ROHDE & SCHWARZ
Test and Measurement
Division

Operating Manual

EMI TEST RECEIVER
ESHS 10

1004.0401.10

Printed in the Federal
Republic of Germany

ZERTIFIZIERTES DIN ISO 9001 QUALITÄTSSICHERUNGSSYSTEM

REG. NR. 1954-02

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätssicherungssystems entwickelt, gefertigt und geprüft. Das Rohde&Schwarz-Qualitätssicherungssystem ist nach ISO 9001 zertifiziert.

Sollten Sie trotzdem bei der Erst-Inbetriebnahme Anlaß zu einer Beanstandung haben, senden Sie bitte das rückseitige Fax-Formular ausgefüllt zurück. Beauftragen Sie bei Bedarf die nächstliegende Rohde&Schwarz-Servicestelle mit der Reparatur.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality assurance standards. The Rohde&Schwarz quality assurance system is certified according to ISO 9001.

Should you nevertheless have cause for a complaint after putting your product into operation for the first time, please fill in the Fax form on the back and return it to us. If the need arises, request your nearest Rohde&Schwarz service center to carry out the repair.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes d'assurance-qualité. Le système d'assurance-qualité de Rohde&Schwarz a été homologué conformément à la norme ISO 9001.

Si, malgré cela, vous avez des réclamations lors de sa première mise en marche, nous vous prions de bien vouloir remplir le formulaire de télécopie au verso et de nous le retourner. Le cas échéant, contacter le point de service après-vente Rohde&Schwarz le plus proche pour qu'il effectue la réparation.

095 1000 Bl 0-0394

ROHDE&SCHWARZ

ROHDE & SCHWARZ

Empfänger
Addressee
Destinataire

ROHDE & SCHWARZ GmbH & Co. KG
Zentrales Qualitätswesen
Mühldorfstraße 15

D-81671 München

Telefax-Nr. des Empfängers
Telefax number of addressee
N° de téléfax du destinataire

(*49) 89 4129 3325

Betreff / Subject / Sujet

Anlieferfehler
Dead on Arrival
Défaut constaté a l'arrivée

Absender
Sender
Expéditeur

____
____
____
____

Telefon
Telephone
Téléphone

Telefax
Téléfax

Anzahl der Seiten inkl. dieser Seite
Number of pages incl. this page
Nombre de pages incluant cette page

Beanstandung / Shortcomings / Défauts

Gerätetype:
Type:
Type d'appareil: ______________________

Sach-Nr.:
Stock No.:
N° de référence: ______________________

Serien-Nr.:
Serial No.:
N° de série: ______________________

R&S-Auftrags-Nr.:
R&S Order No.:
N° de commande R&S: ______________________

Kurze Beschreibung der Beanstandung / Short description of shortcoming / Description de défaut:

____
____
____
____
____
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____

ROHDE&SCHWARZ

EC Certificate of Conformity

(to EMC Directive 89/336/EEC)

CE

This is to certify that

EMI Test Receiver

ESHS 10

1004.0401.10

(equipment type designation)

complies with the provisions of the Directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 89/336/EEC).

This declaration of conformity of the European Communities is the result of an examination carried out by the Quality Assurance Department of ROHDE & SCHWARZ in accordance with European Standards EN 50081-1 and EN 50082-1, as laid down in Article 10 of the Directive.

ROHDE & SCHWARZ
GmbH & Co. KG

ROHDE & SCHWARZ

Instruments Division

User Report

Product:	Serial No.:	Firmware/software version:

Your Name: Date:

Your Firm: Phone

Address: Fax:

Contents of Report

- ☐ New Application (Solution Request)
- ☐ Suggestion for Improvement in Instrument Usage
- ☐ Measurement Error or Hardware Malfunction
- ☐ Firmware or Software Error
- ☐ Correction of Operating or Service Manual

In case of error: Is the error reproducible? ☐ yes ☐ no

Severity Level: ☐ serious ☐ normal ☐ low

Problem Description:
(Give as detailed information as required for duplicating the problem)

Encl(s).: Draft of System Configuration, Measurement Results, Hard Copies
Remedy(ies), Interim Solution, Workaround

The user report is to be completed by the R&S Sales & Support Engineer

R&S Sales & Support Office:

R&S Sales & Support Engineer:

Send a copy to R&S Munich, Product Marketing, for R&S use only

Date of reply to user:

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Supplement to the Data Sheet ESHS 10 /20 /30

Al though specified otherwise in the Data Sheet (see values for the IF bandwidths), the 3-dB bandwidth of the 200-Hz filter is 150 Hz ± 20 %.

2 Preparations for Use

2.1 Putting into Operation

2.1.1 Setting up the Receiver

If an angled power plug (R&S-stock no. DS0086.4400) and retractable supporting feet at the rear of the instrument are used, the receiver can be operated in any position.

It is however recommended to operate the receiver in horizontal position for the following reasons:

- The analog instrument achieves its highest degree of accuracy in this position.
- The LC-displays can be optimally read when seen obliquely from above; thus the best contrast can be achieved in this position.
- The temperature within the receiver is the lowest in this position, as convection through the perforations in the top and bottom cover is optimal.

For measurements carried out on the test bench, it is recommended to fold out the retractable feet at the bottom of the instrument.

Note: *To ensure proper operation of the receiver, note the following:*

- *Do not cover the ventilation openings!*
- *Ambient temperature -10 to +55°C*
- *Avoid moisture condensation. If it however occurs, the instrument must be wiped dry before switching-on.*

2.1.2 Rackmounting

The receiver can be mounted into 19"-racks with the help of the rack adapter, type ZZA-95 (order no. 0369.4911.00) in accordance with the mounting instructions supplied. Since the ESHS is not provided with a fan, it is recommended to provide for forced ventilation in the rack.

Note: *As the power switch is situated at the rear of the instrument, an all-pole mains disconnection must be near at hand for safety reasons when the receiver is mounted into the rack.*

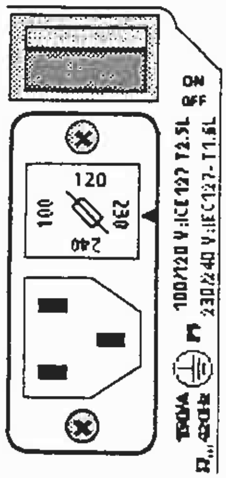
2.1.3 Power Supply

The receiver can be supplied either from the mains, an inserted internal battery or an external battery.

2.1.3.1 Mains Operation

The ESHS operates on A.C. supply voltages of 100 V, 120 V and 240 V ± 10 % and 230 V +6/-10 % and frequencies of 47 to 420 Hz.

Prior to initial switch-on, check whether the ESHS is set to the correct supply voltage. If this is not the case, it must be set in the following way:



- Remove the power supply cable.
- Lever out and withdraw the cover from the voltage selector (rear panel of instrument) using a screwdriver.
- Take the fuse out of the fuse holder.
- Insert the fuse that has the necessary value (part of the accessories supplied).
  - A fuse IEC 127 T2.5L, is required for 100 to 120 V, a fuse IEC 127 T 1.6 L for 230 to 240 V.
- Insert the voltage selector such that the white arrow on the fuse holder points to the desired voltage.

Fig. 2-1 Voltage Selector

2.1.3.2 Operation with Internal Battery

The ESHS can be operated on two 6-V-, 10-Ah-lead-acid batteries, which are fitted into the instrument (cf. Recommended Accessories). In mains operation (standby mode or the instrument is switched on), the batteries are charged. They also have the function of a buffer in the case of a mains failure.

Fitting the batteries:

- Unscrew 4 Philips screws of the rear panel feet and withdraw the latter.
- Remove upper and lower instrument cover backwards.
- Put the receiver on its top (RF-cabling points to the top).

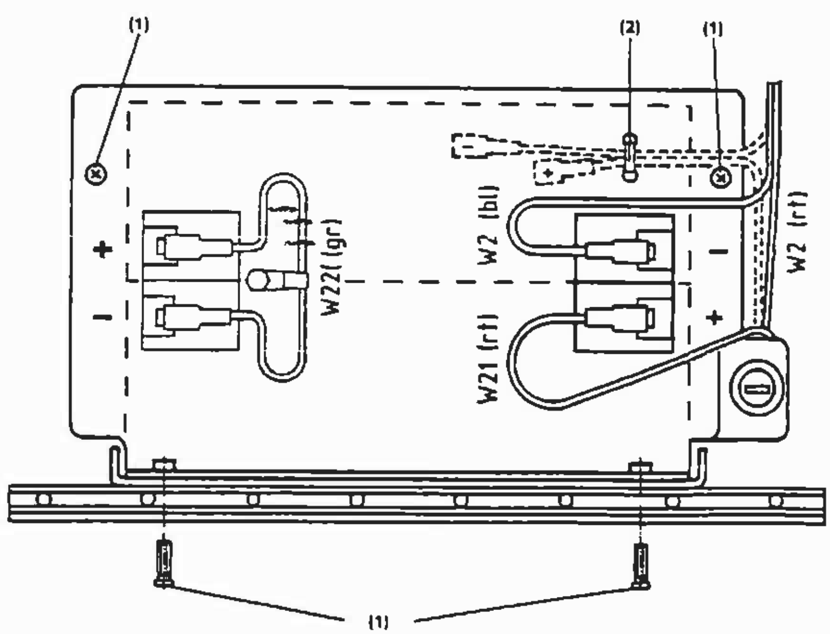


Fig. 2-2 Fitting the batteries

- Loosen the 4 screws (1) of the cover of the battery holder (two screws at the sides of the frame, two screws of the battery box).
- Remove the cover of the battery holder.
- Fit the batteries according to the mounting instructions given on the cover (Pay attention to the poling)
- Put the cover again on the battery holder and fix it using screws.
- Connect the cables to the batteries (cf. fig. 2-1).
- Check whether a suitable battery fuse (F3) is inserted.

  Battery fuse: IEC 127 T 6.3L 250 V
- Slip the top and bottom housing cover on the receiver from the rear side of the housing and mount the rear panel feet by way of screwing.

The receiver can be expected to operate on internal batteries for more than two hours, if the batteries are completely charged and the ambient temperature is > 25° C. If the battery voltage is less than 10.8 V, the receiver automatically switches off to avoid harmful overdischarging of the batteries. Following switch-off the STANDBY-LED on the front panel flashes to indicate that the batteries must be charged.

The discharge degree of the batteries can be checked on the display device by pressing the key BATTERY (Fig. 3-1) . If the pointer is at the left end of the bold bar (dotted line in fig. 2-3), the battery is almost exhausted. The instrument is near to switching-off. If the pointer is in the upper third of the bar (dashed line in fig. 2-3), the battery is completely charged. During charging the pointer is in the range of the thin bar (dashed-dotted line in fig. 2-3; temperature-dependent end of charge of the batteries).

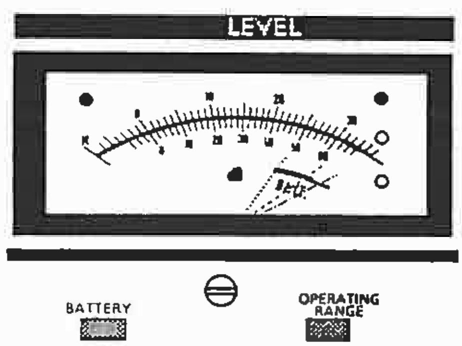


Fig. 2-3 Charge of the batteries

Note: *It is recommended to store the batteries in charged condition, if possible. Batteries that are stored must be recharged after about 12 months, if the average ambient temperature is +20° C . The higher the temperatures, the shorter the period after which recharging is necessary.*

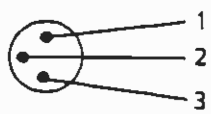
The batteries should be stored in dry environment, as moisture leads to conducting compounds between the connecting poles and thus increases self-discharge.

If the batteries are permanently used at high temperatures, their service life is reduced. Permanent capacity losses may arise. Continuous use at temeratures above +50° C should therefore be avoided.

The display light and IEC bus are not switched off automatically when supplying the test receiver from an internal battery. We recommend you to switch them off by way of special functions 10 and 11 in order to increase the battery life.

2.1.3.3 Operation with External Battery

The instrument can be supplied from an external d.c. voltage source via the connector "BATTERY 11...33 V" situated at the rear of the instrument. Due to the wide voltage range it can be supplied both from a 12-V-battery and a 24-V-battery. The battery connector required is contained in the accessories supplied. The battery is connected to the instrument in the following way:



1 Instrument ground
2 +
3 free

(View of solder side)

Fig. 2-4

The receiver is protected against reverse voltage applied to the battery connector, i.e. a wrongly connected supply will not lead to damages.
Substitute fuses for operation with external battery are contained in the accessories (IEC 127 T 6.3L 250 V).

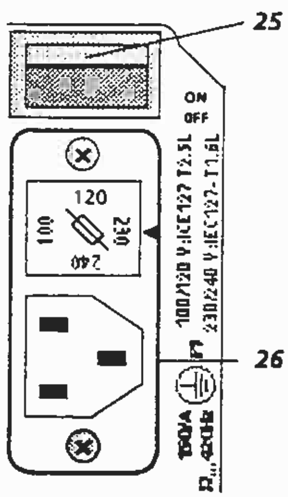
If the A.C. supply is connected to the receiver at the same time, the latter is supplied only from this supply. The external battery is then not charged. Battery back-up with external battery is possible, but whenever it is switched from A.C. supply to external battery an instrument reset takes place.

During operation the external battery voltage can be continuously increased from 11 V to 33 V without the instrument switching off. When however the voltage is increased to more than 15.5 V or decreased to under 14.5 V, an instrument reset occurs, which is due to the internal switch-over of the switching power supply from 24-V-operation to 12-V-operation. When the receiver is supplied from a 12-V- or 24-V- battery, this is not of importance as in this case the voltages stated above never occur. If the instrument is however operated on an external generator, this fact must be considered.

Note: *The ESHS can only be switched on if the voltage at the battery connector is at least 12 V. During operation, the voltage may be maximally reduced to 11 V. The reason for this is an internal switch-on hysteresis which prevents the instrument from being switched on and off continuously with an almost flat battery. In practice, this does not imply any restriction, since the open-circuit voltage of an intact 12-V battery is always at least 12 V*

2.1.4 Switching-on

a) A.C. supply operation:



- Connect the mains cable to the mains connector *26* (rear panel of instrument).
- Press rocker switch *25* (rear panel of instrument) to ON.
  If the instrument is supplied from the mains, the LED STANDBY on the front panel flashes. It also indicates whether an internal battery that may be available is being charged.
- Press the switch-on key.
  The receiver is switched on and the LED ON on the front panel flashes. When the power supply functions correctly, the LED "SUPPLY OK" at the rear panel of the instrument flashes. It also indicates that all internal voltages are within the permissible range.

Fig. 2-5

b) Operation with internal or external battery

If the receiver is operated on internal or external battery (A.C. power supply is not connected), the instrument is switched on using the ON STANDBY switch on the front panel (pos. *9*, cf. fig. 3-1). The power switch on the rear panel is without any meaning. If the instrument is switched on, the LED ON flashes. If the voltage of the internal battery or the external supply is not sufficient for operation, the LED STANDBY flashes and thus indicates that the battery must be charged.

Following switch-on the following text appears on the display DATA INPUT:

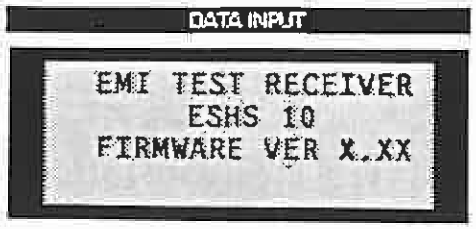


Fig. 2-6 Display after switching on

The receiver is set to basic setting and shows the level applied to the RF input.

2.2 Function Test

The function test of the ESHS is carried out in the following stages:

- Automatic test when switching-on the receiver,
- Total calibration, which ensures correct operation when it has been successfully completed, and
- Self-test, which checks all of the modules at significant points and indicates errors via display, once it is called by the user.

When switching-on the receiver all functions of the processor are initialized and thus simultaneously checked and the test A/D-converter automatically adjusted.

Following a successful initialization it is checked whether an external reference is connected to the receiver. If it is the case, the message *Ext Ref ON* is output on the display and the note "Ext Ref" is entered in the setup menu (cf. Section 3.2.4.2). In addition it is checked whether the level of the external reference is sufficiently high for operation.

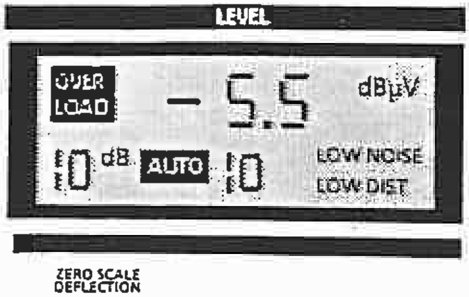
If the frequency of the external reference is not suitable, an interrupt (synthesizer interrupt) automatically occurs. The latter causes the output of an error message (cf. section 4).

Information on the calibrations is given in section 3.2.3.12, self-tests and error messages are described in section 4.

Cold Start:
Pressing the decimal point (in the numeric keypad) during switch-on sets all the functions of the ESHS to their default status. The memory with battery back-up is cleared, i.e. all the stored settings, limit lines and transducer factors get lost. An extensive computer hardware test is subsequently performed in addition to the normal switch-on test. The message *INICOLD* is read out in the LEVEL display during the test. If a computer hardware error not permitting further operation was detected, the message *ERRCPU* is output in the DATA INPUT display. The message can only be deleted by switching off and again on the ESHS.
After successful completion of the extended switch-on test, the receiver is set to its default status.

Note: *After a "cold start" of the receiver (or when a new firmware has been loaded), a total calibration is to be performed as the correction values were completely erased.*

4



- 3 1/2-digit display of the level applied to RF-input, resolution 0.1 dB
  Units:
  dBµV, dBµA, dBm, dBµV/MHz, dBµA/MHz, dBµV/m, dBµV/m/MHz, dBµA/m, dBµA/m/MHz, dBpW
- Display of overload of the signal path (OVERLOAD)
- Display of measurement mode (MODE): LOW NOISE and LOW DIST (low-distortion) (sect. 3.2.3.3)
- Display of RF attenuation (RF ATT), 0 to 120 dB (cf. section 3.2.3.2)
- Display of automatic operation (AUTO) (cf. section 3.2.3.5)
- Display of lower limit of the scale span (ZERO SCALE DEFLECTION) (cf. section 3.2.3.7)

5

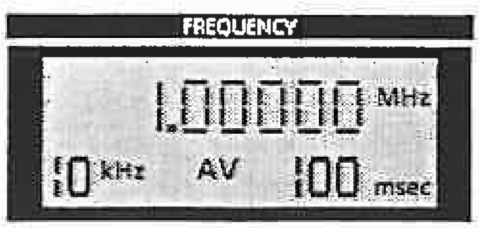
Attenuation

AUTO: RF-attenuation and MODE are automatically adjusted to input signal (cf. section 3.2.3.5)

MANUAL: Switch-over of RF-attenuation: ↑ increasing by 10 dB, ↓ decreasing by 10 dB (cf. section 3.2.3.2)

MODE: Switch-over of IF-attenuation (LOW NOISE/LOW DISTORTION) (cf. section 3.2.3.3)

6



- 7-digit display of receiver frequency resolution 10 Hz, unit in MHz and kHz (cf. section 3.2.3.1)
- Display of measuring time, 1 ms to 100 s in 1, 2, 5-steps, (cf. section 3.2.3.10)
- Indication of detector: AV, Pk, Pk/MHz and QP, (cf. section 3.2.3.9)
- Indication of IF-bandwidths 200 Hz and 10 kHz (cf. section 3.2.3.8)

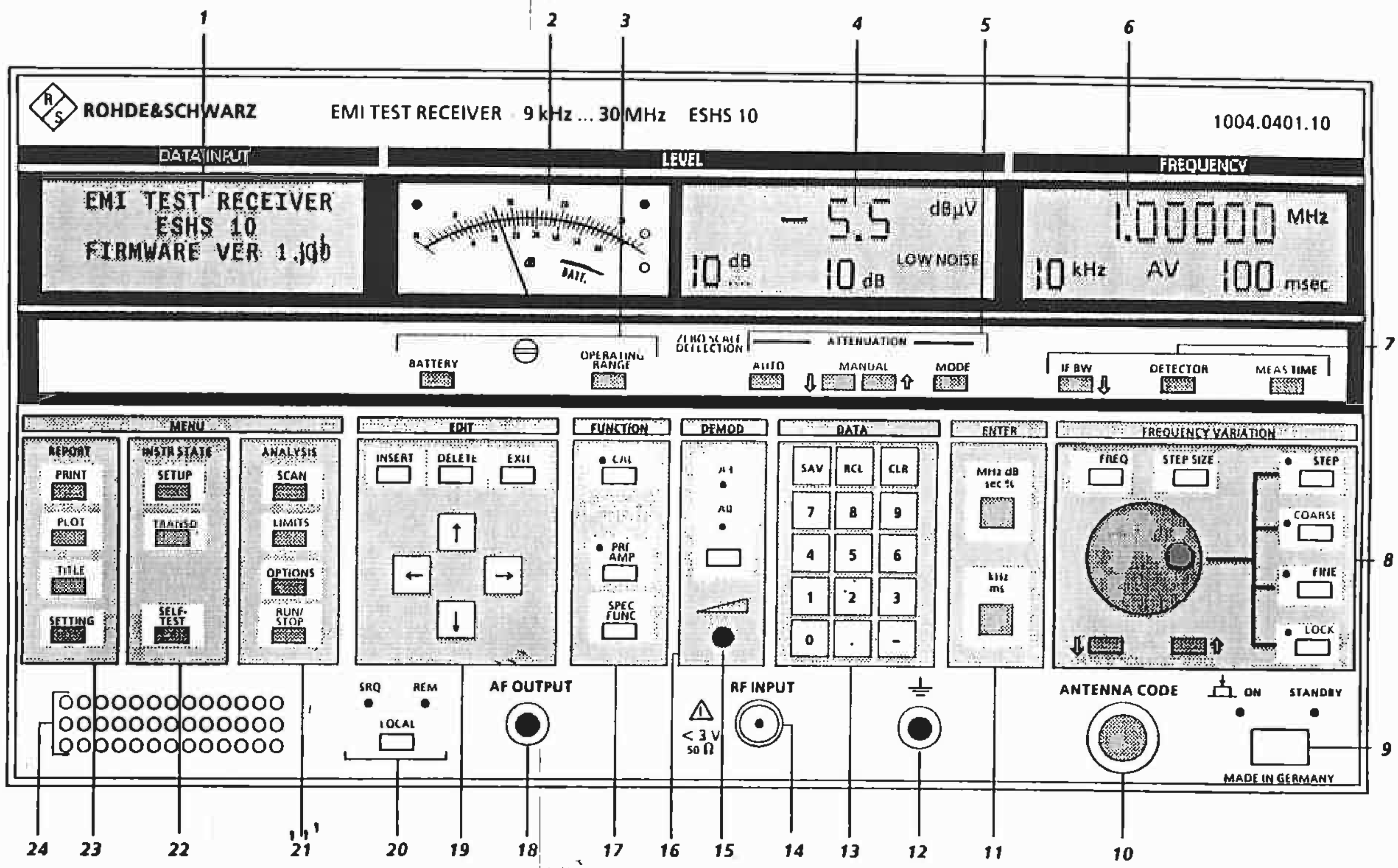


Fig. 3-1 Front panel view

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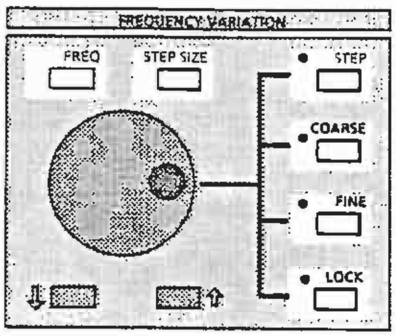
IF BW:	Key for switching over IF-bandwidth
DETECTOR:	Key for switching over the weighting (cf. sect. 3.2.3.9)
MEAS TIME:	Key for activating input of measuring time (cf. section 3.2.3.10)

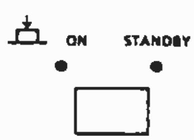
8



Frequency tuning knob

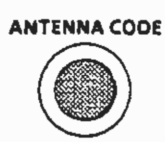
FREQ:	key for input of frequency
STEP SIZE	Input of tuning step size
STEP:	Tuning in the step size entered in STEP SIZE
COARSE:	Frequency tuning coarse (100-kHz steps)
FINE:	Frequency tuning fine (10-Hz steps)
⇧	Frequency is increased by the step size entered in STEP SIZE
⇩	Frequency is reduced by the step size entered in STEP SIZE (cf. section 3.2.3.1)

9



On/Standby switch

10



Supply and code socket for connecting active and passive measuring transducers:

Output:	+ 10 V, -10 V, max. 50 mA
Input:	Coding for level display (cf. section 3.2.5.1)

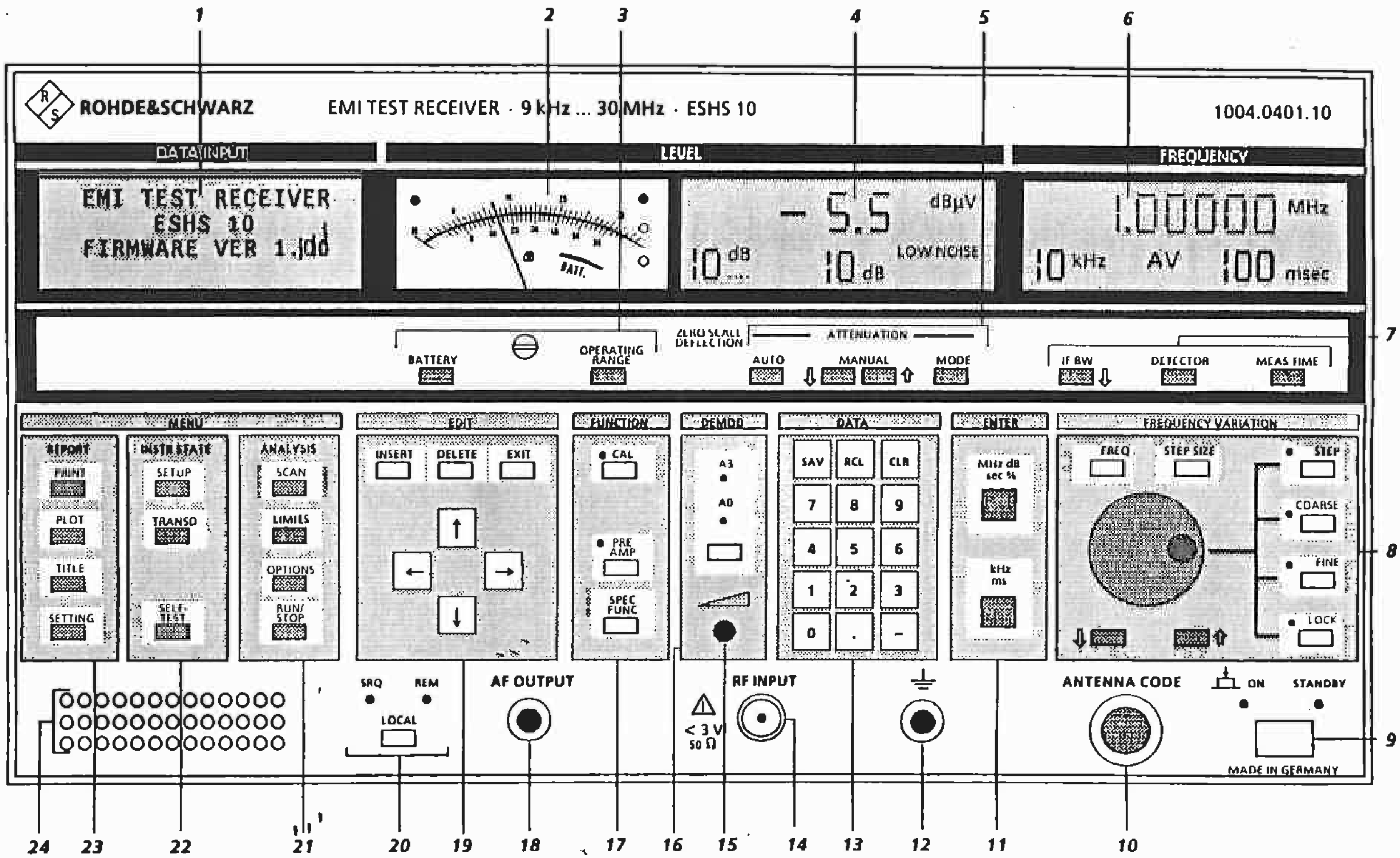


Fig. 3-1 Front panel view

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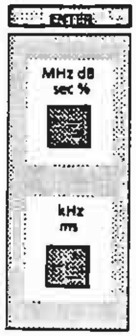


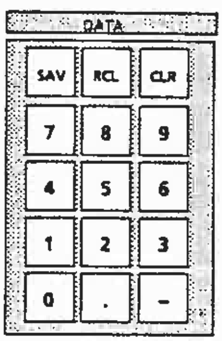
Input keys:

MHz dB sec %:	Input key for the units MHz, dB, seconds and % or for entries without unit
kHz ms:	Input key for the units kHz and milliseconds or for entries without unit (cf. section 3.2.2)

12

Socket for connecting measuring earth

13



Numeric keypad

SAV (0 to 9):	Storing of instrument settings (cf. section 3.2.4.5)
RCL (0 to 9):	Calling of stored settings (cf. section 3.2.4.5)
CLR:	Deleting the character last entered
0 to 9:	Numeric input keypad
-	Minus sign
. :	Decimal point (cf. section 3.2.2)

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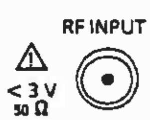

RF-input, N-input socket, 50 Ω, < 3 V (cf. section 3.2.1)

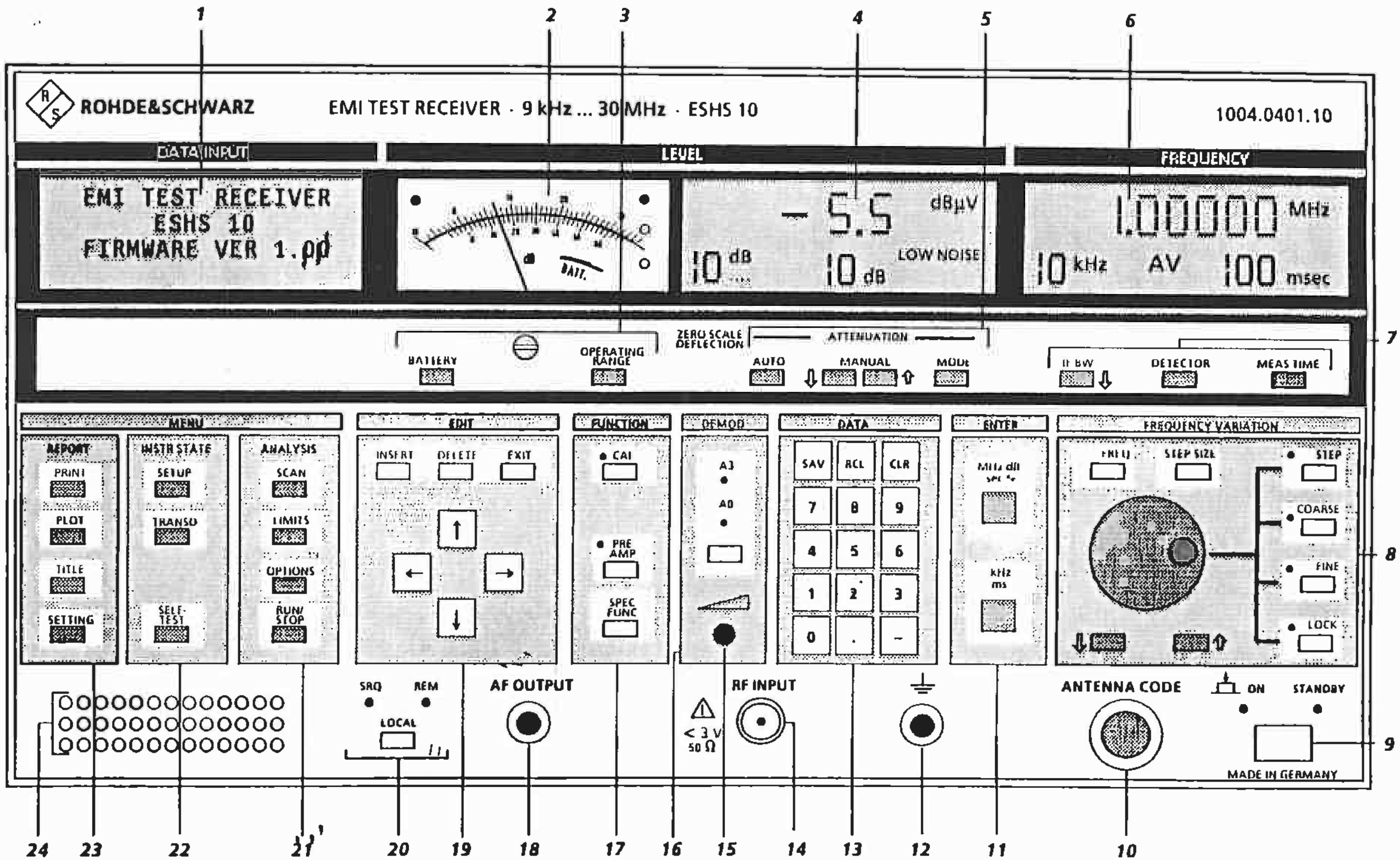

Fig. 3-1 Front panel view

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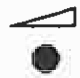

Rotary knob for setting the volume.
(cf. section 3.2.3.11)

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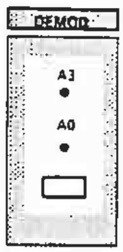

A3: Indicates when AM-demodulation is switched on

A0: Indicates when A0-demodulation is switched on

Key for switching-over the mode of demodulation
(cf. section 3.2.3.11)

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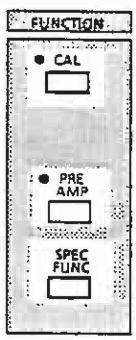
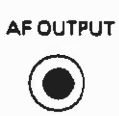


CAL: Initiating calibration process
short key depression → short CAL
long key depression → total CAL
(cf. section 3.2.3.12)

PREAMP: ON/OFF-switch for preamplifier
(cf. section 3.2.3.4)

SPEC FUNC: Calling the special function menu
(cf. section 3.2.3.13)

18



AF-output connector (JK 34)
with break contact for loudspeaker;
R_i = 10 Ω; P > 100 mW

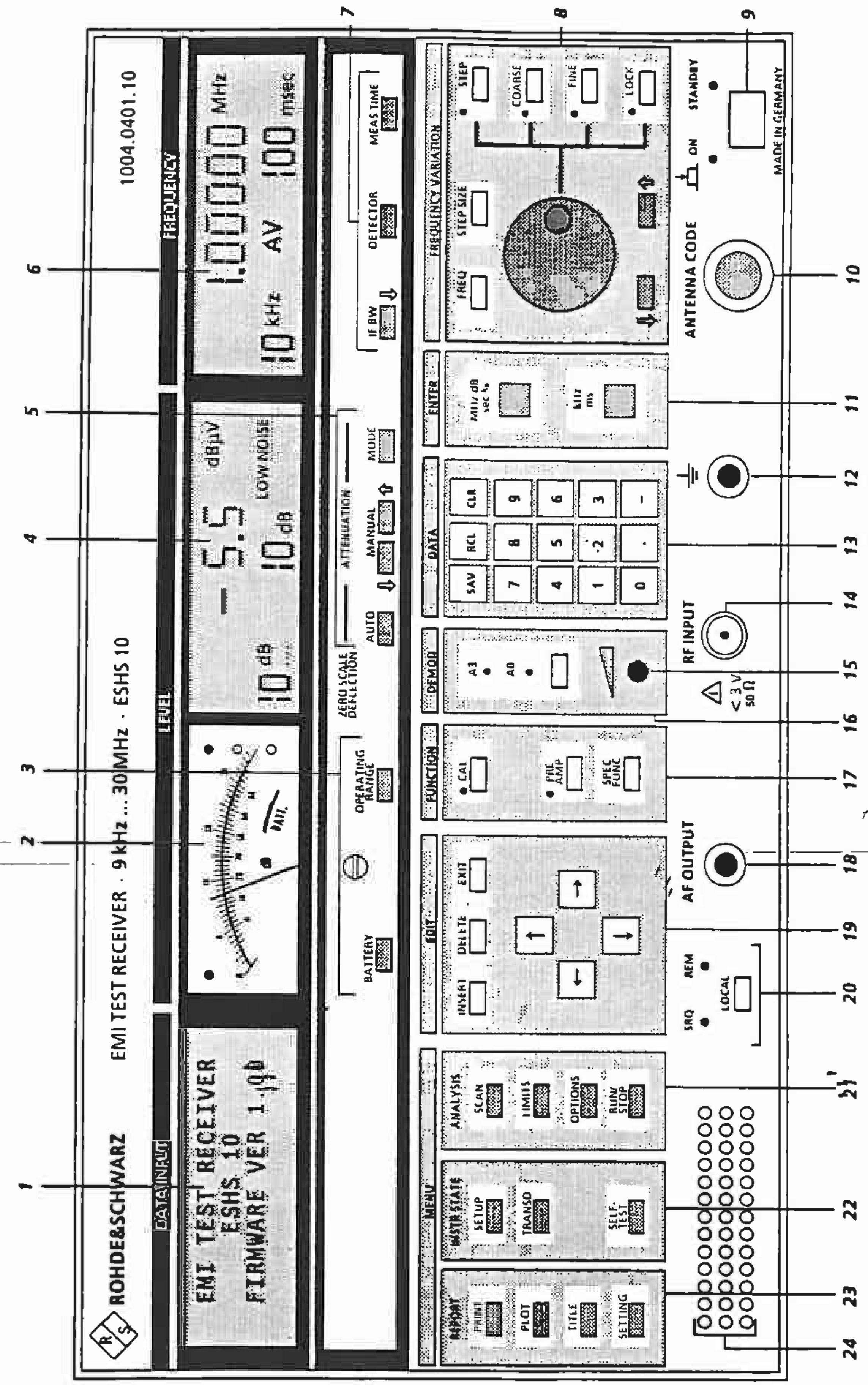


Fig. 3-1 Front panel view

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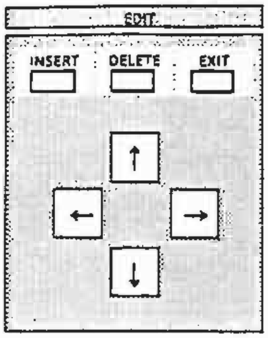

Editing function of display DATA INPUT:

EXIT: Exiting the current menu (cf. section 3.2.4.1)

INSERT: Inserting in already existing lists (cf. section 3.2.4.1)

DELETE: Deleting input lines or -characters (cf. section 3.2.4.1)

→: The cursor moves to the right or to the next submenu, (cf. section 3.2.4.1)

←: The cursor moves to the left or one menu back, (cf. section 3.2.4.1)

↑: The cursor moves one line up (cf. section 3.2.4.1)

↓: The cursor moves one line down (cf. section 3.2.4.1)

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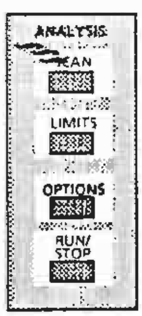
SRQ: LED indicates service request present at IEC-bus (cf. section 3.3)

REM: LED for indicating remote control of ESHS (cf. section 3.3)

LOCAL: Key for switching from remote control to manual operation (cf. section 3.3).

21



SCAN: Calling the menu for input of scan data sets (cf. section 3.2.4.1.1)

LIMITS: Calling the menu for input of limit lines (cf. section 3.2.4.3.2)

OPTIONS: Calling the menu for input of special measurements and complex procedures (cf. section 3.2.4.3.3)

RUN/STOP: Key for starting or stopping a frequency scan (cf. section 3. 2. 4. 3. 4)

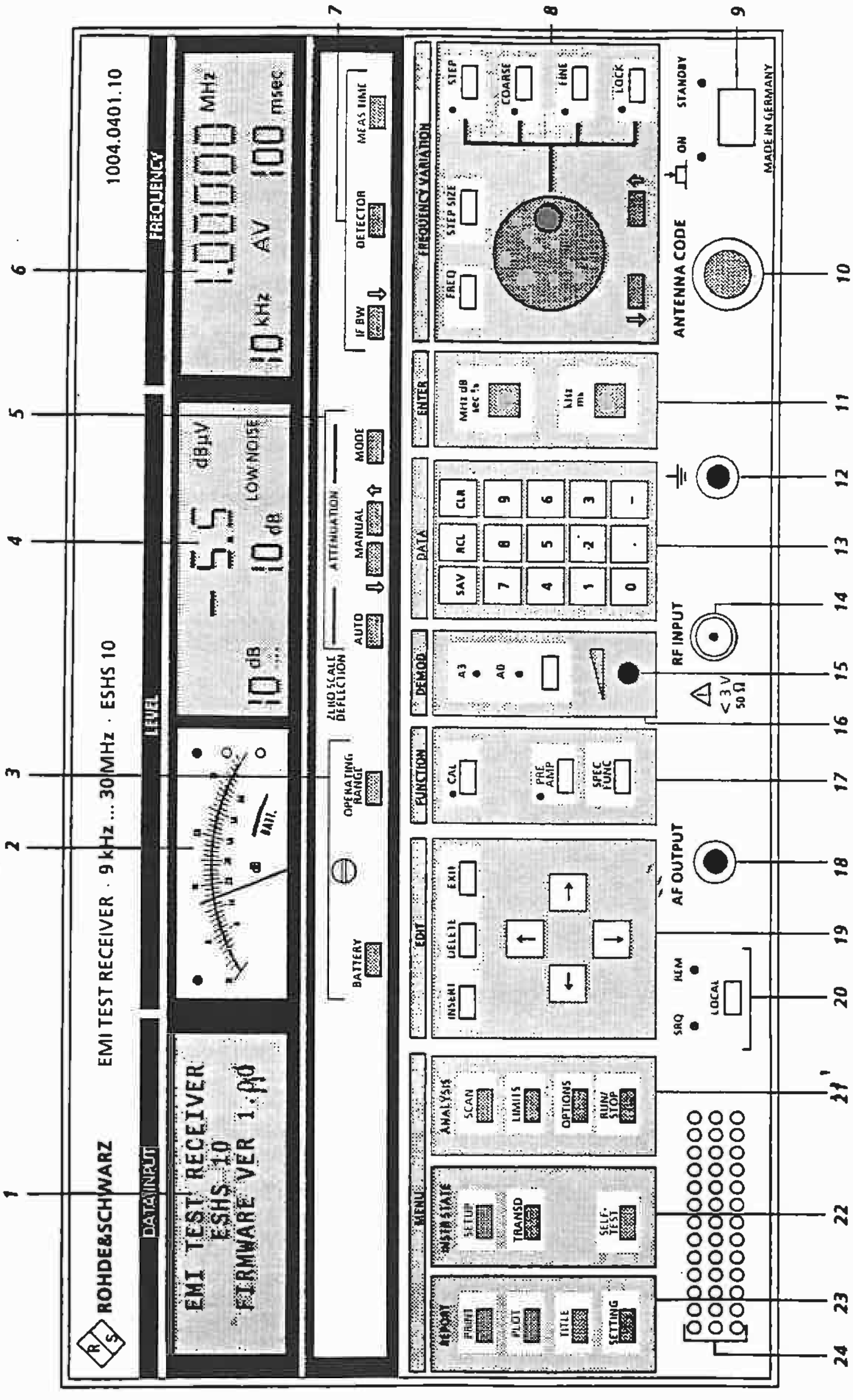


Fig. 3-1 Front panel view

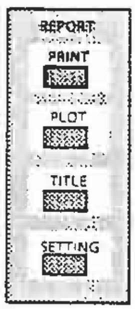
22

SETUP: Calling the menu for the instrument default settings (cf. section 3. 2. 4. 2.1)

TRANSD: Calling the menu for input of transducer factors (cf. section 3.2.4.2.2)

SELF TEST: Calling the menu for instrument self-test (cf. section 3.2.4.2.3)

23



PRINT: Selecting printer output (cf. section 3. 2. 4. 4. 3)

PLOT: Selecting plotter output (cf. section 3.2.4.4.4)

TITLE: Calling the menus for input of headers for printer or plotter output (cf. section 3.2.4.4.2)

SETTING: Calling the menu for presetting the instrument for output (cf. section 3.2.4.4.1)

24

Internal loudspeaker, which is switched off when a connector is inserted into the socket *AF* OUTPUT.

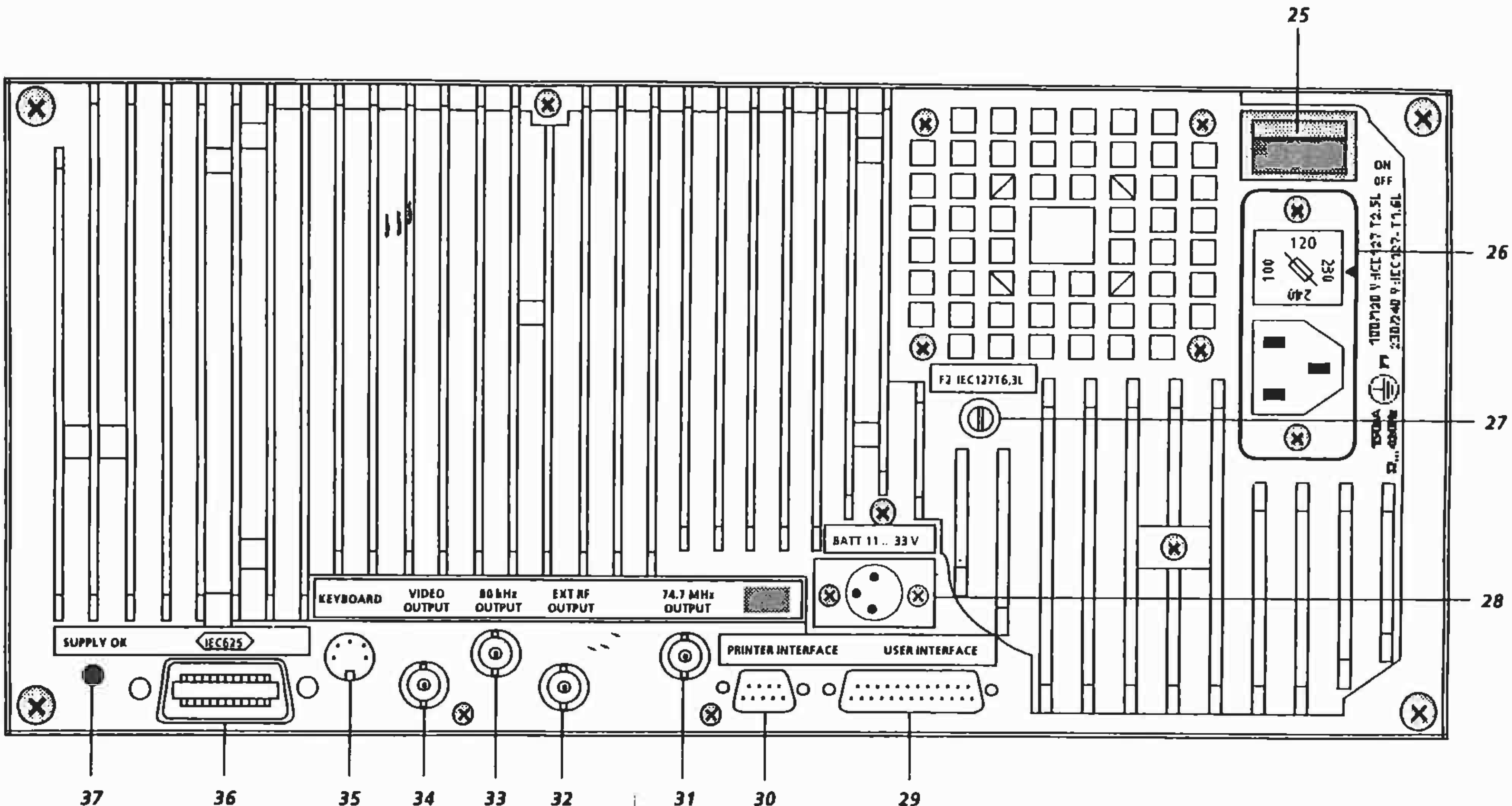
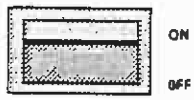


Fig. 3-2 Rear panel view

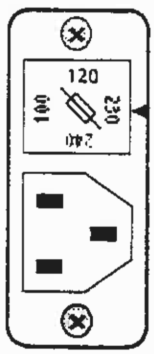
3.1.2 Rear View

25



Power switch

26

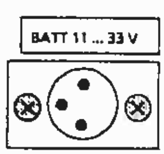


Power input with integrated voltage selector and power fuse (cf. section 2.1.3.1)

27

Fuse for external battery,
F2: IEC 127 T6,3L 250 V
(cf. section 2.1.3.3)

28



Input for an external battery 11 to 33 V,
3-pole special connector; (cf. section 2.1.3.2)

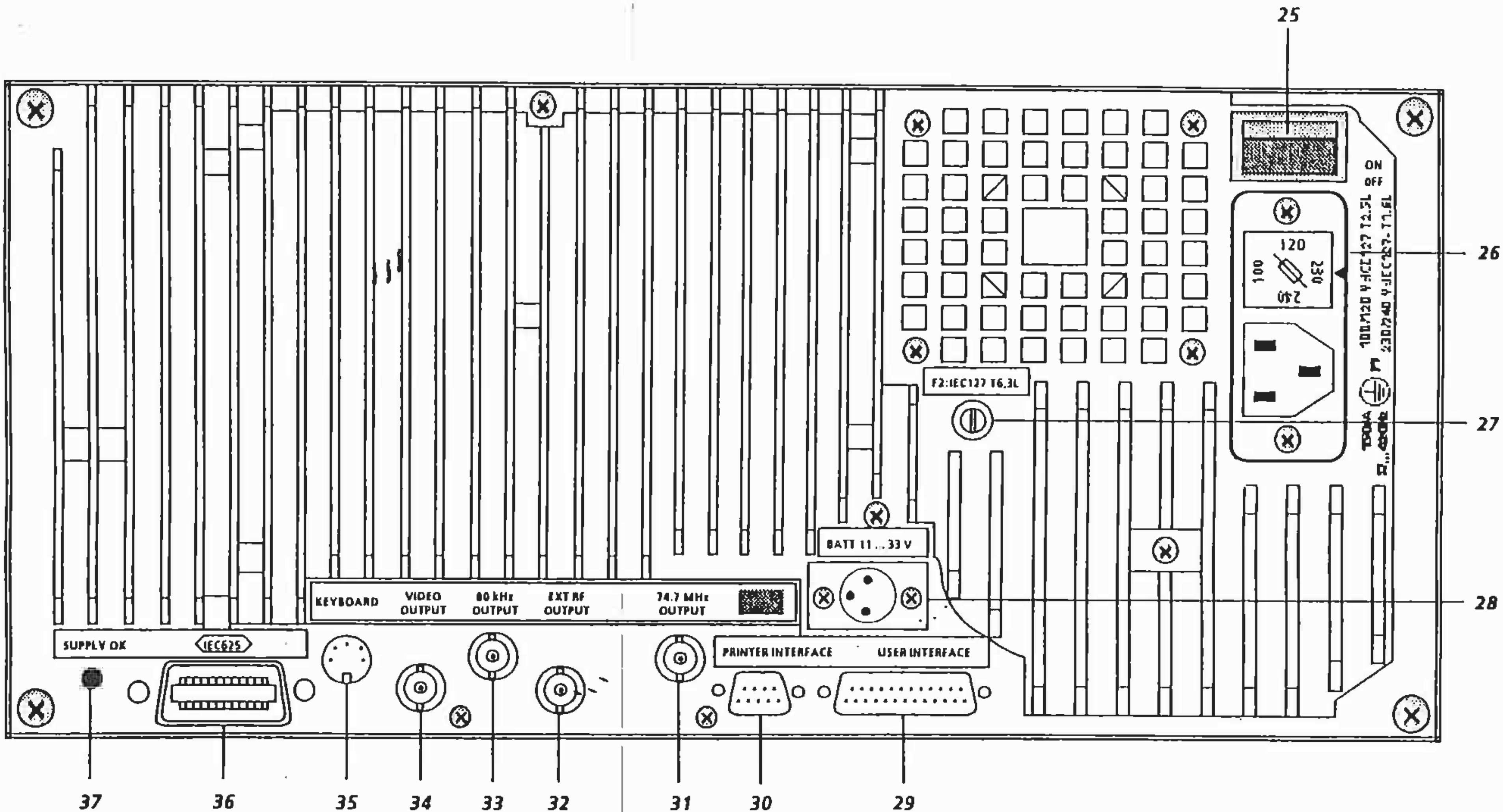
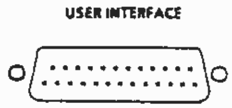


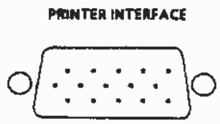
Fig. 3-2 Rear panel view

29



User interface with various inputs and outputs, 25-pole female connector (cf. section 3.2.6.5)

30



Parallel interface for connecting a printer, 15-pole female connector (cf. section 3.2.6.6)

31

BNC-socket for output of the 1st IF (74.7 MHz) for connecting a panoramic monitor (cf. section 3.2.6.6)

32

BNC-socket for connecting an external reference, 5 or 10 MHz (cf. section 3.2.6.4)

33

BNC-socket for output of the 2nd IF (80 kHz) (cf. section 3.2.6.2)

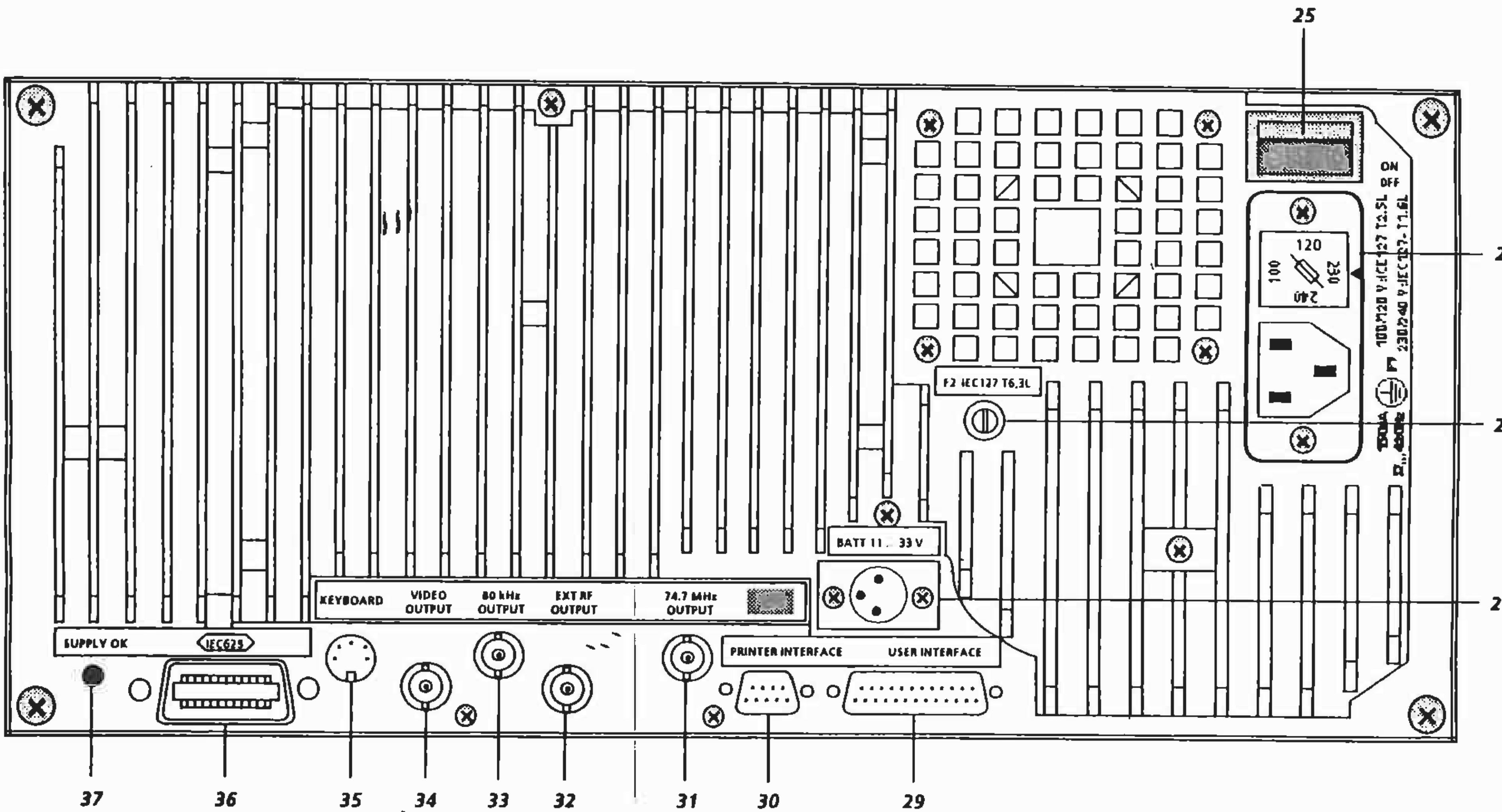
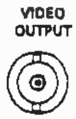


Fig. 3-2 Rear panel view

34

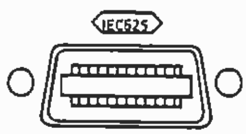


BNC-output socket for the demodulated IF-signal (envelope) (cf. section 3.2.6.3)

35

Connection for external keyboard (cf. section 3.2.6.8)

36



IEC-bus interface, 25-pole female connector (cf. section 3.2.6.7)

37

LED flashes when all the internal supply voltages of the power supply are correct.

3.2 Manual Operation

Manual operation of Test Receiver ESHS 10 can be divided into two groups: operation of the receiver functions and that of the menus calling complex measurement runs.

The receiver functions are:

- frequency input,
- selecting attenuation (RF-attenuation and IF-attenuation),
- selecting IF-bandwidth,
- selecting weighting mode (detector),
- selecting measuring time,
- selecting operating range,
- selecting AF-demodulation,
- testing the internal battery,
- level indication (analog and digital),
- calibration of receiver,
- switching-on of pre-amplifier and
- use of the various special functions.

The menus include:

- selecting the receiver configuration,
- use of transducer factors (transducer),
- setting and performing frequency scans,
- input of limit lines,
- carrying out special measurements (OPTIONS) during frequency scan,
- output of measurement results on printer or plotter,
- input of headers for printer- or plotter outputs,
- setting the printer or plotter configuration and
- carrying out the self-test.

3.2.1 Connecting the Voltage to be Measured

The voltage to be measured is connected to the RF INPUT via a 50-Ω-coaxial cable. The input resistance of the receiver is 50 Ω. The ESHS measures sinusoidal and pulse voltages within the frequency range of 9 kHz to 30 MHz. The total voltage of all signals that may be applied to the input socket of the receiver without causing any permanent damage depends on RF-attenuation (cf. Specifications).

3.2.1.1 Sinusoidal Signals

With an RF-attenuation of 0 dB the RMS value of the total voltage applied to the RF-input may not exceed 3 V at 50 Ω. For RF-attenuations ≥ 10 dB the total voltage may not be more than max. 7 V.

3.2.1.2 Pulse Signals

With an RF-attenuation of 0 dB the pulse spectral density must not exceed 96 dBµV/MHz at 50 Ω. As described in section 3.2.3.5 (autorange operation), after switch-on of the receiver, RF-attenuation is more than 10 dB, if attenuation is set automatically. If, however, automatic operation was switched on with an RF attenuation of 0 dB, this value is also used in autorange operation. Manual setting of RF-attenuation prevents that an RF-attenuation of 0 dB is activated during autorange operation.

With an RF-attenuation > 0 dB the max. permissible pulse energy at 50 Ω is 100 mWs. This means in practice that the attenuator cannot be destroyed by pulses resulting from phase switch-over of the artificial networks ESH2-Z5 and ESH3-Z5.

The input attenuator, pre-amplifier, preselection filter or input mixer may be destroyed, if these values are exceeded. This can be avoided by connecting a power attenuator pad ahead of these components.

3.2.2 Input of Numeric Values

The numeric keypad DATA (pos. *13*, cf. fig. 3-1) and the unit field ENTER (pos. *11*) are used for the input of figures both in the receiver part and menu part.

The keys SAV and RCL that serve to save and call instrument settings are dealt with in section 3.2.4.5. Numeric values are input in accordance with the following flowchart:

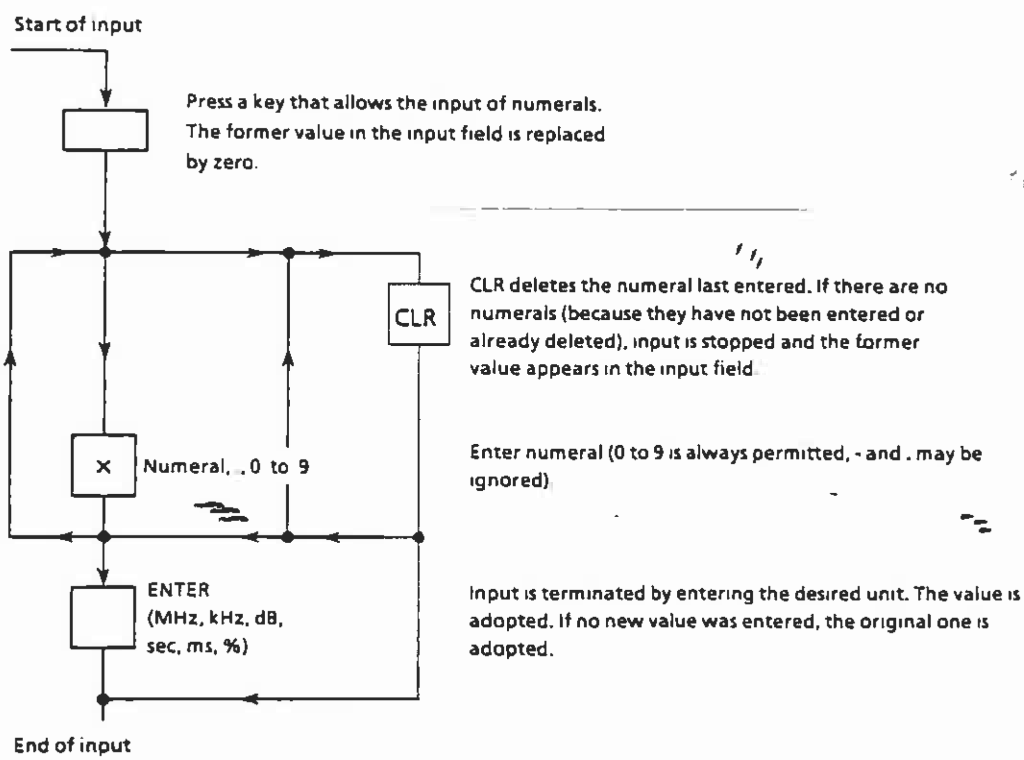


Fig. 3-3 Flowchart for the input of numeric values

3.2.3 Operation of the Receiver Functions

3.2.3.1 Setting the Receiver Frequency

The frequency of the receiver can be entered using the rotary knob, the upward/downward keys or via the numeric keypad (*13*) after having pressed the FREQ key. When setting frequency with rotary knob, frequency increment or decrement is selected using the functions STEP, COARSE and FINE.

3.2.3.1.1 Numeric Input of Frequency

The desired receiver frequency in the range of 9 kHz to 30 MHz can be entered directly using the FREQ key in the keypad FREQUENCY VARIATION. Following the activation of the FREQ key, the current receiver frequency, which is shown in the display FREQUENCY, is cleared and a new one can be entered as described in section 3.2.2.

3.2.3.1.2 Frequency Setting using the Rotary Knob

The rotary knob in keypad FREQUENCY VARIATION serves only for varying the frequency. Independently of any other selected function, the frequency can always be tuned using this knob.

The step size of frequency tuning can be selected using the keys STEP, COARSE, FINE and LOCK. The step size selected is indicated by an LED next to the corresponding key. Tuning is performed in the step sizes given in the following table:

Table 3-1:

Tuning in Position	Step Size
COARSE	10 kHz
FINE	10 Hz
LOCK	Rotary knob is blocked
STEP	0 Hz to 30 MHz (cf. section 3.2.3.1.4)

When the rotary knob is turned slowly, every step between detent positions corresponds to a frequency step. To allow for comfortable tuning of the receiver over relatively wide frequency ranges, tuning is additionally accelerated when the knob is turned more quickly.

3.2.3.1.3 Frequency Tuning using the ↓ and ↑ keys

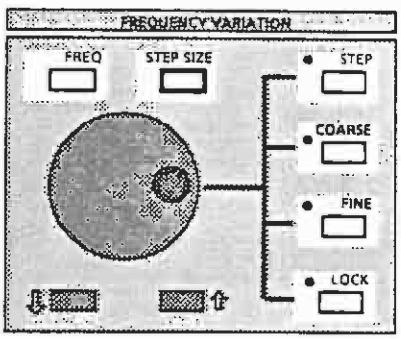
If signals in known frequency steps are to be measured, it is useful to step through the receiver frequency in their distance. This is for example the case with harmonics of the line frequency of monitors. For this purpose the ↓ and ↑ keys are provided in the keypad FREQUENCY VARIATION. Frequency is changed in the step sizes entered with the help of STEP SIZE (cf. section 3.2.3.1.4) using these keys. In addition the receiver frequency can be fine-tuned using the rotary knob in position FINE, when for example the maximum of a harmonic wave is to be determined in the case of a source that is not frequency-stable. Fine-tuning is taken into account when changing the frequency the next time using the ↓ and ↑ keys, i.e. the receiver proceeds taking the new frequency as basis.

3.2.3.1.4 Input of Tuning Step Size

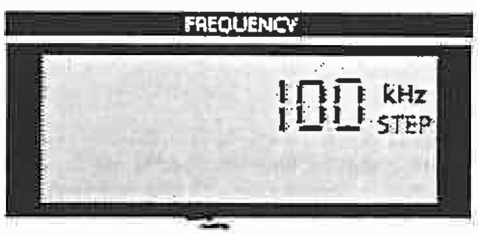
Any step size for tuning the receiver frequency can be input using the STEP SIZE key in the keypad FREQUENCY VARIATION. The defined step size is used when tuning the frequency with the ↓ and ↑ keys or with the tuning knob in the step size setting STEP.

Operation:

Step size is entered as follows:



▸ Press STEP SIZE key.



The frequency in the display FREQUENCY disappears and instead the step size currently set is indicated with the additional remark *STEP*.
When entering a figure the former step size is no longer displayed and the figure is shown in the display (input cf. section 3.2.2)

After termination of input, the receiver frequency is shown again in the display FREQUENCY.

Note: *When changing the receiver frequency while exceeding the filter limit the pre-selection filters are also switched over. As a result of the internal switching processes short-term increase of analog meter display may occur especially in the case of indicating modes Pk (peak value), Pk/MHz (peak value relating to 1 MHz bandwidth) and QP (quasi-peak). This applies to the following frequencies:*

150 kHz,
4.05 MHz,
12.8 MHz and
21.55 MHz.

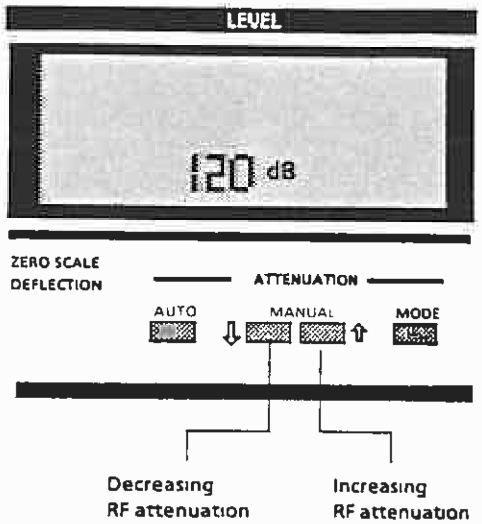
The value indicated by the LC-display and read out via the IEC-bus is, however, always correct, as the switching processes are considered during measurement.

3.2.3.2 Selecting RF Attenuation (ATTENUATION)

Attenuation of the RF input divider can be set in 10-dB steps in the range of 0 to 120 dB. The first two 10-dB-attenuator pads consist of pulse-resistant carbon-film resistors, thus preventing the attenuator of being damaged due to high pulses as they may occur, for example, during phase switch-over of artificial networks. The test receiver may have somewhat less accuracy in the 0-dB position as a result of the higher input reflection coefficient (VSWR < 2). In the case of quasi-peak measurements in accordance with CISPR 16, minimum attenuation of 10 dB must therefore be switched on (VSWR < 1.2).

Operation:

RF-attenuation is increased or decreased in 10-dB steps using the ↓ and ↑ keys in the ATTENUATION keypad. When pressing the respective key for a longer time (> 1 s) the repetition function is switched on, i.e. attenuation is stepwise switched.



The RF attenuation selected is shown in the LEVEL display.

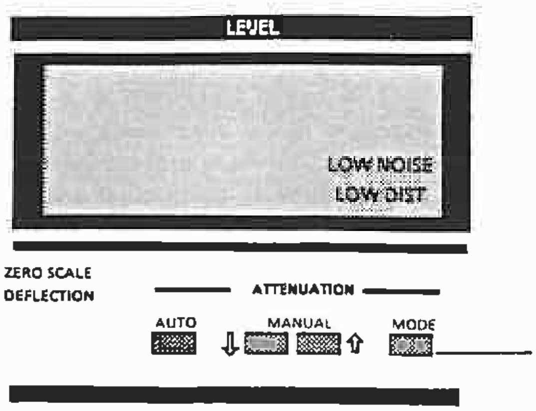
3.2.3.3 Selecting the Operating Mode (MODE)

The ESHS provides the operating modes LOW NOISE (low-noise measurement) and LOW DISTORTION (low-distortion measurement). When measuring in the latter mode IF gain of the receiver is set such that the noise indication is always below the beginning of the meter scale (ZERO SCALE DEFLECTION) or when measuring with preamplifier it is set such that it is in proximity to zero scale deflection of the instrument. The set IF gain depends on the indicating mode and the IF bandwidth. In the mode LOW NOISE, IF gain is 10 dB less, i.e. the signal-to-noise ratio for signals in the valid indication range is 10 dB higher than in the operating mode LOW DISTORTION.

LOW DISTORTION should be used for small signals in the presence of high interference signals or when measuring broadband interference in the indicating modes Pk/MHz and Quasi-peak with low pulse frequency. To obtain the same deflection at the instrument as in the operating mode LOW NOISE, RF attenuation must be selected 10 dB higher. Signals that are 10 dB lower are applied to the input mixer, which is thus less loaded.

For uncritical measurements the setting LOW NOISE is to be preferred as a higher degree of accuracy can be expected due to the higher signal-to-noise ratio.

Operation:



Toggle key LOW NOISE/LOW DISTORTION

The set mode is shown in the LEVEL display.

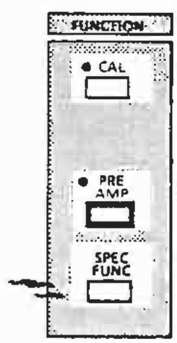
3.2.3.4 Operation with Preamplifier (PREAMP)

The preamplifier of the ESHS is between preselector and first mixer. It reduces the noise figure of the receiver from typically 10.5 dB to typ. 7 dB. Due to its high loading capability the preamplifier itself does not affect the dynamic range of the receiver. However, with pre-amplifier the level at the first mixer is 10 dB higher. Therefore total loading capability is reduced by about 10 dB.

As a result the dynamic range is reduced by approx. 6 dB (4 dB less noise and a maximum level that is reduced by 10 dB) when carrying out quasi-peak or broadband interference measurements.

It is recommended to use the preamplifier when signals in proximity of the inherent noise of the receiver are to be measured or when, in the case of medium-range levels, the measurement error is to be reduced with the help of a higher signal-to noise ratio.

Operation:



- Press PREAMP key. The state of the preamplifier is switched over. The LED flashes when the preamplifier is switched on.

3.2.3.5 Automatic Setting of Attenuation (Autorange Operation)

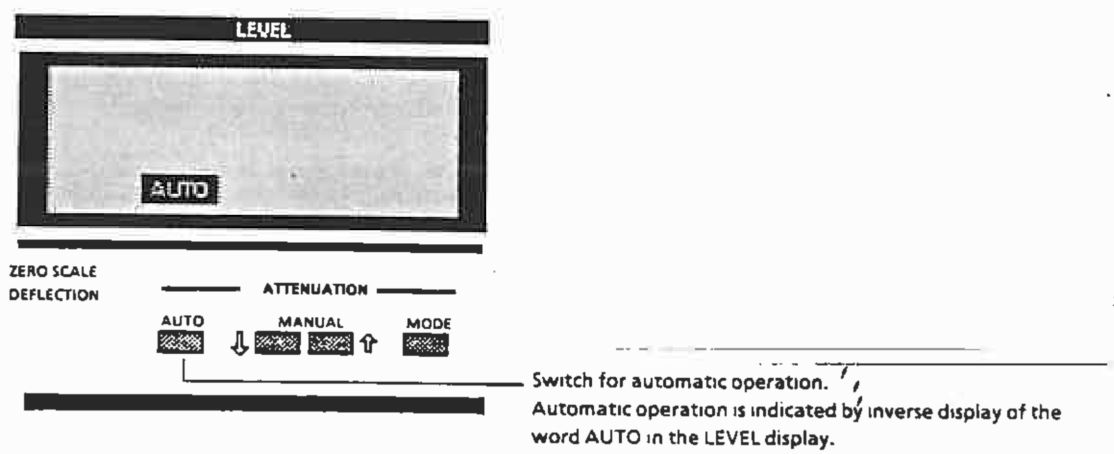
With automatic operation the receiver sets RF attenuation and operating mode (MODE) such that the level applied to the RF input is always within the valid operating range. After switching on of the receiver 10 dB of RF attenuation at least are always switched on. This serves to protect the input mixer and preamplifier against levels inadvertently applied too high. 0 dB of RF attenuation is only used in automatic operation, if it is switched on when activating automatic operation. The following criteria are of importance for setting optimal attenuation:

- the overload indications at the positions critical in the receiving path,
- the peak value at the output of the envelope demodulator and
- the measured value in the set indicating mode (DETECTOR).

Settings in keeping with these criteria make sure that levels measured in autorange operation are valid in any case and not invalidated by overloading in a receiver stage.

Hysteresis for changing over attenuation at the lower end of the operating range prevents continuous switching on and off of attenuation due to varying input levels.

Operation:



Automatic operation can be switched off by

- pressing the AUTO key or
- manual switching of attenuator

3.2.3.6 Selecting the Operating Range (OPERATING RANGE)

The ESHS offers the operating ranges 30 dB and 60 dB. In both ranges the analog indication is dB-linear, i.e. the indication voltage is indicated logarithmically.

The 30-dB range offers the advantage of a higher resolution on the analog instrument.

Recording of strongly varying signals without attenuation switch-over is facilitated in the 60-dB operating range. The step size of the level switch in automatic operation is thus larger than in the 30-dB range. The relation between step size of attenuation and operating range is shown in the following table:

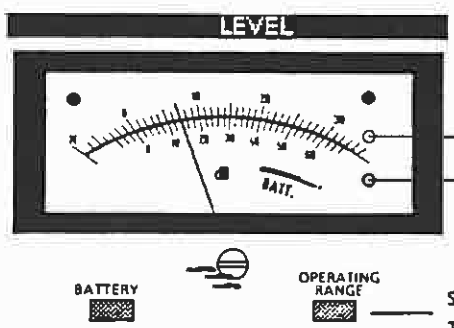
Table 3-2

Operating Range	Attenuation Step
30 dB	10 dB
60 dB	30 dB

In the 60-dB range measuring speed during a frequency scan is higher, if there is a strongly varying spectrum and therefore the attenuator need not be switched over so often as in the 30-dB range. In addition signal-to-noise ratio is increased in the upper half of the operating range.

Note: Although the nominal operating ranges are specified only with 30 or 60 dB, it is possible to measure to the noise limit with only slightly reduced accuracy at ambient temperatures of between + 15° C and + 30 ° C. This means that, e.g in the 60-dB range, indication is linear up to 10 dB below the beginning of the range (= 70-dB range).

Operation:



Switching over of operating range.
The set operating range is indicated by the LED situated at the respective instrument scale.

3.2.3.7 Level Indication

The measured level is displayed both by the analog meter (2) and digitally in the display LEVEL (4).

3.2.3.7.1 Digital Level Indication

Compared to analog indication, digital level indication has the advantage of being more accurate since the correction values for the linearity of the rectifier and that of the logarithmic amplifier which are both determined during total calibration are part of the value displayed. Resolution of the digital display is 0.1 dB in a range of -200 to +200 dB. If indication exceeds the value 200 due to the theoretically possible selection of a transducer of up to ± 200 dB, the level is output with a resolution of 1 dB on the LEVEL display. The unit of the measured quantity is also indicated. The basic unit of the indication is dBµV. Other units can be selected by coding the connector ANTENNA CODE (cf. section 3.2.5.1), entering a transducer factor (cf. section 3.2.4.2.2) or by way of special functions (cf. section 3.3.2.3.13). The following units are possible:

Table 3-3

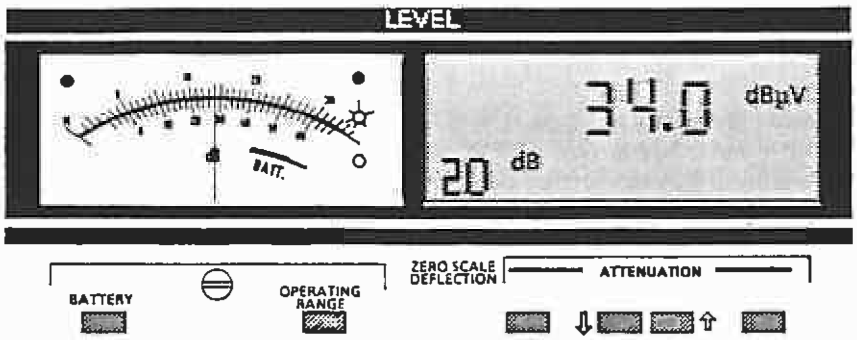
dBµV	Voltage applied to 50 Ω at RF-input of receiver
dBµA	For current measurement, settable by coding connector ANTENNA CODE or by the unit of the transducer factor.
dBµV/m	Electrical fieldstrength, settable by coding connector ANTENNA CODE or by the unit of the transducer factor.
dBµA/m	Magnetic fieldstrength, settable by the unit of the transducer factor.
dBµV/MHz	Spectral pulse voltage density, switched on in indicating mode Pk/MHz.
dBµA/MHz	Spectral pulse current density, settable by coding connector ANTENNA CODE or by the unit of the transducer factor in indicating mode Pk/MHz
dBµV/m/MHz	Spectral pulse density of the electrical fieldstrength, settable by coding connector ANTENNA CODE or by the unit of the transducer factor in indicating mode Pk/MHz
dBµA/m/MHz	Spectral pulse density of the magnetic field strength, settable by the unit of the transducer factor in indicating mode Pk/MHz
dBpW	Power in dB relating to 1 picowatt, settable by the unit of the transducer factor
dBm	Power in dB relating to 1 milliwatt, settable by way of special function 20

3.2.3.7.2 Analog Level Indication

The level of analog indication is the result of adding the value for ZERO SCALE DEFLECTION in display LEVEL to that of the meter display in the selected operating range.

Zero scale deflection is indicated in 10 dB steps so that the addition can be performed without using any further means.

Example:



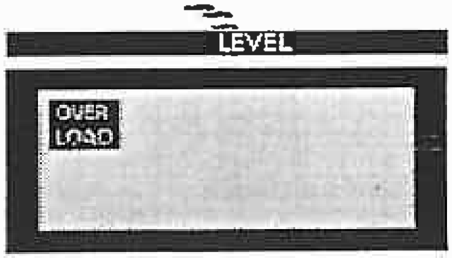
Measured value: 14 dB + 20 dB = 34 dBµV

The unit of the digital measured value is also valid for indication on the analog meter.

Non-decadic transducer factors or the pseudo unit dBm, too are correctly taken into account with analog indication. In this case the complete tens digit is added to zero scale deflection whereas the one digit and the digit after the comma are added internally to the instrument voltage by way of a digital/analog converter. The operating range of the instrument is thus usually shifted, either to higher or to lower values (max. 6 dB). For this purpose, the 30- and 60-dB scale is extended by 6 dB at the upper and lower end of the scale respectively. To ensure that the user detects exceedings of the operating range (higher or lower), a red LED flashes at the upper or lower end of the scale.

3.2.3.7.3 Overload of Receiver

Although analog level indication is within the valid range, the receiver may be overloaded. This is, e.g. the case when a relatively weak signal is within the measuring bandwidth, however a strong signal is present outside the range. This strong signal may overload the stages before the IF-filter. For this reason in the ESHS, the level is monitored at this critical positions. If a stage in the signal path is overloaded, the user will be informed about this by the message OVERLOAD on the LEVEL display.



To guarantee correct measurement RF-attenuation must be switched on additionally until OVERLOAD display disappears. In autorange operation, attenuation is automatically set such that no overload occurs.

3.2.3.8 Selecting IF Bandwidth (IF BW)

Selection of IF bandwidth depends on the bandwidth of the signal to be received and the required adjacent channel suppression. If great demands on sensitivity are made and with unmodulated signals and signals with narrow modulation bandwidth, the 200-Hz bandwidth is preferably used. The 10-kHz bandwidth is however recommended for measurements of broadband signals, such as pulse signals or AM broadcasting signals. With receiving frequencies of under 30 kHz, the 200-Hz bandwidth is always recommended for use since the oscillator for first conversion is not suppressed sufficiently with the 10-kHz bandwidth and thus the sensitivity of the receiver is considerably reduced.

The 200-Hz bandwidth meets the tolerance for the bandwidth of band A (9 kHz to 150 kHz) specified in CISPR 16 or VDE 0876.

Due to the narrow specification of a 6 dB-drop, the 10-kHz bandwidth meets the requirements of CISPR 16, band B (150 kHz to 30 MHz) and VDE 0876 as well as of various military standards that require tolerances of 10 % for a 10-kHz measurement bandwidth.

Both filters have optimal settling characteristics and are thus suitable for average measurement of pulse signals in accordance with CISPR 16.

In the indication mode quasi-peak (QP) bandwidth is linked to the receiver frequency. In band A (f_{rec} < 150 kHz) the 200-Hz bandwidth and in band B ($f_{rec} \geq$ 150 kHz) the 10-kHz bandwidth is automatically switched on.

Effective selectivity of the filters is shown in the following figure:

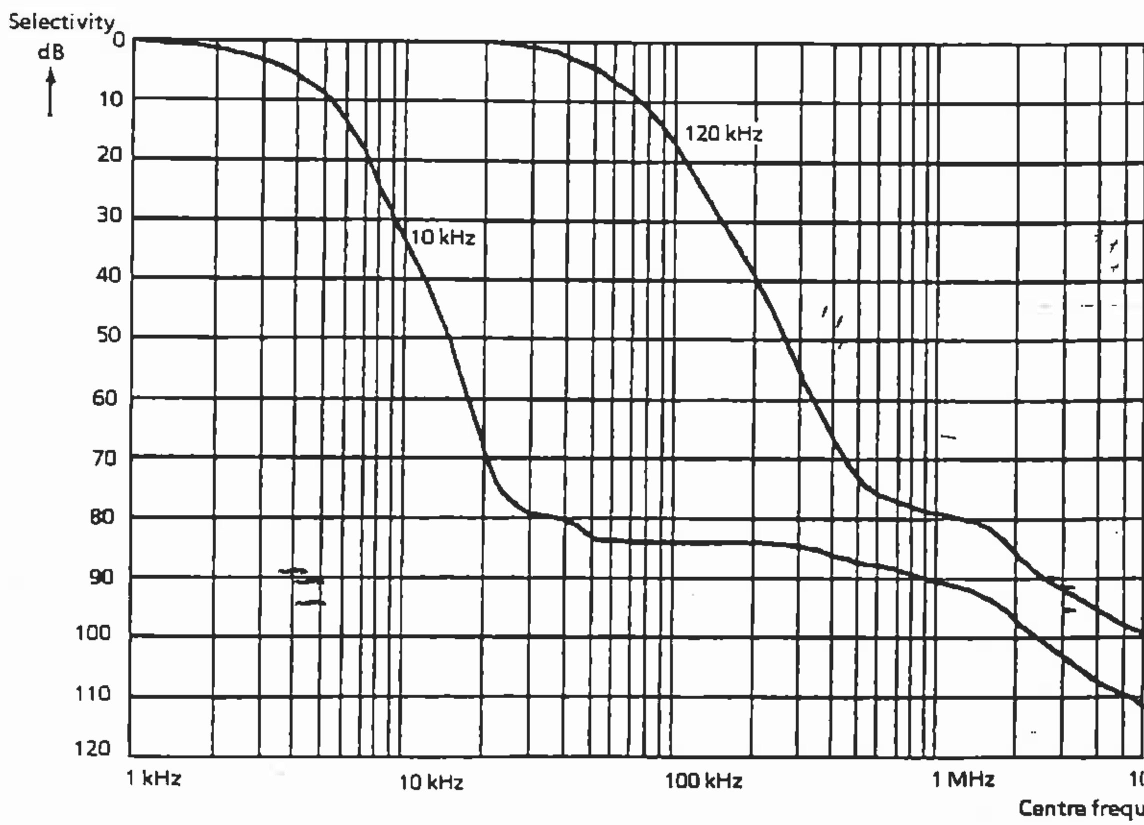
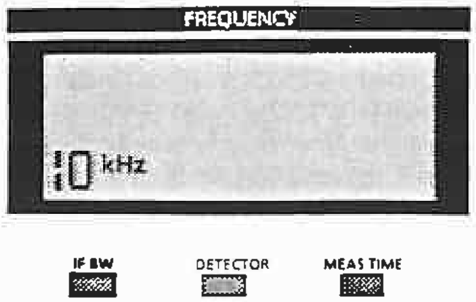


Fig. 3-4 Effective IF-selectivity

Operation:



- Press IF BW key.
  IF-bandwidth is switched over (200 Hz ↔ 10 kHz) and the newly set IF-bandwidth is underlined to indicate that a new entry is possible using the numeric keypad DATA.
- Press ENTER key.
  The bar disappears again (input of bandwidth is inactive).

3.2.3.9 Selecting the Indicating Mode (DETECTOR)

The indicating mode specifies how to weight the envelope of the IF-signal. The weighting modes (detectors) average value (AV), peak value (Pk), peak value relating to 1 MHz bandwidth (Pk/MHz) and quasi-peak value (QP) can be switched on in the ESHS. The consequences brought about by the selection of indicating mode is explained in the following paragraphs.

3.2.3.9.1 Average Measurement (AV)

In the case of average measurement the linear time-averaged value of the rectified voltage at the output of the envelope demodulator is indicated. It is calibrated using the RMS value of an unmodulated sinusoidal signal. If an unmodulated sinusoidal signal is applied to the receiver input, its RMS value is thus indicated; if an AM-modulated signal is present, the RMS value of the carrier is indicated.

With the ESHS, averaging is performed analog using lowpass filters, the time constants of which are switched over depending on the measuring time (cf. section 3.2.3.10). Weighting of pulses is described in sections 3.2.3.9.5 and 3.2.3.10.

3.2.3.9.2 Peak Value (Pk)

In the case of peak value measurement, the maximum value of the rectified voltage at the output of the envelope demodulator within the selected measuring time is indicated. It is calibrated using the RMS value of an unmodulated sinusoidal signal that supplies the same rectified voltage. Average and peak value of an unmodulated sinusoidal signal result basically in the same indication. As, however, with peak value weighting, the noise voltage indication is about 11 dB higher than with average weighting, higher values are indicated when the signal-to-noise ratio is not sufficient (refer also to section 3.2.3.12.4, measuring accuracy).

Peak value indication serves for determining the levels of keyed carriers or pulse signals or peak voltages of AM-modulated signals. As peak value measurement can be carried out considerably faster than quasi-peak measurement, with RFI measurements it is recommended to first perform a general measurement in indicating mode Pk and then a quasi-peak measurement at the critical frequencies.

3.2.3.9.3 Measurement of Broadband Interferences (Pk/MHz)

In indicating mode Pk/MHz the spectral pulse voltage density of the input signal is measured. The peak value present at the output of the envelope demodulator within the selected measuring time is related to 1 MHz bandwidth while it is assumed that pulse-shaped signals are applied to the receiver input. The pulse voltage at the output of the IF-filter is directly proportional to the pulse bandwidth (≈ 6-dB bandwidth) of the filter, provided that the pulse frequency is low enough so that the individual pulses at the output of the filter do not overlap. In indicating mode Pk/MHz the peak value is thus increased arithmetically by the bandwidth factor

$$20 \times \log \frac{1\ \text{MHz}}{B_{IF}}$$

In the case of an IF-bandwidth of 10 kHz (nominal value, actual value of 6-dB bandwidth: 9.5 kHz) this factor amounts to 40.4 dB and with an IF-bandwidth of 200 Hz it is 74.0 dB.

Pulses with repetition frequencies of under 50 Hz provide the same result with both bandwidths. In practice there are, however, usually mixtures of various pulse interferences the individual components of which are uncorrellated. In this case the values indicated are therefore considerably higher with 200 Hz bandwidth than with 10 kHz. The extreme case is white noise, be it thermal noise of the receiver or other similar spurious signals. In this case indication is increased proportionally to the reciprocal value of the root of bandwidth ratio, i.e.

$$\text{increase} = 20 \log \sqrt{\left(\frac{9500\ \text{Hz}}{200\ \text{Hz}}\right)} = 10 \times \log \left(\frac{9500\ \text{Hz}}{200\ \text{Hz}}\right) = 16.8\ \text{dB}.$$

The 10-kHz bandwidth is therefore preferably used as the measurement result comes closest to the amount of interference. It is a bandwidth that is commonly used in this frequency range according to the MIL standards for broadband interference.

Narrow-band signals (sinusoidal signals) in the interference spectrum are most likely to be discovered by switching over to average value indication.

This fact is also illustrated in figure 3-5, section 3.2.3.9.5, which shows weighting of pulses by way of different indicating modes.

3.2.3.9.4 Quasi-peak (QP)

Quasi-peak measurement weights pulse signals using a quasi-peak detector with defined charge and discharge time. IF-bandwidth and mechanical time constant of the meter are also specified. The characteristics the receiver has in this indication mode are defined in CISPR 16 or in VDE 0876. The most important parameters are listed in the following table:

Table 3-4

	CISPR Band A	CISPR Band B
Frequency range	9 kHz to 150 kHz	150 kHz to 30 MHz
IF-bandwidth	200 Hz	9 kHz
Charge time of QP-detector	45 ms	1 ms
Discharge time of QP-detector	500 ms	160 ms
Time constant of meter	160 ms	160 ms

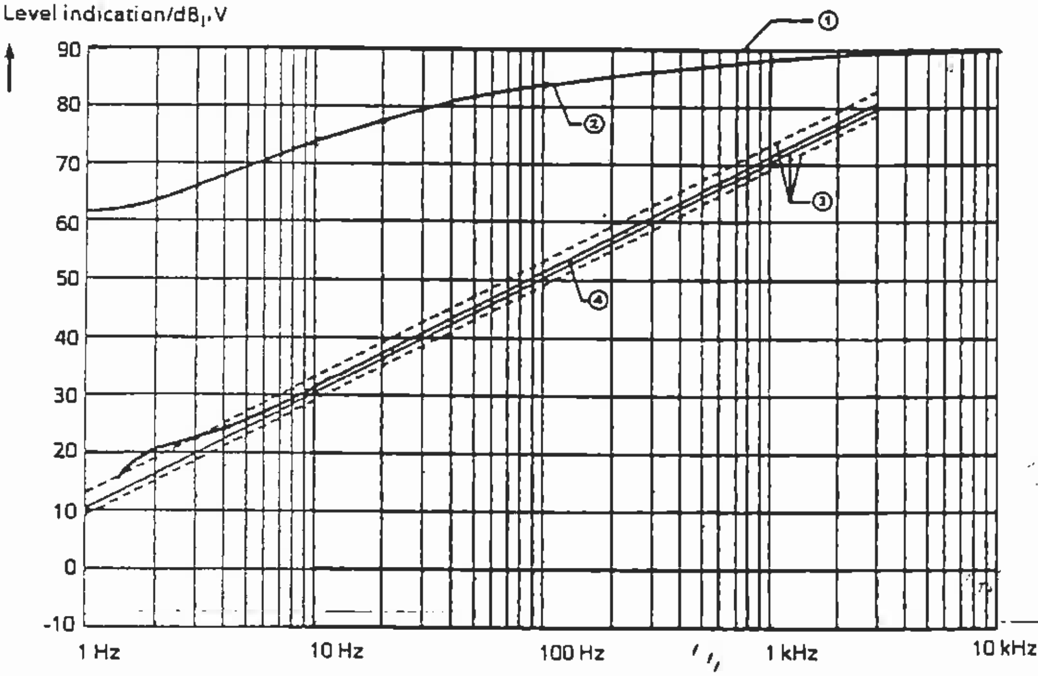
The meter time constant of ESHS is simulated electrically, so that it is also effective with digital indication. The instrument, itself, operates much quicklier so that its own time constant does not affect the measurement result.

Due to the long time constants of weighting, it takes relatively long until a valid measurement result is displayed after every change in frequency or attenuation at the receiver. It is therefore futile to use measuring times of less than 1 s, especially in the case of automatic measurements.

The maximum value of level during the measuring time set is shown by the digital level display. The time varying quasi-peak test voltage can be observed at the analog meter. This often allows - apart from listening in to the interference source - to draw useful conclusions as to the character of the interference.

Although quasi-peak weighting makes high demands on the dynamic characteristics of the receiver, with the ESHS the operating range can be selected without any restrictions. With low pulse frequencies the 60-dB range, however, cannot be made full use of as otherwise RF-input would be overloaded. When overload occurs the user is informed about it by way of the overload indication (OVERLOAD) in the LEVEL display. The user should increase RF attenuation to such an extent that the overload message disappears. In automatic operation the receiver, itself, sets attenuation correctly.

3.2.3.9.5 Pulse Weighting in Various Indicating Modes



① Peak value (Pk)

② QP (Band B) according to CISPR 16 and VDE 0876;

Tolerance values:

Pulse frequency	Level indication	Tolerance
1 kHz	88.5 dBµV	± 1
100 Hz	84 dBµV	—
20 Hz	77.5 dBµV	± 1
10 Hz	74 dBµV	± 1.5
2 Hz	63.5 dBµV	± 2
1 Hz	61.5 dBµV	± 2

③ Average value (AV) with error limits according to VDE 0876, Part 3

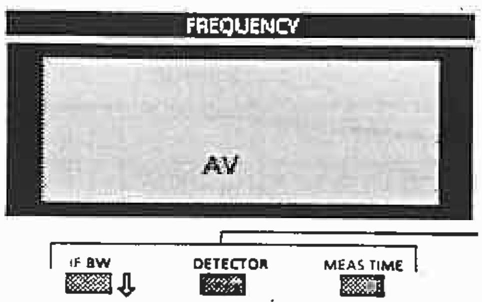
④ Characteristic average value indication with ESHS (60-dB indication range, measuring time 1 s)

Fig. 3-5 Differences in weighting of pulses between the indicating modes AV, Pk and QP with an IF-bandwidth of 10 kHz.

- Sinusoidal signals and pulses with a high repetition frequency result in the same indication in all three weighting modes.
- Peak value indication always shows the peak value of the highest pulse independently of the number of pulses during measuring time.

- In quasi-peak mode level indication drops with decreasing pulse repetition frequency due to time constants specified in CISPR 16.
- Average value indication weights pulses proportionally to pulse frequency. Level indication decreases most rapidly (20 dB per decade) when pulse frequency is reduced. With the ESHS, the characteristic curve of average value indication (curve ④) is about 1 dB above the theoretical curve, however always within the error limits of +3 and -1 dB, which are agreed upon in VDE 0876 Part 3. The reason is a slight overshoot of the IF-filter. Increase in indication for pulse repetition frequencies below 10 Hz is caused by internal receiver noise.

Operation:



The various indicating modes are switched on one after the other by pressing the DETECTOR key. The order in which it is switched over is the following:

AV → Pk → QP → Pk/MHz

3.2.3.10 Selecting the Measuring Time (MEAS TIME)

The measuring time is the time during which the input signal is monitored. The time that is required by the selected detector to settle following a change of attenuation or frequency is not part of it. The measuring time can be chosen within the range of 1 ms to 100 s in the steps 1, 2, 5, 10.

Significance with Peak Measurement:

In indicating mode Pk the maximum value of the level during measuring time is shown. At the beginning of measurement the peak detector is discharged. When the measuring time has elapsed, the output voltage of the detector is A/D-converted and then indicated. With measuring times of over 100 ms the peak voltage is A/D-converted every 100 ms and the maximum value of the individual measurements is taken as measurement value. Unmodulated signals can be measured using the shortest measuring time possible. In the case of pulse signals, measuring time must be set such that at least one pulse occurs during measuring time.

Significance with Average Measurement:

Averaging in indicating mode AV is performed using analog low-pass filters at the output of the linear envelope detector before the logarithmic amplifier. Following a change in frequency or attenuation the receiver therefore waits until the lowpass has settled and then measuring time begins. To keep waiting time as short as possible the receiver monitors the output signal during settling time. If it has already stabilized prior to the end of maximum waiting time, measurement is started earlier. If measurement times of more than 100 ms are selected, the linear output signal of the average value low-pass is also digitally averaged.

Which measuring time to select depends on the IF-bandwidth set and the character of the signal to be measured.

With a bandwidth of 200 Hz it is pointless to set measuring times below 50 ms as otherwise it cannot be guaranteed that the IF-filter has fully settled. Measuring times of less than 50 ms are therefore blocked. This can be rendered void using Special Function "02 MeasTime Cpld", if required (cf. section 3.2.3.13).

Unmodulated sinusoidal signals and signals with correspondingly high modulation frequencies can be measured using short times. Slowly varying signals or pulse signals require longer measuring times. The following table indicates up to which repetition frequencies pulses as a function of measuring time are still measured correctly (add. error of level indication < 1 dB).

Table 3-5

Measuring time	Min. pulse frequency for correct measurements
1 ms to 20 ms	1.3 kHz
50 ms to 200 ms	130 Hz
≥ 0.5 s	1.3 Hz

Thus the shortest measuring time (1 ms) can be used for RFI voltage measurements due to the following reasons: The difference between the limit values for quasi-peak and those for average value in the case of RFI voltage measurements amounts to maximally 13 dB (CISPR, publ. 22, instruments of class A). According to figure 3-5 showing the weighting curves this difference occurs at a pulse frequency of 1.8 kHz.

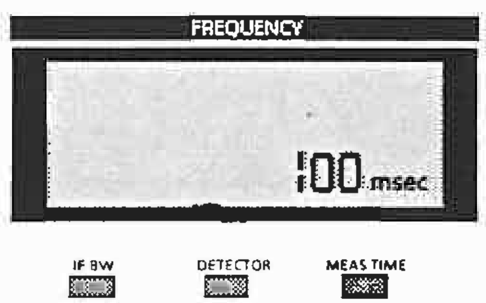
The decisive value for lower pulse frequencies is always the quasi-peak limit value. This means that average value indication has to be correct only up to this pulse frequency. As pulses with repetition frequencies of down to 1 kHz can be averaged correctly using a measuring time of 1 ms, it can be applied without reservation for this type of measurement.

Significance with Quasi-peak Measurement:

The relatively long time constants occurring with quasi-peak weighting result inevitably in relatively long measuring times that must be set in order to obtain a correct test result. In any case it should amount to not less than 1 second, if the signals to be measured are unknown. A measuring time of that length ensures that pulses with a repetition rate of down to about 5 Hz are correctly weighted.

When switching over attenuation or changing frequency the receiver waits until the measurement voltage has settled and then starts measuring. To reduce waiting time it is monitored whether the signal at the output of the weighting circuit has already stabilized before maximum waiting time has elapsed. If this is the case, measurement is started earlier.

Operation:



- Press MEAS TIME key.
  To indicate that the measuring time input is active, a bar appears below the display for measuring time.
- Enter a new measuring time using numeric keypad DATA (cf. section 3.2.2).
- End input by the desired unit.
  The new measuring time is displayed together with the unit.

Note: *Measuring times below 200 ms must be entered in milliseconds; from 200 ms onward seconds must be input as graphical representation is limited to $2\frac{1}{2}$ positions.*

3.2.3.11 Selecting AF Demodulation (DEMOD)

The ESHS offers two demodulation modes: A3 and A0.

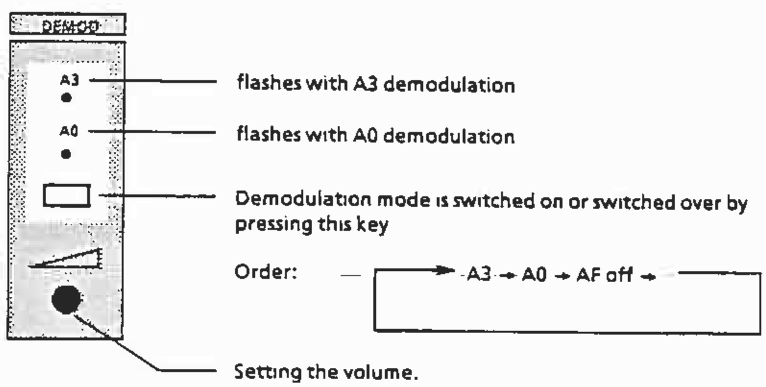
A3 stands for demodulation of AM broadcasting signals. AF bandwidth is limited to 5 kHz. In the indicating mode quasi-peak (QP), noise in the AF-branch is suppressed to some extent in order to show more clearly the devices interfering with pulses. Distortion of signals to which sine-wave modulation has been applied is however higher due to this measure than in other indicating modes.

In the case of A0 a carrier with the frequency of the IF is mixed to the signal on its last IF. If it is an unmodulated signal that is tuned to the receiver centre frequency, zero beat (no audible tone) is the result. When the receiver is detuned, a tone can be heard the frequency of which corresponds to the difference between input signal and receiver frequency. This is helpful when a sinusoidal signal must be discovered in a signal mixture or when the receiver should be tuned exactly to a signal.

Both the volume of the internal loudspeaker and that of the headphones connected to AF OUTPUT socket is set using the rotary knob *(15)*. The loudspeaker is automatically switched off when a PL-55 connector is plugged into the AF OUTPUT socket (e.g. with headphones operation).

Note: *When the beeper is activated (cf. section 3.2.3.13), AF-demodulation must be switched on, as otherwise the beeper is not audible. Nevertheless volume control knob may be at the left stop so that the demodulated AF cannot be heard.*

Operation:



3.2.3.12 Calibration and Measurement Accuracy

The ESHS is calibrated using an internal harmonics generator that generates a 100-kHz spectrum that is flat up to 30 MHz. It is possible to perform both short calibration on the receiving frequency and total calibration, during which the entire receiver is calibrated by a complex process.

3.2.3.12.1 Short Calibration

During short calibration the gain of the receiver at the reference frequency of 1 MHz with and without preamplifier and at the IF-bandwidths is adjusted. The gain determined is maintained until the next calibration is performed. In addition the gain is corrected at the 100-kHz spectral line that is closest to the current receiving frequency. This correction is no longer effective when the receiver frequency is changed.

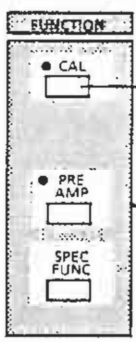
3.2.3.12.2 Total Calibration

When performing a total calibration the following parameters are recorded and saved in a non-volatile memory:

- frequency response with and without preamplifier,
- correction values for the IF-bandwidths (gain and bandwidth for Pk/MHz),
- correction values for IF-gain (low noise and low distortion),
- correction values for quasi-peak weighting and
- linearity correction values for the 30-and 60-dB ranges.

Total calibration takes about 30 seconds. It eliminates the need for a calibration of the receiver after having switched over a receiver setting. Thus optimal measurement speed is possible while high measurement accuracy is ensured. It is recommended to carry out total calibration about 30 minutes after the instrument has warmed up. Due to high stability of the receiver the correction values remain constant for a long time and therefore need not be set anew daily.

Operation:



When shortly pressing the CAL key (< 3 s) short calibration is started. The LED flashes during calibration process and the remark *CAL SHORT* appears in the DATA INPUT display.
When pressing the key for a longer time (> 3 s) total calibration is started. The LED flashes during calibration process and the information *CAL TOTAL* appears in the DATA INPUT display (*1*) during calibration.
Following completion of calibration, the message *CAL COMPLETE* appears in the DATA INPUT display.

3.2.3.12.3 Error Messages during Calibration

During total and short calibration all correction values recorded are checked whether they are within the tolerances internally specified. If one of the tolerances is exceeded, a warning is output on the DATA INPUT display. The receiver can, however, be further used as it still meets the specifications with only slight reservations. If a function does not work correctly, error (*ERR*) is output. This function can no longer be used. With the beeper switched on (cf. section 3.2.3.13) the attention of the user is directed to these faults by a beeping sound. If several errors occur during calibration, they can be read on the DATA INPUT display by scrolling the screen using the keys of the EDIT keypad after calibration was performed. Error messages are automatically output on a printer connected during calibration. In addition the messages are presented to the user via IEC-bus (cf. section 3.3).

The following warnings and error messages are possible:

CAL TOTAL required	If, with short calibration, gain deviates from the value determined during the last total calibration by more than 1 dB, the user is requested to carry out a total calibration.
ERR: Gain at 1 MHz	Gain at the reference frequency 1 MHz cannot be controlled. Calibration is aborted.
WARN: Gain at 1 MHz	Basic gain of the receiver is not within the tolerance limits at the reference frequency 1 MHz. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected. The user is informed about this occurrence by another error messge.
WARN: Gain at BW 200 Hz	Gain at the 200-Hz IF-bandwidth is outside the tolerance limits. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected. The user is informed about this occurrence by another error messge.
ERR: Gain at BW 200 Hz	Gain at 200-Hz IF-bandwidth can no longer be corrected. It is not possible to carry out measurements using this bandwidth. Calibration is, however, continued as the ESHS can still be used to a limited extent. An error message is, however, always output when setting the 200-Hz bandwidth.
WARN: IF Attenuator	IF-attenuation correction value is out of tolerance. The IF-attenuation is set in 10-dB steps depending on the operating mode (MODE) and the indicating mode (DETECTOR). If one of these settings exceeds its tolerance limits, correction of total gain of the ESHS may not be possible anymore. A separate error message informs the user about this fault. Calibration continues.
ERR: IF Attenuator	The IF-gain switch is defect so that it is no longer possible to correct its gain error. Nevertheless calibration continues as the ESHS can still be used to a limited extent. When switching on the respective IF-gain, an error message (*ERR: IF ATT*) is output.
WARN: 30 dB Range *WARN: 60 dB Range*	Linearity of the test detector is out of tolerance, which results in a slightly reduced total linearity as interpolation must make up for relatively great deviations between the interpolation points. Calibration continues.
ERR: 30 dB Range; or *ERR: 60 dB Range*	The 30- or 60-dB operating range is defect and can no longer be used. Nevertheless calibration is terminated as measurements can still be performed in the other range. When switching on the defect range, the error message *ERR: 30 dB* or *ERR: 60 dB* is output.

WARN: Pk/MHz	The correction value for the bandwidth in the indicating mode Pk/MHz is not within the tolerances. This means that the permissible tolerance for the IF-bandwidth 10 kHz is not adhered to. (At 200 Hz no correction value is accepted).
WARN: QP Band A; or *WARN: QP Band B*	Quasi-peak weighting is out of tolerance at the reference pulse frequency (band A: 25 Hz, band B: 100 Hz).
ERR: QP Band A; or *ERR: QP Band B*	Quasi-peak weighting in band A or band B is defect . When switching on the weighting mode, the error message *ERR: QP Band A* or *ERR: QP Band B* is output.
WARN: Gain at xx MHz/(kHz)	When recording frequency response of the receiver it is noted that the internal tolerance is exceeded. This may have the result that the total correction value may be too high and cannot be set anymore.
ERR: Gain at xx MHz/(kHz)	A filter range of the preselection is defect. Measurements in this range are not possible. When setting this range the error message *ERR: Gain* is output.

Error Handling during Measurement: In theory the sum of the individual correction values may exceed the maximum value, although none of the individual values exceeds the tolerances that would lead to an error message. If this is the case, the message *ERR: Meas uncal* is output on the DATA INPUT display. Illegal measurement values are also shown when output is effected via IEC-bus (cf. section 3.3).

3.2.3.12.4 Measurement Accuracy

When performing a total calibration, all the values determined are related to the internal calibration generator and RF-attenuator. The linearity of the operating ranges is recorded in 10-dB steps. It is interpolated between the interpolation points. Due to the high linearity of the envelope detector and logarithmic amplifier (typ. error < 0.15 dB), the interpolation points are sufficient for an optimal correction. The measurement value is internally (by the instrument itself) determined in $^{1}/_{100}$ dB so that rounding errors are not of significance.

The error limits are composed of:

Error limits of attenuator:	0.3 dB
Error limits of calibration generator:	0.4 dB
Setting accuracy of gain:	0.05 dB
Unlinearity of envelope detector:	0.05 dB

On the basis of these values a measurement error of maximally 0.8 dB results for the entire measurable level range. Since the errors do not depend on each other in terms of statistics, quadratic addition of the individual errors is permitted to determine the total error. It is thus 0.5 dB over the entire operating temperature range. In practice measuring accuracy is considerably higher for signals with sufficiently high signal-to-noise ratio.

An additional measurement error, which is determined by physics, is due to the inherent noise of the receiver. The error is least significant with average value indication; with peak value indication, however, it is considerably higher. In indicating mode quasi-peak the error strongly depends on the type of signal to be measured.

In the case of average and peak value the error as a result of the signal-to-noise ratio can be determined approximately using the following formulas:

$$\text{Average value: } = \text{error/dB} \approx 20 \log \left(1 + 0.3 \times \frac{N_1}{S}\right)$$

$$\text{Peak value: } = \text{error/dB} \approx 20 \log \left(1 + 0.8 \times \frac{N_2}{S}\right)$$

S = level of an unmodulated signal in µV,
N_1 = Noise indication with average value (AV) in µV
N_2 = Noise indication with peak value (Pk) in µV
N_2 = N_1 + 11 dB.

Table 3-6 and figure 3-6 illustrate increase in indication in the case of average value measurement of sinusoidal signals and peak value measurement as a function of the signal-to noise ratio.

Table 3-6: Error occurring when measuring an unmodulated sinusoidal signal with average or peak value indication as a function of the signal-to-noise ratio.

Signal-to-noise ratio	Increase in indication in dB with	
	Average value (AV)	Peak value (Pk)
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	0.38
30		0.22
40		0.07
50		0.02

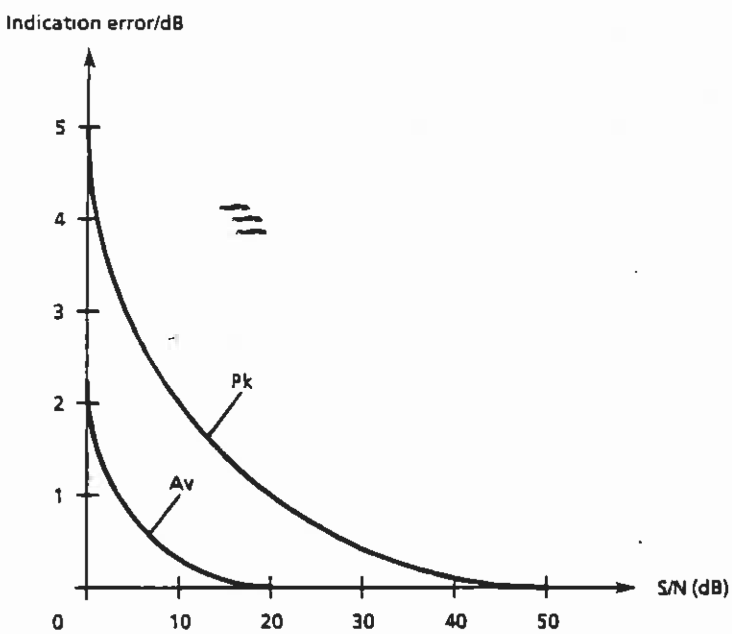


Fig. 3-6 Increase in indication of an unmodulated sinusoidal signal as a result of noise as a function of the signal-to-noise ratio.

Fig. 3-7 illustrates the increase in indication as a result of receiver-internal noise with quasi-peak indication (Band B) for sinusoidal signals and pulse signals with a pulse repetition frequency of 100 Hz. Due to pulse weighting the error strongly depends on the type of input signal. In the case of sinusoidal signals the increase in indication is almost as high as with peak value indication. With pulses the indication error due to noise is reduced with decreasing pulse frequency.

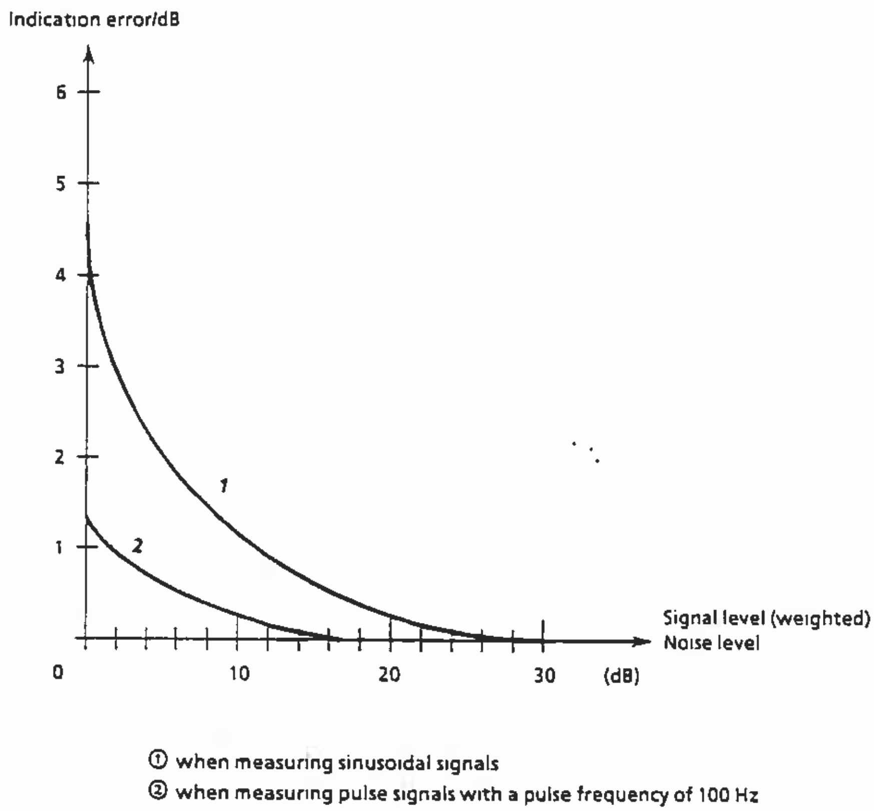


Fig. 3-7 Indication error due to noise with quasi-peak indication

For measurements carried out in practice the following can be recommended:

- To make full use of the accuracy of the ESHS, carry out measurements with a high signal-to-noise ratio, i.e. 60-dB range, low noise.
- When measuring sinusoidal signals use average value indication as it is the least sensitive to the signal-to-noise ratio.
- Carry out quasi-peak measurements using low noise, if the type of input signal permits this mode (cf. section 3.2.3.3, Selecting the Operating Mode). In autorange operation the receiver, itself takes it into account.

3.2.3.13 Special Functions (SPEC FUNC)

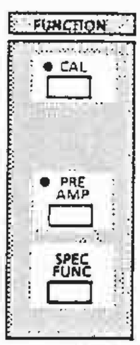
Special functions are integrated into the ESHS for applications requiring special properties of the receiver. The user, himself, can select - to a certain extent - the properties of the receiver using these special functions.

Each special function has a number so that it can be easily addressed. To arrange them even more clearly they are divided into groups, each beginning with a new tens place.

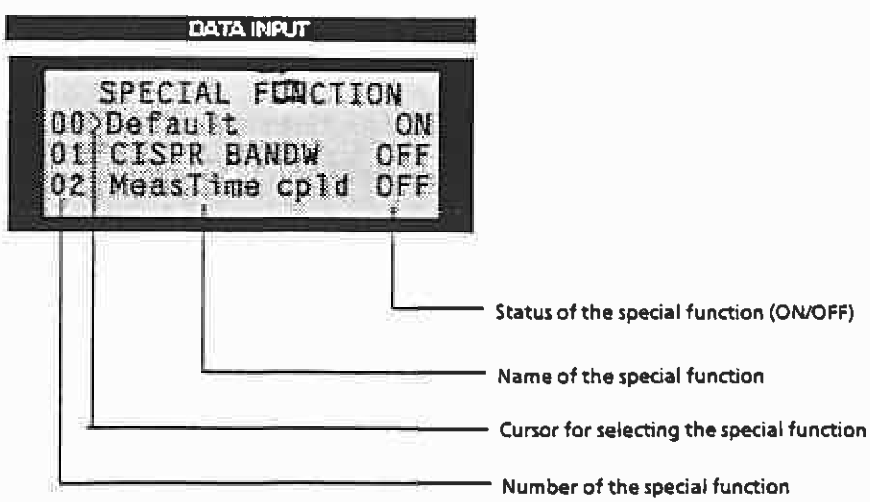
Table 3-7

Special function groups	Call
Test parameters	SPEC FUNC 01, 02,
Switch functions	SPEC FUNC 10, 11, 12, 13, 16, 17, 18
Output of measured values	SPEC FUNC 20,
Special measurement modes	SPEC FUNC 30, 31 32, 33,
Trigger functions	SPEC FUNC 51, 52

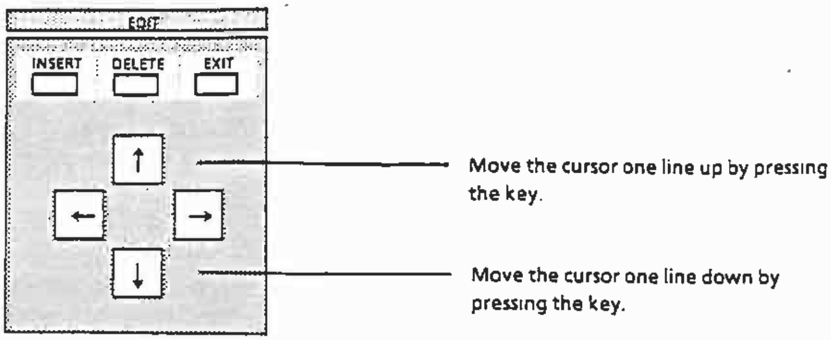
Operation:



- Press SPEC FUNC key.
  In the DATA INPUT display the SPECIAL FUNCTION menu appears:



Each menu features three special functions. The cursor is positioned on the desired function using the ↑ and ↓ keys available in the EDIT keypad. The menu can be scrolled to have access to special functions that are not displayed at the moment.



A special function can be selected more rapidly by entering the respective number. In this case the cursor moves directly to the desired special function.

The status of the special function is switched over (ON → OFF, OFF → ON) by pressing one of the ENTER keys . The cursor remains on the selected function after switch-over. This means that the special function is switched on or off by pressing the ENTER key.

Some special functions call submenus in which numeric data must be input. Following the entry of the respective data the SPECIAL FUNCTION menu with the modified status of the selected function is displayed again.

Explanations to the Various Special Functions:

SPEC FUNC 00 Default — Any special function assumes its default setting using the special function *00 Default.*

SPEC FUNC 01 CISPR BW — Default setting is OFF.
With *CISPR BW ON* the bandwidths specified for the indicating mode quasi-peak are switched on not only in this mode but also in average and peak value indicating mode depending on the receiver frequency (cf. section 3.2.3.9.4).

SPEC FUNC 02 MeasTime Cpld — Default setting is ON.
With default setting measuring time is coupled with the IF-bandwidth, thus ensuring that the signal can settle. Under certain conditions it may be sensible to annul this connection. Example: A sinusoidal signal is measured with fixed receiver frequency setting.

SPEC FUNC 10 Display Light — When operating with internal battery, default setting is OFF, otherwise ON.
To increase operating time when using internal battery, illumination of the LC displays is switched off. The receiver, itself recognizes by which source it is fed and switches lighting correspondingly. When operating under poor lighting conditions, it is however recommended to switch on illumination.
Power consumption of the LCD-illumination: about 5 W. This corresponds to approx. 20 % of the receiver power consumption.

SPEC FUNC 11 IEC 625

When operating with internal battery, default setting is OFF, otherwise ON.
IEC-bus operation is usually not desired when operating with internal battery, as the required controller usually must be mains-operated. The IEC-bus is therefore switched off to increase operating time. The receiver, itself recognizes by which source it is fed and selects the status of the IEC-bus correspondingly.
Power consumption of module "IEC-BUS": about 1.2 W. This corresponds to approx. 5 % of the receiver power consumption. The IEC bus cannot be switched off during plotting.

SPEC FUNC 12 Antenna Code

Default setting is ON.
Active transducers from Rohde & Schwarz, such as the loop antenna HFH2-Z2 or the rod antenna HFH2-Z1 or HFH2-Z6 are supplied by the socket ANTENNA CODE. At the same time the conversion factor of the transducer is coded using this socket. If coding of the conversion factor is not desired because e.g. an additional test cable is used, it can be switched off using this special function. The individual conversion factor can then be input via the transducer factor (cf. section 3.2.4.2.2). Coding at the ANTENNA CODE socket is then always ineffective regardless of the setting of the special function.

SPEC FUNC 13 Beeper

Default setting is OFF.
The ESHS contains an internal beeper, which draws the attention of the user to various states of the instrument. In the following cases a beeping sound can be heard:

- end of a frequency scan,
- end of a plotting process,
- end of a printing process,
- Output of an error message or warning and
- following a faulty key input by the user.

It is however required that the AF is switched on. The loudness of the beeping sound is independent of the volume setting, i.e. if the demodulated AF-signal is not desired, volume control can be turned completely down.

SPEC FUNC 16 Check Limit

Default setting is OFF.
This function is only effective in receiver mode (not in scan mode)
When a limit line is active, each measured value is compared with the limit value provided that the special function is switched on. When the value is higher than the limit, the message *Limit exceeded* is output on the DATA INPUT display. If the value is below the limit value, the message disappears again. With the beeper being switched on (*Spec Func 13*), a beeping sound is audible when the limit value is exceeded during the first measurement on a new frequency.

If a double test mode is switched on in receiver mode (special functions 30 to 33), the message indicating that a limit value was exceeded appears when at least one of the two measurement values exceeds its associated limit value. Chapter 3.2.4.3.2 describes how to assign measurement detectors to limit values. In standards, limit values for peak or quasipeak are always higher than that for average.

SPEC FUNC 17 Check Transd

Default setting is OFF.

With special function 17 switched on, the transducer value (with unit) that has been calculated from the set receiver frequency is indicated instead of the measurement value on the LEVEL display. In this case, the level is not measured. In the LEVEL display there is no indication of ZERO SCALE DEFLECTION, ATTENUATION and MODE and in the FREQUENCY display bandwidth, detector and measuring time are not shown when outputting transducers. The activated transducer can thus be checked manually by detuning the receiver frequency. The transducer can also be output graphically on plotter or printer. The axes for level and frequency are determined by the values defined in the scan data set (cf. section 3.2.4.3.1). Output is initiated by pressing the PLOT or PRINT key (cf. section 3.2.4.4).

SPEC FUNC 18 Transducerswitch

Default setting is OFF.

A port of the USER INTERFACE at the rear panel of the ESHS 10 can be set using special function 18 in combination with an active transducer set. A single port (5-V logic level) is assigned to each transducer range. The number of the active port corresponds with that of the range valid for the current receiver frequency, i.e. port 1 (pin 14) is active in transducer range 1. There is no active port when the receiver frequency is outside the defined transducer set. This function is useful for switching different antennae by way of an antenna matrix during a scan or with manual frequency variation.

Special function 18 is ignored with the scan option 01 RFI Voltage being.

The message *Change Transducer* is suppressed when using special function 18

SPEC FUNC 20 Unit dBm

Default setting is OFF.

The unit dBm is used for the power level at 50 Ω. The ESHS is, however, not an r.m.s. value meter. The voltage indicated in the selected indicating mode together with the rated input resistance of 50 Ω are only converted into the respective power level. Solely the power of a signal that has not been amplitude-modulated is correctly indicated.

As the unit can only be used for power levels related to 1 mW, the special function is only effective when no unit is coded at the ANTENNA CODE socket. The unit is also only active with transducer factors having the unit dB, i.e. only four-terminal networks with specified power attenuation or power gain can be taken into account.

When coding a unit at the ANTENNA CODE socket or entering a unit other than dB in the transducer factor, the unit dBm becomes ineffective and the selected unit is displayed.

SPEC FUNC 30: Pk + AV
SPEC FUNC 31: Pk + Pk/MHz
SPEC FUNC 32: Pk + QP
SPEC FUNC 33: QP + AV

Default setting is OFF.

These are combined test modes; during the measurement two different detectors are simultaneously switched on. If one of these special functions is activated, both active detectors are shown in the display for the detectors. Thus it is for example possible to detect broadband interference by means of the peak value detector and narrow-band interference by way of the average value detector at the same time. In the case of an automatic frequency scan only one scan is required. As only one measured value at one time can be indicated on the level display, these functions are only active in remote control, i.e. both valuesare output via IEC-bus. During a frequency scan in manual mode both values are measured and stored for plotter or printer output; it is however only possible to indicate every first value (example: Pk + AV → Pk is indicated). When outputting the test curve on a plotter during the scan (option "Meas.& Plot, cf. section 3.2.4.3.3) the curve for the first indicating mode is immediately displayed, the second test curve is displayed subsequently (example: QP + AV → the QP-curve is plotted during measurement and then the AV-curve). Only one of the double measurement modes can be active at one time. When switching on a new function, the one that has already been activated is automatically switched off.

SPEC FUNC 51: Ext Trigger +

Default setting is OFF.
The ESHS starts a measurement with a positive signal edge (TTL level) applied to the USER INTERFACE (Pos *28*, fig. 3-2), connector pin assignment, cf. section 3.2.6.5. This is useful, if for example a test item produces interference at a certain time and a suitable trigger pulse can be derived from the test item. It makes sense to set optimum attenuation of the ESHS prior to the measurement, if there is not enough time for autoranging.

SPEC FUNC 52: Ext Trigger -

Default setting is OFF.
The ESHS starts a measurement with a negative signal edge (TTL level) present at the USER INTERFACE (*28*), connector pin assignment cf. section 3.2.6.5. It is useful to set optimally the attenuation of the ESHS prior to the measurement, if the time for autoranging is not sufficient. The special function is automatically deactivated when the special function SPEC FUNC 51 are switched on.

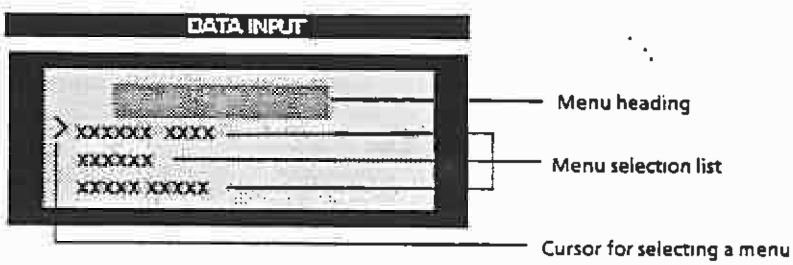
3.2.4 Operation of the Menu Functions

The hardkeys of the keypad MENU are provided for presetting instrument parameters, controlling complex processes, entering limit lines and transducer factors, outputting measurement results and calling instrument self-tests. The keys can be used for calling a menu in the display DATA INPUT, which makes various submenus accessible, if required.

3.2.4.1 Input and Editing in the Display DATA INPUT

3.2.4.1.1 Editing the Menus

The display DATA INPUT is an alphanumeric LC-display with 4 lines featuring 20 characters each. The first line contains the designation of the menu currently active. The remaining three lines consist of the individual menu points. In some menus there is not enough space to display the list of selectable menu points. Every menu point becomes visible by scrolling the list upward or downward using the respective cursors.



Further entries in the menu selection list can be accessed by way of scrolling the display DATA INPUT

Fig. 3-8 Architecture of the display DATA INPUT

A menu point can be selected using the ↑ and ↓ keys in the operator keypad EDIT. Selecting is performed by placing the cursor ">" on the desired menu or in the case of a table on the respective line and then pressing ENTER or → to call the menu; when it is necessary to input a value, it can be entered using the numeric keypad. When e.g. values are entered into a table, a character can be inserted or deleted at the position of the cursor is placed using INSERT or DELETE.

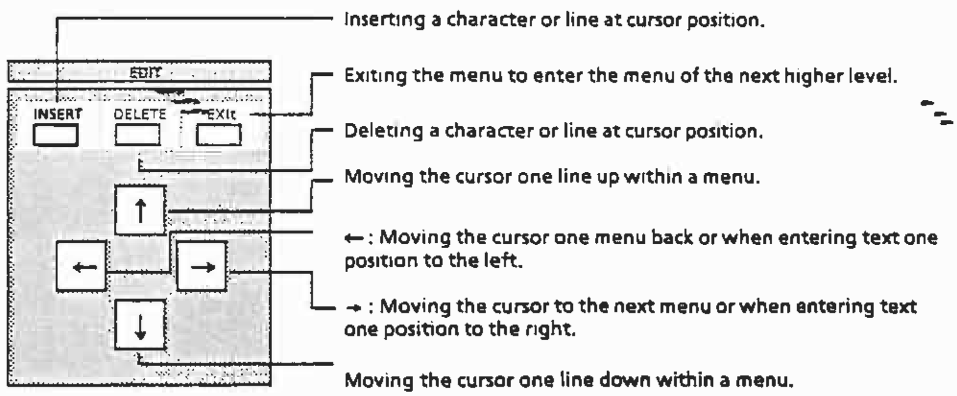


Fig. 3-9

3.2.4.1.2 Input of Texts and Labellings

Transducer factors, limit lines and protocols output on plotter or printer can be given names or labelled by the user. The name or labelling can either be entered via the keyboard that can be connected to the rear panel (cf. section 3.2.6.8) or via auxiliary line editor in the third and fourth line of the display DATA INPUT, if there is no keyboard available.

The receiver recognizes automatically whether a keyboard is connected and if so, the auxiliary line editor is not offered for application. Due to the considerably more convenient way of input a keyboard is recommended to be used especially when labelling test protocols.

Operation of the Auxiliary Line Editor:

When using the auxiliary line editor upper-case letters and punctuation marks are displayed in the third line of the display DATA INPUT, lower-case letters and figures in the fourth line. As the space available is not sufficient, the characters not displayed can be made visible by scrolling to the left or right using the cursor keys of the EDIT keypad.

Fig. 3-10

The character desired for labelling is selected using the cursor keys via an auxiliary cursor and inserted at the position of the main cursor (_) by way of INSERT. The character then appears at the position of the main cursor. The latter moves automatically one position to the right. The respective character that is to the left of the main cursor can be deleted using the DELETE key. Input is terminated by ENTER. The auxiliary line editor then disappears automatically.

3.2.4.2 Configuration of the Receiver (Keypad INSTR STATE)

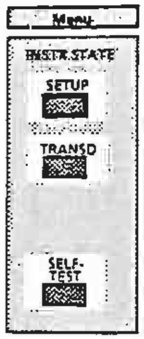
3.2.4.2.1 Selecting the Instrument Presettings (SETUP menu)

The presettings

- input of date and time,
- selection of the IEC-bus address (IEC 625),
- display of the firmware version and
- operation with external reference

are indicated or can be newly entered in the SETUP menu.

Operation:



- Press SETUP key.
  The following menu appears in the DATA INPUT display:

```
DATA INPUT
        SETUP
> Clock
  IEC 625
  Int Ref
  Firmware Ver
  OTP Ver
```

In the last line the reference frequency currently used (*Int Ref* with device-internal reference or *Ext Ref* with external reference frequency, cf. section 3.2.6.4) are displayed. When pressing the ↓ key, the firmware version available in the receiver (*Firmware Ver)* and the version of the boot PROM (*OTP Ver*; OTP = one time programmable ROM) are read out.

The desired function (clock or IEC 625) is selected by placing the ↑ or ↓ keys of the EDIT keypad on it and then pressing ENTER or by the → key. The firmware version and reference indication cannot be selected. A submenu appertaining to each menu point subsequently appears. The respective entries can be made in the submenus.

Setting the internal clock:

```
DATA INPUT
     SETUP Clock
> Date  19:03:91
  Time  13:27:32
```

Fig. 3-11 Display of date and time

The current date and time are contained in the realtime clock of the receiver and are displayed after having called the clock function. If a re-entry is required, e.g. following a change of the internal battery, the respective line for the date or time must be selected using the cursors of the EDIT keypad and then input must be performed using the numeric keypad DATA. Illegal entries are ignored, i.e. the former value is retained. The date is displayed in the order day:month:year and time in the 24-hours format hours:minutes:seconds.

After having terminated the input of the date by way of ENTER the cursor moves to time. Following the entry of time the SETUP menu appears again.

Selecting the IEC-bus address:

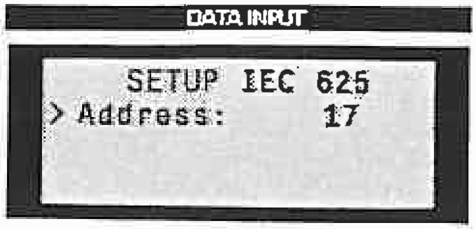


Fig. 3-12 Display of IEC-bus address

Values between 0 and 30 are permissible for the IEC-bus address. The default setting is 17. Illegal inputs are ignored.

3.2.4.2.2 Entering and Calling of Transducer Factors (TRANSDUCER Menu)

When carrying out interference measurements a coupling network, which converts the interfering quantity to be measured into a voltage at 50 Ω, is usually connected ahead of the receiver. Coupling networks may be antennas, artificial mains networks, probes or current probes. They often feature a non-decadic conversion factor which is also frequency-dependent. Transducers with a non-frequency-dependent conversion factor can be coded in 10-dB steps at the ANTENNA CODE connector (cf. section 3.2.5.1). Non-decadic conversion factors must be considered in the transducer factor. The receiver indicates the quantity to be measured that is present at the input of the coupling network, if the transducer is activated.

In the case of the ESHS a distinction is made between transducer factor, in the following text abbreviated by "factor", and transducer set, briefly "set". A factor consists of points, which are defined by frequency and conversion factor, and the unit that determines the unit of the level display. For frequencies between the known points the transducer factor is approximated using modified spline interpolation.

The unit of the transducer applies to the entire frequency range of the receiver, even if the transducer only covers a part of the range. Outside of the definition range it is assumed that the conversion factor is 0 dB. The receiver therefore delivers illegal measurement values, if the receiver frequencies exceed the transducer definition range. This is indicated by the hint *Warn: Transd undef* in the display DATA INPUT. Moreover, in practice it is futile to use a transducer for measurements in a frequency range in which the transducer can actually not be used.

Up to 22 different factors can be defined and stored permanently. They are provided with a number (1 to 22) and a name that can be specified by the user so that they can be told from each other.

Since in practice the required number of points for the various coupling networks varies, the maximally possible number of values depending on the number of the transducer is grouped according to the following table:

Table 3-8

Transducer number	Number of points
1 to 10	10
11 to 20	20
21, 22	50

These 22 factors can be combined to form sets. Maximally 5 sets are possible. A prerequisite is that all factors combined have either the same unit or the unit "dB". The definition range of a set is divided in turn into ranges. Various factors can be activated per individual range. There may be no gaps between the individual ranges, i.e. the stop frequency of a range must be equal to the start frequency of the following range.

The definition range of the transducer factors used in a certain range must cover it completely.

It is recommended to define a transducer set when different coupling networks are used in the frequency range to be measured or when cable attenuation or an amplifier are also to be considered.

If a transducer set is defined, a frequency scan is stopped at the intersection between two ranges and the user is requested to change the coupling network (transducer). The following request appears on the display DATA INPUT:

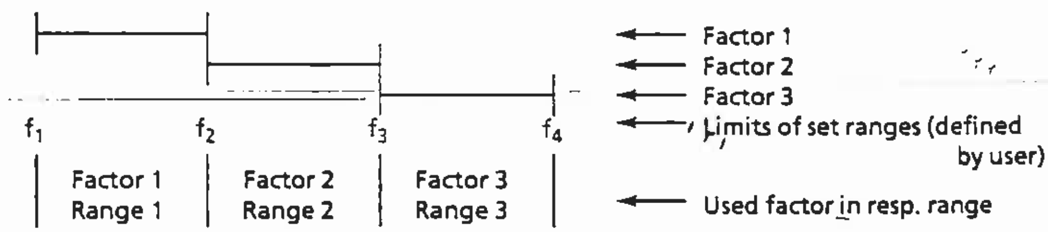
"Connect <Transducer Name>.

If the beeper is activated (special function 13), a short beeping sound can be heard.

The rules according to which the transducer factors can be combined to form sets are summarized with the help of the following examples. The rules are implemented in the ESHS so that the user need not care whether the transducer set entered is valid.

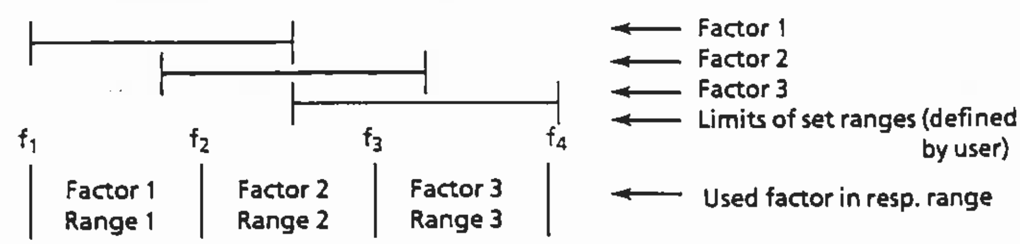
a) Only one single transducer factor is active:

b) Transducer set with several factors lined up in a row:



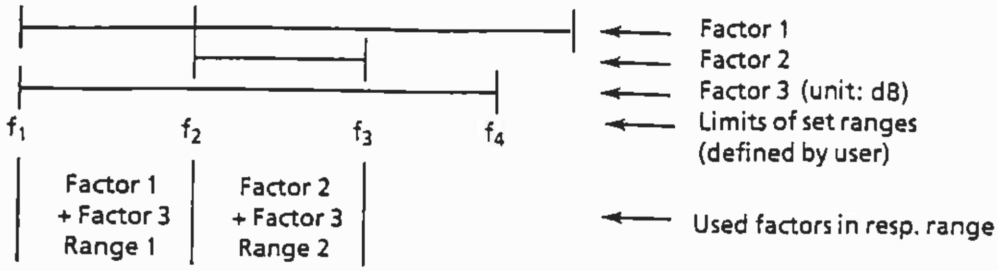
The set is valid from f_1 to f_4. The units of the individual factors are the same. There are no gaps between the individual ranges.

c) Transducer set with several overlapping factors:



With overlapping factors only those factors that cover a range completely can be activated in it.

d) Several factors are simultaneously valid:



Two factors can be activated simultaneously, when the unit of one factor is dB or when both factors have the same unit. The factor 3 is added to factor 2 or factor 1 in their valid range.

Operation:

Input and editing of transducer factors and sets is called using the TRANSD key (in the keypad INSTR STATE).

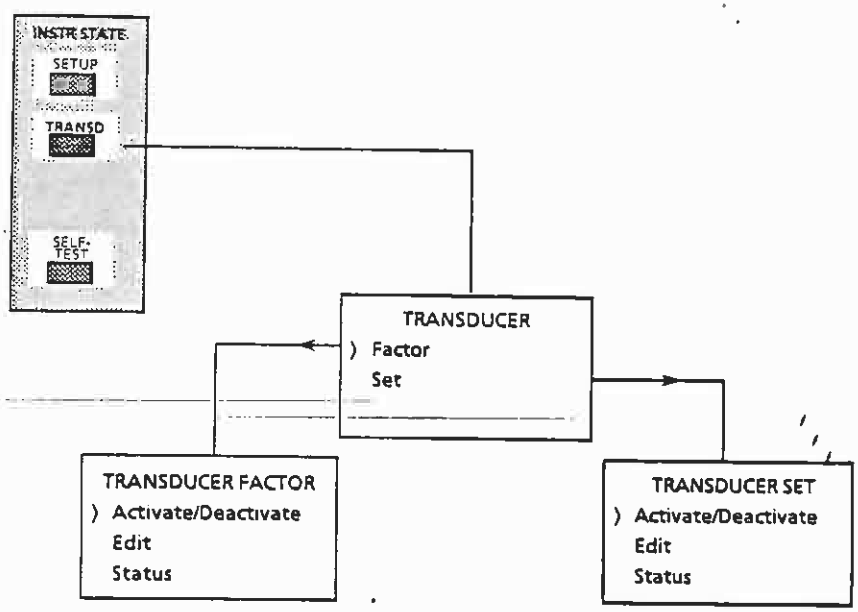


Fig. 3-13 Flowchart for calling the transducer factor

The first few submenus are the same for editing a factor and a set. Here, a factor or a set can be activated *(Activate)* or deactivated *(Deactivate)*, changed or newly entered *(Edit)* and the current status can be indicated *(Status)*.

Input or Editing of a Transducer Factor:

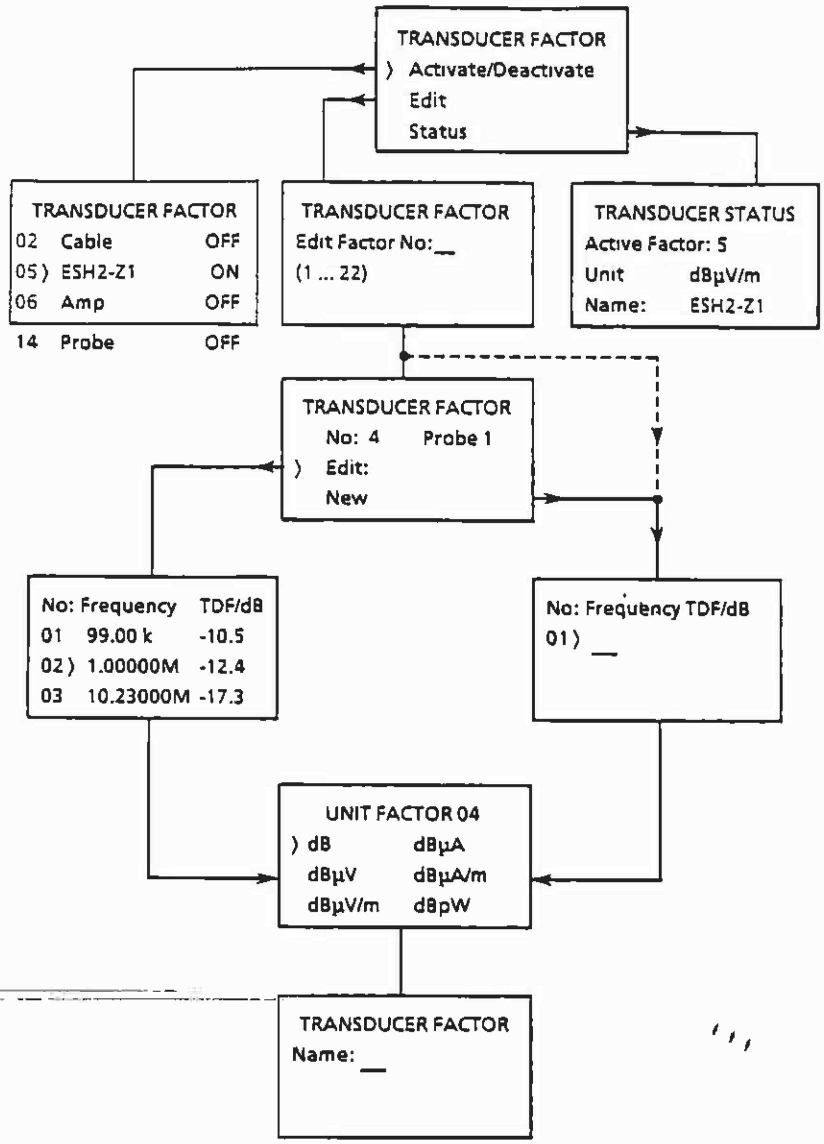


Fig. 3-14 Flowchart for entering or editing a transducer factor

Activate/Deactivate : In this menu a stored factor is activated or an active factor is deactivated. If a factor is active, the menu point is referred to as *Activate/Deactivate*; if there is no active factor, the name is only *Activate*. After having selected the menu point, a submenu, in which all defined transducer factors with their numbers, names and current status are listed, is called. If no transducer has been defined, the message "*None defined*" appears in the DATA INPUT display. The cursor is placed on the active factor or, if there is no active one, on the factor with the lowest number. The cursor is placed on the factor to be activated using the ↓ and ↑ keys or by entering the appertaining two-digit number (e.g. 01 must be entered for factor 1). If the factor with the number entered is not defined, the error message "*<xx> undef*" (<xx> = number entered) appears in the last display line.

The status of the factor is changed by pressing the ENTER key (ON → OFF, OFF → ON). As only one factor or set can be active at one time, an already active factor or set is automatically deactivated, when switching on a factor or set. The menu is exited using the ← key or EXIT.

Transducer Status: In the menu Transducer Status the current status of the receiver is displayed. In the second line the factor currently active is shown. If a transducer set is active, it is also displayed. If neither any factor nor any set is used, *none* appears in the menu. In the third line the unit and in the fourth line the name of the factor or set used is displayed.

Edit Factor: In the Edit menu the desired factor for editing is first asked for. This factor must be entered together with its number. If the factor with the number selected does not yet exist, the blank table appears for entering the points. Otherwise, the name of the factor is represented in the following menu and the choice between editing of the factor *(Edit)* and new entry of the factor *(New)* is offered. The factor to be edited is subsequently represented in a table. If new entry has been selected, the table is blank.

New Entry of Transducer Factors: New entry of factors must be performed in the sequence of increasing frequencies and must be input with frequency and transducer value. The cursor is initially placed on the frequency of the first point. Following frequency input (ended by MHz or kHz) the cursor jumps automatically on the appertaining transducer value.

Values of -200 to +200 are permissible for the transducer. When entering a transducer factor that is higher than 200 dB or lower than -200 dB, the message *"Max Level 200 dB"* or *"Min Level -200 dB"* respectively appears in the fourth line of the display DATA INPUT. Amplifiers have a negative conversion factor, attenuation values must be entered as a positive conversion factor. After having completely entered the point the next one is automatically selected.

If the increasing order is not kept, the error message *"Frequency Sequence"* is output and frequency input is ignored, i.e. the entry is not accepted and the space remains blank after having terminated the input, thus being available for a new input. If a frequency that cannot be set in the receiver is entered, the error message *"Max Freq 30 MHz"* is output in the fourth line when the frequency is too high. When entering a too low frequency, the message *"Min Freq 9 kHz"* is output. Points that have been already present are changed by selecting them using the cursor and then entering a new value.

If the maximum number of points has been entered, the input menu is automatically exited. It can, however, already be exited by pressing the ENTER key while the cursor is in a blank frequency field or by means of the → key. The following submenu subsequently offers a number of units that are possible for the newly entered factor. The desired unit is selected by placing the cursor on it using the ↑ and ↓ keys and pressing ENTER.

The factor can finally be given a name *(Name)*. Input can either be performed via the external keyboard or via the auxiliary lines for text input (cf. section 3.2.4.1.2), if the keyboard is not connected. Maximal eight characters are permissible for the name. If no name is desired, the field *Name* can be kept blank. Definition of the transducer factor is complete, when having pressed ENTER after input of the name.

Editing of Already Existing Transducer Factors:

While editing a transducer factor a point can be deleted,a new one can be inserted or only a frequency or a transducer value can be changed. Inserting or deleting is possible, when the cursor points to the number of the point. The respective point is deleted using the DELETE key and all the subsequent values move up. A blank line is created at the position of the cursor using INSERT and all following points are raised by one number.

When entering the new frequency in the new line it must be ensured that the frequency order is kept to as otherwise input is not accepted. In this case the error message *"Frequency Sequence"* appears in the last menu line. If the transducer factor has already the maximum possible number of points, it is no longer possible to insert a new one. When trying nevertheless, the error message *"Max <xx> values"* appears in the lowest line (<xx>: the maximum number of points depending on the number of transducer factor, cf. table 3-8).

A frequency or a transducer value can be changed when placing the cursor on the desired number. When entering a figure the old frequency is deleted and the new one is displayed. Stick to the increasing frequency sequence in this case, too. When pressing ENTER without having entered a number before, the cursor jumps to the factor value that can then be input anew.

The EDIT menu is exited either by way of the → key or, when the cursor is on the last point by pressing ENTER. The menu for the unit appears (cf. new entry of transducer factors).

Generating or Editing a Transducer Set:

The structure of menus for editing a transducer set is similar to that of a factor. *Activate/ Deactivate* and *Status* lead to submenus in which only factor is replaced by set. Operation and function are analog to that of the transducer factor. Only EDIT menus differ from those of the transducer factor.

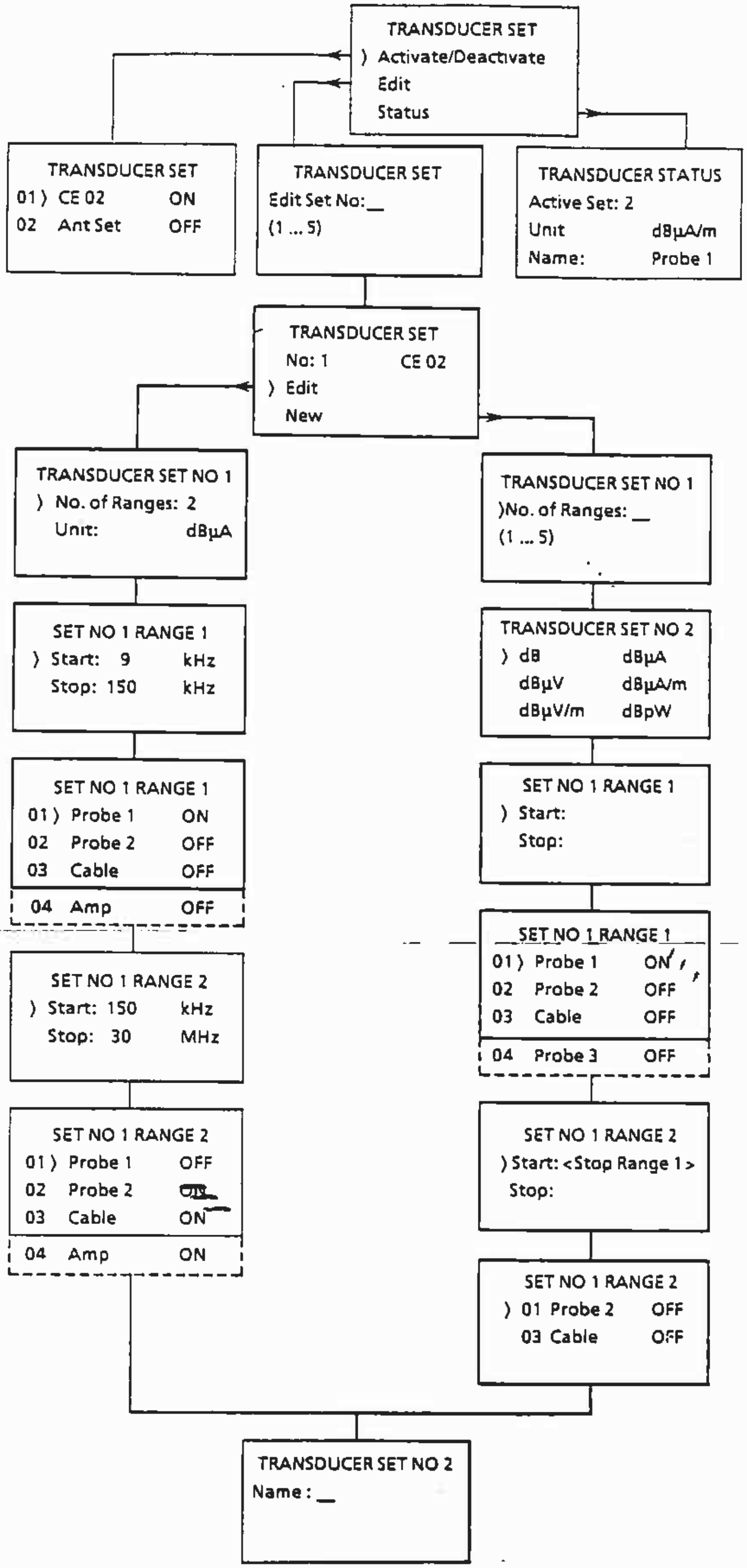


Fig. 3-15 Flowchart for generating/editing a transducer set

Edit: In the EDIT menu the set that is to be edited is first asked for. The desired set must be entered together with its appertaining number. If no set with the selected number exists, the blank table for entering points appears. Otherwise the name of the set is displayed in the following menu and the user can chose between editing the set *(Edit)* and entering a new set *(New)*. With sets that do not yet exist only new entry is permitted.

New Entry of Transducer Sets: When entering transducer sets for the first time, the number of ranges which the transducer set comprises is requested in a menu. Up to five ranges are possible. With the entry of the desired number the next menu appears, in which the unit of the set is specified. The unit is selected by the cursor via the ↑ and ↓ keys and input using ENTER.

The frequency limits of the individual ranges for the set and the factors active in the range are subsequently input one after the other starting with range 1. As there may not be any gaps between the individual ranges, the start frequency is already pre-determined from the second range (stop frequency of the preceding range).

In the list from which the factors can be selected for the range currently to be edited ***only those factors that are matched to the unit of the set and are defined over the entire individual range*** are available. These factors are indicated in the status Off. The desired factors are selected by the cursor and their status is switched over using ENTER (OFF → ON). The menu is exited using the → key. If no factor has been activated in a range, the transducer in this range will be set to 0 dB. The unit is the one defined for the entire set.

After having entered all ranges the set can be provided with a name *(Name)*. Input is possible either by the external keyboard or by the auxiliary lines for text input (cf. section 3.2.4.1.2), if the keyboard is not connected. The name may consist of maximally 8 characters. Punctuation marks are not permissible, i.e. they are ignored. If no name is desired, the field may remain blank (merely pressing ENTER).

Editing of Already Existing Transducer Sets: When editing a transducer set the number of the ranges *(No of Ranges)* and the unit *(Unit)* of the set appear in the menu. The number of ranges may be altered, the unit however not as this would correspond to a new entry. It is possible to move from one point to the other through the various ranges using the ↑ or ↓ keys. The cursor can be moved from menu to menu using the → or ← keys. The individual menus have the same structure as those for new entry. Start and stop frequencies of the individual ranges can be changed by selecting the corresponding menu point and directly entering new values.

When pressing the ENTER key the old value is retained and the cursor jumps to the next line. When changing the stop frequency the start frequency of the next range is also automatically changed. In the case of the ranges 2 to 5 the start frequency cannot be changed as there may not be any gaps between the individual ranges. The status of the factors that are possible in the various ranges is switched over in the same way as with new entry.

Note: *When the frequency limits of the individual ranges are changed, it may occur that transducer factors that used to be active in a range are no longer permissible as their definition ranges do not cover the range. These factors do no longer appear in the selection list. After having edited the last defined range it is possible to change the name of the set (cf. new entry).*

3.2.4.2.3 Calling the Self Test (SELF TEST Menu)

The ESHS is equipped with a wide variety of self-test functions that can detect an instrument error even if it is on module level. The self-test runs independently while the functions that build up on one another are tested in turns starting from the lowest function level. When a faulty function is detected, it is indicated on the DATA INPUT display with a hint to the respective module (*ERR: <Module>*). Only one error can be detected as the following tests cannot be carried out correctly, if there was a faulty function. To avoid unfounded error messages the self-test is aborted following the detection of the first error. Complete instrument settings can be called to allow for convenient setting of the modules in the case of replacement.

The run of the self-test, possible error messages and replacement of modules are described in detail in section 4.

Operation:

The self-test menu is entered by way of the SELFTEST key in the keypad INSTR STATE. The desired function is called either by entering the appertaining number of by way of the cursor. The status of the calibration generator *(CAL Gen)* and of the calibration correction values is switched over. When exiting the menu by means of EXIT, the default operating status is automatically re-established (cf. menu).

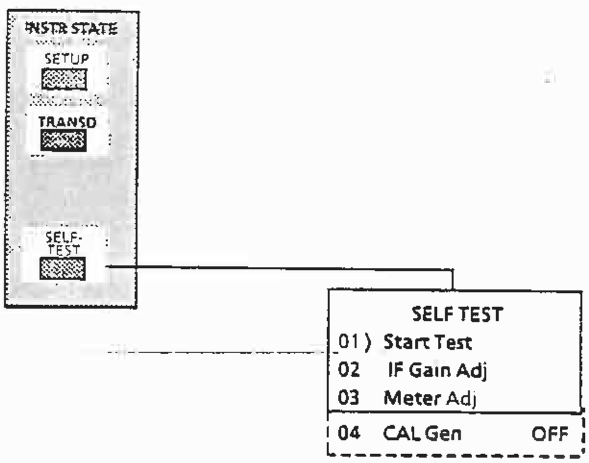


Fig. 3-16 Calling the SELF TEST menu

3.2.4.3 Execution of Frequency Scans (ANALYSIS Keypad)

For measuring interference spectra the most important feature of the ESHS is that it is able to perform independent frequency scans with setting data varying from range to range. A test report can be output in the form of a diagram and/or a table either by means of a printer or a plotter or using both. Limit lines can be defined in accordance with the rules specified for the respective measurement and also be output. The frequency scan can be adapted to the specific measurement problem with the help of various options or complex measurement runs can be carried out, for example complete RFI voltage tests with control of the necessary artificial mains network, preliminary test, data reduction, final test and output of measurement results.

3.2.4.3.1 Generation and Editing of Data for a Frequency Scan

A data set for a frequency scan can consist of up to five partial scans, which are defined by the start frequency, stop frequency and step size. The latter can either be linear *(LIN)* or logarithmic *(LOG)*. With logarithmic setting it is entered as a percentage of the respective receiver frequency. The remaining receiver parameter such as bandwidth, detector, operating range, attenuation, mode and measuring time are set in the receiver during definition of the partial scan in the same way as in manual mode, i.e. those receiver parameters that are selected at the time the input is terminated or the range is quitted are used in the partial scan. (Confirmation of the question *Rec settings ok?* using a key in the ENTER area).

Minimum level (*Min Lev*) and maximum level (*Max Lev*) must finally be defined for the complete scan data set. These two levels determine the display range of the plotter or printer output. They are always entered in dB. The unit follows from the unit that is valid for the measurement and depends on the transducer, antenna code or on special functions set.

The scan data set is stored in the RAM with battery backup. Thus it is available again following switch-off of the receiver. If no scan data set was defined or when having called default setting using RCL0, the default data set is automatically set. It consists of two ranges with the following settings:

Table 3-9

	Scan No 1	Scan No 2
Start frequency	9 kHz	150 kHz
Stop frequency	150 kHz	30 MHz
Step size	100 Hz	5 kHz
IF-bandwidth	200 Hz	10 kHz
Attenuation	AUTO, Low Noise	AUTO, Low Noise
Operating range	60 dB	60 dB
Detector	Pk	Pk
Measuring time	100 ms	20 ms
Preamplifier	off	off

Operation:

The menu which offers initial input (*New Set*) and editing (*Edit Set*) of a scan data set is called by pressing the SCAN key in the ANALYSIS keypad. Depending on the selection the different menus for editing or new entry of a data set are offered one after the other until the data set is complete.

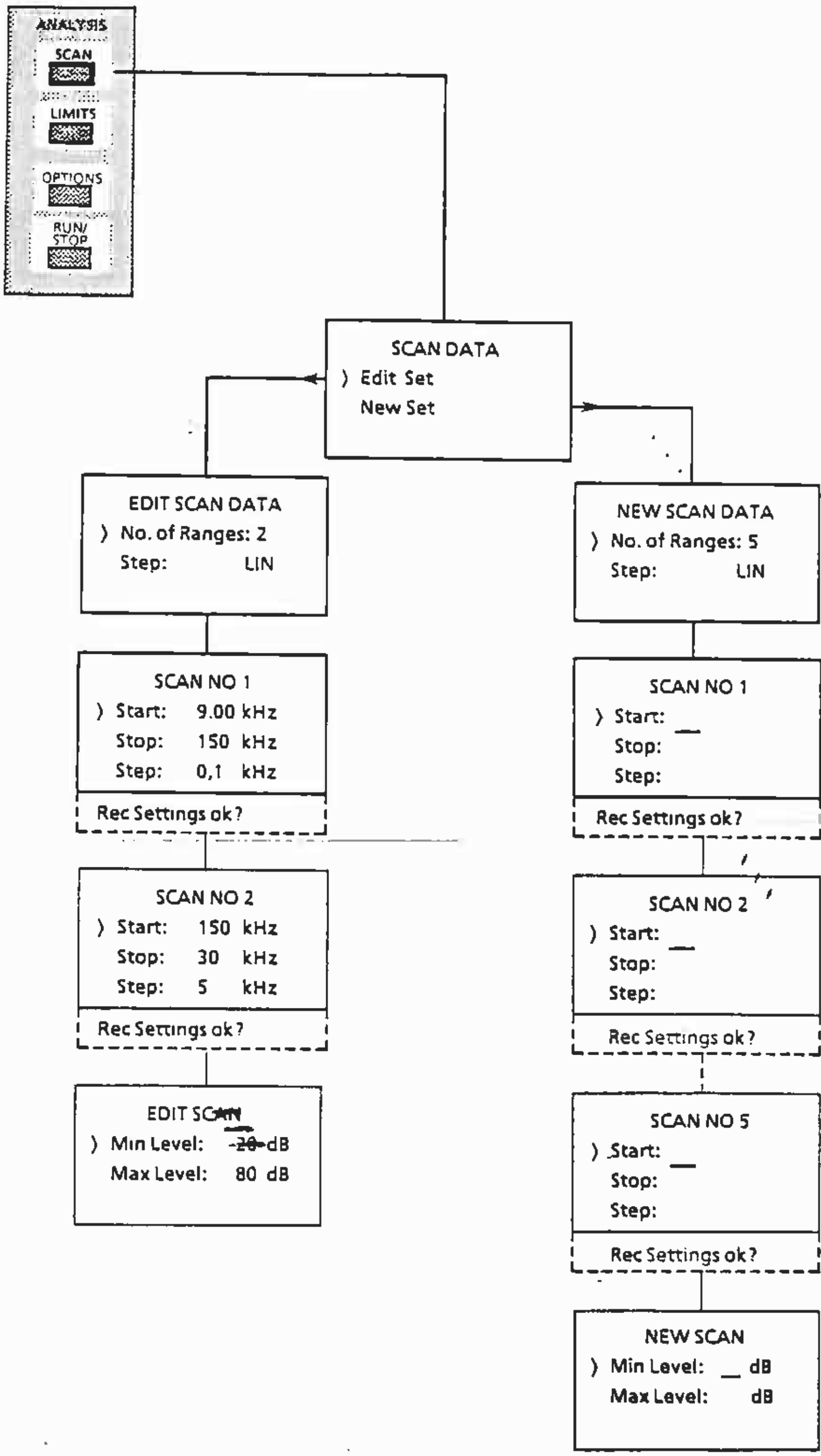


Fig. 3-17 Flowchart of the menus EDIT SET and NEW SET

New Entry of a Scan Data Set:

When entering a new scan data set, the number of ranges (*No of Ranges*) which the scan data set is to contain and the type of frequency scan (linear or logarithmic) is first requested. The default values are 2 ranges and linear frequency scan.

No. of Ranges

The number of ranges may be 1 to 5. Frequency scan is set to logarithmic (LOG) by pressing a key in the ENTER area when the cursor is placed on *Step*. Following the selection of the logarithmic step size the sweep step size in each partial scan must be entered in per cent.The range of values for step size is 0.1 % to 100 % (100 %, 50 %, 25 %, 12.5 % ... 0.1 %). If the user enters a step size other than the ones stated above, the next lower step size is automatically set.

Start
Stop
Step

When pressing the → EDIT key the next menu is entered, in which start frequency, stop frequency and step size of the first partial scan is requested. They are respectively entered together with their unit or in per cent. Unless all parameters requested are entered, the next menu cannot be entered. Following the input of all values the question whether all receiver parameters for the partial scan have been correctly set (*Rec Settings ok* ?) appears in the last line of the menu. The user can thus make sure again that all settings on the front panel are correct before he presses a key in the ENTER area to affirm the question and thus switches to the next menu.

Max Lev
Min Lev

If ENTER is used, all current receiver settings made for the partial scan - with the exception of the frequency - are adopted for the next partial scan and it is also switched to the next menu. The start frequency of this partial scan (= stop frequency of preceding partial scan) is already set, as there may be no gaps between the individual partial scans. Scan input is terminated when the settings of the last partial scan that is defined in *No. of Ranges* have been entered.

If the stop frequency of a preceding partial scan is already 30 MHz, 30 MHz for the start and stop frequency and 0 kHz or 0 % for the step size is then automatically input in the following ranges. The receiver considers the ranges to be non-existing. Entries can be affirmed by way of ENTER. It can be switched directly from menu to menu using the → EDIT key. It is also possible to define several partial scans in this way. The user can intentionally create scan data sets of this kind to have dummy-partial scans, which can be used, if required. It is thus not necessary to enter anew a complete scan data set.

The minimum and maximum level for scaling the diagram that is output via printer or plotter must be entered in the last menu. Multiples of 10 are only permissible. Deviating inputs are automatically rounded off (minimum level) or rounded up (maximum level). The minimum display level that can be entered is -200 dB, the maximum one is +200 dB. The unit is the one that is currently valid for the receiver. The minimum display range (*Max Lev.* - *Min Lev.*) is 10 dB.

Editing an Already Existing Scan Data Set:

As with new entry the number of ranges and type of frequency scan (linear or logarithmic) of the already existing data set is displayed in the first menu.

When increasing the number of ranges, further ranges can be added directly with higher values; when decreasing the number, the ranges with the highest values are deleted.

After having exited the menu (→ key) the first defined partial scan appears. At the same time all receiver settings defined for this partial scan are set in the ESHS and displayed.

Start
Stop

If the partial scan that is to be changed is already known, the menu can be quickly scrolled through using the → key. Start frequency, stop frequency and step size can be edited by selecting the corresponding menu point by way of the cursor and immediately entering new values. When pressing a ENTER key the old value is retained and the cursor moves to the next line.

Rec settings ok?

Changing the stop frequency changes the start frequency of the next partial scan. From the second partial scan onward the start frequency cannot be changed anymore as there may not be any gaps between the individual scans. It can only be changed by entering a new stop frequency for the preceding partial scan.

The question whether all receiver parameters for the partial scan have been correctly set (*Rec Settings ok ?*) appears in the last line of each menu. The user can thus make sure again that all settings are correct before pressing ENTER to affirm the question and to switch to the next menu.

Min Level
Max Level

Level display range (*Min Level* or *Max Level*) for output of diagrams can be modified in the last menu which is for editing the scan data set.

3.2.4.3.2 Input of Limit Lines

The various regulations covering interference measurements include limit values that may not be exceeded. With logarithmic frequency display these values are usually composed of straight lines. In some standards several limit values are specified, e.g. a limit value for quasi-peak and one for average weighting.

The ESHS allows to define and store remanently up to 22 different limit lines. In order to distinguish the different lines they may be supplied by a number (1 to 22) and a name (max. 8 characters).

As in practice the necessary number of points for the limit values is specified differently in the various standards, the maximum possible number of values depending on the number of the limit value is grouped according to the following table:

Table 3-10

Number of Limit Value	Max. Interpol. Values
1 to 10	10
11 to 20	20
21, 22	50

Two of these 22 limit lines can be activated for measurement. If a name is specified for the limit value (max. 8 characters), it is also output in the test diagram.

Furthermore, the acceptance analysis (cf. section 3.2.4.3.3, Options of RF-analysis) also refers to the limit line.

The defined limit lines are stored in the RAM with battery back-up and can be activated or deactivated, if required.

Activated limit lines are used to determine whether limits were exceeded during final measurements in the RF analysis and in the special function 16 (*Check Limit* see chapter 3.2.3.13). With double test modes, the test receiver automatically assigns the detector to the limit line which is to be compared. When this occurs, the detector which measures the higher level refers to the limit line with the larger value.

Operation:

New entry or editing of limit lines is called by pressing the LIMITS key in the ANALYSIS keypad. In the appertaining main menu the user can select between activating or deactivating *(Activate/Deactivate)*, editing *(Edit)*, i.e. new entry or changing of limit lines. Furthermore it specifies the current status of the receiver relating to the limit lines.

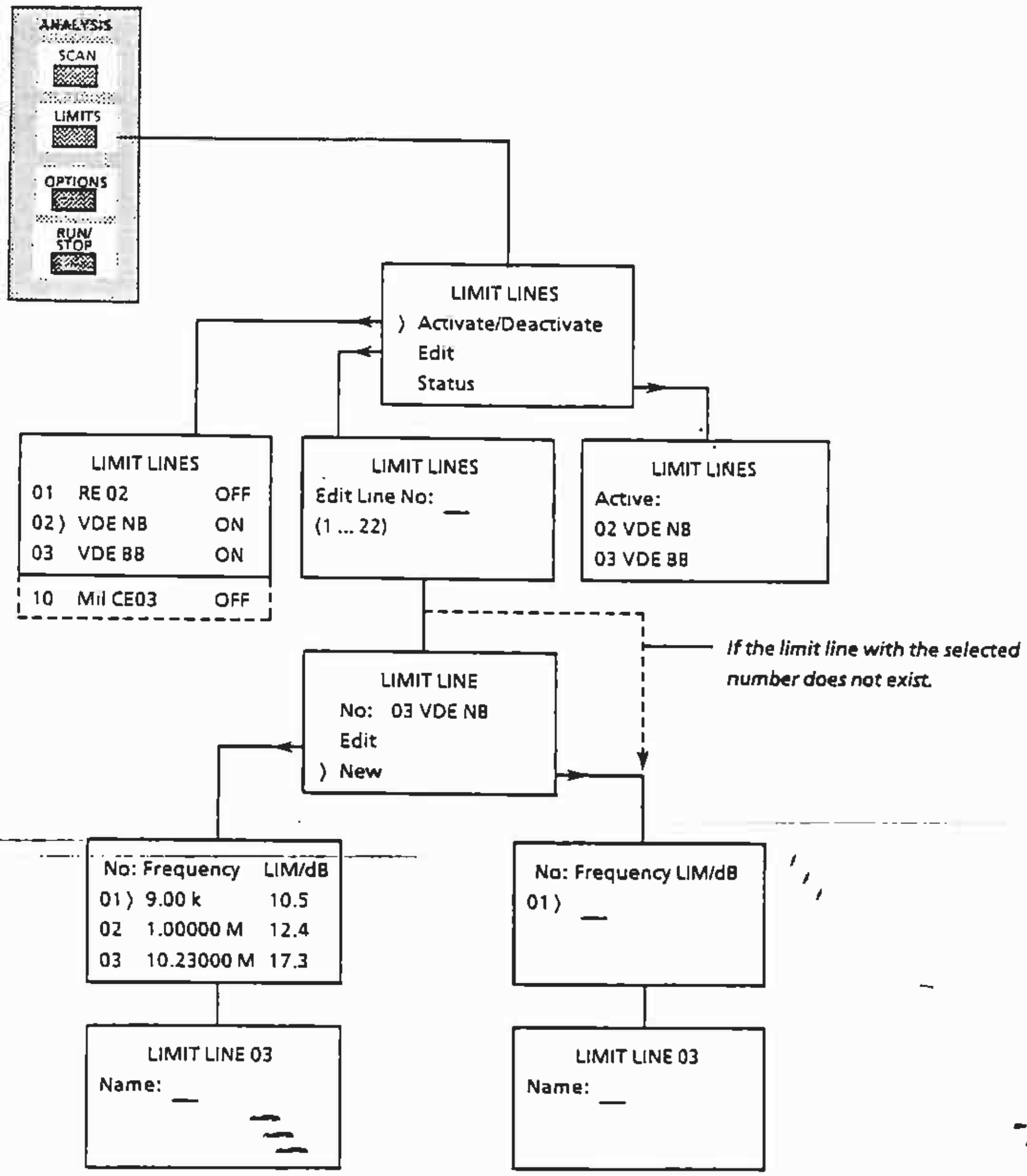


Fig. 3-18 Flowchart for new entry or editing of limit lines

Activating / Deactivating of Limit Lines (*Activate/Deactivate*):

In this menu a stored limit line is activated or an active limit line is deactivated. If there is an active limit line, the name of the menu point is *Activate / Deactivate*; if there is no active one, the menu is only referred to as *Activate*. After having selected the menu point a submenu, in which all the defined limit lines together with their number, name and current status are listed, is called. If there is no defined limit line, the message *"None defined"* appears in the display. The cursor is placed on the active limit line with the lowest number, or, if there is no active one, on the line with the lowest number of all limit lines.

The cursor is placed on the factor to be edited using the ↓ and ↑ keys or by entering the appertaining two-digit number (e.g. 01 must be entered for factor 1). If the factor with the number entered is not defined, the error message *"<xx> undef"* (<xx> = number entered) appears in the last line of the display. The status of the limit line can be changed (ON → OFF, OFF → ON) by pressing the ENTER key. If there are two active limit lines, the cursor jumps automatically to the second active line after having deactivated a line.

Only two limit lines, respectively can be active at one time. When trying to activate a third one, the error message *"Max 2 Limits active"* is output. Before activating the desired limit line an already active one must be deactivated. The menu is exited using the ← key or EXIT.

Editing of Limit Lines:

When calling the EDIT menu the limit line to be edited is requested in the first submenu. It must be entered by its appertaining number. If there is no limit line with the selected number, the blank table for entering the points appears. If a limit line with the selected number does already exist, its name is output in the following menu and a selection between editing *(Edit)* and new entry *(New)* is offered. In the case of new input the blank table appears. If "New" was selected by mistake, the former limit line may be restored by pressing the ← key prior to complete input of the first point.

New Entry of Limit Lines:

New entry of limit values must be performed in the sequence of increasing frequencies with frequency and level. The cursor is placed on the frequency of the first point at the beginning. Following frequency input (ended by MHz or kHz) the cursor jumps automatically to the appertaining level value. Values of -200 to + 200 are permissible for the level. When exceeding these limits the messages *"Max Level 200 dB"* or *"Min Level - 200 dB"* result. The input unit is always dB, i.e. the unit of the limit value is adapted to the unit valid during measurement, which usually depends on the transducer used. After having completed input of the point the cursor jumps automatically to the next one.

If the increasing order is not adhered to, the message *"Frequency Sequence!"* is output and the frequency input is ignored, i.e. entry is not accepted.

If the maximum number of points has been entered, the input menu is automatically exited. It can also be exited beforehand by pressing the ENTER key while the cursor is in a blank frequency field or by using the → key. The limit line can finally be provided with a name (*Name*) in the following submenu. Input can be performed either via the external keyboard or via the auxiliary lines for text input (cf. section 3.2.4.1.2), if the keyboard is not connected. Maximal 8 characters are permitted for the name. If no name is desired, the field *Name* may be left blank.

Editing of Already Existing Limit Lines:

When editing limit values a point can be deleted, a new one can be inserted or only any frequency or level value can be changed. Inserting or deleting a point is possible, when the cursor points to the number of the point. It is deleted using the DELETE key and the subsequent values move up. A free line is created at the position of the cursor using INSERT and all following points are raised by one number. When entering the new frequency in the new line it must be ensured that the frequency order is kept as otherwise input is not accepted. If the limit value has already the maximum possible number of points, it is not possible to insert a new one. In this case the error message *"ERR: Max <xx> values"* (<xx>: the maximum number of points which is dependent on the number of the limit line, cf. table 3-10) appears in the bottom line.

A frequency or a limit value can be changed when placing the cursor on the desired position. When entering a figure the old value is deleted and the new one is displayed. Stick to the increasing frequency sequence in this case, too.

The EDIT menu is exited either by way of the ← or → key or, when the cursor is on the last point by pressing the ENTER key. The menu for the name appears in the DATA INPUT display (cf. New Entry of Limit Lines).

Display of Active Limit Lines: In the menu Limit Status the limit lines currently activated are indicated in the second and third line. They are represented together with their number and name, if the latter is defined. If no limit line is activated, *none* is indicated in the menu.

3.2.4.3.3 Extended Functions of RF-Analysis (OPTIONS)

The *Options* of the ESHS offer new functions that serve for adapting the RF-analysis to specific measurement problems or to optimize measurement runs for various applications. A significant feature is data reduction. It is achieved by dividing the frequency range into subranges. During a pre-test the maximum interference is searched for in a subrange. A measurement is immediately carried out at this maximum in the desired indicating mode - usually quasipeak or average value. In any case it is thus ensured that the highest interference levels are measured with weighting. The relatively time-consuming measurement procedures must however only be carried out with a limited number of frequencies, so that total test time is considerably less. In the case of RFI voltage measurements with artificial networks it is also possible to switch over the phase for weighted measurement, if required. This ensures that the highest interference is detected. The user himself largely determines the measurement run by combining the various options in different ways. Thus the number of subranges (max. 400), parameters of the pre-measurement, type and phases of artificial network, type of weighted measurement and its measuring time and the threshold value for which a weighted measurement is to be performed can be freely determined by the user. How to carry out the measurement is described in section 3.4.

Operation:

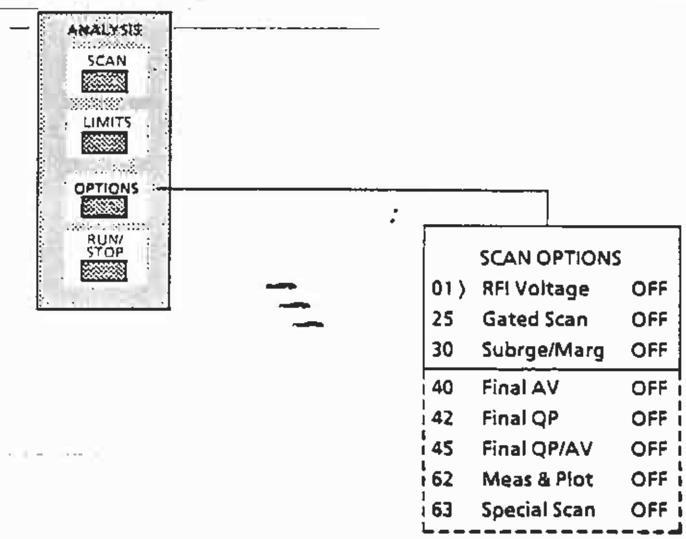


Fig. 3-19 Calling the SCAN OPTIONS menu

The cursor is placed on the desired option using the ↑ and ↓ keys or it is directly entered using its number. The status of the scan options is switched over by way of ENTER (OFF → ON, ON → OFF). Some of the scan options require additional entries. In this case, a submenu in which the necessary values can be input is called during switch-on. The main menu is exited when calling any other menu or by way of the EXIT key.

OPT 01, RFI Voltage: The option together with an Artificial Network ESH2-Z5 or ESH3-Z5 and a plotter and/or printer allows to carry out a complete RFI voltage measurement with documentation of the measurement results. (How to use the function, cf. section 3.4).

Switching on the phase in the submenu *PRESCAN/MANUAL* also causes a connected Artificial Network to be switched on at the same time. This makes it possible to manually select the phases from the receiver. If the Artificial Network is switched off with *OFF*, the remote control is disconnected.

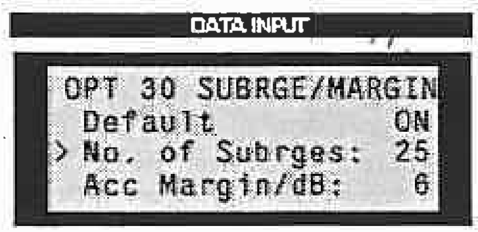
OPT 25, Gated Scan: Default setting of the option is OFF.

With the option switched on, frequency scan starts with a positive edge at the input "External Trigger" (pin 1) of the USER INTERFACE. It continues as long as HIGH level is applied to the input. When the level changes to LOW, frequency scan stops. Following the next positive edge it starts again at the position where it was interrupted.

The function contributes to a considerable reduction in measuring time required for devices under test featuring intermittent interference or systems which are only irregularly activated. The trigger level must be generated by the device under test, itself.

OPT 30, SUBRGE/MARGIN: This option is used in connection with option 01. The user can specify the number of subranges *(SUBRGE(S))* at the maximum levels of which a final test is to be carried out and the level margin *(MARGIN)* compared to the limit line at the frequency from which onward measurement is carried out. Application is described in section 3.4 in connection with option 01.

Operation:



When calling option 30, a submenu appears, in which the required number of subranges and the difference relating to the limit line from which onward a weighted measurement is carried out can be entered. The values of the default setting are 25 subranges and a margin of 6 dB with respect to the limit line. New values can be input by placing the cursor on the desired line and entering a new value.

The permissible values for the number of subranges are 8, 16, 25, 50, 100, 200, 400 (maximum value). When entering a value other than the ones stated above, it is rounded up or down to the next permissible one. For the margin to the limit line all the values between -200 dB and +200 dB are permissible. A positive value leads to a margin that is below the limit line.

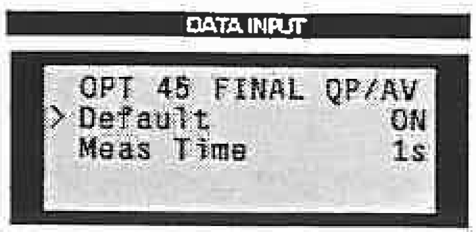
The menu can be exited using EXIT.

Option 40: Final AV
Option 42: Final QP
Option 45: Final QP/AV:

Default setting is OFF.
With the options 40, 42 and 45 ON, quasipeak measurement, average measurement or both is automatically effected at the maximum levels of the subranges following a measurement with scan. One function only can be switched on at one time. When activating one option, the other two are automatically switched off. The options are used in connection with option 01 "*RFI Voltage*". Application is described in section 3.4.

Operation:

- Place the cursor on one of the options 40, 42 or 45:
- Press ENTER.
  With option 45 for example, the following submenu is called:



In this submenu measuring time required for measuring again at the maximum levels of the subranges is specified.

- Place the cursor on *Meas Time* for this purpose and then enter the desired measuring time.
- Set the basic setting (cf. menu) by way of *Default*.

  The menu is exited by pressing eiher the EXIT key or ← key and option 45 is displayed with ON in the option menu. When pressing ENTER while the status is ON, the option is deactivated (status OFF).

Option 62, Meas & Plot:

Default setting of the option is OFF.
To allow to follow the measurement run, the measurement curve can be output on plotter during frequency scan.

If no plotter is connected or it is set to another address than specified in the SETUP menu, the message *Connect Plotter!* is read out in the display DATA INPUT. After having connected a plotter the scan is started by pressing a key in the ENTER area. When pressing only a ENTER key measurement is started without a plot.

With the IEC bus switched off (Spec Func 11 or operation with internal battery) the message *IEC Bus OFF (SF 11)* is output. In this case switch on the IEC bus using Spec Func 11 and restart the plot.

The note *WARN: Plotter active* is output when starting a scan before a plot activated before has been concluded. The scan is not started in this case. Wait until the data are completely output to the plotter or switch off option 62 before restarting the scan using RUN.

When starting the scan everything defined under the point *Report Setting* in the menu *Plot Contents* is plotted. If *Curve* is not activated in this menu, a warning results: "*WARN: Curve OFF*"

Option 63, Special Scan: When *Special Scan* is selected, one measurement at each of the frequencies defined in a frequency data set is carried out with the desired receiver settings. Thus it is possible to obtain a measurement result in minimum time, if the frequencies of emitted interferences are known.

Example:
Measurement of emitted interference at the line frequency plus harmonics and frequency of the switching power supply plus harmonics.

Frequencies for the special scan are entered using the SCAN key. Input menus are different from those of a conventional scan.

Operation:

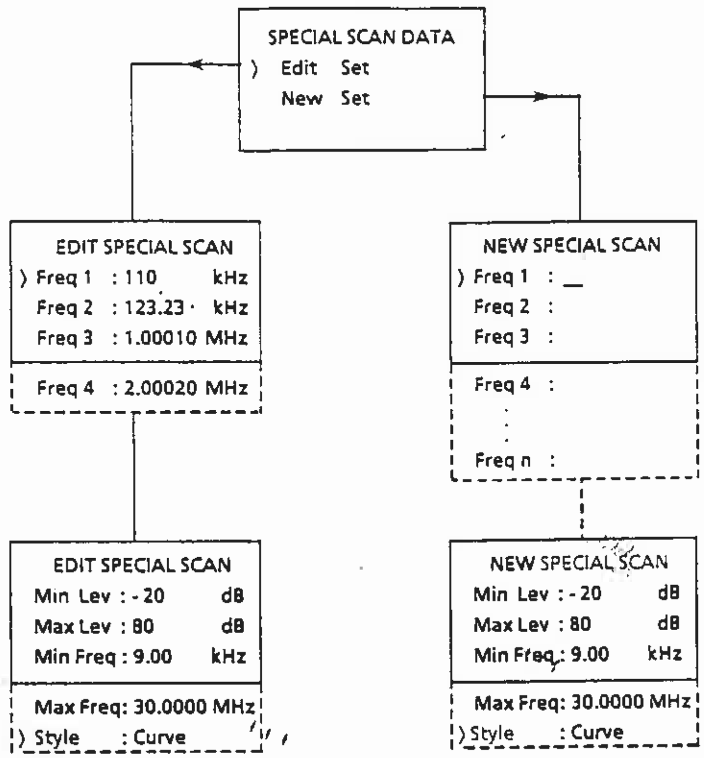


Fig. 3-20 Flowchart for input of a special scan

In the first menu it is possible to select between editing of an already existing data set and new entry. The following menus are essentially the same.

400 frequencies at the most can be entered. The individual frequencies must be entered in increasing sequence. Frequency inputs that are not in line with this order are not accepted. The error message *Frequency Sequence* results. When editing the data set, it is possible to insert additional frequencies using INSERT or delete them by way of DELETE.

The edit menu is exited by way of the ← or → keys or, if the cursor is on a blank input line or on the maximum possible interpolation value by the ENTER key.

Following the input of all frequencies, level and frequency limits must be entered for plotter or printer output.

The *Style* function allows you to select the way a measurement curve is represented on a printer or a plotter. Pressing the ENTER key switches between closed curve sections (*Curve*) and small vertical lines (*Line*).

3.2.4.3.4 Frequency Scan

A scan is started by pressing the RUN/STOP key. It runs in accordance with the set special functions (cf. section 3.2.3.13), transducer factor or transducer set (cf. section 3.2.4.2.2) and options. If several ranges are defined in an active transducer set, the receiver stops at the range intersections and requests changing of the transducer. The data measured are stored in the internal RAM (cf. OPTIONS and section 3.4). Max. 30.000 measured data can be internally stored. If more measured values are produced, they are not available any more for further processing (e.g. subsequent outputvia the IEC bus). Nevertheless, a complete diagram is always output, since only the 400 upper values of the scan are required. When switching off the receiver the stored data get lost.

Operation:

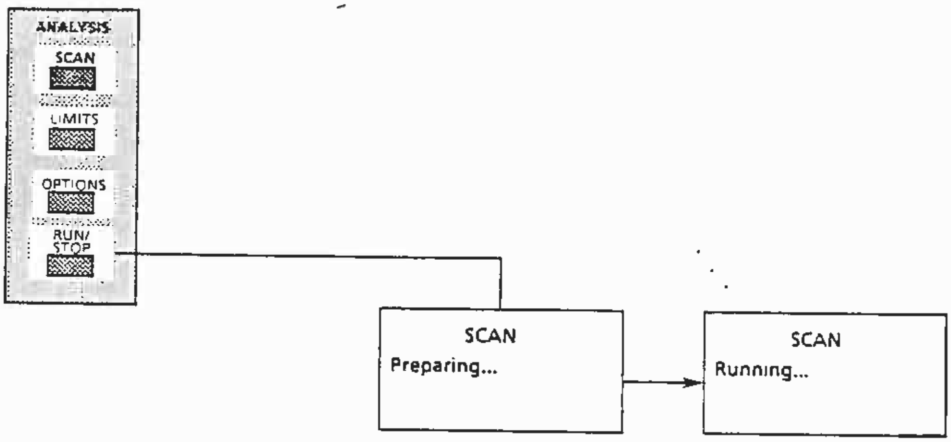
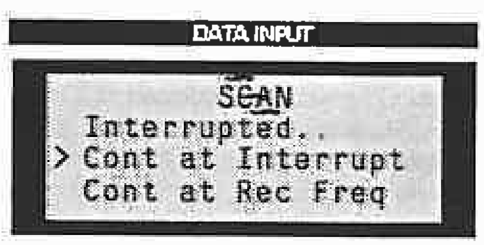


Fig. 3-21 Calling the SCAN menu

- Press RUN/STOP key.
  Frequency scan is initiated. At the beginning the ESHS generates a data set which contains the correction values consisting of frequency response correction values from the total calibration and transducer factors for all frequencies. While establishing the data set *Preparing...* is indicated in the DATA INPUT display. Subsequently the frequency scan starts. The DATA INPUT display shows *Running...*

- Press RUN/STOP key.
  Frequency scan stops. The receiver can now be operated manually to allow e.g. closer examination of the receive signal at a frequency by monitoring or switching over of the detector or measuring time. The following menu appears in the DATA INPUT display:

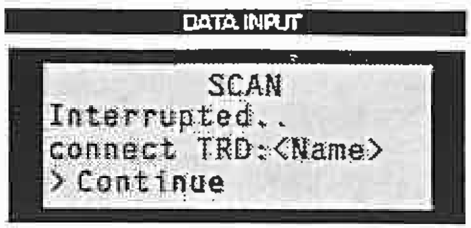


- Select *Cont at Interrupt*.
  Frequency scan continues at the position where it was interrupted with the settings defined in the scan data set.

- If the receiver frequency is lower than that at which the scan was stopped, the frequency scan continues at the position where the receiver is at the moment with the settings defined in the scan data set when selecting *Cont at Rec Freq*. If the frequency is higher, the scan is started at the frequency at which it was interrupted. Thus part of the frequency scan can be repeated, if there has been any irregularity. The measured values already stored are deleted and replaced by the new ones. If the results are simultaneously output via plotter, the old measured values are overwritten.

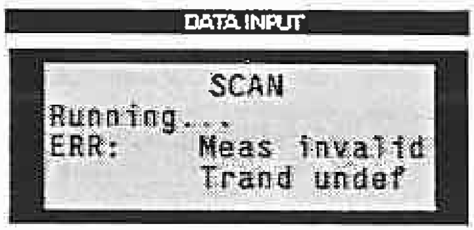
- If the scan was interrupted and the RUN/STOP key is pressed, frequency scan is stopped. The data already measured get lost. The measurement can only be started from the beginning by activating again the RUN/STOP key.

- At the intersection of transducer set ranges it is requested to change transducer by the following menu:



- After having changed the transducer, frequency scan continues when a key in the ENTER area is pressed.

Note: *If an active transducer factor or set is not defined over the whole range of the scan, invalid measured values result in the range where the transducer is not defined. To inform the user about it the following error message is output on the DATA INPUT display*:



In addition the level display flashes in this range. Valid measurements are carried out only at the frequencies where a valid transducer is defined.

After termination of the frequency scan a beeping tone is output, if the beeper is activated and the hint *Complete* appears in the DATA INPUT display.

3.2.4.4 Generating a Test Report (Report Keypad)

The result of a measurement run can be output both on a printer with Centronics interface and via IEC bus on a plotter with HP-GL interface. For printout any EPSON-compatible 24-pin printer may be used. The contents of the plotter or printer output can be determined by the user himself.

The following outputs are feasible:

- Measured value diagram with limit lines
- Measurement settings of the receiver
- User-definable heading
- Up to two measurement curves
- Measured value table
- Date and time

Thus it is possible to e.g. output the diagram on plotter and simultaneously the measured value table on printer. Plotting can also be carried out during the frequency scan (cf. section 3.2.4.3.3).

In addition to final results of an RF analysis scan, the results of a prescan can be copied in tabular form to a printer. The parameter *Scan Res List* in the *Printer Setting* menu has to be switched ON. The name *Meas values* for the final results was replaced by *Final Results*.
This is the new menu for setting the printer:

```
DATA INPUT

  PRINTER SETTING
> Default          ON
  Scan Res List   OFF
  Final Results    ON
  Title            ON
  Scan Table       ON
  Diagram         OFF
```

displayed after having pressed PRINT key

can be scrolled using ↑ and ↓ keys

3.2.4.4.1 Selecting the Pre-setting of the Printer and Plotter

The user himself can largely determine the test report by selecting the presetting of the printer or plotter. He can select the level display range by entering the minimum level *(Min Lev)* and maximum level *(Max Lev)* when defining the scan parameters (cf. section 3.2.4.3.1). In addition the user can select between linear *(Lin)* and logarithmic *(Log)* scaling of the frequency axis. He can also specify what is to be part of the test report. When using the plotter for output, the colors for the individual components of the display can be chosen differently to provide for a more easy-to-understand plot.

The presettings are stored in the memory with battery back-up so that usually the settings must be effected only once. They are even maintained after having called the default setting of the ESHS with the help of RCL 0 (cf. section 3.2.4.5).

Operation:

The menus for determining the design of the measured value output and presettings of the printer or plotter are called using the SETTING key in the keypad REPORT. In the first menu (REPORT SETTING) the user can select between presetting of the plotter or printer. In addition the scaling of the frequency axis can be specified in this menu.

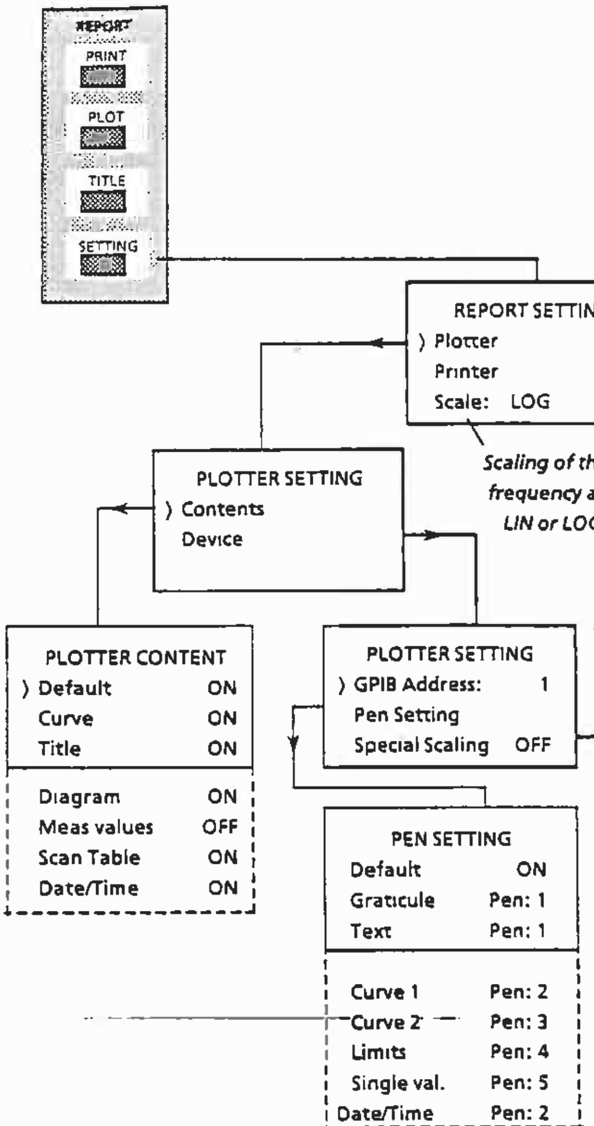


Fig. 3-22 Presettings for plotter or printer output

Scaling the Diagram: Linear or logarithmic scaling can be chosen for the frequency axis. Default setting is logarithmic scaling. If the ratio between maximum and minimum frequency is, however, lower than 1.5, the measured value diagram is automatically output with linear frequency scaling.

The scaling can be switched over using the ENTER key, when the cursor is placed on scale (LOG ↔ LIN).

Presetting of the Plotter: In the menu *PLOTTER SETTING* a distinction is made between contents *(Contents)* of the report and device setting *(Device)* of the plotter.

In the menu *PLOTTER CONTENTS* the various components of a plot can be activated or deactivated. These are

- the graticule with frequency and level labelling and, if defined, the limit lines *(Diagram)*,
- the heading defined by the user *(Title*, cf. section 3.2.4.1.2),
- the measured value curve(s) *(Curve)*,
- the table with measured values *(Meas values)*,

- the table with the list of scan and partial scan settings used with the appertaining receiver parameters (*Scan Table*) and
- date and time.

Default setting (cf. fig. 3-22) is output with graticule including labelling, heading, date/time and test curves. The measured value table is not part of the default setting as it can be output more conveniently and quicklier on a printer.

DEVICE SETTING is used to set the GPIB-address of the plotter, to assign the pens of the plotter to the graticule, labelling, test curves, limit lines and the measured values and to set the scaling of the test report. Values between 0 and 30 can be entered for the IEC-bus address. Other inputs are not accepted, i.e. the original value is maintained.

A submenu in which the individual plotter pens can be assigned to the various components of the test report is called using the menu point *Pen Setting*. With default setting (Default ON) the pens are selected as shown in fig. 3-22. When selecting a different pen assignment, default changes to OFF. Figures from 0 to 8 are permissible for the pen number. Using pen number 0 no pen is selected.

If another type of scaling of the test report than that specified by the plotter used is desired, the bottom left (P1) and the upper right (P2) corner of the report can be set separately with the help of the menu point *"Special Scaling"*. When activating this menu point a submenu is called in which the values selected for P1 and P2 are entered. Values ranging from - 32768 to (+) 32767 are permissible for the coordinates. Illegal values are not accepted. The values for the coordinates depend on the plotter used and must be learnt from the manual of the plotter. The ESHS 10 is preset for the use of the R&S-plotter DOP (cf. fig. 3-22). After having ended the input the status of *Special Scaling* changes to "ON".

Plotter	P1/X	P1/Y	P2/X	P2/Y
DOP /R&S	600	610	7320	10610
R 9833 (Advantest)	650	610	7200	10610
HP 7475		Default ON	Default ON	
HP Color P80		Default ON	Default ON	

Presetting of the Printer:

The menu for setting the printer (PRINTER SETTING) offers the selection between the various elements of a report similarly as with plotter output (see above). Default setting means output of the title with measured value table and output of the scan settings (cf. fig. 3-22).

3.2.4.4.2 Input of the Labellings for Printer or Plotter Output

To provide complete documentation of the measurement results the printer or plotter report can be labelled individually. The following entries can be made:

- *Heading,*
- *Measurement Type,*
- *Equipment u. Test,*
- *Manufacturer,*
- *Operating Condition,*
- *Operator,*
- *Test Specification* and
- *Comment 1 and Comment 2* (two lines for comments).

Operation:

The menu *TITLE*, in which the elements possible to label are stated, is called using the TITLE key in the keypad REPORT. The desired point is selected using the cursors. The following input menu varies depending on the instrument equipment available. If an external keyboard is connected, the desired text can be input using the same. Otherwise input can be made via the auxiliary line editor in the last two lines of the menu (operation cf. section 3.2.4.1.2).

In both cases 40 characters are maximally possible for each labelling element. Two lines with 60 characters each are permissible for the comment. Additional characters are not accepted.

The following menu tree shows the input of the labelling e.g. in the case of the title:

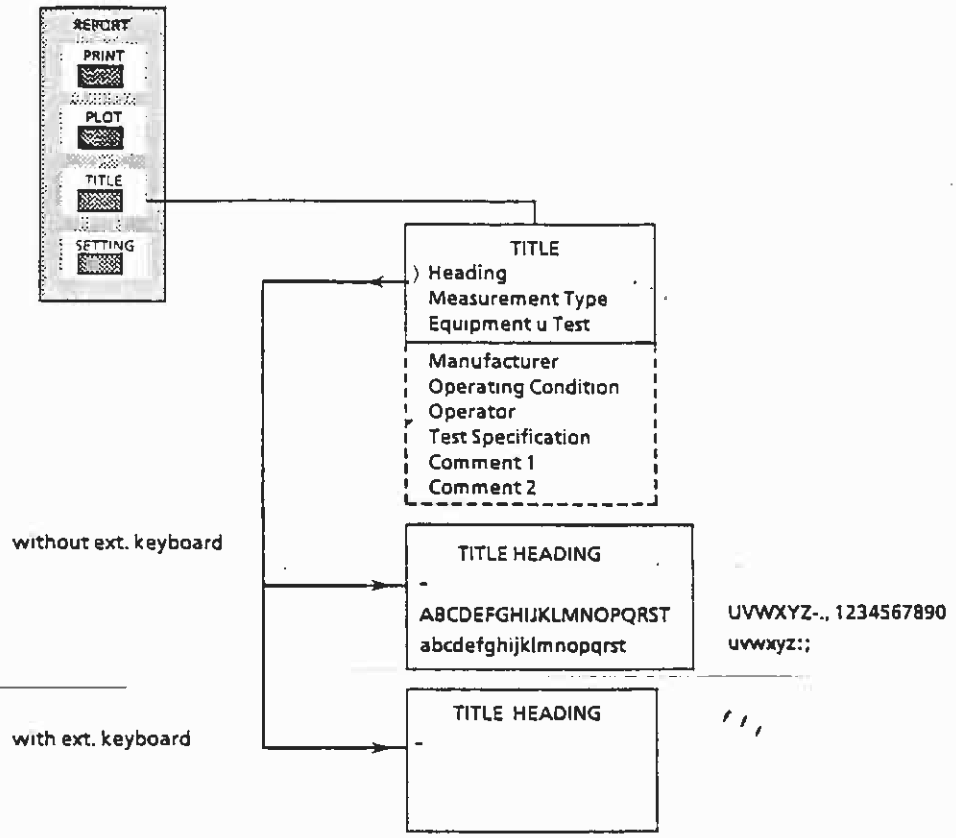


Fig. 3-23 Menu tree for input of the labelling

3.2.4.4.3 Output of the Measurement Results on Printer

When pressing the PRINT key the ESHS immediately starts to print the measurement results in the form they are configured in the *SETTING* and *TITLE* menus. If no printer is connected or it is not ready for operation, the message *"Connect Printer!"* appears on the display DATA INPUT. After having connected a printer the printing process must be started again.

Printing is a background process, i.e. the receiver can be operated during printing. However, fast measurements take somewhat more time.

Printing can be stopped at any time using *Abort Printing*. In this case printing must be re-started for a further printout.

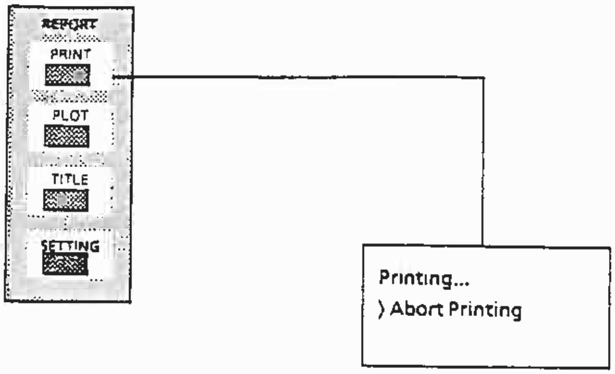


Fig. 3-24 Start of printer output

3.2.4.4.4 Output of the Measurement Results on Plotter

When pressing the PLOT key the ESHS immediately starts to plot the measurement results in the form they are configured in the SETTING and TITLE menus. If no plotter is connected or the plotter connected has a GPIB-address different from that entered in SETTING, the message *"Connect Plotter!"* is output on the DATA INPUT display.

No other controller may be connected to the IEC bus when starting plotter output, as otherwise the ESHS cannot take IEC bus control (message on DATA INPUT display *"Bus Control required"*). In this case the controller must be disconnected from the IEC bus.

When the IEC bus is not in operation (Spec Func 11, cf. section 3.2.3.13), start of plotter output is acknowledged by the message *"IEC Bus OFF (SF 11)!"*. After the IEC bus has been switched on, the plotting procedure must be started again.

Pressing the PLOT key again during plotting, the message *"WARN: Plotter active"* is read out on the DATA INPUT display. This message also appears when the plotter output is started and another plotting procedure which was initiated with option 62 (*Meas&Plot*) has not yet terminated.

The message *WARN: No Pen selected* indicates that an element of the measurement report, for which no pen was selected *(Pen = 0* in *PEN SETTING*), will be outputted.

Plotting is a background process, i.e. the receiver can be operated during the plotting process. However, fast measurements take somewhat more time.

If output of a measured value diagram and of a table is specified, the former is plotted on the first page and the table on the following pages. The user is requested to change the sheet on plotter by the following message in the DATA INPUT display.

Insert new sheet
> press ENTER

Labelling is repeated on every page.

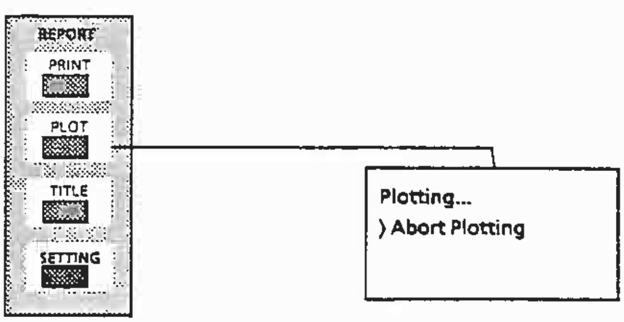


Fig. 3-25 Start of plotter output

Plotting can be stopped at any time using *Abort Plotting*. In this case plotting must be re-started, i.e. the plotting process cannot continue at the point where it was aborted.

ROHDE & SCHWARZ 08. Feb 91 05:13

RFI Voltage Test

EUT:	PC Power Supply
Manuf:	PC & Power
Op Cond:	Screen connected
Operator:	J. Wolf
Test Spec:	CISPR 22
Comment:	Line Filter not grounded

Scan Settings (1Scan):

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150k	30M	5k	10k	QP	500ms	AUTO	LD OFF	60 dB

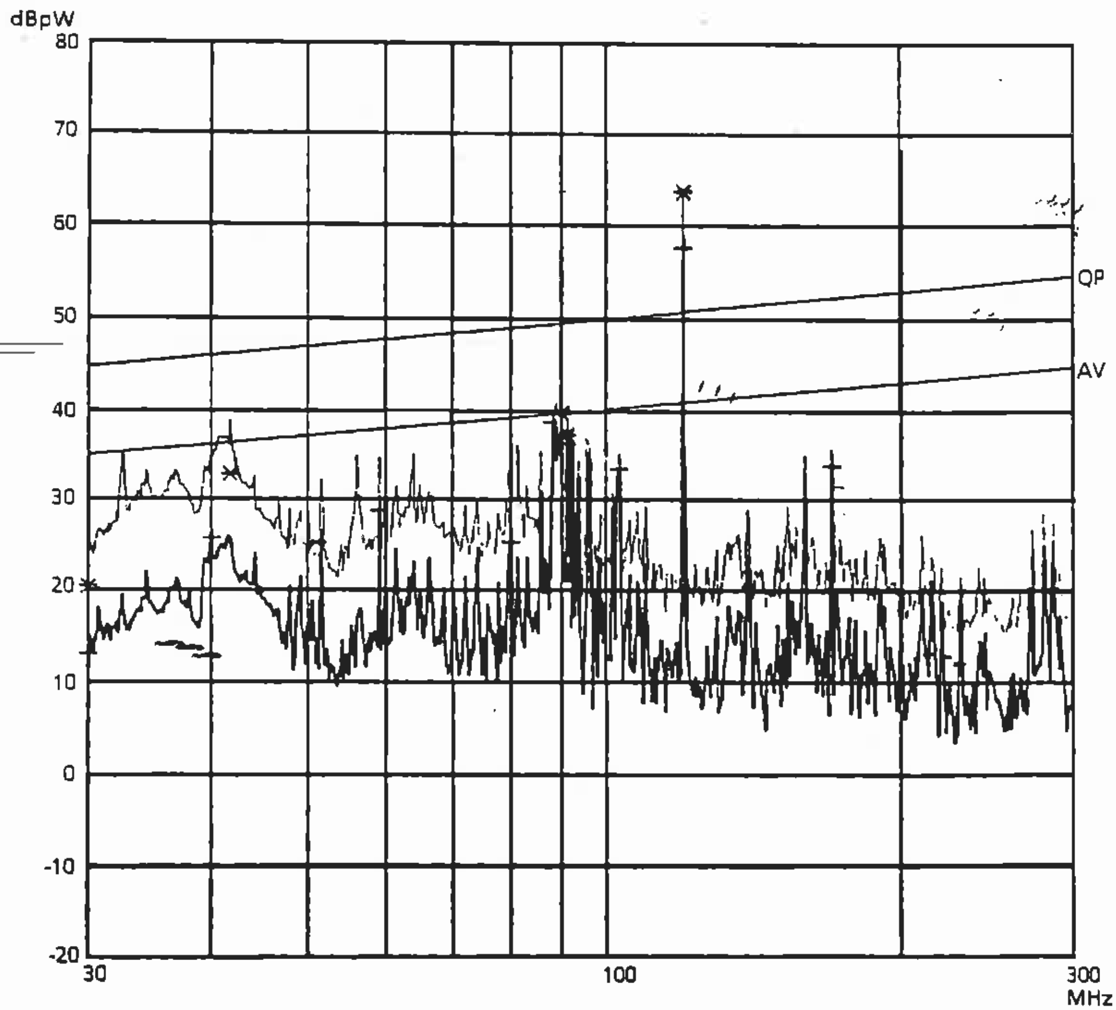


Fig. 3-26 Plotter output

3.2.4.5 Saving and Calling the Receiver Configuration

In the ESHS, 9 complete instrument settings (1 to 9) maximally can be saved. The setting *0* contains the default setting of the receiver and cannot be modified. All the settings are set to their default values using *0*. The settings are stored in the internal CMOS-RAM and are thus maintained even after having switched off the instrument. The settings for measurements that are performed repeatedly must only be entered once and can be re-called at any time.

The following parameters are saved:

- All the current receiver settings, such as frequency, attenuation, operating range, detector, etc.
- the special functions activated,
- the transducer settings currently effective,
- the limit lines,
- the scan data set and
- the set scan options.

To facilitate the recovery of settings saved, they can be provided with a name.

Note: *As the limit lines, transducer and the data sets for the "Special Scan" in turn contain extensive data sets, they are saved completely only once. The data set stored only contains a hint as to the respective limits, transducers or special scan data. If the latter are changed subsequently, it may occur that the initial transducer or limit cannot be reconstructed any more when re-calling an instrument setting.*

Operation:

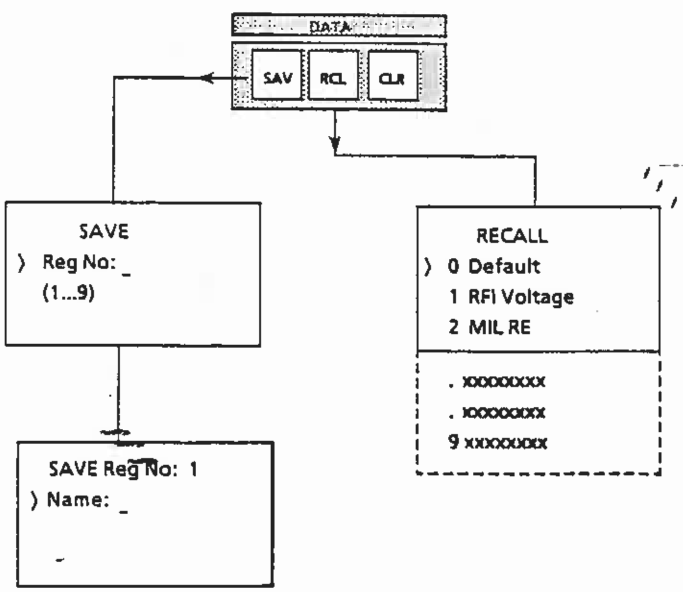


Fig. 3-27

Saving a Device Configuration: The desired register is requested in the DATA INPUT display when pressing the SAV key in the DATA keypad. The permissible registers (1 to 9) are also shown in the display. If the register is already occupied, its contents are overwritten with the new data set. After having entered the respective number (<number> + ENTER) a further menu appears, in which a name for the register selected can be entered. After having input the name the currently effective configuration is saved.

Recalling a Device Configuration: The key RCL in the DATA keypad serves to call a menu in the DATA INPUT display in which all the occupied registers together with their number and name are represented in the form of a list. The desired register can be called either by entering the corresponding number or selecting it with the help of the cursor. Input of registers not occupied is not possible. In this case the receiver outputs the error message *"Register empty"*.

Default setting of the ESHS (RCL 0):

Frequency:	1 MHz
Step size:	COARSE
Attenuation:	AUTO, LOW NOISE (RF-attenuation ≥ 10 dB)
Detector:	AV
IF-bandwidth:	10 kHz
Operating range:	60 dB
Measuring time:	100 ms
Pre-amplifier:	off
Special functions:	Default setting (cf. 3.2.3.13)
Setup:	is not affected
Transducer:	all the transducers defined are deactivated
Limit lines:	all the limit lines defined are deactivated
Options:	none
Scan data set:	Default data set (cf. 3.2.4.3.1)
Printer/Plotter settings:	are not affected

3.2.5 Connecting External Devices

3.2.5.1 Connecting the Transducers (ANTENNA CODE)

The ANTENNA CODE socket is provided for the supply and coding of the conversion factors of transducers. It serves to code the conversion factors of high-impedance probes, current probes and antennas in 10-dB steps. In addition the receiver is informed on the quantity to be measured (fieldstrength, current and voltage). Active transducers can be supplied with ± 10 V by the socket.

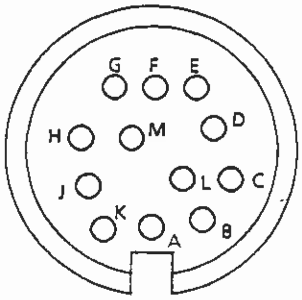
The following R&S-accessories are available with suitable coding:

- Passive Probe 9 kHz to 30 MHz ESH2-Z3,
- Active Probe 9 kHz to 30 MHz ESH2-Z2,
- Rod Antenna 9 kHz to 30 MHz HFH2-Z1,
- Rod Antenna 9 kHz to 30 MHz HFH2-Z6,
- Loop Antenna 9 kHz to 30 MHz HFH2-Z2
- RF-Current Probe 100 kHz to 30 MHz ESH2-Z1 and
- Current Probe 20 Hz to 100 MHz EZ-17.

As the conversion factor of the RF-current probe ESH2-Z1 increases by 20 dB per decade below 100 kHz, it is however more advantageous to enter the exact conversion factor via the transducer factor (cf. section 3.2.4.2.2).

The coding can be rendered ineffective using the special function SPEC FUNC 12. This is useful if with an active transducer the supply is to be used, however the coding is not desired. If a transducer is used during the measurement, the coding at the ANTENNA CODE socket is automatically rendered ineffective.

For fieldstrength measurements in shielded rooms, the ESHS is usually operated outside the room. If an active antenna is used for the measurement, the shield of the supply and coding cable must be fed through the screen of the chamber, such that there is no emitted interference inside the chamber. The ANTENNA CODE socket is assigned as follows:



A ground
B +10 V, max. 50 mA
C µV/m (electr.fieldstr.)
D µA
E 10 dB
F 20 dB
G 40 dB
H 80 dB
K - 10 V, max. 50 mA
M - Reversing the sign of the factor

Fig. 3-28 Assignment of the 12-contact Tuchel-type female connector

A 12-contact connector (Tuchel-type, R&S-order number 0018.5362.00) is used for coding. The inputs for the code must be connected to ground.

Example: An antenna for electric fieldstrength measurements has an antenna factor of 10 dB, i.e. a fieldstrength of 10 dBµV/m produces a voltage of 0 dBµV at the RF-input.

▸ The pins C and E must be connected to ground.

3.2.5.2 AF-Output

An external loudspeaker, headphones or, e.g., an AF-voltmeter can be connected to the AF OUTPUT socket using a PL-55-connector. The internal resistance is 10 Ω, output power is higher than 100 mW. If a connector is connected, the internal loudspeaker is automatically switched off.

3.2.6 Inputs and Outputs at the Rear Panel

3.2.6.1 IF-Output 74.7 MHz (74.7 MHz OUTPUT)

The 74.7 MHz OUTPUT is provided for the connection of the Panorama Monitor EPM or a spectrum analyzer. The gain compared to the RF-input is 10 dB (with pre-amplifier 20 dB), if RF-attenuation is 0 dB. The 3-dB bandwidth is larger than 2 MHz. It is however determined by the RF-bandwidth at low frequencies and at the limits of the pre-selection filters (cf. Specifications).

3.2.6.2 IF-Output 80 kHz (80 kHz OUTPUT)

The 80-kHz output is suitable for tests with oscilloscope, spectral analysis and examination of the modulation. The bandwidth is equal to the IF-bandwidth selected.

The output voltage (EMC) is	1 mV to 1 V	in the 60-dB range
and	1 mV to 30 mV	in the 30-dB range.

3.2.6.3 Video Output

The signal of the envelope demodulator is brought out at the video output. The voltage is identical to the envelope of the IF-signal and is therefore suitable for examinations with the oscilloscope. The output voltage is 0 to 4 V; the internal resistance is 50 Ω; it can however only be loaded with high impedances (> 1 kΩ). The bandwidth corresponds to the IF-bandwidth set.

3.2.6.4 Input for External Reference (EXT REF INPUT)

To increase the frequency accuracy of the ESHS, an external frequency reference can be connected to the connection EXT REF INPUT (pos. 32, fig. 3-2). A 5- or 10-MHz signal with a nominal level of 1 V at 50 Ω is necessary for this purpose. A level of 3 dB is usually sufficient.

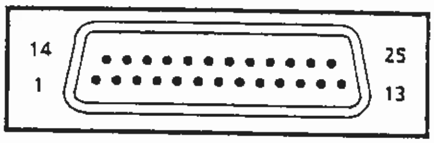
The ESHS, itself detects whether an external reference with a sufficient level is connected. It is checked by the switch-on routine and the hint *"Ext Ref"* is entered in the SETUP menu by the ESHS (cf. section 3.2.4.2.1). If a reference is connected during operation, the hint *"Ext Ref ON"* is output on the DATA INPUT display and simultaneously entered in the SETUP menu. If a signal is not suitable for synchronization, the error message *WARN: Ext Ref Freq* is output, if the frequency for synchronization of the internal reference oscillator is not precise enough. *WARN: Ext Ref Level* is output, if the level applied is not sufficient.

3.2.6.5 USER INTERFACE

The USER INTERFACE at the rear panel of the ESHS is a 25-contact CANNON-socket, to which five different signal groups are assigned. It contains the following interfaces:

- Serial Interface (RS232-C) for loading the firmware,
- Internal serial bus for control of accessories (currently not used),
- 6 parallel TTL-control lines (port 1 to port 6),
- +5-V- and +12-V-voltage for supply of external devices and
- analog outputs for the display voltage.

The pin assignment is shown in the following figure:



Pin	Signal	I/O	Meaning
1	EXTRIG	I	Ext. trigger, switchable pos./neg. trigger
2	RxD	I	Received Data: transmits ASCII data from computer to receiver
3	TxD	O	Transmitted Data: transmits ASCII data to the computer
4	DSR	I	Data Set Ready
5	DTR	O	Data Terminal Ready
6	RTS	O	Request To Send
7	AGND		Analog Ground
8	DCD	I	Carrier Detect
9	SCLK	O	Clock for Serial Bus (Clock Rate 4 MHz)
10	TDATA	O	Data line for serial bus
11	REC2	O	Recorder Output with Artificial Instrument
12	DGND		Digital Ground
13	+5 V		Supply for external accessory
14	PORT1	O	User Port Data 1
15	PORT2	O	User Port Data 2
16	PORT3	O	User Port Data 3
17	PORT4	O	User Port Data 4
18	PORT5	O	User Port Data 5
19	PORT6	O	User Port Data 6
20	CTS	O	Clear To Send
21	Strobe	O	Control signal for transfer of data to register
22	RI	I	Ring indicator
23	REC1	O	Recorder Output without Artificial Instrument
24	AGND		Analog ground
25	+12 V	O	Supply voltage for accessories

Fig. 3-29 Assignment of the user interface X 37 (USER INTERFACE)

3.2.6.5.1 Serial Interface (RS-232 C)

The serial RS-232-C-interface is provided for loading the instrument firmware. It allows the loading of new firmware versions using an IBM-AT-compatible personal computer via its serial interface without opening the instrument. For more details refer to section 4.

The connection to the PC is established via a cable with a 25-contact connector (to the ESHS) and a 9-contact connector (to the PC), which is included in the ESHS-service kit (cf. Specifications, Recommended Accessories). It is also possible to use an adaptor from 25-contact to 9-contact that is commercially available, as the pin assignment of the ESHS is in accordance with the standard. The following table contains the pin assignment of the serial RS-232C-interface:

Table 3-11

Pin	Signal	I/O	Meaning
2	RxD	I	Received Data: transmits ASCII data from the computer to the receiver
3	TxD	O	Transmitted Data: transmits ASCII data to the computer
4	$\overline{DSR}$	I	Data Set Ready
5	$\overline{DTR}$	O	Data Terminal Ready
6	$\overline{RTS}$	O	Request To Send:
8	DCD	I	Carrier Detect
20	CTS	O	Clear To Send

3.2.6.5.2 Serial Bus

(Currently not used)

The device-internal bus, which is also used for control of the modules of the instrument, is brought out for control of accessories. The bus has a high impedance when it is not selected (tri-state output). The word length is a multiple of 8 bit (= 1 byte). The address of the device to be controlled is transmitted as the last byte.

Table 3-12

Pin	Signal	I/O	Meaning
9	SCLK	O	Clock for serial bus (Clock rate 4 MHz)
10	TDATA	O	Data line of serial bus (4 MHz)
12	DGND		Digital Ground
21	$\overline{Strobe}$	O	Control signal for transfer of data to a register (Active Low)

3.2.6.5.3 TTL-I/O-Lines

Six port lines are provided for the control of the Artificial Mains Networks ESH2-Z5 and ESH3-Z6. Thus the phases and the reference ground are switched over. The level corresponds to that of the TTL-logic (low < 0.4 V, high > 2.0 V).

Table 3-13

Pin	Signal	I/O	Meaning
12	DGND		Digital Ground
14	PORT 1	O	User Port Data 1
15	PORT 2	O	User Port Data 2
16	PORT 3	O	User Port Data 3
17	PORT 4	O	User Port Data 4
18	PORT 5	O	User Port Data 5
19	PORT 6	O	User Port Data 6

3.2.6.5.4 Trigger Input

The trigger input (USER PORT, pin 1) allows to start measurements depending on an external event. This input is activated using the special functions 51 and 52 (cf. section 3.2.3.13). The input is triggered by edges and requires TTL-level (low < 0.4 V, high > 2.0 V).

3.2.6.5.5 Analog Voltages

There are two outputs (REC1 and REC2) available for logging the analog display voltage using a YT-recorder or for observing the shape of the display voltage using an oscilloscope. Both outputs provide the analog display voltage. The output REC2 contains a low-pass with the time constant 160 ms, which corresponds to the meter time constant according to CISPR 16. The outputs provide a voltage which is dB-linear and feature the scaling 50 mV/dB in the 60-dB operating range and 100 mV/dB in the 30-dB operating range. Full scale deflection on the display instrument corresponds to a voltage of 3.75 V at the analog outputs (pin assignment cf. figure 3-29).

3.2.6.5.6 Supply voltages

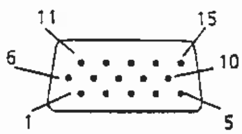
For supplying external devices with low current consumption, the device-internal supply voltages +5 V (5.0 V to 5.5 V) and + 12 V (10.8 to 15 V) are brought out. The current-carrying capacity is 100 mA for both outputs. The receiver automatically switches off in the case of a short-circuit.

Table 3-14

Pin	Signal	Meaning
13	+5V	5-V supply
24	AGND	Analog ground
25	+12V	12-V supply

3.2.6.6 Printer Interface

The 15-contact socket PRINTER INTERFACE at the rear panel of the receiver is provided for connecting a printer. The interface is compatible with the CENTRONICS-interface. A special cable can be supplied for connecting the interface to the printer (EZ11-type, cf. Specifications, Recommended Accessories):

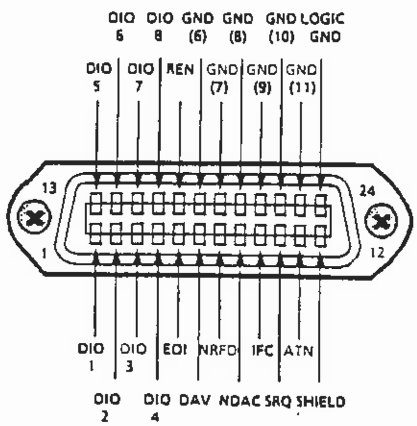


Pin	Signal	I / O	Meaning
1	$\overline{PRISTB}$	O	Pulse for transmitting a data byte
2	PRIDAT2	O	Data line 2
3	PRIDAT5	O	Data line 5
4	$\overline{PRIACK}$	I	Indicates that the printer is ready for reception of the next byte
5	PRISEL	I	The printer supplies HIGH, when it is selected
6	PRIDAT0	O	Data line 0
7	PRIDAT3	O	Data line 3
8	PRIDAT6	O	Data line 6
9	$\overline{PRIBUSY}$	I	Signal HIGH, when the printer is busy
10	PRIRES	O	Initialization of the printer (active LOW)
11	PRIDAT1	O	Data line 1
12	PRIDAT4	O	Data line 4
13	PRIDAT7	O	Data line 7
14	AGND		Analog Ground
15	$\overline{PRIFAU}$	I	Fault of printer (active Low)

Bild 3-30 Pin assignment of the Printer Interface

3.2.6.7 IEC-Bus

The ESHS is equipped with a remote control interface according to the standard IEC 625. It is connected to the socket at the rear panel of the instrument.



Pin	Signal	Pin	Signal
1	Data I/O1	13	Data I/O5
2	Data I/O2	14	Data I/O6
3	Data I/O3	15	Data I/O7
4	Data I/O4	16	Data I/O8
5	EOI	17	REN
6	DAV	18	Ground
7	NRFD	19	Ground
8	NDAC	20	Ground
9	IFC	21	Ground
10	SRQ	22	Ground
11	ATN	23	Ground
12	Shield	24	Logic Ground

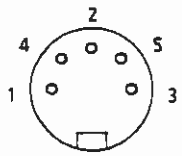
Fig. 3-31 Pin assignment of the IEC-bus socket

The characteristics of the interface can be learnt from the IEC-standard. The interface functions and setting commands are described in section 3.3.

Note: *In order to achieve a long operating time per battery charge, the IEC-bus interface is switched off during operation with internal battery. If remote control via IEC-bus is desired with battery operation, it can be switched on using the Special Function 11 (cf. section 3.2.3.13).*

3.2.6.8 Connecting a Keyboard

A 5-contact DIN*-socket is provided for connecting a keyboard. Due to its low emitted interference it is recommended to use the keyboard PSA-Z1 (order no. 1009.5001.31). It is however also possible to use any other MF keyboard.



Pin	Signal
1	Keyboard Clock
2	Data
3	free
4	ground
5	+ 5-V supply

Fig. 3-32 Assignment of the KEYBOARD socket

*) German Industrial Standard

3.3 Remote Control (IEC-Bus)

The test receiver ESHS features an IEC-bus device as standard equipment. The interface complies with the standards IEEE 488.1 and IEC 625-1. The ESHS furthermore considers the standard "IEEE Standard Codes, Formats, Protocols, and Common Commands ANSI/IEEE Std 488.2 - 1987" also approved of by the IEC commission. The standard IEEE 488.2 describes common commands, data transfer formats, terminator definitions, protocols of passing control. Program examples in R&S-BASIC can be found in section 3.5.

The IEC-bus connection socket is situated on the rear panel of the ESHS. It is a 24-contact Amphenol connector complying with the IEEE 488 standard (cf. section 3.2.6.7). The interface contains three groups of bus lines:

1. **Data bus with the 8 lines DIO1 to DIO8**
   Data transmission is bit-parallel and byte-serial with the characters in ISO 7-bit code (ASCII-code), cf. table 3-18.

2. **Control bus with 5 lines**

   ATN (Attention)
   becomes active Low when addresses, universal commands or addressed commands are transmitted to the connected devices.

   REN (Remote Enable)
   enables the device to be switched to the remote status.

   SRQ (Service Request)
   enables a connected device to send a Service Request to the controller by activating this line.

   IFC (Interface Clear)
   can be activated by the controller in order to set the IEC interfaces of the connected devices to a defined status.

   EOI (End or Identify)
   can be used to identify the end of data transfer and is used with a parallel poll.

3. **Handshake bus with 3 lines**
   It is used to control the data transfer timing via the IEC-bus.

   NRFD (Not Ready For Data)
   an active Low on this line signals to the talker/controller that at least one of the connected devices is not ready to accept data present on the data bus.

   DAV (Data Valid)
   is activated by the talker/controller shortly after a new data byte has been applied to the bus and signals that this data byte is valid.

   NDAC (Not Data Accepted)
   is held at active Low until the connected devices have accepted the data byte present on the bus.

According to the IEC 625-1 standard, devices controlled via the IEC bus can be equipped with different interface functions. The following interface functions are applicable to the ESHS:

Table 3-15 Interface functions

Control characters	Interface functions
SH1	Source Handshake function, full capability
AH1	Acceptor Handshake, full capability
L4	Listener function, full capability, unaddress if MTA
T6	Talker function, full capability, unaddress if MLA
SR 1	Service Request function, full capability
PP1	Parallel Poll function, full capability
RL1	Remote/Local switchover function, full capability
DC1	Device Clear function, full capability
DT1	Device Trigger function, full capability
C1 C2 C3 C11	Controller function, (system controller) transmits IFC transmits REN takes and passes control

3.3.1 Setting the Device Address

The IEC-bus address of the receiver is set in the SETUP menu (cf. section 3.2.4.2.1). The address can be entered using the numeric keys in the range from 0 to 30 and remains stored in the non-volatile memory when the test receiver is switched off. The ESHS is set to address 17 (upon delivery, cold start or firmware update).

The controller uses the IEC-bus address to address the ESHS as IEC-bus talker or -listener. "Talk Only" is not provided in the case of the ESHS.

3.3.2 Local / Remote Switchover

The ESHS is always in the "Local" state at turn-on (manual operation). If the ESHS is addressed as Listener by a controller (e.g. using the R&S-BASIC commands "IECOUT" or "IECLAD"), the test receiver enters the Remote state and remains in this state after data transfer has been completed. This is indicated ty the "REMOTE" LED on the front panel.

Note: *If the ESHS is supplied via internal battery, the IEC bus is switched off following switch-on to reduce power consumption. The IEC bus can be switched on at any time using special function 11.*

In this mode the receiver cannot be operated manually via the front panel. Rotary knob and keys (with the exception of the "LOCAL" key) are disabled, no menu is displayed. There are two methods to return to the LOCAL state:

- by the addressed command "Go To Local" (GTL) from the controller.
- by pressing the LOCAL key.
  Data output from the controller to the ESHS should be stopped before by pressing the LOCAL key, as otherwise the ESHS will immediately enter the Remote state again. The LOCAL key can be disabled by the universal command Local Lockout (LLO) sent by the controller in order to prevent undesired switchover to the Local state. Returning to local mode is possible by way of GTL. The Local Lockout function is again effective when re-entering the Remote state. Activation of the Remote Enable line (REN) by the controller definitely renders LLO ineffective. In R&S-BASIC a combination of the commands IECNREN and IECREN, for example, may be used.

3.3.3 Interface Messages

This group of messages are transmitted to a device via the eight data lines by the controller where the ATN-line is active, i.e low. Only active controllers are able to transmit interface messages. Differentiation is made between universal commands and addressed commands.

3.3.3.1 Universal Commands

Universal commands act, without previous addressing, on all devices connected to the IEC-bus.

Table 3-16 Universal commands

Command	Basic command with R&S contollers	Function
DCL (Device Clear)	IECDCL	Aborts processing of the currently received commands and sets the command processing software to a defined initial status. This command does not affect the device settings.
LLO (Local Lockout)	IECLLO	The LOCAL key is disabled.
SPE (Serial Poll Enable)	IECSPE	Ready for serial poll.
SPD (Serial Poll Disable)	IECSPD	End of serial poll.

3.3.3.2 Addressed Commands

The addressed commands act only on those devices previously addressed as listeners by the controller (e.g. R&S-BASIC command "IECLAD").

Table 3-17 Addressed commands

Command	Basic command with R&S contollers	Function
SDC (Selected Device Clear)	IECSDC	Aborts processing of the currently received commands and sets the command processing software to a defined initial status. This command does not affect the device settings.
GTL (Go to Local)	IECGTL	Change to Local state (manual operation)
GET (Group Execute Trigger)	IECGET	Start of level measurement

A device is addressed as listener until it is unaddressed by the controller (R&S-BASIC command: IECUNL).

Table 3-18 ASCII/ISO- and IEC-character set

Control characters						Numbers and special characters				Upper-case letters				Lower-case letters			
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	GTL	17	DC1	LLO	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	_	111	o	127	DEL
Addressed commands			Universal commands			Listener addresses				Talker addresses				Secondary addresses and commands			

Code for control characters:

9	HT	TCT

e. g. 9 / HT / TCT

- TCT — Interface message ("Take Control")
- HT — ASCII character ("Horizontal Tab")
- 9 — Decimal

3.3.4 Device Messages

Device messages (acc. to IEC 625-1) are transmitted via data lines, in which case the ATN line is not active, i.e. High. The ASCII code (ISO 7-bit code) is used. A differentiation is made between:

- Device-independent commands (common commands acc. to IEC 625, cf. section 3.3.4.3)
- Device-specific commands (cf. section 3.3.4.4)

Commands with a "?", such as FREQUENCY? are referred to as "query messages" and request the ESHS to output the respective value where the same format is used as in the command table. The data and values read in by the controller can thus be directly returned to the ESHS. In this example the output of the test receiver may be "FREQUENCY 9000" where the basic unit (here: Hz) is always valid.

3.3.4.1 Commands Received by the Test Receiver in Listener Mode (Controller to Device Messages)

Input buffer:

All the commands and data sent to the receiver are stored temporarily in the 4096-byte input buffer. It is however also possible to process longer command lines in which case the part received before is processed internally in the receiver.

Terminators:

Each command line must be ended by a terminator (exception: continued command lines). Permissible terminators are:

- <New Line> (ASCII-Code 10 decimal)
- <End> (EOI line active) together with the last character of the command line or the character <New Line>.

The terminator is set using the device-specific commands TERMINATOR LFEOI - <New Line> together with <EOI> - and TERMINATOR EOI - only <EOI> for transmission of binary data blocks (cf. section 3.3.4.4).

As the character <Carriage Return> (ASCII code 13 decimal) is permissible as a filler without effect before the terminator, the combination of <Carriage Return> and <New Line> that is for example sent by the R&S-Controller PCA is also permissible.

All IEC-bus controllers from Rohde & Schwarz send terminators accepted by the test receiver as standard. A command line may require more than one line on the controller screen since it is only limited by the terminator. Most IEC-bus controllers add automatically the terminator to the data transmitted.

Separators:

A command line may contain several commands (program message units) when separated from each other by a semicolon (;).

Command Syntax:

A command may consist of the following parts:

- Only a header
  Example: `*RST`
- Combination of headers
  Example: `CALIBRATION:SHORT`
- Header and question mark ("query")
  Example: `UNIT?`

  These commands request the test receiver to transfer the desired data to its output buffer. These data can be read in by the controller as soon as the device will be addressed as a talker.

- Header and numeric value
  Examples: `MEAS:TIME 50 MS`
  `FREQUENCY 1.045E2`

  According to the IEC-bus standard IEEE 488.2, the header and numeric value must be separated at least by one space (ASCII code 32 decimal). In the case of device-specific commands, the number can be supplemented by a unit (e.g. "MHz", "S", etc.):

- Header and mnemonic
  Example: `DETECTOR AVERAGE`
- Header and string
  Example: `LIMIT:TEXT 'VFG 1046'`
  or `LIMIT:TEXT "VFG 1046"`
  The two different types of notation allow to use them in different programming languages without any difficulties. The character ' is preferably used in R&S-BASIC.

The headers and their meanings are explained in section 3.3.4.4. Lower-case letters are equivalent to upper-case letters. Thus units can be used in the usual form, e.g. dBm instead of the notation using upper-case letters "DBM".

The IEC-bus syntax makes it possible to insert additional spaces at the following points:

- at the beginning of a header
- between header and numeric value, mnemonic or string
- between numeric value and unit
- before and after commas (,) and semicolons (;)
- before the terminator.

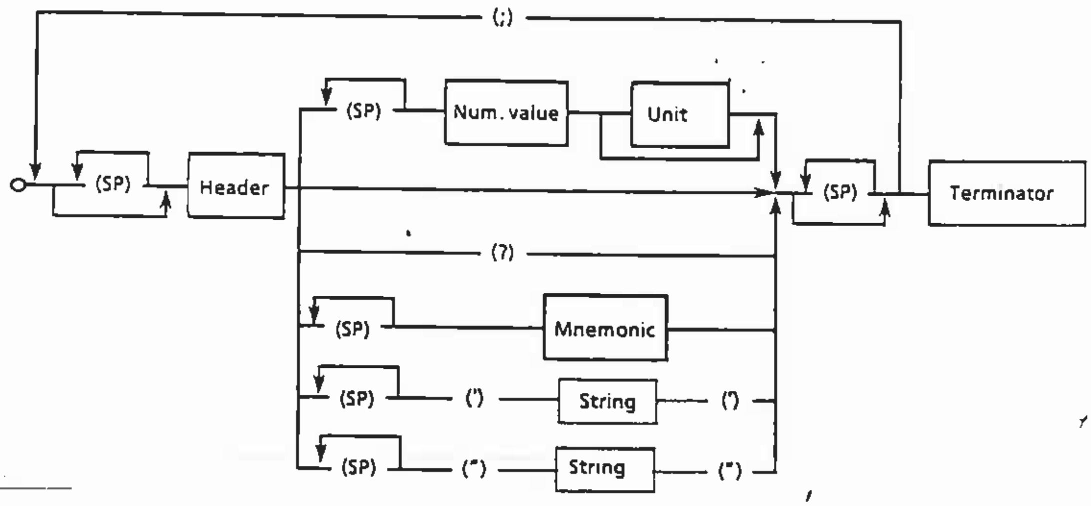
Numeric values:

Only decimal numbers are allowed as numeric values, the following notations are permissible:

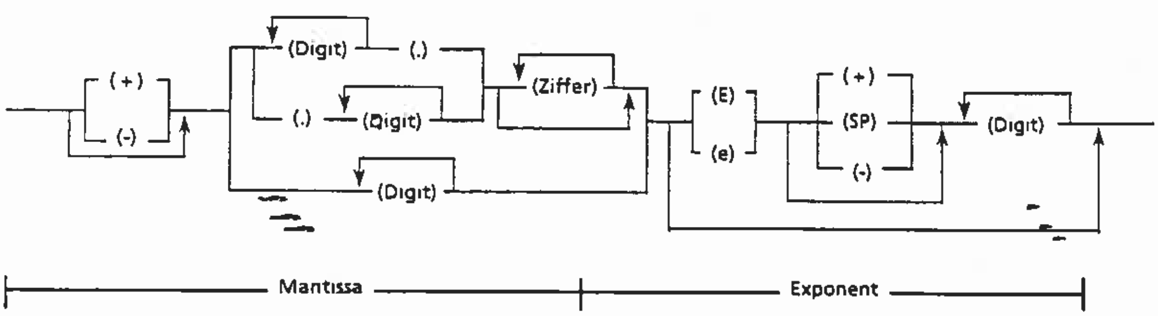
- With and without sign
  Example: `10, +10, -10`
- With and without decimal point, any position of the decimal point is permissible.
  Example: `1.234     -200.5     .123`

- With or without exponent to base 10, "E" or "e" can be used as the exponent character.
  Example: `451`   `451E-3`   `+4.51e-2`
- The exponent is permissible with or without a sign, a space is also permissible instead of the sign
  Example: `1.5E+3`   `1.5e-3`   `1.5E 3`
- Specification of the exponent only (e.g. E-3) is not permissible, 1E-3 is correct.
- Leading zeros are permissible in the mantissa and exponent.
  Example: `+0001.5`   `-03.7E-03`
- The length of the numeric value, including the exponent, may be up to 20 characters. The number of digits for the mantissa and exponent is only limited by this condition. Digits that exceed the resolution of the device are rounded up or down; they are, however, always considered for the order of magnitude.

Command line



Numeric value



SP: Any character with ASCII code 0 to 9 and 11 to 32 decimal, especially space.

Fig. 3-34 Syntax diagram of a command line

3.3.4.2 Messages Sent by the Test Receiver in Talker Mode (Device to Controller Messages)

The ESHS sends messages via the IEC-bus, if it

- has been requested to make data available in its output buffer by one or more query messages with a question mark within one command line,
- indicates by setting bit 4 in the status byte (Message Available) that the requested data are now available in the output buffer,
- has been addressed as a talker (e.g. by the R&S-BASIC command "IECIN").

It is necessary for the command line with the data requests to be transmitted directly before talker addressing; if another command line is present in between, the output buffer is cleared and bit 2 in the event status register is set (query error; cf. section 3.3.5).

The output buffer has a capacity of 4096 byte.

A query message is formed by adding a question mark to the respective header, e.g. FREQUENCY?.

If the ESHS is addressed as a talker directly after the query message, the bus handshake is disabled until the requested data are available. This may take several seconds since e.g. with *CAL? a calibration is performed before addressing. In this case it is more useful to wait for the MAV-bit (cf. section 3.3.5).

The syntax for data output is exactly the same as for commands received by the ESHS. <New Line> together with END (EOI active) is always used as terminator. The transmission of header and numeric value enables the messages sent by the ESHS as a talker to be returned unchanged from the controller to the test receiver. Thus a setting performed via the front panel can be read, stored in the controller and returned later to the receiver via the IEC-bus.

Notes:

If the ESHS receives several query messages, it also returns several messages within one line separated by semicolons (;).

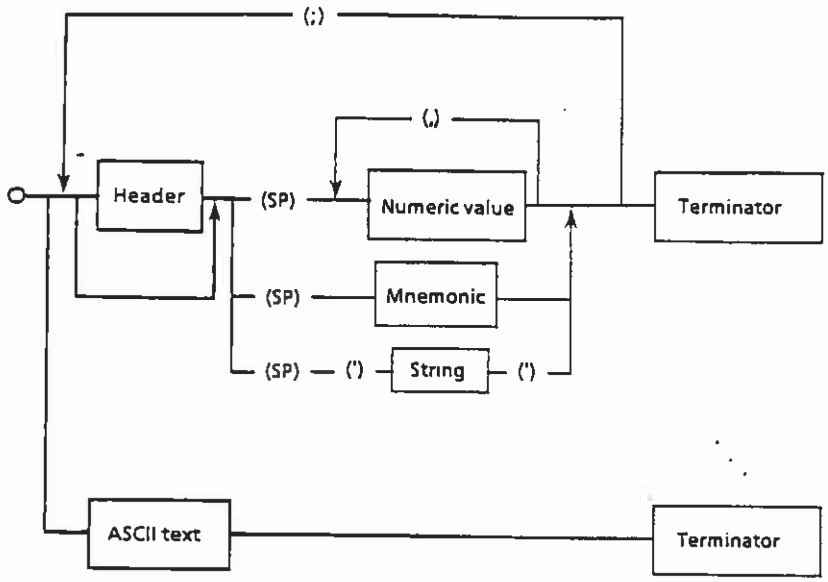
Several numeric values (day, month and year) can be sent as a reply to certain query messages (e.g. SYSTEM:DATE?). They are separated by commas (,).

Header and numeric values are always separated by spaces. Headers only consist of upper-case letters and the characters ":" "_" and "".*

The messages sent by the ESHS do not contain units. In the case of physical variables, the numeric values are referred to the basic unit (cf. section 3.3.4.4).

Output of the header can be switched on or off using the commands "HEADER ON" and "HEADER OFF".

Output message line



Numeric value

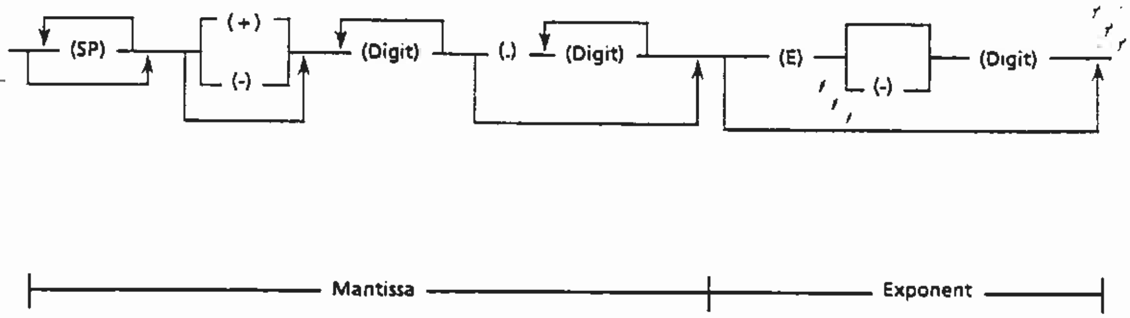


Fig. 3-35 Syntax diagram of messages sent by the receiver

3.3.4.3 Common Commands

The common, device-independent commands are grouped as follows:

- Commands referring to the Service Request function with the associated status and mask registers
- Commands for device identification
- Commands referring to the Parallel Poll function
- Commands for triggering sequences
- Commands for device-internal sequences (reset, calibrate, self-test) and for synchronizing sequences.

The common commands are taken from the new IEEE488.2 (IEC 625-2) standard. This ensures that these commands have the same effect in different devices. The headers of these commands consist of an asterisk "*" followed by three letters.

Table 3-19 Device-independent commands (common commands) received by the ESHS

Command	Numeric value/ Range	Meaning
*RST	---	**Reset** The receiver is set to its default status as it is possible with RCL 0 on the front panel. This command does not change the status of the IEC-bus interface, the set IEC-bus address, the mask registers of the Service Request function and the output buffer.
*PSC	0 to 65535	**Power On Status Clear** (reset on power-up) If the numeric value is higher than 0, the Service Request Enable mask register (SRE) and the Event Status Enable mask register (ESE) are cleared during power-up. If the value is equal to 0, the registers mentioned above retain their contents when the device is switched on and off. Bit 7 in the Event Status register is set when switching on the test receiver. If the Event Status and Service Request Enable register have the appropriate configuration prior to switch-off, a Service Request may be enabled (cf. section 3.3.5).
*OPC	—	**Operation Complete** (ready-signal) Sets bit 0 (Operation Complete) in the Event Status register (ESR), if all previous commands have been processed.
*CLS	—	**Clear Status.** Sets the status registers ESR and STB to zero. The mask registers of the Service Request function (ESE and SRE) are not changed. This command does not change the status of the IEC-bus interface, the set IEC-bus address, the mask registers of the Service Request function and the output buffer
*ESE	0 to 255	**Event Status Enable** The Event Status Enable mask register is set to the specified value which is interpreted as a decimal number (see section 3.3.5)

Command	Numeric value /Range	Meaning
*SRE	0 to 255	**Service Request Enable** The Service Request Enable mask register is set to the specified value which is interpreted as a decimal number (cf. section 3.3.5).
*PRE	0 to 65535	**Parallel Poll Enable** The Parallel Poll Enable mask register is set to the specified value which is interpreted as a decimal number.
*PCB	0 to 30	**Pass Control Back** The numeric value specifies the address of the controller to which the IEC-bus contol is to be returned after completion of the plotter output.
*TRG	—	**Trigger** Level measurement of the ESHS is re-started, a current measurement is aborted. This command has the same function as the message GET. Measurement values are however not made available for output as the IEC-bus standard permits output only following a query command. The device-specific commands are provided for this purpose: • LEVEL:LASTVALUE? the value of the last level measurement, which was triggered by e.g. *TRG, is made available in the output buffer. • LEVEL? level measurement is started and the measured value is subsequently made available in the output buffer. • LEVEL:CONTINUE? the value of the last level measurement is made available in the output buffer and a new level measurement is started. Same function as a sequence consisting of the commands LEVEL:LASTVALUE? and *TRG.
*RCL	0 to 15	**Recall** Recalls a stored device setting (1 to 10) or a report configuration (11 to 15). *RCL 0 sets the ESHS to its default status analog to the command *RST. The command has the same function as the RCL key.
*SAV	1 to 15	**Save** Saves a current device settingor a report configuration. Same function as the SAVE key.
*WAI	—	**Wait To Continue** Only processes the subsequent commands when all previous commands have been completely executed (cf. section 3.3.7).

Table 3-20 Common Commands leading to data output

Command	Output message Data value		Meaning
	No. of digits	Range	
*IDN?	28	alphanumeric	**Identification Query** The following identification text is sent via the IEC-bus as a reply to the *IDN? command (always without header). **Example:** Rohde&Schwarz, ESHS10,0,1.00 Rohde&Schwarz = Manufacturer ESHS10 = Model 0 = reserved for serial number, (not used with ESHS) 1.00 = Firmware version (for example)
*PSC?	1	0 or 1	**Power On Status Clear Query** Reading the status of the Power On Clear flag (cf. *PSC)
*OPC?	1	0 or 1	Operation **Complete Query** (ready message) The message "1" is entered into the output buffer and bit 4 (message available) is set in the status byte when all previous commands have been completely executed. Bit 0 (operation complete) is also set in the Event Status register (cf. section 3.3.7).
*ESR?	1 to 3	0 to 255	**Event Status** Register Query The contents of the Event Status register is output in decimal form and the register then set to zero.
*ESE?	1 to 3	0 to 255	**Event Status Enable Query** The contents of the Event Status Enable mask register is output in decimal form.
*STB?	1 to 3	0 to 255	**Status Byte** Query The contents of the status byte is output in decimal form.
*SRE?	1 to 3	0 to 63 and 128 to 191	**Service Request Enable Query** The contents of the Service Request Enable mask register is output in decimal form. The gap in the range of values results from the fact that bit 6 (rsv) cannot be set. The value results from ORing of the other bits (cf. fig. 3-47).
*TST?	1 to 3	0 to 255	**Self-Test Query** A device self-test is executed. The output value "0" indicates proper termination of the self-test. Values > "0" signal faults in the respective module(s).
*IST?	1	s. Tab. 3-2	**Individual Status Query** Reads the current device status (Parallel Poll message to IEEE488.1). "0" means the current status is FALSE, "1" means TRUE.
*PRE?	1 to 3	0 to 255	**Parallel Poll Enable Query** The contents of the Parallel Poll register is output in decimal form.
*STB?	1 to 3	0 to 255	**Status Byte Query** The contents of the status byte is output in decimal form.
*CAL?	1 to 2	s. Tab. 3-21	**Calibration Query** The receiver is calibrated. If the calibration is completed successfully, "0" is output as a reply; otherwise a number between 25 and 167 the meaning of which can be learnt from table 3-21 is output. The commands "CALIBRATION:SHORT" or "CALIBRATION:TOTAL" serve to select the calibration to be performed (the commands however do not trigger a calibration!).

Table 3-21 Meaning of the Error Messages during Calibration

Output value	Meaning
25	The gain at the reference frequency 1 MHz cannot be controlled.
37	The gain with the 200-Hz IF-bandwidth is out of tolerance.
65	The IF-gain switch is defective, so that its gain error cannot be corrected anymore.
81	The 30-dB operating range is defective and can no longer be used.
83	The 60-dB operating range is defective.
97	The correction value for the bandwidth in the indicating mode Pk/MHz is out of tolerance.
103	Quasipeak weighting in band A is defective.
105	Quasipeak weighting in band B is defective.
	A filter range of the pre-selection is defective; frequency response with the respective frequency is more than 6 dB:
129	100 kHz
131	200 kHz
133	2 MHz
135	4 MHz
137	4.1 MHz
139	6.2 MHz
141	8.4 MHz
143	9.6 MHz
145	12.7 MHz
147	12.8 MHz
149	15 MHz
151	17.2 MHz
153	19.4 MHz
155	21.5 MHz
157	21.6 MHz
161	23.7 MHz
163	25.8 MHz
165	27.9 MHz
167	30 MHz

Note: Warnings are not considered and result in the return value 0.

A more detailed description of the error messages can be found in section 3.2.3.12.3 Error Messages during Calibration.

Table 3-22 Meaning of the Return Values of the Self-test

Value	Meaning
0	The self-test was completed without any error
1	+ 5-V-supply voltage out of tolerance
2	+ 10-V-supply voltage out of tolerance
3	-10-V-supply voltage out of tolerance
4	+ 28-supply voltage out of tolerance
15	Any other defect of the module CPU-board
18	Component of the real-time clock is defective
19	Serial bus is defective
45	FRN Synthesizer is defective
46	HF Synthesizer is defective
47	IF Amplifier is defective
110	HF Module is defective
111	Detector board is defective

3.3.4.4 Device-specific Commands

The query messages are identified by an added "?". They enable the ESHS to transmit device settings or measured values to the controller. The structure of the data output format is the same as that of data input thus making it possible that the data read by the controller can be returned to the test receiver without further processing in the controller. If no unit is stated, the respective basic unit is used (Hz, s, dB, %).The used syntax is in accordance with the new standard "IEEE 488.2" that has been valid since 11/87. Program examples concerning IEC-bus programming are stated in section 3.5.

Note: *When reading the data in the controller please do make sure that the settings of the terminators are correct. The R&S-BASIC command for ASCII-texts is IEC TERM 10; for binary data IEC TERM 1.*

Some headers can be abbreviated. The shortest possible notation is marked by bold letters in the tables 3-23 to 3-27

Table 3-23 Receiver Functions

Command	Data	Unit	Meaning
ATTENUATION **A**TTENUATION?	0 to 120 dB **I**NCREMENT **D**ECREMENT	**D**B	RF-attenuation
:**A**UTO :**A**UTO?	**ON** **OF**F	—	Auto-range on off
:**M**ODE :**M**ODE?	**LOWN**OISE **LOWD**ISTORTION	—	Attenuation mode
:**Z**SD?	—		Zero Scale Deflection
BANDWIDTH:**I**F :**I**F?	200 Hz to 10 kHz	**H**Z **K**HZ **M**HZ **G**HZ	IF-bandwidth of the receiver
CALIBRATION:**S**HORT :**T**OTAL	— —	— —	Short calibration Configure total calibration (cf. *CAL? table 3-20)
:**C**ORRECTION	**ON** **OF**F	—	Considering the calibration correction values during level measurement on/off
DEMODULATION **DEM**ODULATION?	**A3** **A0** **OF**F	—	Demodulation mode
DETECTOR **DET**ECTOR?	**A**VERAGE **PE**AK **Q**UASIPEAK **PEAKM**HZ	—	Weighting mode (Detector)

Command	Data	Unit	Meaning
FREQUENCY FREQUENCY?	9 kHz to 30 MHz	HZ KHZ MHZ GHZ	Receiver frequency
	INCREMENT DECREMENT		Step up Step down
:STEPSIZE :STEPSIZE?	0 Hz to 30 MHz	HZ KHZ MHZ GHZ	Step size of frequency variation
:VARIATION :VARIATION?	STEP COARSE FINE LOCK	—	Step size of frequency variation using rotary knob
LEVEL?	—	—	Starting a level measurement and making the measured value available
:CONTINUE?	—	—	Making the value of the last level measurement available in the output buffer and starting a new measurement.
:LASTVALUE?	—	—	Making the value of the last level measurement available in the output buffer.
:FORMAT :FORMAT?	ASCII BINARY	—	Measured value output with ASCII characters. Measured value output in binary format.
MEASUREMENT:TIME MEASUREMENT:TIME?	1 ms to 100 s	S MS	Measuring time
PREAMPLIFIER PREAMPLIFIER?	ON OFF	—	Preamplifier on/off
RANGE RANGE?	30 dB 60 dB	DB	Operating range
SPECIALFUNC SPECIALFUNC?	Number, ON/OFF (,Number, ON/OFF...)	—	Special functions:
	0		Default setting
	1		CISPR-bandwidths
	2		Coupled measuring times
	10		Background lighting
	12		Coding socket
	13		Beeper
	16		Limit check
	17		Transducer check
	18		Transducer switch
	20		Unit dBm
			Double measurement modes:
	30		Peak + AV
	31		Peak + Pk/MHz
	32		Peak + Quasi Peak
	33		Quasi Peak + AV
	51		External trigger positive edge
	52		External trigger negative edge
UNIT?	—	—	Polling the level unit

Table 3-24 RF-analysis

Command	Data	Unit	Meaning
GRID:FREQAXIS GRID:FREQAXIS?	LIN LOG	—	Pitch of axes of the diagram of RF-analysis
:MINLEVEL :MINLEVEL?	-200 to +200	DB	Minimum level of the diagram of RF-analysis
:MAXLEVEL :MAXLEVEL?	-200 to +200	DB	Maximum level of the diagram of RF-analysis
LIMIT LIMIT?	1 to 22 [,ON] 1 to 22 [,OFF]	—	Selecting and switching on or off limit lines
:TEXT :TEXT?	"ASCII text" max. 8 characters	—	Name of limit line
:DEFINE :DEFINE?	Number, Frequency 1, level 1, Frequency 2, level 2,...	HZ KHZ MHZ GHZ DB	Definition of limit line by frequency-level pairs in increasing order
:VALUE?	n[,limit 1[,limit 2]] n: number of limit lines, 0 to 2 limit 1: 1st limit limit 2: 2nd limit	DB	Output of interpolated intermediate values at the current receiver frequency. The value 0 is returned if no limit lines have been switched on.
SCAN SCAN?	1 to 5	—	Selection of a partial scan
:RUN			Starting a scan
:INTERRUPT			Interrupting a scan
:CONTINUE			Continuing an interrupted scan
:STOP			Stopping a scan
:RANGES :RANGES?	1 to 5	—	Number of scans to be executed
:FREQUENCY:START :START?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Start frequency of partial scan
:STOP :STOP?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Stop frequency of partial scan
:STEPMODE :STEPMODE?	LIN LOG	—	Type of step size, the same for all partial scans
:STEPSIZE :STEPSIZE?	0 to 30 MHz 0 to 100 %	HZ, KHZ, MHZ, GHZ PCT	Step size, in Hz for linear steps, in % for logarithmic frequency switching
:SAVE		—	The scan settings for the start and stop frequency as well as the step size are adopted and checked whether they are consistent using this command. Error messages refer to the previous settings for the partial scan ranges.
:RECEIVER:MEASUREMENT:TIME :MEASUREMENT:TIME?	1 ms to 100 s	S MS	Measuring time per measured value of partial scan
:DETECTOR :DETECTOR?	AVERAGE PEAK QUASIPEAK PEAKMHz	—	Weighting mode for partial scan

Command	Data	Unit	Meaning
:BANDWIDTH:IF :BANDWIDTH:IF?	200 Hz to 10 kHz	HZ, KHZ, MHZ, GHZ	IF-bandwidth for partial scan
:ATTENUATION :ATTENUATION?	0 to 120 dB	DB	RF-attenuation for partial scan (manual)
:ATTENUATION:AUTO :ATTENUATION:AUTO?	ON OFF	—	Auto-range on/off
:ATTENUATION:MODE :ATTENUATION:MODE?	LOWNOISE LOWDISTORTION	—	IF-attenuation for partial scan
:RANGE :RANGE?	30 dB, 60 dB	DB	Operating range
:PREAMPLIFIER :PREAMPLIFIER?	ON OFF	— —	Preamplifier for partial scan
:DEMODULATION :DEMODULATION?	A3, A0, OFF		Demodulation for partial scan
SCAN:OPTION			Special functions of RF-analysis
:SUBRANGES :SUBRANGES?	8 16 25 50 100 200 400	—	Number of subranges
:MARGIN :MARGIN?	-200 to 200 dB	DB	Margin from acceptance line to limit line
:GATEDSCAN :GATEDSCAN?	ON OFF		Option Gated Scan
:SPECIALSCAN :SPECIALSCAN?	ON OFF		Switching on/off the option Special Scan.
:STYLE :STYLE?	CURVE LINE	—	The measurement curves can be represented either in the form of a closed curve (CURVE) or vertical lines (LINE).
:MAXLEVEL	-200 to 200 dB	DB	Maximum level of the RF analysis diagram
:MAXLEVEL ?	-200 to 200 dB	DB	Minimum level of the RF analysis diagram
:MINLEVEL :MINLEVEL? :MAXFREQ :MAXFREQ?	Receiver frequency range	HZ, KHZ; MHZ, GHZ	Maximum frequency of the RF analysis diagram
:MIN FREQ :MIN FREQ?	Receiver frequency range	HZ, KHZ; MHZ, GHZ	Minimum frequency of the RF analysis diagram
:FREQUENCIES :FREQUENCIES?	Number, Frequency1, Frequency2, ...,	HZ, KHZ; MHZ, GHZ	Frequency values for the option Special Scan; max. 400 values in increasing sequence

Command	Data	Unit	Meaning
:REPETITIVE :REPETITIVE?	OFF MAXHOLD CLRWRITE MAXCLR	—	Operating mode "Repetitive Scan" Storage of the maximal values Overwriting of previous measured values Clr/Write + Maxhold
SCAN:BLOCK?		—	Output of the scan results in the form of blocks (cf. section 3.3.8 and 3.5)
:COUNT :COUNT?	Number	—	Number of the measured values that are transmitted in a block (the max. number depends on the structure of the data). The value 0 means: measured value output during scan is switched off.
	MAX MAX?		The output buffer is used to its maximum. Max. number of block elements.
	SUBRANGE		All the measured values of a subrange are combined to form a block, if the size of the output buffer is sufficient.
:FORMAT :FORMAT?	ASCII BINARY DUMP SDUMP	—	Output format for scan results (cf. section 3.3.8.)
:SIZE?	—		Size of a block element when the measured values are output in the form of bytes (this size is variable for output in ASCII format)
:TEMPLATE?	—		Composition of the individual components of a block element (see chapter 3.3.8).
:RESULTS	–	—	Using this command, scan results can be output at a later date. This command sets the appropriate bits in the ERD register, however does not make available the data in the output buffer.
:CLEAR	—	—	Clearing the memory with measured values

Table 3-25 Transducer

Command	Data	Unit	Meaning
TRANSDUCER	OFF	—	Switching off consideration of transducer factors
:FACTOR :FACTOR?	1 to 22		Selecting a transducer factor
:TEXT :TEXT?	"ASCII text" max. 8 characters		Name of transducer
:DEFINE :DEFINE?	Number Frequency 1, level 1, Frequency 2, level 2, ...	HZ, KHZ, MHZ, GHZ, DB	Definition of transducer factors by frequency-level pairs in increasing order
:VALUE?		—	Output of the interpolated intermediate value at the current receiver frequency
:SELECT :SELECT?	1 to 22		Activating a transducer factor
:UNIT :UNIT?	DB, DBUV, DBUV_M, DBUA DBUA_M, DBPW		Unit of transducer factor
:SET	1 to 5	—	Selecting a transducer set
:SET:SELECT :SET:SELECT?	1 to 5, NONE		Activating a transducer set
:RANGES :RANGES?	1 to 5		Number of ranges of a transducer set
:NUMBER :NUMBER?	1 to 5		Selecting a transducer set range
:START :START?	9 kHz to 30 MHz	HZ, KHZ, MHZ, GHZ	Start freqeuncy of the selected transducer set range
:STOP :STOP?	9 kHz to 30 MHz	HZ, KHZ, MHZ, GHZ	Stop freqeuncy of the selected transducer set range
:DEFINE :DEFINE?	Number, factor1, factor2, ...	—	Selecting the transducer factors that are combined in a transducer set range.
:UNIT :UNIT?	DB, DBUV, DBUV-M, DBUA DBUA-M, DBPW	—	Unit of the transducer set
:TEXT :TEXT?	"ASCII-text" max. 8 characters		Designation of the transducer set

Table 3-26 Test Report

Command	Data	Unit	Meaning
PLOTTER:START	—	—	Starting plotter output (transfer of controller function is required (cf. section 3.3.9, program examples cf. 3.5).
:SETUP:ADDRESS	0...30	—	Die eingestellte IEC-Bus -Adresse des Plotters wird vom Empfänger für die Ausgabe von Test Reports verwendet. Sie muß sich von der eigenen Adresse des Empfängers unterscheiden.
:SETUP:FORMAT :SETUP:FORMAT?			
:LEFT :LEFT? :RIGHT :RIGHT? :TOP :TOP? :BOTTOM :BOTTOM?	ON OFF -99.999 to 99.999 Plotter-Units	— — — — —	Special scaling of plotter output on/off Definition of the limits P1 and P2: Left margin Right margin Top margin Bottom margin
:SETUP:PEN :SETUP:PEN?	ON OFF	—	Selection of pen for plotter output on/off Pen for:
:GRID :GRID?	0 to 8	—	Diagram
:LIMIT :LIMIT?	0 to 8	—	Limit line
:CURVE1 :CURVE1?	0 to 8	—	Measurement curve 1
:CURVE2 :CURVE2?	0 to 8	—	Measurement curve 2
:TEXT :TEXT?	0 to 8	—	Labelling
:SINGLEVALUES :SINGLEVALUES?	0 to 8	—	List of measured values
:DATE :DATE?	0 to 8	—	Data
:CONTENT:DEFAULT :CONTENT:DEFAULT?	ON OFF	—	Elements of a test report: Default setting
:CURVE :CURVE?	ON OFF	—	Measurement curve(s)
:HEADER :HEADER?	ON OFF	—	Header of protocol
:DIAGRAM :DIAGRAM?	ON OFF	—	Diagram
:LIST :LIST?	ON OFF	—	List of measured values
:SCANTABLE :SCANTABLE?	ON OFF	—	Table with scan data
:DATE :DATE?	ON OFF	—	Data

Command	Data	Unit	Meaning
PRInter:STARt :STOp	—	—	Starting printer output Stopping printer output
:CONTent:DEFault :CONTent:DEFault?	ON OFF	—	Elements of a test report: Default setting
:CURVe :CURVe?	ON OFF	—	Measurement curve(s)
:HEADer :HEADer?	ON OFF	—	Header of protocol
:DIAGram :DIAGram?	ON OFF	—	Diagram
:LIST :LIST?	ON OFF	—	List of measured values
:SCANtable :SCANtable?	ON OFF	—	Table with scan data
REPort:HEADer:COMPany :COMPany?	"ASCII text" (max.40 characters)	—	texts for the protocol header Test company
:PROGram :PROGram?	"ASCII text" (max.40 characters)	—	Measurement program
:EUT :EUT?	"ASCII text" (max.40 characters)	—	Equipment under test
:MANufacturer :MANufacturer?	"ASCII text" (max.40 characters)	—	Manufacturer
:CONDition :CONDition?	"ASCII text" (max.40 characters)	—	Operating conditions
:OPERator :OPERator?	"ASCII text" (max.40 characters)	—	Operator
:SPEC :SPEC?	"ASCII text" (max.40 characters)	—	Test specifications
:REMARK1 :REMARK1?	"ASCII text" (max.60 characters)	—	Remark/comment
:REMARK2 :REMARK2?	"ASCII text" (max.60 characters)	—	Remark/comment

Table 3-27 Common Commands

Command	Data	Unit	Meaning
ERA?	—	—	Event Status register A for specifying the instrument states
ERAE ERAE?	0 to 65535	—	Event Status Enable register A
ERB?	—	—	Event Status register B for indicating synthesizer errors.
ERBE ERBE?	0 to 65535	—	Event Status Enable register B
ERC?	—	—	Event Status register C for specifying the validity of a measured value (section 3.3.8)
ERCE ERCE?	0 to 65535	—	Event Status Enable register C
ERD?	—	—	Event Status register D for specifying the scan states
ERDE ERDE?	0 to 65535	—	Event Status Enable register D
Header	ON Off	—	Switching on and off output of header during poll
Lisn Lisn?	ESH2zs ESH3zs	—	Selecting the LISN to be controlled
:PHase	N L1 L2 L3		Setting the phase; with ESHS3-Z5, N and L1 are permissible only
:PE	Grounded Floating		Setting the PE
PRESet	—	—	Resetting of device settings without resetting IEC-bus interface. It corresponds to the function RCL0.
SErvice:SElftest:CALGen	ON Off	—	Switching on/off the calibration generator
SYstem:Errors?	—	—	Polling device-dependent errors (cf. table 3-31)
:Date :Date?	dd,mm,yy	—	Date of real-time clock
:Time :Time?	hh,mm,ss	—	Time of real-time clock
TErminator			Listener terminator:
	LFeoi	—	Linefeed (10 decimal) with EOI
	Eoi		only EOI for binary data
USerport	1 to 6, ON 1 to 6, OFF	—	Setting the user port

Table 3-27a Commands for reading out device configurations

Command	Data	Unit	Meaning
SYSTEM:SETUP	Block data	—	The complete receiver configurations (without transducer and limit lines) can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 12.5 kbyte
:BANDWIDTH?	—	—	Polling the bandwidths of the IF filters integrated in the device. Output in ASCII format; the values are separated by commas.
:RECEIVER :RECEIVER?	Block data	—	Complete receiver settings, such as SYSTEM:SETUP?, however without SAVE or RECALL data can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form.
:LIMIT :LIMIT?	Block data	—	All limit lines can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 6 kByte
:TRANSDUCER :TRANSDUCER?	Block data	—	The complete transducer factors and transducer sets can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 11 kByte
:LABEL :LABEL?	n,"label",n,"label" ,...., n: register "label": name of register	—	The names of the SAVE/RECALL registers can be programmed and queried. After the query, the complete list from 1 to 9 is provided. Any combination can be programmed.

3.3.5 Service Request and Status Register

In line with the new IEC-bus standard the ESHS features the following registers:

- Event Status (ESR)
- Event Status Enable (ESE)
- Status byte (STB)
- Service Request Enable (SRE) and
- Parallel Poll Enable (PRE).

The individual registers have the following meanings:

a) **Event Status (ESR):**

The Event Status register is an extended version of the status byte used in earlier IEC-bus programmable measuring instruments. In this register the ESHS specifies special events that can be polled by the controller. The respective bit associated with the event or status is set to 1. This bit remains set until it is cleared by reading the Event Status register (command *ESR?) or by one of the following conditions:

- the commands *RST or *CLS
- switching on the power supply voltage (the power-on bit is however set afterwards).

Table 3-28 Meaning of the individual bits of the Event Status register

Bit No.	Meaning
7	**Power On** Is set when the device is switched on or the power returns following a power failure.
6	**User Request** This bit is set in the ESR by activating the LOCAL key. If the mask register is set appropriately, the ESHS can generate a Service Request of the controller.
5	**Command Error** Is set, if one of the following errors is detected during analysis of the received commands: • syntax error • illegal unit • illegal header • a numeric value was combined with a header that requires no subsequent numeric value.
4	**Execution Error** Is set, if one of the following errors was detected during execution of the received commands: • A numeric value is out of the permissible range (for the respective parameter) • A received command is incompatible with a currently active device setting.
3	**Device-dependent Error** Is set, if function errors occur.
2	**Query Error** Is set, if: • an attempt is being made by the controller to read data from the ESHS when no query command has been issued before • the data prepared in the output buffer are not read and instead a new command is sent to the ESHS. The output buffer is cleared in this case.
1	**Request Control** Is set, if the ESHS requires the IEC-bus for control purposes (e.g. plotter).
0	**Operation Complete** Is set in response to the commands *OPC and *OPC? when all the pending commands have been processed and executed.

b) **Event Status Enable (ESE):**

This register is set by the controller and forms the mask for the Event Status register. The user can select which bits in the Event Status register also effect the setting of the sum bit ESR (bit 5 in the status byte) thus enabling a service request. The sum bit can only be set when at least one bit in the ESR and the appropriate bit in the ESE are set to 1. The sum bit is automatically cleared, when the condition stated above no longer prevails, e.g. when the bits in the ESR have been cleared by reading out the ESR or, when the ESE-register has been changed. The ESE-register is set to zero upon switching on the power supply when the power-on-status-clear flag is 1 (*PSC 1). The command "*ESE value"serves to set the Event Status Enable mask register where "value" is the contents of the register in decimal form. The current value of the register can be read out again using *ESE?.

c) **Status byte (STB):**

There are the following ways for reading the status byte:

- By way of the command *STB?
  The contents is output in decimal form. The status byte is not changed by the readout and the Service Request is not cleared.
- By way of a Serial Poll
  The contents is transmitted in binary form. As a result the RQS-bit is set to zero and the Service Request inactive, the remaining bits of the status byte are not changed.

The status byte is cleared:

- By way of the command *CLS, provided that the output buffer is empty.
  This command clears the Event Status register (ESR) andthe output buffer, thus setting the bit ESR in the status byte to zero. This in turn brings about the clearing of the RQS-bit and the Service Request message.
- By reading the ESR using *ESR? or by setting the ESE to zero using *ESE 0 or by reading the contents of the output buffer.

Table 3-29 Meanings of the individual bits of the status byte

Bit	Bus line	Designation	Meaning
0	DIO 4	ERD	Sum bit of the Event Status register D for specification of the scan states.
1	DIO 5	ERC	Sum bit of the Event Status register C for identification of the validity of a measured value.
2	DIO 2	ERB	Sum bit of the Event Status register B for specifying synthesizer loop errors.
3	DIO 7	ERA	Sum bit of the Event Status register A for specificatio of device states.
4	DIO 6	MAV	Message available, i.e. output buffer is not empty, a message available, e.g. a measured value can be read.
5	DIO 6	ESR	Sum bit of the Event Status register
6	DIO 6	RQS	Request Service

d) Service Request Enable (SRE)

This mask register for the status byte can be set by the controller. The conditions that enable a Service Request can thus be selected. The command SRE 32, for example, sets the mask register such that a Service Request is only generated when the ESR-bit is set. When switching on the power supply the SRE-register is reset (= 0) provided that the Power On Clear flag has the value "1". The SRE-register is not changed by DCL and SDC.

According to the standard, the bit positions 0 to 3 and 7 can be freely assigned for further events. In the case of the ESHS the bits 0 to 3 (ERA, ERB, ERC and ERD) are used to specify certain events and states.

e) Parallel Poll Enable Register

The Parallel Poll Enable register has a capacity of 16 bit. Each bit in this register has a corresponding bit in the status byte or in a device-specific register. If the bit-for-bit operation of the Parallel Poll Enable register with the two ones stated above does not result in 0, the IST-bit (Indivdual Status) is set to 1. The IST-bit is sent as a reply to a parallel poll of the process controller, thus allowing the identification of the reason for the service request. (The IST-bit can also be read using "*IST?"). Figure 3-41 illustrates the relations.

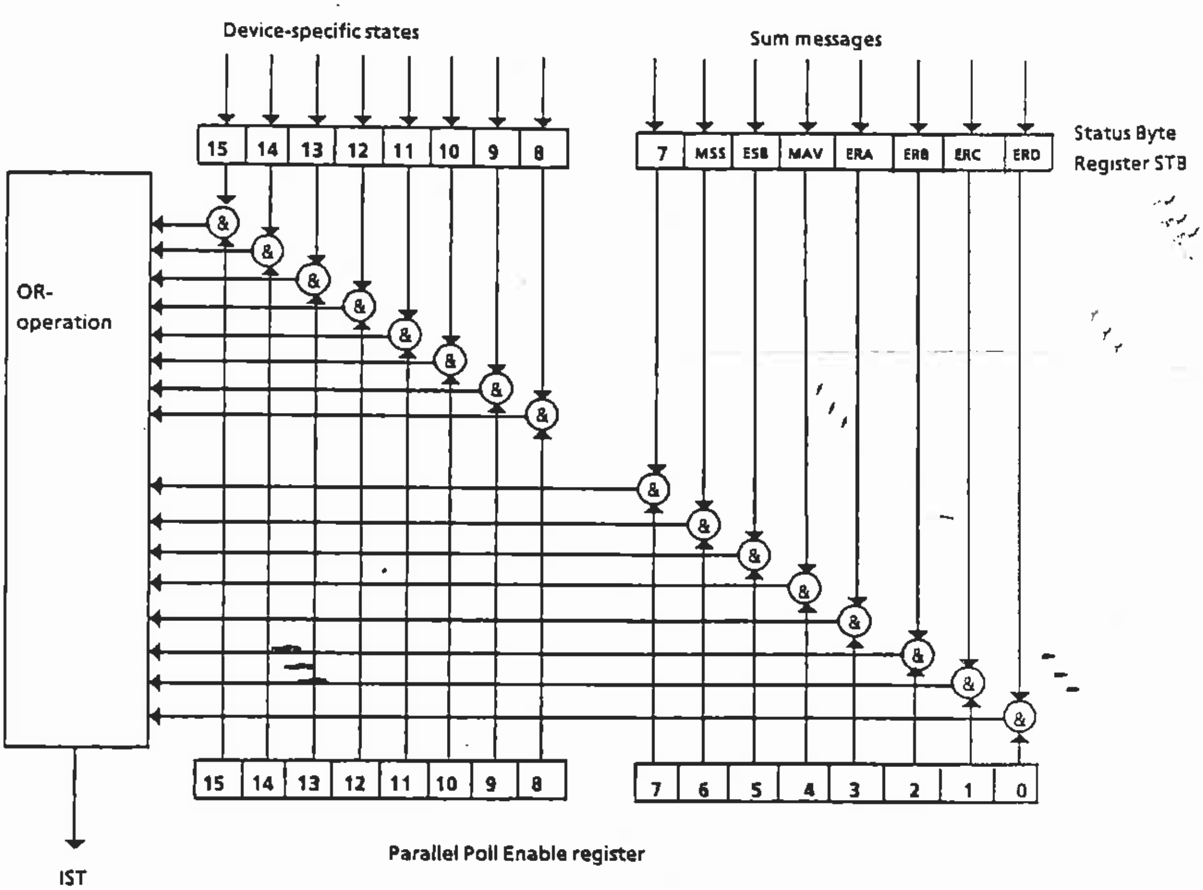


Fig. 3-36 Parallel Poll Enable Register PRE

f) Assignment and relation of the individual registers

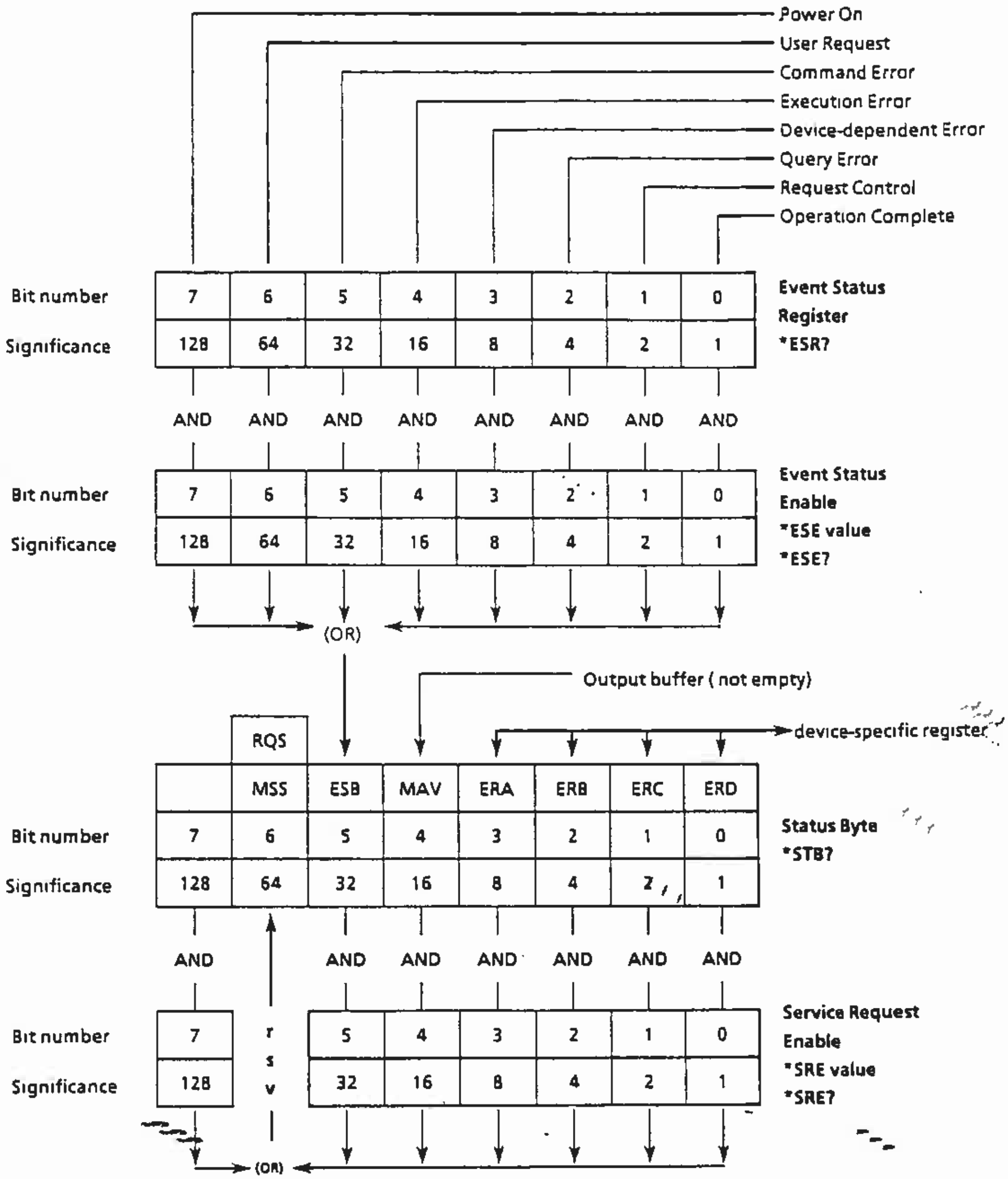


Fig. 3-37 Status register

The assignment of the extended Event Register ERA and the identification of the instrument states are explained by the following diagram:

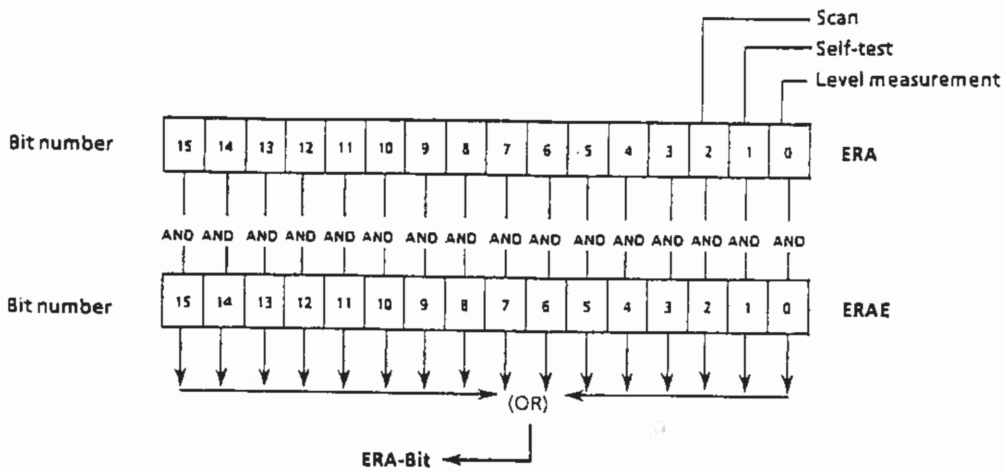


Fig. 3-38 Status register ERA

The assignment of the extended Event Register ERB and the indication of the synthesizer-loop errors and switch-on/off of the external reference are illustrated by the following diagram:

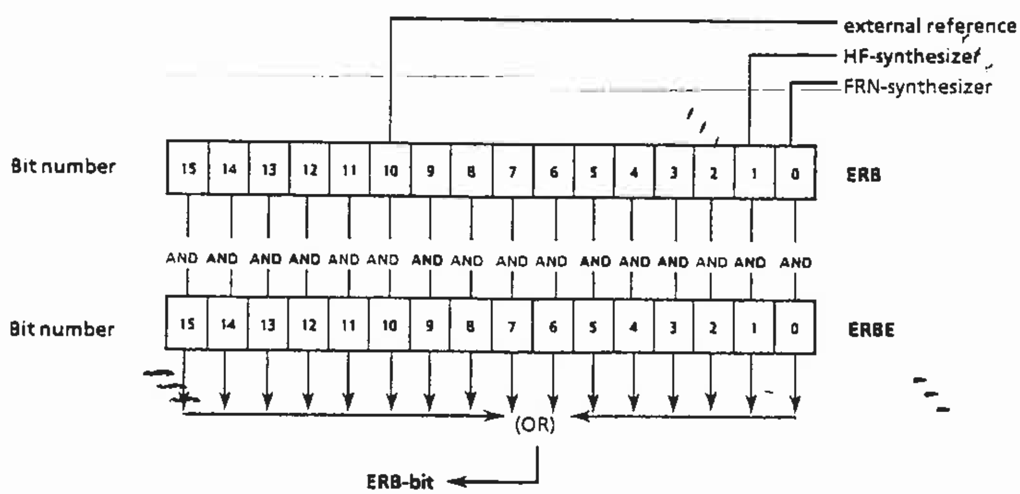


Fig. 3-39 Status register ERB

The assignment of the extended Event Register ERC and the indication of the validity of the measured values are shown in the following diagram:

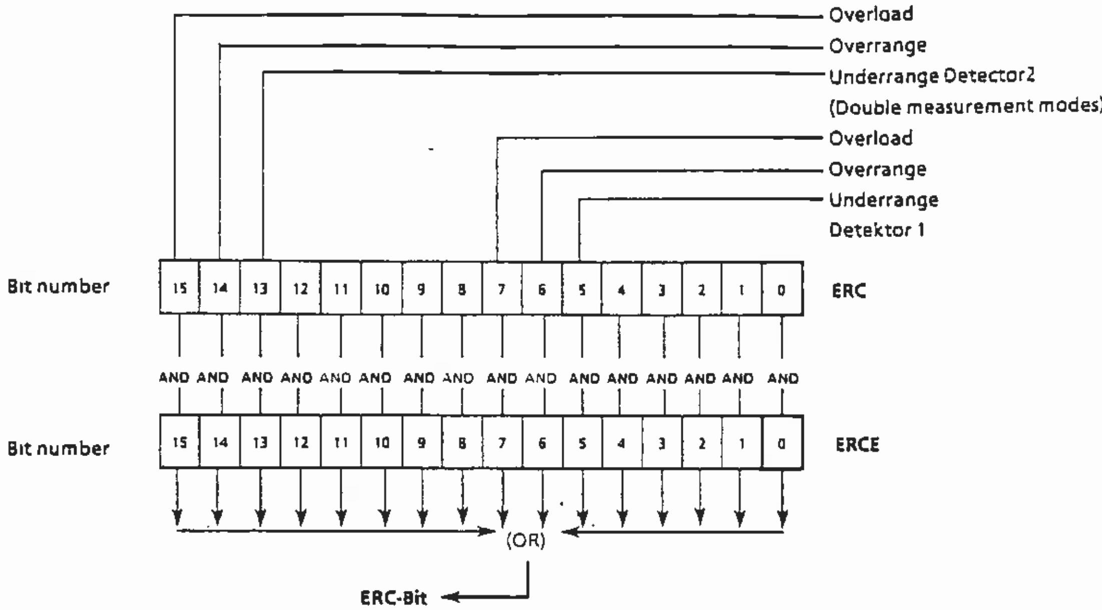


Fig. 3-40 Status register ERC

The assignment of the extended Event Register ERD and the identification of the scan states illustrates the following diagram:

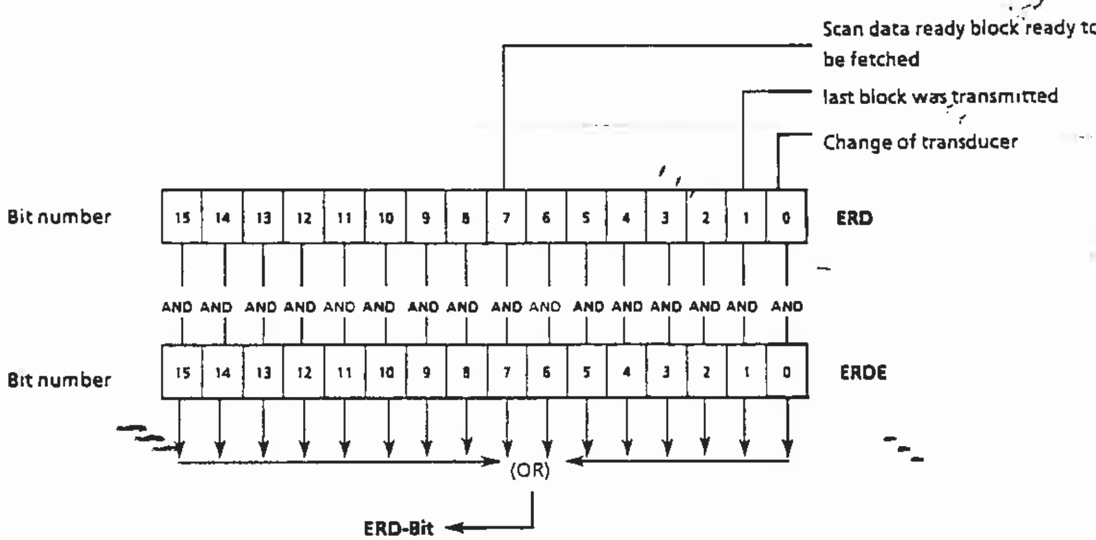


Fig. 3-41 Status register ERD

3.3.6 Resetting of Device Functions

The following table shows various commands and events that cause individual device functions to be reset:

Table 3-30 Resetting of various device functions

Event	Switching on the operating voltage		DCL, SDC (Device Clear, Selected Device Clear)	Commands		
	Power On Clear Flag			*RST	*CLS	RCL 0
	0	1				
Device default setting	–	–	–	yes	–	yes
Set ESR to zero	yes	yes	–	–	yes	–
Set ESE and SRE to zero	–	yes	--	–	--	--
Clear output buffer	yes	yes	yes	–	–	–
Clear Service Request	yes	1)	2)	–	3)	--
Reset command processing and input buffer	yes	yes	yes	–	–	–

1) Yes, but "Service Request on Power On" is possible.
2) Yes, if only conditioned by a message in the output buffer.
3) Yes, if not conditioned by a message in the output buffer.

3.3.7 Command Processing Sequence and Synchronization

The commands received by the ESHS are first stored in an input buffer which can accommodate up to 4096 characters. Once the terminator has been received, the commands are processed in the sequence in which they were sent. During this time, the IEC-bus can be used for communication with other devices. Command lines which exceed the capacity of the input buffer are processed in several sections. The bus is occupied during this time.

The commands *OPC and *OPC? (operation complete) are used as feedbacks to inform on the time at which processing of the received commands was terminated and a scan (if any) has been completely executed.

*OPC sets bit 0 in the Event Status register, and a Service Request can then be enabled if all previous commands have been executed.

*OPC? additionally provides a message in the output buffer and sets bit 4 (MAV) in the status byte.

This synchronization can be established within a command line by the command *WAI, i.e. all subsequent commands are only executed when the previous commands have been completely executed.

3.3.8 Output of Measurement Results via IEC-Bus

a) Single Measurements

The result of a single measurement is provided following a request by one of the device-specific commands LEVEL?, LEVEL:LASTVALUE? or LEVEL:CONTINUE?. The latter is especially suited for time-critical applications since the value of the last measurement can be read in immediately using an IEC bus command and the controller can subsequently process this measured value while the test receiver is already performing a new level measurement. The availability of the measurement result in the output buffer is indicated by setting the MAV bit (message available) in the Event Status register. If the associated mask register has been configured appropriately, a Service Request is thus enabled. (Program example cf. section 3.5).

The data can be output in binary or ASCII format. Selection is effected by the commands LEVEL:FORMAT BINARY or LEVEL:FORMAT ASCII. Binary output is made with 2 byte where the measured value was multiplied by 100 to obtain an integer. Resolution is 0.01 dB and the output in ASCII format is performed correspondingly e.g. with the header LEVEL 12.56.

With a double measurement mode set the measured value of the second detector is also output. In ASCII format the value is separated from the first value by a decimal point, e.g. LEVEL 12.56,7.98. In binary format two more bytes are added without using any separators.

The associated header can be switched on and off using the commands HEADER ON and HEADER OFF.

The validity of a measured value is indicated via the Extended Status register ERC. The individual bits indicate exceedings of the display range or overload of the test receiver. The low-order byte (bits 0-7) is used for detector 1, the high-order byte (bits 8-15) for detector 2 in the case of double measurement modes. If only one detector is switched on, the low-order byte is used..

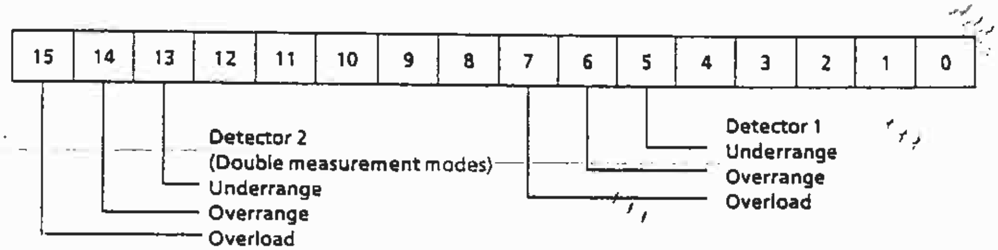


Fig. 3-37 Assignment of the Event Register ERC

The conditions overload, overrange and underrange can be used for generating a Service Request by setting a suitable bit in the associated Enable register ERCE and bit 3 in the Service Request Enable register.

b) Scan

For output of the scan results various formats are available. If complete information on each test point is desired, it is possible to output with each frequency the appertaining level values, a status word, the appertaining transducer factor, if switched on, one or two limit values at the respective frequency and a limit value byte providing information on whether the limit value(s) have been exceeded. The command "SCAN:BLOCK:ELEMENT COMBINED" serves to select this output form.

"SCAN:BLOCK:ELEMENT TRACE" serves to output only the highest level values of the 400 scan subranges. They correspond to the values contained in a test report output on printer or plotter. They are suited for graphical representation of the measurement results without loading the evaluation program and test receiver with the transmission and evaluation of unnecessary data

"SCAN:BLOCK:ELEMENT SUBRMAX" is used to select a similar format. However only the number of subrange maxima defined by the user by way of the command "SCAN:OPTION:SUBRANGES n" is output.

The block elements stated above can be further distinguished by output in binary format and in ASCII format. The commands "SCAN:BLOCK:FORMAT BINARY" and "SCAN:BLOCK:FORMAT ASCII" serve to select between the formats. Please note that in ASCII format the length of a block element may reach more than twice the size of an element in binary format and that internal data processing takes longer than with binary format.

Another form is the unformatted output described below. Three more types of block elements are available for this kind of output.

The table provides an overview on the assignment of the possible block elements to the formats:

	ASCII	BINARY	DUMP	SDUMP
COMBINED	√	√		
TRACE	√	√		
SUBRMAX	√	√		
DET1	√	√	√	√
DET2			√	√
VALID			√	√

To ensure that data transmission is as fast as possible and the scan is not slowed down by unnecessary IEC bus traffic, the scan measurement results are output in the form of blocks. The block size can be selected by the user using the command "SCAN:BLOCK:COUNT value" where "value" is the number of individual measurements that can be transmitted together. The output of measurement values is suppressed during a scan using SCAN:BLOCK:COUNT 0. The number of blocks is calculated automatically depending on the output buffer size after having programmed SCAN:BLOCK:COUNT MAX.

SCAN:BLOCK:COUNT SUBRANGE is used to set the number of values to be transmitted such that the "measured value ready" bits (see below) are set only when a complete subrange is ready. In case the number of data appertaining to a subrange exceed the size of the output buffer transmission must be performed in sections. Bit 3 in the extended Event Register ERD is set to indicate complete transmission of a subrange.

Formats ASCII and BINARY:

Please note that block size and format must be defined prior to the start of RF analysis.

During a scan the measurement values are stored internally until the selected block size is reached or the output buffer is filled. In this case bit 7 in the Event register ERD is set. This in turn triggers a Service Request of the receiver, if bit 7 in the Event Enable register ERDE is set. The stored results can then be requested using the command SCAN:BLOCK?. The measurement values collected are transmitted at one go.

The space a single measurement requires in the output buffer depends on the measurement mode and the use of transducer factors and limit lines. The elements of the data blocks can be polled using SCAN:BLOCK:TEMPLATE?. A word the respective bits of which represent the components of a block element is returned. If a bit has the value 1, the respective element is contained in the data block.

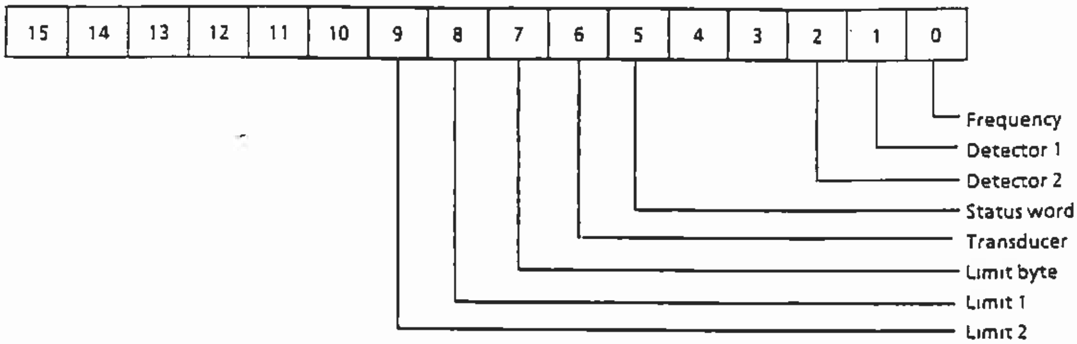
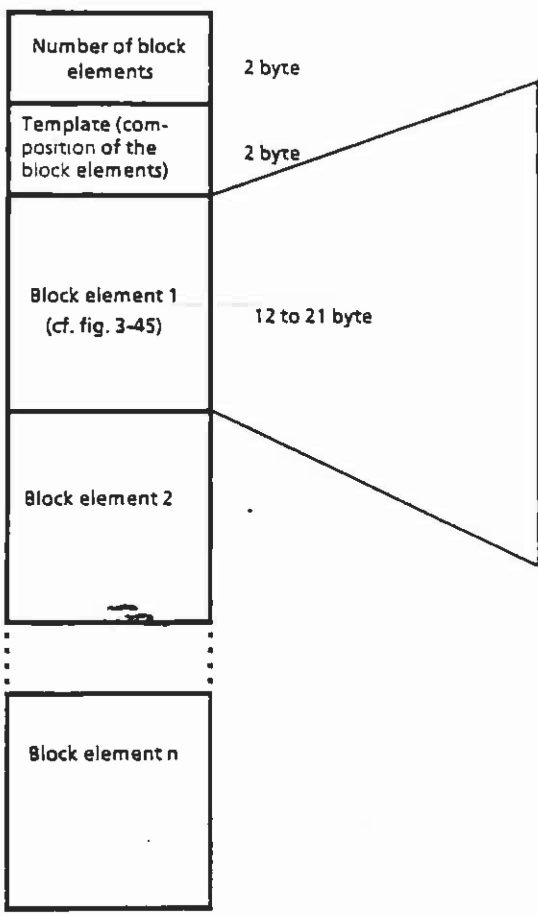


Fig. 3-43 Format of template word



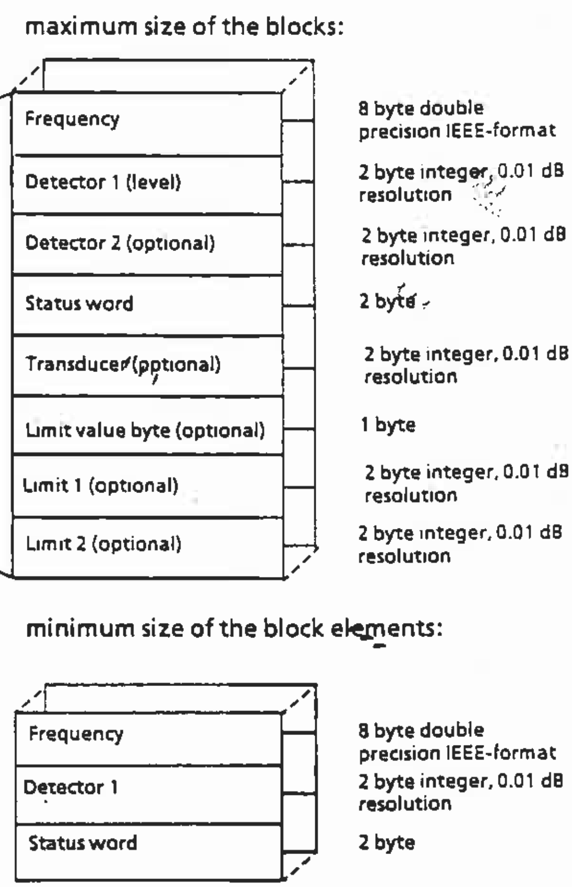


Fig. 3-44 Composition of a data block in binary format

Fig. 3-45 Examples of block elements in binary format

ASCII-format of the Block Elements:

Frequency,detector1[,detector2],status word[,transducer][,limit byte][,limit 1] [,limit 2]

The frequency is transmitted in the basic unit Hz, level (detector(s), transducer and limits) in dB with a resolution of 0.01 dB and the status word as well as the limit byte as decimal values.

The format of the status word corresponds to the extended Event register ERC.

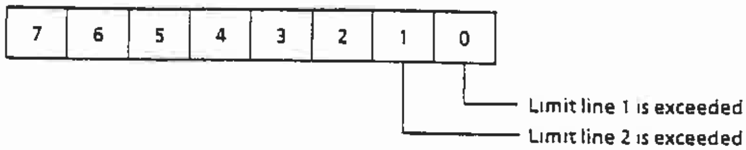


Fig. 3-46 Format of the limit byte

IEEE-number format for floating decimal point variables (Double precision for frequencies):

V EEE EEEE Byte 7	EEEE MMMM Byte 6	MMMM MMMM Byte 5	MMMM MMMM Byte 4
MMMM MMMM Byte 3	MMMM MMMM Byte 2	MMMM MMMM Byte 1	MMMM MMMM Byte 0

V = 1 bit sign, E = 11 bit exponent, M = 52 bit mantissa

The sign bit 1 means a negative number, 0 a positive number.

The exponent in the E-field is specified as a complement on two to the basic value 1024.

The mantissa is normalized, i.e. MSB is always assumed to be "1". An effective precision of 53 bit is thus achieved.

The decimal value is obtained by multiplying the mantissa by 2 ^ (E-1023). Make sure that the MSB of the mantissa is 1 at any rate, i.e. the value of the mantissa may only be higher than or equal to 1 and lower than 2.

The bytes are always arranged in increasing order.

Formats for DUMP and SDUMP

For applications requiring the data to be made ready for use as fast as possible the results of RF analysis can be output unformatted.

"SCAN:BLOCK:FORMAT DUMP" and "SCAN:BLOCK:FORMAT SDUMP" serve to select this type of output.

The data are transferred in the form they are present in the internal measured value memory of the ESHS. Each value is represented in the data block by a 2-byte integer number with a resolution of 0.01 dB in binary format. The results are arranged in increasing sequence. Since the receiver frequencies are not output, assignment of the level values to the frequencies must be performed using the start and stop frequencies and step widths of the scan data set.

With a double detector selected, the level values of the second detector are stored internally in a separate measured value memory. This applies also to the validity bytes which are contained in another memory and are arranged in increasing sequence.

Since the data can be transferred directly from the measured value memory, only one of the three types of results can be output. The command "SCAN:BLOCK:ELEMENT DET1" is used to select detector 1, "SCAN:BLOCK:ELEMENT DET2" detector 2 and "SCAN: BLOCK:ELEMENT VALID" the validity byte, respectively. It is possible to make a selection while a scan is running.

The number of measured values transferred in one block can also be defined using the command "SCAN:BLOCK:COUNT n". With the number set to the value 0, output is not performed during analysis. Please note in this case that the maximum size a block can reach is not limited by the size of the output buffer, which is 4096 bytes. The limit is however 60,000 bytes as each of the measured value memories has a capacity of 30,000 values each represented by 2 bytes.

Since the output is not performed via the output buffer the command "SCAN:BLOCK?"must not be combined with other polling commands with unformatted output being selected.

As a rule, no header is output.

Users of R&S-BASIC must observe that a string can achieve a maximum length of 32 kbytes. For this reason a maximum of approx. 16,000 values each represented by two bytes can be transferred at one time.

With a corresponding amount of measured values being ready to be fetched a message is given by bits set in the extended Event Register ERD.

Results from detector 1 are indicated by bit 7, results from detector 2 by bit 6 and the validity byte by setting bit 5, respectively. This assignment allows to use a universal program routine during the evaluation of the ERD register contents.

The mechanism of data transfer is not affected by how far RF analysis has proceeded. Even with the scan already terminated the availability of measured values not yet fetched is indicated by repeated setting of the appropriate bits in the ERD register.

Scans providing more results than the measured value memory with a storage capacity of 30,000 values can accept are exceptions. With its capacity exhausted, the measured values are stored in a temporary buffer. If the latter is also fully used, or the configured number of measured values per block is reached, RF analysis can only be continued after all results, i. e. from detector 1, or, as the case may be, from detector 2 and the validity byte have been read out.

With format DUMP, bit 2 is set in the ERD register (last block has been transmitted) either after all measured values from detector 1 *or* from detector 2 *or* all validity bytes have been transferred.

With format SDUMP (Synchronized DUMP), bit 2 is set only after all measured values *and* all validity bytes have been read out.

The status word which is assigned in the same way as in the Event register ERC is saved internally in a byte. With unformatted output, the internal format is output, which is different from the status word in the block formats ASCII and BINARY.

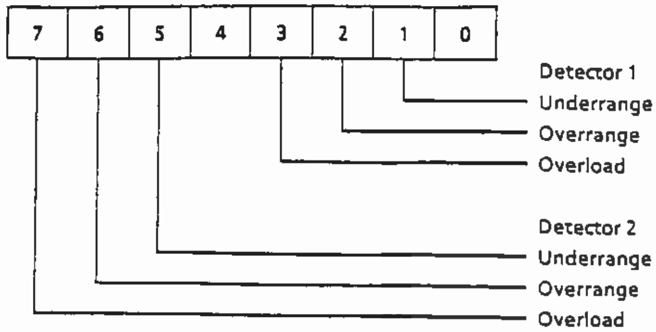


Fig. 3-46a Format of the validity byte with unformatted output of scan results.

The scan results can be queried as often as desired even after termination of scans carried out in LOCAL or REMOTE mode. There are two ways to query the results:

1) Execution of command SCAN:BLOCK?. The presence of measured values causes a data block to be made available and the bits in the ERD register to be set.

2) Execution of command SCAN:RESULTS. Only the bits in the ERD register are set, which has the advantage that afterwards the same mechanism as in a parallel transmission can be applied. Using this command, transmission always starts with the first value in the measured value memory.

3.3.9 Transfer of the IEC-Bus Controller Function

The ESHS must be able to activate the control line ATN (Attention) so that it is possible to send commands to other IEC-bus devices. Only the active IEC-bus controller (Controller in Charge) is entitled to do so. The ESHS needs to be Controller in Charge in order to program IEC-bus controlled plotters and thus output test reports.

The test receiver can obtain the controller function in the following ways:

1. **There is no process controller connected to the IEC-bus.**

   This is recognized by the ATN-line and is usually the case when the ESHS operates in the Stand-Alone mode.

   The ESHS can then configure itself as IEC-bus controller and end the controller function following completed plotter output (Release Control).

2. **A process controller is IEC-bus controller.**

   This is always true, when the ESHS is controlled by a controller connected to the IEC-bus.

   In this case IEC-bus control is transferred to the test receiver via talker addressing and passed back to the controller after plotter output has been terminated ("Pass Control Back").

3.3.10 Error Handling

Errors that are detected in connection with IEC-bus operation are indicated by setting a bit in the Event Status register. These are bit 2 for a query error, bit 4 for an execution error and bit 5 for command error. Device-specific errors are signaled by setting bit 3 (device-dependent error).

These bits remain set until the Event Status register is read out or cleared by the commands *RST or *CLS. A Service Request can thus be enabled and the type of error can be evaluated by way of program control.

A more detailed error message can be obtained by way of the command SYSTEM:ERROR?. A decimal value is output, which can be interpreted in accordance with table 3-31.

Table 3-31 Error messages

0	no error
-100	internal error
-101	syntax not correct
-102	wrong data type
-113	unknown command or command not clear
-130	wrong or unclear unit
-141	wrong or unclear character data
-161	illegal block data
-221	input not allowed
-222	date is out of the permissible range, if not already specified by error message >0
-400	overflow of output buffer
-410	output data were not read and overwritten
-420	no output data available during the attempt to read them
3	setting not allowed in this connection
4	date is out of permissible range
9	unit not correct
16	minimum frequency exceeded (e.g. transducer factors)
17	maximum frequency exceeded
18	minimum level exceeded
19	maximum level exceeded
20	wrong order of frequency values
100	no scan defined during the attempt to program scan data

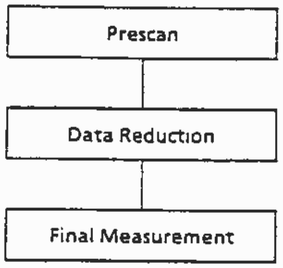
3.4 Applications

The *options* of the RF-analysis serve to specify the measurement sequences that are optimal for the different applications of the ESHS. The options can be divided into groups and some of them can be combined with each other.

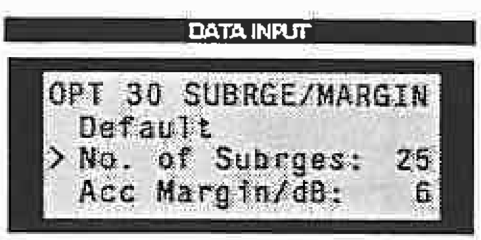
The automatic measurements described below can be applied when the interference is stable within the measuring time. Manual measurement is recommended to be used for intermittent, quickly drifting and cyclic interferences with long cycle times.

The option 01 defines the test configuration for RFI-voltage and RFI-current measurements. (For more details refer to section 3.4.1b).

Measurements with high time constants, such as quasi-peak measurements, cannot be performed at each frequency. For this reason the measurement sequence must be optimized with respect to time. The interference spectrum is first analyzed (*Prescan*) to this end. Data reduction is subsequently performed so that a final measurement must be carried out only at some frequencies.



The scan data set specifies the pre-analysis *(prescan)*. The option 30 (subrange maxima and acceptance analysis) is used for data reduction, which is of paramount importance:



Frequencies with especially high interference levels can be determined already during prescan with the help of option 30. It implies two methods for data reduction:

- Determination of subrange maxima, i.e. the interference spectrum is only further examined at those frequencies with the highest interference levels within one frequency subrange. The entire frequency range is divided up into up to 400 subranges. A subrange maximum is determined for each subrange during the prescan.
- Acceptance analysis, i.e., the interference spectrum is only further examined at those frequencies with levels exceeding a line which is parallel to the limit value line. Thus, measuring frequencies with the interference levels being far below the limit value is no longer necessary. The safety margin between the assumed acceptance line and the limit line is freely definable by the user as *Acceptance Margin*.

Two values have therefore to be specified:

- the number of *subranges* (a value out of 8, 16, 25, 50, 100, 200, 400; default value: 25)
- the *acceptance margin* (Acc. Margin/dB; default value: 6 dB). This applies to each of two limit lines.

A menu for selecting and entering these values is displayed when calling the option 30. Upon pressing the → key, the cursor is located at the line *>Default...*, if the default values have not yet been set, otherwise the cursor is set to the number of *subranges*. If *Default* is set to *OFF*, the default values can be activated by pressing the ENTER key. The cursor can be moved to the desired line using the ↑ ↓ keys.The values for *No of Subrges* and *ACC Margin/dB* can be set using the numeric keys and are accepted by way of ENTER. Both, switching on the option and changing the values can also be performed after the prescan has been executed, since 400 subrange maxima are always stored.

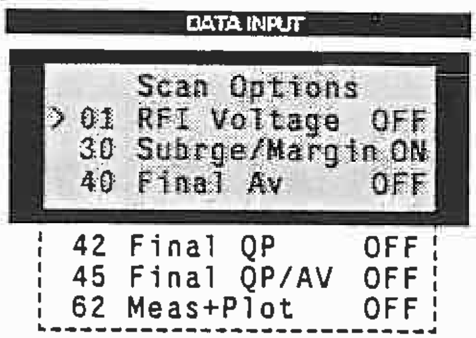
Options 40 to 45 serve to specify the detectors for the final measurement at the frequencies determined during the data reduction. If none of the options 40 to 45 is switched on, a final measurement is not performed.

Option 62 defines that the interference spectrum is output via the plotter simultaneously with the measurement.

When the option 63 (Special Scan) is selected, entering <RUN> does not lead to a scan according to the RF-analysis data set but only to scanning the frequencies of a frequency list entered by means of this option or the frequencies of a list resulting from the data reduction.

Calling the options (see also section 3.2.4.3.3):

▸ Press OPTIONS key 21.
The list of options apears on the display DATA INPUT:



visible when calling using the OPTIONS key

can be relocated using the ↑ and ↓ keys

3.4.1 Measuring the RFI Voltage

RFI voltage measurements are carried out either using artificial mains networks or probes with an impedance of 1.5 kΩ or ≥ 100 kΩ.

The following R&S-accessories are used for RFI voltage measurements

• Active Probe, Z_{in} ≥ 100 kΩ	ESH2-Z2
• Passive Probe, Z_{in} = 1.5 kΩ	ESH2-Z3
• Artificial Mains Network (four-wire system)	ESH2-Z5
• T-network	ESH3-Z4
• Two-line V-network	ESH3-Z5
• V-network 5 µH//50Ω	ESH2-Z6
• 4-wire-T-network	EZ 10

The probes and V-networks serve to test the unsymmetrical RFI voltage whereas the T-networks are suitable for asymmetrical ones. The frequency range of RFI voltage measurements is generally limited to the range 9 kHz to 30 MHz in national and international standards. RFI voltage measurements on automotive accessories involve frequencies of up to 108 MHz; thus the ESHS is suitable for this purpose only to a limited extent.

Detailed information on which artificial mains networks are to be used in which cases is given in the latest versions of the standards - CISPR Standards, European Standards, VDE-Regulations, FCC Rules & Regulations, etc.

a) **Test Setup**

To avoid measurement errors caused by ambient interference the device under test and measuring sensor (artificial mains network or probe) should be operated inside the shielded room, whereas the test receiver together with printer and plotter should be set up outside the room.

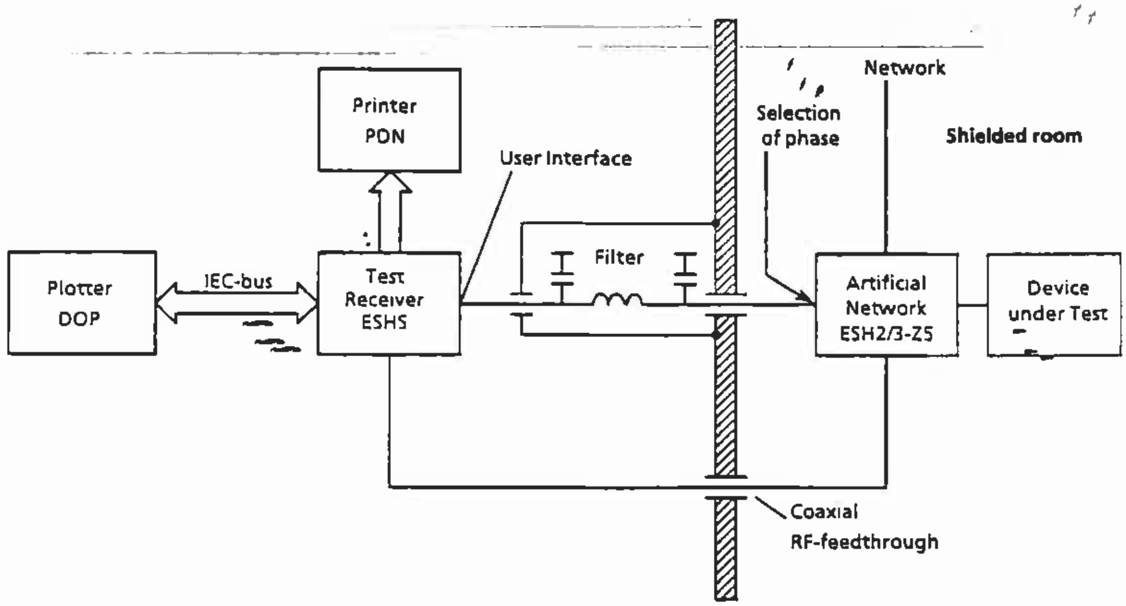


Fig. 3-40 Block diagram of a test setup with artificial mains network and device under test in a shielded room

The Test Receiver ESHS itself can be set up inside the shielded room due to its low radiation. Simultaneous operation of printer and plotter inside the room may however cause problems if the setup is unfavourable. In this case the output of the test report should be performed upon the measurement.

The following connections between ESHS user interface and artificial mains network serve for automatic phase selection when using the artificial mains networks ESH2-Z5 and ESH3-Z5:

ESHS user interface	pin	Filter	ESH2-Z5 pin	
N	14		46	N
L1	15		21	L1
L2	16		22	L2
L3	17		23	L3
GND	12		50	GND
PE fl.	18		24	PE fl.
+5 V	13		48	+5 V *)

*) not necessary with ESH2-Z5 with power supply of its own

Fig. 3-41 Connection between ESHS and ESH2-Z5 (cable EZ-13)

ESHS user interface	pin	Filter	ESH3-Z5 pin	
N	14		2	N
L	15		6	L
PE fl.	18		3	PE fl.
DGND	12		8	DGND
+5 V	13		1	+5 V

Fig. 3-42 Connection between ESHS and ESH3-Z5 (cable EZ-14)

The supply voltage +5 V and some of the control lines must be fed through the wall of the shielded room for control of the phase selection and PE simulating network of the Artificial Mains Networks ESH2-Z5 and ESH3-Z5.

The connecting cables EZ-14 and EZ-5 can be supplied for the Four-line Network ESH2-Z5 and the cables EZ-14 and EZ-6 are designed for the Two-line Network ESH3-Z5.

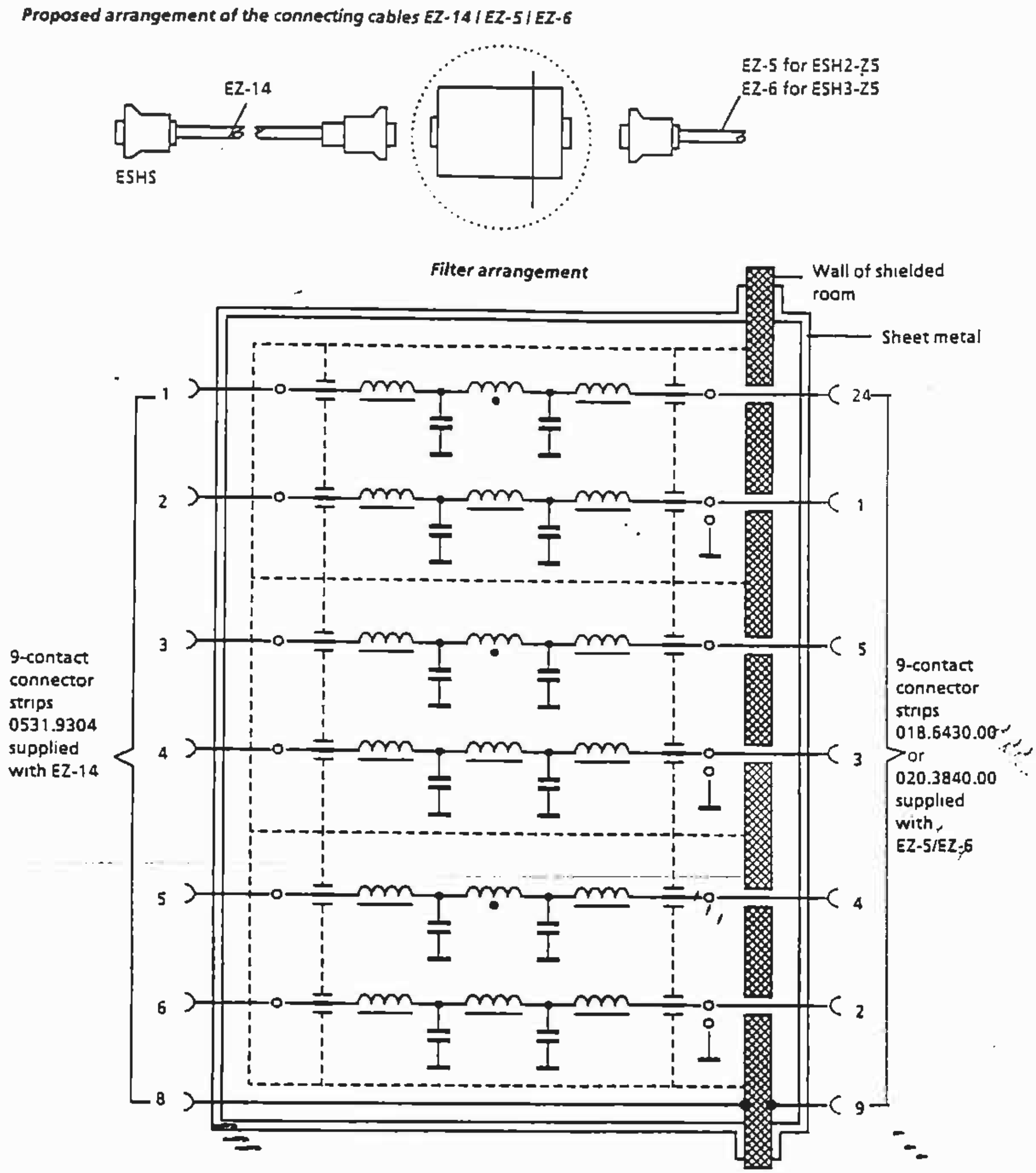


Fig. 3-43 Arrangement of the connecting cables EZ-5, -6 and -14 with AF-filters to provide the 5-V supply and control information for the Artificial Mains Networks ESH2-Z5 and ESH3-Z5 in a shielded room.

Note: *If the ESHS 10 is operated inside the shielded room, the filter arrangement will be rendered unnecessary. The cable EZ-14 serves to control the ESH3-Z5, the cable EZ-13 is used to control the ESH2-Z5.*

Recommended low-pass filters used for the feedthroughs into the shielded room:
Siemens order no.: B 84311-C30-B3 contains low-pass filters for 2 lines. 3 units are therefore necessary for the ESH2-Z5, 2 units for the ESH3-Z5.

The setup of the device under test in the shielded room is specified in the standards relevant to the subject, e.g. VDE 0877 part 1.

b) **Setting of the Test Receiver**

The scan setting of the test receiver determines the data of the prescan. For RFI voltage measurements it usually comprises a range of 0.15 to 30 MHz or two ranges from 0.009 or 0.01 to 0.15 and 0.15 to 30 MHz; for measurements according to FCC Part 15 the range is from 0.45 to 30 MHz.

Further data:		
Frequency range/MHz	.009 - .15	.15 - 30
Stepsize/kHz	.1	5 1)
Bandwidth (IF BW)/kHz	.2	10
Detector	Pk + Av	Pk + Av 2)
Meas. Time/s	.05	.02 3)
Attenuation	Auto Low Noise	Auto Low Noise
Operating range/dB	60	60

1) With pure broadband interference, frequency-proportional step size (LOG step) can be used instead of steps half the bandwidth

2) For measurements according to standards with narrowband and broadband interference limit values or average and quasipeak limit values, the special function 30 with which it is possible to measure simultaneously peak and average value during one scan is useful. If there is only one limit value, it is sufficient to switch on one detector, e.g. Pk or Av.

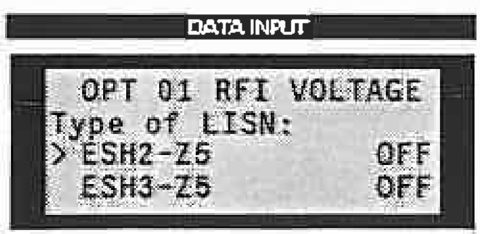
3) The measuring time per measured value is determined by the type of interference signal. It must be selected such that the highest value is recorded in the case of fluctuations during time. Minimum measuring times of 20 or 10 ms are therefore required for network-synchronous pulse interferences (50 Hz or 100 Hz, 60 or 120 Hz).

The scan option 01 serves for RFI-voltage measurements. It is used to specify the following features:

- Type of artificial mains network (LISN).
  If none of the artificial mains networks ESH2-Z5 or ESH3-Z5 is defined, it is assumed that the measurement is performed using a probe or a single-phase artificial mains network. As some standards also demand RFI current measurements, it can be measured instead of the RFI-voltage using an RF current probe, when the transducer factor has been entered in the unit dBµA (cf. section 3.4.2). Specification of the artificial mains networks in option 01 is no longer necessary.
- Details relating to the sequence (phase on which the pre-analysis is carried out; phases on which the final measurement is to be performed)

Operation

- Press the OPTIONS key.
  The menu *SCAN OPTIONS* is called.
- Press one of the ENTER keys.
  OPT 01 RFI VOLTAGE switches from *OFF* to *ON*.
- Press the → key.
  The first menu is called:



- Specify the type of artificial mains network (LISN).
  If both artificial mains networks are *OFF*, the RFI voltage measurement is carried out only on one line. It must be specified, if the test is performed using a probe or a single-phase LISN (ESH3-Z4, ESH3-Z6) or an RF-current probe. One LISN maximally can be selected. If another one is switched *ON*, the first one becomes automatically *OFF*. Only when one of the two LISNs is selected, the next menu appears.

- Press one of the ENTER keys to select the LISN
- Press the → key.
  The next menu is called, the test configuration for the prescan is specified as follows:

  * Using the ESH3-Z5:

```
DATA INPUT
OPT 01 PRESCAN/MANUAL
> Phase L1          ON
  Phase N          OFF
  PE grounded       ON
```

Only one phase can be switched on. If *PE grounded* is *OFF*, the PE simulating network is switched on.

* Using the ESH2-Z5:

```
DATA INPUT
OPT 01 PRESCAN/MANUAL
> Phase L1          ON
  Phase L2         OFF
  Phase L3         OFF
  Phase N          OFF
  PE grounded       ON
```

Only one phase can be switched on. If *PE grounded* is *OFF*, the PE choke is switched on.

- Press the →key.
  The next menu is called, the test configuration for the prescan is specified as follows:

  * Using the ESH3-Z5:

```
DATA INPUT
  OPT 01 FINAL MEAS
> Phase L1          ON
  Phase N           ON
  PE grounded      OFF
  PE floating       ON
```

In this example it is measured on both phases. If both *PE grounded* and *PE floating* are set to *ON*, four measurements are carried out on each frequency determined by data reduction to find out the configuration with the highest RFI voltage. In line with a resolution by the CISPR/G it is measured on both phases only using a PE simulating network , i.e. *PE grounded OFF* and "*PE floating ON*.

* *Using the ESH2-Z5*:

```
DATA INPUT

  OPT 01 FINAL MEAS
> Phase L1         ON
  Phase L2        OFF
  Phase L3        OFF
  Phase N          ON
  PE grounded      ON
  PE floating      ON
```

As already described with the ESH3-Z5, four measurements are carried out at each frequency in this case.

c) **Measurement Sequence, Measurement and Analysis Procedure**

The prescan is started by activating the RUN/STOP key. It can further be interrupted by pressing this key once and aborted by pressing the key twice (for more details cf. section 3.2.4.3.4).

At the end of each subrange the phase with the highest RFI voltage is determined and the QP-measurement is started, if one of the following options is selected (measuring time for the final measurement can be set separately in each case, cf. section 3.2.4.3.2):

Option 40 Av Meas. = ON: Comparison of the Av-values of the RFI-voltages on all phases provided in the menu *Final Measmt* with the possible PE-configuration(s) and determination of the phase with the highest Av-level at the frequency of the subrange maximum. (The option 40 requires the Av-detector during prescan; it is therefore automatically set with this option).

Option 42 QP Meas. = ON: Comparison of the QP values of the RFI voltages on all phases provided in the menu *Final Measmt* with the possible PE-configuration(s) and determination of the phase with the highest QP level at the frequency of the subrange maximum. (The option 42 requires the Pk detector during prescan; it is therefore automatically set with this option).

Option 45 QP/Av Meas. = ON: With the Pk maximum of the subrange:

Comparison of the QP values of the RFI voltages on all phases provided in the menu *Final Measmt* with the possible PE-configuration(s) and determination of the phase with the highest QP level.

With the Av-maximum of the subrange:

Comparison of the Av-values of the RFI-voltage on all phases with the possible PE-configuration(s) and determination of the phase with the highest Av-level. (The option 45 requires the SF 30 (Pk and Av) during prescan; it is therefore automatically set with this option.)

Option 62 Meas + Plot = ON: Plotting of the interference spectrum during the measurement. When starting the scan, everything defined under *Report Setting* in the menu is plotted. If *Curve* in this menu is switched off, the warning *Warning Curve OFF* appears.

3.4.2 Measuring the RFI Current

a) Test setup

To avoid measurement errors as a result of ambient interference, the device under test and RF-current probe should be operated in a shielded room whereas the test receiver with printer and plotter should be set up outside the room.

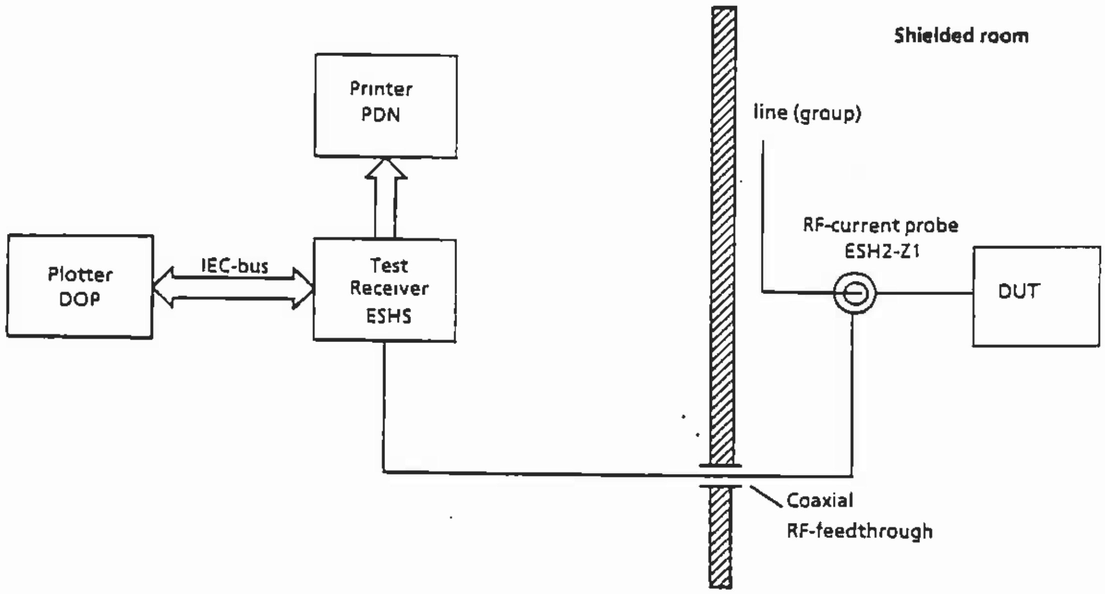


Fig. 3-51 Block diagram of a test setup with RF-current probe (ESH2-Z1) and device under test in a shielded chamber

b) Setting of the Test Receiver

The measurement configuration is specified by the option 01. If, as described in section 3.4.1., there is no artificial mains network selected, preparations can be made for RF-current measurements by selecting the transducer with the unit dBµA.

The scan setting specifies the run of the prescan (recommended setting data, section 3.4.1.).

The data reduction is defined by the option 30.

For the final measurement the options 40 to 45 are of significance.

The option 62 specifies whether the interference spectrum is to be plotted during or only after the measurement.

c) Measurement Sequence, Measurement and Analysis Procedure

The explanations given in section 3.4.1.3 are also true in this case. There is, of course, no comparison between the RFI currents on the different phases.

3.4.3 RFI-Fieldstrength Measurements

a) **Test Setup**

RFI-fieldstrength measurements in line with the commercial standards are performed in the frequency range from 9 kHz to 30 MHz using the R&S-Loop Antenna HFH2-Z2. The shielded room offers the advantage of preventing ambient interferences, it may however impair the magnetic field especially in the case of small dimensions. Therefore, measurements in the shielded room can usually not replace open air tests.

Test Setup with Measurements in the Shielded Room

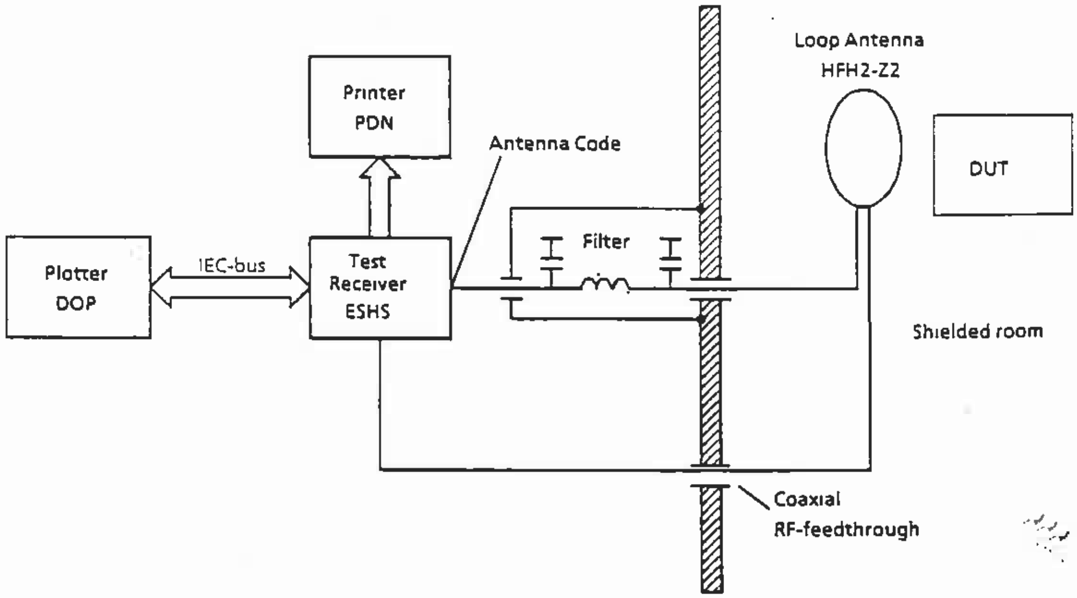
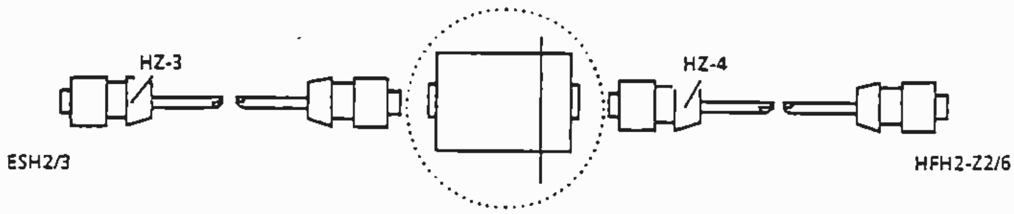


Fig. 3-52 Block diagram of a test setup with the Loop Antenna HFH2-Z2 and device under test in the shielded chamber

For the Loop Antenna HFH2-Z2 the supply voltages + 10 V and -10 V, the codings of the antenna factor and of the dimension "electric fieldstrength" (dBµV/m) must be fed through the wall of the shielded room. The connecting cables HZ-3 (3 m) and HZ-4 (10 m) can be used for this purpose.

If the magnetic fieldstrength is indicated in dBµA/m, a transducer factor of -31.5 dB must be entered.

Proposed arrangement of the connecting cables EZ-13 / EZ-5 / EZ-6



Filter arrangement

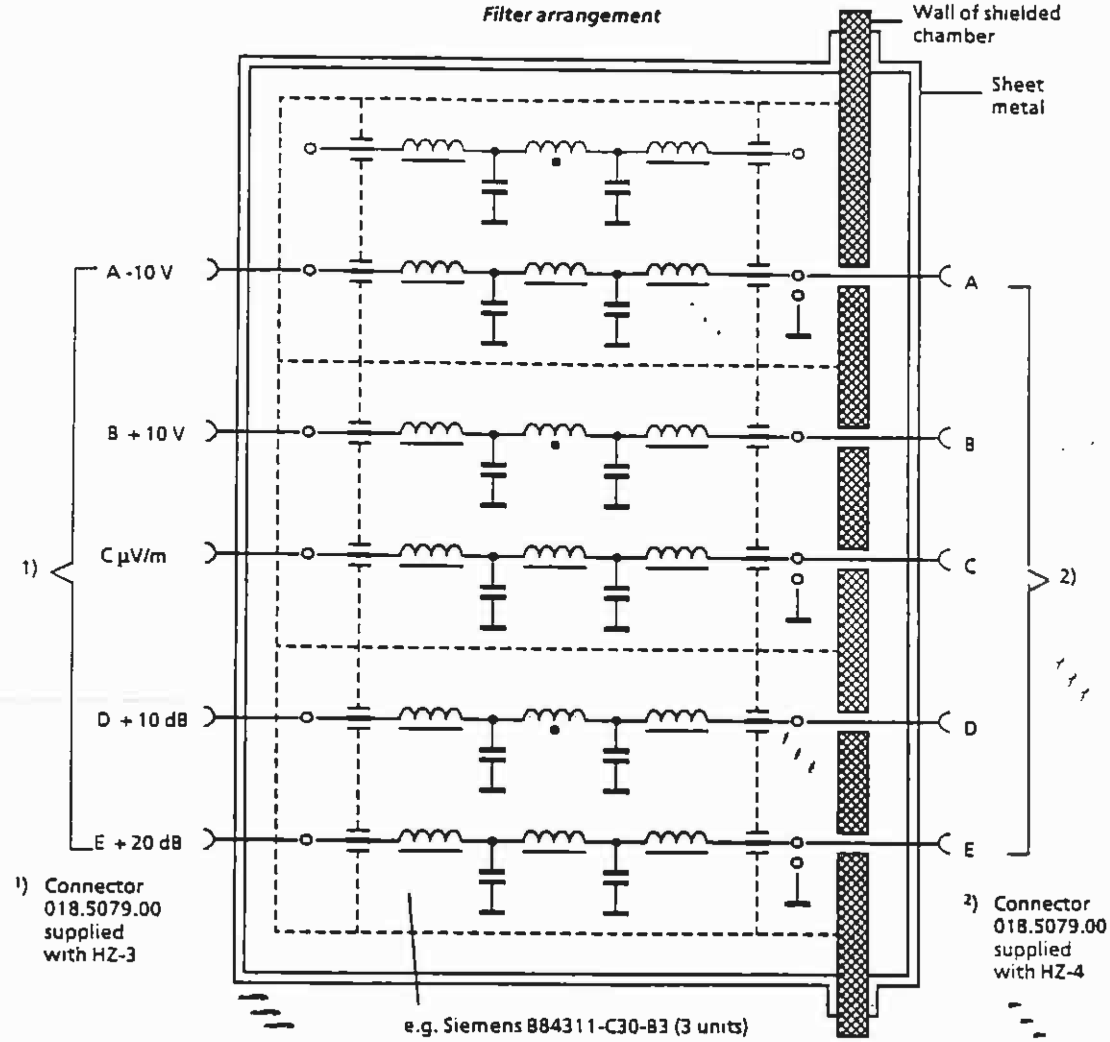


Fig. 3-53 Arrangement of the connecting cables HZ-3/4 with AF-filters for supplying and coding the Active Antennas HFH2-Z2 and -Z6 in shielded rooms

Note: *If the connectors are arranged favourably, the AF filters can also be used for control of the artificial mains networks (cf. section 3.4.1).*

If the transducer factor is used, the feedthroughs of the coding lines can be dispensed with. If the power supply unit is used for the Active Antenna HZ-9 inside the shielded room, the feedthroughs for the supply voltages can also be dispensed with.

Test Setup with Open Air Measurements:

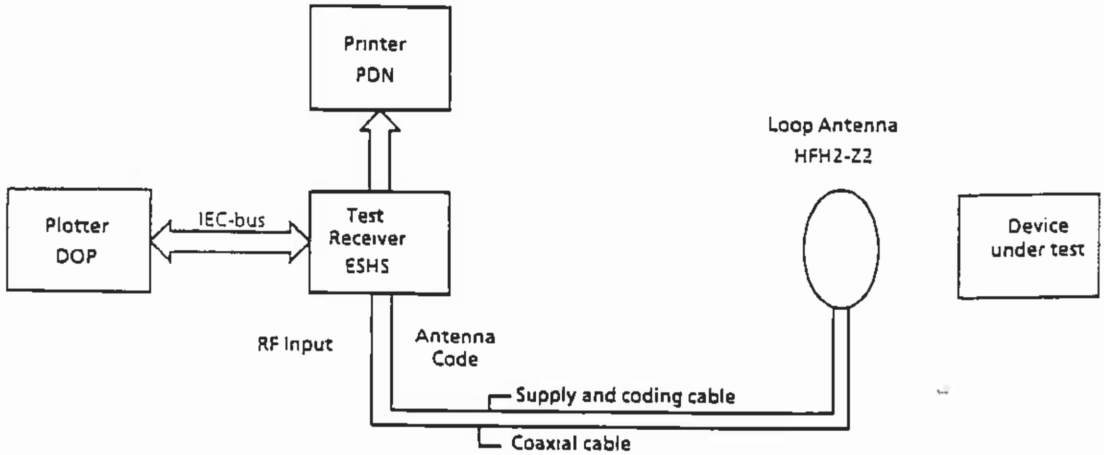


Fig. 3-54 Block diagram of a test setup with open air test. Make sure that the antenna is isolated from printer and plotter.

b) Setting of the Test Receiver

An automatic scan can only be recommended for measurements carried out in the shielded room, for example as a pre-measurement to roughly determine the fieldstrength and interference frequencies and subsequently check on individual frequencies in open air.

Measurement configurations need not be specified. Before starting the scan it is useful to align the antenna and device under test to maximum level indication of the frequency with the highest RFI fieldstrength (e.g. on the operating frequency of a switching power supply or on the line frequency of a screen).

The scan setting determines the run of the Prescan. The setting data recommended in section 3.4.1 are also true in this case. Pk must however be used as detector since there is only one QP-limit value.

The data reduction is defined by option 30.

For the final measurement option 42 (measuring again with QP-detector) is usually suitable.

The option 62 specifies whether the interference spectrum is plotted during or only following the measurement.

c) Measurement Sequence, Measurement and Analysis Procedure

The explanations given in section 3.4.1 are also valid for RFI-fieldstrength measurements, however without phase selection.

3.5 Program Examples

The examples given in this section illustrate how to program the test receiver and may be the foundation for the solution of more complex spheres of measurement. The examples are based on each other step by step and each one is explained.

The programming language used is the Rohde & Schwarz-BASIC from version 2.00 onward. It is, however, possible to translate the programs into other languages.

3.5.1 Initialization and Initial State

At the beginning of every program, the IEC-bus and the settings of the receiver should be brought into a defined default status. It is helpful to use subprograms, in this case "Prolog" and "Init_eshs".

The controller terminator should be set to "linefeed" (decimal 10), which - together with EOI - is the only permissible terminator according to the standard IEEE 488.2 and is also made use of in the ESHS.

```
10000 '
10010Prolog:
10020 '
10030    IEC TERM 10: '              Linefeed
10040    IEC TIME 1000: '            Timeout 1s
10050 '
10060    Eshs=17: '                  Receiver IEC address
10070 '
10080 '                              other initialization
10090 '
10100 RETURN
10110 '-----------------------------
```

The IEC-bus status register and the device settings of the receiver are brought to their default status using a further subprogram:

```
11000 '
11010Init_eshs:
11020 '
11030 '                              reset status registers
11040     IEC OUT Eshs,"*CLS"
11050 '
11060 '                              reset Receiver settings
11070     IEC OUT Eshs,"*RST"
11080 '
11090 '                              init other devices
11100 '
11110 RETURN
11120 '-----------------------------
```

3.5.2 Sending a Device Setting Command

In this example some settings of the receiver section are made: frequency, RF-attenuation and demodulator.

```
100 '-------------------------------
110 '      Send Receiver settings
120 '-------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_eshs
160 '                                   send new settings
170 IEC OUT Eshs,"FREQUENCY 20 MHZ"
180 IEC OUT Eshs,"ATTENUATION 30 DB;DETECTOR PEAK"
190 '
200 END
210 '-------------------------------
10000 '
10010Prolog:
10020 '
10030    IEC TERM 10: '                 Linefeed
10040    IEC TIME 1000: '               Timeout 1s
10050 '
10060    Eshs=17: '                     Receiver IEC address
10070 '
10080 '                                 other initialization
10090 '
10100 RETURN
10110 '-----------------------------
11000 '
11010Init_eshs:
11020 '
11030 '                                 reset status registers
11040     IEC OUT Eshs,"*CLS"
11050 '
11060 '                                 reset Receiver settings
11070     IEC OUT Eshs,"*RST"
11080 '
11090 '-----------------------------    init other devices
11100 '
11110 RETURN
11120 '-----------------------------
```

The subprograms "Prolog" and "Init_eshs" still integrated in this example will no longer be part of the following examples.

3.5.3 Reading of the Device Settings

The settings made in the preceding example are read in this program. The commands are used in short form for this purpose.

```
100 '-------------------------------
110 '      Read Receiver settings
120 '-------------------------------
130 '
140 GOSUB Prolog
150 '
160 '                                   read settings
170 IEC OUT Eshs,"F?"
180 IEC IN Eshs,Frequency$
190 '
200 IEC OUT Eshs,"A?
210 IEC IN Eshs,Rf_attenuation$
220 '
230 IEC OUT Eshs,"DET?"
240 IEC IN Eshs,Detector$
250 '                                   print settings on screen
260 PRINT Frequency$
270 PRINT Rf_attenuation$
280 PRINT Detector$
290 '
300 END
```

In line with the settings that have been made earlier, the following indication results:

FREQUENCY 20000000
ATTENUATION 30
DETECTOR PEAK

3.5.4 Triggering a Single Measurement and Synchronization using *WAI

In this case a level measurement at a frequency previously set is started using the common command *TRG. *WAI serves to delay the processing of further commands until all the previous commands - in this case the level measurement - are executed. Only then is the result of the last measurement read in and indicated on the screen. When using *WAI, please note that the set timeout must be longer than the processing time of the commands, as otherwise an error message results. In this example the timeout of 1 s set in the prolog is sufficient for the default measuring time of 100 ms.

```
100 '--------------------------------
110 '    Trigger and read result
120 '--------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_eshs
160 '                                set frequency
170 IEC OUT Eshs,"FREQUENCY 98.5 MHz"
180 '                                Trigger and Wait
190 IEC OUT Eshs,"*TRG;*WAI"
200 '                                get result
210 IEC OUT Eshs,"LEVEL:LASTVALUE?"
210 IEC IN Eshs,Level$
220 '                                print result on screen
230 PRINT Level$
240 END
```

The output on the screen might be as follows:

LEVEL:LASTVALUE 23.87

To simplify this frequently used sequence, the ESHS offers the command LEVEL?, which synchronizes internally level measurement and retrieving of the measured value. It substitutes for the commands *TRG;*WAI;LEVEL:LASTVALUE?. The synchronization mechanism described above can also be applied to all other commands.

3.5.5 Service Request Routine

The smartest and most flexible way of synchronization of sequences is offered by the Service Request.

It requires an interrupt routine being part of the program of the system controller. The routine can be serviced asynchronously to the usual program run, if a Service Request occurs.

In the case of this subprogram the device(s) having sent the Request can be identified by their status bytes when polling the devices that might have sent one. Subsequently the appropriate measures can be taken.

To activate the interrupt capability of the controller, the command

```
nnn    ON SRQ GOSUB label
```

must be added to the main program.

Service Request Routine:

```
12000 '-------------------------------
12010 '     Service Request Routine
12020 '-------------------------------
12030 Srq_routine:
12040 '                                   Serial Poll
12050     IEC SPL Eshs,Sb%
12060 '                                   Check SRQ-Bit
12070  IF (Sb% AND 64) THEN
12080 '                                   SRQ-Flag TRUE
12090      Srq%=1
12100 '                                   e.g. check registers
12110  ELSE
12120 '                                   poll other devices
12130  ENDIF
12140 '                           enable SRQ Interrupt and return
12150 '                           in the same line to avoid nesting!
12160 '
12170 ON SRQ GOSUB Srq_routine: RETURN
```

This very simple Service Request routine can be extended for the respective applications. It includes the operation of other devices connected to the bus or the weighting of additional IEC-bus register or error recoveries.

If a Service Request is to be generated at the end of processing of a command, the Event Status Enable register ESE and Service Request Enable register must be configured correspondingly.

The command *OPC sets the bit 0 in the Event Status register. Analog to this setting, the bit 0 in the Event Status Enable register must be set. Bit 5 in the Service Request Enable register must finally be set to enable a Service Request.

3.5.6 Synchronization with the End of the Scan using *OPC

In this example a scan, the end of which is waited for with the help of the command *OPC, is triggered. The end can be identified by the flag Srq% which is set in the Service Request routine. The registers stated in the before-mentioned example are previously configured.

```
100 '--------------------------------
110 '      Wait for Scan ready
120 '--------------------------------
130Exec_scan:
140    GOSUB Prolog
150    GOSUB Init_eshs
160 '                                 Init SRQ-Routine
170    ON SRQ GOSUB Srq_routine
180 '                                 Config Registers
190    IEC OUT Eshs,"*CLS;*ESE 1;*SRE 32"
200 '                                 Init SRQ-Flag
210    Srq%=0
220 '                                 Start Scan
230    IEC OUT Eshs,"SCAN:RUN;*OPC"
240 '
250 '                                 Do something useful
260 '                                 while scanning
270 '
280    REPEAT
290 '                                 Do something useful too
300 '                                 or just wait
310    UNTIL Srq%
320 '                                 Scan is completed
330 RETURN
```

3.6 Error Messages and Warnings

Error Messages

Error message	Cause	Section
1. LO HF unlock	Hardware error synthesizer	4.2.3
2. LO HF unlock	Hardwarefehler Synthesizer	4.2.3
Bus Control required	Plotter output cannot be performed since receiver does not control IEC bus.	3.2.4.4.4
CAL TOTAL required	Total calibration must be performed.	3.2.3.12.3
Connect Plotter!	Plotter output was started without a plotter being connected or the plotter address is wrong.	3.2.4.4.4 (3.2.4.4.1)
Connect Printer!	Printer output was started without a printer being connected.	3.2.4.4.3
Ext Ref	Receiver is synchronized with an external reference frequency.	3.2.4.1
Freqency Sequence	Increasing frequency sequence concerning entries into the table has not been adhered to.	3.2.4.2.2 3.2.4.3.2 3.2.4.3.3
FRN Osc unlock	Hardware error synthesizer	4.2.3
IEC Bus OFF(SF11)!	Plotter output cannot be performed since the IEC bus is switched off. Switch it on using special function 11.	3.2.4.3.3
Int Ref	Receiver operates with internal reference.	3.2.4.1
Limit exeeded	Measured value exceeds a limit line with Spec Func 16 ON	3.2.3.13
Max 2 Limits active	Attempt to activate a third limit line was made.	3.2.4.3.2
Max Freq 30 MHz	A frequency > 30 MHz was entered (transducer factor, limit value).	3.2.4.2.2
Max Level 200 dB	With the input of a transducer factor or a limit line a value > 200 dB was entered.	3.2.4.2.2 3.2.4.3.2
Max xx Values (xx = 10, 20 or 50)	Maximum number of points for transducer factor or limit line is reached; no further point possible	3.2.4.2.2 3.2.4.3.2
Measurement invalid Transd undefined	An active transducer is not defined in the complete scan range. Invalid measured values out of the definition range.	3.2.4.3.4
min Freq 9 MHz	A frequency < 9 MHz was entered (transducer, limit value)	3.2.4.2.2

Error message	Cause	Section
Min Level-200 dB	With the input of a transducer factor or a limit line a value < -200 dB was entered.	3.2.4.2.2 3.2.4.3.2
Register empty	A register containing no setting data is called using RCL.	3.2.4.5
<xx> undef	A transducer or limit line not defined is activated.	3.2.4.2.2 3.2.4.3.2
ERR: 30 dB Range *ERR: 60 dB Range*	Error during total calibration.	3.2.3.12.3
ERR: Detector Board	Hardware error during self-test	4.2.4
ERR: FRN Synth	Hardware error during self-test	4.2.4
ERR: HF Module	Hardware error during self-test	4.2.4
ERR: HF Synthesizer	Hardware error during self-test	4.2.4
ERR: gain at 1 MHz	Error during total calibration.	3.2.3.12.3
ERR: gain at xx MHz/kHz	Error during total calibration.	3.2.3.12.3
ERR: gain at BW 200 Hz	Error during total calibration.	3.2.3.12.3
ERR: IF Amplifier	Hardware error during self-test	4.2.4
ERR: IF Attenuator	Error during total calibration.	3.2.3.12.3
ERR: Meas uncal	Gain of the receiver cannot be set. Measured values are not accurate.	3.2.3.12.3
ERR: Pk/MHz	Error during total calibration.	3.2.3.12.3
ERR: QP Band A *ERR: QP Band B*	Error during total calibration.	3.2.3.12.3

Warnings

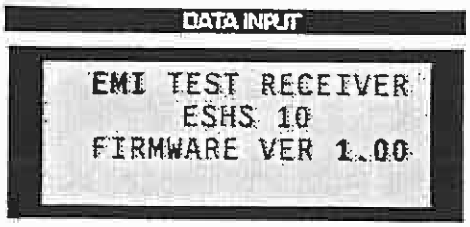
Warnings	Cause	Section
WARN: 30 dB Range *WARN:* 60 dB Range	Warning during total calibration	3.2.3.12.3
WARN: Curve OFF	Hint that the measurement curve is not plotted (Curve in Plotter Settings is off) in the case of plotter output during measurement (option 62).	3.2.4.4.1 3.2.4.3.3
WARN:EXT REF FREQ	The internal reference oscillator cannot synchronize with the connected reference (frequency not precise enough)	4.2.3
WARN:EXT REF LEV	Level of the external reference connected is not sufficient.	4.2.3
WARN: Gain at 1 MHz	Warning during total calibration	3.2.3.12.3
WARN: Gain at xx MHz/kHz	Warning during total calibration	3.2.3.12.3
WARN: Gain at BW 200 Hz	Warning during total calibration	3.2.3.12.3
WARN: IF Attenuator	Warning during total calibration	3.2.3.12.3
WARN: No Pen selected	No pen is selected for plotter output (Pen 0.)	3.2.4.4.4
WARN: Pk/MHz	Warning during total calibration	3.2.3.12.3
WARN: Plotter active	Plotter output is started anew using "PLOT" while the preceding plot is not yet concluded	3.2.4.4.4
WARN: QP Band A *WARN: QP Band B*	Warning during total calibration	3.2.3.12.3

3 Operating Instructions

3.1 Explanation of Front and Rear Panel View

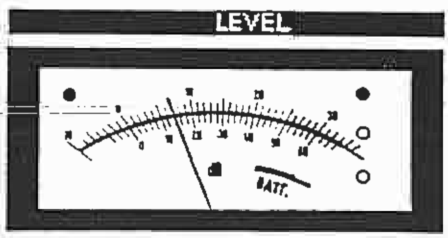
3.1.1 Front View

1



Menu input display for ANALYSIS, INSTR STATE and REPORT, 4 lines with 20 characters each, editing with DATA (cf. section 3.2.2)

2



- Moving coil instrument with scales for the 30-dB- and 60-dB-operating ranges;
- Display of battery voltage and mechanical zero display;
- Setting screw for the mechanical zero;
- Yellow LEDs for indicating the operating range;
- Red LEDs for indicating whether the operating range (upper or lower limit) is exceeded (cf. section 3.2.7.3)

3

BATTERY: Key for indicating the charge of battery (cf. section 2.1.3.2)

OPERATING RANGE: Key for switching-over the operating range (cf. section 3.2.3.6)

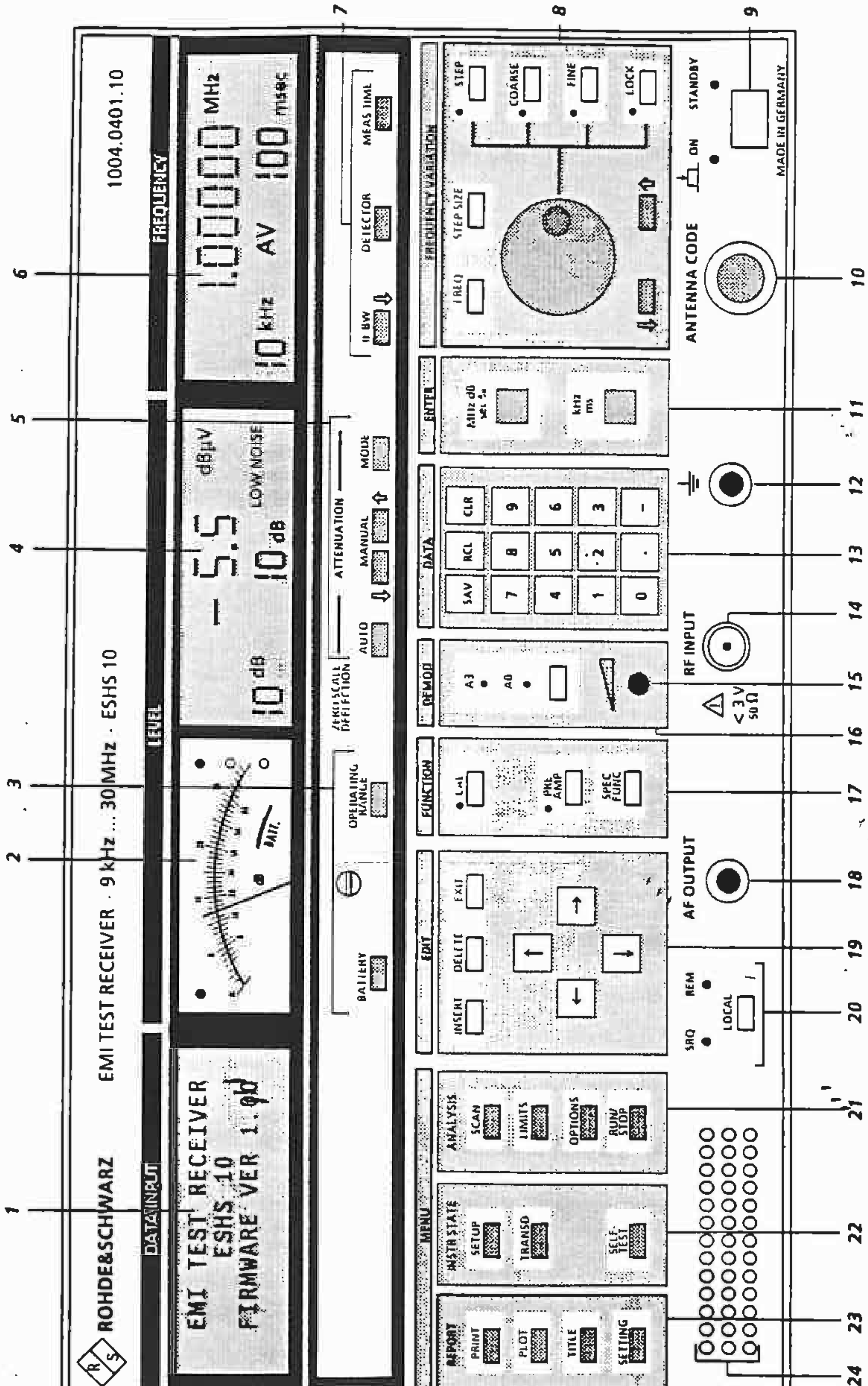


Fig. 3-1 Front panel view

4 Maintenance and Troubleshooting

Note: *In this section troubleshooting is described only up to replacement of the modules. For more detailed infomation we recommend the service manual with the order no.: ...*

4.1 Maintenance

4.1.1 Mechanical Maintenance

The ESHS requires no mechanical maintenance at all. The front panel should be cleaned from time to time preferably using a soft, damp cloth

4.1.2 Electrical Maintenance

4.1.2.1 Testing the Level Measuring Accuracy

As it is possible to perform a total calibration with the help of the built-in calibration generator, a high long-term stability of the level measurement characteristics, which exclusively depends on the aging of the calibration generator, is ensured. The measurement accuracy should be checked once every year according to section 5.2.6.1.1. The re-adjustment of the calibration generator required following exceedings of the tolerance limits should be effected by an R&S-service station

4.1.2.2 Testing and Adjustment of the Frequency Accuracy

The frequency accuracy of the reference oscillator should be checked once a year according to section 5.2.1. Re-adjustment, if required, may be performed only after at least 30 minutes of warming-up.

- Remove the instrument cover (cf. section 4.3)
- Connect the frequency counter (error < 1×10^{-8}) to the socket X165 (fig. 4-1)

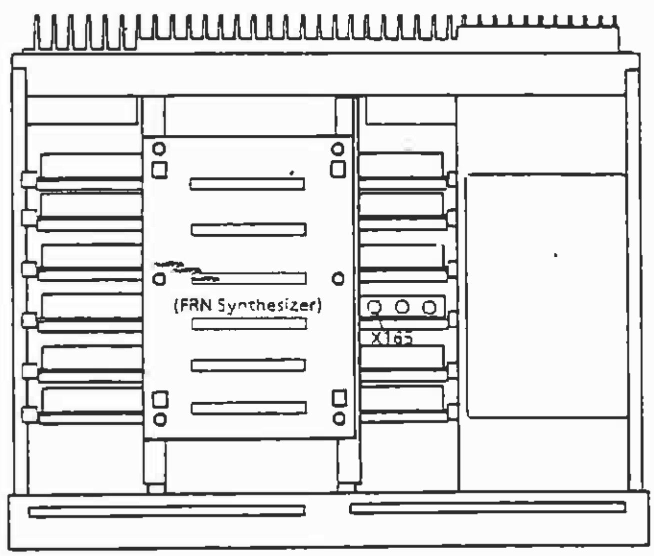


Fig. 4-1 Location of the socket X165 (instrument seen from below)

- Adjust the frequency accuracy to 64 MHz ± 10 Hz using the potentiometer VCXO TUNING (fig. 4-2).

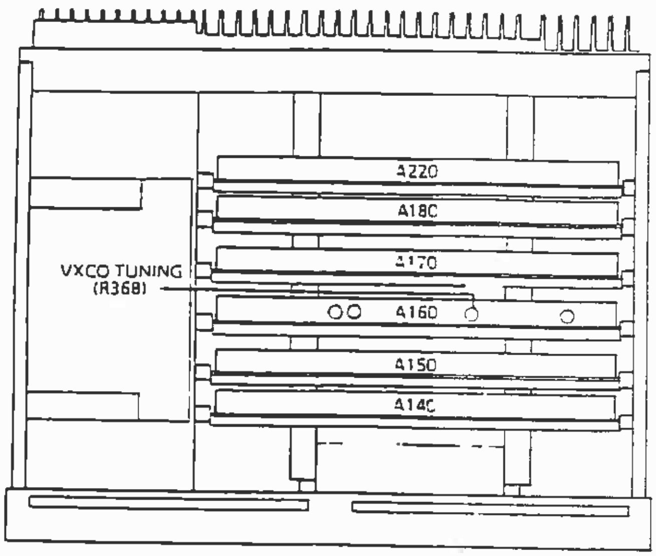


Fig. 4-2 Location of the potentiometer VCXO TUNING, R368 (instrument seen from above)

4.1.3 Replacing the Battery

The instrument contains a lithium battery for buffering the static RAM. The durability at normal ambient temperatures is 5 years. A discharged battery leads to the loss of data stored in the CMOS RAM when the instrument is switched off. This back-up battery is located on the module A220 (CPU-BOARD). It can be replaced in the following way:

- Withdraw the instrument cover.
- Remove the CPU-board (cf. section 4.3).
- Unsolder the discharged battery.
  The following types of batteries can be used instead:
  - SAFT LS3 CNA (R&S order no. 565.1687)
  - ELECTROCHE QTC85 1/2AA 3B960 (R&S order no. 565.1687)

  When fitting the new battery by way of soldering, make sure that the polarity is correct (cf. fig. 4-3)

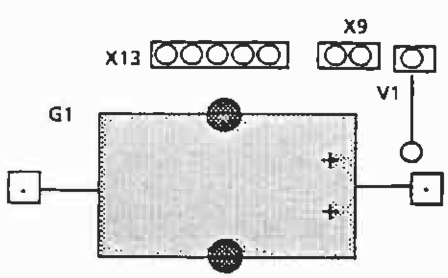


Fig. 4-3 Mounting position of the battery

4.2 Function Check and Self-Test

The ESHS features extensive equipment for checks and self-test, which allow comprehensive control of the receiver functions. If there is a fault, the device itself is able to locate the defect module. Exactly defined module interfaces make it possible to replace the modules without individual adjustment (cf. section 4.3). The adjustment to the total receiver, which may be required subsequently, is performed by menu-control and using the internal calibration generator so that no additional measuring instruments and devices are necessary.

The receiver functions are checked at four levels:

- Automatic test of the processor functions and adjustment of the A/D-converter following switch-on of the instrument.
- Test of all processor functions with cold start of the instrument.
- Permanent check of the synthesizer and power supply during operation.
- Function check of the total receiver (processor, synthesizer, signal unit) by manually calling the self-test.

4.2.1 Switch-on Test

When switching on the instrument the self-test of the processor functions first runs. Subsequently a rough function test of the CMOS RAM is subsequently performed by polling the contents of a memory location. The following pre-initialization of the analog modules serves to check the correct functioning of the interface module for the serial module control. Function test and self-adjustment of the A/D-converter terminate the switch-on test of the ESHS.

4.2.2 Cold Start

An extended switch-on test is carried out with the so-called cold start of the receiver. It is triggered by pressing the "." key in the numeric keypad during switch-on of the ESHS.

Compared to the usual test (see above) the program memory (EPROM), the static (CMOS RAM) and the volatile data memory (DRAM), the IEC-bus as well as the interfaces of the remaining modules are tested additionally in the case of the cold start following switch-on. Upon the detection of an error the message *ERR: CPU* is output on the frequency display. The receiver can no longer be operated.

Since not every device function makes use of all function units of the processor module, it may be possible that the receiver can be further operated. In this case a detailed hint as to the defect function unit can be obtained by calling the self-test after having switched off and on again the ESHS.

Caution: ***With the cold start all the data stored internally, such as limit lines and transducer factors are deleted and all the settings are brought to their default status.***

4.2.3 Checking the Synthesizer and the Power Supply

During operation all synthesizer loops in the instrument are checked as to whether the tuning voltages of the oscillators are within the permissible range. The following error messages may occur:

- *FRN Osc unlock*
- *1. LO HF unlock*
- *2. LO HF unlock*

If the level applied to the socket EXT REF INPUT is too small, the message *WARN:EXT REF LEV* appears on the DATA INPUT display.

If the reference signal has a frequency that is not suitable for the ESHS, the message *WARN:EXT REF FREQ* appears on the DATA INPUT display.

The internal supply voltages are checked both following switch-on of the instrument and permanently during the operation independently of the controller. The flashing of the green LED SUPPLY OK on the rear panel signals the correct functioning of the power supply. The instrument is switched off within 3 s when a supply voltage deviates from its nominal value or when there is a short-circuit in the instrument or in one of the accessories supplied by the ESHS. In connection with a short-circuit current limiting device operating without delay, grave sequence errors are prevented. Due to the processor-independent operation this protective functions are still effective even when the CPU-board fails.

4.2.4 Self-Test

The self-test allows to check the functions of the instrument without using additional measuring instruments (cf. section 3.2.4.2.3). If there is an error in the instrument, the module causing the error is indicated in the DATA INPUT display. The error is located by means of the following measures:

- The A/D-converter on the processor module has an additional test input in order to measure voltages within the modules.
- During the self-test the important d.c. voltages, such as module-internal supply voltages or amplifier operating points, are measured and compared to their nominal values on every module.
- Level detectors check the oscillator levels required for operation of the mixer.
- The calibration generator produces a signal with an exactly known level at the RF-input of the instrument. The processing of the input signal in the individual RF-and IF-stages of the receiver can be followed and faulty stages, e.g. amplifiers the gain of which deviates from the nominal value can be detected with the help of level detectors in the signal path. The detectors are available on every RF- and IF-module.

To avoid error messages that are not true, it must be checked whether all the functions of a lower function level operate correctly prior to checking a higher function level. It is thus only possible to recognize one error. The sequence in which the tests are performed results from the hierarchy of the functions in the instrument. The self-test is triggered by calling the function START TEST (cf. section 3) in the self-test menu. The hint *SELFTEST RUNNING* appears on the DATA INPUT display.

a) Testing the Processor Function

After having started the self-test or a cold start (cf. section 4.2.2) the processor functions and the internal supply voltages are first checked. If there is an error in one of the following function blocks on the CPU-board:

- MAIN CPU (processor),
- OT PROM (memory for operating system),
- FLASH EPROM (firmware program memory) or
- IFPAS CONTROLLER (serial interface for control of the modules),
- CMOS RAM (non-volatile data memory),

the instrument may not be able to output a detailed error message; the first and the third line of the DATA INPUT display appears in inverse screen: the instrument can no longer be operated.

An error occurring in one of the function blocks

- DRAM (volatile data memory),
- MUART (multi-function component),
- INTERRUPT CONTROLLER or
- A/D-converter

leads to the output of the message *ERR: CPU BOARD;* in addition the instrument can no longer be operated in order to prevent faulty measurements.

A faulty function in one of the blocks

- IEC BUS CONTROLLER (IEC-BUS interface),
- RS232 CONTROLLER (serial interface for loading a new firmware)

is indicated by the error messages

- *ERROR:Time Clock,*
- *ERROR:IEC* or
- *ERROR:RS232* during the self-test.

The error message remains visible until it is deleted by calling a menu. Since not every instrument function makes use of all function units, operation with reduced characteristics may be possible. To give a hint as to the defect module the message *ERR:CPU BOARD* appears. If there is no error, it is indicated by *CPU BOARD ok.*

b) Supply Voltage Test

First the device-internal supply voltages +5 V, +10 V, -10 V and +28 V are checked. The following messages are output on the DATA INPUT display, if the deviations exceed the permissible range:

- *ERR: +5 V,*
- *ERR: +10 V,*
- *ERR: -10 V* or
- *ERR: +28 V;*

the self-test is aborted and the message *"Test aborted"* appears.

c) Synthesizer Test

The correct operation of all oscillators is required for testing the signal path. For this reason all the synthesizer modules are checked. As can be seen in figure 4-4, the ESHS contains two synthesizer modules. The reference oscillator and the function units REFERENCE LOOP and FRN LOOP are located on the module A160 (FRN SYNTHESIZER).

The module A150 (HF-SYNTHESIZER1) contains the VCO for controlling the first mixer and control loop 1. LO LOOP.

The module tests comprise the test of the control loops at various synthesizer divider factors, checking the operating points of oscillator and amplifier as well as the internal signal levels. An error contained in one of the two modules is indicated by *ERR:FRN Synth* or *ERR:HF Synth*; the self-test is aborted and the hint *"Test aborted"* appears.

Subsequently the second conversion oscillator, which is contained on the module A 170 (IF AMPLIFIER), and the associated control loop are checked. The message *ERR:IF Amplifier, Test aborted"* is indicated on the DATA INPUT display, when there are deviations from the nominal frequency or when the oscillator level falls below that required for operation of the 2. mixer.

After the successful completion of all synthesizer tests, *"Synth Boards ok"* appears on the DATA INPUT display.

d) Testing the Signal Path

Subsequently all the RF-, IF- and weighting modules contained in the receiver are checked. Figure 4-4 provides an overview on the signal flow:

The calibration generator available on the module A140 (HF MODULE) generates the test signal for checking the signal-processing stages. The signal flow via the pre-selection filters and the 1. mixer is checked by means of a level detector; in addition internal supply voltages, the working point of the 1. IF-amplifier and the oscillator level at the input of the 1. mixer are tested. Any errors detected are indicated by the message *ERR HF Module, Test aborted"* on the DATA INPUT display.

The d.c. operating points of the 74.7-MHz IF-amplifier are first checked on the module A170 (IF Amplifier); the signal flow via the amplifiers and the 10-kHz main selection filter is performed by a level detector at the 80-kHz output of the 2. mixer: subsequently the 80-kHz IF-amplifier and the separate signal processing unit for the two IF-bandwidths 10 kHz and 200 Hz are tested. In the case of an error the message *ERROR:IF Amplifier, Test aborted* appears.

The self-test of the module A180 (DETECTOR BOARD) starts with the testing of the envelope detector. After that the average value (AV-) detector and the quasipeak detector are examined.

The logarithmic amplifier and the peak value detector are then tested. Finally the control circuitry for the analog instrument and the transducer correction are tested. If there is a faulty function, the message *ERROR:DETECTOR BOARD, Test aborted"* appears on the DATA INPUT display.

After having carried out successfully the module test a total calibration of the insrument is performed to check the measurement characteristics. If any tolerance is exceeded, a hint as to the module causing the error results. The correct termination of the self-test is indicated by the message *"SELFTEST COMPLETE, Instrument ok"*. The ESHS then returns to its normal operating condition. The entire self-test takes about 120 seconds, when it is completed with *"Instrument ok"*.

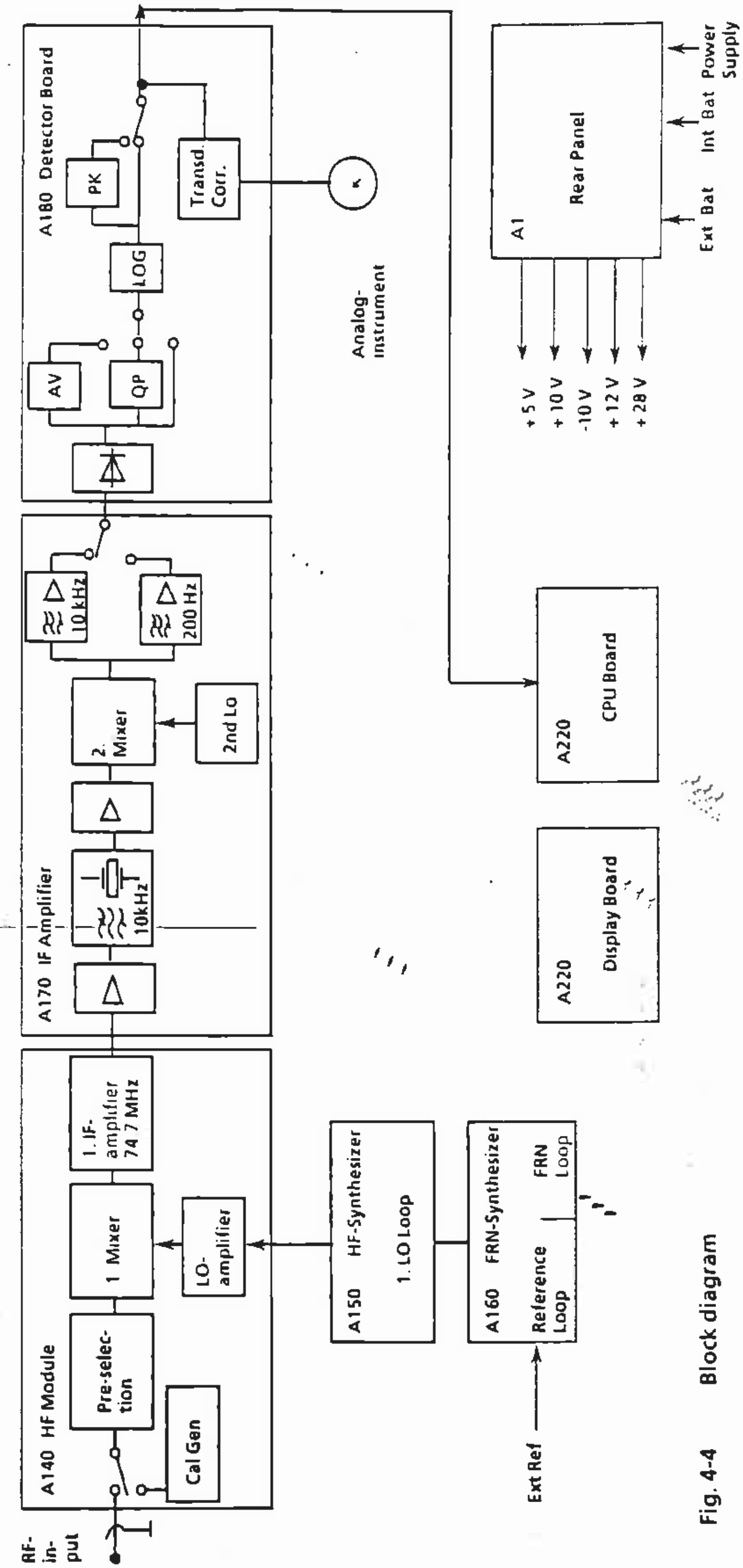


Fig. 4-4 Block diagram

4.3 Replacing the Modules

4.3.1 Opening the Instrument

- Switch off the instrument and remove the power plug.
- Unscrew the 4 Philips screws in the two rear panel feet and withdraw them to the rear.
- Withdraw the upper and lower instrument covers to the rear.

4.3.2 Removing a Module from the Instrument

- Put the instrument on its top side.

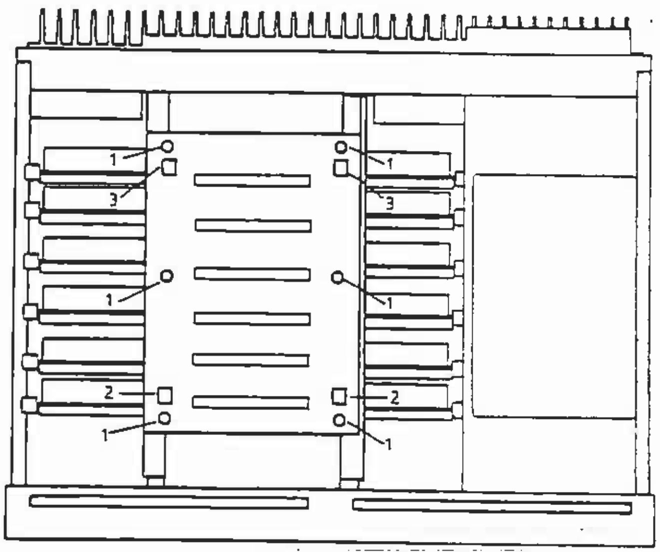


Fig. 4-5 Opened instrument seen from below

- Unscrew 6 Philips screws ① (*do not remove!*)
- Push the two locking rails ② toward the front panel using a slotted screwdriver (cf. hints "BOARDS UNLOCK").
- Removing the CPU-BOARDs:
  - Remove two ribbon cables at the bottom side and one ribbon cable at the top side of the respective module.
- Removing the remaining modules:
  - Remove the SMB-RF-connector from the module to be replaced.
- Withdraw the respective module to the top by pushing it out of the instrument without effort.

4.3.3 Fitting a Module

- Slide the module into the instrument from above without effort. The upper side of each module (identifiable by the cover with service labelling) must point to the rear panel.
- Plug the SMB-RF connector or ribbon cable again onto its place in line with the labelling. With correctly connected RF-cabling, the cables may not cross each other.
- Slide the module locking rails ③ toward the rear panel using a slotted screwdriver (cf. notes "BOARDS LOCK")
- Tighten the 6 Philips screws ①.

4.3.4 Taking the Receiver into Operation after the Replacement of a Module

- Switch on the receiver.
  ▌ ***Caution! Pay attention to the safety regulations!*** ▌
- Press the SELFTEST key.
  The self-test menu is called.

  Note: *Following the replacement of the modules HF MODULE, HF SYNTHESIZER1, FRN SYNTHESIZER and CPU BOARD no adjustment is required.*

- Only when replacing the module IF AMPLIFIER:
- Call the function *IF Gain Adj* in the self-test menu.
  When the LEVEL display indicates a value in the range of 59.0 to 61dBµV, no re-adjustment is necessary.
- In the case of an indication outside this range the level display must be set to 60 dBµV ± 0,2 dB by turning the potentiometer IF GAIN ADJ (cf. fig. 4-6).

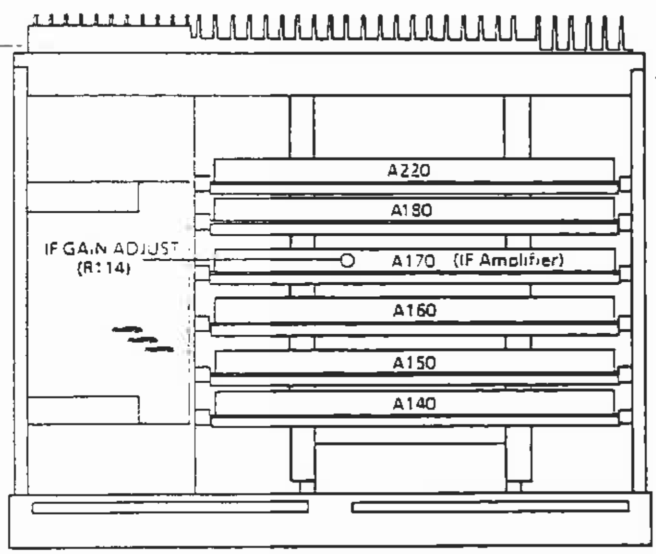


Fig. 4-6 Position of the potentiometer IF GAIN ADJUST, R114 (instrument seen from above)

- Start self-test.
  When all the modules operate correctly and the RF-cabling has been connected rightly, the message *Instrument ok* appears on the DATA INPUT display.

- Only when replacing the module DETECTOR BOARD:
  - Call the function *Meter Adj* in the self-test menu.
  - Turn the potentiometer "INST FULL SCALE" ① R354 (fig. 4-7) such that the indication of the instrument is identical with the 50-dB mark.

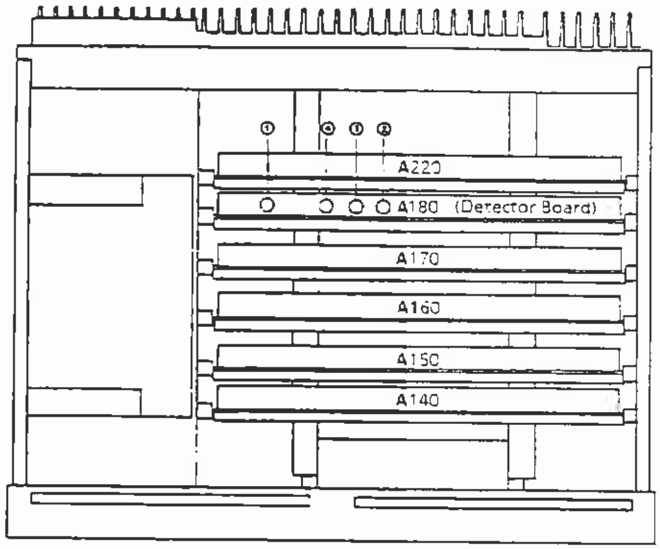


Fig. 4-7 Position of the adjustment points for the module DETECTOR BOARD

- Set the RF-attenuation to 60 dB
- Set the pointer to 0 dB using the potentiometer "INST ZERO 60 dB" (R 331) ②.
- Set the OP RANGE to 30 dB.
- Set the pointer to 0 dB using the potentiometer "INST ZERO 30 dB" (R 330) ③.
- Set the RF-attenuation to 30 dB.
- Call the function *CAL GEN ON/OFF* in the self-test menu.
- Activate and deactivate the calibration generator by pressing repeatedly the ENTER key while turning the potentiometer INST SPEED (R 354) ④ such that the pointer of the moving-coil instrument overshoots by one pointer width when the calibration generator is switched on.

5 Testing the Rated Specifications

5.1 Measuring Equipment and Accessories

Item	Type of Instrument	Required Characteristics	Suitable R&S-instrument	Order No.	Application
1	Frequency counter	up to 100 MHz error < $1 \cdot 10^{-8}$ resolution 0.1 Hz			5.2.1
2	Digital multimeter	4¹/₂-digit	UDS5	349.1510.02	5.2.7.2 5.2.7.5.1 5.2.7.5.2 5.2.8.2 5.2.8.3
3	Signal generator	9 kHz to 200 MHz level: -130 to 13 dBm frequency error: < $1 \cdot 10^{-8}$	SMG	801.0001.52	5.2.1 5.2.2.3 5.2.2.3.1 5.2.2.3.2 5.2.2.3.3 5.2.2.4.1 5.2.8.1
4	Signal generator	9 kHz to 30 MHz level -130 to 13 dBm	SMK	348.0010.03	5.2.2.4.1 5.2.2.4.2 5.2.3 5.2.6.1.1 5.2.6.1.2 5.2.6.1.3 5.2.6.2 5.2.6.3 5.2.7.1 5.2.7.2 5.2.7.3 5.2.7.4 5.2.7.5.1
5	3-dB coupler	9 kHz to 30 MHz decoupling >20 dB			5.2.2.4.1
6	Reflection coefficient measuring instrument	9 kHz to 30 MHz	ZPV	291.4012.92	5.2.2.1
7	50-Ω termination	9 kHz to 30 MHz	RNA	272.4510.50	5.2.4 5.2.5
8	Spectrum analyzer	9 kHz to 200 MHz sensitivity: -127 dBm	FSA	804.8010.52	5.2.2.2
9	Power meter	9 kHz to 30 MHz, Z = 50 Ω -30 to 10 dBm, error <0.1 dB	NRV	828.2511.02	5.2.6 5.2.7.2
10	Pulse generator	Schwarzbeck 3-standard-pulse generator IGUS calibrated to ≤ 0.1 dB			5.2.6.1.2 5.2.6.1.3
11	Attenuator	9 kHz to 30 MHz accuracy ≤ 0.1 dB	RSP	831.3515.02	5.2.6.2 5.2.6.3
12	Oscilloscope	f_{max} = 10 MHz			5.2.7.1
13	Power supply unit	0 to 65 V, 4 A	NGB 70	177.7227.90	5.2.8.2

5.2 Test Run

The rated specifications of the receiver are tested following at least 30 minutes of warm-up time and after having performed a total calibration. This is the only way to ensure that the guaranteed data are adhered to.

The values given in the following sections cannot be guaranteed; only the specifications stated in the data sheet are binding.

5.2.1 Frequency Accuracy

Measuring equipment: Frequency counter
signal generator, frequency error < $1 \cdot 10^{-8}$

-17 DBM

Test setup: Connect the signal generator (29 MHz, 90 dBµV) to the RF input of the ESHS.

Connect the frequency counter to the 80-kHz output (rear panel).

ESHS settings:

Frequency:	30 MHz 29 MHz
RF ATT:	50 dB
MODE:	LOW NOISE
IF BW:	10 KHZ
OP RANGE:	60 dB

Test: Indication on the frequency counter .... 80 kHz ± 90 Hz

5.2.2 RF Input

5.2.2.1 Input VSWR

Measuring equipment: Reflection coefficient measuring instrument

Test setup: Connect the reflection coefficient measuring instrument to the RF input of the ESHS via a low-reflection N-cable.

Test: Measure the return loss of the ESHS with the following settings:

RF ATT 0 dB, PREAMP OFF .... VSWR < 2
RF ATT 10 dB, PREAMP OFF .... VSWR ≤ 1.2
RF ATT 0 dB, PREAMP ON .... VSWR < 2
RF ATT 10 dB, PREAMP ON .... VSWR < 1.2

Perform the measurement at no less than 3 frequency points (at the beginning, mid and end of the range) per input filter range (cf. data sheet).

5.2.2.2 RFI Voltage of the Oscillator

Measuring equipment: Spectrum analyzer

Test setup: Connect the spectrum analyzer to the RF input of the ESHS.

ESHS setting: RF ATT 0 dB

Analyzer Settings:

Start frequency	74.7 MHz
Stop frequency	104.7 MHz
Indication in	dBµV
Reference level	60 dBµV
Scale	10 dB/DIV
Bandwidth	1 kHz
Measurement mode	Max. Hold

Test: Tune through the receiver frequency from 9 kHz to 30 MHz in 100-kHz steps such that the level at each frequency is indicated by the analyzer.

Level indicated by the analyzer
without preamplifier (PREAMP OFF) .... < 20 dBµV
with preamplifier (PREAMP ON) .... < 10 dBµV

5.2.2.3 Interference Immunity

Measuring equipment: Signal generator

Note: *To avoid that the sideband noise of the generator is measured at the receiver frequency, the sideband signal-to-noise ratio should be higher than 140 dBc/Hz. This can be achieved by connecting a 30-MHz high-pass filter between generator output and receiver input, if required.*

Test setup: Connect the signal generator to the RF input of the ESHS.
Level: 100 dBµV

ESHS settings:

RF ATT:	0 dB
MODE:	LOW DISTORTION
DETECTOR:	AV
OP RANGE:	60 dB
IF-BW:	200 Hz

5.2.2.3.1 Image of the First Intermediate Frequency

Test:

- Set the generator frequency to f_{rec} + 149.4 MHz.
- Measure the level L_{ind} at the receiver frequency f_{rec}.
  The image frequency rejection is obtained as follows:

  $100 - L_{ind}$ /dBµV

  Level indication on the receiver .... < 20 dBµV
  (PREAMP OFF and ON)

5.2.2.3.2 Image of the Second Intermediate Frequency

Test:

- Set the generator frequency to 1.16 MHz.
- Set the receiver frequency to 1 MHz.
- Measure the level (L_{ind}).
  The image frequency rejection is obtained as follows:

  100 - L_{ind} /dBµV

  Level indication on the receiver .... < 25 dBµV
  (PREAMP OFF and ON)

5.2.2.3.3 IF Interference Immunity

Test:

- Set the generator frequency to 74.7 MHz.
  Receiver frequency 9 kHz to 30 MHz
- Measure the level L_{ind} at the respective receiving frequencies.
  The IF-interference immunity is obtained as follows:

  100 - L_{ind} /dBµV

  Level indication on the receiver .... < 20 dBµV
  (PREAMP OFF and ON)

5.2.2.4 Non-Linearities

5.2.2.4.1 Intercept of Third Order

Measuring equipment: Signal generator (2 units)
3-dB coupler

Test setup: Connect the signal generator to the RF input of the ESHS via the 3-dB coupler.

Level applied to the ESHS : 97 dBµV at both f_{g1} and f_{g2}

The intercept point of third order of the test setup must be > 30 dBm to avoid falsification of the measurement (level of the interference products < -13 dBµV).

ESHS settings:

RF ATT:	0 dB (PREAM OFF) / 10 dB (PREAM ON)
MODE:	LOW NOISE
DETECTOR:	AV
OP Range:	60 dB
IF BW:	10 kHz

Test:

- Set the generator frequencies f_{g1} and f_{g2} in steps of ≥ 100 kHz in the receiving frequency range 9 kHz to 30 MHz.
- Measure the levels of the generators at the respective frequencies (nominal value: 97 dBµV).
- Measure the interference products at the frequencies

  $f_{rec1} = 2 \cdot f_{g1} - f_{g2}$ and

  $f_{rec2} = 2 \cdot f_{g2} - f_{g1}$.

▸ The intercept IP3 can be calculated according to the following formula:

with preamplifier

$IP3/dBm = (87\ dB\mu V-(level\ at\ f_{rec})/dB\mu V)/2-20\ dBm$

without preamplifier

$IP3/dBm = (97\ dB\mu V-(level\ at\ f_{rec})/dB\mu V)/2-10\ dBm$

Receiver frequency (nominal values)	Pre-amplifier off	Pre-amplifier on
f_{rec} < 2 MHz	typ. 15 dBm	typ. 0 dBm
f_{rec} ≥ 2 MHz	> 15 dBm typ + 20 dBm	> 0 dBm typ + 5 dBm

5.2.2.4.2 Intercept of Second Order

Measuring equipment: Signal generator

Test setup: Connect the signal generator to the RF input of the ESHS.
Level applied to the ESHS : 97 dBµV
The harmonics suppression of the signal generator signal must be > 70 dB to avoid falsification of the measurement. It can be achieved using suitable low-pass filters which attenuate the first harmonic of the signal generator signal.

ESHS settings:

RF ATT:	0 dB
MODE:	LOW NOISE
DETECTOR:	AV
OP RANGE:	60 dB
IF BW:	10 kHz

Test:

▸ Set the generator frequency within the frequency range 9 kHz to 15 MHz.

▸ Measure the level at the generator frequency (nominal value: 97dBµV).

▸ Set the receiver frequency f_{rec} to the first harmonic of the generator frequency and measure the level.

▸ The intercept IP2 can be calculated according to the following formula:

$IP2/dBm = (97\ dB\mu V-(level\ at\ f_{rec})\ /dB\mu V)-10\ dBm$

Nominal value:
without preamplifier (PREAMP OFF) .... > 40 dBm
with preamplifier (PREAMP ON) .... > 20 dBm

5.2.3 IF Bandwidths

Measuring equipment: Signal generator

Test setup: Connect the signal generator to the RF input of the ESHS.
Level: 90 dBµV
Frequency: 10 MHz

ESHS settings:
Frequency: 10 MHz
RF ATT: AUTO
MODE: LOW NOISE
DETECTOR: AV
OP RANGE: 60 dB

Test:

- Turn the frequency of the receiver in 10-Hz steps such that the level indication assumes its maximum value.
- Measure the 3-dB-, 6-dB- and 60-dB- or 50-dB-bandwidth in accordance with the following table by increasing and decreasing the generator frequency.

nom. bandwidth	3-dB bandwidth	6-dB bandwidth	harmonic factor
10 kHz	5.6 to 8.4 kHz	9.0 to 10.0 kHz	$B_{6\,dB}/B_{60\,dB}$ = 1:3.5 typ
200 Hz	112 to 168 Hz	170 to 220 Hz	$B_{6\,dB}/B_{50\,dB}$ = 1:7.5 typ

5.2.4 Noise Indication

Measuring equipment: 50-Ω termination

Test setup: Terminate the RF input of the ESHS using 50 Ω.

ESHS settings:
RF ATT: 0 dB
MODE: LOW DISTORTION
OP RANGE: 60 dB
MEAS TIME: 100 ms

Test: Measure the noise indication with the following receiver settings:

DETECTOR AV, IF BW 10 kHz, PREAMP OFF
DETECTOR AV, IF BW 10 kHz, PREAMP ON
DETECTOR AV, IF BW 200 Hz, PREAMP OFF
DETECTOR AV, IF BW 200 Hz, PREAMP ON

DETECTOR	IF BW	Frequeny range	Noise indication	
			PREAMP OFF	PREAMP ~~OFF~~ ON
AV	200Hz	9 to 50 kHz ≥ 50 kHz	10 to -30 dBµV <-30 dBµV	20 to -36 dBµV <-36 dBµV
AV	10 kHz	≥ 50 kHz	<-14 dBµV typ. -17 dBµV	<-20 dBµV typ. -25 dBµV

5.2.5 Testing the Inherent Spurious Responses

Test setup: Terminate the RF input of the ESHS using 50 Ω.

ESHS settings:

RF ATT:	0 dB
IF BW:	200 Hz
MODE:	LOW DISTORTION
OP RANGE:	30 dB
MEAS TIME:	100 ms

Test: Tune the receiver in 100-Hz steps in the frequency range of 9 kHz to 30 MHz and measure the level at each frequency set. The level indicated due to inherent spurious responses must not be higher than -10 dBµV.

5.2.6 Measuring Accuracy

The level measuring accuracy of the ESHS depends on:

- the accuracy of the internal calibration generator,
- the accuracy of the RF attenuator,
- the linearity of the demodulator and the logarithmic amplifier
- the residual calibration error and
- the signal-to-noise ratio.

Provided that the signal-to-noise ratio is sufficient, the maximum total error for sinusoidal signals with average and peak value indication is lower than ± 1 dB (typ. 0.5 dB).

Measuring equipment:

Signal generator
Power meter
Pulse generator: Level 80 dBµV/MHz ± 0.1 dB (at 1 MHz),
selectable pulse frequency (1 Hz to 1 kHz)
frequency response < ± 0.2 dB (9 kHz to 30 MHz)

The output level of the signal generator is calibrated to the nominal value at each frequency set with the help of a thermal power meter (error <0.1 dB).

5.2.6.1 Frequency Response

5.2.6.1.1 Indicating Mode AV

Test setup: Connect the signal generator to the RF input of the ESHS.
Level 90 dBµV ± 0.1 dB

ESHS settings:

RF ATT:	60 dB
MODE:	LOW NOISE
DETECTOR:	AV
OP RANGE:	30 dB
IF BW:	10 kHz
MEAS TIME:	100 ms

Test: Check the level measuring accuracy in the frequency range of 9 kHz to 30 MHz. Perform a short calibration before every measurement.

Nominal indication (analog and digital) .... 90 dBµV
permissible error digital indication .... ± 0.4 dB
permissible error analog indication .... 1 dB

5.2.6.1.2 Indicating Mode Pk and Pk/MHz

a) Accuracy for Sinusoidal Signals

Test setup: Connect the signal generator to the RF input of the ESHS..
Level 90 dBµV ± 0.1 dB

ESHS settings:

RF ATT:	70 dB
MODE:	LOW NOISE
DETECTOR:	Pk
OP RANGE:	30 dB
IF BW:	200 Hz
MEAS TIME:	100 ms

Test: Check the level measuring accuracy at 1 MHz.

Nominal indication (analog and digital) .... 90 dBµV
permissible error digital indication .... ± 0.5 dB
permissible error analog indication .... 1 dB

b) Accuracy for Pulse Signals (Pk)

When measuring pulse signals the tolerance of the 6-dB bandwidth (= pulse bandwidth) of the IF-filters is part of the measurement result. The permissible error is thus increased by the bandwidth tolerance.

Test setup: Connect the pulse generator to the RF input of the ESHS.
Pulse frequency: f_p = 25 (IF BW 200 Hz)/100 Hz (IF BW 10 kHz)
Level: 80 dBµV/MHz

ESHS settings:

IF bandwidth	10 kHz	200 Hz
RF ATT MODE DETECTOR OP RANGE MEAS TIME FREQUENCY	10 dB LOW NOISE PK 30 dB 100 ms 1 MHz	10 dB LOW NOISE Pk 30 dB 500 ms 100 MHz

Test: Measure the level at the ESHS with and without preamplifier.

IF BW	nom. level	permissible error digital indication
200 Hz	6 dBµV	+ 2.5/-0.5 dB
10 kHz	40 dBµV	+ 2/-1 dB

c) Accuracy for Pulse Signals (Pk/MHz)

ESHS settings: DETECTOR Pk/MHz
the other settings as under b).

Test: Measure the level at the ESHS.

IF BW	nominal level	permissible error digital indication
10 kHz	80 dBµV/MHz	± 0.5 dB

5.2.6.1.3 Indicating Mode QP

a) Accuracy for Pulses

Test setup: Connect the pulse generator to the RF input of the ESHS.

Pulse frequency: with f_{rec} < 150 kHz 25 Hz
with f_{rec} > 150 kHz 100 Hz

Level: 80 dBµV/MHz ± 0.1 dB

ESHS settings:
RF ATT: 10 dB
MODE: LOW NOISE
DETECTOR: QP
OP RANGE: 30 dB
MEAS TIME: 500 ms

Test: Check the measuring accuracy at 100 kHz and 1 MHz.

Nom. level f_{rec} = 100 kHz .... 0.4 dBµV ± 1 dB
f_{rec} = 1 MHz .... 33 dBµV ± 1 dB

b) Accuracy for Sinusoidal Signals

Test setup: Connect the signal generator to the RF input of the ESHS.
Level: 80 dBµV ± 0.1 dB

ESHS settings:

Receiver frequency	9 to < 150 kHz (band A)	0.15 to 30 MHz (band B)
RF ATT	70 dB	50 dB
MODE	LOW NOISE	LOW NOISE
DETECTOR	QP	QP
OP RANGE	30 dB	30 dB
MEAS TIME	500 ms	500 ms

Test: Check the measuring accuracy at 100 kHz and 1 MHz.

Nominal level .... 80 dBµV ± 1 dB

c) Quasipeak Weighting Curve

Test setup: Connect the pulse generator to the RF input of the ESHS.
Level: 80 dBµV/MHz ± 0.1 dB

ESHS settings:

Receiver frequency	100 kHz (Band A)	1 MHz (Band B)
RF ATT	0 dB	10 dB
MODE	LOW DIST.	LOW DIST.
DETECTOR	QP	QP
OP RANGE	60 dB	60 dB
MEAS TIME	2 s	2 s

Test: Measure the level applied to the ESHS depending on the pulse frequency of the pulse generator according to the following tables. In the case of band A the reference value is the level at the pulse frequency of 25 Hz; in the case of band B it is the level at the pulse frequency of 100 Hz.

Band A:

Pulse frequency	Level nom. value	Nom. value weighting	Tolerance
25 Hz	0 4 dBµV	--	±0.5 dB
100 Hz	4.4 dBµV	+4 dB	±1 dB
60 Hz	3.4 dBµV	+3 dB	±1 dB
10 Hz	-3.6 dBµV	-4 dB	±1 dB
5 Hz	-7.1 dBµV	-7 5 dB	±1.5 dB
2 Hz	-12.6 dBµV	-13 dB	±2 dB
1 Hz	-16.6 dBµV	-17 dB	±2 dB
Single pulse	-18.6 dBµV	-19 dB	±2 dB

Band B:

Pulse frequency	Level nom. value	Nom. value weighting	Tolerance
100 Hz	33 dBµV	--	±0.5 dB
1000 Hz	37.5 dBµV	+4.5 dB	±1 dB
20 Hz	26.5 dBµV	-6.5 dB	±1 dB
10 Hz	23 dBµv	-10 dB	±1.5 dB
2 Hz	12.5 dBµV	-20.5 dB	±2.0 dB
1 Hz	10.5 dBµV	-22.5 dB	±2.0 dB
Single pulse	9 5 dBµV	-23 5 dB	±2.0 dB

5.2.6.2 Indication Linearity

Measuring equipment:	Signal generator Attenuator, attenuation corrected, max. permissible error < 0.1 dB
Test setup:	Connect the signal generator to the RF input of the ESHS via the attenuator.

Level of the signal generator .... 83 dBµV
Basic attenuation of the attenuator .... 3 dB

a) 30-dB Range

ESHS settings:

Frequency:	1 MHz
RF ATT:	50 dB
MODE:	LOW NOISE
DETECTOR:	AV
OP RANGE:	30 dB
IF BW:	10 kHz
MEAS TIME:	100 ms

Test:

- Set the level applied to the signal generator such that the ESHS indicates full-scale deflection (80.0 dBµV).
- Increase the attenuation of the attenuator to 33 dB using 2-dB steps and measure the level indication at each individual setting. At the same time check the level analog indication on the instrument.
  The level indication decreases by 2 dB with each attenuation step.

Permissible linearity error:
Digital indication ≤ 0.2 dB
Analog indication ≤ 1 dB

b) 60-dB Range

ESHS settings:

Frequency:	1 MHz
RF ATT:	20 dB
MODE:	LOW NOISE
DETECTOR:	AV
OP RANGE:	60 dB
IF BW:	10 KHz
MEAS TIME:	100 ms

Test:

- Set the level applied to the signal generator such that the ESHS indicates full-scale deflection (80.0 dBµV).
- Increase the attenuation of the attenuator from 3 to 63 dB using 5-dB steps and measure the level indication at each setting. At the same time check the level analog indication on the instrument.
  The level indication decreases by 5 dB with each attenuation step.

Permissible linearity error:
Digital indication .... ≤ 0.2 dB
Analog indication .... ≤ 1 dB

5.2.6.3 Accuracy of the Attenuator

Measuring equipment: Signal generator
Attenuator, attenuation corrected, max. permissible error < 0.1 dB

Test setup: Connect the signal generator to the RF input of the ESHS via the attenuator.
Level of the signal generator: 123 dBµV
Attenuation of the attenuator: 80 dB

ESHS settings:

Frequency:	30 MHz
RF ATT:	40 dB
MODE:	LOW NOISE
DETECTOR:	AV
OP RANGE:	30 dB
IF BW:	200 Hz
MEAS TIME:	200 ms

Test:

- Set the level on the signal generator such that the ESHS indicates 43.0 dBµV.
- Set the attenuator to 120 dB and RF attenuation of the ESHS to 0 dB.
- Decrease the attenuation of the attenuator to 3 dB using 10-dB steps.
- At the same time increase the RF attenuation of the ESHS in 10-dB steps
- Measure the level indication at each attenuation setting.
  Nominal level .... 3 dBµV + set RF attenuation
  Tolerance .... ≤ 0.3 dB

5.2.7 Testing the Outputs

5.2.7.1 AF Output

Measuring equipment: Signal generator
Oscilloscope

Test setup: Connect the signal generator to the RF input of the ESHS.
Frequency: 1 MHz, 30 %-AM-modulated, AF = 1 kHz
Level: 80 dBµV

Connect the oscilloscope to the AF output of the ESHS using jack plugs.

ESHS settings:

Frequency	1 MHz
RF ATT	20 dB
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB
IF BW	10 kHz
MEAS TIME	100 ms

Test: Set the voltage using the volume control of the oscilloscope such that no visible distortions are currently present.
Settable voltage (peak value) .... > 1.9 V

5.2.7.2 74.7-MHz Output

Measuring equipment: Signal generator
Power meter

Test setup: Connect the signal generator to the RF input of the ESHS.
Frequency: 10 MHz
Level: 90 dBµV ± 0.2 dB

Connect the power meter to the 74.7-MHz OUTPUT located at the rear panel of the ESHS

ESHS settings:

Frequency:	10 MHz
RF ATT:	10 dB
PREAMP:	OFF

Test:

- Measure the level using the power meter.
  Nominal value .... -17 dBm
  Permissible deviation .... ± 2 dB
- Switch on the preamplifier at the ESHS (PREAMP ON).
- Measure the level using the power meter.
  Nominal value .... -6 dBm
  Permissible deviation .... ± 2 dB
- Measure the 3-dB bandwidth by detuning the signal generator.
  Nominal value .... > 2 MHz

5.2.7.3 80-kHz Output

Measuring equipment: Signal generator
Digital voltmeter (A.C.)

Test setup: Connect the signal generator to the RF input of the ESHS,
Frequency: 1 MHz
Level: 80 dBµV ± 0.2 dB

Connect the RF millivoltmeter to the 80-kHz output situated at the rear panel of the ESHS.

ESHS settings:

Frequency:	1 MHz
RF ATT:	20 dB
OP RANGE:	60 dB
DETECTOR:	AV

Test:

- Measure the output level using the RF millivoltmeter.
  Nominal value .... typ. 1000 mV

5.2.7.4 Envelope Output (VIDEO OUTPUT)

Measuring equipment: Signal generator
Digital voltmeter

Test setup: Connect the digital voltmeter to the envelope output situated at the rear panel of the ESHS.

Connect the signal generator to the RF input of the ESHS.
Frequency: 1 MHz
Level: 80 dBμV ± 0.2 dB

ESHS settings: cf. section 5.2.7.3.

Test: Measure the output voltage using the digital voltmeter .
Nominal value .... + 4 V typ.

5.2.7.5 User Port

5.2.7.5.1 Analog Outputs

Measuring equipment: Signal generator
Digital voltmeter

Test setup: Connect the signal generator to the RF input of the ESHS.
Frequency: 1 MHz
Level: 80 dBμV ± 0.2 dB.

ESHS settings:

Frequency:	1 MHz
RF ATT:	20 dB
MODE:	LOW NOISE
IF BW:	10 kHz
PREAMP:	OFF
Transducer:	OFF

Test:

- Connect the digital voltmeter to the USER PORT between pin 13 (gnd) and pin 14 (recorder 1)
  Voltage applied to the DVM .... 3.75 V
  Permissible error .... 100 mV
- Set the level available at the signal generator to 20 dBμV ± 0.2 dB.
  Voltage applied to the DVM .... 0.75 V
  Permissible error .... 100 mV
- Connect the DVM to the USER PORT between pin 13 (gnd) and pin 15 (recorder 2).
- Set the level available at the signal generator to 80 dBμV ± 0.2 dB.
  Voltage applied to the DVM .... 3.75 V
  Permissible error .... 100 mV
- Set the level available at the signal generator to 20 dBμV ± 0.2 dB.
  Voltage applied to the DVM .... 0.75 V
  Permissible error .... 100 mV

5.2.7.5.2 Power Supply Outputs

Measuring equipment: Digital voltmeter

Test setup: Connect the DVM to the user port + 5-V output or + 12-V output.

Test: Measure the voltage present at the + 5-V- or + 12-V output.
Nominal value + 5 V .... 5.0 V to 5.5 V
Nominal value + 12 V .... 10.8 to 15 V

5.2.8 Testing the Inputs

5.2.8.1 Checking the External Reference

Measuring equipment: Signal generator

Test setup: Connect the signal generator to the EXT REF input.
Frequency 5/10 MHz
Level > 4 dBm

Call the SETUP menu available in the ESHS.
EXT REF ON is entered in the setup menu.

Test:

- Switch off the level present at the signal generator.
  Int Ref is entered in the setup menu.
- Set the signal generator to 5 MHz.
  The ESHS prompts *EXT REF ON*.

5.2.8.2 Checking the Battery

a) Internal Battery

Measuring equipment: Power supply unit NGB
Digital voltmeter

Test setup: Connect the power supply unit to the terminals provided for the internal battery.
Voltage at the battery terminals: 12.7 V ± 50 mV
Separate the ESHS from the power supply.

Test:

- Switch on the ESHS.
  The receiver is activated.
- Decrease the voltage at the power supply unit.
  Press the BATTERY key at the front panel.
  The ESHS is deactivated if there is a voltage of .... 10.8 V ± 0.2 V
  Immediately before switch-off the pointer deflection of the instrument is at the beginning of the bar for indication of the battery charge.
  The Standby-LED on the front panel flashes.
- Increase the voltage to 12 V ± 0.5 V. The Standby-LED on the front panel goes out.
- Switch off and again on the instrument using the ON/Standby-switch on the front panel.
  The ESHS is activated.

b) External Battery

Measuring equipment:	Power supply unit Digital voltmeter
Test setup:	Connect the power supply unit to the EXT-BATT input of the ESHS. Voltage: 12 V

Test:

- Switch on the ESHS.
  The receiver is activated.
- Vary the voltage between 11 and 33 V.
  The ESHS remains in the activated state.
- Decrease the voltage available at the power supply unit.
  The ESHS switches off, if there is a voltage of .... 11 V ± 0.2 V

Note: An instrument reset may occur when increasing the supply voltage to about 15.5 V and when decreasing it to about 14.5 V.

5.2.8.3 Checking the Antenna Code Socket (X3)

Measuring equipment: Digital voltmeter

Test setup: ESHS settings:

RF ATT	10 dB
MODE	LOW DISTORTION
DETECTOR	AV
PREAMP	OFF

Test:

- Connect the DVM between X3/A (gnd) and X3/B (+10 V) and measure the voltage.
  Nominal value .... +10 V ± 50 mV
- Connect the DVM between X3/A (gnd) and X3/K (-10 V) and measure the voltage.
  Nominal value .... -10 V ± 50 mV
- Connect X3/C to X3/A.
  The level unit in the LEVEL display changes from dBµV to dBµV/m.
- Connect X3/D to X3/A.
  The level unit in the LEVEL display changes from dBµV to dBµA.
- Connect X3/E to X3/A.
  Zero scale deflection on the LEVEL display changes from 0 to 10 dB.
- Connect X3/F to X3/A.
  Zero scale deflection changes from 0 to 20 dB.
- Connect X3/G to X3/A.
  Zero scale deflection changes from 0 to 40 dB.
- Connect X3/H to X3/A.
  Zero scale deflection changes from 0 to 80 dB.
- Connect X3/E and X3/M to X3/A.
  Zero scale deflection changes from 0 to -10 dB.

5.3 Performance Test Report

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
1	Frequency accuracy	5.2.1	28.9999	....	29.0001	MHz
2	Input-VSWR RF ATT: 0 dB PREAMP: OFF	5.2.2.1				
	9 kHz		-	....	2.0	-
	100 kHz		-	....	2.0	-
	149.9 kHz		-	....	2.0	-
	150 kHz		-	....	2 0	-
	1 MHz		-	....	2 0	-
	4.049 MHz		-	....	2.0	-
	4.05 MHz		-	....	2 0	-
	8 MHz		-	....	2.0	-
	12.799 MHz		-	....	2.0	-
	12.8 MHz		-	....	2.0	-
	17 MHz		-	....	2.0	-
	21.499 MHz		-	....	2.0	-
	21.5 MHz		-	....	2.0	-
	26 MHz		-	....	2 0	-
	30 MHz		-	....	2 0	-
3	Input-VSWR RF ATT: 0 dB PREAMP: ON	5.2 2.1				
	9 kHz		-	....	2.0	-
	100 kHz		-	....	2.0	-
	149.9 kHz		-	....	2.0	-
	150 kHz		-	....	2.0	-
	1 MHz		-	....	2.0	-
	4.049 MHz		-	....	2.0	-
	4.05 MHz		-	....	2.0	-
	8 MHz		-	....	2.0	-
	12.799 MHz		-	....	2.0	-
	12.8 MHz		-	....	2.0	-
	17 MHz		-	....	2.0	-
	21.499 MHz		-	....	2.0	-
	21.5 MHz		-	....	2.0	-
	26 MHz		-	....	2.0	-
	30 MHz		-	....	2.0	-

Item No.	Characteristic		Test according to section	Min.	Actual	Max.	Unit
4	Input-VSWR RF ATT: 10 dB PREAMP: OFF		5.2.2.1				
	9	kHz		-	....	1 2	-
	100	kHz		-	....	1.2	-
	149.9	kHz		-	....	1.2	-
	150	kHz		-	....	1.2	-
	1	MHz		-	....	1.2	-
	4.049	MHz		-	....	1.2	-
	4.05	MHz		-	....	1.2	-
	8	MHz		-	....	1 2	-
	12.799	MHz		-	....	1.2	-
	12.8	MHz		-	....	1.2	-
	17	MHz		-	....	1.2	-
	21.499	MHz		-	....	1.2	-
	21.5	MHz		-	....	1.2	-
	26	MHz		-	....	1.2	-
	30	Hz		-		1.2	-
5	Input-VSWR RF ATT: 10 dB PREAMP: ON		5.2.2.1				
	9	kHz		-	....	1.2	-
	100	kHz		-	....	1.2	-
	149.9	kHz		-	....	1.2	-
	150	kHz		-	....	1.2	-
	1	MHz		-	....	1.2	-
	4.049	MHz		-	....	1.2	-
	4.05	MHz		-	....	1.2	-
	8	MHz		-	....	1.2	-
	12.799	MHz		-	....	1.2	-
	12.8	MHz		-	....	1.2	-
	17	MHz		-	....	1.2	-
	21.499	MHz		-	....	1.2	-
	21.5	MHz		-	....	1.2	-
	26	MHz		-	....	1.2	-
	30	MHz		-	....	1.2	-
6	RFI-voltage of oscillator		5.2.2.2				
	PREAMP: OFF			-	....	20	dBµV
	PREAMP: ON			-	....	10	dBµV
7	Interference immunity						
	Image 1st IF		5.2.2.3.1	-	....	20	dBµV
	Image 2nd IF		5.2.2.3.2	-	....	25	dBµV
	1st IF		5.2.2.3.3	-	....	20	dBµV

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
8	Intercept of third order	5.2.2.4.1				
	PREAMP: OFF					
	110/210 kHz		typ. 15	....	-	dBm
	1.0/1.1 MHz		typ. 15	....	-	dBm
	2.0/2.1 MHz		15	....	-	dBm
	5.0/5.1 MHz		15	....	-	dBm
	10.0/10.1 MHz		15	....	-	dBm
	15.0/15.1 MHz		15	....	-	dBm
	20.0/20.1 MHz		15	....	-	dBm
	25.0/25.1 MHz		15	....	-	dBm
	29.8/29.9 MHz		15	....	-	dBm
9	Intercept of third order	5.2.2.4.1				
	PREAMP: ON					
	110/210 kHz		typ. 0	....	-	dBm
	1.0/1.1 MHz		typ. 0	....	-	dBm
	2.0/2.1 MHz		0	....	-	dBm
	5.0/5.1 MHz		0	....	-	dBm
	10.0/10.1 MHz		0	....	-	dBm
	15.0/15.1 MHz		0	....	-	dBm
	20.0/20.1 MHz		0	....	-	dBm
	25.0/25.1 MHz		0	....	-	dBm
	29.8/29.9 MHz		0	....	-	dBm
10	Intercept of second order	5.2.2.4.2				
	PREAMP: OFF					
	50 kHz		40	....	-	dBm
	200 kHz		40	....	-	dBm
	1 MHz		40	....	-	dBm
	2 MHz		40	....	-	dBm
	5 MHz		40	....	-	dBm
	10 MHz		40	....	-	dBm
	15 MHz		40	....	-	dBm
	PREAMP: ON	5.2.2.4.2				
	50 kHz					
	200 kHz		20	....	-	dBm
	1 MHz		20	....	-	dBm
	2 MHz		20	....	-	dBm
	5 MHz		20	....	-	dBm
	10 MHz		20	....	-	dBm
	15 MHz		20	....	-	dBm
			20	....	-	dBm
11	IF bandwidths	5.2.3				
	IF BW 10 kHz					
	3-dB bandwidth		5.6	....	8.4	kHz
	6-dB bandwidth		9.0	....	10.0	kHz
	B_{60dB}/B_{6dB}		typ. 3.5	....	-	-

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
12	IF bandwidths	5.2.3				
	IF BW 200 Hz					
	3-dB bandwidth		112	....	168	Hz
	6-dB bandwidth		180	....	220	Hz
	B_{30dB}/B_{6dB}		typ 7.5	....	-	-
13	Noise indication	5.2.4				
	PREAMP OFF					
	DETECTOR AV					
	IF BW 200 Hz					
	9 kHz		-	....	-10	dBµV
	50 kHz		-	....	-30	dBµV
	100 kHz		-	....	-30	dBµV
	1 MHz		-	....	-30	dBµV
	2 MHz		-	....	-30	dBµV
	5 MHz		-	....	-30	dBµV
	10 MHz		-	....	-30	dBµV
	15 MHz		-	....	-30	dBµV
	20 MHz		-	....	-30	dBµV
	25 MHz		-	....	-30	dBµV
	30 MHz		-	....	-30	dBµV
14	Noise indication	5.2.4				
	PREAMP ON					
	DETECTOR AV					
	IF BW 200 Hz					
	9 kHz		-	....	-20	dBµV
	50 kHz		-	....	-36	dBµV
	100 kHz		-	....	-36	dBµV
	1 MHz		-	....	-36	dBµV
	2 MHz		-	....	-36	dBµV
	5 MHz		-	....	-36	dBµV
	10 MHz		-	....	-36	dBµV
	15 MHz		-	....	-36	dBµV
	20 MHz		-	....	-36	dBµV
	25 MHz		-	....	-36	dBµV
	30 MHz		-	....	-36	dBµV
15	Noise indication	5.2.4				
	PREAMP OFF					
	DETECTOR AV					
	IF BW 10 kHz					
	50 kHz		-	....	-14	dBµV
	100 kHz		-	....	-14	dBµV
	1 MHz		-	....	-14	dBµV
	2 MHz		-	....	-14	dBµV
	5 MHz		-	....	-14	dBµV
	10 MHz		-	....	-14	dBµV
	15 MHz		-	....	-14	dBµV
	20 MHz		-	....	-14	dBµV
	25 MHz		-	....	-14	dBµV
	30 MHz		-	....	-14	dBµV

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
16	Noise indication PREAMP ON DETECTOR AV IF BW 10 kHz	5.2.4				
	50 kHz		-	....	-20	
	100 kHz		-	....	-20	dBµV
	1 MHz		-	....	-20	dBµV
	2 MHz		-	....	-20	dBµV
	5 MHz		-	....	-20	dBµV
	10 MHz		-	....	-20	dBµV
	15 MHz		-	....	-20	dBµV
	20 MHz		-	....	-20	dBµV
	25 MHz		-	....	-20	dBµV
	30 MHz		-	....	-20	dBµV
17	Inherent spurious response	5.2.5	-	....	-20	dBµV
18	Measuring accuracy DETECTOR AV PREAMP OFF	5.2.6.1.1				
	9 kHz		89.6	....	90.4	dBµV
	100 kHz		89.6	....	90.4	dBµV
	149.9 kHz		89.6	....	90.4	dBµV
	150 kHz		89.6	....	90.4	dBµV
	1 MHz		89.6	....	90.4	dBµV
	4.049 MHz		89.6	....	90.4	dBµV
	4.05 MHz		89.6	....	90.4	dBµV
	8 MHz		89.6	....	90.4	dBµV
	12.099 MHz		89.6	....	90.4	dBµV
	12.1 MHz		89.6	....	90.4	dBµV
	21.499 MHz		89.6	....	90.4	dBµV
	21.5 MHz		89.6	....	90.4	dBµV
	26 MHz		89.6	....	90.4	dBµV
	30 Hz		89.6	....	90.4	dBµV
19	Measuring accuracy DETECTOR AV PREAMP ON	5.2.6.1.1				
	9 kHz		89.6	....	90.4	dBµV
	100 kHz		89.6	....	90.4	dBµV
	149.9 kHz		89.6	....	90.4	dBµV
	150 kHz		89.6	....	90.4	dBµV
	1 MHz		89.6	....	90.4	dBµV
	4.049 MHz		89.6	....	90.4	dBµV
	4.05 MHz		89.6	....	90.4	dBµV
	8 MHz		89.6	....	90.4	dBµV
	12.099 MHz		89.6	....	90.4	dBµV
	12.1 MHz		89.6	....	90.4	dBµV
	21.499 MHz		89.6	....	90.4	dBµV
	21.5 MHz		89.6	....	90.4	dBµV
	26 MHz		89.6	....	90.4	dBµV
	30 MHz		89.6	....	90.4	dBµV

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
20	Measuring accuracy	5.2.6.1.2a				
	1 MHz					
	DETECTOR Pk		89.5	....	90.5	dBµV
	DETECTOR Pk	5.2.6.1.2b				
	IF BW 200 Hz		5.5	....	8.5	dBµV
	IF BW 10 kHz		39	....	42	dBµV
	DETECTOR PK/MHz	5.2 6.1.2c				
	IF BW 10 kHz		79.5	....	80.5	dBµV/MHz
21	Measuring accuracy					
	DETECTOR QP	5.2.6 1.3a				
	Freq.: 100 kHz		-0.6	....	1.4	dBµV
	Freq.: 1 MHz		32	....	34.0	dBµV
	DETECTOR QP	5.2.6.1.3b				
	Freq.: 100 kHz		89.0	....	91.0	dBµV
	Freq.: 1 MHz		89.0	....	91.0	dBµV
	DETECTOR QP	5.2.6.1.3c				
	Freq.: 100 kHz					
	Pulse frequency					
	25 Hz		0.4	....	0.4	dBµV
	100 Hz		3.4	....	5.4	dBµV
	60 Hz		2.4	....	4.4	dBµV
	10 Hz		-4.6	....	-2.6	dBµV
	5 Hz		-8.6	....	-5.6	dBµV
	2 Hz		-14.6	....	-10.6	dBµV
	1 Hz		-18.6	....	-14.6	dBµV
	Single pulse		-20.6	....	-16.6	dBµV
	Freq.: 1 MHz	5.2.6 1.3c				
	Pulse frequency					
	100 Hz		33.0	....	33.0	dBµV
	1000 Hz		36.5	....	38.5	dBµV
	20 Hz		25.5	....	27.5	dBµV
	10 Hz		21.5	....	24.5	dBµV
	2 Hz		10.5	....	14.5	dBµV
	1 Hz		8.5	....	12.5	dBµV
	Single pulse		7.5	....	11.5	dBµV

Item No.	Characteristic		Test according to section	Min.	Actual	Max.	Unit
22	Indication linearity digital indication 30-dB range Attenuation of attenuator		5.2.6.2				
	3	dB			80.0		dBµV
	5	dB		77.8	....	78.2	dBµV
	7	dB		75.8	....	76.2	dBµV
	9	dB		73.8	....	74.2	dBµV
	11	dB		71.8	....	72.2	dBµV
	13	dB		69.8	....	70.2	dBµV
	15	dB		67.8	....	68.2	dBµV
	17	dB		65.8	....	66.2	dBµV
	19	dB		63.8	....	64.2	dBµV
	21	dB		61.8	....	62.2	dBµV
	23	dB		59.8	....	60.2	dBµV
	25	dB		57.8	....	58.2	dBµV
	27	dB		55.8	....	56.2	dBµV
	29	dB		53.8	....	54.2	dBµV
	31	dB		51.8	....	52.2	dBµV
	33	dB		49.8	....	50.2	dBµV
	Digital indication 60-dB range Attenuation of attenuator		5.2.6.2				
	3	dB			80.0		dBµV
	8	dB		74.8	....	75.2	dBµV
	13	dB		69.8	....	70.2	dBµV
	18	dB		64.8	....	65.2	dBµV
	23	dB		59.8	....	60.2	dBµV
	28	dB		54.8	....	55.2	dBµV
	33	dB		49.8	....	50.2	dBµV
	38	dB		44.8	....	45.2	dBµV
	43	dB		39.8	....	40.2	dBµV
	48	dB		34.8	....	35.2	dBµV
	53	dB		29.8	....	30.2	dBµV
	58	dB		24.8	....	25.2	dBµV
	63	dB		19.8	....	20.2	dBµV

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
23	Indication linearity analog indication 30-dB range Attenuation of attenuator	5.2.6.2				
	3 dB					
	5 dB			80.0		dBμV
	7 dB		77	....	79	dBμV
	9 dB		75	....	77	dBμV
	11 dB		73	....	75	dBμV
	13 dB		71	....	73	dBμV
	15 dB		69	....	71	dBμV
	17 dB		67	....	69	dBμV
	19 dB		65	....	67	dBμV
	21 dB		63	....	65	dBμV
	23 dB		61	....	63	dBμV
	25 dB		59	....	61	dBμV
	27 dB		57	....	59	dBμV
	29 dB		55	....	57	dBμV
	31 dB		53	....	55	dBμV
	33 dB		51	....	53	dBμV
			49	....	51	dBμV
	Analog indication 60-dB range Attenuation of attenuator	5 2.6.2				
	3 dB			80.0		dBμV
	8 dB		74	....	76	dBμV
	13 dB		69	....	74	dBμV
	18 dB		64	....	72	dBμV
	23 dB		59	....	70	dBμV
	28 dB		54	....	68	dBμV
	33 dB		49	....	66	dBμV
	38 dB		44	....	64	dBμV
	43 dB		39	....	62	dBμV
	48 dB		34	....	60	dBμV
	53 dB		29	....	58	dBμV
	58 dB		24	....	56	dBμV
	63 dB		19	....	54	dBμV

Item No.	Characteristic	Test according to section	Min.	Actual	Max.	Unit
24	Attenuator	5.2.6.3				
	RF ATTENUATION			....		
	0 dB			123.0		dBµV
	10 dB		112.7	....	113.3	dBµV
	20 dB		102.7	....	103 3	dBµV
	30 dB		92.7	....	93.3	dBµV
	40 dB		82.7	....	83 3	dBµV
	50 dB		72.7	....	73.3	dBµV
	60 dB		72.7	....	63.3	dBµV
	70 dB		52.7	....	53.3	dBµV
	80 dB		42.7	....	33.3	dBµV
	90 dB		32.7	....	33.3	dBµV
	100 dB		22.7	....	23.3	dBµV
	110 dB		12.7	....	13.3	dBµV
	120 dB		2.7	....	3.3	dBµV
25	AF-output	5.2.7.1	1.9	....	-	V
26	74.7 MHz					
	Output	5.2.7.2				
	Gain					
	PREAMP OFF		-19.0	....	-15.0	dBm
	PREAMP ON		-8.0	....	-4.0	dBm
	3-dB bandwidth		2.0	....	-	MHz
27	80-kHz Output	5.2.7.3	800	....	1200	mV
28	Video Output	5.2.7 4	3.5	....	4.5	V
29	User Port					
	Recorder 1	5.2.7.5.1				
			3.65	....	3.85	mV
			0.65	....	0.85	mV
	Recorder 2	5.2.5.7.1	3.65	....	3.85	mV
			0.65	....	0.85	mV
	+ 5-V output	5.2.7.5.2	5.0	....	5.5	V
	+ 12-V output	5.2.7.5.2	10.8	....	15.0	V