TEST RECEIVER
OPERATION MANUAL

ESH 2

VOLUME 1 OF 3

303.2020.32

Table of Contents

1.1 Description

(See block diagram)

The signal applied to the input socket (BNC) passes from the electronic thin-film RF attenuator, switchable in steps of 10 dB, via one of the 16 automatically selected RF filters to the 1st mixer where it is converted to the 1st IF of 75.0 MHz by mixing it with a synthesized frequency from 75.000 MHz to 104.9999 MHz in steps of 100 Hz. An overload detection circuit with precisely-defined level and bandwidth checks the signal level at the input to the 1st IF stage at 75 MHz. A crystal filter with a 6-dB bandwidth of just under 10 kHz is provided for filtering the signal. The signal then passes via an amplifier to the 2nd conversion oscillator, where it is converted to the IF of 9 MHz by means of a frequency of about 66 MHz (the exact frequency depends on the selected type of modulation). Another overload detection circuit checks the instantaneous signal level at this stage. From the low-noise two-stage amplifier, which is followed by switchable crystal filters of 2.4-kHz and 500-Hz 6-dB bandwidth, the signal is taken to the 3rd mixer, where it is converted to the last IF of 30 kHz by means of an oscillator frequency of 8.97 MHz. The signal then passes via an amplifier with controlled amplification (for calibration) and a multi-stage amplifier switchable in 10-dB steps (IF attenuation) to still another overload detection circuit and from there via a mechanical filter with a 6-dB bandwidth of 200 Hz, that can be switched into circuit, either directly or via an instantaneous logarithmic-conversion amplifier to the active rectifier, which rectifies the 30-kHz signal at a low level. Subsequently, for peak-value indication, it is taken to a circuit with an adjustable hold time of 1 or 3 seconds and for CISPR to a weighting circuit which is adjusted to suit the standard for the receive frequency involved. The signal level is indicated on the front panel meter via a buffer amplifier.

The logic levels of the three overload detection circuits have been gated together and if the receiver is overloaded the level reference indication blinks. Another independent amplifier with AGC operates in parallel with the measuring and indicating section. It is used for aural monitoring of the selected signal. Different demodulators permit aural monitoring of telegraphy signals (A1) with a sidetone of about 1 kHz, of AM signals (A3), of SSB signals (A3J) and of FM signals. In addition, a position is provided on the demodulation selector switch for tuning to zero beat (AØ). Audio frequencies can be monitored via the built-in loadspeaker. When a headphone plug, for example, is inserted in the front panel socket, the loadspeaker is automatically turned off.

For CISPR measurements, a standard pulse generator is used for calibration, and for average- and peak-value measurements a sinewave generator. This sinewave generator operates as a tracking generator: by mixing a fixed oscillator, the frequency of which corresponds to the last IF, with the three conversion oscillators used, it produces a signal which is always in the centre of the IF passband whatever receive frequency is selected and, on the one hand, permits two-port measurements via the generator output, and, on the other hand, calibration of the receiver gain via the RF input attenuator. Special measures are taken to avoid the signal being affected by temperature or frequency variations. Gain calibration of the receiver is triggered by pushing a button or by switching over the IF bandwidth. The gain calibration process itself is automatic.

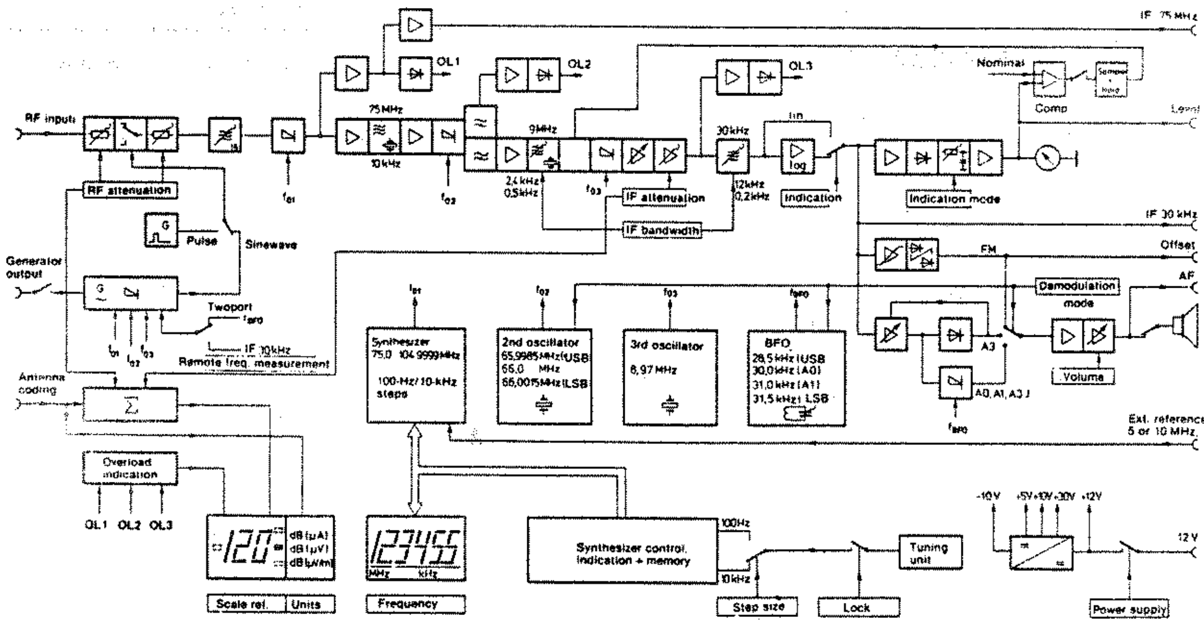
A logic circuit determines from the positions of the RF and IF attenuator switches and the coding pins of the sensor, if any has been used, the level corresponding to the 0-dB marking on the scales of the meter, and, from additional coding pins of the sensor, the correct unit, e.g. dB (µA) when using RF current probes and dB (µV/m) when using antennas. This is indicated on a multi-digit liquid crystal display.

A further logic circuit controls the gain of the last IF as a function of IF bandwidth and type of indication so that the pointer of the meter is always close to the mechanical zero of the meter when no input signal is applied.

The receiver is tuned by means of a two-loop low-noise synthesizer with minimum increments of 100 Hz, which in turn is controlled by means of an opto-electronic pulse generator, with magnetic locking, via an up/down counter. This counter is continuously powered, the on/off switch of the receiver being bypassed so that the last frequency setting before switching off the receiver is preserved when switching the receiver back on again. Preservation of the last setting is particularly important for battery operation. Frequency readout is on a 6-digit liquid crystal display. The receiver can be quickly tuned through its range in steps of 10 kHz. Inadvertent tuning of the receiver can be prevented by electronically inhibiting the tuning mechanism.

The receiver is externally supplied with +12-V DC voltage (current: approx. 1 A). The various required internal DC voltages (+5 V, +10 V, -10 V, +30 V) are produced by means of a DC converter and various stabilizing circuits.

The compact-design receiver is, in addition to normal panelling, provided with an inner frame made of sheet iron which improves the rejection of magnetic interference. The good internal layout, featuring motherboard, plug-in removable front panel, directly plugged-in open PC boards, and shielded cassette-type subassemblies with screw-in coaxial connectors, makes for an extremely easy-to-service receiver, at the same time fully utilizing the space available in the interior of the receiver.



2. Preparation for Use and Operating Instructions

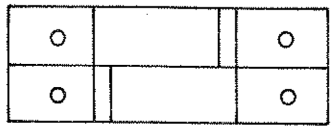
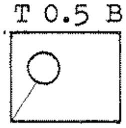
(See Figs. 2-9 and 2-10 in the Appendix)

2.1 Legend for Front- and Rear-panel Views (Figs. 21 and 22)

Ref. No.	Labelling	Function
1		Internal loudspeaker; disconnected when inserting plug into socket 25
2	DEMODULATION	Rotary switch for selection of AF demodulation
	F3	For frequency-modulated signals, the deviation of which does not markedly exceed the IF bandwidth
	A3J (USB symbol)	For SSB signals (USB)
	A3J (LSB symbol)	For SSB signals (LSB)
	A3	For amplitude-modulated signals
		The AF bandwidth of the demodulated signals depends on the IF bandwidth selected by means of 13 (maximum AF bandwidth (3 dB down) about 4 kHz)
	A1	For telegraphy reception
	AO	For adjustment to zero beat by means of 8
	OFF	The AF amplifier is switched off
3	dB(μA) dB(μV) dB(μV/m)	Indicates the 0-dB scale reference level of meter 5, depending on the RF attenuation set on 17, the RF attenuation set on 18 and a scale factor encoded via socket 19. The numerical value is added to the value indicated on 5.
4	LAMP	Button to light up displays 3 and 7 and meter 5
5		Meter scaled 20 dB (LIN), 40/60 dB (LOG); also shows battery voltage
6		Screw to set mechanical zero of meter 5
7		6-decade frequency display with 100 Hz resolution
8	TUNING	Knob to set receive frequency
9	ON OFF	On/off switch

Ref. No.	Labelling	Function
10		**Rotary switch:**
	10 kHz 1 kHz 0.1 kHz	**Tuning by means of 8 in 10-kHz steps** **Tuning by means of 8 in 1-kHz steps** **Tuning by means of 8 in 0.1-kHz steps**
	LOCK	**Knob 8 disabled**
11	INDICATION	Switch to set meter range:
	LIN	5 reads linearly over 20 dB
	LOG 40 dB	5 reads logarithmically over 40 dB
	LOG 60 dB	5 reads logarithmically over 60 dB
12	INDICATION	Switch to select type of indication on meter 5
	CISPR	Indication acc. to CISPR always in 20-dB range; has priority over 11, 13 and 2
	PK 3s	Peak value of IF signal held for 3 seconds
	PK	Peak value of IF signal held for 1 second
	AV	Average value of IF signal
13	IF BANDWIDTH	Rotary switch to select IF bandwidth
	200 Hz	CISPR3 test bandwidth; use with sinewave signals limited
	500 Hz 2.4 kHz	Average or peak test bandwidths; cannot be used for CISPR testing
	10 kHz	CISPR1 test bandwidth for general-purpose use (MIL).
14		LED for indication of calibration (blinking indicates ongoing calibration process)
15	CAL.	Button to initiate calibration
16	BATT.	Button to check state of charge of battery using 5
17	IF	IF attenuation control
	AUTO	Automatic selection of optimum IF attenuation depending on 12 and 13
	0 dB 10 dB 20 dB 30 dB 40 dB	Manually selectable values of IF attenuation

Ref. No.	Labelling	Function
18	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 a range of 0 to 110 dB. The 0-dB position is marked since in this position the VSWR may be as high as 2, thus reducing the accuracy of the calibration (CISPR Publ. 1 and 3).
19	ANT. CODING	Socket to connect active and passive accessories. Output: +10 V, -10 V (50 mA, max.) Input: encoding for display 3
20	⏚	Socket for connection to chassis or non-fused earthed conductor of the AC supply
21	RF IN 50 Ω < 3 V ⚠	BNC input socket (not adaptable) Do not exceed maximum input voltage rating
22	GEN. OUT 50 Ω 80 dBµV	BNC output socket (not adaptable) Output voltage: 10 mV into 50 Ω, for two-port and remote frequency measurements
23	 FREQ. M. ON OFF	Generator switch Generator output 22 on (for remote frequency measurements). The signal applied to 21 is filtered and limited. Generator output 22 on Generator output 22 off
24	VOL. ↷	Volume control for 1 and 25
25	AUDIO OUT R_s 10 Ω	AF output socket with a contact switching off 1
26	J23 POWER SUPPLY	Special 4-contact connector for 12-V supply from power supply unit
27	J22 BATT.	Special 4-contact socket for 12-V supply from battery the 24-V adapter or any other 12-V source
28	J1	50-contact Amphenol socket with various outputs
29		Screws securing battery unit and power supply unit

Ref. No.	Labelling	Function
30		Battery unit
31	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 to the left) External reference 10 MHz (lower switch to the left, upper to the right)
32	EXT. REF. INPUT	BNC input socket for external reference frequency of 5 or 10 MHz
33	75 MHz	BNC output socket for the first IF of 75 MHz
34	AM	BNC output socket for the demodulated amplitude modulation
35	FM	BNC output socket for the demodulated frequency modulation
36	30 kHz	BNC output socket for the 3rd IF of 30 kHz
37		Power supply unit
38		Power plug (without earthing contact)
39	220 V T 0.5 B 235 V  115 V T 1 B 125 V	Voltage selector
40		4-way special connector of power supply unit
41		4-way special connector of battery unit

2.2 Preparation for Use

2.2.1 Setting up the Receiver

The performance of the ESH 2 is differently affected by 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 was 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, that is, above all in the field, it can 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 1.5) for the rear of the receiver.

The reading shown on the meter 5 (Fig. 21) may vary by 2% approx. when the receiver is in a vertical position, compared with the horizontal.

2.2.1.2 Temperature

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 (2 A max.) and receiver operating) the heat developing 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.

2.2.1.3 Vibration and Low-frequency Magnetic Fields

The ESH 2 contains several varactor-tuned phase-locked oscillators. Strong magnetic fields and heavy vibration may cause the unwanted sideband-noise of these oscillators to worsen as a result of interference from these magnetic fields and the mechanical vibration. We, therefore, recommend that the equipment be set up such as to minimize vibration and magnetic fields.

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. However, at this level the wideband test antennas are starting to overload, and should therefore not be subjected to field strengths greater than 1 V/m, if possible.

2.2.1.5 Earth Connection

a) Battery operation:

Input socket 21 (Fig. 2-9) on the ESH 2 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 must a voltage be applied to the inner conductor of the input socket that is harmful to the human body, since this voltage would become effective if the operator simultaneously touched 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

When the unit is being moved, we recommend that the carrying handle should be set in front of the front panel. When carrying the unit, make sure that the rubber feet are pointing away from your body to take full advantage of the convenience offered by the carrying handle.

When the unit 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 unit, or an external 12-V or 24-V source (only via 24-V adapter).

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

2.2.2.1 AC Supply Operation

The ESH 2 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 115 V. If it is necessary to adjust the unit for a different AC supply voltage, unscrew the fuse in the voltage selector 28 (Fig. 2-10) remove the cover plate and replace it such that the fuse can be screwed into the position that is identified with the desired voltage. The unit is then ready for operation from the new AC supply voltage. The fuses for all adjustable AC supply voltages are contained in the voltage selector.

For 115 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 60 VA, maximum.

WARNING
The power supply unit of the Receiver ESH 2 is provided with protective insulation (safety class II IEC 348). Thus a safety 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 Earth Connection).

2.2.2.2 Operation with 12-V Battery Unit or External Sources

(For external 12-V source, see 2.2.2.3)

The 12-V battery unit 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:

- Remove power plug 38
- Remove plug from low-voltage socket 40

- Remove screws 29.
- 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 unit or the +24-V adapter in the cutouts on the rear panel of the ESH 2.
- Tip up battery unit or +24-V adapter.
- Replace screws.
- Connect the plug to socket 27.

When the receiver is powered from the 12-V battery unit, an operating time, depending on the state of charge of the battery and the ambient temperature, (battery fully charged, ambient temperature > +25°C) of more than four 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.

If possible, the batteries should be stored in a fully charged state. Stored or standby batteries must be recharged after about 12 months if kept at an average ambient temperature of +20°C. 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, since otherwise a permanent loss of capacity 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.

To insert the batteries, proceed as follows:

- Remove the two screws from the cover of the battery unit.
- 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.
- Replace the two screws in the cover.

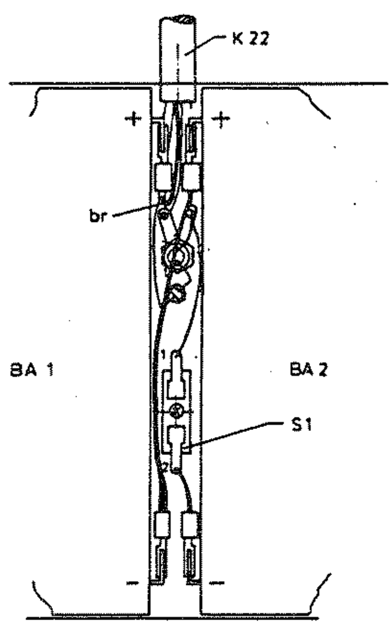


Fig. 2-1 Battery connection diagram

The state of charge of the batteries can be checked on meter 5 after pressing button 16 BATT. If the pointer is at the right end of the thick bar (Fig. 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.

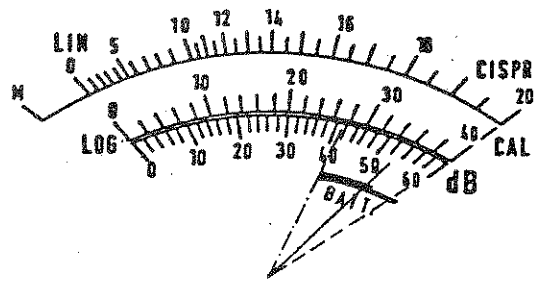


Fig. 2-2 State of charge of batteries

The connection of the external 12-V source is described in section 2.2.3a and the connection of the external 24-V source in section 2.2.3b.

2.2.2.3 Combined AC Supply and Battery Operation

The following combinations are possible with the power supply unit:

a) Power supply unit and external 12-V source

The receiver is connected to the source via the plug supplied with it (for pin assignment see Fig. 3), preferably a 1.6-A slow-blow fuse (T 1,6 D, IN 020.7500) and a twin-core lead. The resistance of the twin-core lead must be such as to ensure that at a current of 1.2 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 power supply connector J 23. The voltage at this point however must not fall below 11.2 V.

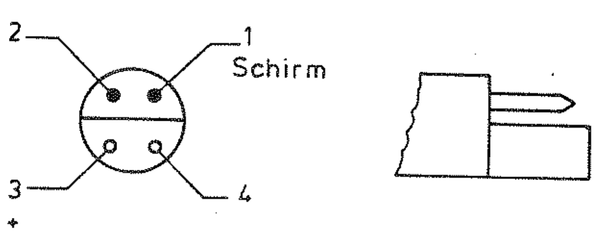


Fig. 2-3 Pin allocation of socket 27

b) Power supply unit and external 24-V source

When the +24-V Adapter ESH 2-Z4 is used, a 24-V source (voltage in the range 21.5 V to 30 V, max.) can also be connected. The low-voltage plug of the adapter is connected to socket 27 and the input plug of the adapter is connected to the 24-V source. The adapter will not be damaged by a shortcircuit or wrong input polarity. It is not possible to charge the 24-V source when powering the receiver from the AC supply. Either the power supply unit or the +24-V adapter can be fitted to the ESH 2 (for mounting instructions see section 2.2.2.2).

c) Power supply unit and 12-V battery unit

When the power supply unit is in operation, it takes over the supply to the receiver and recharges (max. 2 A) or trickle-charges the battery.

2.2.3 Checking the Mechanical Zero of the Meter

With the receiver switched off, turn the adjusting screw 6 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 connected, the receiver can be switched on by pressing the on/off switch 9 (Fig. 21) on the front panel. When the receiver is switched on, 3 and 7 light. In addition, one of the five LEDs at the IF attenuator switch 17 lights. Pressing button 4 illuminates the displays 3, 5 and 7.

As soon as the receiver is switched on, the internal temperature-stabilized reference oscillator starts to warm up. To avoid transient frequency errors, 30 seconds should elapse before using the receiver. After this warmup period, the error is $\leq 1 \times 10^{-5}$.

The receiver is switched on in just the same way by pressing the on/off switch 9, when the receiver is powered from batteries (for information on connecting the battery see section 2.2.2.2). In this case, the displays 3 and 7 operate as well as one of the five LEDs at the IF attenuation switch 17 lights when the receiver is switched on. Pressing button 4 illuminates the displays 3, 5 and 7.

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 four hours. The current drain of the receiver is about 1.2 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 used 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 (see section 2.2.2.2).

2.2.5 Performance Check

A performance check of calibration, two-port measurement and LIN-LOG display covers the most important functions of the Test Receiver ESH 2. Additional information on the receiver functions can be found in section 2.3 Operating Instructions.

2.2.5.1 Calibration

Pressing the CAL. button 15 initiates a complex and extensive calibration procedure (at CISPR with pulses and at AV, PK and PK 3 s with sinewave signals) (see section 4.18), whose completion is indicated when the red LED 14 goes out. Table 1 explains the various meanings of the LED.

Table 1

Button 15 pressed	LED lights permanently
Button 15 released	LED blinks until the calibration procedure has been completed (depends on 12)
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 level span. Calibration is effected referred to full-scale deflection on meter 5, independent of the position of switch 11.

2.2.5.2 Two-port Measurement

The input attenuator switch 18 of the receiver can be thoroughly checked by a two-port measurement carried out as follows:

- Connect the RF IN socket 21 to the GEN. OUT socket 22 with a short BNC cable.
- Turn the IF BANDWIDTH switch 13 to 200 Hz.
- Turn switch 12 to AV.
- Turn switch 11 to ~~LIN.~~ LOG 60
- Set IF ATTEN. switch 17 as shown in the table below.
- Set RF ATTEN. switch 18 as shown in the table below.
- Set GEN. OUT switch 23 to ON.
- Socket 19 remains free.

18	10	20	30	40	50	60	70	80	90	100	110
17	40	40	40	40	40	30	20	10	0	0	0
3	20	30	40	50	60	60	60	60	60	70	80
5	60	50	40	30	20	20	20	20	20	10	0
3+5	80	80	80	80	80	80	80	80	80	80	80

The values read out on 3 and 5 (approximately full-scale deflection) after the receiver has been calibrated should add up to 80 ±1 dB.

If the sum of the readouts on 3 and 5 remains 80 ±1 dB when the attenuation on IF switch 17 is increased four times by 10 dB each time, then all of the thin-film components making up the attenuator are in order.

Changing the frequency by means of the tuning control 8 (with 10 set to 10 kHz) will show the frequency response of the receiver on the panel meter 5.

The nominal frequency response is flat within ±2 dB without calibration (typ.)
flat within ±1 dB with calibration.

2.2.5.3 LIN-LOG Display

To check the LIN-LOG display, set the receiver as follows:

- Connect the RF IN socket 21 to the GEN. OUT socket 22 with a short BNC cable.
- Turn the IF BANDWIDTH switch to 200 Hz.
- Turn switch 12 to AV.
- Turn the IF ATTEN. switch 17 to 20 dB.
- Set GEN. OUT switch 23 to ON.
- Socket 19 remains free.

a) Checking the LIN display requires the following additional settings:

  - Turn switch 11 to LIN.
  - Turn RF ATTEN. switch 18 to 70 dB.

  After the calibration, the needle of indicator 5 must be at full-scale (tolerance ±1 dB). By increasing the attenuation set on the IF ATTEN. switch 17 in two steps of 10 dB, the 10-dB point and the 0-dB point can be checked (tolerance ±1 dB).

b) Checking the 40-dB LOG display requires the following additional settings:

  - Turn switch 11 to LOG 40 dB.
  - Turn RF ATTEN. switch 18 to 50 dB.

  After the calibration, the needle of indicator 5 must be at full-scale (tolerance ±1 dB). By increasing the attenuation set on the IF ATTEN. switch 17 in four steps of 10 dB, the 30, 20, 10 and 0-dB points can be checked (tolerance ±1 dB).

c) Checking the 60-dB LOG display requires the following additional settings:

  - Turn switch 11 to LOG 60 dB.
  - Turn RF ATTEN. switch 18 to 30 dB.

  The checking procedure is similar to that for the 60-dB LOG display.

2.3 Operating Instructions

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

The Test Receiver ESH 2 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 0.6 V/MHz within the largest RF bandwidth provided (5 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)
  and
- the position (horizontal or vertical).

In addition, the measurement accuracy is influenced by the finite signal, i.e. the signal-to-noise ratio of the signal to be measured. See tables 2 and 3. From the curves shown in Figs. 2-4 and 2-5, the additional error as a function of the types of indication AV and PK and the IF attenuation can be taken.

Table 2

S/N	Error $20 \log \sqrt{1 + 10^{-\frac{S/N\ 1}{10\ dB}}}$ dB
0 dB	3.01 dB
1	2.54
2	2.12
3	1.76
4	1.46
5	1.19
6	0.97
7	0.79
8	0.64
9	0.51
10	0.41
11	0.33
12	0.27
13	0.21
14	0.17
15	0.13
16	0.11
17	0.09
18	0.07
19	0.05
20	0.04
21	0.03
22	0.03
23	0.02
24	0.02
25	0.01

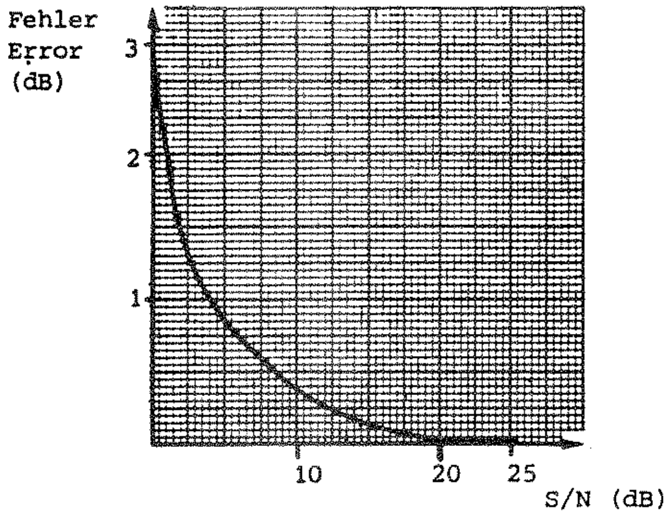


Fig. 2-4 Reading error due to noise as a funktion of the signal-to-noise ratio with AV indication

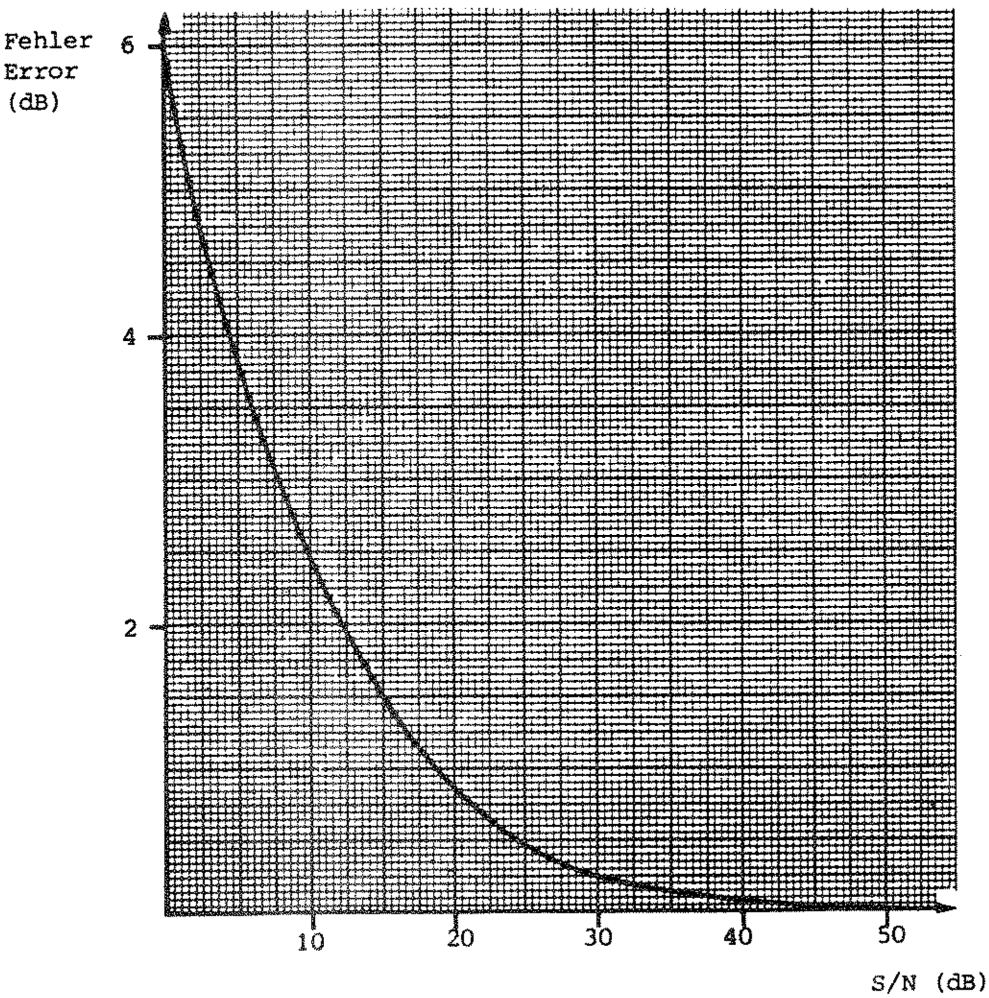


Fig. 2-5 Reading error due to noise with PEAK indication

Table 3

S/N measured with peak indication

$(S/N)_{min}$ is higher by about 11 dB

S/N	Error $20 \log \left(1 + 10^{-\frac{S/N}{20\ dB}}\right)$ dB
0 dB	6.02 dB
1	5.53
2	5.08
3	4.65
4	4.25
5	3.88
6	3.53
7	3.21
8	2.91
9	2.64
10	2.39
11	2.16
12	1.95
13	1.75
14	1.58
15	1.42
16	1.28
17	1.15
18	1.03
19	0.93
20	0.83
22	0.66
24	0.53
26	0.42
28	0.34
30	0.27
32	0.22
34	0.17
36	0.14
38	0.11
40	0.09
45	0.05
50	0.03

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 5 when the RF attenuation is varied, and hence can lead to erroneous measurements.

2.3.4 Frequency Tuning

The receiver, which can only be operated manually, is tuned by means of the tuning knob 8 provided on the front panel (Fig. 21). The step size for tuning with the tuning knob 8 is selected by means of switch 10 which in position 0.1 kHz effects a change in frequency of 4.6 kHz and in position 10 kHz a change in frequency of 460 kHz per rotation. In position 10 kHz, it is possible to tune through the entire frequency range between 10 kHz and 30 MHz by giving it a good spin and the 1-kHz and 100-Hz digits are reset to 0.

The smooth-running magnetic lock of the tuning knob ensures that the tuning knob is pulled to the next stable position if the tuning is not exact, thanks to the pull of the magnet; i.e. after letting the knob go, the tuning may vary by a set step and have to be corrected afterwards.

The receiver can be tuned down to the frequency 00.000.0. Calibration is possible down to about 6 kHz. When the frequency drops below 0, the digital display goes out. Only the decimal points between MHz and kHz or kHz and Hz are visible.

If the frequency is 0, the oscillator frequency becomes equal to the 1st IF and causes the IF amplifier to be overdriven. This cannot be remedied by varying the attenuator switch 18.

The receiver can be tuned up to the upper receive frequency of 29.999.9 MHz. If this frequency is exceeded, the receiver will read out "30.   . ". Operation at this frequency is not possible.

Table of frequency ranges and input filters

Range	Filter	Frequency range
1	Band-pass filter	20 kHz to 149.9 kHz
2	Sub-octave filter	150 kHz to 199.9 kHz
3	Sub-octave filter	200 kHz to 279.9 kHz
4	Sub-octave filter	280 kHz to 389.9 kHz
5	Sub-octave filter	390 kHz to 539.9 kHz
6	Sub-octave filter	540 kHz to 749.9 kHz
7	Sub-octave filter	750 kHz to 1.0499 MHz
8	Sub-octave filter	1.05 MHz to 1.4499 MHz
9	Sub-octave filter	1.45 MHz to 1.9999 MHz
10	Sub-octave filter	2.0 MHz to 2.6999 MHz
11	Sub-octave filter	2.7 MHz to 3.6999 MHz
12	Sub-octave filter	3.7 MHz to 5.1999 MHz
13	Sub-octave filter	5.2 MHz to 7.1999 MHz
14	Sub-octave filter	7.2 MHz to 9.9999 MHz
15	Tracking filter	10.0 MHz to 19.9999 MHz
16	Tracking filter	20.0 MHz to 29.9999 MHz

2.3.5 Range Selection

The indicating ranges of meter 5 can be selected by means of switch 11. When taking a reading, make sure that the correct meter scale is read on meter 5 depending on the setting of switch 11.

NOTE: With switch 12 in position CISPR, the 20-dB LIN scale of meter 5 always applies.

Switch 12 permits the various rectifier responses of the level indication to be selected:

AV. Indication of averaged rms value of signal applied and thus independent of modulation up to a modulation frequency limit of < 20 Hz.

PK Indication of rms value of peak signal applied, held approximately 1 s.

PK 3 s Same as for PK, but held 3 s.

CISPR This indication plays a special role because it controls such a large number of internal circuits. The readout on 5 is always in the linear 20-dB range independent of the position of 11.

At a receive frequency between 10 kHz and 149.9 kHz, the measurement is made according to CISPR 3.

Automatic setting:
- IF bandwidth 200 Hz (independent of 13)
- LIN 20 dB (independent of 11)

Weighting circuit for indication according to CISPR 3.
Calibration pulse with pulse repetition frequency of 25 Hz according to CISPR 3 triggered by pushbutton 15.
A3 demodulation.

At a receive frequency of > 150 kHz, the measurement is made according to CISPR 1.

Automatic setting:
- IF bandwidth 9 kHz (independent of 13)
- LIN 20 dB (independent of 11)

Weighting circuit for indication according to CISPR 1.
Calibration pulse with pulse repetition frequency of 100 Hz according to CISPR 1 triggered by pushbutton 15.
A3 demodulation.

2.3.6 Selection of IF Bandwidth

The bandwidths selected by 13 correspond approximately to the 6-dB bandwidths. For details see the Technical Specifications. The effective selectivity of the various filters can be seen from Fig. 2-6. It results from the IF selectivity of the filters used and the sideband noise of the receive oscillators. The effective selectivity of the 500-Hz and 200-Hz bandwidths can be enhanced by replacing the 500-Hz filter with a compatible 500-Hz filter of identical design but with a higher skirt selectivity (IN 303.9001). The replacement is very simple.

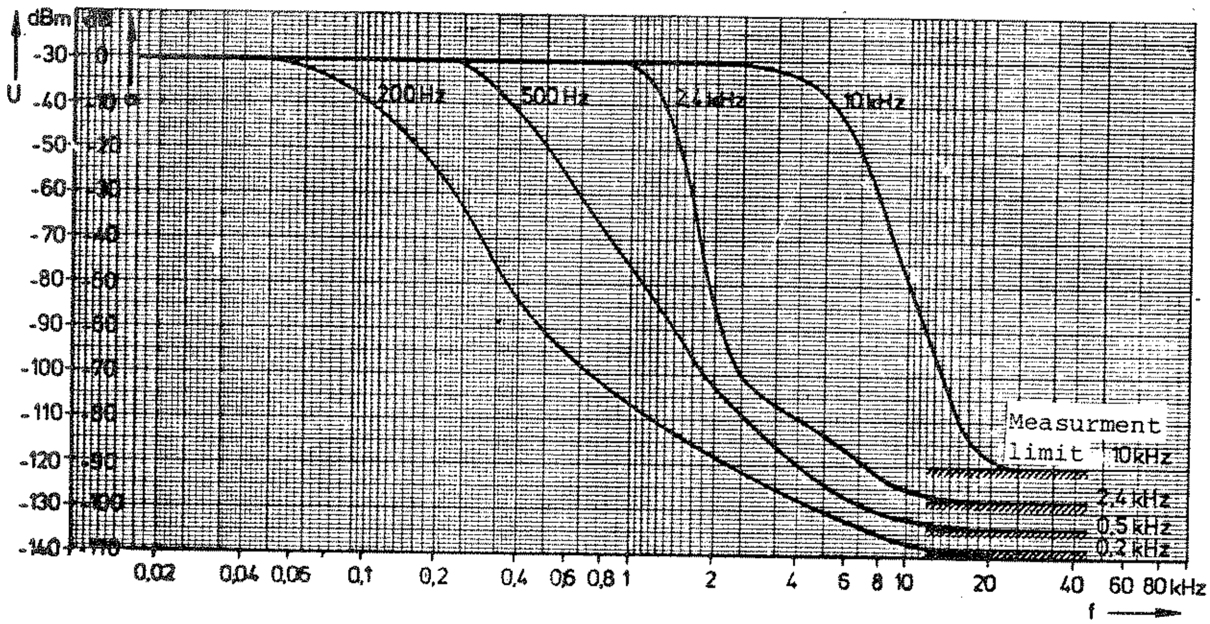


Fig. 2-6 Effective selectivity of the ESH 2 with an input signal of -30 dBm corresponding to 77 dB (µV) into 50 Ω

When switching over the IF bandwidth by means of switch 13, a calibration process is triggered automatically to avoid inaccurate readouts due to a change in gain.

NOTE: With the following settings, the IF bandwidth is selected automatically independent of the rotary switch 13:

CISPR, f < 150 kHz:	200 Hz
CISPR, f > 150 kHz:	9 kHz
A3J (selected by means of 2, not CISPR)	2.4 kHz

When using the 200-Hz bandwidth for measuring sinewave signals, an additional error of < 1.5 dB may be introduced as a result of tuning in 100-Hz steps.
If in setting A3J a DSB signal with carrier is received, the difference between signal frequency and receiver tuning frequency may appear as additional AF.

When the 10-kHz bandwidth is selected for receive frequencies below 50 kHz the increase in noise can lead to calibration difficulties and hence to measurement errors. This can be avoided by selecting a narrower bandwidth.

2.3.7 Adjustment of Attenuation

Switch 17 varies the IF gain in steps of 10 dB. This is required, for example, for overload checks or for improvement of the signal-to-noise ratio.

In position AUTO, the IF gain is controlled as a function of the switches 12 and 13 in such a way that the unwanted deflection on the meter 5 does not go much beyond 0 dB. The signal-to-noise ratio is about 20 dB for LIN full-scale deflection.

At receive frequencies < 50 kHz because of increasing inherent noise it is recommended to increase the IF attenuation above the automatic setting.

The value selected by means of 17, the setting of the RF attenuator 18 and the scale factor encoded via socket 19 determine the 0-dB reference value of the meter 5 which is displayed by 3.

2.3.8 Pin Allocation of Socket 19

Table 4 Pin allocation of 12-way female Tuchel connector:

A	chassis	D	µA +)	G	40 dB +)	K	-10 V
B	+10 V	E	10 dB +)	H	80 dB +)	L	—
C	µV/m +)	F	20 dB +)	J	—	M	—

Cable screening connected to connector housing.

+) These settings are selected when the corresponding pin is grounded.

The encoded scale factor is automatically taken into consideration in the display on 3.

2.3.9 Use of Internal Generator

The internal generator delivers an EMF of 86 dB(µV) to socket 22 at exactly the frequency to which the receiver is tuned, with switch 23 in position ON.

Use: two-port measurements over an attenuation range of > 100 dB and gain range of > 50 dB.

In position FREQ. M., an EMF of 86 dB(µV) is available at this output at the exact signal frequency independent of the frequency to which the receiver is tuned as long as the input signal is in about the centre of the IF bandwidth.

Use: remote frequency measurement with accuracy dependent on counter used for this purpose.

NOTE: In position ON, the AF amplifier of the receiver is inhibited. Hence, no AF is heard even with AF demodulation switched on.

2.4 Measurement Examples

2.4.1 Sinewave Signal Measurement

Assuming that frequency and level are unknown.

a) Average value

Basic setting:

- Set the switch 10 to position 10 kHz.
- Set the switch IF BANDWIDTH 13 to position 10 kHz.
- Set the switch 11 to position LIN.
- Set the switch 12 to position AV.
- Set the IF attenuator switch 17 to position AUTO.
- Set the RF attenuator switch 18 to position 10 dB.
- Set the rotary switch DEMODULATION 2 to position A3.
- Turn the volume control 24 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 > 0 dB(µV), approx. For signals > -30 dB(µV), the following basic setting is required:

- Set the switch 10 to position 0.1 kHz.
- Set the switch IF BANDWIDTH 13 to position 200 Hz.
- Set the switch 12 to position AV.
- Set the IF attenuator switch 17 to position AUTO.
- Set the RF attenuator switch 18 to position 0 dB.
- Set the switch DEMODULATION 2 to position A3.
- Turn the volume control 24 until some noise can be heard.

If the receiver is overdriven by sinewave or pulse signals, the display 3 blinks.

Remedy: Increase RF attenuation.

Determination of level:

After calibration add the readouts on 3 and 5.

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. Modulation causes a mathematically explainable decrease in the logarithmic indication, due to the instantaneous logarithmic conversion. This decrease is shown in Fig. 7 and Table 5.

Table 5

Mod. depth m	Decrease
0	0 dB
0.1	-0.022
0.2	-0.088
0.3	-0.202
0.4	-0.370
0.5	-0.602
0.6	-0.915
0.7	-1.340
0.8	-1.938
0.9	-2.878
1	-6.021

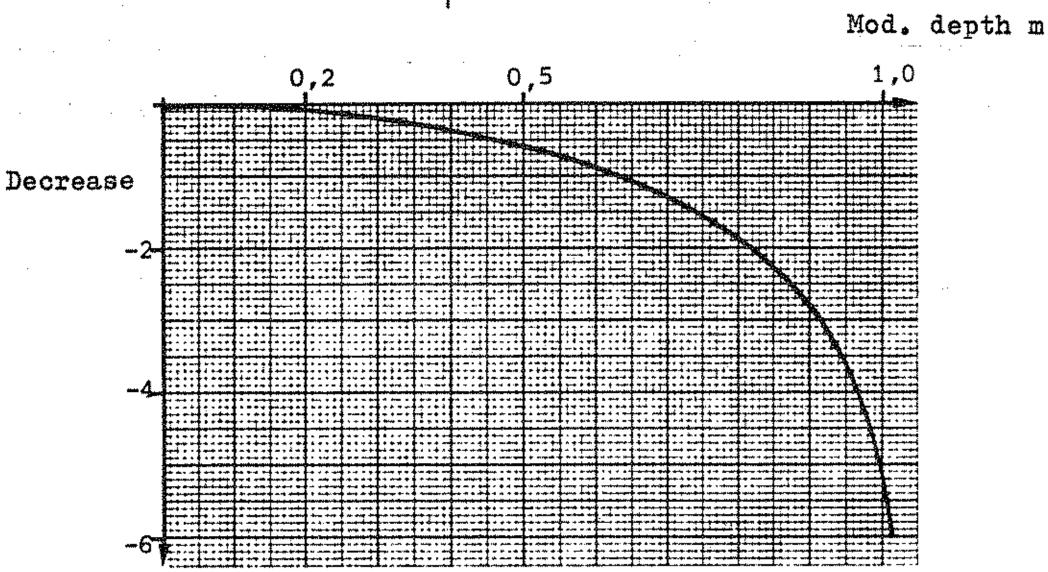


Fig. 2-7 Decrease when measuring AM modulated signals caused by instantaneous logarithmic conversion

Determination of frequency:

- Set the switch 2 to position AO and tune the signal to zero beat. Read off frequency on 7. For more detailed method see section 2.4.4 Remote Frequency Measurement.

b) Peak value

Basic setting:

- Set the switch 10 to position 10 kHz.
- Set the switch IF BANDWIDTH 13 to position 10 kHz.
- Set the switch 11 to position LIN.
- Set the switch 12 to position PK.

- Set the IF attenuator switch 17 to position AUTO.
- Set the RF attenuator switch 18 to position 10 dB.
- Set the rotary switch DEMODULATION 2 to position A3.
- Turn the volume control 24 until some noise can be heard.

With this basic setting, it is possible to rapidly scan the entire frequency range for signals with a level of > +10 dB(μV). For lower signal levels, the bandwidth can be decreased and the RF attenuation reduced to zero. Maximum sensitivity is then at approximately -20 dB(μV).

NOTE: Use of 200-Hz bandwidth with sinewave signals:

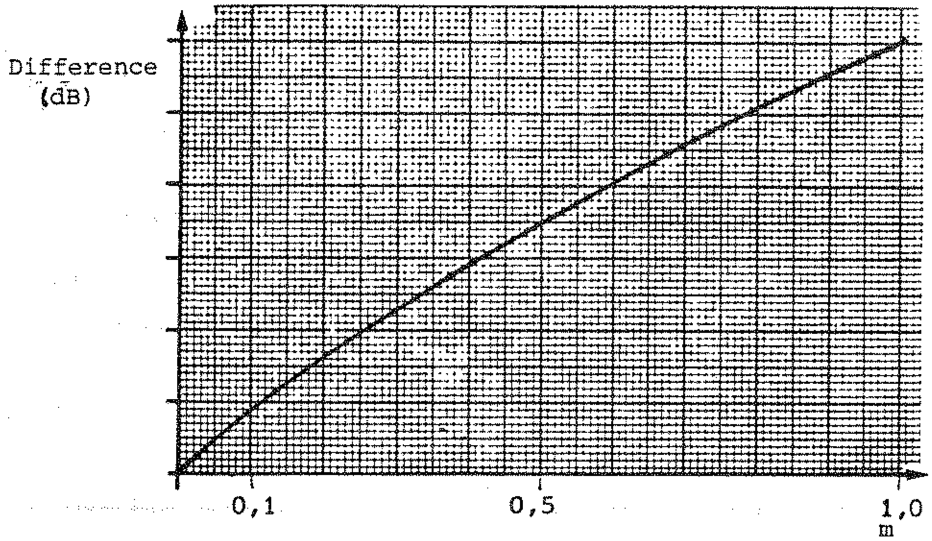
When using the 200-Hz bandwidth (6 dB down), an additional error of < 1.5 dB may be introduced at a possible offset of the signal to be measured of 50 Hz, maximum, as a result of tuning in steps of 100 Hz.

Use: Estimation of modulation depth of a sinewave signal by switching over between average value and peak value (Fig. 8).

Peak-value of an AM signal

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.

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



0 ≙ AV indication

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

2.4.2 Measurement of Pulse Signals

The receiver reads out that spectral portion of the pulse signal that appears within its IF bandwidth. The 200-Hz bandwidth can be used without any restrictions if the RF bandwidth of the pulse is > 200 Hz.

a) CISPR (Publ. 1 and 3)

Basic setting

- Set the switch 10 to position 10 kHz.
- The switch 11 is inoperative in the CISPR mode and the meter indication is in the 20-dB range (LIN).
- The switch IF BANDWIDTH 13 is inoperative in the CISPR mode.
  For f < 150 kHz: 200 Hz (CISPR Publ. 3).
  For f > 150 kHz: 9 kHz (corresponds to 10-kHz position of switch; CISPR Publ. 1).
- Set the IF attenuator switch 17 to position AUTO (exception: linearity check).

- Set the RF attenuator switch 18 to position 10 dB (select 0-dB position only in exceptional cases, e.g. for linearity check, since the measuring error is higher).
- Set the switch DEMODULATION 2 to position A3.
- Turn the volume control 24 until some noise can be heard.

NOTE: When capacitors are switched, for example, when artificial mains networks are charged to the AC supply voltage, a peak power of several kW may occur that could immediately destroy the input attenuator. By connecting a pulse-proof discrete 20-dB attenuator pad to the input (not a thin-film circuit), this can be prevented. It is then also possible to use the marked 0-dB position of 18.

Use: CISPR measurements with antennas

The Receiver ESH 2 contains logic functions and special circuits which simplify the complex CISPR measurements. In position CISPR of the switch 12, the IF bandwidth, the weighting circuit and the calibration pulse are switched over as a function of frequency according to the applicable regulation (for $f < 150$ kHz CISPR 3 applies and for $f > 150$ kHz CISPR 1). Measurement errors are avoided by the aural monitoring capability for pulse signals, automatic encoding of the scale factor and automatic indication of overload.

b) MIL

Measurements according to MIL specs are peak-value measurements (21 in position PK or PK 3 s) with the voltage referred to the bandwidth (e.g. dB(μV/kHz)). Be careful when converting to any other bandwidth than the test bandwidth.

- The voltage of a correlated broadband signal is directly proportional to the 6-dB test bandwidth.
- The voltage of white noise is proportional to the square root of the 3-dB test bandwidth.
- The voltage of non-correlated interference increases at a rate somewhere between directly proportional to, and the root of the 3-dB test bandwidth.

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

By measuring with the next narrower or the next wider test bandwidth, one can get a general idea about the probable proportionality factor.

Example:

MIL measurement referred to IF bandwidth of 0.1 MHz (= B1).

When measuring with a 10-kHz IF bandwidth (= B2), 92 dB(μV/10 kHz) (= A) is obtained.

When measuring with a 24-kHz IF bandwidth (= B3), 83 dB(μV/2.4 kHz)(= C) is obtained.

$$\text{Correction } K = \frac{A - C}{\log \frac{B2}{B3}} \log \frac{B1}{B2} = 14.5 \text{ dB}$$

The predicted measured value is then A + K = 92 + 14.5 = 106.5 dB(μV/0.1 MHz).

c) Linearity check

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

- Note input voltage reading.
- Decrease RF attenuation by 10 dB.
- Increase IF attenuation by 10 dB.
- Compare new input voltage reading with old value. If the difference is greater than 2 dB, the receiver may have been overdriven.

2.4.3 Two-port Measurement

Basic settings and test setup:

- Set the IF attenuator switch 17 to position AUTO.
- Set the switch 23 to position ON.
- Connect the input of the test item to the generator output 22 with a well-screened coaxial cable.
- Connect the output of the test item to the generator input 21 with a well-screened coaxial cable.

The test voltage is 10 mV into 50 Ω and the frequency corresponds to the tuning frequency of the receiver (tracking generator operation).

The measurement range depends on the positions of the switches 12 and 13:

Gain > 50 dB ---> 12: AV

Attenuation > 110 dB ---> 13: 200 Hz

Uses: filters, amplifier, antenna decoupling.

2.4.4 Remote Frequency Measurement

Basic setting:

- Set the IF attenuator switch 17 to AUTO.
- Set the switch 23 to FREQ.M.

Connect the input of a frequency counter with a well-screened coaxial cable (crosstalk) to output GEN. OUT 22. The sensitivity of the counter must be $\leqq$ 10 mV into 50 Ω. The accuracy of the frequency counter determines the accuracy of the measurement independent of the step width of receiver tuning. Tune the receiver to the signal to be measured with IF BANDWIDTH selector switch 13 in the appropriate position. In the case of signals whose level fluctuates only very little, the frequency can be read off the counter requiring no further measures to be taken. In the case of pulse signals or signals whose level fluctuates heavily, the analog Y voltage at 26 pin 5 can be used for triggering the counter after conversion to TTL level.

Check: If a signal with constant frequency is applied, the frequency readout on the counter must remain constant when detuning the receiver as long as the level indicated on meter 5 remains constant.

2.4.5 Modulation Analysis and Frequency Analysis

2.4.5.1 Determining Modulation Depth with the ESH 2 (without Accessory Unit)

Example: Measuring the modulation depth of a modulated carrier signal.
Modulation frequency > 500 Hz.

Basic setting:

- Set the switch 11 to position LIN.
- Set the switch 12 to position AV.
- Set the switch IF BANDWIDTH 13 to position 200 Hz.

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 difference Z = X-Y (dB)
- Compute modulation depth from difference:

$$m\left[\%\right] = \frac{200}{10^{\frac{Z}{20}}} \qquad Z = X-Y = 20\ \text{dB} \qquad m\left[\%\right] = \frac{200}{10^{\frac{20}{20}}} = 20\%$$

2.4.5.2 Determining the Modulation Distortion

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 the known formulae.

Moreover, from the difference between the frequencies, the modulation frequency f_{mod} can be computed.

2.4.5.3 Investigating the Signal with Accessory Units

a) 75-MHz output using an analyzer

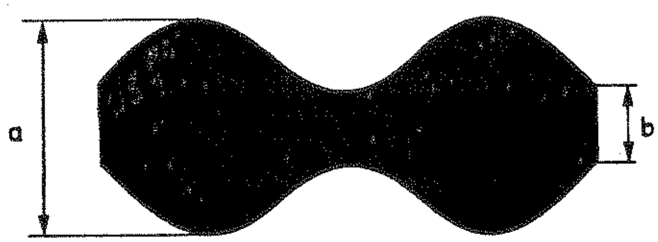
The occupancy of the selected frequency range or the characteristics of a signal within the passband of the RF filter selected can be observed and analyzed at the 75-MHz IF by connecting a wave analyzer to socket 33. The gain between the input sockets 21 and 33 is 9 ± 3 dB. The 75-MHz amplifier is activated by changing a link (BU5) in the RF cassette "1st and 2nd mixers" (Y9).

b) 30-kHz output 34

The signal set can be investigated in the following ways:

Using an oscilloscope

Example: Modulated signal



$$\text{Modulation depth } m\,[\%] = \frac{a - b}{a + b} \times 100\,[\%]$$

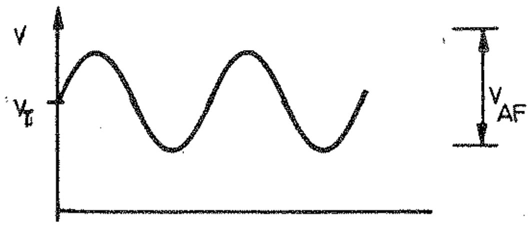
Using IF analyzer

Example: Modulated signal

Measurement procedure: Determine Z = X-Y from the screen display and convert according to the formula given in section 2.4.5.1.

c) Outputs AM 34 and FM 35 using an oscilloscope

Example: AM



$$m\ \% = \frac{V_{AF}}{2\ V_T}\ 100\ \%$$

Output socket 28

Pin allocation: 1 ---> Frequency offset simulated
2 ---> Level (via instrument, e.g. for digital voltmeter)
5 ---> Level (without low-pass filter, e.g. for recorder)
25.50 --> Chassis

At pin 1 of BU1 28, it is possible to measure, e.g. frequency drift or unwanted deviation by connecting a YT recorder.

NOTE: FM calibration

For a very exact calibration of the outputs 35 and 28 pin 1, a frequency-stabilized signal can be fed to the socket RF IN 21 which permits the receiver to be detuned in accurately known 100-Hz steps and the DC voltage variation to be recorded.

2.4.6 Recording

2.4.6.1 Recording the Voltage Indicated on Meter 5 as a Function of Time

In many cases, one aims at an unambiguous test report for documentation. This can be achieved by recording the voltage indicated on the meter over a longer period of time.

To this end, the Y deflection of the recorder is connected to BU28 pin 5 and at full-scale deflection of the meter 5, the Y deflection of the recorder is adjusted to maximum.

a) Calibration of the recorder with the switch 11 in position LIN.

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

- Connect the input socket RF IN 21 to the output socket GEN. OUT 22 with a short BNC cable.
- Set the IF attenuator switch 17 to position 40 dB.

- Vary the RF attenuator switch 18 until the meter 5 gives 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 in each of these positions tracing a calibration staircase.

Finer calibration can be obtained by connecting 21 to 22 via an attenuator that can be switch-selected in 1-dB steps, the calibration process as to the production of the calibration staircase being similar to the procedure above.

b) Calibration of the recorder with the switch 11 in the position LOG 40 or 60 dB.

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

2.4.6.2 Recording the Offset Voltage as a Function of Time

Connect the Y deflection of the recorder to socket J1 28 pin 1. When using high-speed recorders (with respect to Y recording speed), adding an RC low-pass 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 DEMODULATION 2 to position AO.
- Adjust the tuning knob 8 for zero beat and the recorder pen to the centre of the recording chart.
- Detune the receiver by desired frequency with the aid of tuning knob 8.
- Adjust the recorder to 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.

2.4.7 Single-sideband Two-tone Measurements

Thanks to high intermodulation suppression, the receiver can be used to advantage for measuring intermodulation on single-sideband transmitters with two-tone modulation.

Basic setting:

- Set the switch 11 to position LIN.
- Set the switch 12 to position AV.
- Set the IF BANDWIDTH selector switch 13 to position 200 Hz.
- Set the IF attenuator switch 17 to position AUTO.

The level to be measured is adjusted such that each of the two signals causes the meter 5 to give exactly full-scale deflection. The difference in frequency between the two signals should be > 1 kHz. The suppression of the inherent intermodulation of the receiver is typically 60 dB with this level.

2.4.8 Sideband Noise Power Measurements

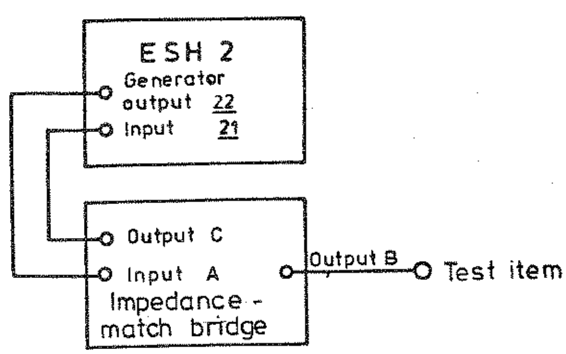
Thanks to the very high suppression of the sideband noise power of the internal oscillators and the selective IF filters, it is readily possible to make measurements in the vicinity of the carrier at high levels (see Fig. 6).

The 500-Hz filter can be readily replaced by a filter with a higher selectivity (see section 2.5.3).

2.4.9 Reflection-coefficient Measurement

With the aid of an impedance match bridge, it is possible to measure reflection coefficients according to magnitude with very <u>low</u> test voltages.

<u>Test setup</u>



$$r\,[\%] = \left(10^{\frac{Z}{20}}\right)^{-1} \cdot 100$$

$$VSWR = \frac{100 + r\,[\%]}{100 - r\,[\%]}$$

The receiver is operated as a two-port measuring instrument (switch 23 in position ON).

- For calibration terminate output B with 50 Ω and record level X (dB(μV)).
- Connect test item.
- Read off level Y (dB(μV)).
- Form difference X-Y = Z (dB)
- Convert Z to VSWR or r (%).

Use: Fast matching measurements on medium-wave and short-wave antennas (with low test voltages).

2.5 Connecting Sensors

Antennas, probes, current transformers, etc. are connected to the sockets 19 and 21, the voltage to be measured passing via the socket 21 to the receiver and the active sensor being supplied via socket 19; also the scale factor is encoded. The scale factor is thus already taken into consideration in the display 3.

Accessory units can be connected for further investigation and evaluation of the signals available at the receiver. Connection is via the sockets 22 (front panel), 28 and 31 to 36 (rear panel). When connecting instruments of safety class I, it should be borne in mind that the protective insulation of the ESH 2 becomes ineffective due to the chassis connection of the two instruments. The ESH 2 must then also be handled as a safety class I instrument.

2.6 Conversion Formulae

$B\ [dB(\mu V)] \longrightarrow A\ [\mu V]:\ A\ [\mu V] = 10^{\frac{B}{20}}$

$A\ [\mu V] \longrightarrow B\ [dB(\mu V)]:\ B\ [dB\mu V] = 20 \log A$

$B\ [dB(\mu V)] \longrightarrow C\ [dB(m)]:\ C\ [dBm] = -107 + B$

$C\ [dB(m)] \longrightarrow B\ [dB(\mu V)]:\ B\ [dB(\mu V)] = 107 + C$