VXI HF Receiver EM 010

Efficient and versatile solution for radiomonitoring systems

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

Excellent RF characteristics paired with 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

Description of VXI HF Receiver EM010

The VXI HF Receiver EM010 is based on the long-standing experience of Rohde & Schwarz in the design of high-end short-wave receivers. Since the receiver is a VXI unit, it allows powerful, compact and flexible system solutions to be created. Thanks 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. Control can optionally be performed via the C40 COMM port.

The baseband data can be output via VXI or via the C40 COMM port (option).

The receiver operates in the following modes:

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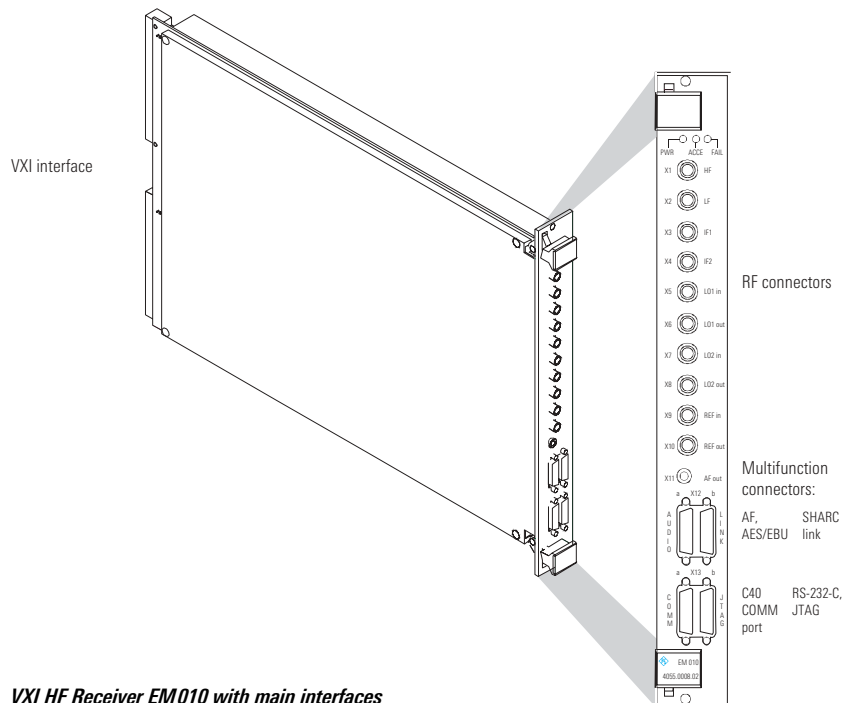◆ Frequency scan mode
◆ Replay (IF) and playback mode
◆ Selftest

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 ±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 head-phones)

VXI HF Receiver EM010 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 EM010LF)
- **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 and 9000 ms; with 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 or the C40 COMM 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.
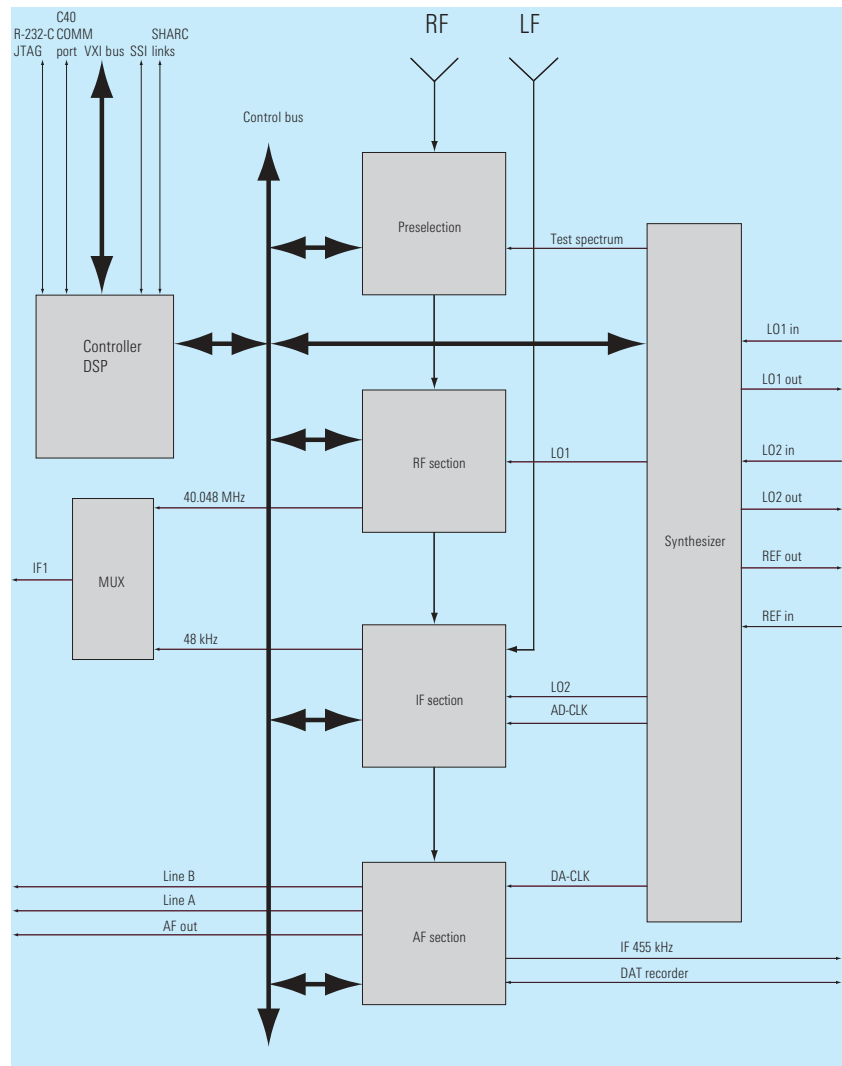
Selftest

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 is performed by two signal processors on the controller board.

All functional units are accommodated on PCBs. Milled and screwed-on shielding covers ensure excellent electromagnetic compatibility even in critical environments.

C40
R-232-C COMM SHARC
JTAG port VXI bus SSI links

RF   LF

Control bus

Preselection

Test spectrum

LO1 in

LO1 out

Controller DSP

LO2 in

RF section   LO1   LO2 out

40.048 MHz   Synthesizer   REF out

IF1   MUX   REF in

48 kHz

IF section   LO2
AD-CLK

Line B   DA-CLK

Line A

AF out   AF section

IF 455 kHz

DAT recorder

Block diagram of VXI HF Receiver EM010

Use in VXI systems for radiomonitoring with AMMOS

Comparison of previous radiomonitoring systems and AMMOS

Conventional solution:

Dedicated and limited functions per box

AMMOS:

Flexible functions of modules

RF distribution

Receiver

IF distribution

Demodulator

Decoder

AF distribution

Control

Workstation
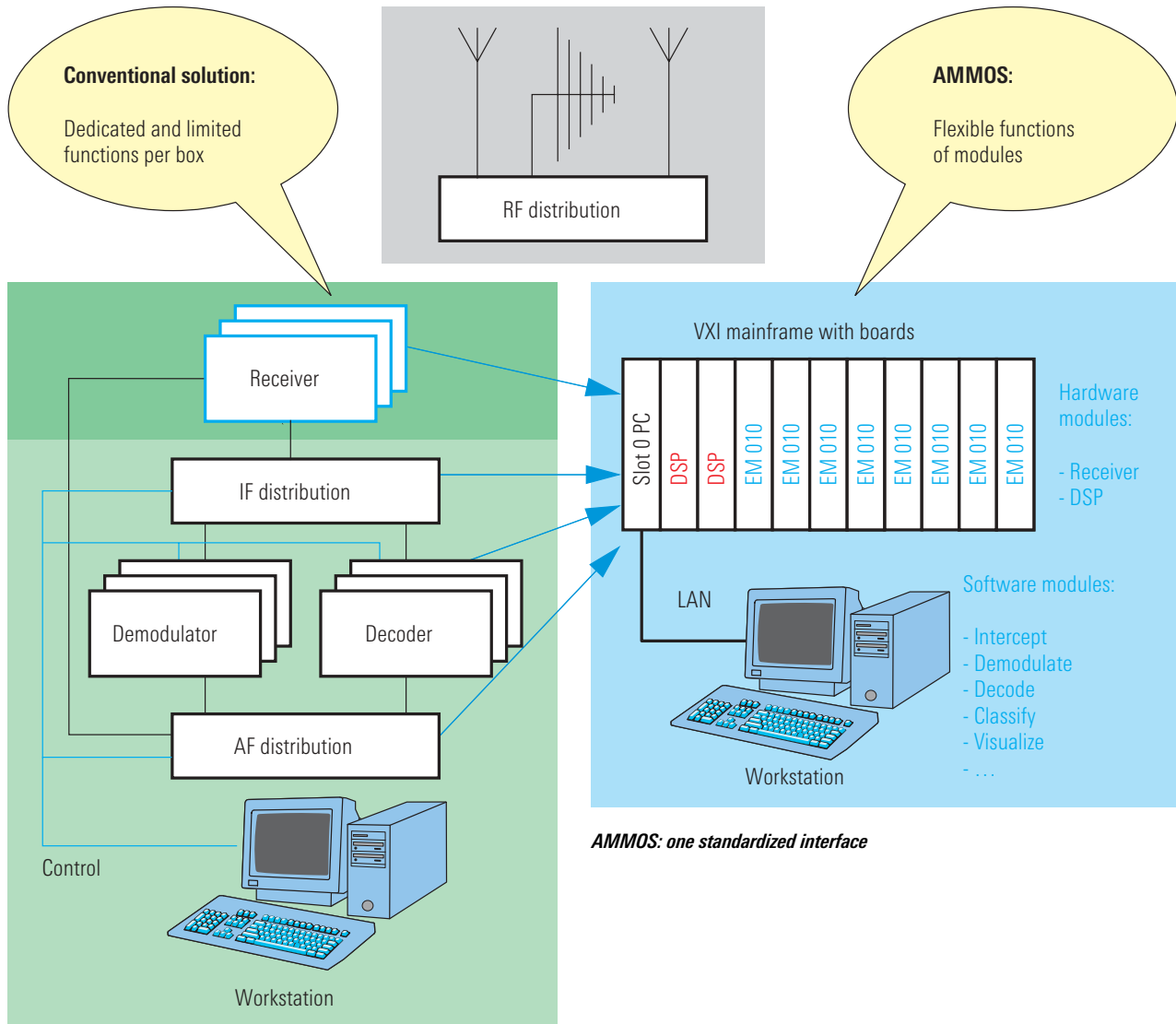
Previously: many different, highly specialized interfaces

VXI mainframe with boards

Slot 0 PC | DSP | DSP | EM 010 | EM 010 | EM 010 | EM 010 | EM 010 | EM 010 | EM 010

Hardware modules:

- Receiver
- DSP

LAN

Software modules:

- Intercept
- Demodulate
- Decode
- Classify
- Visualize
- …

Workstation

AMMOS: one standardized interface

The radiomonitoring and analysis system 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. AMMOS provides unique radiomonitoring and technical signal analysis solutions for voice and data transmission.

Previous monitoring systems consisted of a variety of special individual units with different tasks and functions. The customized software allowed only rigid workstation configurations with fixed cabling, whereas AMMOS features versatile functions: the use of standard hardware components in conjunction with a set of flexible standard software modules enables

the AMMOS system to perform a large variety of tasks for interception, analysis, demodulation, decoding, and visualization of signals on the workstation.

Configuration of an 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
◆ AMMOS-IT as remote-control software for the total system (external workstation)

Configuration example of AMMOS sensor group (including controller) with AMMOS remote-control software, consisting of 2 DSP boards and 8 HF Receivers EM010 (fully equipped)

Specifications

Frequency

Frequency range	10 kHz to 30 MHz (10 kHz to 1.5 MHz with reduced specs) 300 Hz to 60 kHz via separate input (optional)
Frequency spacing	1 Hz
Frequency stability (internal reference)	$\leq 1 \times 10^{-7}$ in operating temperature range
Phase noise	$\leq$–110 dBc (1 Hz) (1 kHz offset)
External frequency locking	10 MHz

Tuning

Tuning time	$\leq$10 ms (bandwidth 20 kHz)[1] $\leq$25 ms (delay of AF at 3 kHz IF bandwidth)
Synthesizer setting time	$\leq$5 ms

Antenna input

Nominal impedance	50 Ω
VSWR	$\leq$2, peaks up to 2.5 max.
Maximum input level	+7 dBm
Overvoltage protection	$\leq$50 V EMF (Z_{in} = 50 Ω)
Preselection	8 switchable suboctave filters
Noise figure[2]	$\leq$10 dB, 8 dB typ. (with preamplifier, 0.1 MHz to 20 MHz) $\leq$11 dB, 9 dB typ. (with preamplifier, 20 MHz to 30 MHz) $\leq$20 dB, 17 dB typ. (without preamplifier 0.1 MHz to 20 MHz) $\leq$21 dB, 18 dB typ. (without preamplifier, 20 MHz to 30 MHz)

Linearity

2nd order intercept point	$\geq$85 dBm, 90 dBm typ. (preamplifier off) $\geq$75 dBm, 90 dBm typ. (preamplifier on)
3rd order intercept point[3]	$\geq$35 dBm, 40 dBm typ. (preamplifier off, 1 MHz to 30 MHz) 24 dBm typ. (preamplifier off, 0.1 MHz/0.13 MHz) $\geq$22 dBm, 26 dBm typ. (preamplifier on, 1 MHz to 20 MHz) $\geq$19 dBm, 23 dBm typ. (preamplifier on, 20 MHz to 30 MHz) 16 dBm typ. (preamplifier on, 0.1 MHz/0.13 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 –60 dBm is attenuated by less than 3 dB by an unmodulated signal of 6 dBm (frequency offset 100 kHz)

Dynamic range of A/D converter	16 bit resolution

Interference rejection

Image frequency rejection	$\geq$90 dB, 120 dB typ.
IF rejection	$\geq$100 dB, 110 dB typ. (with suboctave filter)
Oscillator reradiation at antenna input	$\leq$–90 dBm, –115 dBm typ.
Spurious responses	$\leq$–110 dBm (max. 3 exceptions with $\leq$–100 dBm)

Gain control	AGC or MGC
RF control AGC range AGC time constants Attack time MGC range	$\geq$30 dB, 40 dB typ. $\leq$2 ms (20 dB step) $\geq$30 dB, nominal 40 dB in 1 dB steps
Overall control (analog narrowband IF) AGC range AGC time constants Attack time Hold time (incl. decay) MGC range	110 dB $\leq$2 ms (60 dB step) 10/20/50/100/200/500 ms/1/5/9 s for 60 dB rolloff 110 dB in 1 dB steps
Squelch	syllabic, level squelch selectable above 120 dB in 1 dB steps

Filters

Analog IF filter 3 dB bandwidth Inband ripple	$\geq$20 kHz $\leq$2 dB (BW = 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 $\geq$90 dB $\leq$1.5 (with bandwidths above 300 Hz) 0.5 dB typ. (without ripple of analog IF filter)
Notch filter Stopband Stopband attenuation Shape factor (40 dB/1 dB)	2 max., 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 $\geq$40 dB at BW = 80 Hz 1.53 typ.

Demodulation

Demodulation modes	AM, FM, USB, LSB, CW ISB (bandwidth 2.8 kHz)
AF spectrum	0.3 kHz to 6 kHz

Tuning aid	32-point FFT, output via data interface, matched to selected bandwidth
Sensitivity (0.1 MHz to 30 MHz)	
AM (m = 50%, f_{mod} = 1000 Hz, bandwidth 6 kHz)	−100 dBm for (S+N)/N = 16 dB with preamplifier −100 dBm for (S+N)/N = 8 dB without preamplifier
FM (5 kHz deviation, f_{mod} = 400 Hz, bandwidth 14.4 kHz)	−95 dBm for (S+N)/N = 26 dB with preamplifier −95 dBm for (S+N)/N = 20 dB without preamplifier
CW (bandwidth 313 Hz)	−118 dBm for (S+N)/N = 15 dB with preamplifier −118 dBm for (S+N)/N = 10 dB without preamplifier
SSB (bandwidth 2.75 kHz)	−108 dBm for (S+N)/N = 18 dB with preamplifier −108 dBm for (S+N)/N = 10 dB without preamplifier
Sensitivity of LF input (option) **f = 10 kHz, CW (bandwidth 313 Hz)**	3 dBμV (corresponds to −114 dBm into 600 Ω) for (S+N)/N = 10 dB and LF gain = 30 dB
BFO	settable in the range ±10 kHz in 1 Hz steps, can be switched off
Scan functions	
Memory scan	1000 programmable channels
Frequency scan (sweep)	start frequency − stop frequency, step size according to IF filter
Power supply	
Supply voltages	+24 V DC, 20 mA max. +12 V DC, 1500 mA max. −12 V DC, 240 mA max. +5 V DC, 2500 mA max.
Total power consumption	34 W typ.
Inputs/outputs	

Inputs
  HF
 	
  LF
 	
  1st LO
  2nd LO
  10 MHz reference
	
	10 kHz to 30 MHz, impedance 50 Ω (SMA)
	300 Hz to 60 kHz, impedance 600 Ω (SMA)
	40.058 MHz to 70.048 MHz (SMA)
	40 MHz (SMA)
	SMA

Outputs IF0 (software-configurable)	 baseband digital I and Q (VXI) optional: baseband digital I and Q via C40-Link bandwidth 20 kHz AF digital (VXI, C40-Link (optional)) 16 ksample/s
IF1 (SMA)	broadband 40.048 MHz, bandwidth 4 MHz (when this output is used, the narrowband function/demodulation of the receiver is deactivated)
IF2 (software-configurable, SMA)	IF analog, 455 kHz regulated (15 kHz bandwidth) or IF analog, frequency 0 Hz to 40 kHz, selectable
1st LO	40.058 MHz to 70.048 MHz (SMA)
2nd LO	40 MHz (SMA)
10 MHz reference	SMA
AES/EBU	32 ksample/s
AF line	600 Ω balanced (26-pin AMPLIMITE .050 series)
AM, CW, SSB	0 dBm ± 3dB (modulation depth at AM: 50%)
FM	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	26-pin AMPLIMITE .050 series
LINK	26-pin AMPLIMITE .050 series
JTAG	26-pin AMPLIMITE .050 series
Displays	status LED "FAILED" LED "VXI bus active" LED "POWER"

General data

Operating temperature range	−10°C to +55°C
Storage temperature range	−40°C to +75°C
Shock	30 g, 11 ms DIN IEC68-2-27, 40 g shock spectrum

Vibration
  Sine
  Random
	
	5 Hz to 55 Hz, 0.15 mm amplitude
	DIN IEC68-2-36, 10 Hz to 300 Hz, 1.2 g (rms)

Relative humidity	50% to 95% at +25°C to +40°C, non-condensing
EMC	EN 50081-1/82-2
Weight	1.75 kg
MTBF	≥10 000 h to MIL-HDBK, ≥70 000 h to ISO 1709

[1] Level deviation ±1 dB.
[2] Values apply in the range +10°C to +30°C. A limit value higher by 1 dB applies in the full range from −10°C to +55°C.
[3] Frequency spacing between intermodulated signals ≥30 kHz.

Ordering information

Designation	Type	Order No.
VXI HF Receiver	EM010	4055.0008.03
VXI Mainframe	GX400VM	4056.9509.02
VXI Controller	GX400VC	4056.9896.02
VXI Platform Software	GX400PS	4057.0305.02
Tuner Software to control VXI HF Receivers EM010	GX400RX	4056.9209.02
LF Receiver (option) 300 Hz to 60 kHz	EM010LF	4055.0014.02

Certified Environmental System
ISO 14001
REG. NO 1954

Certified Quality System
ISO 9001
DQS REG. NO 1954

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