ROHDE&SCHWARZ

Measuring Instruments
and Systems Division

Manual

TEST RECEIVER
ESV

342.4020.33
342.4020.52
342.4020.53
342.4020.55

Printed in the Federal
Republic of Germany

Supplement
to Data Sheet
342 402 E-2
of the ESV

Specifications

For model 55 of the ESV, the following values do not comply with the data sheet specifications:

The 1-MHz bandwidth is replaced by 200 kHz.

Nominal bandwidth	-3 dB ±20%	-6 dB ±10%	typ. ratio 6:60 dB
200 kHz	200 kHz	225 kHz	1:2.5

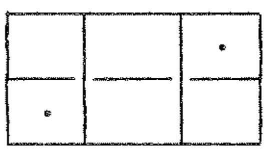
Underlined figures refer to the reference numbers used in Figs. 2-13 and 2-14 of appendix.

2.1 Explanation of Figs. 2-13 and 2-14

Ref. No.	Labelling	Function
1		Built-in loudspeaker; cut off by inserting plug into socket 27.
2	dB µA dB µV dB µV/m	Readout of 0-dB reference level of the selected scale of meter 4 and unit, depending on the settings of IF attenuator 19 and RF attenuator 18 as well as the conversion factor encoded via socket 21. The numerical value is added to the value indicated on 4.
3	⊗	Button for backlighting of 2, 4 and 6.
4	INDICATION	Panel meter with LIN 20-dB scale (for exact measurement), CISPR 10-dB scale and LOG 40/60-dB scale; also indicates state of battery charge, has mechanical zero.
5		Screwdriver adjustment of mechanical zero of meter 4.
6		6-digit frequency display with 1 kHz resolution.
7		Carrying handle; unlocked by pushing in the two plastic round ends of the handle.
8		Tuning aid for signals that are above the noise; centre LED lights: correct tuning left LED lights: turn tuning knob clockwise right LED lights: turn tuning knob counterclockwise.
9	TUNING	Knob for tuning receiver.
10	 100 kHz 10 kHz 1 kHz BLOCK	Rotary switch for selecting tuning step widths of 9 in 100-kHz steps; in 10-kHz steps; in 1-kHz steps. Knob 9 disabled.

Ref. No.	Labelling	Function
11		ON/OFF switch
12	INDICATION LIN LOG 40 dB LOG 60 dB	Switch to select indicating range on meter 4: linear 20-dB range; logarithmic 40-dB range; logarithmic 60-dB range.
13	INDICATION CISPR SP 1s SP PK MW AV	Switch to select indicating mode: CISPR indication is always in upper 10-dB range of the LIN 20-dB scale; CISPR has priority over 12 and 14. 4 indicates peak value of IF signal held for 1 s; 4 indicates peak value of IF signal held for 50 ms; 4 indicates average value of IF signal.
14	IF BANDWIDTH 7.5 kHz 12 kHz 120 kHz 200 kHz(mod.55) 1 MHz(mod.52 and 53)	Rotary switch to select IF bandwidth. Test bandwidth for 12.5-kHz channel spacing Test bandwidth for 20-kHz channel spacing Test bandwidth acc. to CISPR (Publ. 2 and 4) Test bandwidth for MIL measurements.
15		LED for indication of calibration (blinking indicates ongoing calibration process).
16	BATT.	Button to check state of charge of battery and battery voltage on panel meter 4.
17	CAL.	Button to initiate calibration.
18	ATTEN. RF 60 dB 50 dB 70 dB 40 dB 80 dB 30 dB 90 dB 20 dB 100 dB 10 dB 110 dB 0 dB	RF attenuator switch with setting range from 0 to 110 dB. The 0-dB position is marked as in this position of the input attenuator the VSWR may be as high as 2 thus reducing the measuring accuracy (CISPR Publ. 2 and 4).
19	ATTEN. IF AUTO 40 dB 30 dB 20 dB 10 dB 0 dB	IF attenuator switch Automatic selection of optimum IF attenuation as a function of 13 and 14. Selection of IF attenuation by hand.

Ref. No.	Labelling	Function
20	⏚	Measurement earth terminal.
21	SUPPLY	Socket for connecting active and passive accessories Output: +10 V, - 10 V (50 mA, max.) Input: encoding for readout on 2 For pin assignment see section 2.3.13.
22	HF (50 Ω) RF < 3 V	N input socket (not convertible) Do not exceed maximum input voltage rating.
23	SQUELCH	Level range corresponds to LOG 60 dB Left stop; squelch switched off.
24		LED for squelch status Lit up: AF switched off.
25		Volume control for 1 and 27 Adjust maximum volume so as to prevent feedback when tuning signal to filter edge.
26	AF DEMODU- LATION	Rotary switch for selection of AF de- modulation mode
	F3	For frequency-modulated signals, the deviation of which does not markedly exceed 1/2 IF bandwidth 3-dB AF bandwidth: approx. 3 kHz
	F3	For frequency-modulated signals, the deviation of which does not markedly exceed 1/2 IF bandwidth 3-dB AF bandwidth: approx. 16 kHz
	A3	For amplitude-modulated signals 3-dB AF bandwidth: approx. 3 kHz
	A3	For amplitude-modulated signals 3-dB AF bandwidth: approx. 16 kHz
	A0	For tuning to zero beat by means of 9
	AUS OFF	AF amplifier switched off.
27	NF AF	AF output socket (JK 34) with switch-off contact for 1; R_i = 10 Ω, P >100 mW.

Ref. No.	Labelling	Function
28	X6 POWER SUPPLY	4-way special socket for 12-V supply from power supply unit.
29	X5 BATT.	4-way special socket for 12-V supply from battery pack, 24-V adapter or another 12-V source.
30	POWER SUPPLY	4-pin special plug for power supply unit.
31	BATT.	4-pin special plug for battery pack.
32	X251	50-way amphenol socket with various outputs. For pin assignment see section 2.3.14
33		Screws for securing battery pack and power supply unit.
34		Battery pack.
35	5 MHz 10 MHz  EXT. INT.	Slide switches for internal reference (lower switch to the right) external reference 5 MHz (lower switch to the left, upper switch to the left) external reference 10 MHz (lower switch to the left, upper switch to the right)
36	EXT. REF.	BNC input socket for external reference frequency of 5 or 10 MHz.
37	10.7 MHz ⎍	BNC output socket for 2nd IF of 10.7 MHz Bandwidth corresponds to the bandwidth resulting from the RF and the 1st IF.
38	AM	BNC output socket for the demodulated amplitude modulation.
39	FM	BNC output socket for the demodulated frequency modulation.
40	10.7 MHz ⎍	BNC output socket for 2nd IF of 10.7 MHz Bandwidth corresponds to the selected IF bandwidth.

Ref. No.	Labelling	Function
41		Power supply unit.
42		Power plug (without earthing contact)
43	220V~ T0.5B 235V~  115V~ T1B 125V~	Voltage selector

2.2 Preparation for Use

2.2.1 Setting up the Receiver

The performance of the ESV is affected differently by various environmental influences. The following should, therefore, be observed:

2.2.1.1 Position

The normal operating position is horizontal. This is the position in which the receiver is tested and calibrated. When using the receiver on a bench, it is advisable to swing the carrying handle fully down (the handle is released by pressing the centers of the two plastic hinges simultaneously) so that the unit rests on the handle. When using the receiver as a portable unit, i.e. in the field, it may be helpful to be able to operate the receiver in a vertical position. In that case, we recommend the use of the protective cover (see Specifications) for the rear of the receiver. With the receiver in vertical position, the readings of meter 4 (Fig. 2-13) may vary by 2% approx. compared to those in horizontal use.

2.2.1.2 Temperature and Condensed Moisture

The maximum allowable temperature up to which the performance specifications hold is +45° C. If the unit is being operated from batteries, the self-heating is negligible. For the worst case in AC supply operation (10% overvoltage, battery charging at 2.5 A max. and receiver operating), the heat developed at the rear of the unit is considerable. It is then advisable to maintain a distance of 10 cm from surrounding objects in order to avoid a build-up of heat which could damage the equipment. As far as protection from direct sunlight is concerned, a good rule of thumb is to put your hand against the case, and if the case does not feel too hot, no protection is required. However, it should be borne in mind that the rate of failures occurring in any device increases with rising temperature.

The receiver complies with the provisions of the IEC 359 safety class II regulations. Since the ESV contains high-impedance circuits, condensation should be avoided during its operation. Since this is not always possible, in particular when a cold receiver is moved to a warm room with a high relative humidity, some time should be allowed for the condensed moisture to evaporate before switching on.

2.2.1.3 Vibration and Low-frequency Magnetic Fields

The ESV contains several varactor-tuned phase-locked oscillators. Strong magnetic fields and heavy vibration may cause the sideband noise of these oscillators to worsen. If exposed to vibration over extensive periods of time, the failure rate of the receiver may go up considerably. Receivers used permanently in vehicles or aircraft should therefore be shock-mounted.

2.2.1.4 RF Fields

As a consequence of the excellent screening of the receiver, RF fields are harmless up to 10 V/m. The measuring accuracy is not appreciably degraded by field strengths of this order. With fieldstrength levels > 110 dBμV/m the receiver should be detuned, so that $f_{rec} \neq f_{field}$.

2.2.1.5 Earth Connection

a) Battery operation:

Input socket 22 (Fig. 2-13) on the ESV connects (50 Ω) from the inner conductor to the chassis if the RF attenuation is set to greater than 0 dB. As a consequence, on no account may a voltage be applied to the inner conductor of the input socket that is harmful to the human body, since this voltage becomes effective if the operator simultaneously touches the chassis and ground.

It is therefore generally recommended that the receiver be earthed (connect socket 20 to, for example, the non-fused earthed conductor of the AC supply).

b) AC supply operation:

The power supply unit is designed in compliance with the provisions of VDE 0411 and IEC 348, safety class II; i.e. there is no connection to the earthed conductor of the AC supply. Therefore the same applies as under a) above.

If it is possible to do without protective insulation, it is urgently recommended that socket 20 be connected to the non-fused earthed conductor of the AC supply.

2.2.1.6 Transport

For moving the receiver, we recommend that the carrying handle be set in front of the front panel thus providing easy means of transportation.

When the receiver is to be moved outside the laboratory, for example in the field, the front panel and, even more importantly, the rear of the unit should be protected by covers (see recommended extras).

2.2.2 Power Supply

The unit can be operated from a power supply unit, a 12-V battery pack or an external 12-V or 24-V source (only via 24-V adapter).

Power supply unit, 12-V battery pack and 24-V adapter are interchangeable. Instructions for mounting the power supply unit, the 12-V battery pack and the 24-V adapter are given in section 2.2.2.2.

2.2.2.1 AC Supply Operation

The ESV is designed for operation from AC supply voltages of 115 V, 125 V, 220 V and 235 V. The unit is factory-adjusted for operation from 220 V. If it is necessary to operate the receiver from a different AC supply voltage, unscrew the fuse holder in the voltage selector 43 (Fig. 2-14), remove the cover plate and replace such that the fuse can be screwed into the position that is marked with the desired voltage. The receiver is then ready for operation from the available AC supply voltage. The fuses for all adjustable AC supply voltages are contained in the voltage selector.

For 110 V and 125 V a T 1 B (DIN 41571) fuse is required;
for 220 V and 235 V a T 0.5 B (DIN 41571) fuse is required.

The AC supply voltage may fluctuate between -15% and +10%. The power consumption in the worst case (10% overvoltage, full charging current to the connected batteries and receiver operating) is 70 VA maximum. When charging completely discharged batteries, it is therefore recommended that the receiver should not be operated for at least one hour to avoid heat problems.

Warning: The power supply unit of the Receiver ESV is provided with protective insulation (safety class II VDE 0411). Thus a connection to the earth conductor of the AC supply does not exist. For all applications which, in view of the maximum voltages which might occur, present a hazard to the human body and where it is possible to do without protective insulation, it is strongly recommended that the receiver be connected to the earthed conductor of the AC supply via socket 20 (see section 2.2.1.5 Earth Connection).

2.2.2.2 Operation from 12-V Battery Pack or External Source

(For external 12-V source, see 2.2.2.3)

The 12-V battery pack or the 24-V adapter can be fitted in the receiver in place of the power supply unit. To do so, proceed in the following manner:

- Pull out power plug 42
- Pull out plug from low-voltage socket 30
- Loosen screws 33
- Tip the power supply unit and lift out.
  (The power supply unit is prevented from falling out by two metal flaps on the underside.)
- Insert the retaining flaps of the battery pack or the +24-V adapter in the cutouts on the rear panel of the ESV.
- Tip up battery pack or +24-V adapter.
- Tighten screws.
- Insert plug 31 into socket X5 29 BATT.

When the receiver is powered from the 12-V battery pack, the operating time depends on the state of charge of the battery and the ambient temperature. With the battery fully charged and the ambient temperature >+25° C, an operating time of more than three hours can be expected. When the receiver is powered from an external battery (with or without +24-V adapter), the operating time depends on the capacity of the source. Maximum current drain is about 1.2 A. If the input supply voltage falls below +10.8 V, the receiver automatically switches off to avoid damaging the battery by discharging it too far. Max. permissible battery voltage +15 V.

If possible, the batteries should be stored in a fully charged state. Stored or standby batteries kept at an average ambient temperature of +20° C must be recharged after about 12 months. This period is reduced if the temperature is higher and increased if the temperature is lower. If the batteries are in frequent use, the self-discharge may increase slightly. Since storage in a fully charged state enhances the lifetime and rechargeability of the batteries, we recommend that the batteries be recharged after storage periods corresponding to a self-discharge of about 25%.

The batteries should be stored in a dry room since dampness causes conductive paths to appear across terminals, increases the self-discharge and leads to corrosion.

Since the density of the electrolyte decreases with the state of charge, causing the freezing point of the batteries to rise, the following states of charge must be observed for storage at low temperatures (otherwise a permanent capacity loss may result):

$T_{ambient}$ (° C)	-10	-20	-30	-40
State of charge (%)	30	50	70	80

Continual use at very high temperatures has an adverse effect on the life of all storage batteries. There is, of course, no objection to operation for a few hours at an ambient temperature as high as +80° C (slightly below the temperature at which the plastic case softens), but for longer periods of time ever increasing permanent losses in capacity must be reckoned with. Permanent use above +50° C should, therefore, be avoided.

Adverse effects on the performance of the ESV due to excessive discharging of batteries are not likely since the receiver contains a built-in electronic discharge protection circuit which automatically switches off the receiver when the battery voltage drops below 10.8 V. After the batteries have been cut off, they should be recharged as soon as possible with the aid of the power supply unit to maintain the battery capacity.

To insert the batteries, proceed as follows:

- Loosen the two screws 33 on the cover of the battery pack.
- Remove the cover of the battery unit.
- Connect the batteries as shown in Fig. 2-1.
- Insert the batteries.
- Replace the cover and lock into place.
- Tighten down the two screws on the cover.

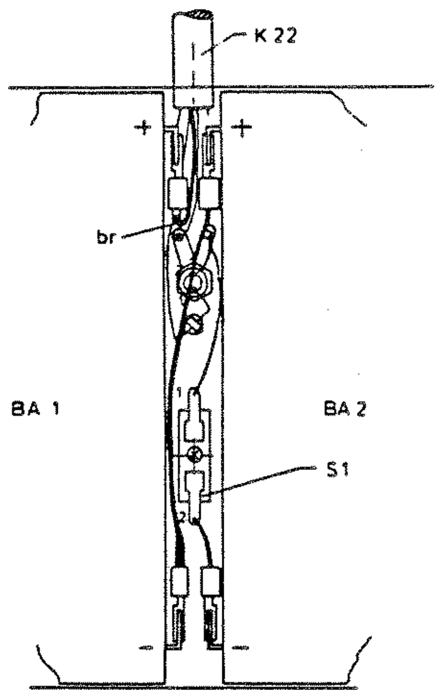


Fig. 2-1 Battery connection diagram

The state of charge of the batteries can be checked on meter 4 after pressing button 16 BATT. If the pointer is at the right end of the thick bar (Fig. 2-2), the batteries are fully charged. If the left end of the bar is reached, the receiver automatically switches off to prevent the batteries from discharging too far. While the batteries are being charged, the pointer is within the range of the thin bar.

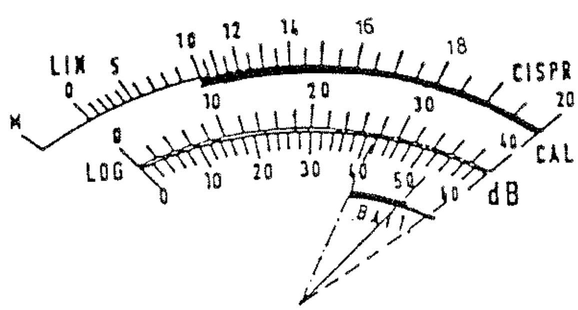


Fig. 2-2 State of charge of batteries

The pin assignment of socket 29 is described in section 2.2.2.3a and that of the external 24-V adapter in section 2.2.2.3b.

2.2.2.3 Combined AC Supply and Battery Operation

The following combinations with the power supply unit are possible:

a) Power supply unit and external 12-V source

The receiver is connected to the power source via the plug supplied with it (for pin assignment see Fig. 2-3), preferably a 2-A slow-blow fuse (T 2 D) and a twin-core lead. The resistance of the twin-core lead must be such as to ensure that at a current of 2 A the voltage at the low-voltage connector does not fall below 10.8 V. The power supply unit should preferably remain fitted to the receiver. When the receiver is powered from the AC supply, the external battery is charged at a rate of 2 A, max.

Caution: Reverse polarity protection is effective only when the external 12-V source is connected to socket 29. The voltage at this point however must not be less than 11.2 V.

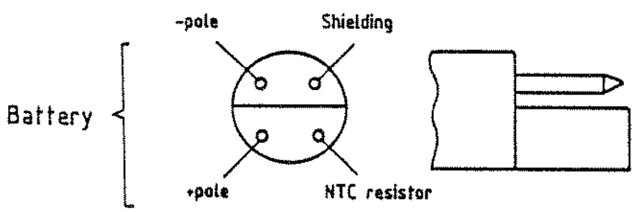


Fig. 2-3 Pin assignment of socket 29

b) Power supply unit and external 24-V source

When the +24-V Adapter ESH 2-Z4 is used, a 24-V source (voltage range 21.5 V to 30 V, max.) can be connected. The low-voltage plug of the adapter is connected to socket 29 and the input plug of the adapter is connected to the 24-V source. The adapter is shortcircuit-proof and protected against reverse polarity. It is **not** possible to charge the 24-V source in AC supply operation. Either the power supply unit or the +24-V adapter can be fitted to the Receiver ESV (for mounting instructions see section 2.2.2.2).

c) Power supply unit and 12-V battery pack

When the power supply unit is in operation, it takes over the supply to the receiver and charges (2 A, max.) or trickle-charges the battery. When charging completely discharged batteries, it is recommended that the receiver should not be operated for about one hour to avoid heat problems.

2.2.3 Checking the Mechanical Zero of the Meter

With the receiver switched off, turn the adjusting screw 5 for the pointer of the meter to coincide with the marking at the left-hand end of the meter scale. This check is particularly advisable when the operating position has been changed (from horizontal to vertical or vice versa).

2.2.4 Switching on

After the power plug has been inserted, the receiver can be switched on by pressing the on/off switch 11 (Fig. 2-13) on the front panel. When the receiver is switched on, 2 and 6 light. In addition, one of the five LEDs at the IF attenuator switch 19 lights. Pressing button 3 illuminates the displays 2, 4 and 6 for reading in the dark.

On switching the receiver on, the internal temperature-stabilized reference oscillator starts to warm up. To avoid transient frequency errors, 30 seconds should be allowed for before using the receiver. After this warmup period, the error is $<2 \times 10^{-5}$.

When the receiver is powered from batteries (for information on connecting the battery see section 2.2.2.2), the receiver is also switched on by pressing the on/off switch 11. The displays 2 and 6 as well as one of the five LEDs at the IF attenuator switch 19 light when the receiver is switched on. Pressing button 3 illuminates the displays 2, 4 and 6 for reading in the dark.

The state of charge of the batteries can be read from meter 5 by pressing button 16 BATT.

The operating time of the receiver with normally charged intact batteries at room temperature is more than three hours. The current drain of the receiver is about 1.8 A at 12 V. The operating time that the receiver can achieve depends on the capacity of the batteries, and, to a still greater extent, on their temperature. At a temperature of -10°, the capacity of the batteries drops to about 60% of normal, and with it the operating time of the receiver is shortened. When the receiver is operated from the AC supply, the battery connected is automatically recharged, or, depending on the state of charge, trickle-charged.

2.2.5 Performance Check

A performance check of calibration and LIN-LOG display covers the most important functions of the Test Receiver ESV. Additional information on the receiver functions can be found in section 2.3 Operating Instructions.

2.2.5.1 Calibration

Pressing the CAL. button 17 initiates a complex and extensive calibration procedure by means of a pulse generator of high level accuracy and temperature stability (see section 5) whose completion is indicated when the red LED 14 goes out.

Table 2-1 explains the various meanings of the LED.

Table 2-1

Button 17 pressed	LED lights permanently
Button 17 released	LED blinks until the calibration procedure has been completed (depends on 13)
Fault detected	LED blinks permanently (t >10 s)

By switching the receiver off and on, it goes out of calibration.

In order to achieve the guaranteed measurement accuracy, it is advisable to always go through the calibration procedure a second time after switching the receiver on, as due to transient response of all the active stages during the initial calibration, appreciable calibration deviations may occur because of the wide amplitude swings. Calibration is effected referred to full-scale deflection on meter 4, independent of the position of switch 12.

Proper functioning of the input filters and the synthesizer can be verified by checking the calibration according to the following frequency pattern (tolerance of frequency setting: +5 MHz):
30 and 60   120 and 240   360 and 430   510 MHz (model 52).
In addition, check the frequencies 530, 620, 750, 880, 950 and 999 MHz for model 53.

The calibration check does not give an indication of the overall functioning of the RF attenuator switch. This can only be checked with the aid of a signal (e.g. derived from a signal generator) (see Maintenance 3.2.3).

2.2.5.2 LIN-LOG Display

Calibration of the Receiver ESV should be possible in any position of 12, 13 and 14 and at any frequency after pressing button 17. Check measuring accuracy with the aid of a signal generator and a high-precision power meter according to section 3.2.3 (Maintenance).

2.3 Operating Instructions

(Important: first check performance of receiver as described in Section 2.2.5)

The Test Receiver ESV enables the measurement of one or several sinewave signals and/or pulse signals. The maximum permissible sum voltage of all signals applied to the input socket of the receiver that will not cause any permanent damage depends on the RF attenuation, the RF bandwidth and the frequency.

2.3.1 Sinewave Signals and DC Voltage

At an RF attenuator setting of 0 dB, the sum voltage within the RF bandwidth must not exceed 3 V into 50 Ω.

At an RF attenuator setting of > 10 dB, the broadband sum voltage must not exceed 7 V into 50 Ω.

2.3.2 Pulse Signals

At an RF attenuator setting of 0 dB, the sum voltage within the RF bandwidth must not exceed 3 V into 50 Ω. This corresponds to a maximum spectral density of 30 mV/MHz within the largest RF bandwidth provided (100 MHz).

At an RF attenuator setting of > 10 dB, the broadband pulse signals applied must not exceed 7 V into 50 Ω. The maximum permissible pulse energy is 1 mWs. The pulse voltage may for a short time go up to as high as 100 V.

If the above values are exceeded, the input attenuator, RF filters or the input mixer may be destroyed. Appropriate measures should, therefore, be taken to prevent this.

2.3.3 Measurement Accuracy

The level measurement accuracy of the receiver is a function of

- the accuracy of the RF and IF attenuators (maximum error 0.3 dB)
- the accuracy of the calibration generator (maximum error 0.5 dB depending on the frequency and temperature)
- calibration error (maximum error 0.1 dB)
- scale and meter movement error (maximum error 0.1 dB)
- the position (horizontal or vertical)
- and the bandwidth-dependent signal-to-noise ratio during calibration.

In addition, the measurement accuracy is influenced by the finite signal-to-noise ratio of the signal to be measured. See table 2-2. From the curve shown in Fig. 2-4, the additional error as a function of the types of indication AV and PEAK and the IF attenuation can be taken.

At certain frequencies, due to multiple heterodyning, an increase in the noise indication may occur, the level of which is a characteristic of the particular instrument. These spurious responses (see data sheet) remain constant in indicated level when the RF attenuation is varied, and hence can lead to erroneous measurements.

Table 2-2

S/N1 or S/N2	Indication error/dB AV	PEAK
0	2.28	5.10
1	1.86	4.67
2	1.50	4.27
3	1.21	3.98
4	0.98	3.54
5	0.79	3.22
6	0.63	2.92
7	0.50	2.65
8	0.40	2.39
9	0.32	2.16
10	0.26	1.95
12	0.16	1.59
14	0.10	1.28
16	0.06	1.03
18	0.04	0.83
20	0.02	0.67
25	0.01	0.382
30		0.217
40		0.07
50		0.02

Error of AV indication/dB $\approx 20 \log \left(1 + 0.3 \frac{N_1}{S}\right)$

Error of PEAK indication/dB $\approx 20 \log \left(1 + 0.8 \frac{N_2}{S}\right)$,

$\frac{N_1}{S}$ or $\frac{N_2}{S}$ being the respective S/N ratio.

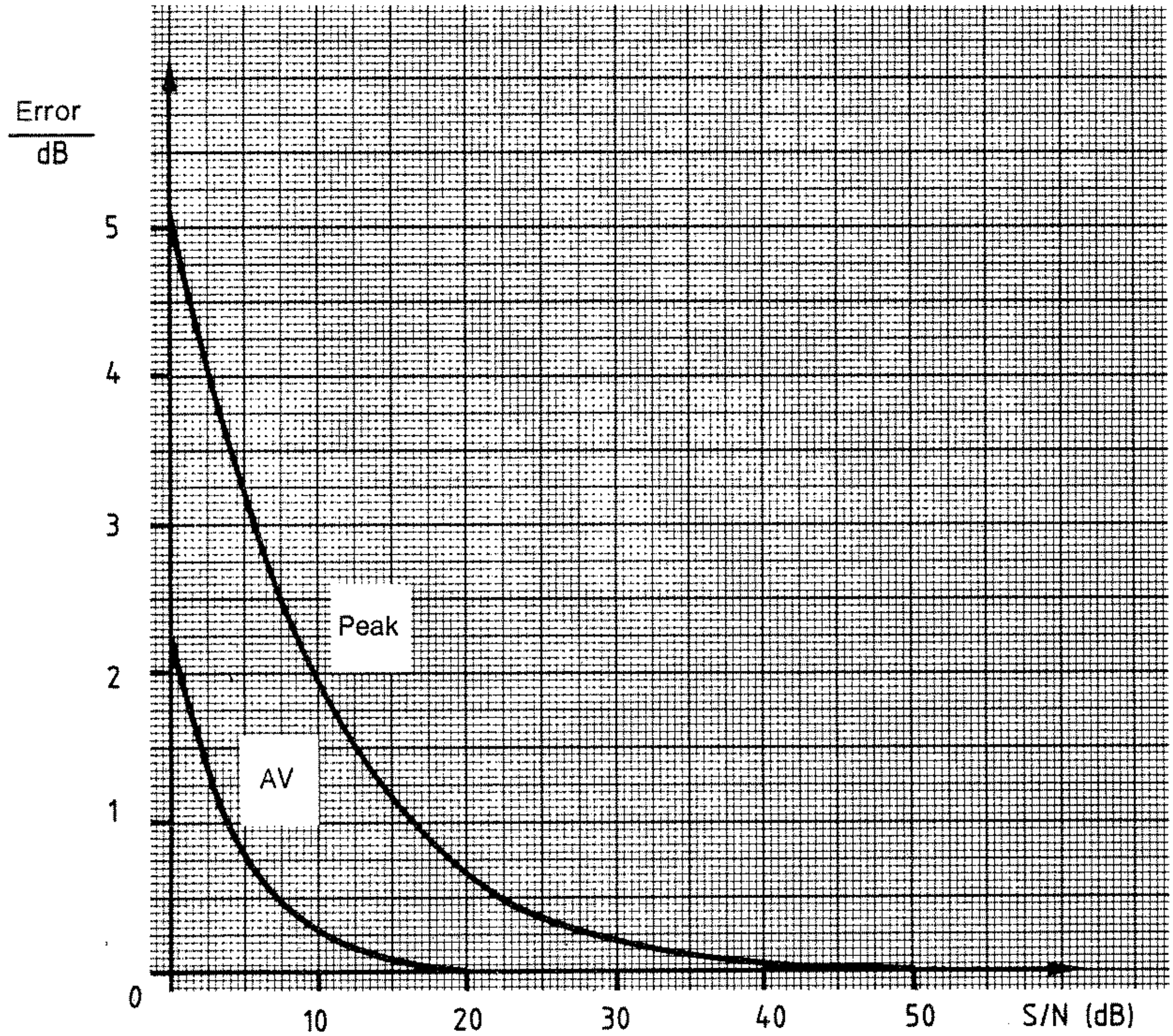


Fig. 2-4 Reading error due to noise with AV and PEAK indication

2.3.4 Frequency Tuning

The receiver, which can only be operated manually, is tuned by means of the tuning knob 9 provided on the front panel (Fig. 2-13). The tuning step size is selected by switch 10. In position 1 kHz, the change in frequency per revolution of tuning knob 9 is 40 kHz, in position 10 kHz, the change per revolution is 400 kHz and in position 100 kHz, the change per revolution is 4 MHz. In position 100 kHz of 10 it is possible to tune through the entire tuning range of the receiver by giving the tuning knob a good spin. In position 10 kHz of 10, the 1-kHz digit of 6 is reset to 0 and in position 100 kHz of 10, the 1-kHz digit as well as the 10-kHz digit are reset to 0.

The smoothly operating magnetic lock of the tuning knob ensures that if the tuning is not exact, the tuning knob is pulled to the next stable position as a result of magnetic attraction; i.e. after letting the knob go, the tuning may vary by a step. This will have to be corrected afterwards.

The ESV can be tuned down to a lower frequency of 20,000 MHz. The upper limit is at 519,999 MHz for model 52 and 999,999 MHz for model 53. If the upper limit of model 52 is exceeded (> 520 MHz), the last three digits of 6 go out.

Blinking of the frequency display 6 indicates that either one of the internal PLLs is out of lock or that the correct input filter cannot be selected because of an existing fault.

An internal logic control circuit automatically switches over the five input filters (9 with model 53) and the synthesizer. The switching operation involved may cause the readout on 4 to increase momentarily, in particular with peak-value or CISPR indication and, as a result, 6 will also blink momentarily.

List of frequencies which if not reached or exceeded trigger a switching operation:

40, 80, 100, 160, 200, 300, 320, 400 and 500 MHz.

In addition, for model 53:

520, 600, 690, 700, 800, 820, 900 and 930 MHz.

8 indicates the direction in which the tuning knob must be turned if the signal is markedly stronger than the inherent noise. When the LED on the left lights, the receiver is tuned to too low a frequency. When 9 is turned clockwise, the centre LED lights on reaching the proper tuning frequency.

over the selected IF bandwidth. The indicating range of the centre LED is matched to the IF bandwidth. At the IF bandwidths of 7.5 kHz and 12 kHz, it is about 1 kHz, at 120 kHz and 200 kHz (mod. 55) about 15 kHz and at 1 MHz (mod. 52 and 53) about 50 kHz. If the noise integral over the IF bandwidth as a function of the filter ripple and gain of the IF amplifier causes a voltage at the frequency discriminator that exceeds the tuning range of the centre LED, the left or right LED may also light if the signal is too weak or if there is only the inherent noise. If, however, a sufficiently strong signal is in the IF branch, the display functions properly.

2.3.5 Selection of IF Bandwidth

The bandwidths selected by 14 correspond approximately to the 6-dB bandwidths. For details see Specifications. The effective selectivity of the various filters can be seen from Fig. 2-5. It results from the IF selectivity of the filters used and the sideband noise of the receiver oscillators. The effective selectivity is only to a minor degree frequency-dependent.

When switching over the IF bandwidth by means of switch 14, a calibration process is triggered automatically to avoid inaccurate readouts due to a change in gain. This also happens when CISPR has been selected with 13 or when switching over from CISPR to PEAK 1s.

Recommended uses of the various bandwidths:

1 MHz (mod.52, 53):	TV signals, broadband pulse jammers, MIL measurements
200 kHz (mod.55):	Measurement and demodulation of FM broadcasting transmitters
120 kHz:	Interference measurements to CISPR, FM sound broadcasting
12 kHz:	Radio communication with 20- and 25-kHz channel spacing
7.5 kHz:	Radio communication with 12.5-kHz channel spacing, noise sideband measurements, intermodulation measurements.

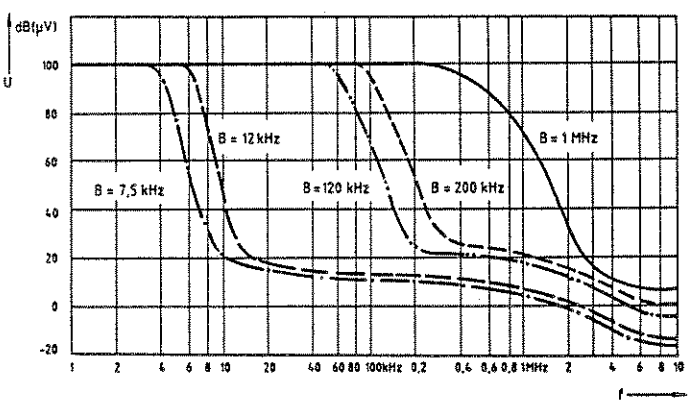


Fig. 2-5 Effective IF selectivity

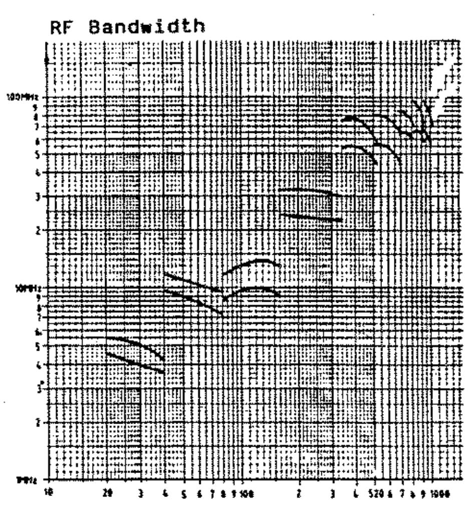


Fig. 2-6 Typical RF selectivity (3- and 6-dB bandwidths)

Switch 13 is used to select the type of rectifier for the level measurement. The following indicating modes can be selected:

AV. The **mean value** of the input signal, more exactly, the linear time-averaged value of the demodulated voltage at the output of the envelope demodulator, calibrated in the rms values of an unmodulated sinewave signal.

Hence, with an unmodulated sinewave signal, the exact rms value is indicated, and with a symmetrically modulated AM signal, the rms value of the carrier. The AV value indication is used for measuring sinewaves with non-suppressed carrier.

PEAK the **peak value** of the input signal, more exactly, the maximum demodulated voltage at the output of the envelope demodulator calibrated in the rms values of an unmodulated sinewave signal from which the same rectified voltage is obtained with a hold time of 50 ms.

PEAK 1 s as with PEAK, but hold time 1 s.

Basically, the **average** and **peak** values of an unmodulated sinewave signal should give the same indication; e.g., an unmodulated sinewave signal with an rms value of 10 µV produces an average as well as a peak-value indication of 20 dBµV. The actual indications differ because the noise voltage at the output of the demodulator is weighted higher in peak-voltage measurements than in average-value measurements (see Fig. 2-4). The peak-value indication is used for measuring the power of keyed carriers and the peak power of AM and SSB emissions.

CISPR The quasi-peak value of the input signal with pulse weighting in accordance with CISPR Publ. 2 and 4 or Publ. 16.

This indicating mode is identical with the indicating mode specified or recommended in VDE 0876 for radio interference measurements according to VDE 0871, 72 75, 79 and other German specifications.

The indication on meter 4 is always within the linear 20-dB range independent of the position of switch 12 whereby the upper 10-dB range (marked with a thick bar) is valid. Independent of the position of switch 14, the 120-kHz bandwidth, the pertaining rectifier with weighting and A3-demodulation (without AGC) are selected.

Instead of the 10-dB IF attenuation used in position AUTO the IF attenuator switch 19 may also be set to 20 dB if the pulse frequencies to be measured are not too low (<2 Hz). This setting increases the AF S/N ratio affording an easier aural monitoring.

2.3.7 Selection of Indicating Range

Switch 12 permits the indicating range of meter 4 to be selected.

LIN 20 dB:

Maximum measuring accuracy of the ESV is achieved in the upper 10-dB range of the LIN 20-dB scale where the resolution of the measured value is at its highest.

NOTE: With switch 13 in position CISPR, the readout on 4 is always on the linear scale but only in the upper 10-dB range, i.e. the range between 10 dB and 20 dB of the scale applies (thick bar!).

LOG 40 dB:

dB-linear scale over 40 dB. This range is generally used for measurements wich medium level fluctuations (e.g. directional radiation patterns of antennas).

LOG 60 dB:

dB-linear scale over 60 dB. This range is used for measurements with heavy level fluctuations (e.g. sound and TV broadcasting coverage measurements in cities).

When reading off the measured value, make sure that the position of switch 12 corresponds with the scale on meter 4.

2.3.8 Selection of Measuring Range

The measuring range is selected by varying the IF gain by means of switch 19 and the attenuation of the input attenuator 18. 2 reads out the 0-dB reference level of meter 4, depending on the operating mode of the rectifier, the IF attenuation, the RF attenuation and the conversion factor encoded via socket 21.

IF attenuator 19

The IF attenuator switch 19 permits the IF gain to be varied in steps of 10 dB. This is necessary for overload detection and to improve the signal-to-noise ratio.

In position AUTO of 19, the IF gain is controlled as a function of the switches 13 and 14 such that the noise indication on meter 4 does not go much beyond 0 dB. The signal-to-noise ratio is about 20 dB with full LIN scale deflection. For measurements with stringent accuracy requirements, the signal-to-noise ratio can be improved by increasing the IF attenuator setting 19 as against the AUTO position and decreasing the RF attenuator setting 18. The IF attenuator setting is indicated by lighting of the particular LED.

RF attenuator 18

The RF input attenuator setting can be varied in steps of 10 dB from 0 to 110 dB. The measuring accuracy may be not quite as high at 0 dB because of the higher input reflection coefficient. For CISPR measurements a minimum attenuation of 10 dB is required according to CISPR Publ. 2 and 4.

2.3.9 AF Demodulation

Switch 26 permits the AF amplification for 27 and 1 to be switched on and over.

In position AO the ESV can be adjusted to zero beat. If the signal received is exactly between two tuning steps of the receiver, minimum beat frequencies of up to 500 Hz may be obtained because of the limited step size of 1 kHz. In positions A3 and F3 it is possible to cut in an AF bandpass filter with a range of 300 Hz to 3.3 kHz in order to ensure an optimum signal-to-noise ratio in the AF transmission range. This is marked with the symbol ⎍ in contrast to ⊓ for the full AF range from 50 Hz to 16 kHz.

25 controls the volume of 27 and 1 in parallel. Disturbing noise can be suppressed with the aid of SQUELCH 23. The squelch is inhibited at the left stop of 23. The control range corresponds to the LOG 60-dB range. The switch-off hysteresis is determined by the level and lies between 2 and 4 dB. When the squelch is active, the LED 24 lights indicating that the AF path is blocked. By inserting a PL-55 connector into 27 (e.g. for headphones operation), 1 is automatically switched off.

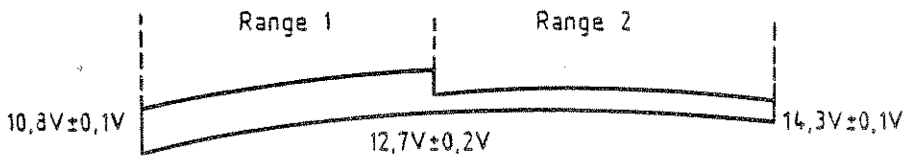
2.3.10 Backlighting

In battery operation backlighting of 2, 4 and 6 is switched on by means of 3 for the time this button is pressed.

In AC supply operation, backlighting is also switched on at the push of a button. If permanent backlighting is desired in AC supply operation, an additional link must be soldered in (see 4.1.1).

2.3.11 Battery Indication

The 12-V supply voltage is indicated on meter 4 after pressing button 16.



Range 1 (for battery or AC supply operation)

Lower limit: +10.8 V (response threshold of the discharge protection)

Upper limit: +12.9 V (fully charged batteries)

Range 2 (for trickle-charge operation)

Lower limit: +12.5 V

Upper limit: +14.4 V.

The temperature-dependent supply voltage of the power supply unit lies within this range in trickle-charge operation.

2.3.12 Reference Switch 35

The reference switch 35 permits the ESV to be synchronized with an external reference frequency of 5 or 10 MHz which is fed in at 36. This is, however, only useful if the error of the external reference frequency is $< 1 \times 10^{-5}$.

If the receiver is operated in the position EXT. REF. without such a reference or with an incorrect reference frequency being applied, a higher error of the set frequency is produced.

Internal reference

The lower switch is on the right, the position of the upper switch is unimportant.

Ext. 5-MHz reference

The upper switch is on the left and the lower switch is also on the left.

Ext. 10-MHz reference

The upper switch is on the right and the lower switch on the left.

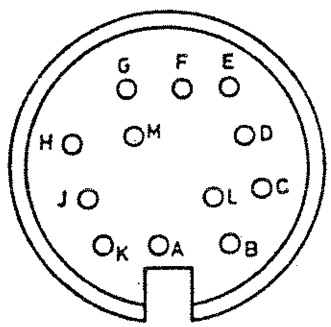
2.3.13 Supply and Coding Socket 21

The socket 21 serves two purposes:

a) The two supply voltages +10 V and -10 V are available at this socket. Maximum permissible load: 50 mA.

b) It permits access to the display 2. The numerical value of 2 can be increased in 10-dB steps by soldering in appropriate earthing links, or decreased (additional link from pin M to ground required). A further earthing link permits the readout on 2 to be switched over from dBμV to dBμA or dBμV/m. This is important when connecting a test antenna or probe to the input in order to consider the conversion factor in steps of 10 dB and type of test antenna or probe used in the 0-dB reference readout on 2.

Since the coding inputs may also be used for connecting external test antennas or probes, pin assignment of socket 47 is given below (front panel view):



A	ground
B	+10 V (max. 50 mA)
C	μV/m (electr. field strength)
D	μA
E	10 dB
F	20 dB
G	40 dB
H	80 dB
J	μA/m (magnetic field strength)
K	-10 V (max. 50 mA)
M	sign reversion for factor

2.3.14 Recording Outputs (50-contact Amphenol Connector 32)

The 50-contact Amphenol connector has several analog outputs for the connection of a digital voltmeter or an XY or YT recorder. A "pen lift" output disables recording during calibration.

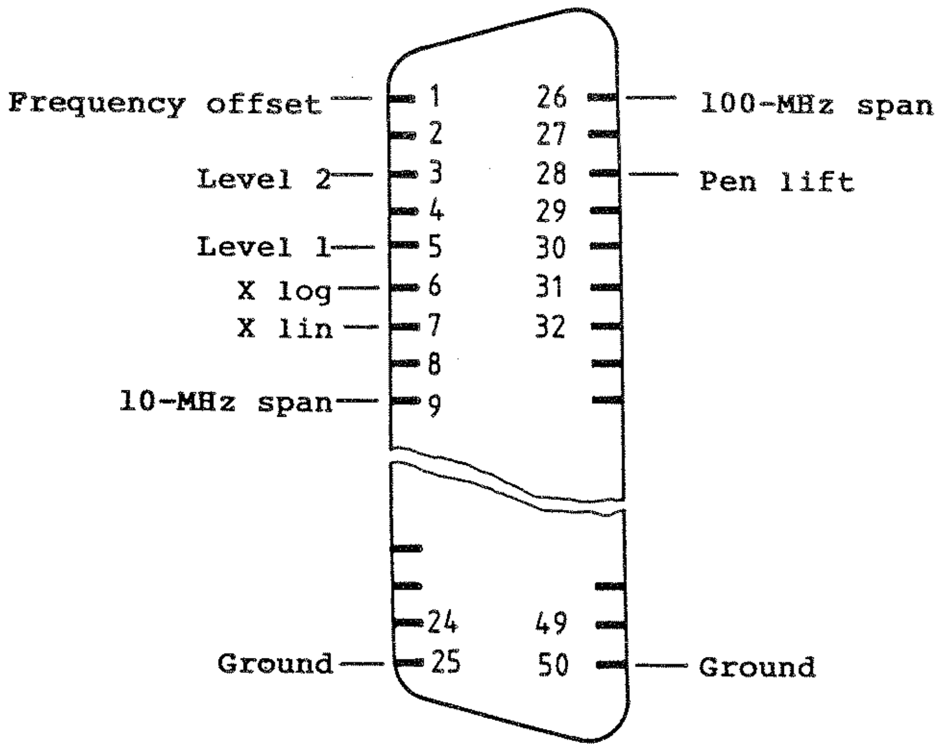


Fig. 2-7 Pin assignment of 50-contact Amphenol connector 32

The individual inputs and outputs are explained in table 2-3.

Table 2-3

Pin	Designation	Function	Level
1	Frequency offset	Output voltage indicates offset between receiver frequency and received signal frequency.	1 V/kHz at 7.5- and 12-kHz IF bandwidth 1 V/100 kHz at 120-kHz and 1-MHz IF bandwidth
3	Level 2	Voltage proportional to indication on meter 4 (via simulated meter)	0.2 to 2 V (2 V fsd)
5	Level 1	Voltage proportional to indication on meter 4 (without simulated meter for recorder)	0.4 to 4 V (4 V fsd)
6	X log	X recorder output. Voltage proportional to receiver frequency, logarithmic scaling.	0 to 5 V
7	X lin	X recorder output. Voltage proportional to receiver frequency, linear scaling.	0 to 5 V
9	10-MHz span	X recorder output operates with 10-MHz span. (20 to 30 MHz, 30 to 40 MHz, etc.) 10-kHz resolution	Pin connected to ground. 10-MHz span
25	Ground		
26	100-MHz span	X recorder output operates with 100-MHz voltage. (20 to 99.9 MHz, 100 to 199.9 MHz, etc.) 100-kHz resolution	Pin connected to ground. 100-MHz span
28	Pen lift	"Pen lift" output disables recording during calibration	0 V is pen lift
50	Ground		

When pin 9 and pin 26 of 32 are open circuit, the X recorder outputs supply 0 to 5 V for the overall ESV-frequency range (20 MHz to 1000 MHz corresponds to 0 to 5 V at the X log output, 0 to 1000 MHz corresponds to 0 to 5 V at the X lin output). Frequency resolution 1 MHz.

For calibrating the X and the Y axis of the recorder and for matching them to the 50-contact Amphenol connector an adapter is available from Rohde & Schwarz (Adapter ESV-Z4).

2.3.15 Operation of ESV in Conjunction with an XY Recorder

For recording of frequency-band occupation and interference spectra with the XYT Recorder ZSKT it is recommended to use the Recorder Adapter ESV-Z4. To do so connect the Amphenol connector of the adapter with connector 32, the clips of the recorder cable with the X, Y or ground input of the ZSKT and the 6-contact plug with the control input of the ZSKT. It is advisable to use preprinted recording paper with imprinted frequency values, level values and possibly limit-value lines.

Printed forms with logarithmically scaled frequency axis (20 MHz to 1000 MHz) without limit-value lines and with limit values acc. to Vfg. 1046/1984, VDE 0875 (Part 1), VDE 0875 (Part 3) and MIL-STD 461 RE02 (narrowband emissions) are supplied in the Annex.

With limit values according to Vfg. 1046 and MIL-STD 461 RE02 the factors of the antenna to be used are already accounted for. The resulting limit value results from the given limit value minus the antenna factor K.

The following antennas are considered:

Vfg 1046/1984:	Broadband Dipole (20 to 80 MHz) HUF-Z1 Log.-per. Broadband Antenna (80 to 1000 MHz) HL 023 A1
MIL-STD 461 RE02:	Double-conical antenna (20 to 200 MHz) Log. conical spiral antenna (200 to 1000 MHz)

For calibrating the recorder set the Adapter ESV-Z4 as follows:

- Set switch "Recorder Calibration" to "ESV" for AV or PEAK value measurements or to "CISPR" for measurements in compliance with CISPR.
- Set switch "Indication Mode" to "CAL".
- MIN/MAX switch to "MIN".
- Position the pen of the recorder on the lower left corner of the paper (marked on the preprinted form).
- MIN/MAX switch to "MAX".

- Position pen of the recorder on the upper right corner of the paper.

- Repeat calibration until corner points are properly lined up.

- Set switch "Indication Mode" to "Record" and select requested mode of indication.

With switch "SCALING" it is possible to select between linear (LIN) and logarithmic (LOG) frequency axis (X axis). The frequency display range is set with switch "SPAN". It is possible to select the ranges "MIN", "MED" and "MAX". These ranges correspond with the frequency ranges according to table 2-4:

Table 2-4

SPAN	Frequency range		Frequency resolution
	LIN	LOG	
MAX	0 to 1000 MHz	20 to 1000 MHz	1 MHz
MED	0 to 99.9 MHz/ 100 to 199.9 MHz etc.	2 to 99.9 MHz/ 102 to 199.9 MHz etc.	100 kHz
MIN	20 to 29.99 MHz/ 30 to 39.99 MHz etc.	20.2 to 29.99 MHz/ 30.2 to 39.99 MHz etc.	10 kHz

It is advisable to use logarithmic scaling only for the MAX span and linear scaling for recording smaller frequency ranges.

To prevent recording during calibration, automatic pen lift is provided.

Note: When turning through the receiver frequency range, voltage peaks caused by switching processes in the synthesizers may occur at the transition frequencies 99.999/100 MHz and 199,999 MHz/200 MHz particularly in the operating modes PEAK and CISPR. It is recommended to lift the recorder pen at these transition frequencies.

2.3.16 IF, AF and Recorder Outputs 37 to 40

A number of outputs are provided for signal evaluation with oscilloscopes, analyzers and YT recorder.

+ **10.7-MHz IF output ⎍ 40**
  The bandwidth is the same as that set on IF bandwidth key 5.

  Output voltages (EMF, Z_{out} = 50 Ω):

Operating range 20 dB	10 to 100 mV
Operating range 40 dB	10 to 1000 mV
Operating range 60 dB	1 to 1000 mV

  Suitable for evaluation with oscilloscope, spectral analyzer and modulation analyzer.

+ **10.7-MHz IF output ⎍ 37**
  Bandwidth approx. 2 MHz; gain compared to RF input 50 with 0 dB RF attenution: typical 7.5 dB

  Suitable for input to an IF Panorama Adapter (e.g. EZP) or a spectrum analyzer.

Note:

In order to interconnect a Panoramic Adapter EZP with the ESV via a BNC cable, the EZP must be modified as follows:

Disconnect cable K1 from input filter (K1 open circuit).

Disconnect cable K3 from oscillator input and connect it instead of cable K1 to the input filter.

+ **AM demodulator output 38**
  Output voltage (EMF_{pp}, Z_{out} = 1 kΩ) for m = 50%: 1 V

  This output is DC-coupled and furnishes a 1-V output with an unmodulated carrier. Maximum bandwidth >0.3 MHz.

  Suitable for connection to an oscilloscope or a S/N-ratio meter.

Accessory units can be connected for further investigation and evaluation of the signals available at the receiver. Connection is made via sockets 32, 37 and 40 (rear panel). It should be borne in mind that the protective insulation of the ESV becomes ineffective when an instrument of safety class I is connected up. The ESV must then also be handled as a safety class I unit.

→ **FM demodulator output 39**
Output voltage (EMF, Z_{out} = 1 kΩ):

for IF bandwidths 120 kHz and 1 MHz: 1 V/100 kHz offset
for IF bandwidths 7.5 kHz and 12 kHz: 1 V/1 kHz offset
maximum bandwidth: 0.5 MHz.

Suitable for oscilloscopic analysis and for connection to an S/N-ratio meter. The frequency-transients behaviour of mobile radio transmitters can also be measured on this output.

→ An additional output is point STX210 of the 10.7-MHz amplifier on the inside of the instrument. It can be brought out to the rear panel by means of cable W9 of the external reference 36:

the **test demodulator output,** which accurately follows the envelope of the IF signal and can thus serve for oscilloscopic investigations.

Output voltages (EMF) 0 to 4 V, Z_{out} = 50 Ω, but only connectible to a high-impedance (> 1 kΩ) load. Bandwidth 0.5 MHz.

2.4.1 Sinewave Signal Measurement

Assumption: frequency and signal are unknown.

a) Average-value rectification

Basic setting for signals >10 dBµV:

Step width 10:	100 kHz
IF bandwidth 14:	1 MHz (mod. 52 and 53) or 200 kHz (mod. 55)
IF attenuator 19:	AUTO
Switch 13:	AV.
Indication 12:	LIN.
RF attenuator 18:	0 dB
Squelch 23:	at left stop
Demodulation 26:	A0
Volume control 25:	until some noise can be heard

With this basic setting, it is possible to rapidly scan the entire frequency range for sinewave signals with a level of >10 dBµV.

For signals <10 dBµV, the following basic setting is required:

Step width 10:	1 kHz
IF bandwithh 14:	7.5 kHz.

Otherwise, same as above.

If the 1st IF channel is overdriven by sinewave or pulse signals, the display 2 of the ESV blinks.

Remedy: Increase RF attenuation (18).

Determination of level:
After calibration add the readouts on 2 and 4.

Use:
Average-value indication of a modulated signal (e.g. from a sound broadcasting transmitter) independent of the modulation depth by averaging using a low-pass filter with a very low cutoff frequency.

Determination of frequency:
Tune the signal to zero beat (< 500 Hz). Read off frequency on 6. The accuracy of the frequency measurement depends on the frequency (see data sheet).

b) Peak-value rectification

Basic setting for signals >20 dBµV:
Same as under a) but:
Switch 13 PEAK or PEAK 1s

With this basic setting, it is possible to rapidly scan the entire frequency range for signals with a level >20 dBµV.

The IF bandwidth and tuning step size can be reduced for lower signal levels. Maximum sensitivity is about -4 dBµV at 7.5 kHz IF bandwidth.

Use:
Estimation of modulation depth of a sinewave signal by switching over between average-value and peak-value indication (Fig. 2-8, Table 2-5). Beware of reading errors due to noise: Refer to Fig. 2-4.

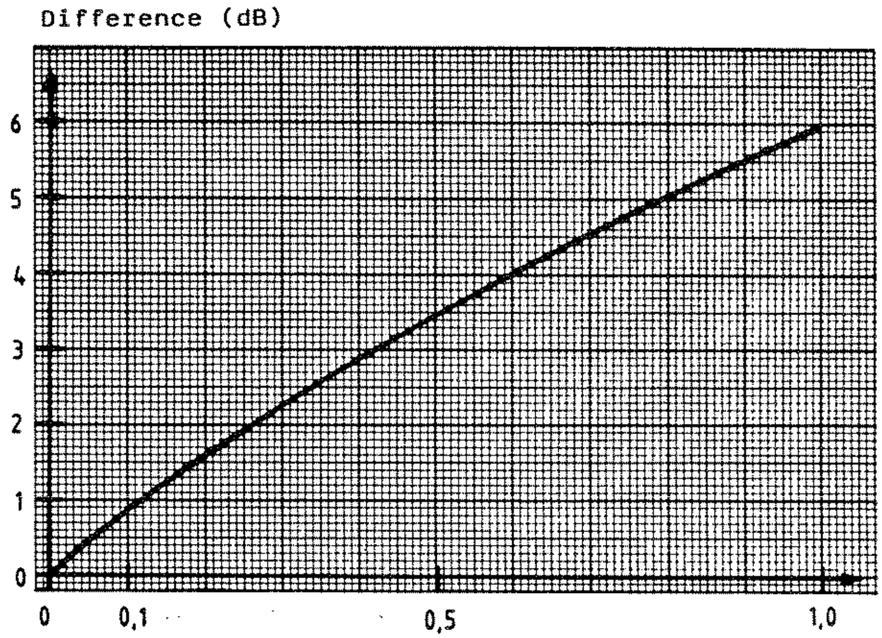


Fig. 2-8 Modulation depth as a function of the difference between average-value and peak-value indication

Table 2-5 Peak-value indication of an AM signal

m	20 log (1+m) dB
0	0 dB
0.05	0.42
0.10	0.83
0.15	1.21
0.20	1.58
0.25	1.94
0.30	2.28
0.35	2.61
0.40	2.92
0.45	3.23
0.50	3.52
0.55	3.81
0.60	4.08
0.65	4.35
0.70	4.61
0.75	4.86
0.80	5.10
0.85	5.34
0.90	5.58
0.95	5.80
1.00	6.02

Increase in indication in dB as against unmodulated carrier or difference between peak value and average value as a function of modulation depth with sinewave modulation.

2.4.2 Measurement of Pulse Signals

The ESV reads out that spectral portion of the pulse signal that appears within its IF bandwidth.

Pulse signals may possess different characteristics:

+ The obtainable voltage of a correlated broadband signal is directly proportional to the 6-dB test bandwidth.

+ The obtainable voltage of white noise is proportional to the root of the 3-dB test bandwidth.

+ The obtainable voltage of a technically non-correlated interference has a proportionality which is between (i) and (ii) above.

For this reason, it is necessary to measure with the test bandwidth that is closest to the reference bandwidth.

Moreover, it is distinguished between
weighted measurements (e.g. according to CISPR Publ. 2 and 4) and
unweighted measurements (e.g. MIL):

a) Quasi-peak weighting according to CISPR Publ. 2 and 4 and VDE 0876

Basic setting:

Step width 10:	100 kHz (or 10 kHz)
Switch 13:	CISPR
IF attenuation 19:	AUTO *)
RF attenuation 18:	>10 dB
AF demodulation 26:	switched on
Volume control 25:	until noise is audible

In CISPR Publ. 2 and 4 operation, switch 12 (indicating range) is disabled. Regardless of the type of demodulation selected, the unregulated AM can be heard via the AF filter (300 Hz to 3.3 kHz). Only the readout in the upper 10-dB range, i.e. between 10 and 20 dB, of the LIN 20-dB range applies. According to CISPR Publ. 2 and 4, the RF attenuator setting should be >10 dB, otherwise the measuring accuracy can be affected. For calibration with 17, a pulse generator complying with the provisions of CISPR is used. The CISPR Publ. 2 and 4 weighting curve is shown in Fig. 4-4 (see Service Manual).

Use:
CISPR measurements using test antennas or probes.

The ESV contains several logic circuits to simplify the complex CISPR measurements. Specially designed circuits improve the measuring accuracy in particular with slow repetition frequencies. Measurement errors are avoided by the aural monitoring capability of the pulse signals, automatic encoding of the conversion factor of the test antenna of probe used and automatic overload detection.

*) Instead of using the 10-dB IF attenuation available when switched to AUTO, 20 dB can be selected with the IF attenuation selector switch 19 providing it is not intended to measure a very low pulse frequency (<2 Hz). With this setting, the AF S/N ratio increases and thus eases the acoustic control.

measurements to CISPR

The suitability of average-value indication of test receivers for pulse noise measurements is determined according to VDE 0876 Part 3. As can be obtained from Figs. 2-8.1 and 2-8.2, the average-value indication of the ESV is suitable both for linear and logarithmic indication.

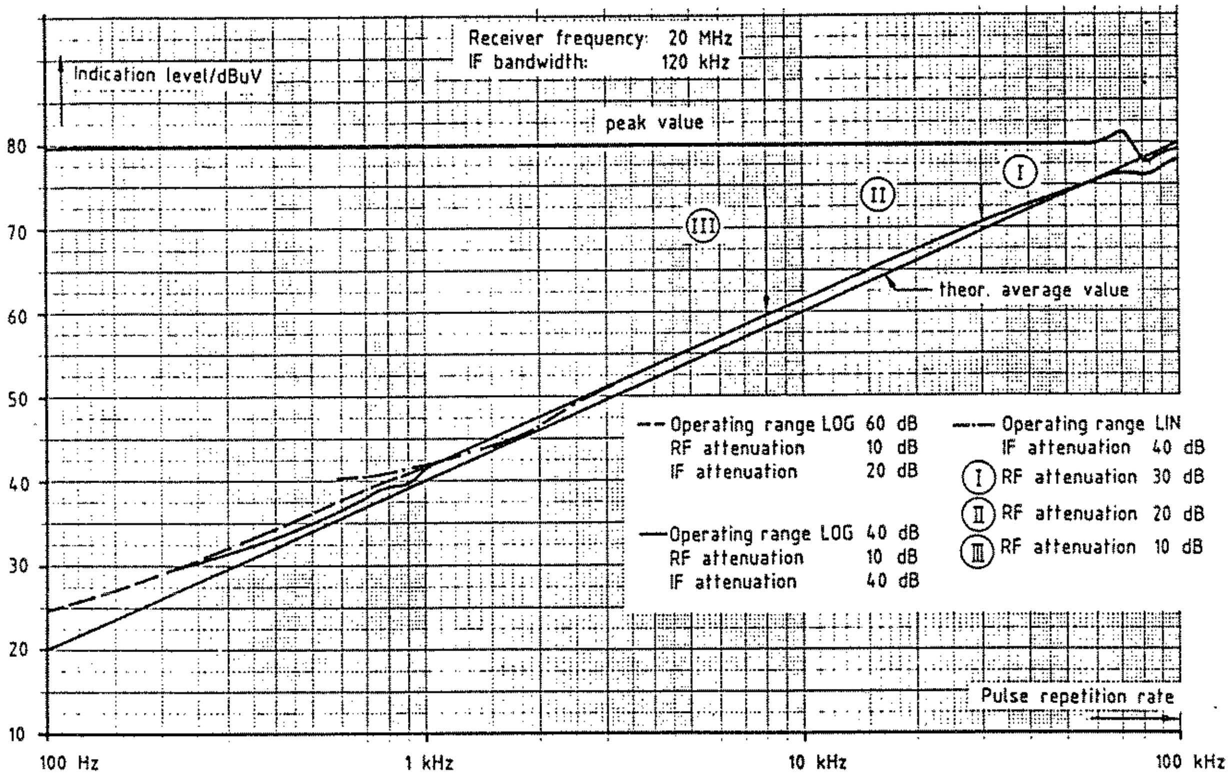


Fig. 2-8.1 Peak- and average-value indication as a function of the pulse repetition rate

tion is about 200 Hz with logarithmic indication and about 1 kHz with linear indication. The validity of average-value indication can be checked as follows:

If the peak-value indication of the ESV is less than 10 dB above full-scale deflection, the average-value indication is correct. With average-value indication, the IF attenuation must always be set to the highest possible value (40 dB).

The latest CISPR publications (CISPR 22, CISPR 14) specify limit values both for quasi-peak as well as for average-value indication. Since the quasi-peak limit values exceed the average-value limit values by roughly 10 to 13 dB, the pulse-weighting curves (Fig. 2-8.2) permit to determine the overload reserve required for the average-value indication range to be used. It is 14 dB and is required for correct measurement of pulse noise with a pulse repetition rate of approx. 25 kHz with average-value indication.

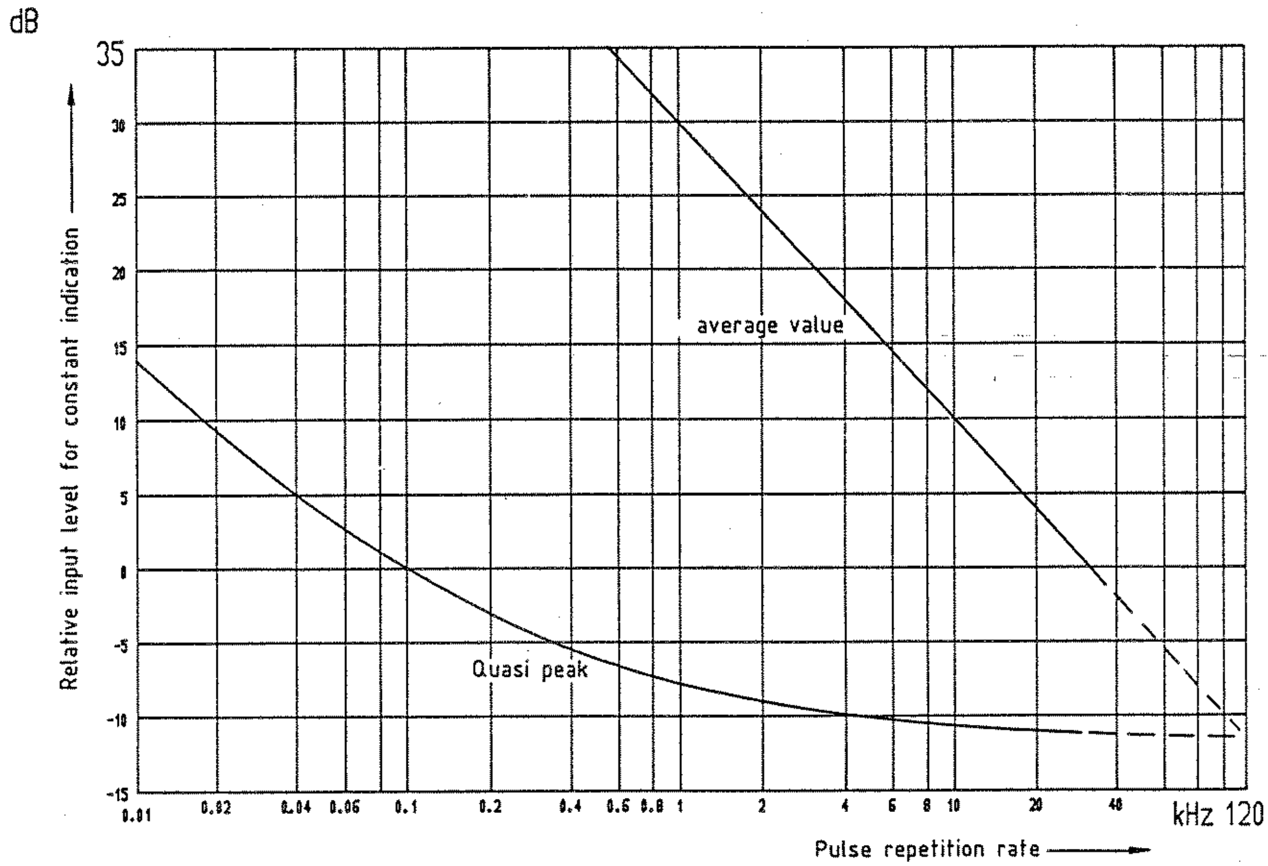


Fig. 2-8.2 Weighting curves for the frequency range 30 to 1000 MHz

The overload reserve of the average-value indication of the ESV is approx. 10 dB at full-scale deflection. For this reason, the usable indicating range of the panel meter is

10 to 57 dB for LOG 60 dB
0 to 37 dB for LOG 40 dB
0 to 17 dB for LIN (20 dB).

Thus, the procedure for using average-value indication is as follows:

- Set IF attenuation 19 to 40 dB.
- Set indicating mode 13 to MW AV.
- Read off the indication on panel meter 4 in the previously specified usable indicating range according to the selected indicating range 12.

b) MIL

Measurements of wideband interferences to MIL STD 461/462 is an unweighted peak-value measurement (13 in position PEAK or PEAK 1 s) with the voltage referred to the bandwidth (e.g. dB(μV/MHz)). Be careful when converting to any bandwidth other than the test bandwidth. The usual IF bandwidth for MIL wideband interference measurements is 1 MHz.

For tracing the maxima of pulse interferences it is advisable to use mode "SP" because of the short hold time. Taking into consideration the inertia of the meter the indication error increases with decreasing pulse frequency (<20 Hz). This error is displayed in Fig. 2-9 for the LIN range and in Fig. 2-10 for the LOG-40-dB or LOG-60-dB range.

For the accurate determination of the level switch over to SP (1 s).

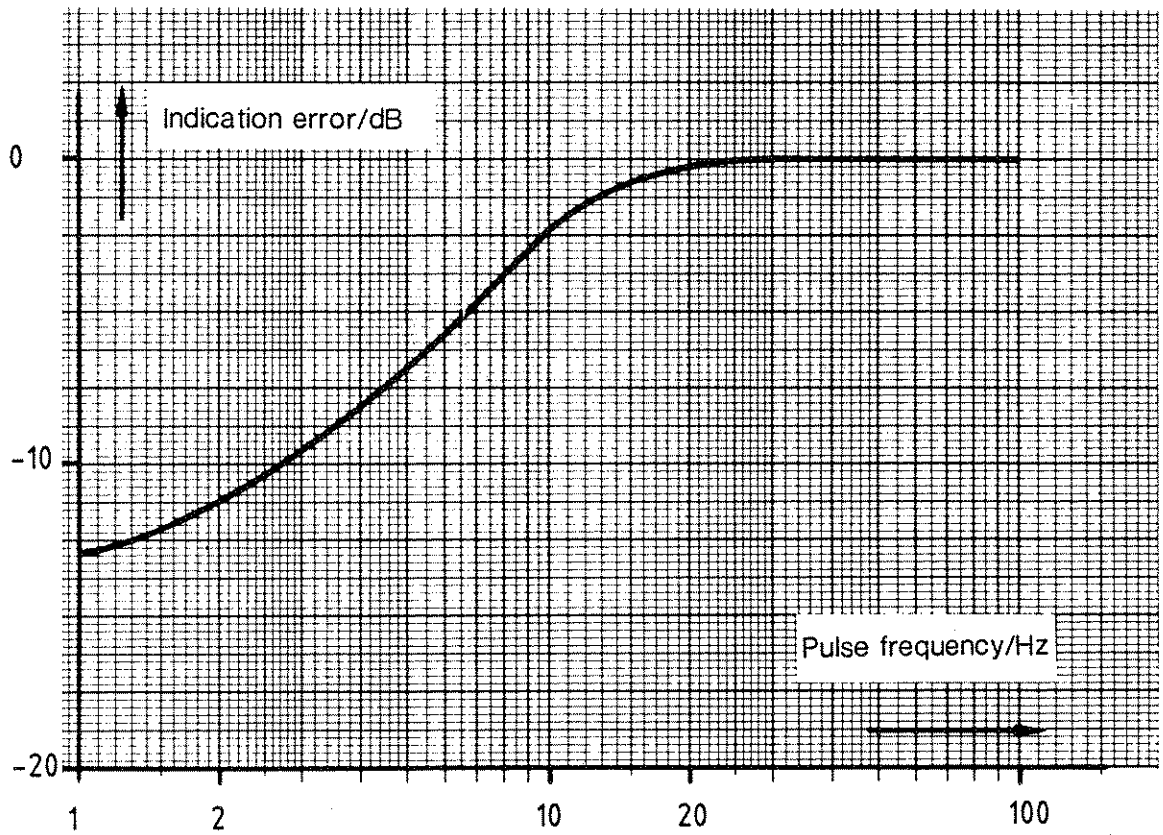


Fig. 2-9 Accurate indication of fast peak-value indication LIN range

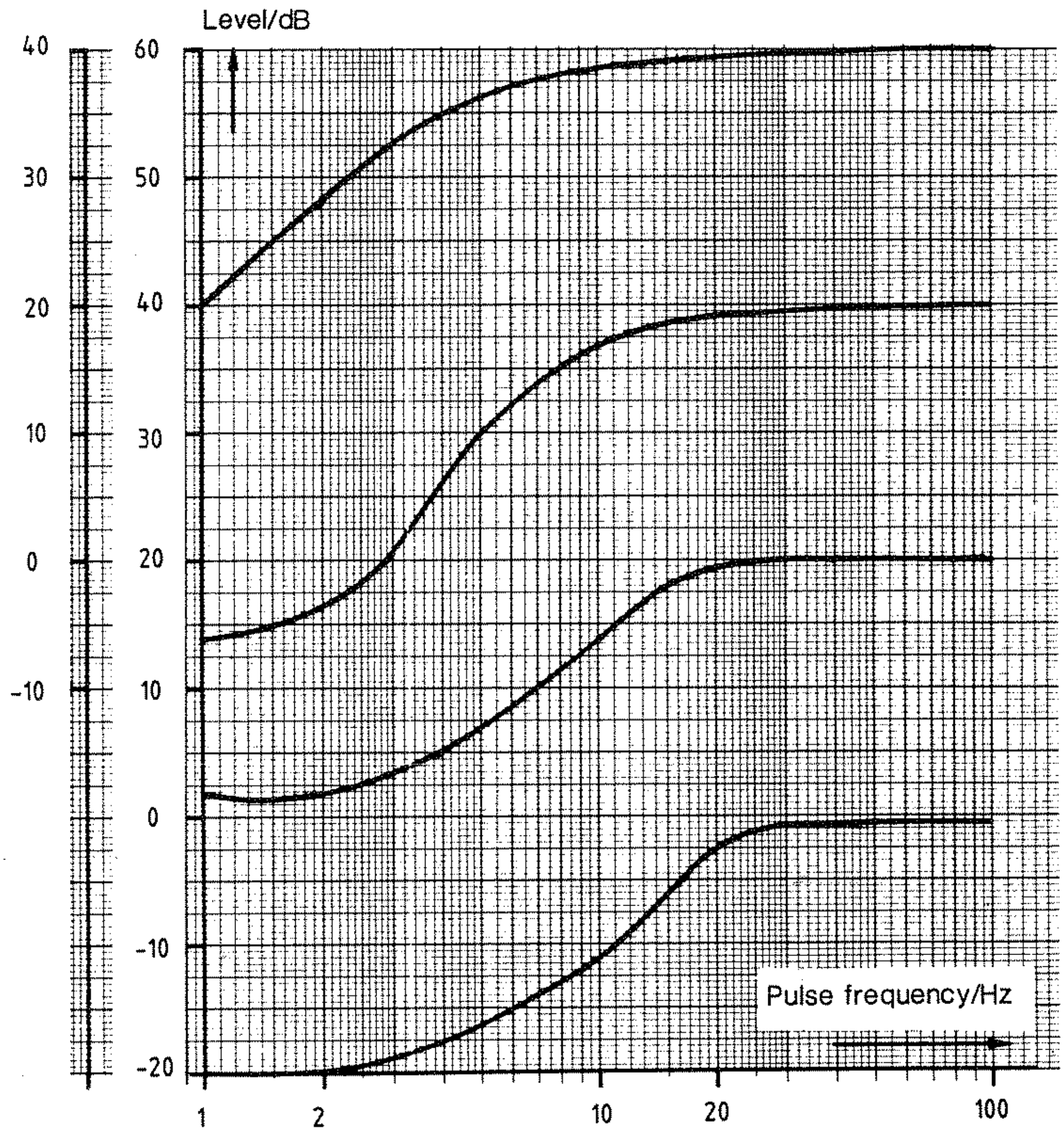


Fig. 2-10 Accurate indication of fast peak-value indication LOG-40-dB and LOG-60-dB range

c) Linearity check

The linearity of the receiver is checked by proving the direct proportionality of the input voltage to the indicated value. Free access to the IF and RF attenuators facilitates this check:

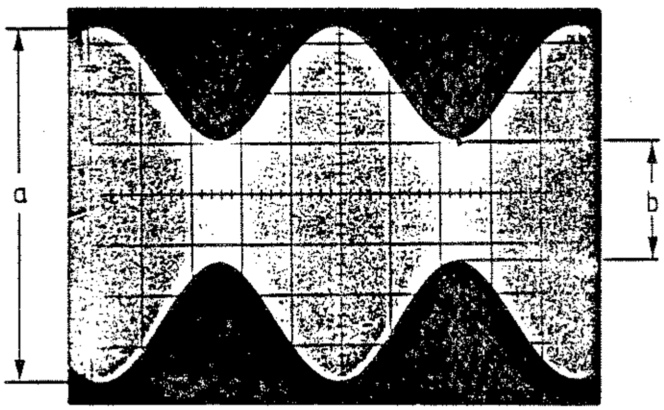
- Note measured value.
- Decrease RF attenuation by 10 dB.
- Increase IF attenuation by 10 dB.
- Compare the new measured value with the old one. If it differs by more than 2 dB, the receiver may have been overdriven.

2.4.3 Modulation Analysis and Frequency Analysis

a) 10.7-MHz output (wide) (37)
At 37 a spectrum analyzer or panoramic adapter, such as the EZP from R&S can be connected to observe and analyze the signal occupancy within a range of about ±2 MHz or the characteristics of a signal within the passband of the RF filter cut into circuit.

b) 10.7-MHz output (narrow) (40)
The bandwidth corresponds to the selected IF bandwidth. The modulation depth can be measured at either outputs in the following way:

Using an oscilloscope
Example: modulated signal



$$\text{Modulation depth } m/\% = \frac{a-b}{a+b}\ 100/\%$$

Using an IF analyzer
Example: modulated signal
Measurement procedure: Determine Z = X-Y from the screen display and convert according to the following formula:

$$m/\% = \frac{200}{10^{Z/20}}$$

Measurement procedure:

- Determine the carrier level X dB(μV); e.g. 96 dB(μV)
- Determine the 1st sideband Y dB(μV); e.g. 76 dB(μV)
- Subtract to obtain the difference Z = X-Y (dB)
- Compute modulation depth from difference:

$$\rightarrow Z = X-Y = 20 \text{ dB}$$

$$\rightarrow m/\% = \frac{200}{10^{20/20}} = 20\%$$

Determining the modulation distortion using the analyzer

By measuring the other sidebands of the modulated signal and forming the ratio to the 1st sideband, the distortion of the individual components is obtained from which the total distortion can be computed according to known formulae. The modulation frequency f_{mod} can be determined from the difference between the frequencies.

SSB reception
The ESV with its step size of 1 kHz is normally not suitable for SSB reception. By connecting a receiver designed for SSB reception, such as the ESH2 and 3 from R&S to the IF output 37 or 40, the ESV can be used as a pre-converter and thus for SSB reception up to 1 GHz.

2.4.4 Recording

2.4.4.1 Recording the Voltage Indicated on Meter 4 as a Function of Time

An unambiguous test report for documentation can be obtained by recording the voltage indicated on the meter over an adequate period of time. To this end, the Y deflection of the recorder is connected to 32 pin 5 and at full-scale deflection of meter 4 adjusted to maximum.

a) Calibration of the recorder with the switch 12 in position LIN

Calibration of the recorder without auxiliary equipment is possible only at three levels: 0, 10 and 20 dB. To do so, proceed as follows:

- Connect the RF input socket 22 to the generator socket with a short cable.
- Set the IF attenuator switch 19 to 40 dB.
- Vary the RF attenuator switch 18 until the meter 4 gives a full-scale deflection. Now increase the RF attenuation, first by 10 dB and then by 20 dB, the recorder being activated for a short time at each of these settings tracing a calibration staircase.

Finer calibration can be obtained by varying the level of the generator in steps of 1 dB and tracing a calibration staircase as above.

b) Calibration of the recorder with the switch 12 in position LOG 40 or LOG 60 dB

In this case, the recorder is calibrated in 10-dB steps. Subdivision is accomplished by interpolation thanks to the linear dB gradation.

2.4.4.2 Recording the Offset Voltage as a Function of Time

Connect the Y deflection of the recorder to X251 32 pin 1. When using speed recorders (with respect to Y recording speed), interconnecting an RC lowpass filter may prove useful if, for example, a frequency-modulated signal is to be recorded.

Calibrate the recorder as follows:

- Apply a signal to the receiver.
- Set the switch AF DEMODULATION 26 to position A0.
- Adjust the tuning knob 9 to zero beat and the Y deflection of the recorder to the centre of the recording chart.
- Detune the receiver by the desired frequency with the aid of tuning knob 9.
- Adjust the recorder for maximum deflection.

It is advisable to repeat the calibration procedure since these settings are mutually interdependent with some recorders. The offset voltage being a linear function of the frequency, it is possible to linearly interpolate the trace.

2.4.4.3 Recording of the Level as a Function of Frequency

For the recording of frequency spectra with the aid of an XY recorder, it is recommended to use the Recorder Adapter ESV-Z4. (Operation and adjustment of recorder see section 2.3.15.)

It is in addition advisable to use preprinted recording paper with limit-value lines for RFI measurements in line with national and international standards (see Annex). Fig. 2-11 shows the interference spectrum of a desktop computer between 20 to 1000 MHz, measured in line with MIL 461A RE02 in a screened cabin at a distance of 1 m. The limit-value lines for narrowband emissions are included in the diagram taking into account the antenna factors of a biconal antenna between 20 to 200 MHz and a log conical spiral antenna between 200 and 2000 MHz.

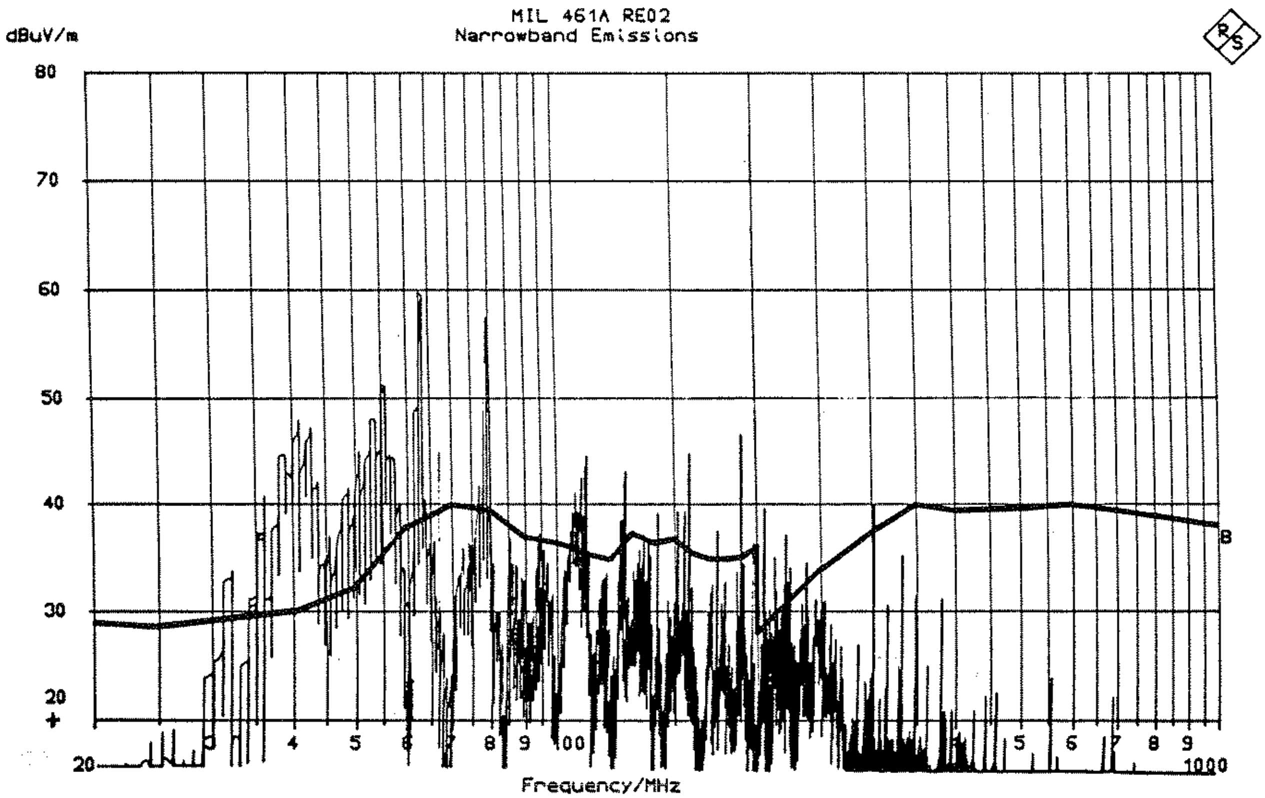


Fig. 2-11 Interference spectrum of a desktop computer in line with MIL 461A RE02

Setting of the ESV:	RF attenuation	0 dB
	IF attenuation	30 dB
	IF bandwidth	120 kHz
	Indication	PEAK
	Display range of recorder	1000 MHz, logarithmic

As in this setting the stepwidth of the recorder display is 1 MHz, vertical lines are drawn on the diagram at 1-MHz spacing, joining the maximum and minimum value in a 1-MHz range. If a higher resolution is required, a smaller display range can be employed.

The sweep speed of the ESV is to be selected so that the recorder can fully settle even for large level swings. With the receiver fixed to a frequency for an extended period of time, it is recommended to lift up the pen in order to avoid soaking and damaging the paper.

2.4.5 Sideband Noise Power Measurements

Thanks to the very high suppression of the sideband noise power of the internal oscillators and the selective IF filters, it is readily possible to make measurements in the vicinity of the carrier at high levels (see Fig. 2-5). This is particularly important for adjacent-channel power measurements at 12.5-, 20- and 25-kHz channel spacing.

2.4.6 Two-port Measurements

The ESV in conjunction with a signal generator can be used for two-port measurements over a wide level range (-10 dBµV to +137 dBµV).

Basic setting on the ESV: Tune to signal generator frequency by means of 9.

	Switch 13:	AV
	IF bandwidth 14:	7.5 kHz
	IF gain 19:	AUTO

Measurement procedure:
- Connect the signal generator output to the receiver input.
- Determine the signal generator level.
- Connect two-port network between signal generator output and receiver input.
- Determine the new level.
- The difference between the two levels is the attenuation or the gain of the two-port network.

Uses:
Filters, amplifiers, antenna decouplers.

2.4.7 Connecting Test Antennas or Probes

Test antennas, test probes, current probes, etc. are connected to the sockets 21 and 22, the voltage to be measured passing via the socket 22 to the receiver and the active probe being powered via the socket 21. The conversion factor is also encoded via socket 21, which is thus taken into consideration in the readout on 2.

2.4.8 Conversion Formulae

B/dB(µV) → A/µV	: A/µV	=	$10^{\frac{B}{20}}$
A/µV → B/dB(µV)	: B/dB(µV)	=	20·logA
B/dB(µV) → C/dBm	: C/dBm	=	-107+B (-107 dBm corresponding to 1 µV into 50 Ω)
C/dBm → B/dB(µV)	: B/dB(µV)	=	107+C

2.4.9 Recommended Extras

Signal generator for two-port measurements

R&S Type SMPC 300.1000.55

Panoramic adapter for checking the band occupancy

R&S Type EZP 254.0017.04

Modulation analysis

Oscilloscope >20 MHz 10 mV/cm
R&S Type BOL 374.2000.02

SSB reception

R&S Type ESH2 303.2020.52

Recording

R&S Type ZSKT 301.9010.02

2.5 Fitting the Option ESV-B2

Fitting this option extends the frequency range of Model 52 to 1 GHz. The unit corresponds then fully to the specifications of Model 53.

The Option ESV-B2 consists of the 0.5- to 1-GHz Option (IN 353.6012) and the coaxial cables W16, W17 and W18 as well as a trim cover.

Fitting procedure is as follows (see Fig. 2-12):

- Loosen the external cover panels (8 Phillips screws).
- Loosen the inside covers (2x16 Phillips screws).
- Insert the 0.5- to 1-GHz Option.
- Disconnect W2 from X172 on RF module 1.
- Connect W2 to X182 on the 0.5- to 1-GHz Option.
- Remove W8 from X155 on Synthesizer 1.
- Connect W8 to X184 on the 0.5- to 1-GHz Option.
- Connect X185 on the 0.5- to 1-GHz Option to X155 on Synthesizer 1 with cable W17.
- Connect X183 on the 0.5- to 1-GHz Option to X172 on RF module 1 with cable W16.

Check:

- The ESV should now be tunable to frequencies above 520 MHz by means of tuning knob 9. Check calibration according to 2.2.5.1.

- Replace inside covers.

- Replace external cover panels.

- Mount trim cover on the front panel (3 Phillips screws).

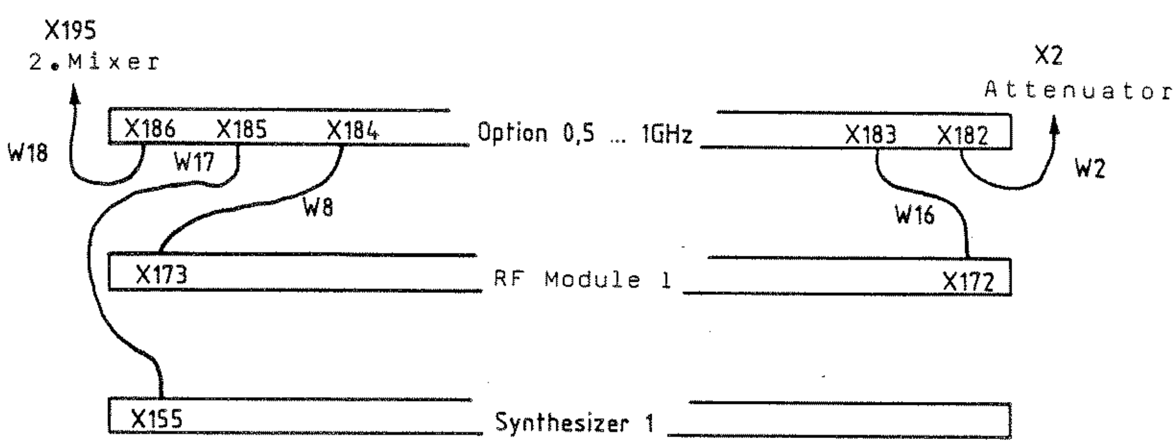


Fig. 2-12 Wiring of synthesizer 1, RF module 1, Option 0.5 to 1 GHz

3.1 Required Measuring Instruments and Auxiliary Equipment

Ref. No.	o Type of instrument required, performance rating ● Recommended R&S instrument	Type	Order No.	See section
1	o Multimeter 20 V, 2 A Accuracy better than 1% ● Digital Multimeter	 UDL33	 388.8011.02	3.2.1 3.2.2 3.2.15.3 3.2.15.4 3.2.15.4 3.2.15.5 3.2.15.6
2	o Signal generator 20 to 1000 MHz Level 0 dBm Low sideband noise Harmonics down >35 dB With modulation capability ● Signal Generator 0.05 to 1360 MHz	 SMPC	 300.1000.52	3.2.3.1 3.2.3.2 3.2.3.4 3.2.3.5 3.2.4 3.2.5 3.2.7 3.2.9 3.2.10 3.2.11 3.2.12 3.2.13
3	o Power meter 50 Ω, Accuracy better than +0.1 dB Frequency range 20 to 100 MHz ● Microwave Power Meter with Probe	 NRS	 100.2433.92 100.2440.50	3.2.3.1 3.2.3.2
4	o Attenuator 50 Ω 0 to 110 dB Accuracy better than 0.3 dB ● Programmable Attenuator	 DPVP	 214.8017.55	3.2.3.1 3.2.3.2 3.2.3.4 3.2.3.5 3.2.11 3.2.12
5	o CISPR standard pulse generator 50 Ω Adjustable pulse repetition frequency, such as Schwarzbeck Meßelektronik, CISPR 2/4 Standard Pulse Generator IGU			3.2.3.1 3.2.3.2 3.2.3.3
6	● Oscilloscope 10 MHz single channel, 10 mV/cm	BOL	374.2000.02	3.2.15.3 3.2.15.4

Ref. No.	o Type of instrument required, performance rating ● Recommended R&S instrument	Type	Order No.	See section
7	o Noise generator 0 to 16 dB, 50 Ω, 20 to 1000 MHz ● Noise Generator	SKTU	100.4688.50	3.2.6
8	o Impedance meter 50 Ω, 20 to 1000 MHz, 0 to 100% ● Vector Analyzer with Tuner	ZPV ZPV-E2	291.4012.92 292.0010.02	3.2.7
9	o Selective microvoltmeter 50 Ω, 600 to 1350 MHz, 1 µV such as Takeda Riken TR4172			3.2.8. 3.2.15.1 3.2.15.2
10	o Low-pass filter 50 Ω, 1st harmonic down >60 dB			3.2.11 3.2.12 3.2.13
11	o Power splitter 50 Ω Decoupling >25 dB 20 to 100 MHz			3.2.11 3.2.12 3.2.13
12	o Attenuator 50 Ω 20 dB ● High-power Attenuator	RBD	100.2962.50	3.2.12 3.2.13
13	o Antennas Reference field 10 V/m ● Broadband Dipole 20 to 80 MHz ● Log-periodic Antenna 80 to 1300 MHz	HFU3-Z1 HLO23 A1	358.0512.52 577.8017.02	3.2.14
14	o Power amplifier 10 W, 50 Ω 20 to 1000 MHz			
15	o Test receiver 10 kHz to 30 MHz ● Test Receiver	ESH2	303.2020.52	3.2.6
	Auxiliary equipment: Adjustable resistor, 10 Ω, 25 W Cable fitted with N connectors Dezifix B-to-N adapter			3.2.1

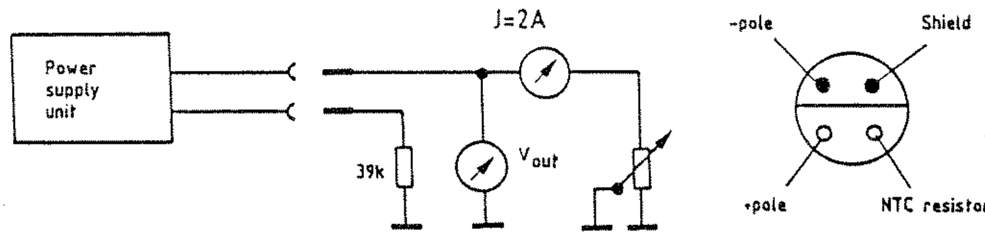
3.2 Checking the Performance Specifications

Make these checks after the performance check according to section 2.2.5 has been made. This avoids making measurements on faulty receivers.

3.2.1 Checking the Power Supply Unit 303.3210

Check the voltage after the battery has been fully charged using a resistor of 39 kΩ in place of the NTC resistor in the battery pack.

Test setup:



Connect a load resistor and the 39-kΩ resistor to the output cable of the power supply unit according to the above drawing.

V_{out} (if I = 2 A) .... 14.3 V ±0.1 V
Without NTC resistor .... 12.5 V ±0.2 V

3.2.2 Checking the Battery Pack

After having been charged for 14 hours from the power supply unit 303.3210, it should be possible

- to operate the Test Receiver ESV for a period of >3 hours or
- to keep up a voltage of >+10.8 V over more than three hours at a discharge rate of 1.8 A.

3.2.3 Checking the Measuring Accuracy

With the ESV switched off, check the mechanical zero on the panel meter and correct, if necessary, by means of the screwdriver adjustment 5 (Fig. 2-12).
The measuring accuracy of the Test Receiver ESV is determined by:

- the accuracy of the internal calibration generator
- the accuracy of the internal attenuator
- the accuracy of the panel meter scales
- calibration offset and
- signal-to-noise ratio (depending on IF bandwidth).

Permissible total error with sinewave signals (provided that the signal-to-noise ratio is satisfactory) for average- and peak-value indication ....<±1.5 dB

3.2.3.1 Checking the Level Indication in Switch Position ... (20 dB)

dBµV -107 = dBm (50)

a) **Average value:**

Setting of the ESV: switch 13: AV
IF attenuation 19: 40 dB
RF attenuation 18: 50 dB
IF bandwidth 14: 120 kHz
calibrate the receiver.

Apply a sinewave signal of 98 dBµV ±0.1 dB in the frequency range 20 to 520 (1000) MHz. -9 dBm

Nominal indication .... 98 dBµV
Permissible error of level indication .... <±1.2 dB

b) **Peak value:**

Setting of the ESV: switch 13: PEAK or PEAK 1 s
IF bandwidth 14: 1 MHz (mod.52 and 53)
200 kHz (mod 55)
RF attenuation 18: 40 dB
IF attenuation 19: 40 dB

Setting of the signal generator: pulse repetition frequency 100 Hz.

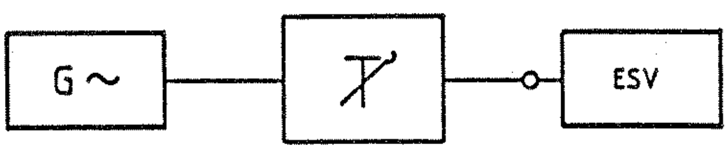
Apply pulse signal of 88 dBµV/MHz derived from a standard pulse generator to the RF input 22 of the ESV (this corresponds to a setting of 58 dB in the case of the Schwarzbeck CISPR 2/4 standard pulse generator).

Nominal indication .... 88 dBµV (mod.52, 53)
75 dBµV (mod. 55)
Permissible error of level indication ...<-1 dB
+2 dB

c) **Checking the scale accuracy:**

Same setting of the ESV as under 3.2.3.1 a).

Test setup:



Starting with full-scale deflection, reduce the level by 20 dB in steps of 1 dB by means of the external attenuator.
Permissible scale error .... <0.2 dB

LOG 40 dB/LOG 60 dB

a) Average value:

Setting of the ESV: switch 13: AV.
IF attenuation 19: 40 dB
RF attenuation 18: 30 dB or 10 dB
IF bandwidth 14: 120 kHz
calibrate the receiver.

Apply a sinewave signal of 98 dBμV ±0.1 dB in the frequency range 20 to 520 (1000) MHz
Nominal indication .... 98 dBμV
Permissible error of level indication .... <±1.2 dB

b) Peak value:

Setting of the ESV: switch 13: PEAK or PEAK 1 s
IF bandwidth 14: 1 MHz (mod.52 and 53)
200 kHz (mod. 55)
RF attenuation 18: 20 dB
IF attenuation 19: 40 dB

Apply pulse signal of 88 dBμV/MHz derived from a standard pulse generator to the RF input of the ESV (this corresponds, for example, in the case of the Schwarzbeck CISPR 2/4 standard pulse generator to a setting of 58 dB).
Pulse repetition frequency 100 Hz
Nominal indication .... 88 dBμV (mod.52, 53)
75 dBμV (mod. 55)
Permissible error of level indication .. <±2 dB

c) Checking the scale accuracy:

Setting of the ESV: switch 12: LOG 40 dB (LOG 60 dB)
(all other settings same as under 3.2.3.2.a))

Starting with full-scale deflection reduce the signal level by 40 (60) dB in steps of 2 dB by means of the external attenuator.
Permissible scale error .... <±1 dB

3.2.3.3 Checking the Level Indication in Switch Position CISPR (Publ. 2 and 4)

Setting of the ESV: switch 13: CISPR;
IF attenuation 19: AUTO
RF attenuation 18: 40 dB

Connect standard pulse generator which supplies a standard pulse with an EMF of 0.044 μVs (Z_{out} = 50 Ω) and a repetition frequency of 100 Hz to socket 22.

Nominal indication .... 60 dBμV
Permissible error of level indication .... ±1 dB.

When varying the repetition frequency according to Fig. 4-4, the indication on the receiver must be within the tolerances specified.

3.2.3.4 Checking the Attenuator

Test setup: see 3.2.3.1 c)

Tune the signal generator to the frequency of the ESV (level: 118 dBµV).

Setting of the ESV:

IF attenuation	19:	20 dB;
switch	12:	LIN
switch	13:	AV
IF bandwidth	14:	7.5 kHz
RF attenuation	18:	90 dB

Set the external attenuator to 0 dB.
Readout on 2 and 4 .... 118 dBµV

Increase the setting of the external attenuator in steps of 10 dB and reduce the RF attenuation of the ESV starting from 90 dB. Note deviation from original pointer deflection.
Permissible deviation .... 0.4 dB

3.2.3.5 Checking the IF Level Switch

Test setup: see 3.2.3.1 c)

Tune the signal generator to the frequency of the ESV (level: 118 dBµV).

Setting of the ESV:

RF attenuation	18:	70 dB
IF attenuation	19:	40 dB
switch	12:	LIN
switch	13:	AV
IF bandwidth	14:	7.5 kHz

Set the attenuator to 10 dB.
Pointer deflection .... 28 dBµV

Reduce the IF attenuation of the ESV in steps of 10 dB and increase the setting of the attenuator. Note deviation from original pointer deflection.
Permissible deviation .... <0.2 dB

3.2.4 Checking the Frequency Accuracy

Connect a signal generator with accuracy of better than 1×10^{-7} and f = 500 (1000) MHz to the generator output GEN. 22.

Setting of the ESV:

demodulation	26:	A0
switch	13:	AV

Connect oscilloscope to 27.
Adjust with 25 until sinewave can be measured.
Permissible beat frequency at f = 500 MHz .... 5 kHz
f = 1000 MHz .... 10 kHz

Setting of the ESV: frequency: any
switch 12: LIN
switch 13: AV
IF attenuation 19: 40 dB

Adjust level of generator signal of same frequency as applied to the RF input of the receiver 22 until the panel meter 4 reads full-scale deflection. At each of the four bandwidths provided detune the generator first towards lower frequencies and subsequently towards higher frequencies until the indication on the panel meter 4 decreases by 3 and 6 dB, and note the respective frequencies at which these level drops occur. The IF bandwidth is determined by the difference between the tuning frequencies of the generator at these level drops.

3.2.6 Checking the Noise Figure

Connect a noise generator to the RF input 22 of the Test Receiver ESV.
Connect a selective test receiver (e.g. ESH 2) to the narrowband 10.7-MHz output of the ESV via a calibrated attenuator.

Setting of the ESV: RF attenuation 18: 0 dB
switch 12: LIN
switch 13: AV
IF bandwidth 14: 1 MHz (mod. 52 and 53)
200 kHz (mod. 55)

Read off the noise indication on the test receiver at 10.7 MHz with the attenuator set to 3 dB. Next increase the attenuation to 6 dB and increase the level of the noise generator until the previous indication is obtained. The setting of the noise generator corresponds to the noise figure.

Noise figure

if f < 520 MHz .... typ. 15 dB,
if f < 1000 MHz .... typ. 16 dB.

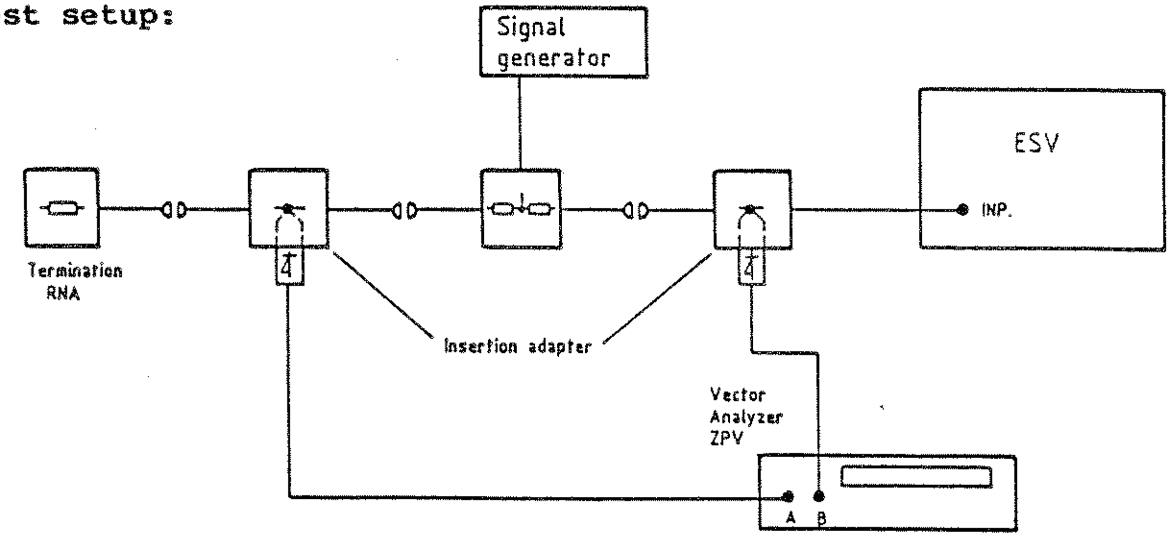
Check the typical noise deflection at the various IF bandwidths (13: AV) according to table 3-1.

Table 3-1

Bandwidth	f < 520 MHz	f < 1 GHz
1 MHz (mod.52 and 53)	+ 8 dBµV	+ 9 dBµV
200 kHz (mod.55)	+ 1 dBµV	+ 2 dBµV
120 kHz	- 1 dBµV	0 dBµV
12 kHz	-11 dBµV	-10 dBµV
7.5 kHz	-13 dBµV	-12 dBµV

3.2.7 Checking the Input Reflection Coefficient

Test setup:



The signal generator and the reflection-coefficient indicator operate at the tuning frequency of the receiver.

RF attenuation	0 dB	r <33% (= VSWR <2)
	>0 dB	r <10% (= VSWR <1.2)

3.2.8 Checking the Oscillator Reradiation at the RF Input 22

Setting of the ESV: RF attenuation 18: 0 dB

Connect a sensitive selective indicator, such as an analyzer to input 22 of the ESV. The receive frequency of this indicator should be:

$f_{receive}$ + 810.7 MHz if f <520 MHz
$f_{receive}$ + 310.7 MHz if f >520 MHz

Level indication <10 dBµV if $f_{receive}$ <520 MHz
<20 dBµV if $f_{receive}$ >520 MHz

3.2.9 Checking the IF Rejection

Setting of the ESV:			
	RF attenuation	18:	0 dB
	IF attenuation	19:	AUTO
	IF bandwidth	14:	7.5 kHz
	switch	13:	AV

Apply a signal level of +80 dBµV and a sideband S/N ratio >130 dB/Hz to RF input 22. Check all tuning frequencies of the ESV.

Permissible increase in indication .... <0 dBµV
Frequency of signal .... 810.7 MHz if $f_{receive}$ <520 MHz
310.7 MHz if $f_{receive}$ >520 MHz

3.2.10 Checking the Image Frequency Rejection

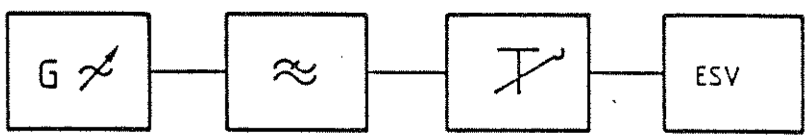
Setting as under 3.2.9.
Signal generator level as under 3.2.9.
Signal generator frequency:
Signal generator frequency $f_{receive}$ + 2 x 810.7 MHz if $f_{receive}$ <520 MHz.
Signal generator frequency $f_{receive}$ + 2 x 310.7 MHz if $f_{receive}$ >520 MHz.

3.2.11 2nd Order Harmonic Distortion (a_{K2})

Apply signal of low harmonic content (frequency f_1) to the RF input 22. Due to the non-linearity of the input mixer, for example, a signal $f_2 = 2 \cdot f_1$ is obtained. Measure the level of this signal and compare it with the input signal level. There is a square-law relationship between the level of the spurious product and the input signal level. This means that when the input level is increased by n dB, the spurious product increases by 2·n dB and the level difference between the two signals decreases by n dB.

The requirements placed on the test assembly for measuring harmonic distortion and intermodulation rejection are very exacting since the ESV features excellent characteristics.

Test setup:



The attenuation of the low-pass filter should be >60 dB at the 2nd harmonic of the generator signal and the harmonic distortion of the signal generator should be down >35 dB.

Calculation of the harmonic distortion and the 2nd-order intercept point K2:

Input signal to the receiver: level l_1/dBµV
frequency f_1

Resulting unwanted signal: level l_2/dBµV, frequency f_2

Harmonic distortion a_{K2}/dB = down $l_1 - l_2$ at a level of l_1/dBµV

Intercept point K2: K2 intercept point/dBm= $l_1^* + a_{K2}$

where
$l_1^* = l_1$ converted into dBm.

Measurement:

Setting of the ESV:	RF attenuation	18:	0 dB
	switch	13:	AV
	IF bandwidth	14:	7.5 kHz

Signal generator level at f_1 .... <73 dBµV
Indication on the ESV at 2 x f_1 .... < 0 dBµV

3.2.12 3rd Order Intermodulation Rejection (a_{D3})

Apply two signals of low harmonic content at frequencies f_1 and f_2 to the input of the receiver. Due to the non-linearity of the input mixer signals of the

3rd order: $f_3 = 2 f_2 - f_1$
$f_4 = 2 f_1 - f_2$

are produced.

Measure the level of the signals f_1, f_2, f_3 and f_4. The averaged level difference between f_1, f_2 and f_3, f_4 determines the 3rd order intermodulation rejection (a_{D3}).

The minimum frequency spacing between the two signals f_1, f_2 must be >2 MHz. Very exacting requirements are placed on the test assembly for measuring intermodulation rejection since the Test Receiver ESV features excellent characteristics.

The inherent intermodulation rejection of the test assembly should be about 20 dB better than the values to be measured on the ESV.

Calculation of the intermodulation rejection and the intercept point D3:

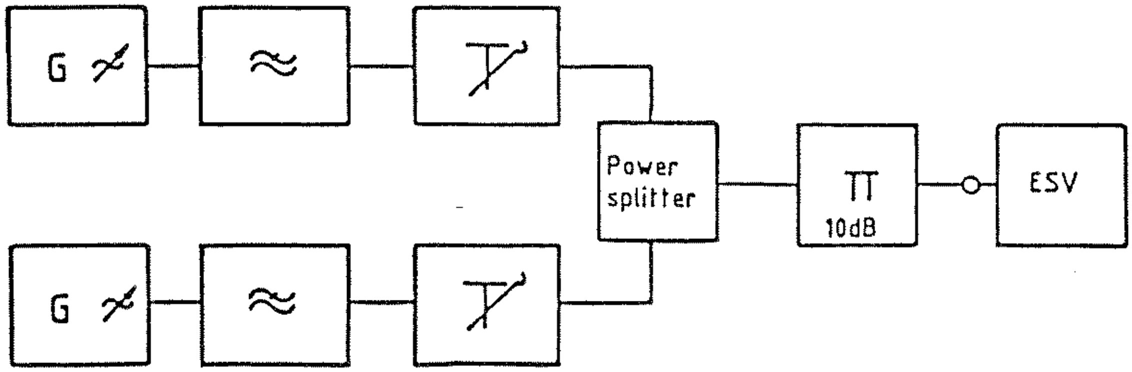
Input signals: level l_1/dBµV, frequency f_1
level $l_2 = l_1$/dBµV, frequency f_2

Resulting 3rd order IM products: level l_3/dBµV, frequency $f_3 = 2f_2 - f_1$
level l_4/dBµV, frequency $f_4 = 2f_1 - f_2$

3rd order intermodulation rejection a_{D3}/dB = $l_1 - \frac{l_3 + l_4}{2}$ at a level of l_1/dBµV

Intercept point D3: D3 intercept point/dBm = $l_1/\text{dBm} + \frac{a_{D3}}{2}$

Test setup:



Both signal generators are set to maximum output. The attenuation of the lowpass filters must be >60 dB at twice the useful-frequency.

Measurement:

Setting of the ESV: RF attenuation 18: 0 dB
switch 13: AV
IF bandwidth 14: 7.5 kHz

Signal generator level at f_1 and f_2 .... 97 dBµV
Indication on the ESV at f_3 and f_4 .... <46 dBµV

3.2.13 Desensitization

Test setup: same as under 3.2.12.

Level of signal generator tuned to receive frequency of the ESV: 39 dBµV.

Frequency spacing between 2nd signal generator and 1st signal generator: >10 MHz.

Increase the level of the 2nd signal generator until the indication on the ESV has increased by 1 dB.

The level of the 2nd signal generator should be >100 dBµV.

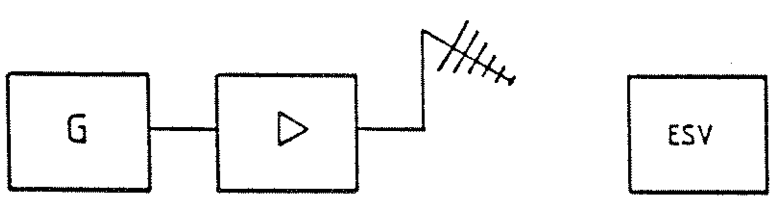
3.2.14 Checking the RF Shielding

Place the ESV in an electromagnetic field of 10 V/m:

On all frequencies and IF-frequencies the indication of the ESV at this fieldstrength must be smaller than .... -5 dBµV

The receiver input is closely terminated with 50 Ω.

Test setup:



3.2.15.1 10.7-MHz IF Output (Broadband) 37

Setting of the ESV: RF attenuation 18: 0 dB
Frequency 6: 500 MHz

Signal generator level .... 80 dBµV
Output level into 50 Ω .... typ. 87.5 dBµV
6-dB bandwidth .... >2 MHz

3.2.15.2 10.7-MHz IF Output (Narrowband) 40

Setting of the ESV: see 3.2.15.1.

Signal generator level .... 80 dBµV
Output level into 50 Ω .... >97 dBµV

The 3-dB and 6-dB bandwidths correspond to the selected IF bandwidths.

3.2.15.3 AM Demodulator Output

Apply signal of 50% modulation depth (modulation sidebands are within the IF passband) to the RF input 22 and measure using high-impedance (>>10 kΩ) voltmeter.

V_{pp} .... 1 V
Permissible error 10%

3.2.15.4 FM Demodulator Output

Apply signal of exactly known frequency (operate signal generator and ESV with external reference) to the RF input 22 of the ESV and after tuning the receiver to this frequency measure at the FM demodulation output 39.

Voltage .... 0 V
Permissible error (IF bandwidth 7.5/12 kHz) .... <±500 mV corresponding to ±0.5 kHz

Permissible error
IF bandwidth 120 kHz/1 MHz (mod. 52 and 53) .... <±150 mV
or 200 kHz (mod. 55) corresponding to ±15 kHz

When tuning the receiver to higher frequencies, the voltage should increase by 1 V ±80 mV (0.1 V ±20 mV) with every 1-kHz step (10-kHz step) at the IF bandwidths 7.5/12 kHz (120 kHz/200 kHz/1 MHz).

Conversely, when tuning the receiver to lower frequencies, the voltage should decrease accordingly. Detune the receiver by 5 kHz (500 kHz) and measure voltage by means of a high-impedance (>>10 kΩ) voltmeter:

5 kHz	(IF bandwidth 12 kHz)	
	Offset voltage	±5 V
	Permissible error	400 mV
100 kHz	(IF bandwidth 200 kHz (mod. 55))	
	Offset voltage	±1 V
	Permissible error................................	100 mV
500 kHz	(IF bandwidth 1 MHz)	
	Offset voltage	±5 V
	Permissible error	100 mV

3.2.15.5 Frequency-offset Output (32 pin 1)

Setting and level as under 3.2.15.4

3.2.15.6 Level Output 1 (32 (x251) pin 5)

Setting of the ESV: switch 13: AV, PEAK or PEAK 1s.

At full-scale deflection of the panel meter, measure positive output voltage using high-impedance (>> 10 kΩ) voltmeter.

Voltage .... 4 V
Permissible error .... ±75 mV

With CISPR indication:

Voltage .... 4 V
Permissible error .... ±75 mV

3.2.15.7 Level Output 2 (32 (x251) pin 3) for CISPR

Setting of the ESV: see 3.2.15.

Voltage (at f.s.d.) .... 2 V
Permissible error .... ±50 mV

This output includes a lowpass network for simulation of panel-meter response according to CISPR (Publ. 2 and 4).

3.2.15.8 X Recorder Output (logarithmic) (32 (x251) pin 6)

Setting of the ESV: Recorder display range .... 20 to 1000 MHz
(32, pin 9 and pin 28 open circuit)

Set receive frequency to 20.000 MHz:

Voltage at 32, pin 6 .... 0 V ±50 mV

Set receive frequency to 1000.000 MHz:

Voltage at 32, pin 6 .... ±5 V ±50 mV

3.2.15.9 X Recorder Output (linear) (32 (x251) pin 7)

Setting of the ESV: Recorder display range ....100 MHz
(32, pin 26 at ground, pin 9 open circuit)

Set receive frequency to 100.000 MHz:

Voltage at 32, pin 7 .... 0 V ±50 mV

Set receive frequency to 99.99 MHz:

Voltage at 32, pin 7 .... +5 V ±50 mV

3.2.15.10 AF Output 27

Insert phone plug (PL 55) into 27.

Connect oscilloscope with 8-Ω resistor in parallel to phone plug (PL 55).

Connect AM/FM signal generator to 22.

Setting of the ESV:

switch	12:	LOG 60 dB
switch	13:	AV
IF bandwidth	14:	1 MHz
IF attenuation	19:	AUTO
squelch	23	left stop
demodulation	26:	A3 ⎍ or A3 ⎍

Setting of the signal generator:

Frequency = ESV receive frequency

AM:
AM-modulated signal generator, f_{mod} = 1 kHz, modulation depth = 50%.
A low-distortion sinewave signal must be obtained with a level indication on meter 4 between 0 and 60 dB depending on the volume control.
f_{mod} = 100 Hz or 10 kHz: decrease in level >10 dB.
Check at the other IF bandwidths: as above.
(Decrease in level greater with A3 ⎍ and 7.5 kHz or 12 kHz IF bandwidth at 10 kHz modulation frequency.)
Squelch 23 must be adjustable over the entire 60-dB range.

FM:
FM modulated signal generator. f_{mod} = 1 kHz, frequency deviation = 1/3 IF bandwidth. A low-distortion sinewave signal must be obtained at all IF bandwidths.

3.2.15.11 Ext. Reference 36

Same as under 3.2.4, but feed reference frequency (5 or 10 MHz) to both, signal generator and ESV, and switch ESV over to external reference frequency (35). Exact tuning is achieved if the beat frequency is zero.

3.3 Electrical Maintenance

The ESV requires little electrical maintenance thanks to its design. It is advisable to:

- check the batteries every 6 months (1 charge cycle 14 hours, 1 discharge cycle > 4 hours);
- check the frequency accuracy (see 4.2) and adjust the reference oscillator (once a year);
- check the calibration level (see 4.2) once a year.

3.4 Mechanical Maintenance

On account of a minimum of movable mechanical parts, the ESV requires little mechanical maintenance. The maintenance required depends on the frequency and nature of the receiver use. For frequent use of the ESV in a helicopter or motor vehicle, more mechanical maintenance will be required as compared to using it in the laboratory.

The following maintenance work must be carried out:

- Clean front panel with a soft cloth dipped in alcohol.
- Check that all control knobs and screws are tightened down properly.
- Check the plastic feet and trims on the top underside and rear panel of the ESV.

3.5 Storage

After removal of the batteries, the ESV can be stored considerable periods of time at temperatures between -25° C and +70° C. At high temperatures and high relative humidity, seal the receiver as far as possible with plastic material or waxed paper to minimize any ill effects.

After the receiver has been stored for some time at high relative humidity, proceed as follows:

- Unscrew the upper and the lower panels.
- Unscrew the two inner covers at the top and bottom of the ESV.
- Allow the receiver to dry for a period of 4 to 6 hours at a temperature of between about +40 and +45° C.
- Make performance check according to 2.2.6 using the power supply unit.
- Replace the batteries.

ROHDE & SCHWARZ
MÜNCHEN

Bilder
Figures

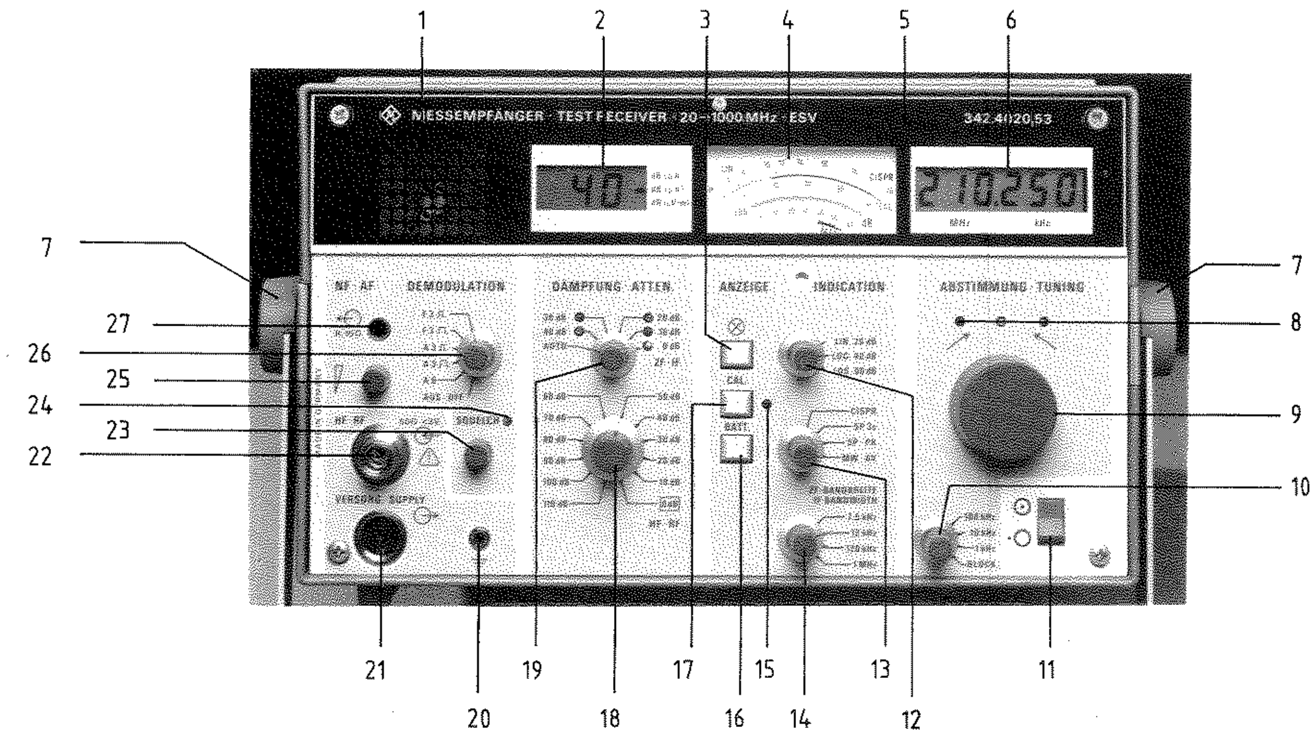


Bild 2–13 Frontansicht
Fig.2–13 Front panel

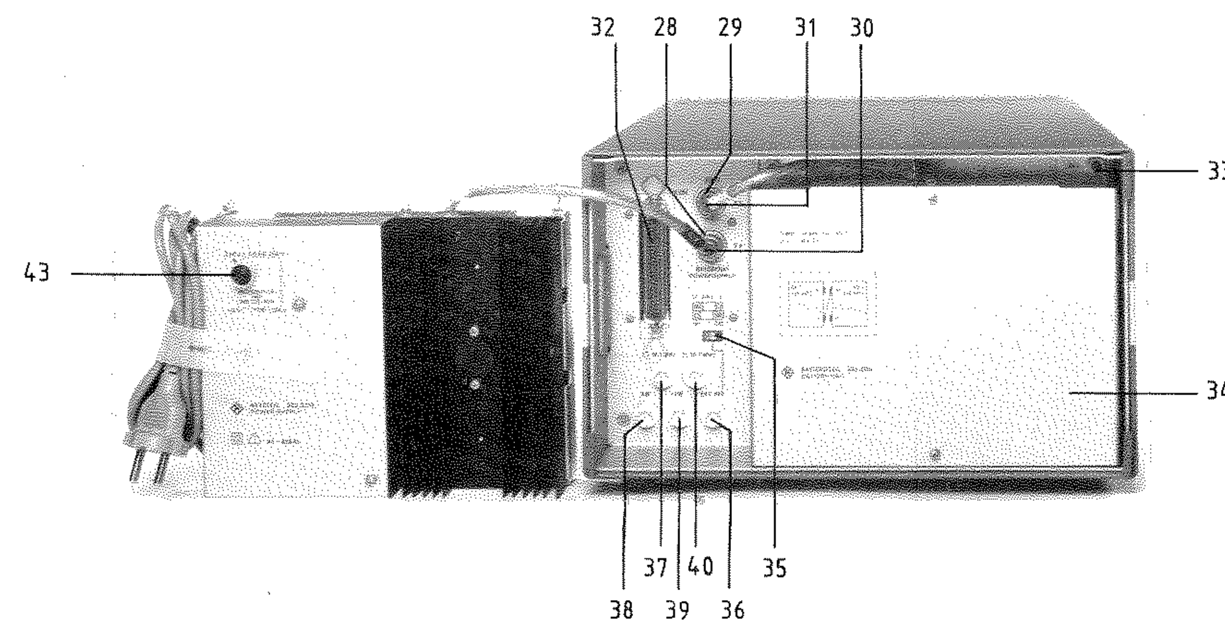
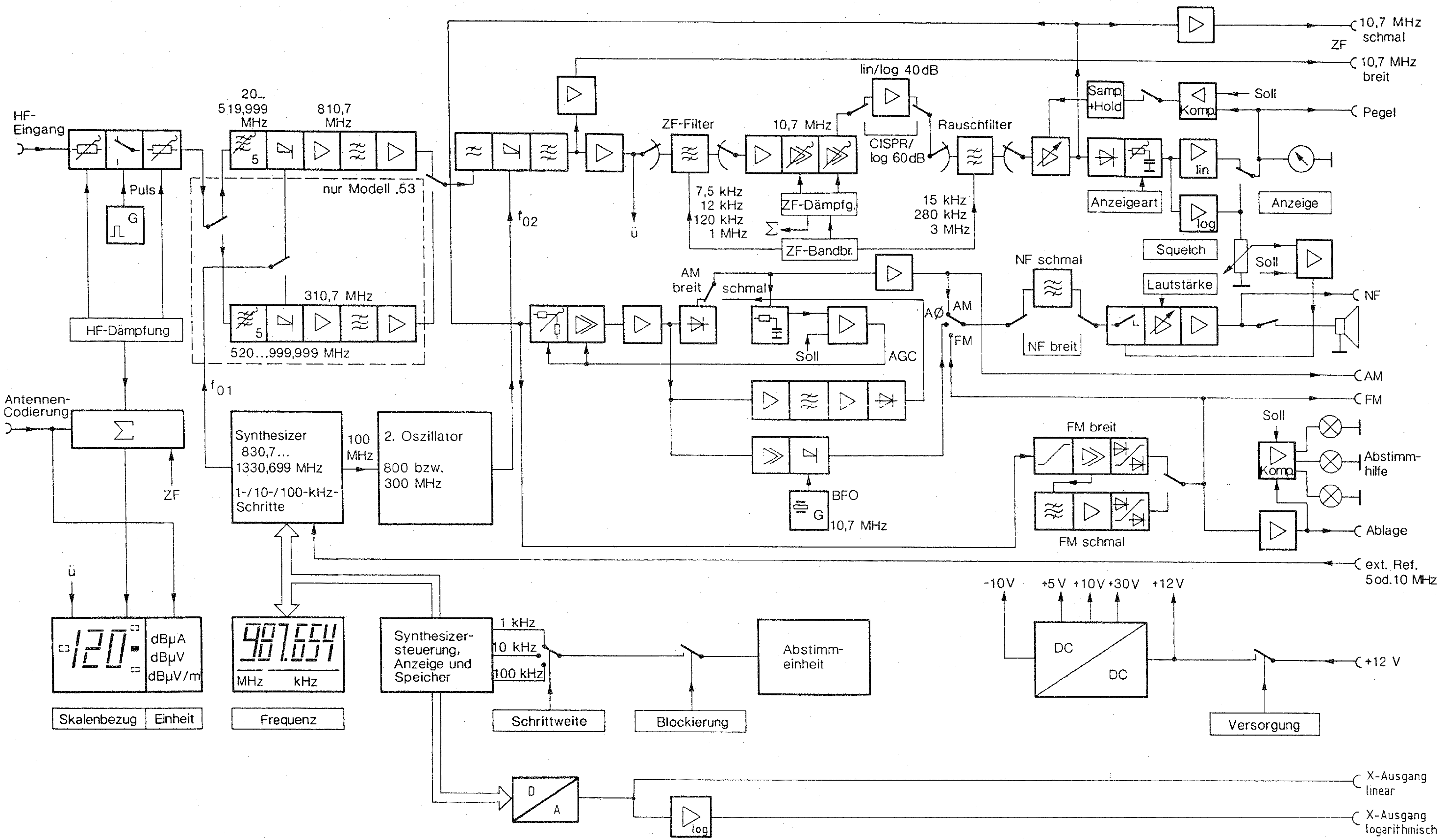
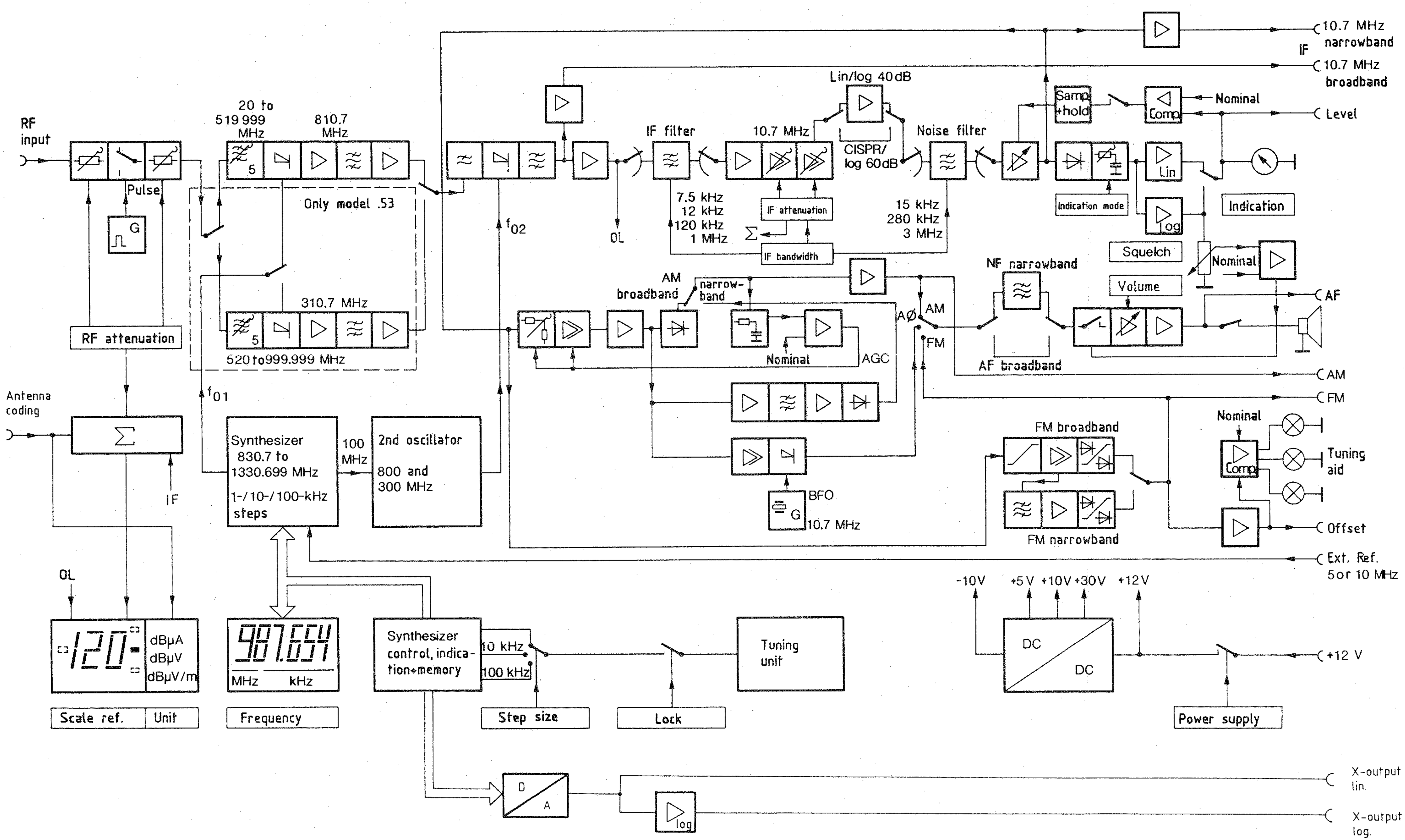
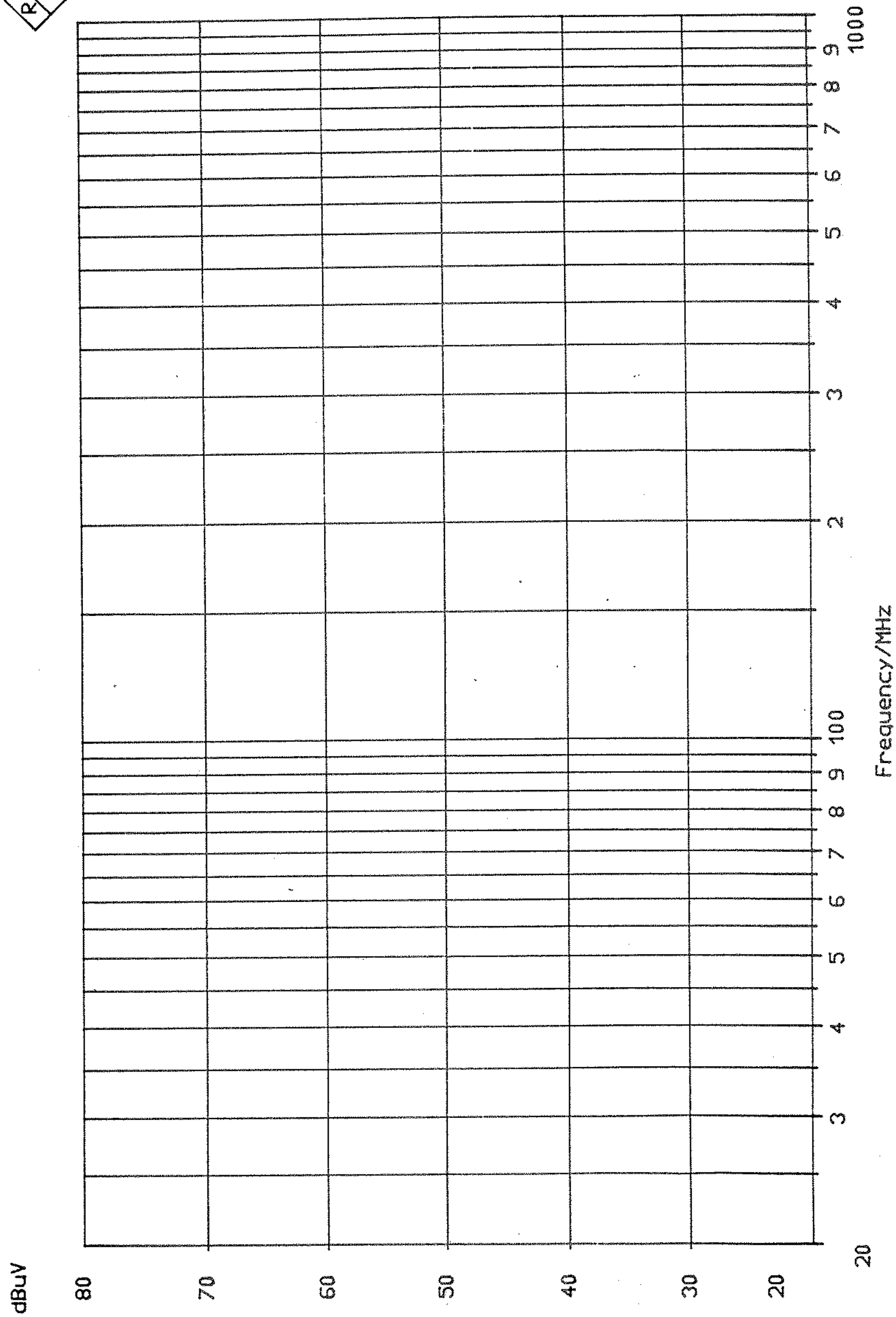


Bild 2–14 Rückansicht
Fig.2–14 Rear panel

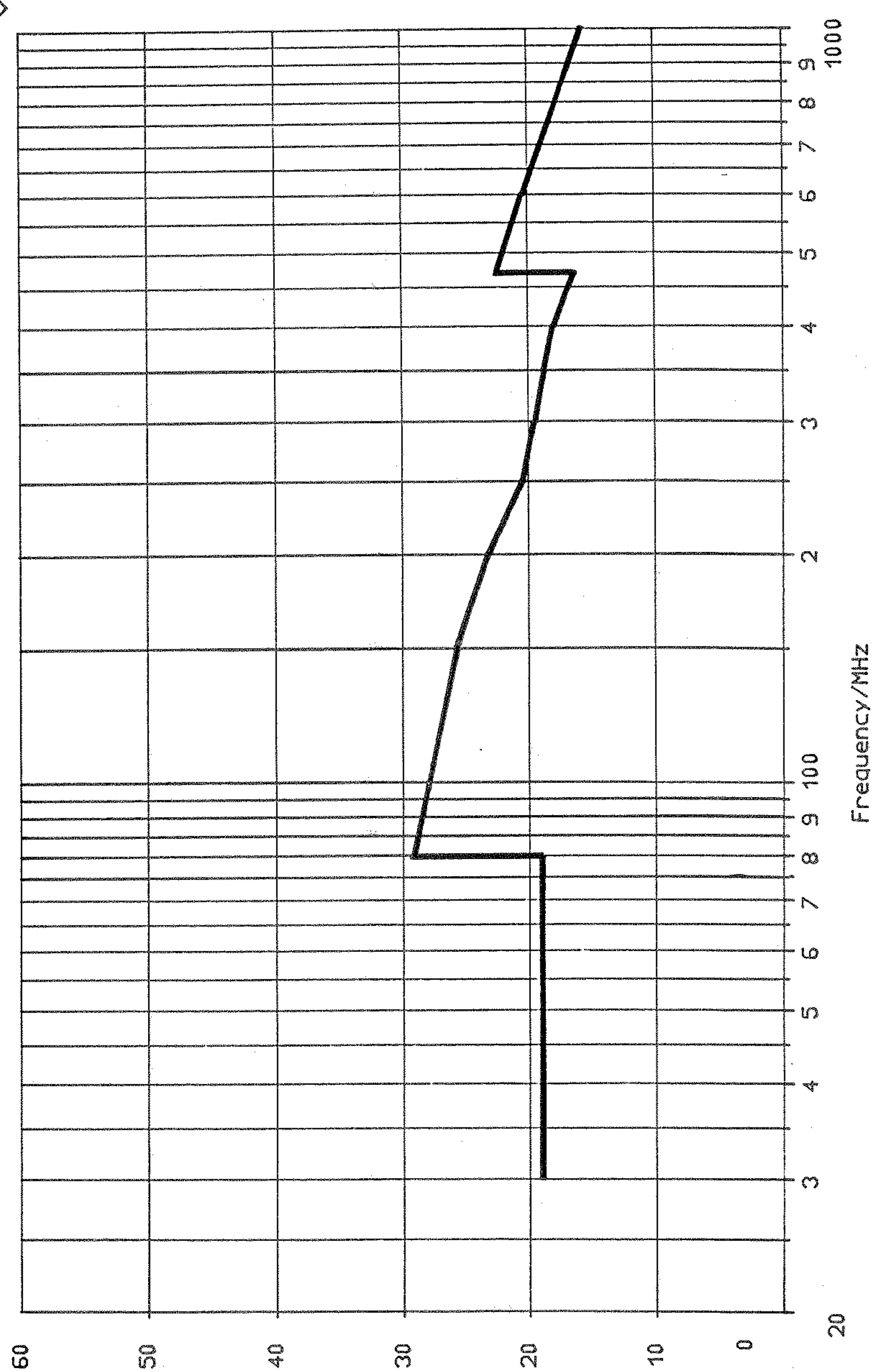

HF-Eingang
Puls
G
HF-Dämpfung
Antennen-Codierung
ZF
20... 519,999 MHz
810,7 MHz
nur Modell .53
310,7 MHz
520...999,999 MHz
f01
f02
Synthesizer 830,7... 1330,699 MHz 1-/10-/100-kHz-Schritte
100 MHz
2. Oszillator 800 bzw. 300 MHz
ü
ZF-Filter
7,5 kHz 12 kHz 120 kHz 1 MHz
10,7 MHz
ZF-Dämpfg.
ZF-Bandbr.
lin/log 40dB
CISPR/ log 60dB
Rauschfilter
15 kHz 280 kHz 3 MHz
Samp +Hold
Komp
Soll
lin
log
Anzeigeart
Anzeige
Squelch
Lautstärke
ZF
10,7 MHz schmal
10,7 MHz breit
Pegel
AM breit
schmal
AGC
AØ
AM
FM
NF schmal
NF breit
NF
AM
FM
BFO 10,7 MHz
FM breit
FM schmal
Abstimm-hilfe
Ablage
ext. Ref. 5od.10 MHz
-10V
+5V
+10V
+30V
+12V
DC
+12 V
Versorgung
dBµA
dBµV
dBµV/m
Skalenbezug
Einheit
MHz
kHz
Frequenz
Synthesizer-steuerung, Anzeige und Speicher
1 kHz
10 kHz
100 kHz
Schrittweite
Blockierung
Abstimm-einheit
D
A
X-Ausgang linear
X-Ausgang logarithmisch

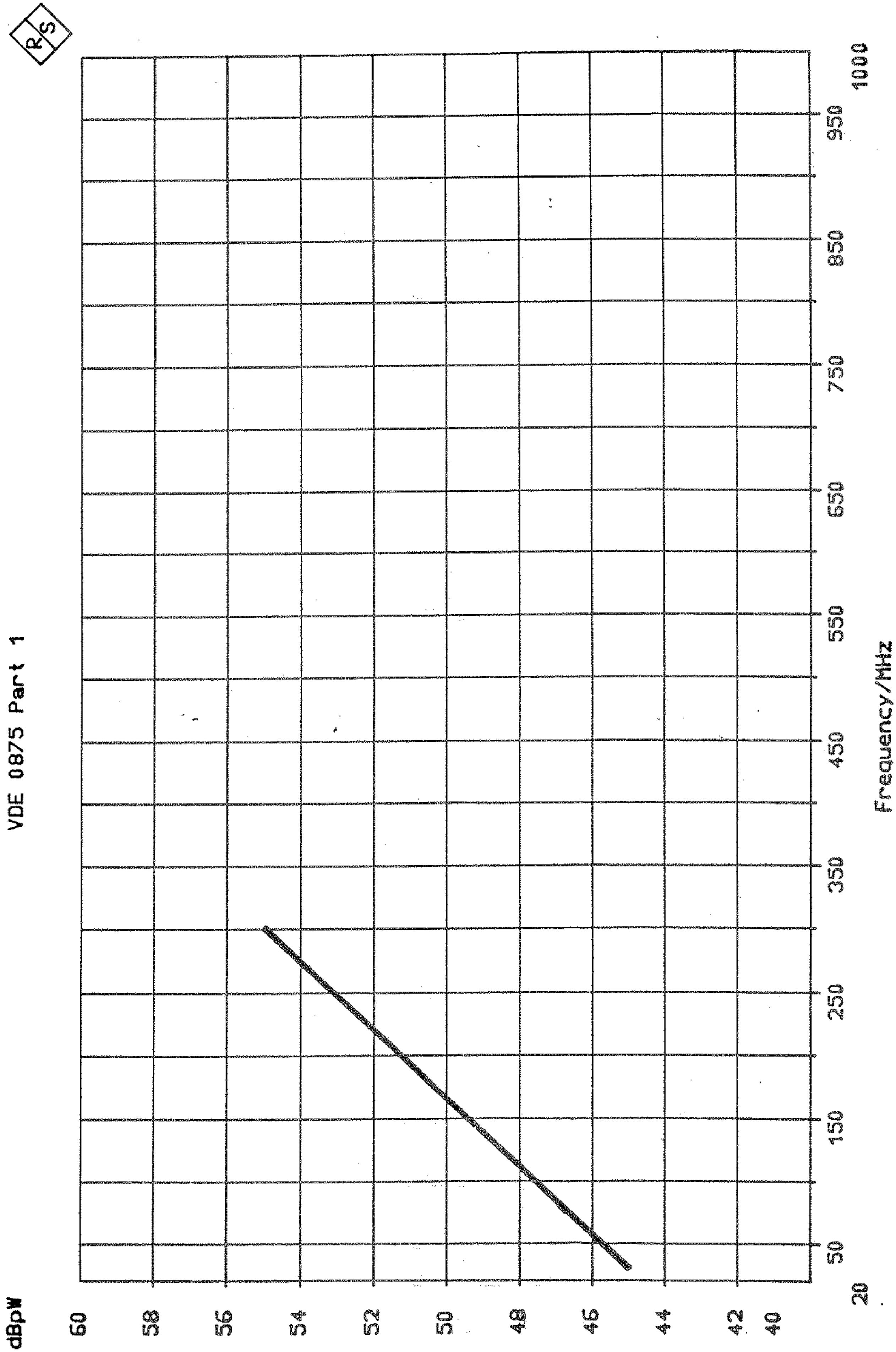


RF input
Pulse
G
RF attenuation
Antenna coding
IF
20 to 519 999 MHz
810.7 MHz
Only model .53
310.7 MHz
520 to 999.999 MHz
f01
f02
Synthesizer 830.7 to 1330.699 MHz 1-/10-/100-kHz steps
100 MHz
2nd oscillator 800 and 300 MHz
OL
IF filter
7.5 kHz 12 kHz 120 kHz 1 MHz
10.7 MHz
IF attenuation
IF bandwidth
Lin/log 40dB
CISPR/ log 60dB
Noise filter
15 kHz 280 kHz 3 MHz
Samp. +hold
Comp.
Nominal
Lin
Log
Indication mode
Indication
Squelch
Volume
AM broadband
narrow-band
Nominal
AGC
BFO
10.7 MHz
NF narrowband
AF broadband
AM
AØ
FM
FM broadband
FM narrowband
Tuning aid
10.7 MHz narrowband
IF
10.7 MHz broadband
Level
AF
AM
FM
Offset
Ext. Ref. 5 or 10 MHz
120
dBµA dBµV dBµV/m
Scale ref.
Unit
987.654
MHz kHz
Frequency
Synthesizer control, indication+memory
10 kHz
100 kHz
Step size
Lock
Tuning unit
-10V +5V +10V +30V +12V
DC DC
+12 V
Power supply
D A
log
X-output lin.
X-output log.

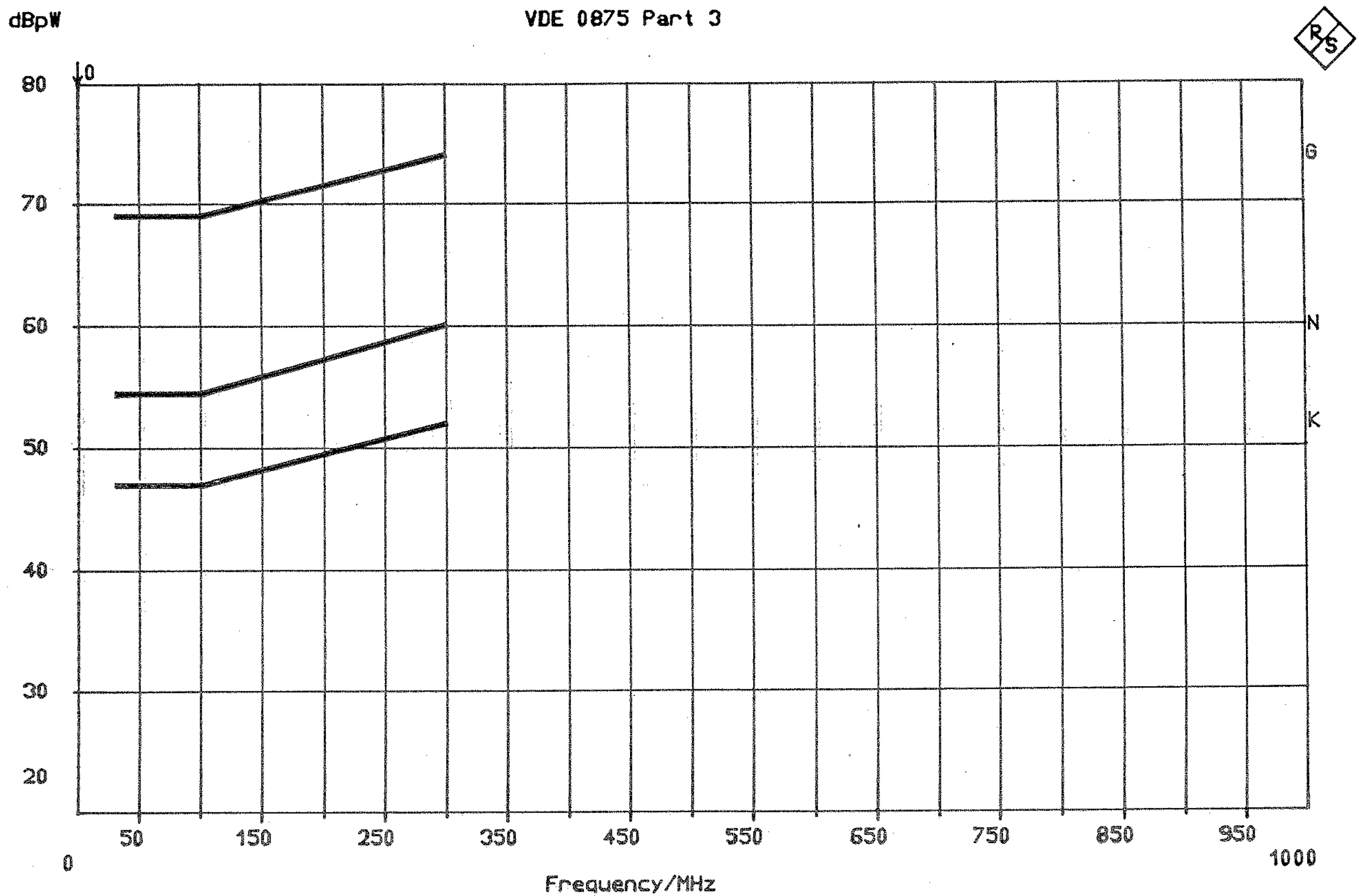

dBuV
80
70
60
50
40
30
20
Frequency/MHz
20
3
4
5
6
7
8
9
100
2
3
4
5
6
7
8
9
1000

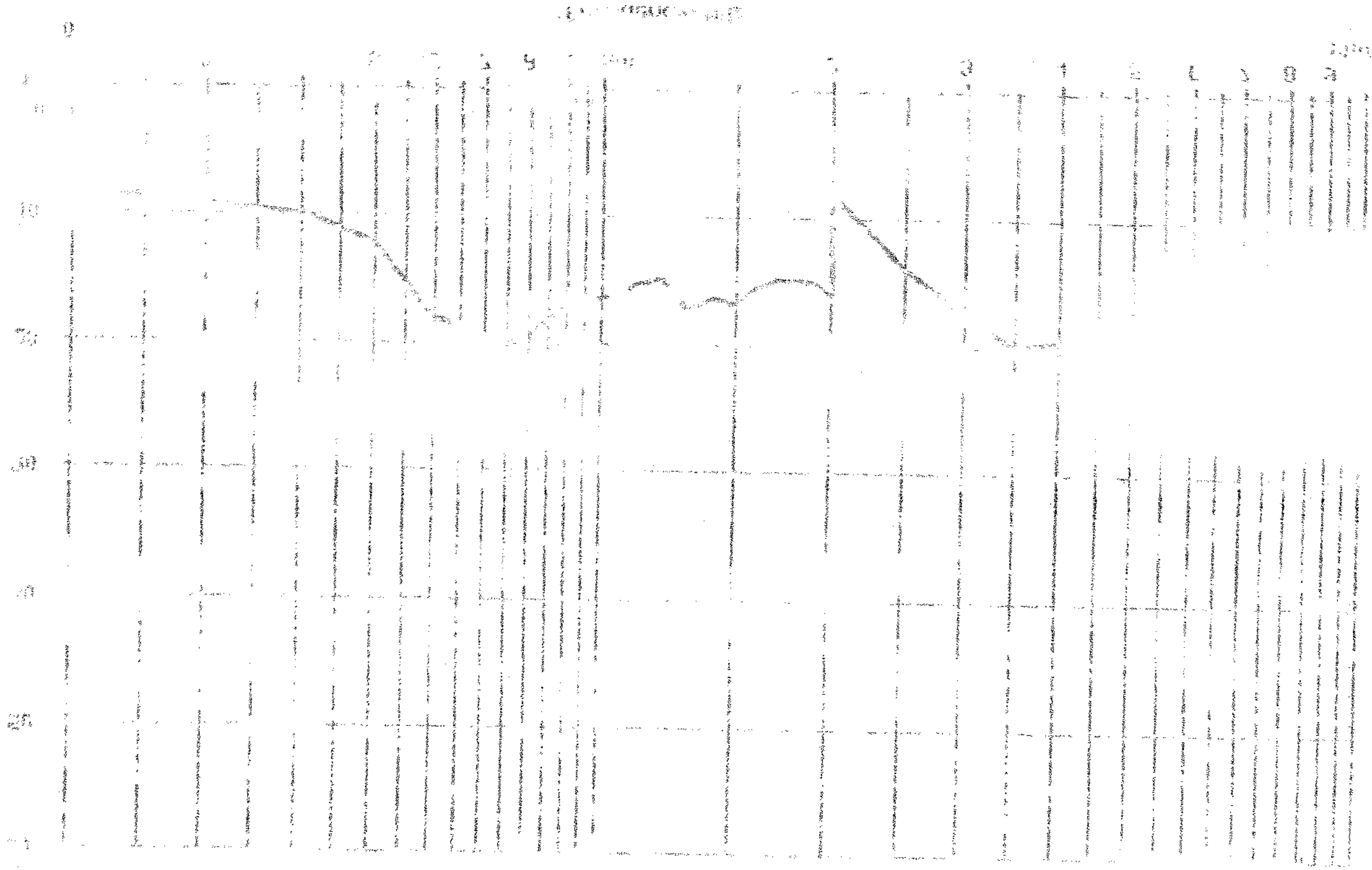
Vfg. 1046 /1984





VDE 0875 Part 1
dBpW
60
58
56
54
52
50
48
46
44
42
40
20
50
150
250
350
450
550
650
750
850
950
1000
Frequency/MHz


dBpW
VDE 0875 Part 3
80
70
60
50
40
30
20
0
50
150
250
350
450
550
650
750
850
950
1000
Frequency/MHz
G
N
K



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