

VXI HF Receiver R&S®EM 010

Efficient and versatile solution for radiomonitoring systems

The R&S®EM 010 is a DSP-based VXI HF receiver of advanced design for the frequency range 300 Hz to 30 MHz. It is a key component and integral part of the R&S®AMMOS® radiomonitoring and analysis systems from Rohde & Schwarz.

Excellent RF characteristics plus powerful signal processors create the prerequisites for optimum system solutions.

- ◆ System compatibility on a variety of platforms
- ◆ Only one single C-size module for covering the total frequency range
- ◆ Suitable for all common reconnaissance methods
- ◆ Frequency and memory scan
- ◆ Excellent price/performance ratio



ROHDE & SCHWARZ

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The receiver operates in the following modes:

- ◆ Fixed frequency mode (FFM)
- ◆ Memory scan mode
- ◆ Frequency scan mode
- ◆ Replay (IF) and playback mode
- ◆ Selftest

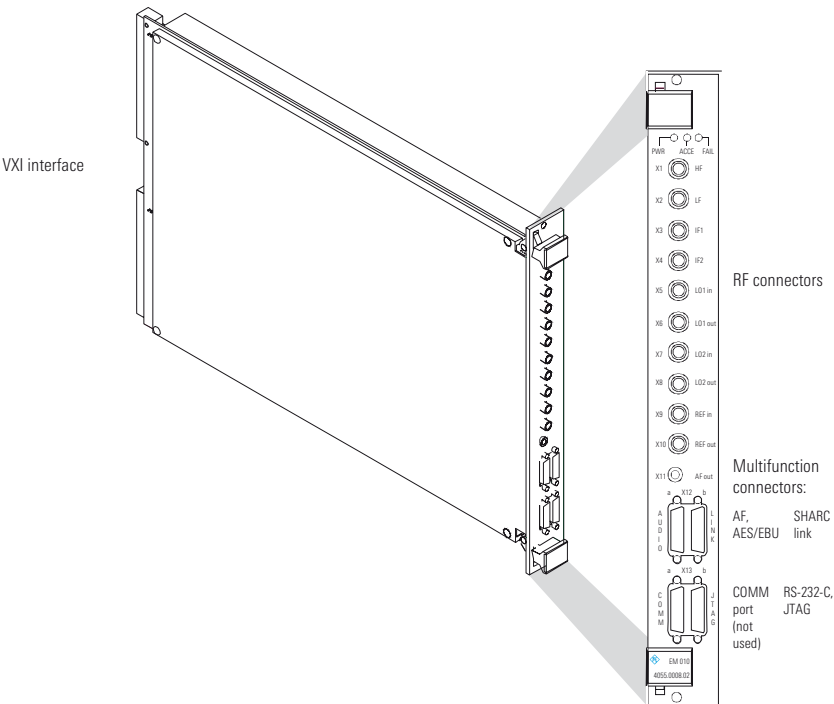
Data can be output in the following formats:

- ◆ Baseband signal (I and Q) in digital form, bandwidth 20 kHz
- ◆ IF1: IF in analog form (40.048 MHz \pm 2 MHz)
- ◆ IF2: IF in analog form (455 kHz) or 0 Hz to 40 kHz, selectable
- ◆ AES/EBU for recording and replay of IF data
- ◆ AF digital
- ◆ AF analog (600 Ω line and headphones)

The VXI HF Receiver R&S®EM 010 is based on the long-standing experience of Rohde & Schwarz in the design of high-end shortwave receivers. Since the receiver is a VXI unit, it allows powerful, compact and flexible system solutions to be created. Owing to the use of modern signal processors, filtering, demodulation and data formats can be tailored to the signal scenario.

The receiver is controlled via the VXI interface as standard with binary control based on the OSI Common Management Information Service Element (CMISE) Standard.

The baseband data is output via VXI or SHARC link port.



VXI HF Receiver R&S®EM 010 with main interfaces

Operating modes and control

Fixed frequency mode

The fixed frequency mode is the standard mode of the receiver. A fixed frequency is set at which the signal is received, filtered and demodulated.

The following parameters can be set:

- ◆ Frequency: can be set in 1 Hz steps in the range 10 kHz to 30 MHz (300 Hz to 30 MHz with option R&S®EM 010LF)
- ◆ Demodulation mode: AM, FM, USB, LSB, CW, ISB
- ◆ Bandwidth: IF bandwidths are valid for the analog IF output and the AF; selectable in 70 steps between 52 Hz and 20 kHz
- ◆ BFO frequency: can be set in 1 Hz steps in the frequency range ± 10 kHz
- ◆ Squelch: either syllabic or level squelch can be selected (level squelch settable in 1 dB steps in the range -20 dBuV to $+100$ dBuV)
- ◆ Preamplifier: can be switched on or off
- ◆ Gain control: automatic (AGC) or manual (MGC) gain control can be selected (with AGC, the hold time can be set in steps of 10/20/50/100/200/500/1000/5000/9000 ms; in the case of reception via the VLF input, only MGC can be used); for setting ranges see page 7
- ◆ Notch filter: two notch filters can be selected independently of each other (stopband limits settable in 1 Hz steps from 50 Hz to 500 Hz, which are converted in the receiver to 28 steps; the minimum stopband attenuation is 40 dB with 80 Hz filter bandwidth)

Memory scan mode

In the memory scan mode, receiver settings can be programmed for monitoring up to 1000 channels. These channels can be scanned with the Memory Scan command. A single channel can be called with the Recall command.

The squelch level serves as a criterion for dwelling at the same frequency or for switching to the next channel. If the level criterion is met, the receiver waits for the selectable dwell time to elapse before it switches to the next channel.

Parameters selectable for each channel:

- ◆ Memory location
- ◆ Frequency
- ◆ Demodulation mode
- ◆ Bandwidth
- ◆ BFO frequency
- ◆ IF path
- ◆ IF shift
- ◆ Squelch parameters

The Continue command can be used for switching to the next channel before the dwell time has elapsed.

Frequency scan mode

In the frequency scan mode, a lower and upper limit and the step width are defined for monitoring a specific frequency range. The frequency range is then scanned with the Frequency Scan command.

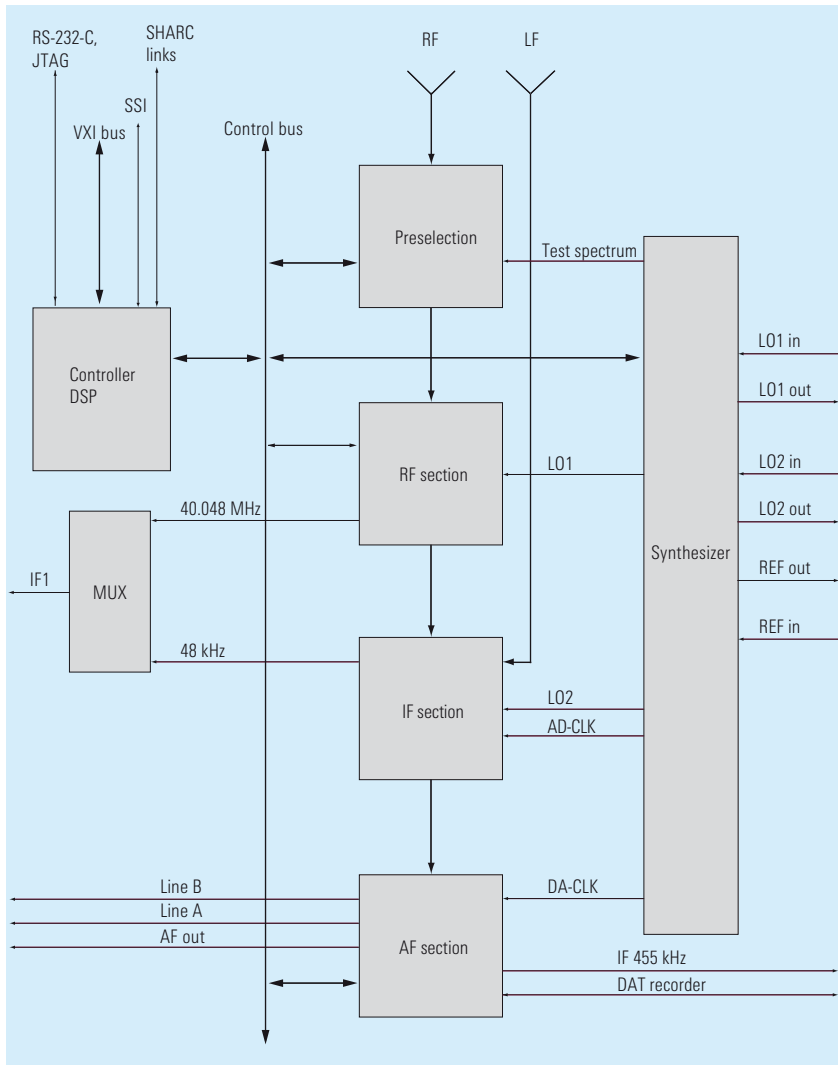
The squelch level serves as a criterion for dwelling at the same frequency or for switching to the next. If the signal level exceeds the threshold, the receiver waits for the set dwell time to elapse and then switches to the next frequency. The demodulator settings are fixed for the defined search range.



In this case too, the Continue command can be used for switching to the next channel before the dwell time has elapsed.

Replay and playback mode

In the replay mode, data can be fed in at the VXI interface, e.g. for further processing with a different bandwidth or demodulation mode. In the playback mode, the signal from the AES/EBU interface can be processed.



Block diagram of the VXI HF Receiver R&S®EM 010

Selftest

In the fixed frequency mode, a comprehensive selftest can be performed. The test can be carried out in full or in a shorter version where only Go or Nogo is issued.

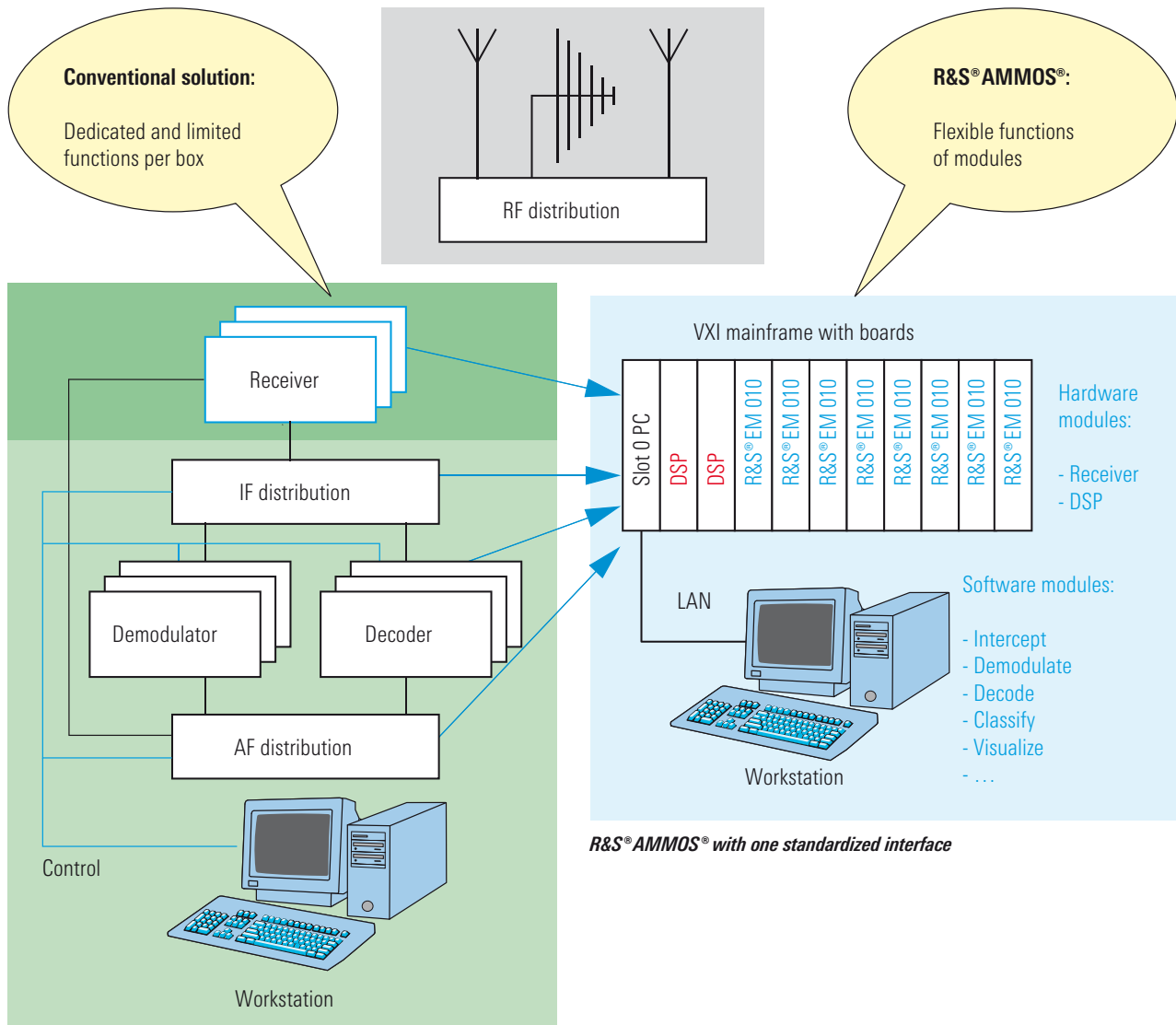
Design

Control and signal processing are performed by two signal processors on the controller board.

All functional units are accommodated on printed boards. Milled and screw-connected shielding covers ensure excellent electromagnetic compatibility even in critical environments.

Use in VXI systems for radiomonitoring with R&S® AMMOS®

Comparison of previous radiomonitoring systems and R&S® AMMOS®



Previously: many different, highly specialized interfaces

The radiomonitoring and analysis system R&S® AMMOS® (automatic modular monitoring of signals) from Rohde & Schwarz can be adapted by users to carry out specific radiomonitoring tasks (for internal and external security) as well as spectrum management tasks.

The system is suitable for strategic and tactical intelligence alike. It can be used in search and signal production as well as in technical signal analysis. R&S® AMMOS® provides unique radiomonitoring and technical signal analysis solutions for voice and data transmission.

Previous monitoring systems consisted of a variety of special units with different tasks and functions. The customized software allowed only rigid workstation configurations with fixed cabling, whereas R&S® AMMOS® features versatile functions. The use of standard hardware components in conjunction

with a set of flexible standard software modules enables the R&S® AMMOS® system to perform a large variety of tasks for interception, analysis, demodulation, decoding, and visualization of signals on the workstation.

Configuration of an R&S® AMMOS® radiomonitoring system

A system comprises the following VXI modules:

- ◆ Mainframe
- ◆ Controller
- ◆ Narrowband and broadband HF and VHF/UHF receivers
- ◆ DSP boards
- ◆ Software modules for controlling the receivers and for demodulation, decoding and further analysis of analog and digital signals, as well as fully automatic interception
- ◆ R&S® AMMOS® IT as remote-control software for the total system (external workstation)



Configuration example of an R&S® AMMOS® sensor group (including controller) with R&S® AMMOS® remote-control software, consisting of two DSP boards and eight HF Receivers R&S® EM 010 (fully equipped)

Specifications

Frequency	
Input frequency ranges	10 kHz to 30 MHz (10 kHz to 1.5 MHz with reduced specs) ¹⁾ 300 Hz to 60 kHz via separate input (optional)
Frequency spacing	1 Hz
Frequency stability (internal reference)	$\leq 10^{-7}$ in operating temperature range $\leq 10^{-7}$ aging/year (after 30 days of operation)
Phase noise	≤ -110 dBc (1 Hz) (1 kHz offset) typ. -114 dBc (1 Hz) (1 kHz offset)
External frequency locking	10 MHz 0 dBm ± 10 dB from 50 Ω source
Tuning	
Tuning time	≤ 10 ms (bandwidth 20 kHz) ²⁾ ≤ 25 ms (delay of AF at 3 kHz IF bandwidth)
Synthesizer setting time	≤ 5 ms, user-selectable ≤ 1 ms, ≤ 100 kHz
Antenna input	
Nominal impedance	50 Ω
VSWR	≤ 2 , peaks up to max. 3.0
Maximum input level	+7 dBm
Overvoltage protection	≤ 50 V EMF ($Z_{in} = 50 \Omega$)
Preselection	10 kHz to 1.5 MHz: one switched broadband filter 1.5 MHz to 30 MHz: eight switched suboctave filters ³⁾ 10 kHz to 30 MHz: one switched broadband filter
Noise figure ⁴⁾	≤ 10 dB, typ. 8 dB (with preamplifier, 1 MHz to 20 MHz) ≤ 11 dB, typ. 9 dB (with preamplifier, 20 MHz to 30 MHz) ≤ 20 dB, typ. 17 dB (without preamplifier 0.1 MHz to 20 MHz) ≤ 21 dB, typ. 18 dB (without preamplifier, 20 MHz to 30 MHz)
Linearity	
2nd order intercept point ⁵⁾	with suboctave filters of preselection (1.5 MHz to 30 MHz): ≥ 75 dBm, typ. 90 dBm (preamplifier off) ≥ 70 dBm, typ. 90 dBm (preamplifier on) with broadband filter of preselection (300 kHz to 1.5 MHz or 300 kHz to 30 MHz) ≥ 50 dBm, typ. 70 dBm (preamplifier off) ≥ 30 dBm, typ. 50 dBm (preamplifier on)
3rd order intercept point ⁶⁾	≥ 35 dBm, typ. 40 dBm (preamplifier off, 1.5 MHz to 30 MHz) ⁷⁾ ≥ 27 dBm, typ. 33 dBm (preamplifier off, 0.2 MHz to <1.5 MHz) ≥ 22 dBm, typ. 26 dBm (preamplifier on, 1.5 MHz to 20 MHz) ≥ 19 dBm, typ. 23 dBm (preamplifier on, 20 MHz to 30 MHz) ≥ 17 dBm, typ. 23 dBm (preamplifier on, 0.5 MHz to <1.5 MHz)

Crossmodulation	a 30% AM-modulated signal of 6 dBm produces less than 10% crossmodulation for an unmodulated signal of -60 dBm (frequency offset 100 kHz)
Blocking	a useful signal of -52 dBm is attenuated by less than 3 dB by an unmodulated signal of 23 dBm (frequency offset 59 kHz)
Dynamic range of A/D converter	16 bit resolution
Interference rejection	
Image frequency rejection	≥ 100 dB, typ. 120 dB (suboctave filter and broadband filter)
IF rejection	≥ 100 dB, typ. 110 dB (suboctave filter and broadband filter)
Oscillator reradiation at antenna input	≤ -107 dBm, typ. -115 dBm
Spurious responses 30 kHz to 30 MHz	≤ -110 dBm
Gain control	AGC or MGC
RF control (antenna input) AGC range AGC time constants Attach time MGC range RF control (LF input) MGC range No AGC available	≥ 30 dB, typ. 40 dB ≤ 2 ms (20 dB step) ≥ 30 dB, nominal 40 dB in 1 dB steps 30 dB, in 10 dB steps
Overall control antenna input (analog narrowband IF) AGC range AGC time constants Attack time Hold time (incl. decay) MGC range Overall control LF input (analog narrowband IF) MGC range	110 dB ≤ 2 ms (60 dB step) 10/20/50/100/200/500 ms/1/5/9 s for 60 dB roll-off 110 dB in 1 dB steps 110 dB in 1 dB steps
Squelch	syllabic, level squelch selectable above 120 dB in 1 dB steps
Filter	
Analog IF filter 3 dB bandwidth Inband ripple	≥ 20 kHz ≤ 2 dB ($B = 8$ kHz)
Digital IF filter 3 dB bandwidths Stopband attenuation Shape factor (60 dB/6 dB) Inband ripple	52 Hz to 20 kHz in 70 steps ≥ 90 dB ≤ 1.5 (with bandwidths above 300 Hz) typ. 0.5 dB (without ripple of analog IF filter)
Notch filter Stopband Stopband attenuation Shape factor (40 dB/1 dB)	max. 2, selectable in baseband, separately adjustable in 1 Hz steps 28 steps in range 50 Hz to 500 Hz, automatic selection at any frequency in 1 Hz steps ≥ 40 dB at BW = 80 Hz typ. 1.53

Demodulation	
Demodulation modes	AM, FM, USB, LSB, CW ISB (bandwidth 2.8 kHz)
AF bandwidth	0.3 kHz to 6 kHz
Tuning aid	32-point FFT, output via data interface, matched to selected bandwidth
Level measurement	
Measurement accuracy (0.1 MHz to 30 MHz without preamplifier, 1 MHz to 30 MHz with preamplifier)	±3 dB input level in IF bandwidth RMS value; selectable averaging time
Output resolution	0.01 dB
Sensitivity	
0.1 MHz to 30 MHz without preamplifier, 1 MHz to 30 MHz with preamplifier (with external CCITT filter)	
AM ($m = 50\%$, $f_{\text{mod}} = 1000$ Hz, bandwidth 6 kHz)	–111 dBm for $(S+N)/N \geq 10$ dB with preamplifier –102 dBm for $(S+N)/N \geq 10$ dB without preamplifier
FM (5 kHz deviation, $f_{\text{mod}} = 400$ Hz, bandwidth 14.4 kHz)	–106 dBm for $(S+N)/N \geq 25$ dB with preamplifier –100 dBm for $(S+N)/N \geq 25$ dB without preamplifier
CW (bandwidth 313 Hz, BFO: 1 kHz)	–126 dBm for $(S+N)/N \geq 10$ dB with preamplifier –117 dBm for $(S+N)/N \geq 10$ dB without preamplifier
SSB (bandwidth 2.75 kHz, $f_{\text{mod}} = 1000$ Hz)	–120 dBm for $(S+N)/N \geq 10$ dB with preamplifier –111 dBm for $(S+N)/N \geq 10$ dB without preamplifier
Sensitivity of LF input (option) $f = 10$ kHz, CW (bandwidth 313 Hz)	3 dB μ V (corresponds to –114 dBm into 600 Ω) for $(S+N)/N = 10$ dB and LF gain = 30 dB
BFO	settable in range ±10 kHz in 1 Hz steps, can be switched off
Broadband mode (RF input → IF1 output)	
The narrowband function/demodulation of the receiver is deactivated in narrowband mode.	
Frequencies (RF)	input receive range of center frequency: 10 kHz + B/2 to 30 MHz – B/2 ³⁾
Frequencies (IF1)	center frequency: 40.048 MHz bandwidth: B ≤ 4 MHz (inverted) ³⁾
VSWR (IF1)	≤2.5 (40.048 MHz ±2 MHz)
Image frequency rejection	≥90 dB, typ. 110 dB
IF rejection	≥95 dB, typ. 105 dB
Spurious responses referenced to RF input	≤–110 dBm (B ≤ 1 MHz) ≤–108 dBm, typ. –113 dBm (B ≤ 4 MHz)
Interference signals outside useful bandwidth	
1st LO	typ. –20 dBm (above useful bandwidth)
1st LO + F _{use}	level similar to useful signal level
Gain RF – IF1	typ. –10 dB (without preamplifier) typ. 1 dB (with preamplifier)
Noise figure	typ. 10 dB (without preamplifier) typ. 6 dB (with preamplifier)
Linearity (IP2, IP3)	see specs under narrowband mode

Scan functions	
Memory scan	1000 programmable channels
Frequency scan	start frequency – stop frequency – step size
Power supply	
Supply voltages	+24 V DC, max. 20 mA +12 V DC, max. 1500 mA –12 V DC, max. 240 mA +5 V DC, max. 2500 mA
Total power consumption	typ. 34 W
Inputs/outputs	
Inputs	
HF	10 kHz to 30 MHz, impedance 50 Ω (SMA)
LF	300 Hz to 60 kHz, impedance 600 Ω (SMA)
1st LO	40.058 MHz to 70.048 MHz (SMA) level: 0 dBm ± 3 dB (impedance 50 Ω)
2nd LO	40 MHz (SMA) level: 0 dBm ± 3 dB (impedance 50 Ω)
10 MHz reference	input impedance 250 Ω (SMA) level: 0 dBm ± 10 dB from 50 Ω source
Outputs	
IF0 (software-configurable)	baseband digital I and Q (VXI) (32 ksample/s) AF digital (VXI) (16 ksample/s)
IF1 (SMA)	broadband mode if this output is used: center frequency: 40.048 MHz bandwidth: B ≤ 4 MHz (inverted) ³⁾ impedance 50 Ω (SMA)
IF2 (software-configurable, SMA)	IF analog, 455 kHz regulated (15 kHz band- width) or IF analog regulated, frequency 0 Hz to 40 kHz, selectable
1st LO	40.058 MHz to 70.048 MHz (SMA) level: 0 dBm ± 3 dB (impedance 50 Ω)
2nd LO	40 MHz (SMA) level: 0 dBm ± 3 dB (impedance 50 Ω)
10 MHz reference	level: 0 dBm ± 3 dB sine (impedance 50 Ω), SMA
AES/EBU AF line	32 ksamples/s 600 Ω balanced (26-pin AMPLIMITE .050 series)
AM, CW, SSB FM	0 dBm ± 3 dB (modulation depth at AM: 50%) 0 dBm ± 3 dB (frequency deviation 2.5 kHz) at bandwidths >6 kHz
AF phone (3.5 mm jack)	8 Ω load resistor, 0 V to 3 V V _{pp}
Control data interfaces	VXI (meets VXI standard IEEE 1155-1992)
AUDIO	26-pin AMPLIMITE .050 series
COMM (not used)	26-pin AMPLIMITE .050 series
RS-232-C, JTAG	26-pin AMPLIMITE .050 series
Displays	status LED "FAILED" LED "VXI bus active" LED "POWER"

General data

Operating temperature range	0 °C to +50 °C
Permissible temperature range	-10 °C to +55 °C
Storage temperature range	-40 °C to +75 °C
Shock	30 g, 11 ms EN 60068-2-27- MIL-PRF-28800F, 40 g shock spectrum
Vibration	
Sine	5 Hz to 55 Hz, 0.15 mm amplitude
Random	IEC 68-2-36, 10 Hz to 300 Hz, 1.2 g (rms)
Relative humidity	50% to 95% at +25 °C to +40 °C, non-condensing
EMC	EN 300339
Weight	1.75 kg
MTBF	≥10 000 h to MIL-HDBK, ≥70 000 h to ISO 1709

¹⁾ Warrantied data is specified separately.

²⁾ Level deviation ±1 dB.

³⁾ At range limits of suboctave filters, the wide useful IF may be limited.
Remedy: switch on broadband input filter (10 kHz to 30 MHz).

⁴⁾ Values apply in the range +10 °C to +30 °C.

A 1 dB higher limit value applies in the full range -10 °C to +55 °C.

⁵⁾ Test level: without preamplifier: 2 × 0 dBm; with preamplifier: 2 × -10 dBm.

⁶⁾ Frequency spacing between intermodulated signals ≥30 kHz.
Test level: without preamplifier: 2 × 0 dBm; with preamplifier: 2 × -10 dBm.

⁷⁾ Limited frequency range: 2.5 MHz to 30 MHz in temperature range 0 °C to +10 °C.

Ordering information

Designation	Type	Order No.
VXI HF Receiver	R&S®EM 010	4055.0008.03
LF Receiver (option) 300 Hz to 60 kHz	R&S®EM 010LF	4055.0014.02
VXI Mainframe	R&S®GX 400VM	4056.9509.02
VXI Controller	R&S®GX 400VC	4056.9896.02
VXI Platform Software	R&S®GX 400PS	4057.0305.02
Tuner Software for controlling VXI HF Receivers R&S®EM 010	R&S®GX 400RX	4056.9209.02



More information at
www.rohde-schwarz.com
(search term: EM010)



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