800 Mpoints	2
	Segmentation is available on all analog and logic channels, protocol decoding and spectrum analysis.		
Fast-segmented mode	continuous recording of waveforms in acquisition memory without interruption due to visualization; blind time between consecutive acquisitions, see Acquisition system		
History mode	function	The history mode always provides access to past acquisitions in the segmented memory.	
	timestamp resolution	1 ns	
	history player	replays the recorded waveforms; repetition possible; adjustable speed; manual next/previous segment; numerical segment number input	
	analyze options	overlay all segments, average all segments, envelope all segments	

[6] With R&S®MXO4-B108 memory option. The maximum number of segments depends on the number of active channels and the bit resolution of the acquired data and, therefore, on the settings of the acquisition system settings, such as decimation mode, use of waveform math or high definition (HD) mode. The maximum number of segments without R&S®MXO4-B108 memory option is limited to 10 000.

Mask testing

Test definition	number of masks	up to 8 simultaneously
	source	acquired waveforms (input channels), math waveforms, reference waveforms, spectrum waveforms, XY plots
	fail condition	waveform hit
	test rate	up to 4 million waveforms/s
	action on error	acquisition stop, beep, save waveform, pulse on trigger out, screenshot
Mask definition with segments	number of segments per mask test	up to 8
	segment definition	array of at least 3 points defines an inner region
Result statistics	category	total completed acquisition, failed acquisition, passed acquisition, fail rate, overall test result (pass/fail)
Visualization options	waveform style	vectors, dots
	mask colors	predefined colors for mask without violation (translucent gray), mask with violation (translucent red)

R&S®ScopeSync

Supported instruments	MXO 44, MXO 54, MXO 58, MXO 54C, MXO 58C	any combination of these instruments is supported, both as oscilloscope 1 and oscilloscope 2
Maximum number of channels	oscilloscope 1: MXO 44 oscilloscope 2: MXO 44 or MXO 54 or MXO 54C	8 with R&S®ScopeSync 16 with R&S®ScopeSync + additional GetSignals
	oscilloscope 1: MXO 44 oscilloscope 2: MXO 58 or MXO 58C	12 with R&S®ScopeSync 20 with R&S®ScopeSync + additional GetSignals
Trigger out to trigger in jitter	across two instruments, oscilloscope 1/oscilloscope 2	250 ps (RMS) (meas.)

Miscellaneous

Remote control	web interface	full operation of the instrument's touch interface, keys and multifunction wheel via web browser
	VNC	control of the instrument through virtual network computing
	SCPI	standard instrument programming interface through VISA
	WebDAV	support for the web distributed authoring and versioning (WebDAV) protocol, which provides secure access through an application proxy
Languages	available languages for the user interface	English, German, French, Simplified Chinese, Traditional Chinese, Japanese, Russian, Spanish, Italian, Portuguese, Korean, Czech, Polish
	online help on the instrument	English
Save	destination	internal storage, USB media and remote network drive
	data and file management	settings: saveset, generator, screenshot
		waveform data and results: waveform, session, results, histogram
	waveform file format	Rohde & Schwarz waveform data binary (.bin) comma separated values (.csv), hierarchical data format (.h5) multi-waveforms compressed format (.zip/.csv)
	export mode control	display, all data, cursor, gate, manual
	sessions	compressed format (.zip) that can include setting on display/diagram, channel waveforms and reference waveforms

Recall	data and file management	settings: saveset and generator
		waveform data: reference and session

Input and output

Front		
Channel inputs		BNC; for details, see Vertical system
	probe interface	auto detection of passive probes, Rohde & Schwarz active probe interface
External trigger input		BNC; for details, see Trigger system
	probe interface	auto detection of passive probes
Waveform generator outputs (requires R&S®MXO4-B6 option)		BNC; for details, see R&S®MXO4-B6, waveform generator, demo lugs and GND lug
Digital channel inputs	D15 to D8, D7 to D0	interface for R&S®RT-ZL04 logic probe
Probe compensation output	signal shape	rectangle, V_{low} = 0 V, V_{high} = 3.3 V amplitude 3.3 V (V_{pp}) ± 5 % (meas.)
	frequency	1 kHz ± 1 % (meas.)
USB interface		1 × USB 3.1 gen1 port, type A plug, 2 × USB 2.0 high speed ports, type A plug

Rear		
Trigger out		BNC; for details, see Trigger system
USB interface		2 × USB 3.1 Gen 1 ports, type A plug, 1 × USB 3.1 Gen 1 port, type B plug
LAN interface		RJ-45 connector, supports 10/100/1000BASE-T, LXI compliant
External monitor interface		HDMI, 1920 × 1080 pixel at 60 Hz, output of oscilloscope display
Reference input	connector	BNC
	impedance	50 Ω (nom.)
	input frequency	10 MHz (±20 ppm)
	sensitivity	≥ –10 dBm into 50 Ω, ≤ 10 dBm at 10 MHz
Reference output	connector	BNC
	impedance	50 Ω (nom.)
	output signal	10 MHz (specified with timebase accuracy), 8 dBm (nom.)
Security slot		for standard Kensington style lock
VESA mount		VESA compatibility mounting interface, 100 mm × 100 mm pattern size

Right side		
Ground jack		connected to ground

General data

Display	type	13.3" LC TFT color display with capacitive touchscreen
	resolution	1920 × 1080 pixel (Full HD)

Temperature		
Temperature range	operating temperature range	0 °C to +50 °C
	storage temperature range	–40 °C to +70 °C
		in line with MIL-PRF-28800F section 4.5.5.1.1.1 class 3 tailored to +45 °C for operation
Climatic resistance	damp heat	+25 °C/+50 °C at 85 % relative humidity cyclic, in line with IEC 60068-2-30

Altitude		
Operating		up to 3000 m above sea level
Nonoperating		up to 4600 m above sea level

Mechanical resistance		
Vibration	sinusoidal	5 Hz to 150 Hz, max. 1.8 g at 55 Hz; 0.5 g from 55 Hz to 150 Hz, in line with EN 60068-2-6
		10 Hz to 55 Hz, in line with MIL-PRF-28800F, section 4.5.5.3.2 class 3
	random	8 Hz to 500 Hz, acceleration 1.2 g (RMS), in line with EN 60068-2-64
		5 Hz to 500 Hz, acceleration 2.058 g (RMS), in line with MIL-PRF-28800F, section 4.5.5.3.1 class 3
Shock		40 g shock spectrum, in line with MIL-STD-810G, method no. 516.6, procedure I
		30 g functional shock, halfsine, duration 11 ms, in line with MIL-PRF-28800F, section 4.5.5.4.1

Electromagnetic compatibility (EMC)		
RF emissions		in line with CISPR 11/EN 55011 group 1, class A (for a shielded test setup); the instrument complies with the emission requirements stipulated by EN 55011, EN 61326-1 and EN 61326-2-1 class A, making the instrument suitable for use in industrial environments
Immunity		in line with IEC/EN 61326-1 table 2, immunity test requirements for industrial environment [7]

Certifications		VDE, $_{C}$CSA$_{US}$, KC
EU legislation	EU: in line with Data Act – Regulation (EU) 2023/2854	for details, see user documentation

Calibration interval		1 year

[7] Test criterion is displayed noise level within ±1 div for input sensitivity of 5 mV/div.

Power supply		
AC supply		100 V to 240 V ±10 % at 50 Hz to 60 Hz and 400 Hz ±5 %, max. 2.3 A to 1.3 A, in line with MIL-PRF 28800F, section 3.5
Power consumption	maximum	210 W
Safety		in line with IEC 61010-1, EN 61010-1, CAN/CSA-C22.2 No. 61010-1, UL 61010-1

Mechanical data		
Dimensions	W × H × D	414 mm × 279 mm × 162 mm (16.3 in × 10.99 in × 6.38 in)
Weight	without options, nominal	6.0 kg (13.23 lb)
Rackmount height	with R&S®ZZA-MXO4 rackmount kit	6 HU

Options

R&S®MXO4-B1 mixed signal option

Mixed signal capability is a standard functionality of the MXO 4 series oscilloscopes. The R&S®MXO4-B1 mixed signal option provides 16 digital channels with two R&S®RT-ZL04 probes.		
Input channels		16 logic channels (from D15 to D0)
Arrangement of input channels		arranged in two logic probes with 8 channels each, assignment of the logic probes to the channels D15 to D8 and D7 to D0
DC input resistance	at probe tips	100 kΩ ± 2 % (meas.)
Input capacitance		4 pF (meas.)
Maximum input frequency	signal with minimum input voltage swing and hysteresis setting: normal	400 MHz (meas.)
Maximum input voltage		±40 V (V_p); 32 V (RMS), derates to 7 V (RMS) with 20 dB/decade at frequencies above 25 MHz
Minimum input voltage swing		500 mV (V_{pp}) (meas.)
Threshold groups		4 (from D15 to D12, D11 to D8, D7 to D4 and D3 to D0)
Threshold level	manual	±8 V
	predefined	CMOS 5.0 V, CMOS 3.3 V, CMOS 2.5 V, TTL, ECL, PECL, LVPECL
Threshold error	threshold setting between ± 4 V	±(100 mV + 3 % of threshold setting)
Hysteresis settings		small, medium, large
Channel deskew	range for each channel	±200 ns

R&S®MXO4-B6 arbitrary waveform generator

Arbitrary function/waveform generator, 2 analog channels		
General		
Output channel		2 channels
Vertical resolution		16 bit
Operating modes		function generator, arbitrary waveform generator, modulation, frequency sweep
Function generator	output of predefined waveforms	
Sample rate		625 Msample/s
Waveforms	sine, square/pulse, ramp, DC, noise, sine cardinal (sinc), Gaussian pulse, Lorentz, exponential fall, exponential rise, cardiac	
Sine	frequency range	1 mHz to 100 MHz
	amplitude flatness (relative to 1 kHz)	≤ ±0.5 dB (meas.)
	total harmonic distortion (into 50 Ω)	
	f ≤ 10 MHz	≤ –60 dBc (meas.)
	f > 10 MHz	≤ –40 dBc (meas.)
	nonharmonic spurious	–75 dBc (meas.)
Square/pulse	frequency range	1 mHz to 30 MHz
	duty cycle (if pulse width limit is not exceeded)	0.01 % to 99.99 %, 0.01 % resolution
	pulse width	≥ 16.5 ns, 0.1 ns resolution
	rise/fall time	9 ns (meas.)
	overshoot	≤ 2 % (meas.)
	jitter (cycle-to-cycle) (≥ 0.2 V (V_{pp}))	≤ 40 ps (RMS) (meas.)
Ramp (triangle, sawtooth)	frequency range	1 mHz to 1 MHz
	variable symmetry	0 % to 100 %, 0.1 % resolution
DC	level range	
	into 50 Ω	± 2.5 V
	into open circuit	± 5 V
	resolution	1 mV

Noise	amplitude	
	DC	0 V to 5 V (V_{pp}) (into 50 Ω), 0 V to 10 V (V_{pp}) (into open circuit), 1 mV resolution
	all other waveforms	0 % to 100 % of AC signal amplitude, 1 % resolution
	bandwidth	≥ 100 MHz
Sine cardinal (sinc)	frequency range	1 mHz to 5 MHz
Gaussian pulse	frequency range	1 mHz to 25 MHz
Lorentz	frequency range	1 mHz to 10 MHz
Exponential rise/fall	frequency range	1 mHz to 10 MHz
Cardiac	frequency range	1 mHz to 1 MHz

Arbitrary waveform generator	output of user-defined waveforms	
Waveform length		1 sample to 40 Msample on each channel
Sample rate		1 sample/s to 312.5 Msample/s
Filter bandwidth		100 MHz
Modulation		
Modulation types		amplitude modulation (AM), frequency modulation (FM), frequency-shift key modulation (FSK), pulse width modulation (PWM)
Carrier waveform	AM, FM, FSK	sine
	PWM	square/pulse
AM	modulation signals	sine, square, ramp (triangle, sawtooth)
	modulation frequency	1 mHz to 1 MHz
	depth	0 % to 100 %, 0.1 % resolution
FM	modulation signals	sine, square, triangle, ramp, inverse ramp
	modulation frequency	1 mHz to 1 MHz
	frequency deviation	1 mHz to 10 MHz
FSK	modulation signal	50 % duty cycle square wave
	range of frequency 1, frequency 2	1 mHz to 100 MHz
	hop rate	1 mHz to 1 MHz
PWM	modulation signals	sine, square, ramp
	depth	0 % to 99.99 % of the duty cycle, 0.01 % resolution

Frequency sweep	output of a sinusoidal waveform with the frequency changing linearly between the start frequency and the stop frequency within the sweep time	
	waveform	sine
	frequency range	1 mHz to 100 MHz
	direction	up (start frequency < stop frequency)
		down (start frequency > stop frequency)
	sweep time	1 ms to 500 s

Two-channel operation	operating modes	independent channels, coupled parameters, differential
	parameter coupling	none, frequency and/or amplitude
	relative phase	–180° to 180°, 0.1° resolution
	channel-to-channel skew (each channel with same output amplitude)	≤ 200 ps (meas.)
	channel-to-channel isolation (each channel with same output amplitude)	≥ 70 dB (meas.)
Outputs		
Connectors		BNC; on the front of the instrument
Function		on/off, inverted
Output impedance		nom. 50 Ω

Overload protection	V_{pp} > 200 mV into open circuit	a short-circuit to ground is tolerated indefinitely, automatic shutoff in case of voltages ≥ +12 V or ≤ –12 V (meas.)
	V_{pp} ≤ 200 mV into open circuit	a short-circuit to ground is tolerated indefinitely, automatic shutoff in case of voltages ≥ +4 V or ≤ –4 V (meas.)
Amplitude range [8]	sine, square/pulse, ramp, exponential rise/fall, arbitrary waveforms, sine cardinal (sinc), Gaussian, Lorentz, cardiac	
	into 50 Ω	5 mV to 5 V (V_{pp})
	into open circuit	10 mV to 10 V (V_{pp})
	resolution	1 mV
	accuracy	±1 % at 1 kHz
DC offset range	sine, square/pulse, ramp, exponential rise/fall, arbitrary waveforms	
	into 50 Ω	±2.5 V (V_{pp} > 100 mV), ±1.25 V (V_{pp} ≤ 100 mV)
	into open circuit	±5.0 V (V_{pp} > 200 mV), ±2.5 V (V_{pp} ≤ 200 mV)
	sine cardinal (sinc): DC offset range is signal amplitude dependent	
	into 50 Ω	–2.823 V to +2.177 V (V_{pp} = 1 V)
	into open circuit	–5.323 V to +4.677 V (V_{pp} = 1 V)
	Gaussian, Lorentz: DC offset range is signal amplitude dependent	
	into 50 Ω	–3.000 V to +2.000 V (V_{pp} = 1 V)
	into open circuit	–5.500 V to +4.500 V (V_{pp} = 1 V)
	cardiac: DC offset range is signal amplitude dependent	
	into 50 Ω	–2.814 V to +2.186 V (V_{pp} = 1 V)
	into open circuit	–5.314 V to +4.686 V (V_{pp} = 1 V)
	resolution	1 mV
	accuracy	±(1 % of control + (0.5 % of amplitude) + 2 mV)
Frequency accuracy		| Δf | ≤ [(timebase accuracy) × (nominal frequency) + 1.1 µHz] (calc.) (timebase accuracy, see Horizontal system)

R&S®MXO4-B108 memory upgrade to option, 800 Mpoints on 2 channels

Extension of memory depth and memory segments		
Memory depths		800 Mpoints with 2 active channels (single), 800 Mpoints with 1 active channel (run)
Memory segmentation	maximum number of segments	1 048 575 segments

R&S®MXO4-K12 basic jitter analysis

General description	The R&S®MXO4-K12 basic jitter analysis option extends the functionality of the standard MXO 4 firmware with a suite of measurement, analysis and visualization tools for signal integrity analysis and jitter characterization.	
Waveform measurements	category	jitter
	measurements on acquired waveforms (input channels), math waveforms, reference waveforms	cycle-to-cycle jitter, N-cycle jitter, cycle-to-cycle width, cycle-to-cycle duty cycle, time-interval error, data rate, unit interval, skew delay, skew phase
	gate	delimits the display region evaluated for measurements
	reference levels	user-configurable vertical levels define support structures for measurements
	statistics	displays maximum, minimum, mean, standard deviation and measurement count for each measurement
	track	measurement results displayed as continuous trace that is time-correlated to the measurement source

[8] Amplitude is the sum of the AC amplitude and the noise amplitude.

R&S®MXO4-K31 power analysis

Power analysis		
General description	The R&S®MXO4-K31 power analysis option extends the MXO 4 firmware with measurement functionality focused on switched mode power supplies (SMPS) and DC/DC converters. Up to three sets of power analysis measurements are possible.	
Input	quality	evaluation of power quality at an AC input; measures real power, apparent power, reactive power, power factor and phase angle of power, frequency, crest factor, RMS of voltage and current
	harmonics	measures up to the 334th harmonic of the incoming line frequency; precompliance checking for IEC 61000-3-2 (A, B, C, D), RTCA DO-160, MIL-STD-1399, max. limit checks
Power path	switching loss	measures switching loss and conduction loss of a power device
	turn on/off time	measures relationship between input AC/DC and output DC voltage, when turning SMPS off and on
	efficiency	measures input power and output power to calculate the efficiency of a power device
	safe operating area (SOA)	checks violation of voltage and current limits in which a power device can operate without damage; current versus voltage view; violation mask is user-defined; up to 4 masks; save/load of masks; export of mask violation data
Deskew	automated	automated compensation of the propagation delay
Zero offset	automated	automatic compensation of input offset

R&S®MXO4-K36 frequency response analysis

Frequency response analysis (requires R&S®MXO4-B6 option)		
Stimulus	frequency mode	single sweep, repeated sweep and single frequency
	frequency range	10 mHz to 100 MHz
	amplitude mode	fixed or amplitude profile
	amplitude level	10 mV to 10 V into high Z
		5 mV to 5 V into 50 Ω
Input and output sources		any analog input channel
Number of test points		10 points to 500 points per decade
Measurement		dual pair of tracking gain, phase and reference cursors
Diagram types	manually changeable vertical window size	parallel display of result window and input and output signal view
Result table		navigation and export functions
Scaling	during and after test	auto-scale and manual scaling and positioning
References	number of reference waveforms	up to 4

R&S®MXO4-K333 3-phase power analysis

3-phase power analysis		
General description	The R&S®MXO4-K333 3-phase power analysis option extends the MXO 4 firmware and enables comprehensive characterization of 3-phase power systems. Automated measurements cover total power, harmonics, phase quantities and distortion, with flexible wiring configurations to quickly visualize waveforms, harmonic spectra, numerical results and phasor diagrams.	
Wiring configuration	2V2A (3-phase-3-wire), 3V3A (3-phase-3-wire), 3VN3A (3-phase-4-wire)	
L-L to L-N conversion	Conversion is done for 2V2A and 3V3A wirings and used for measurements.	
Cycle source	selectable edge qualifier source with adjustable filter cut-off frequency	
Electrical analysis	power quality, harmonics, efficiency	
Offset compensation	automatic compensation of input offset	
Degauss	degauss the current probe from the menus for each channel	
Deskew	user can deskew voltage and current probes automatically	
Source support	live analog signals, math waveforms, reference waveforms, scope sync waveforms	
Report	data export to CSV format, screenshot	
Power quality	measurements	real power, apparent power, reactive power, power factor and phase angle of all phase power waveforms and total power waveform
		crest factor, RMS and maximum on voltage and current of the phases
		RMS total voltage and current
	plots	phasor diagram, single phase power waveforms, total power waveform, result table
Harmonics	supported limit check standards	IEC 61000-3-2 A, B, C, D (2011 & 2019), MIL-STD-1399
	THD measurements	THD RMS, THD fundamental
	plots	bar graph, single phase power waveforms, total power waveform, result table
Efficiency	measurements	total input power, total output power, total efficiency between input and output; statistic values of these measurements
	plots	total input power waveform, total output power waveform, result table
	additional wiring configurations	1V1A for AC or DC

R&S®MXO4-K337 impedance analysis

Impedance analysis (requires R&S®MXO4-B6 option)		
Stimulus	frequency mode	single sweep, repeated sweep and single frequency
	frequency range	10 mHz to 100 MHz
	amplitude mode	fixed or amplitude profile
	amplitude level	5 mV to 5 V into 50 Ω
Input and output sources		any analog input channel, math waveforms
Measure types		Shunt through, series through, voltage current
Number of test points		10 points to 500 points per decade
Measurement		dual pair of tracking cursors
Diagram types	manually changeable vertical window size	parallel display of result window and input and output signal view
Result table		navigation and export functions
Scaling	during and after test	auto scale during test and manual definition of start and stop, logarithmic diagram axis
References	number of reference waveforms	up to 4

R&S®MXO4-K360 motor drive analysis

Motor drive analysis	
General description	The R&S®MXO4-K360 motor drive analysis option extends the MXO 4 firmware and enables comprehensive characterization of motor or generator systems. Automated measurements cover mechanical power, electrical power and the total system efficiency.
Electrical wiring configuration	1V1A (AC or DC), 2V2A (3-phase-3-wire), 3V3A (3-phase-3-wire), 3VN3A (3-phase-4-wire)
Measurements	torque, speed, angle, electrical power, mechanical power, efficiency between electrical and mechanical power, statistic values of these measurements
L-L to L-N conversion	Conversion is done for 2V2A and 3V3A wirings and used for measurements.
Cycle source	selectable edge qualifier source with adjustable filter cut-off frequency
Offset compensation	automatic compensation of input offset
Degauss	degauss the current probe from the menus for each channel
Deskew	user can deskew voltage and current probes automatically
Source support	analog signals, digital signals, math waveforms, reference waveforms
Report	data export to CSV format, screenshot
Plots	single phase power waveforms, total electrical power waveform, torque track waveform, angle track waveform, speed track waveform, total mechanic power waveform, result table
Mechanical encoder for torque	analog frequency, analog mV/V, analog 0 V DC
Mechanical sensors for speed and angle	Hall sensors, sin/cos resolvers, quadrature encoder interface (QEI)

R&S®MXO4-K500 bus analysis

Protocol measurements (require corresponding R&S®MXO4-K510 to R&S®MXO4-K560 protocol options)		
Frame to frame	measures the distance between the starts of two selectable frame types in seconds	• from: frame type, field type, field value • to: frame type, field type field value
Trigger to frame	measures the distance between the trigger event and the start of a selectable frame type in seconds	frame identification; frame type, field type, field value
Frame to trigger	measures the distance between the start of a selectable frame type and the trigger event	frame identification; frame type, field type, field value
Field value	allows for the selection of frame types and displays the value of a specified field	frame identification; frame type, field type, field value tracked; field type
Main bit rate	measures the main bit rate of a protocol based on the relevant bits in a frame; if a protocol provides multiple bit rates, the most relevant bit rate is being measured	frame identification; frame type, field type, field value
Second bit rate	for protocols with multiple bit rates, the secondary bit rate is available	only available for protocols with 2 bit rates frame identification; frame type, field type, field value
Bus idle	measures the percentage of idle time on a bus; idle time is defined as the time where the bus is not occupied by frames	no settings
Gap	measures the distance between the end of a frame to the start of another	no settings
Frame count	counts the total number of frames in each acquisition	no settings
Frame errors	counts the total number of erroneous frames in each acquisition	no settings
Frame error rate	measures the percentage of erroneous frames in relation to the total frames	no settings
Consecutive frame error rate	measures the percentage of follow up (consecutive) frame errors, ignoring all single frame errors	no settings

R&S®MXO4-K510 low speed serial buses

I²C triggering and decoding		
Protocol configuration	bit rate	auto detected
Trigger (hardware based)	source (clock and data)	any analog input channel or logical channel
	trigger event setup	start, stop, restart, missing ACK, address, data, address + data
	address setup	7 bit or 10 bit address (value in hex or binary); read, write or either; condition =, ≠, ≤, ≤, in range, out of range
	data setup	data pattern up to 8 byte (hex or binary); condition =, ≠; offset within frame in range from 0 byte to 4095 byte
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	write, read, 10 bit write, 10 bit read
	write	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; ACK-A; value 0, 1 data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; ACK-D word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ACK-D index: selects the specific data word; conditions =, in range
	read	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; ACK-A; value 0, 1 data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; ACK-D word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ACK-D index: selects the specific data word; conditions =, in range
	10 bit write	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; ACK-A, ACK-A2; value 0, 1 for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; ACK-D word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ACK-D index: selects the specific data word; conditions =, in range

	10 bit read	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; ACK-A; value 0, 1 data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; ACK-D word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ACK-D index: selects the specific data word; conditions =, in range
	error condition	no stop bit, 10 bit read address different, unknown
Decode	source (clock and data)	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	frame, start/restart, address (read/write), data, ACK/NACK, stop, error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

SPI triggering and decoding		
Protocol configuration	type	2-wire, 3-wire and 4-wire SPI
	bit rate	auto detected
	bit order	LSB first, MSB first
	word size	4/8/12/16/20/24/28/32 bit
	frame condition	CS, timeout
	polarity (MOSI, MISO, CS, CLK)	active high, active low
	phase (CLK)	first edge, second edge
Trigger (hardware based)	source (MOSI, MISO, CS, CLK)	any analog input channel or logical channel
	bit rate	up to 50 Mbps
	trigger event setup	start of frame, end of frame, MOSI, MISO
	data setup	data pattern up to 32 bit (hex or binary); condition =, ≠; offset within frame in range from 0 bit to 4095 bit
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	MISO, MOSI, MISOMOSI
	MISO	data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	MOSI	data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	MISOMOSI	data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	error condition	void, length
Decode	source (MOSI, MISO, CS, CLK)	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	frame, word, error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

QUAD-SPI triggering and decoding		
Protocol configuration	source (CS, SCLK, IO0 to IO3)	any analog or logical input channel; math or reference waveform
	bit rate	auto detected
	polarity (SCLK)	rising, falling
	polarity (CS, IO0 to IO3)	active high, active low
	instruction mode	single, dual, quad
	opcode	configurable list for opcode translation opcode list can be saved and loaded
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	data
	data	opcode, addr, alt, dummy; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	error condition	length, opcode
Decode	display type	decoded bus, tabulated list
	color coding	frame, word, error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

OCTO-SPI triggering and decoding		
Protocol configuration	source (CS, SCLK, IO0 to IO7, and DS)	any analog or logical input channel; math or reference waveform
	bit rate	auto detected
	polarity (SCLK, DS)	rising, falling
	polarity (CS, IO0 to IO7)	active high, active low
	instruction mode	single, dual, quad, octo
	command code	configurable table of command code (opcode) definitions; table can be saved and loaded from file
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	multiple frame types as defined by user in opcode table. Each opcode (command code) becomes a unique frame type.
	data	opcode, cmd ext, addr, alt, dummy; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	error condition	length, opcode error
Decode	display type	decoded bus, tabulated list
	color coding	frame, word, error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown n the result table. Events that do not match the criteria set will not be displayed on the table when the filter is turned on.	
	settings	same as trigger settings

UART/RS-232/RS-422/RS-485 triggering and decoding		
Protocol configuration	bit rate	300 bps to 20 Mbps
	signal polarity	idle low, idle high
	number of bits	5 bit to 9 bit
	bit order	LSB first, MSB first
	parity	odd, even, mark, space, none
	stop bit	1, 1.5 or 2
	end of packet	timeout, none
Trigger (hardware based)	source (TX and RX)	any analog input channel or logical channel
	trigger event setup	start bit, packet start, data, parity error, stop error, break condition
	data setup	data pattern (hex, decimal, octal, binary or ASCII); condition =, ≠; offset within packet in range 0 word to 4095 words
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	TX, RX
	TX	data; conditions =, ≠, <, ≤, >, ≥, in range, out of range
	RX	data; conditions =, ≠, <, ≤, >, ≥, in range, out of range
	error condition	start, stop, parity, break
Decode	source (TX and RX)	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	packet, data payload, start error, parity error, stop error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

Clocked NRZ (NRZC) triggering and decoding		
Protocol configuration	signal type	up to 3 selectable channels: data, clock and optional enable (CS); differential or single-ended
	min. gap time	optional (off by default); range 1 ns to 1 s; indicates min idle time for gap detection and frame separation
	auto threshold setup	assisted threshold configuration
	source	any analog or logical input channel; math or reference waveform
	properties	active data state (high/low), clock edge (rising/falling/both), enable state (high/low)
	frame separation	gap or enable (CS) signal

Frame format	frame	multiple frame management, frame identification and sync, variable length frames, variable number of cells
	cells	name, size (bit count), condition, numeric format, bit order, RGB color, result column
	file storage of frame format	save/load as xml files
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	variants	all supported bit encodings
	trigger event setup	frame start
		pattern
		advanced trigger
	frame start	gap, start bit
	advanced trigger	frame type (with OR combinations), frame fields (with AND combinations), frame field data; conditions =, ≠, <, ≤, >, ≥, in range, out of range for data count, word count, data value; error types
Decode	display type	decoded bus, logical signal, bus signal, tabulated list, result details, decode layers
	color coding	according to cell configuration table
	data format	according to cell configuration table
	decode layer	edges, binary
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

Unclocked NRZ (NRZU) triggering and decoding		
Protocol configuration	signal type	up to 2 selectable channels: data and optional enable (CS); differential or single-ended
	min gap time	optional (off by default); range 1 ns to 1 s; indicates min idle time for gap detection and frame separation
	bit rate	optional (off by default); if not provided, it will be automatically calculated
	auto threshold setup	assisted threshold configuration
	source	any analog or logical input channel; math or reference waveform
	properties	active data state (high/low), enable state (high/low)
	frame separation	gap or enable (CS) signal
Frame format	frame	multiple frame management, frame identification and sync, variable length frames, variable number of cells
	cells	name, size (bit count), condition, numeric format, bit order, RGB color, result column
	file storage of frame format	save/load as xml files
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	variants	all supported bit encodings
	trigger event setup	frame start
		pattern
		advanced trigger
	frame start	gap, start bit
	advanced trigger	frame type (with OR combinations), frame fields (with AND combinations), frame field data; conditions =, ≠, <, ≤, >, ≥, in range, out of range for data count, word count, data value; error types

Decode	display type	decoded bus, logical signal, bus signal, tabulated list, result details, decode layers
	color coding	according to cell configuration table
	data format	according to cell configuration table
	decode layer	edges, binary
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

Manchester triggering and decoding		
Protocol configuration	signal type	up to 2 selectable channels: data and optional enable (CS); differential or single-ended
	data phase	first/second edge
	min gap time	optional (off by default); range 1 ns to 1 s; indicates min idle time for gap detection and frame separation
	bit rate	optional (off by default); if not provided, it will be automatically calculated
	source	any analog or logical input channel; math or reference waveform
	properties	active data state (high/low), enable state (high/low)
	frame separation	gap or enable (CS) signal
Frame format	frame	multiple frame management, frame identification and sync, variable length frames, variable number of cells
	cells	name, size (bit count), condition, numeric format, bit order, RGB color, result column
	file storage of frame format	save/load as xml files
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	variants	all supported bit encodings
	trigger event setup	frame start
		pattern
		advanced trigger
	frame start	gap, start bit
	advanced trigger	frame type (with OR combinations), frame fields (with AND combinations), frame field data; conditions =, ≠, <, ≤, >, ≥, in range, out of range for data count, word count, data value; error types
Decode	display type	decoded bus, tabulated list, result details, decode layers
	color coding	according to cell configuration table
	data format	according to cell configuration table
	decode layer	edges, binary
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

R&S®MXO4-K520 automotive protocols

CAN FD/CAN XL triggering and decoding		
Protocol configuration	signal type	CAN_H, CAN_L
	bit rate	
	nominal bit rate	100 kbps to 1 Mbps
	FD data rate	100 kbps to 15 Mbps
	XL data rate	100 kbps to 15 Mbps
	sampling points	30 % to 90 % within bit period; independent settings for nominal bit rate, FD data rate and XL data rate
	device list	associate frame identifier with symbolic ID, load DBC file content
Trigger (hardware based)	source	any analog input channel or logical channel
	trigger event setup	start of frame, frame type, identifier, identifier + data, error condition (any combination of CRC error, bit stuffing error, form error and ACK error)
	identifier setup	identifier type (standard or extended); condition =, ≠, ≥, ≤, in range, out of range
	FD bits	BRS and ESI (0, 1, X)
	XL setup	SDT, VCID, AF; condition =, ≠, ≥, ≤, in range, out of range
	data setup	data pattern up to 8 byte (hex, decimal, octal, binary or ASCII); condition =, ≠
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	CBFF, CBFF-R, CEFF, CEFF-R, FBFF, FEFF, XLFF, overload, error
	CBFF	ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	CBFF-R	ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options;
	CEFF	EXT-ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	CEFF-R	EXT-ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	FBFF	ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; BRS, ESI; value 0, 1 for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range

	FEFF	ID, DLC; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; BRS, ESI; value 0, 1 for each of these options; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	XLFF	priority ID, SDT, DLC, VCID, AF; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; SEC; value 0, 1; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	error condition	EOF, ack delimiter, no ack, CRC delimiter, CRC, stuff count, form, bit stuffing, unknown
Decode	source	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	start of frame, identifier, DLC, ADS, SDT, VCID, AF, data payload, CRC, end of frame, error frame, overload frame, CRC error, bit stuffing error
	data format	hex, decimal, octal, binary, ASCII, symbolic
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

LIN triggering and decoding		
Protocol configuration	version	1.3, 2.x or SAE J602; mixed traffic is supported
	bit rate	1 kbps to 20 Mbps
Trigger (hardware based)	source	any analog input channel or logical channel
	trigger event setup	start of frame (sync break), identifier, identifier + data, wake-up frame, error condition (any combination of checksum error, parity error and sync field error)
	identifier setup	range from 0d to 63d; condition =, ≠, ≥, ≤, in range, out of range
	data setup	data pattern up to 8 byte (hex, decimal, octal, binary or ASCII); condition =, ≠
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	data, wake up, unknown
	data	Id; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	error condition	checksum, parity, start, sync, length
Decode	source	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	frame, frame identifier, data payload, checksum, error condition
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

SENT triggering and decoding		
Protocol configuration	signal type	data signal
	clock period (clock tick)	1 µs to 100 µs
	clock tolerance	0 % to 25 %
	data nibbles	1 to 6
	serial message type	none, short serial message and enhanced serial message
	CRC version	Legacy (Feb 2008) and v2010 (Latest)
	CRC calculation	SAE J2716 standard and TLE 4998X
	pause pulse	no, yes, for constant frame length
	frame length in clock ticks (applicable only when pause pulse = constant frame length)	104 to 922
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	trigger event setup	calibration or sync, transmission sequence, serial message and error condition
	transmission sequence status nibble setup	from 0 to F, condition =, ≠, ≥, ≤, in range, out of range
	transmission sequence data nibbles setup	each nibble value from 0 to F, condition =, ≠, ≥, ≤, in range, out of range
	serial message identifier setup	from 00 to FF, condition =, ≠, ≥, ≤, in range, out of range
	serial message identifier type setup (applicable only when the serial protocol = enhanced serial message in protocol configuration)	4 bit and 8 bit
	serial message data setup	00 to FF (short serial message) 000 to FFF (enhanced serial message with 8 bit ID) 0000 to FFFF (enhanced serial message with 4 bit ID)
	error condition setup	form error, calibration pulse error, pulse period error, CRC error and irregular frame length error
Decode	source	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list
	color coding	transmission sequence: sync/calibration, status, data bits, CRC, pause pulse (optional), calibration pulse error, pulse period error, irregular frame length error and CRC error; serial message: identifier, data, CRC, form error, CRC error
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

R&S®MXO4-K530 aerospace protocols

ARINC 429 triggering and decoding		
Protocol configuration	bit rate	high (100 kbps), low (12.0 kbps to 14.5 kbps)
	signal polarity	A leg, B leg
	min. gap	0 to 100 bit, off
	max. gap	0 to 1000 bit, off
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	ARINC429-word
	ARINC429-word	label, SDI, data, SSM; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	error condition	coding, parity, unknown, gap
Decode	source	any analog channel, math or reference waveform
	display type	decoded bus, tabulated list, decode layers
	color coding	for different cell types
	data format	hex, decimal, octal, binary, ASCII
	decode layer	off, ternary symbols, bits, words
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

MIL-STD-1553 triggering and decoding		
Protocol configuration	signal type	single-ended
	bit rate	standard bit rate (1 Mbit/s)
	polarity	normal, inverted
	device list	associate frame identifier with symbolic ID
	auto threshold setup	assisted threshold configuration
	timing	min. gap (2 µs to 262 µs) or off; max. response (2 µs to 262 µs) or off
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	command, status, cmd/status, data
	command	RTA, Info; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; P value 0, 1
	status	RTA, Info; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; P value 0, 1
	cmd/Status	RTA, Info; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; P value 0, 1
	data	data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; P value 0, 1
	error condition	sync, Manchester coding, parity, gap, response timeout

Decode	source	any analog channel, math or reference waveform
	display type	decoded bus, logical signal, bus + logical signal, tabulated list
	color coding	frame (word), sync, RTA, status bit field, parity, data field, error condition
	data format	hex, octal, binary, ASCII, signed, unsigned
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

SpaceWire triggering and decoding		
Protocol configuration	signal type	two channels: strobe and data (differential or single-ended)
	bit rate	auto adjust (strobe + data)
	auto threshold setup	assisted threshold configuration
	timing	min. gap (1 ns to 1 s)
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	data, time, FCT, null, EOP, EEP, bad esc
	data	conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	time	conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	bad esc	conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; P value 0, 1
	error condition	parity error, length error
Decode	source	any analog channel, math or reference waveform
	display type	decoded bus, logical signal, bus + logical signal, tabulated list, decode layers
	color coding	control frame, data frame, null frame, time code
	data format	hex, octal, binary, ASCII, signed, unsigned
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

R&S®MXO4-K550 MIPI low speed protocols

SPMI triggering and decoding		
Protocol configuration	bit rate	auto detected
	supported version	2.0
	GSID	selectable in range 0 to 15
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	register 0 write, register write, register read, extended register write, extended register read, extended register write long, extended register read long, main write, main read
	register 0 write setup	sub address, data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ack
	register write/read	sub address, register address, data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; ack (write only)
	extended register write/read	sub address, byte count, register address, data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range; ack (write only)
	extended register write long/read long	sub address, byte count, register address, register address 2, data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, ≠, <, ≤, >, ≥, in range; ack (write only)
	main write/read	main address, register address, data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; frame byte; conditions =, ≠, <, ≤, >, ≥, in range; ack (write only)
	error condition	no response, ack, bus park, parity, length, arbitration, SSC, command, coding
Decode	source (SCLK and SDATA)	any analog or logical input channel; math or reference waveform
	display type	decoded bus, tabulated list, details, decode layers
	color coding	arbitration sequence, command sequence, sequence start condition, device address, command, byte count, register address, data payload, parity bits, bus park cycle, ack, error
	data format	hex, decimal, octal, binary, ASCII
	decode layer	off, edges, bit
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

RFFE triggering and decoding		
Protocol configuration	signal type	two channel, single-ended
	bit rate	auto detected
	source (SCLK, SDATA)	any analog or logical input channel; math or reference waveform
	supported version	1.X, 2.0,2.1 and 3.1
	read mode	standard or read mode
	glitch filter	configurable glitch filter
	gap detection	detect gaps between sequences

Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	trigger event setup	sequence start, sequence stop, register 0 write, register write, register read, extended register write, extended register read, extended register write long, extended register read long, error condition types
	sequence start setup	4 bit sub device address; conditions =, ≠, <, ≤, >, ≥, in range, out of range
	sequence stop setup	4 bit sub device address; conditions =, ≠, <, ≤, >, ≥, in range, out of range
	register 0 write setup	4 bit sub device address, 7 bit data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	register write/read	4 bit sub device address, 5 bit register address, 8 bit data word; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options
	extended register write/read	4 bit sub device address; 8 bit address, byte count: 0 to 15 (inclusive), data pattern: 1 to 16 byte (hex or binary); conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; index: 1 to 16 selects the specific data frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	extended register write long/read long	4 bit sub device address, 8 bit address, byte count: 0 to 7 (inclusive), data pattern: 0 to 8 byte (hex or binary); conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; index: 1 to 8 selects the specific data frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	interrupt summary and notification	4 bit sub device address, bit count 0 to 32, notification and interrupt bits
	masked write	4 bit sub device address; 8 bit address, 8 bit mask, 8 bit data pattern; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options;

		frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	main device ownership handover	2 bit MID; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	main device write/read	2 bit MID, 8 bit address, 16 bit data pattern; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	main device context transfer write/read	2 bit MID, 8 bit byte count, 8 bit address, data pattern: 1 to 8 byte (hex or binary); conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; index: 1 to 256 selects the specific data frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	error condition	SSC error; length error, bus park error, parity error, no response, unknown sequence, version error, min. gap between frames: 1 ns to 10 us
	extended register write long/read long	4 bit sub device address, 8 bit address, byte count: 0 to 7 (inclusive), data pattern: 0 to 8 byte (hex or binary); conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; index: 1 to 8 selects the specific data frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	interrupt summary and notification	4 bit sub device address, bit count 0 to 32, notification and interrupt bits
	masked write	4 bit sub device address; 8 bit address, 8 bit mask, 8 bit data pattern; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; frame byte; conditions =, ≠, <, ≤, >, ≥, in range
	main device ownership handover	2 bit MID; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; frame byte; conditions =, ≠, <, ≤, >, ≥, in range
Decode	display type	decoded bus, logical signal, bus + logical signal, tabulated list, decode layers
	color coding	sequence, frame, error
	data format	hex, octal, binary, ASCII, signed, unsigned
	decode layer	off, edges, bit
	result export	export of all result data into CSV, XML, HTML and Py file formats
	display type	decoded bus, logical signal, bus + logical signal, tabulated list, decode layers
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings

Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

I^3C triggering and decoding		
Protocol configuration	signal type	two channel, single-ended
	bit rate	auto detected
	source (SCL, SDA)	any analog or logical input channel; math or reference waveform
	gap detection	detect gaps between sequences
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	I^3C probe, read, write, CCC broadcast, CCC direct, HDR-DDR, HDR-ternary
	I^3C probe	reserved; conditions =, ≠, <, ≤, >, ≥, in range, out of range; R/W; value 0, 1 ACK; value 0, 1
	read	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; R/W; value 0, 1 ACK-A; value 0, 1 data; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data index: selects the specific data word; conditions =, in range
	write	address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; R/W; value 0, 1 ACK-A; value 0, 1 data; conditions =, ≠, <, ≤, >, ≥, in range, out of range for each of these options; data index: selects the specific data word; conditions =, in range
	CCC broadcast	reserved; conditions =, ≠, <, ≤, >, ≥, in range, out of range; R/W; value 0, 1 ACK-A; value 0, 1 ccc; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data index: selects the specific data word; conditions =, in range
	CCC broadcast	reserved; conditions =, ≠, <, ≤, >, ≥, in range, out of range; R/W; value 0, 1 ACK-A; value 0, 1 ccc; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data index: selects the specific data word; conditions =, in range

	HDR-DDR	command; conditions =, ≠, <, ≤, >, ≥, in range, out of range; address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data index: selects the specific data word; conditions =, in range p; conditions =, ≠, <, ≤, >, ≥, in range, out of range; p index: selects the specific data word; conditions =, in range crc; conditions =, ≠, <, ≤, >, ≥, in range, out of range;
	HDR-ternary	R/W; value 0, 1 command; conditions =, ≠, <, ≤, >, ≥, in range, out of range; address; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data; conditions =, ≠, <, ≤, >, ≥, in range, out of range; data index: selects the specific data word; conditions =, in range p; conditions =, ≠, <, ≤, >, ≥, in range, out of range; p index: selects the specific data word; conditions =, in range
	error condition	ACK, parity, CRC, length, unknown
Decode	source (clock and data)	any input channel, logical channel
	display type	decoded bus, tabulated list
	color coding	frame, field types, status
	data format	hex, decimal, octal, binary, ASCII
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

R&S®MXO4-K560 automotive Ethernet protocols

10BASE-T1S triggering and decoding		
Protocol configuration	source	any analog input channel, math or reference waveform
	threshold	upper/lower
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	frame type	MAC, COMMIT, BEACON or unknown
	MAC frame setup	destination address (condition =, ≠, <, >, ≥, ≤, in range, out of range), source address (condition =, ≠, <, >, ≥, ≤, in range, out of range), length/type (condition =, ≠, <, >, ≥, ≤, in range, out of range), data (condition =, ≠, <, >, ≥, ≤, in range, out of range), data index (condition =, in range)
	error condition setup	preamble, SFD, ESD, CRC

Decode	display type	decoded bus, tabulated list, details, decode layers
	color coding	for different cell types
	data format	hex, decimal, octal, binary, signed, unsigned, ASCII
	decode layer	reversed bits, descrambled bits, scrambled bits, ternary symbols
	result export	export of all result data into CSV, XML, HTML and Py file formats
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed in the table when the filter is turned on.	
	settings	same as trigger settings
Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

R&S®MXO4-K570 USB protocols

USB 1.1/2.0 triggering and decoding		
Protocol configuration	signal type	single-ended, differential
	protocol type	low, full, high speed
	bit rate	standard bit rates (1.5/12/480 Mbit/s)
	source	any analog input channel; math or reference waveform
Trigger (software based)	primary event trigger (hardware based)	edge, glitch, width, runt, windows, timeout, interval, slew rate
	trigger event setup	start of packet; frame types: token (IN, OUT, SOF, SETUP), data (DATA0, DATA1, DATA2 [9], MDATA [9]), handshake (ACK, NAK, STALL, NYET [9]), special (PRE/ERR, SPLIT [9], PING [9], Reserved [9]); error conditions (PID error, CRC error, length error, bit-stuffing error, incomplete)
	frame detail setup (field conditions)	condition =, ≠, ≥, ≤, in range, out of range
	data setup	byte search (hex, decimal, octal, binary or ASCII), bit separately configurable (1, 0 or don't care); condition =, ≠; position-based or range-based triggering (first occurrence in packet payload)
	error condition	PID error, CRC error, bit-stuffing error, length error
Decode	source	any input channel, math waveform
	display type	decoded bus, logical signal, bus + logical signal, tabulated list
	color coding	packet identifier, payload length, frame, address, endpoint, data payload, CRC5, CRC16, error condition
	data format	hexadecimal, decimal, octal, binary, ASCII, unsigned
Filter	The filter function selects those decode events that shall be shown in the result table. Events that do not match the criteria set will not be displayed on the table when the filter is turned on.	
	settings	same as trigger settings

[9] Only available in USB2.0 (high speed).

Format	custom frame definition	save and open xml file with format description; create, delete, reorder frames
	frame	identify frames by type and up to 3 field values; set new name and color
	custom payload field definition	add and delete fields that reinterpret the frame's payload (data field)
	payload field	name, color, first bit, bit count, repetition, bit order, numeric format with value list, linear function

Ordering information

Designation	Type	Order No.
MXO 4 series, base model		
Oscilloscope, 200 MHz, 4 channels	MXO 4	1335.5050.04
Base unit (including standard accessories: 700 MHz passive probe (10:1) per channel, accessories bag, quick start guide, power cord)		
Choose your bandwidth upgrade		
Upgrade of MXO 4 to 350 MHz bandwidth	R&S®MXO4-B243	1335.4276.02
Upgrade of MXO 4 to 500 MHz bandwidth	R&S®MXO4-B245	1335.4299.02
Upgrade of MXO 4 to 1 GHz bandwidth	R&S®MXO4-B2410	1335.4318.02
Upgrade of MXO 4 to 1.5 GHz bandwidth	R&S®MXO4-B2415	1335.4330.02
Choose your options		
Mixed signal option for MXO 4 series with 16 digital channels	R&S®MXO4-B1	1335.4130.02
Arbitrary waveform generator, 100 MHz, 2 analog channels	R&S®MXO4-B6	1335.4147.02
Memory upgrade to 800 Mpoints on 2 channels	R&S®MXO4-B108	1335.5772.02
Basic jitter analysis	R&S®MXO4-K12	1335.6091.02
Power analysis	R&S®MXO4-K31	1335.5566.02
Frequency response analysis	R&S®MXO4-K36	1335.5572.02
3-phase analysis	R&S®MXO4-K333	1335.5995.02
Impedance analysis	R&S®MXO4-K337	1335.6085.02
Motor drive analysis	R&S®MXO4-K360	1335.6162.02
Bus analysis	R&S®MXO4-K500	1335.5243.02
Low speed serial buses (I^2C/SPI/QuadSPI/OctoSPI/UART/RS-232/RS-422/RS-485/NRZ clocked/ NRZ unclocked/Manchester)	R&S®MXO4-K510	1335.5195.02
Automotive protocols (CAN/CAN FD/CAN XL/LIN/SENT)	R&S®MXO4-K520	1335.5550.02
Aerospace protocols (ARINC 429/MIL-STD-1553/SpaceWire)	R&S®MXO4-K530	1335.5208.02
MIPI low speed protocols (SPMI/RFFE/I^3C)	R&S®MXO4-K550	1335.5214.02
Automotive Ethernet protocols (10BASE-T1S)	R&S®MXO4-K560	1335.5943.02
USB protocols (USB 1.1/2.0)	R&S®MXO4-K570	1335.6156.02
Application bundle, consists of the following options: R&S®MXO4-B6, R&S®MXO4-K31, R&S®MXO4-K36, R&S®MXO4-K510, R&S®MXO4-K520	R&S®MXO4-PK1	1335.5237.02
R&S®ScopeStudio Software	R&S®MXO-PC	1801.9005.02
R&S®ScopeStudio protocol decode option	R&S®MXO-PC-K1	1804.8874.02
Choose your additional probes		
Single-ended passive probes		
700 MHz, 10 MΩ, 10:1, 400 V, 9.5 pF, 2.5 mm	R&S®RT-ZP11	1803.0005.02
500 MHz, 10 MΩ, 10:1, 400 V, 9.5 pF, 2.5 mm	R&S®RT-ZP10	1409.7550.00
500 MHz, 10 MΩ, 10:1, 300 V, 10 pF, 5 mm	R&S®RT-ZP05M	1335.3505.02
700 MHz, 14.9 MΩ, 25:1, 30 V, 4 pF, MMCX	R&S®RT-ZPMMCX	1803.1599.02
38 MHz, 1 MΩ, 1:1, 55 V, 39 pF, 2.5 mm	R&S®RT-ZP1X	1333.1370.02
Active broadband probes: single-ended		
1.0 GHz, active, 1 MΩ, Rohde & Schwarz probe interface	R&S®RT-ZS10E	1418.7007.02
1.0 GHz, active, 1 MΩ, R&S®ProbeMeter, micro button, Rohde & Schwarz probe interface	R&S®RT-ZS10	1410.4080.02
1.5 GHz, active, 1 MΩ, R&S®ProbeMeter, micro button, Rohde & Schwarz probe interface	R&S®RT-ZS20	1410.3502.02
Active broadband probes: differential		
1.0 GHz, active, differential, 1 MΩ, R&S®ProbeMeter, micro button, incl. 10:1 external attenuator, 1 MΩ, 60 V DC, 42.4 V AC (peak), Rohde & Schwarz probe interface	R&S®RT-ZD10	1410.4715.02
1.5 GHz, active, differential, 1 MΩ, R&S®ProbeMeter, micro button, Rohde & Schwarz probe interface	R&S®RT-ZD20	1410.4409.02
Power rail probe		
2.0 GHz, 1:1, 50 kΩ, ±0.85 V, ±60 V offset, Rohde & Schwarz probe interface	R&S®RT-ZPR20	1800.5006.02
High voltage probes: passive		
250 MHz, 100:1, 100 MΩ, 850 V, 6.5 pF	R&S®RT-ZH03	1333.0873.02
400 MHz, 100:1, 50 MΩ, 1000 V, 7.5 pF	R&S®RT-ZH10	1409.7720.02
400 MHz, 1000:1, 50 MΩ, 1000 V, 7.5 pF	R&S®RT-ZH11	1409.7737.02

Designation	Type	Order No.
High voltage probes: differential		
200 MHz, 250:1/25:1, 5 MΩ, 750 V (peak), 300 V CAT III, Rohde & Schwarz probe interface	R&S®RT-ZHD07	1800.2307.02
100 MHz, 500:1/50:1, 10 MΩ, 1500 V (peak), 1000 V CAT III, Rohde & Schwarz probe interface	R&S®RT-ZHD15	1800.2107.02
200 MHz, 500:1/50:1, 10 MΩ, 1500 V (peak), 1000 V CAT III, Rohde & Schwarz probe interface	R&S®RT-ZHD16	1800.2207.02
100 MHz, 1000:1/100:1, 40 MΩ, 6000 V (peak), 1000 V CAT III, Rohde & Schwarz probe interface	R&S®RT-ZHD60	1800.2007.02
Current probes		
20 kHz, AC/DC, 0.01 V/A and 0.001 V/A, ±200 A and ±2000 A, BNC interface	R&S®RT-ZC02	1333.0850.02
100 kHz, AC/DC, 0.1 V/A, 30 A, BNC interface	R&S®RT-ZC03	1333.0844.02
2 MHz, AC/DC, 0.01 V/A, 500 A (RMS), Rohde & Schwarz probe interface	R&S®RT-ZC05B	1409.8204.02
10 MHz, AC/DC, 0.01 V/A, 150 A (RMS), BNC interface	R&S®RT-ZC10	1409.7750.02
10 MHz, AC/DC, 0.01 V/A, 150 A (RMS), Rohde & Schwarz probe interface	R&S®RT-ZC10B	1409.8210.02
50 MHz, AC/DC, 0.1 V/A, 30 A (RMS), Rohde & Schwarz probe interface	R&S®RT-ZC15B	1409.8227.02
100 MHz, AC/DC, 0.1 V/A, 30 A (RMS), BNC interface	R&S®RT-ZC20	1409.7766.02
100 MHz, AC/DC, 0.1 V/A, 30 A (RMS), Rohde & Schwarz probe interface	R&S®RT-ZC20B	1409.8233.02
120 MHz, AC/DC, 1 V/A, 5 A (RMS), BNC interface	R&S®RT-ZC30	1409.7772.02
EMC near-field probe		
Probe set for E and H near-field measurements, 30 MHz to 3 GHz	R&S®HZ-15	1147.2736.02
Logic probe [10]		
400 MHz logic probe, 8 channels	R&S®RT-ZL04	1333.0721.02
Probe accessories		
Accessory set, for R&S®RT-ZP11 passive probe (2.5 mm probe tip)	R&S®RT-ZA1	1409.7566.02
Probe power supply, for R&S®RT-ZC10/-ZC20/-ZC30 current probes	R&S®RT-ZA13	1409.7789.02
External attenuator 10:1, 2.0 GHz, 1.3 pF, 60 V DC, 42.4 V AC (peak), for R&S®RT-ZD20/-ZD30 probes	R&S®RT-ZA15	1410.4744.02
Probe pouch for the logic probes	R&S®RT-ZA19	1335.7875.02
Power deskew and calibration test fixture	R&S®RT-ZF20	1800.0004.02
3D positioner with central tensioning knob for easy clamping and positioning of probes (span width: 200 mm, clamping range: 15 mm)	R&S®RT-ZAP	1326.3641.02
Choose your accessories		
Front cover	R&S®MXO4-Z1	1335.4360.02
Soft case	R&S®MXO4-Z3	1335.5589.02
Transit case	R&S®MXO4-Z4	1335.5595.02
Rackmount kit, for MXO 4 oscilloscopes with 6 HU	R&S®ZZA-MXO4	1335.5108.02
VESA mount (compatible with standard 100 mm × 100 mm pattern)	Choose industry standard mounts	

Warranty and service

Warranty		
Base unit		3 years
All other items		1 year
Service options		
	Service plans	**On demand**
Calibration	up to five years [11]	pay per calibration
Warranty and repair	up to five years [11]	standard price repair
Contact your Rohde & Schwarz sales office for further details.		

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[10] The R&S®MXO4-B1 mixed signal option contains two R&S®RT-ZL04 logic probes.

[11] For extended periods, contact your Rohde & Schwarz sales office.

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