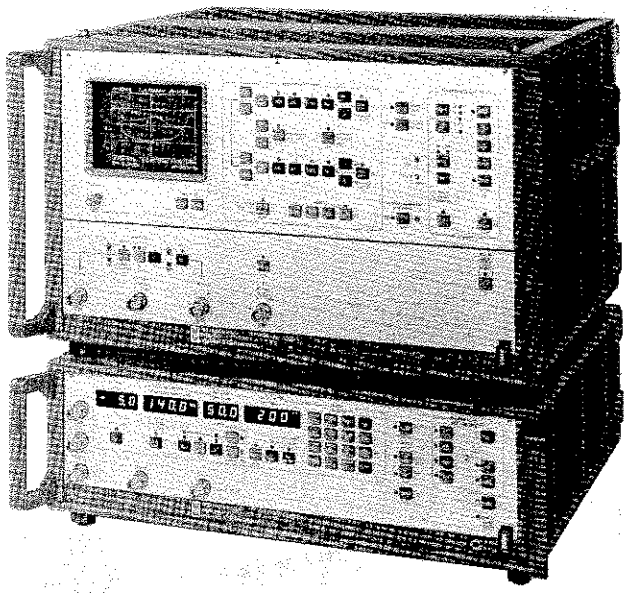
RM-5
Radio-link Measuring Setup 35/70/140 MHz IF

for distortion measurements on radio-link and satellite systems

IEEE 488
IEC 625



- **All standard IFs:**
  70 MHz (basic version), 35 and/or 140 MHz (options)
- **Test frequencies from 25 kHz**
- **Very accurate IF setting, no calibration required**
- **Easy to use: all important data displayed on screen**
- **IF frequency counter for center frequency and sweep limits**
- **Digital noise averaging and normalizer functions**
- **Optional wideband facility for 70 and 140 MHz IFs**
- **Optional facility for calculating intermodulation noise from the results of distortion measurements**
- **Simultaneous display of two INTELSAT tolerance masks possible**
- **IF switch for determination of absolute delay difference**

The exceptional versatility of the RM-5 radio-link measuring setup makes it suitable for testing any radio-link or satellite system.

- Wideband FM radio-links for telephone and TV transmissions:
  The RM-5 has 70 and 140 MHz IFs, test frequencies up to 5.6 MHz and color subcarriers
- Narrow band PM and FM radio-links:
  The RM-5 has 35 and 70 MHz IFs and test frequencies from 25 kHz upwards
- Digital radio-links:
  The RM-5 has 70 and 140 MHz IFs and a wide dynamic range for IF to IF frequency response measurements
- FDMA and TDMA satellite systems:
  The RM-5 has 70 and 140 MHz IFs, test signals from 55.55 kHz and can detect test signals when the C/I ratio is as low as 10 dB. A facility for noise averaging is also fitted.

The RM-5 is specially suitable for test departments, where more rational and flexible test procedures need to be adopted to cope with the increasing number and variety of test items.
All generator and receiver functions can be remote-controlled via a standard IEEE 488/IEC 625 interface so that the RM-5 can easily be incorporated into ATE systems.
An optional wideband facility (modulator/demodulator) is available for white noise loading and for measuring BB to BB frequency response between the IF ports of wideband analog radio-link systems. The necessary pre- and de-emphasis networks are available separately.

Operating the RM-5 is simple, thanks to modern design features. The generator and receiver functions are pushbutton controlled, and the accuracy of the parameters set is extremely high. The RM-5 incorporates some of the best features of older

IF range	70 ±30 MHz
as options	140 ±50 MHz
	and/or 35 ±5 (10) MHz
Seven test frequencies between	25 kHz and 5.6 MHz
Sweep frequencies	18 and 70 Hz

W&G radio-link test sets, such as automatic test frequency deviation correction, gap pulse generation (RMS-5 generator) and automatic test frequency recognition (RME-5 receiver). All of the more important generator parameters are shown clearly on the multidigit 7-segment LED display of the RMS-5. Settings can be made via the keypad or using the up/down step keys. Device settings which are often used can be stored and recalled as required. The memory has back-up battery power, so that data is retained even when the RM-5 is switched off.

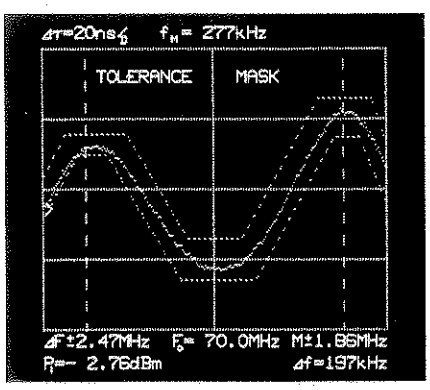
The results of measurements are shown as a trace on the VDU of the RME-5 receiver, along with the relevant parameter settings. This information can be permanently recorded by photographing the display or by printout via a video plotter. Adjustable cursor pairs for the horizontal and vertical axes are provided, which considerably simplifies reading off trace values. The vertical pair is spaced symmetrically to the center line and the indicated frequency difference to the center value is also shown in clear text on the screen. The difference between the horizontal cursors is similarly displayed.

Operation of the complete RM-5 setup is further simplified by the various automatic features built into the RME-5 receiver:

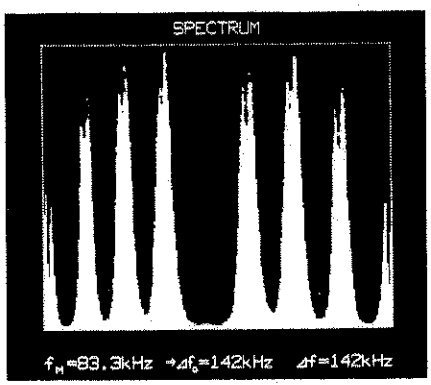
- automatic adjustment to a wide range of IF and BB signal input levels and frequencies, even for signals with high dynamic range,
- pushbutton selection of calibrated ranges for distortion measurements, with instant display of the chosen scale on the screen,
- frequency counter automatically determines the IF signal center frequency and deviation,
- simultaneous display of center frequency IF level and sweep curves,
- automatic display of test signal deviation as a check that correct test conditions are maintained.

Further useful features for display, evaluation and recording of results are provided by the microprocessor controller and VDU of the RME-5:

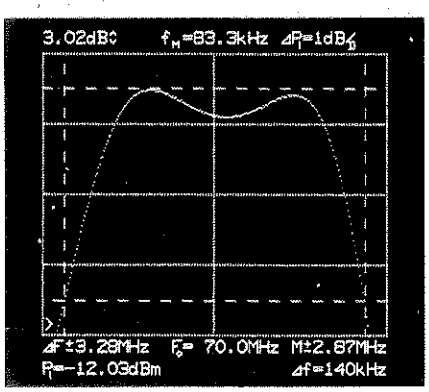
- SLOPE CONTROL corrects the linear frequency response of the setup.
- NORMALIZER function stores a reference curve and automatically calculates and displays the difference between the reference and the measured curve.
- AVERAGING feature smooths out noisy traces. An averaging factor between 2 and 32 can be selected. Use of digital noise averaging is superior to conventional analog techniques, since the fine structure of the signal is not swamped (reducing the test bandwidth causes transient response problems).
- Curve analysis feature displays the linear (LIN) and parabolic (PARAB) components of a distortion measurement between the frequency markers.



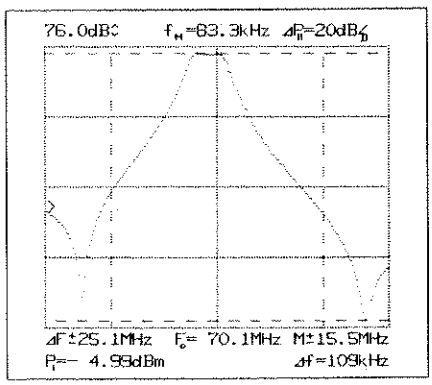
IF filter group delay response. Texts and tolerance masks programmed via the IEEE 488/IEC 625 interface.



Spectrum mode. IF spectrum modulated by 83.3 kHz with IF carrier suppressed (Bessel zeros).



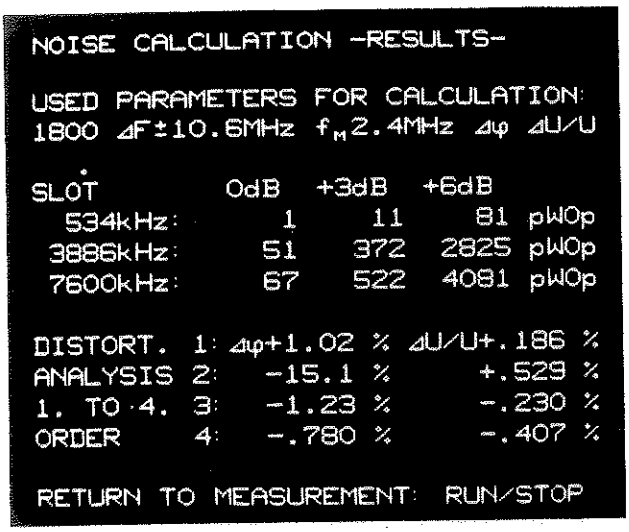
Use of the frequency markers and cursors to determine the 3 dB points of an IF filter.



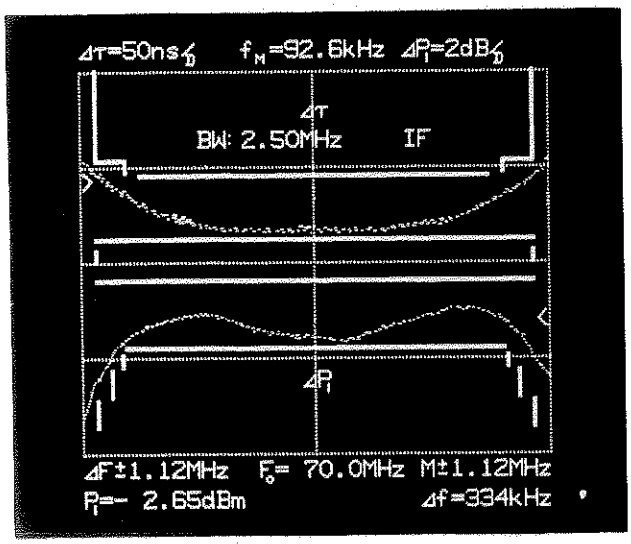
Video plot of the overall loss of an IF filter obtained using the P_H input.

Examples of VDU display and video plots

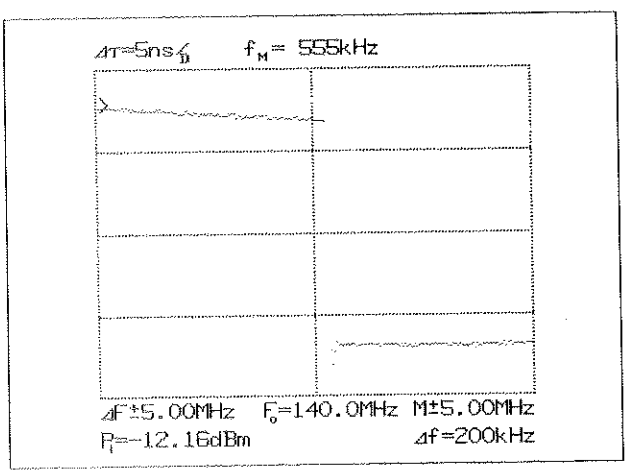
- Horizontal cursors mark a given tolerance band or can be used to display the separation between two lines on the screen.
- Video output, useful for connecting a video plotter for hard-copy of the results or a remote monitor.
- Optional X-Y recorder interface*) provides facilities for recording a complete test protocol which includes the measured curves, measurement range lines (f.s.d.), frequency markers and horizontal cursors as appropriate.
- Optional IEEE 488/IEC 625 interface*) allows computer remote control of all instrument functions (except display brightness) and result evaluation. It is also possible to display tolerance masks instead of the horizontal cursors and to define reference curves for the normalizer function by suitable programming of the computer.
- Optional noise calculation facility**) determines the intermodulation noise in the baseband noise slots from the differential phase distortion ($\Delta\varphi$) and differential gain ($\Delta U/U_0$) measured between the system IF ports.
- Optional INTELSAT tolerance mask facility**) display all IF to IF frequency- and group delay response tolerance masks. It is possible to display a combined result for the transmit and receive paths, or show them separately. Two masks (ΔP and $\Delta\tau$) can be displayed together.



Noise calculation and distortion curve analysis results display



INTELSAT tolerance mask for a carrier bandwidth of 2.5 MHz



Absolute delay difference for RX signal paths in a space diversity receiver station. The video plot shows $\Delta\tau$ to be 13.9 ns. This corresponds to a 2.8 m length of coaxial cable with $\varepsilon_r = 2.3$.

Wideband facility for RM-5

The wideband facility for the RM-5 is a useful accessory for measurements on wideband radio-link systems with IF ports. It allows white noise loading and BB to BB frequency response measurements to be made at the IF level.
It consists of a wideband modulator option for the RMS-5 generator and the RMED-5 wideband demodulator, which is a stand-alone instrument. The RMED-5, which comprises two 19" units, can be used for certain monitoring tasks in repeater stations, leaving the RME-5 receiver free for other tasks.

Absolute delay difference measurement for space diversity receivers

The absolute delays of the receive paths in systems which use space diversity and combination techniques to counteract the effects of multipath distortion must be equal. Due to the different antenna and receiver arrangements, it is generally necessary to make adjustments when lining up the system to equalize the delays. The usual method for systems where the signals are combined at the IF levels is to insert a section of coaxial cable of appropriate length in the path having the shorter absolute delay. The absolute delay difference can be easily determined using the RM-5 with a RMES-5 IF switch. This alternately connects the two IF receive paths to the RME-5 input. The switching rate is the same as the sweep rate used for the group delay measurement. The difference between the two group delays thus displayed represents the absolute delay difference, from which the length of cable required for compensation can easily be calculated. Since the power supply and switching signals for the RMES-5 are drawn from the RME-5, a separate dc power supply and function generator are not needed. The RMES-5 has a very short switching time, so that the automatic test frequency recognition facility of the RME-5 receiver can still be used.

*) The X-Y plotter interface and IEEE 488 interface cannot both be fitted.
**) The noise calculation and INTELSAT tolerance mask options cannot both be fitted.

If not otherwise stated, the data is valid in the nominal range of use for the a.c. line voltage, the a.c. line frequency and the ambient temperature. For test frequencies f_M of 25 and 50 kHz or 27.778 and 55.556 kHz, the sweep frequency f_A = 18 Hz should be used. With the 35 MHz IF option the highest test frequency is 500 or 555.556 kHz.

IF and BB distortion measurements

The data applies to the whole IF input-level range P_I from −20 to + 10 dBm, and to the IF ranges 70 MHz (standard) and 35 MHz and 140 MHz (options), or to the whole BB input-level range from −50 to −10 dBm. All measurement ranges are displayed over the full height of the screen.

Group delay distortion "$\Delta\tau$" (f_M <1 MHz)
Measurement ranges:
f_M = 500 or 555.556 kHz . . . . . 0.8, 2, 4, 8, ..., 80 ns
f_M = 250 or 277.778 kHz . . . . . 1.6, 4, 8, 16, ..., 160 ns
f_M = 83.3 or 92.593 kHz . . . . . 4, 10, 20, 40, ..., 400 ns
f_M = 50 or 55.556 kHz . . . . . 8, 20, 40, 80, ..., 800 ns
f_M = 25 or 27.778 kHz . . . . . 16, 40, 80, 160, ..., 1600 ns
Max. sensitivity at f_M = 500 or 555.556 kHz . . . . 0.2 ns/div.

Non-linearity distortion "$\Delta U/U_o$" (f_M < 1 MHz)
Measurement ranges . . . . . 0.4, 1, 2, 4, ..., 40 %
Max. sensitivity . . . . . 0.1 %/div.

Differential phase "$\Delta\varphi$" (f_M >1 MHz)
Measurement ranges . . . . . 0.4, 1, 2, 4, ..., 40 % rad
Max. sensitivity . . . . . 0.1 % rad./div.

Differential gain "$\Delta U/U_o$" (f_M > 1 MHz)
Measurement ranges . . . . . 0.4, 1, 2, 4, ..., 40 %
Max. sensitivity . . . . . 0.1 %/div.

Other IF measurements and parameters

Attenuation/frequency distortion "ΔP_I"
(IF-to-IF frequency response)
Measurement ranges . . . . . 0.4, 0.8, 1.6, ..., 16 dB
Max. sensitivity . . . . . 0.1 dB/div.

Attenuation/frequency distortion, "ΔP_{II}" (selective)
(An IF reference signal with the same frequency is applied to input P_I)
Level range at input P_{II} . . . . . −50 to −10 dBm
Measurement ranges . . . . . 8, 16, 40, 80 dB
Max. sensitivity . . . . . 2 dB/div.

IF return loss, "ΔP_{II}"
with RFZ-1 return loss bridge
Measurement ranges . . . . . 8, 16, 40, 80 dB

"$Y_{external}$" (e.g. for RF detector signals)
Measurement ranges . . . . . 8, 20, 40, 80, ..., 800 mV
Max. sensitivity . . . . . 2 mV/div
Input impedance . . . . . 10 kΩ

IF level "P_I" (at center frequency F_o)
Measurement range . . . . . −20 to + 10 dBm
Resolution . . . . . 0.01 dB

Test frequency deviation "Δf" (r.m.s.)
Measurement range . . . . . 15 to 500 kHz
Resolution . . . . . 0.01 dB
Modulation frequency
in the 70 and 140 MHz IF ranges . . . . . 25 kHz to 5.6 MHz
in the 35 MHz IF range . . . . . 25 to 556 kHz
(calibrated with the Bessel-zero method, f_M = 250/277.778 kHz and 83.3/92.593 kHz)

Sweep width "$\Delta\hat{F}$"
Measurement range . . . . . ±0.2 to ±50 MHz
Resolution
0.2 to 9.99 MHz . . . . . 0.01 MHz
10 to 50 MHz . . . . . 0.1 MHz

Frequency markers "M"
(Two vertical lines symmetrical about F_o)
Setting range . . . . . ±0.03 to ±50 MHz
Resolution
0.03 to 9.99 MHz . . . . . 0.01 MHz
10 to 50 MHz . . . . . 0.1 MHz

Centre frequency "F_o" (see IF counter)
Measurement range . . . . . 25 to 190 MHz
Resolution . . . . . 0.1 MHz

IF counter for unswept IF signals
Measurement range . . . . . 25 to 190 MHz
Resolution . . . . . 0.01 MHz

Spectrum mode
For setting the sensitivity of modulators and demodulators
Test frequencies for calibrating the deviation meter
frequency series I [1] . . . . . 92.593 and 277.778 kHz
frequency series II [1] . . . . . 83.3 and 250 kHz
Carrier suppression
at 92.593 and 83.3 kHz . . . . . ≧40 dB
at 277.778 and 250 kHz . . . . . ≧50 dB

Further BB measurements

BB level for unswept signals between 10 kHz and 12.5 MHz
Measurement range . . . . . −50 to −10 dBm
Resolution . . . . . 0.01 dB

BB return loss
For unswept sinusoidal signals between 75 kHz and 12.5 MHz (using RFZ-1 return loss bridge)
Level range at BB level meter input . . . . . −50 to −10 dBm
Resolution . . . . . 0.01 dB

1) See Ordering Information for more details

Horizontal cursors

For reading the results of IF and BB swept measurement. The cursors are symmetrical about the center line and are adjustable. The separation between the two cursors is shown on the screen in terms of the scale selected.

Wideband facility for the RM-5 (70 and 140 MHz)

Wideband Modulator, BN 916/00.31

BB input

Sensitivity at 277.778 or 250 kHz . . . . . 10 MHz/V ±5 %

Modulation frequency range
for (70) 140 MHz IF . . . . . 50 Hz to (12.5) 13.6 MHz

Max. baseband level for noise signals
corresponding to (1800) 2700 channels
at 6 dB overload . . . . . (−2.2) −0.4 dBm

Max. level for sinusoidal signals . . . . . −10 dBm

IF output

Center frequency . . . . . 70 MHz and 140 MHz

Level range, smallest step 0.1 dB . . . . . −59.9 to +10 dBm

Basic noise
(70 MHz/1800 channels)
140 MHz/2700 channels . . . . . ≦(15) 20 pW0p

RMED-5 Wideband Demodulator, BN 2018/01

IF input

Center frequency . . . . . 70 MHz ±50 kHz

Switchable to . . . . . 140 MHz ±100 kHz

Level range . . . . . −4 to +6 dBm

BB output

Sensitivity . . . . . 50 mV/MHz ±10 %

Demodulation frequency range
(70) 140 MHz IF . . . . . 50 Hz to (12.5) 13.6 MHz

Basic noise
(70 MHz/1800 channels)
140 MHz/2700 channels . . . . . ≦(8.5) 16 pW0p

Characteristics of the modem loop

Basic and intermodulation noise
(70 MHz/1800 channels) 140 MHz/2700 channels
under CCIR conditions

Nominal load . . . . . ≦(40) 50 pW0p

3 dB overload . . . . . ≦(60) 80 pW0p

BB-to-BB frequency response

from 50 Hz to 12.5 MHz (at 70 MHz IF) . . . . . ±0.5 dB

from 50 Hz to 13.6 MHz (at 140 MHz IF) . . . . . ±0.5 dB

Transmission of TV signals

Droop for a 50 Hz rectangular modulation signal . . . . ≦1 %

RMES-5 IF Switch, BN 917/00.20

IF ranges . . . . . 35, 70 and 140 MHz

Switching rates . . . . . 18 and 70 Hz

Switching time . . . . . typically 1 µs

Delay difference between signal paths . . . . . <100 ps

Max. signal level . . . . . +5 dBm

Insertion loss . . . . . 6 dB ±1 dB

Isolation (between disconnected input and output) . . ≧34 dB

Input and output impedances . . . . . 75 Ω

Return loss (up to 190 MHz) . . . . . ≧26 dB

Group delay network RMLP-5, BN 917/00.21

Frequency range . . . . . 68 to 82 MHz

Parabolic group delay coefficient τ_2 . . . . . 0.0833 ns/MHz^2

Amplitude/frequency response . . . . . typically <0.1 dB

Characteristic impedance . . . . . 75 Ω

General specifications

Power supply

Nominal ranges of use for a.c. line voltage . . . . 96.5 to 140 V and 193 to 261 V

Nominal range of use of the a.c. line frequency . . 47.5 to 63 Hz

Power consumption

RMS-5 Generator . . . . . approx. 80 VA

RME-5 Receiver . . . . . approx. 90 VA

RMED-5 Wideband Demodulator . . . . . approx. 20 VA

Safety class to IEC 348 and VDE 0411 . . . . . Class I

RFI/EMI suppression to spec. 1046/1984 of the DBP

Ambient temperature

Nominal range of use (≅ Limits range of operation)

Height of use above sea-level	With cooling fan (accessory)	Without cooling fan
Up to 1000 m	0 to +50 °C	0 to +40 °C
Up to 3000 m	0 to +40 °C	0 to +30 °C

Storage and transportation . . . . . −40 to +70 °C

Dimensions (w×h×d) in mm

RMS-5 Generator . . . . . 477×155×434

RME-5 Receiver . . . . . 477×288×434

RMED-5 Wideband Demodulator . . . . . 477×110×434

Weight

RMS-5 Generator . . . . . approx. 13 kg

RME-5 Receiver . . . . . approx. 19.5 kg

with cooling fan . . . . . approx. 20.5 kg

RMED-5 Wideband Demodulator . . . . . approx. 8 kg

Ordering information

RM-5 70 MHz radio-link measuring setup [1] comprising: **RMS-5 generator*** **BN 916/..**
Sweep frequencies: 18 and 70 Hz **RME-5 receiver*** **BN 917/..**

Test frequencies						Order number
Series I: 27.778 kHz 55.556 kHz 92.593 kHz 277.778 kHz and 555.556 kHz	Series II: 25 kHz 50 kHz 83.3 kHz 250 kHz and 500 kHz	2.4 MHz	3.580 MHz or 3.579545 MHz	4.430 MHz or 4.433619 MHz	5.6 MHz	
■		■	□	□	■	BN 916/11 [2] ~~BN 917/11~~
	■	■	□	□	■	BN 916/12 BN 917/12

■ Standard □ Color subcarrier (on request) replaces the 2.4 or 5.6 MHz test frequency, see options

Wideband facility for the RM-5

Wideband modulator* (option, fitted in RMS-5)	BN 916/00.31
RMED-5 wideband demodulator*	BN 2018/01

Permanent options:
(Unless otherwise stated these are factory-fitted and charged extra)

	Fitted to RMS-5	Fitted to RME-5
35 MHz IF option	BN 916/00.03	BN 917/00.03
140 MHz IF option	BN 916/00.30	BN 917/00.30
IF quartz signal output 35/70/140 MHz*	BN 916/00.20	—
IEEE 488/IEC 625 interface board [3] with IEEE 488 connector and K 420 connection cable	BN 958/21	BN 853/21
X-Y recorder interface [3]	—	BN 917/00.01
Color subcarriers		
M/NTSC, 3.580 MHz [4]	BN 916/00.06	BN 917/00.06
M/NTSC, 3.579545 MHz [4]	BN 916/00.04	BN 917/00.04
B, G, H, I/PAL 4.430 MHz [5]	BN 916/00.07	BN 917/00.07
B, G, H, I/PAL 4.433619 MHz [5]	BN 916/00.05	BN 917/00.05
Noise calculation option [6] [7]	—	BN 917/00.11
INTELSAT tolerance masks [6]	—	BN 917/00.12
Frequency deviation correction for satellite system measurements [8]	—	BN 917/00.22

Accessories (charged extra)

Cooling fan for RME-5	BN 917/00.10
RFZ-1 return loss bridge (for frequencies from 75 kHz to 190 MHz)	BN 2045/10
RN-... standard mismatches	see Versacomp® 75 data sheet
RMSF-5 frequency splitter*	BN 916/00.10
RMES-5 IF switch*	BN 917/00.20
RLMP-5 group delay network*	BN 917/00.21
Pre- and de-emphasis Networks	see separate data sheet
IEEE 488/IEC 625 adapter (m – m) for IEEE 488/IEC 625 interface board	S 832
50 sheets XY recorder paper (German/English)	BN 917/00.79
Transport containers	
TPK-3 for the RMS-5 generator	BN 626/09
TPK-6 for the RME-5 receiver	BN 626/12
Case for accessories	BN 926/19
Protective covers (1 set, front and back panels)	
SD-3 for the RMS-5 generator	BN 700/00.23
SD-6 for the RME-5 receiver [9]	BN 700/00.26
SD-2 for the RMED-5 demodulator	BN 700/00.22
19" conversion kit	
for the RMS-5 generator	BN 700/00.03
for the RME-5 receiver	BN 700/00.06
for the RMED-5 demodulator	BN 700/00.02

* Fitted with the Versacon® 9 75 Ω basic connector and BNC adapter as standard. If you require other types of adapter please state this in your order – see Versacon® 9 data sheet for details

1) 35 MHz and/or 140 MHz, see under options
2) Fitted with INTELSAT test frequencies of 55.556 kHz, 95.593 kHz and 277.778 kHz
3) The IEEE 488/IEC 625 interface and the recorder interface cannot both be fitted
4) 3.580 or 3.579545 MHz are available instead of the 2.4 or 5.6 MHz test frequency. Unless otherwise specified, the standard 2.4 MHz test frequency will be replaced by the chosen test frequency.
5) 4.430 or 4.433619 MHz are available instead of the 2.4 or 5.6 MHz test frequency. Unless otherwise specified, the standard 5.6 MHz test frequency will be replaced by the chosen test frequency.
6) The noise calculation option and the INTELSAT tolerance masks cannot both be fitted
7) Noise calculation facility not available for the following test frequency combinations: 2.4 and 3.5 ... MHz, 4.4 ... and 5.6 MHz.
8) Not for RM-5 setups fitted with 35 MHz IF option.
9) When the cooling fan is fitted, the back panel cover for the RME-5 cannot be used