ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

EMI TEST RECEIVER
ESS

1011.4509.30

Printed in the Federal
Republic of Germany

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 Operating Manuals ESS
for Firmware Version 1.07

- **Logarithmic transducer interpolation**

Amendment to Section 3.2.4.2.1:
The interpolation of the transducer factors can be based on a linear or logarithmic frequency axis. The interpolation on the basis of logarithmically arranged frequency points is suitable for transducers with logarithmic characteristic of the transducer factor (e.g., absorber clamps). Therefore, a setting function is provided in the transducer-factor menu. This function can be set individually for each individual factor. A corresponding softkey has been added to the submenu.

Values	Unit	Name	LIN/LOG	

A transducer set allows for interpolation of factors with various frequency axes. The corresponding IEC-bus command is TRANSDUCER:INTERPOLATION LIN I LOG.

- **Test reports on desk jet and laser jet printers**

Amendment to Section 3.2.4.5.4:
The Epson 24-needle printer, HP Desk-Jet and HP Laser-Jet II are supported for output of test reports to a printer.
The IEC-bus command for selection of the printer is PRINTER EPSON24 I LASERJET I DESKJET.
The limit lines and the symbols for the check values are bold-faced in order to better distinguish them from the grid lines.

PRINTER SETTING

>Default	ON
Final Results	ON
Scan Res List	OFF
Title	ON
Scan Table	ON
Diagram	OFF
Page Count	ON
Epson 24	ON
DeskJet	OFF
LaserJet II	OFF

PLOTTER CONTENTS

>Default	ON
Curve	ON
Title	ON
Diagram	ON
Final Results	OFF
Scan Table	ON
Date/Time	ON
Page Count	ON

- **Switching off page numbering**

Amendment to Section 3.2.4.5.4:
The page numbering in the test report may be switched off.
Via IEC bus: PRINTER:CONTENT:PAGE ON I OFF and
PLOTTER:CONTENT:PAGE ON I OFF.

- **Switching off the displays in remote mode**

Amendment to Section 3.3.4.4:
The IEC-bus-command DISPLAY ON I OFF is used to switch on and off the displays. The current setting of the analog instrument is frozen simultaneously.

- **The RF analysis allows for curve traces to be stored as reference curve**

Amendment to Section 3.2.4.3
If test results are obtained in the RF analysis, they can be storead as reference curve. The **Curves** softkey has therefore been added to the Scan menu. The softkey is displayed as soon as measured values are obtained.

Scan Data	Limit Lines	Options	Curves	

Curves branches to a submenu where the **Copy to Memory** softkey may be used to define the measurement curve to be the reference curve. If a reference curve is provided, the **Curve - Memory** and **Delete Memory** softkeys are additionally accessible.

Copy to Memory	Curve - Memory	Delete Memory		

Curve - Memory subtracts the reference curve from the current measurement curve and can be used, e.g., for normalization.
Delete Memory deletes the reference curve.

Besides, the life of the reference curve is terminated by modification or use of the following parameters and functions:
number of scan subranges
start frequencies, stop frequencies and step sizes
scaling of the frequency axis
use of double detectors
repetitive scan Clr/Write + MaxHold

The reference curve can be stored on a floppy disc and output to a printer and plotter.

The IEC-bus commands for these functions are:

SCAN:CURVE:COPY	copy to memory
SCAN:CURVE:DELETE	delete memory
SCAN:CURVE:CALCULATE	curve - memory

- **Direct control of the user port**

Amendment to Section 3.2.4.2
The **User Port** softkey has been added to the Config menu. The softkey branches to a submenu which allows for switching the user port outputs to HIGH or LOW level, individually.

USER PORT

>Port 1	Low
Port 2	High
Port 3	High
Port 4	High
Port 5	High
Port 6	High

				Status Hi/Low

This function allows for directly controlling the accessories via the receiver.
E.g., to control the triple-loop antenna HM020 via the control cable EZ-14, the user ports 1,2 and 3 must be switched to High state for loops 1,2 and 3, respectively.

F1	F2	F3	F4	Key	F5	F6	F7	F8	Key	F9	F10	F11	F12
Frequency	IF Bw	Detector	MeasTime	---	Auto	Att down	Att up	Mode	---	Demod	Generator	Preamp	Op Range
Softkey 1	Softkey 2	Softkey 3	Softkey 4	Shift	Softkey 5	Config	Floppy	Report	Shift	Marker	IF	RF	Run
Step	Coarse	Fine	Lock	Ctrl	Stepsize		Cal Short	Cal Total	Ctrl	Specfunc	Save	Recall	

Function Keys F1-F12 on external Keyboard with Test Receiver ESHS20/30 ESVS20/30 and ESS

ROHDE&SCHWARZ
EC Certificate of Conformity

CE

Certificate No.: 960242

This is to certify that:

Equipment type	Order No.	Designation
ESS	1011.4509.30	EMI Test Receiver
ESS-B1	1026.7250.02	Reference Oscillator

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1992

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 25.09.96

Central Quality Management FS-QZ / Becker

2 Preparations for Use

2.1 Putting into Operation

2.1.1 Setting up the Receiver

Using the angled power plug (R&S part no. DS0086.4400, included in the supplied accessories) and retractable supporting feet at the rear of the instrument, the receiver can be operated in any position.

Operation of the receiver in horizontal position is recommended for the following reasons:

- The analog meter achieves its highest degree of accuracy in this position.
- The LC-displays can be optimally read when seen obliquely from above so that the best contrast can be achieved in this position.

For measurements carried out on the test bench fold out the retractable feet at the bottom of the instrument. To ensure good readability of the screen in the case of open-air operation or exposure to sunlight from the front, use the sunshade supplied.

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

- *Do not cover the lateral ventilation openings!*
- *Do not obstruct the exit of air at the rear panel (spacing > 10 cm)*
- *Ambient temperature -10 to +55°C, with operation of the floppy disk drive +5 to +50 °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, ZZA-95-type (order no. 0369.4911.00) in accordance with the mounting instructions supplied. To ensure sufficient ventilation keep an adequate gap between the rack housing and the lateral openings for the incoming air the rear ventilation openings, respectively. Provide for sufficient air supply inside the rack (forced ventilation).

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 Transport

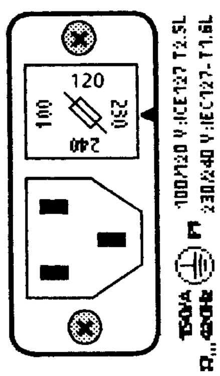
For transport or shipping the ESS is to be packaged in a rigid case. We strongly advise using the supplied covering caps for protection of the front and rear panel.

2.1.4 Power Supply

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

2.1.4.1 Mains Operation

The ESS 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 ESS is set to the correct supply voltage. If this is not the case, it must be set in the following way:

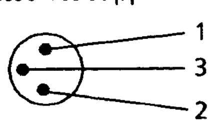


- Remove the power supply cable.
- Lever out and withdraw the cover from the voltage selector (rear panel of instrument) using a screwdriver.
- Take the fuse out of the fuse holder.
- Insert the fuse with the necessary value (incl. in the accessories supplied).
  A fuse IEC 127 T2.5L, is required for 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 at the rear panel of the ESS

2.1.3.2 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 required battery connector 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 included in the accessories (IEC 127 T10H 250 V).

If the A.C. supply is connected to the receiver at the same time, it is supplied only from this supply. The external battery is then not charged. Battery back-up with external battery is possible, however an instrument reset may take place whenever a switch-over from A.C. supply to external battery is performed.

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 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 ESS 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:

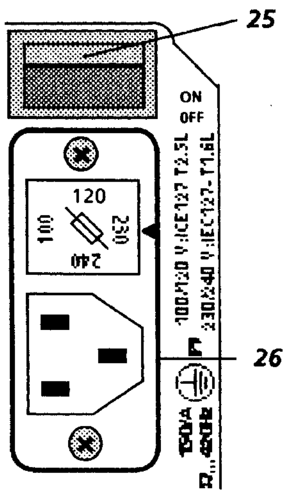


Fig. 2-3

- Connect the mains cable to the mains connector *26* (rear panel of instrument).
- Press rocker switch ***25*** (rear panel) to ON.
  If the instrument is supplied from the mains, the LED STANDBY on the front panel flashes.
- 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.

b) Operation with external battery

If the receiver is operated on external battery (A.C. power supply is not connected), the instrument is switched on using the ON STANDBY switch on the front panel (item **9**, cf. fig. 3-1). The power switch on the rear panel is then not effective. With the instrument being switched on, the LED ON flashes. If the voltage of the external battery is not sufficient for operation, the LED STANDBY flashes and thus indicates that the battery must be charged. After switch-on the following is displayed on the screen:

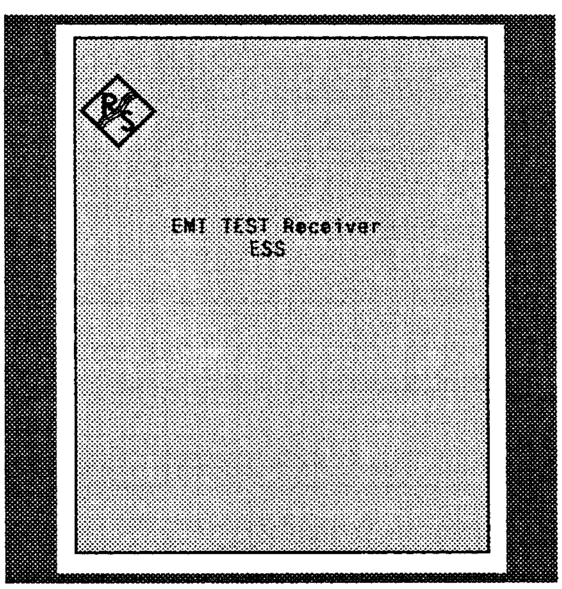


Fig. 2-4 Power-on display

This display is held for about 3 seconds. Subsequently the ESS returns to the operating mode selected prior to the last switch-off.

Default setting of the ESS is IF analysis.

2.2 Function Test

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

- Automatic power-on test,
- Total calibration, which ensures correct operation after its successful completion, and
- Self-test called by the user checks all modules at significant points and displays errors, if any.

When switching-on the receiver all functions of the processor are initialized and thus simultaneously checked and the test A/D-converter automatically adjusted. In the case of an error a message cannot be output on the screen already in this state, the instrument simply stops operation.

Following a successful initialization the ESS checks whether an external reference is connected to the receiver. If it is the case, the message *Ext Ref ON* is output in the display and the note "Ext Ref" is entered in the Setup menu (cf. Section 3.2.4.2). In addition the ESS checks 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, which causes the output of an error message (cf. section 4).

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

Cold Start

Note: *Prior to a cold start all stored data such as limit lines and transducer factors are to be stored on diskette in order to prevent the data from getting lost.*

After a cold start of the receiver (also when a new firmware has been loaded), it is neccessary to perform a total calibration, because the correction values are erased during a cold start.

All the functions of the ESS are set to their default status by pressing the decimal point in the numeric keypad during switch-on. This means that the memory with battery back-up is cleared, i.e. all the stored settings, limit lines and transducer factors are no longer available. In addition to the usual switch-on test an extensive test of the computer hardware is subsequently performed. During this procedure the message *INICOLD* appears in the FREQUENCY display. If an error in the computer hardware is detected, the message *ERRCPU* is read out in the FREQUENCY display. This message can only be deleted by switching off and again on the ESS.

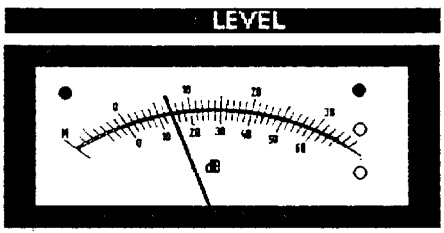
After having successfully completed the extended switch-on test, the test receiver is in its default state.

3 Operating Instructions

3.1 Explanation of Front and Rear Panel View

3.1.1 Front View

1

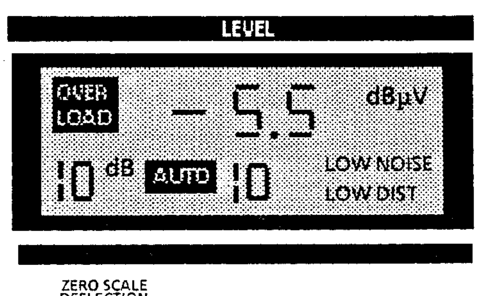


- Moving coil instrument with scales for the 30-dB- and 60-dB-operating ranges;
- Setting screw for the mechanical zero;
- Yellow LEDs for indicating the operating range;
- Red LEDs for indicating exceedings of the operating range (upper or lower limit) (cf. section 3.2.7.3)

2

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

3



- 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, dBpT
- Display of overload of the signal path (OVERLOAD)
- Display of measurement mode (MODE): LOW NOISE and LOW DIST (low-distortion) (section 3.2.3.3)
- Display of RF attenuation (RF ATT) 0 to 120 dB (cf. section 3.2.3.2)
- Display of operation with automatic attenuation setting (AUTO) (cf. section 3.2.3.5)
- Display of beginning of the measurement range on the instrument (ZERO SCALE DEFLECTION) (cf. section 3.2.3.7)

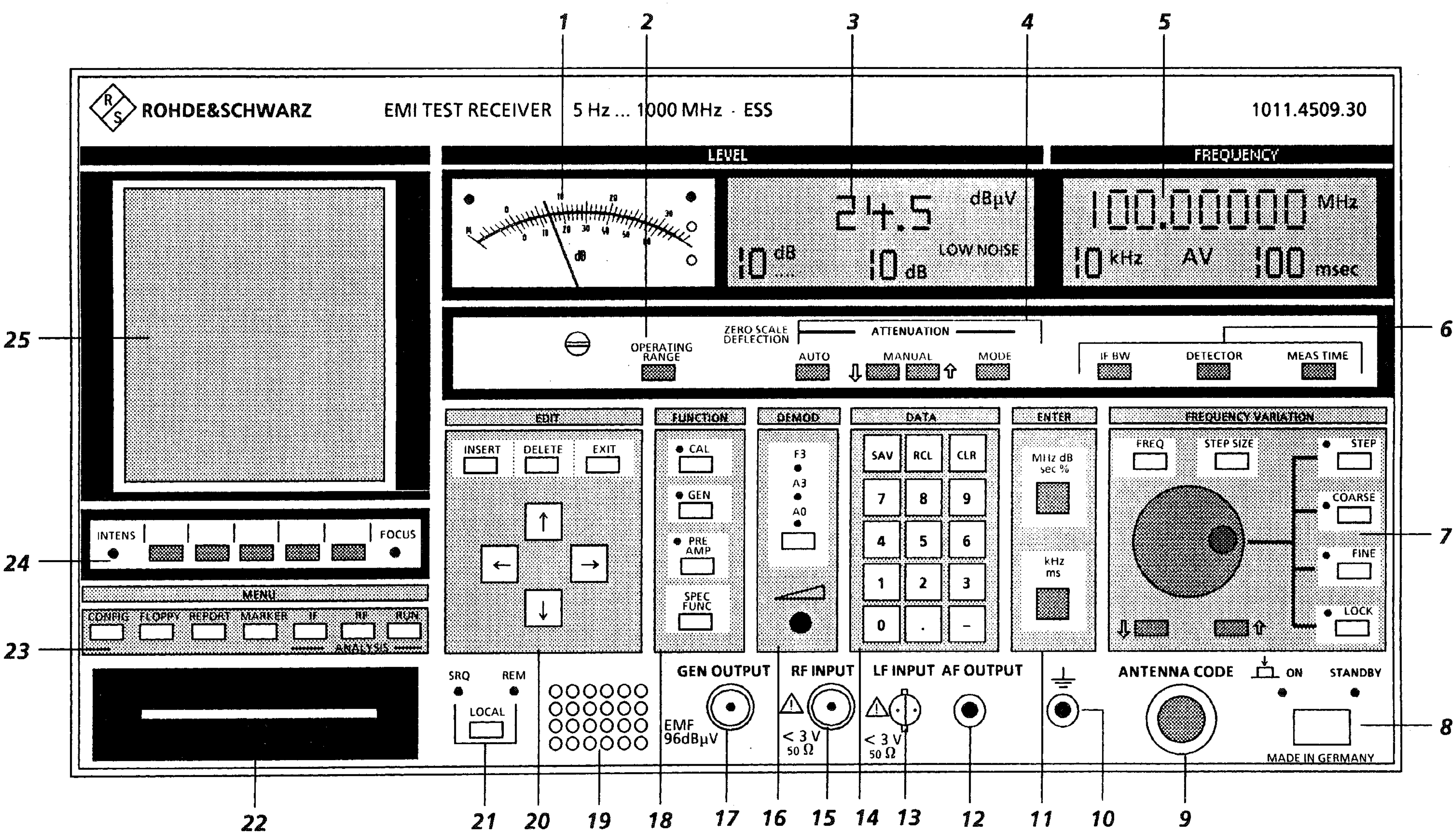
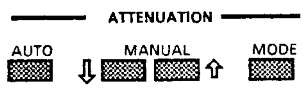


Fig. 3-1 Front panel view

4



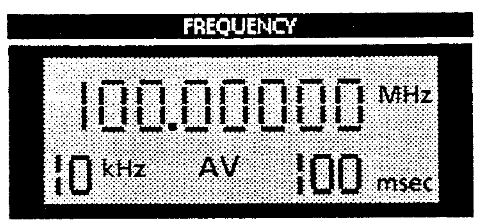
Attenuation

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)

5



- 8-digit display of receiver frequency, resolution 0.1 Hz, unit in MHz or 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)
- Display of detector: AV, RMS, Pk, Pk/MHz and QP (cf. section 3.2.3.9)
- Display of IF bandwidths: 2 Hz to 1 kHz in 1/2/5 steps, 10 kHz, 100 kHz, 120 kHz and 1 MHz (cf. section 3.2.3.8)

6

IF BW: Key for switching over IF bandwidth

DETECTOR: Key for switching over the indicating mode (cf. sect. 3.2.3.9)

MEAS TIME: Key for activating input of measuring time (cf. section 3.2.3.10)

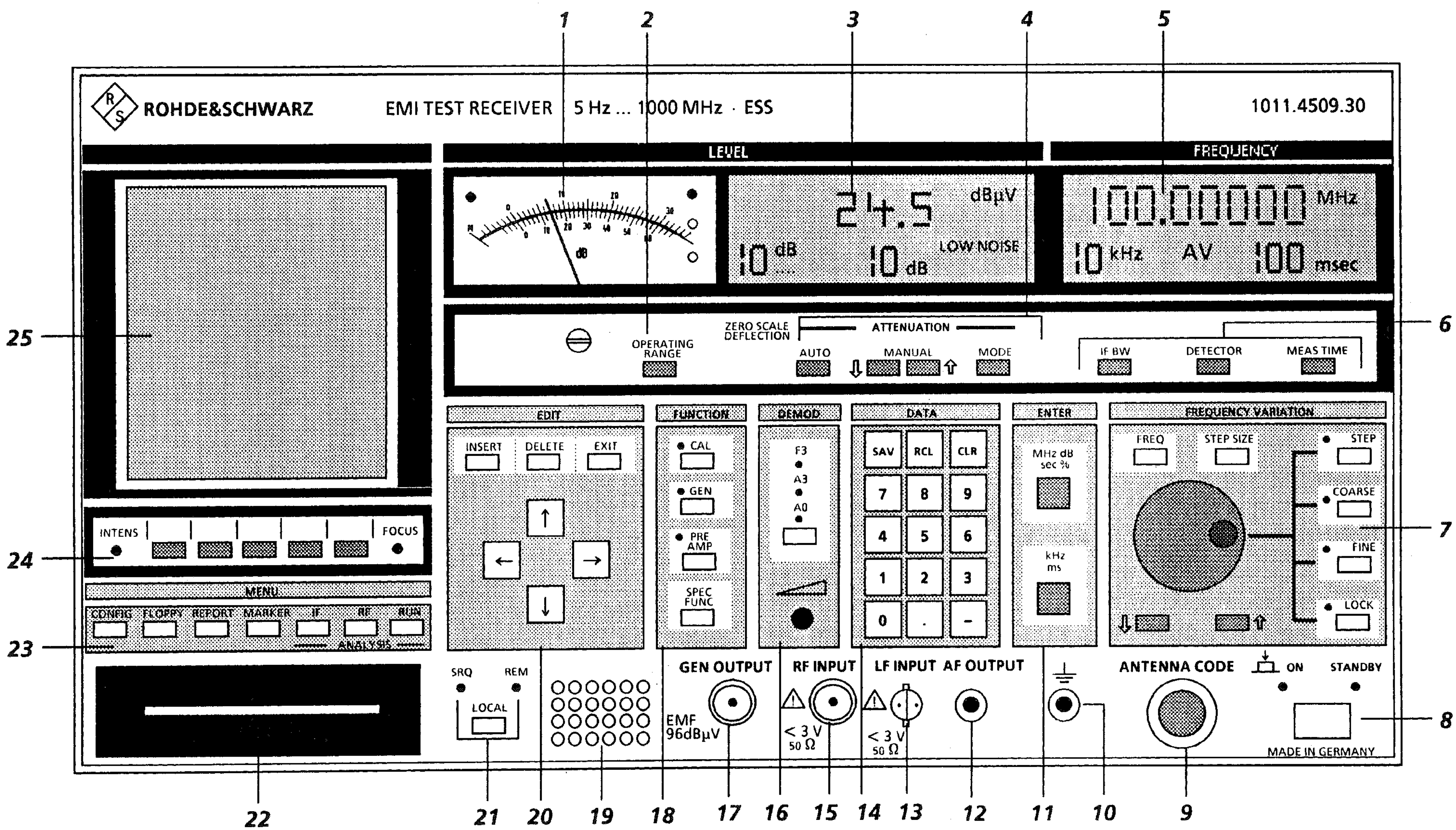
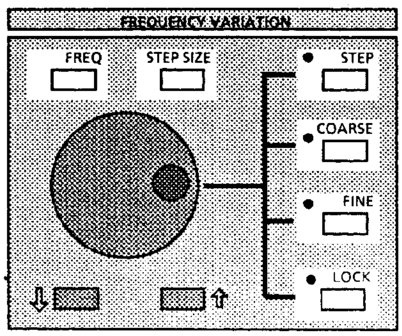


Fig. 3-1 Front panel view

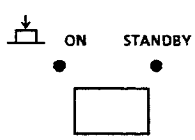
7



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-, 10- or 1-kHz steps)
FINE:	Frequency tuning fine (100-Hz steps)
LOCK:	Frequency tuning using rotary knob is locked
⇧	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)

8



On/Standby switch

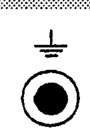
LED ON illuminated:	ESS is switched on.
LED STANDBY illuminated:	Power supply is switched on. The Oven-controlled Crystal Oscillator ESS-B1 is heated.

9

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

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

10



Socket for connection of measuring earth

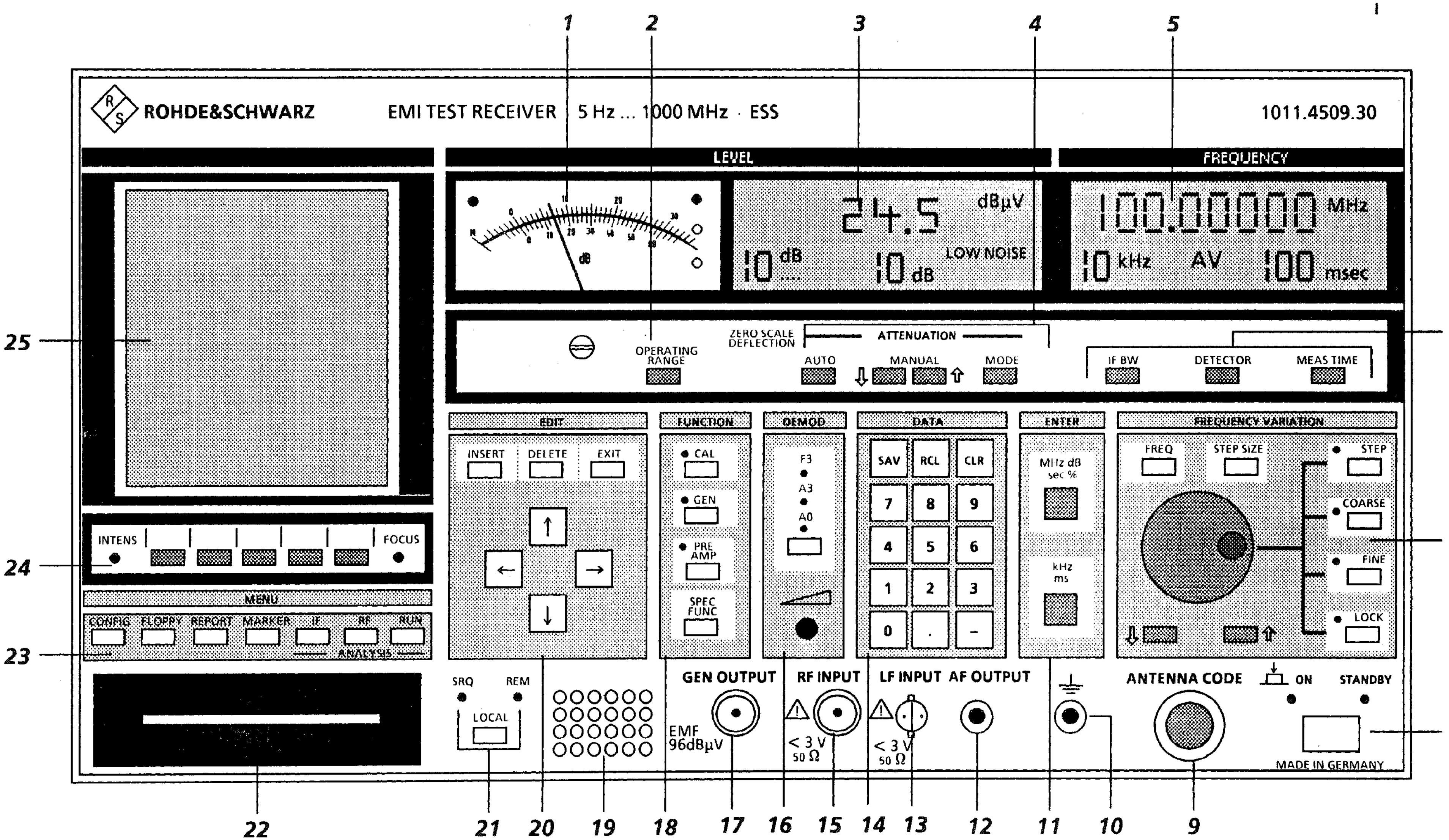


Fig. 3-1 Front panel view

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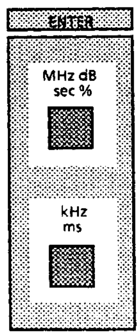


Input keys:

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

AF OUTPUT

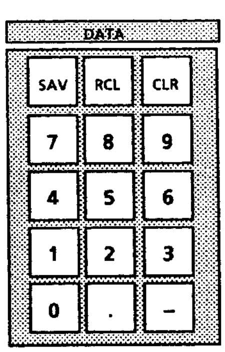
AF output connector (JK 34)
with break contact for loudspeaker;
$R_i = 10\ \Omega$; output voltage > 1.5 V

13

LF INPUT

LF input, Twinax input socket
balanced input, 5 Hz to 50 kHz
$50\ \Omega$, < 3 V

14



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 enter-ed
0 to 9:	Numeric input keypad
-	Minus sign
. :	Decimal point (cf. section 3.2.2)

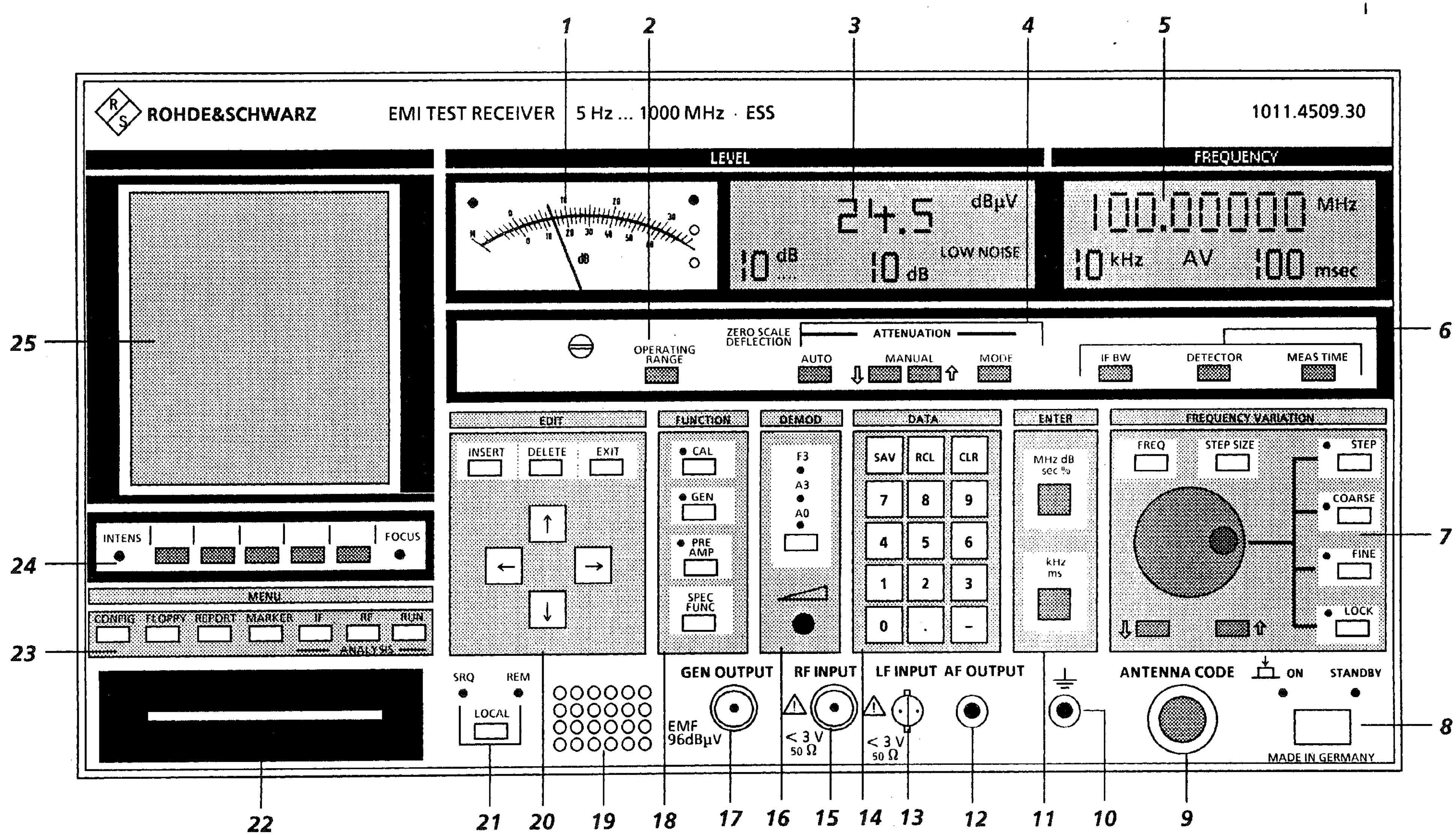
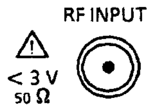


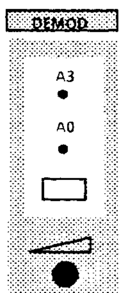
Fig. 3-1 Front panel view

15



RF input, N socket,
unbalanced input, 5 Hz to 50 kHz
50 Ω, < 3 V
(cf. section 3.2.1)

16



F3: Indicates when FM demodulation is switched on

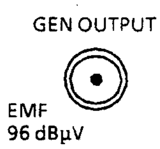
A3: Indicates when AM demodulation is switched on

A0: Indicates when A0 demodulation is switched on

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

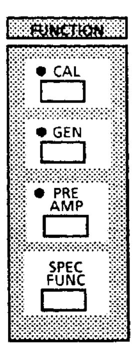
Rotary knob for volume control
(cf. section 3.2.3.11)

17



Generator output, N socket
frequency = receiver frequency
level = 96 dBµV (EMF)
(cf. section 3.2.3.12)

18



CAL:	Initiating calibration process short key depression → short calibration long key depression → total calibration (cf. section 3.2.3.12)
GEN:	ON/OFF switch for tracking generator
PREAMP:	ON/OFF switch for preamplifier (cf. section 3.2.3.4)
SPEC FUNC:	Calling the special function menu (cf. section 3.2.4.7)

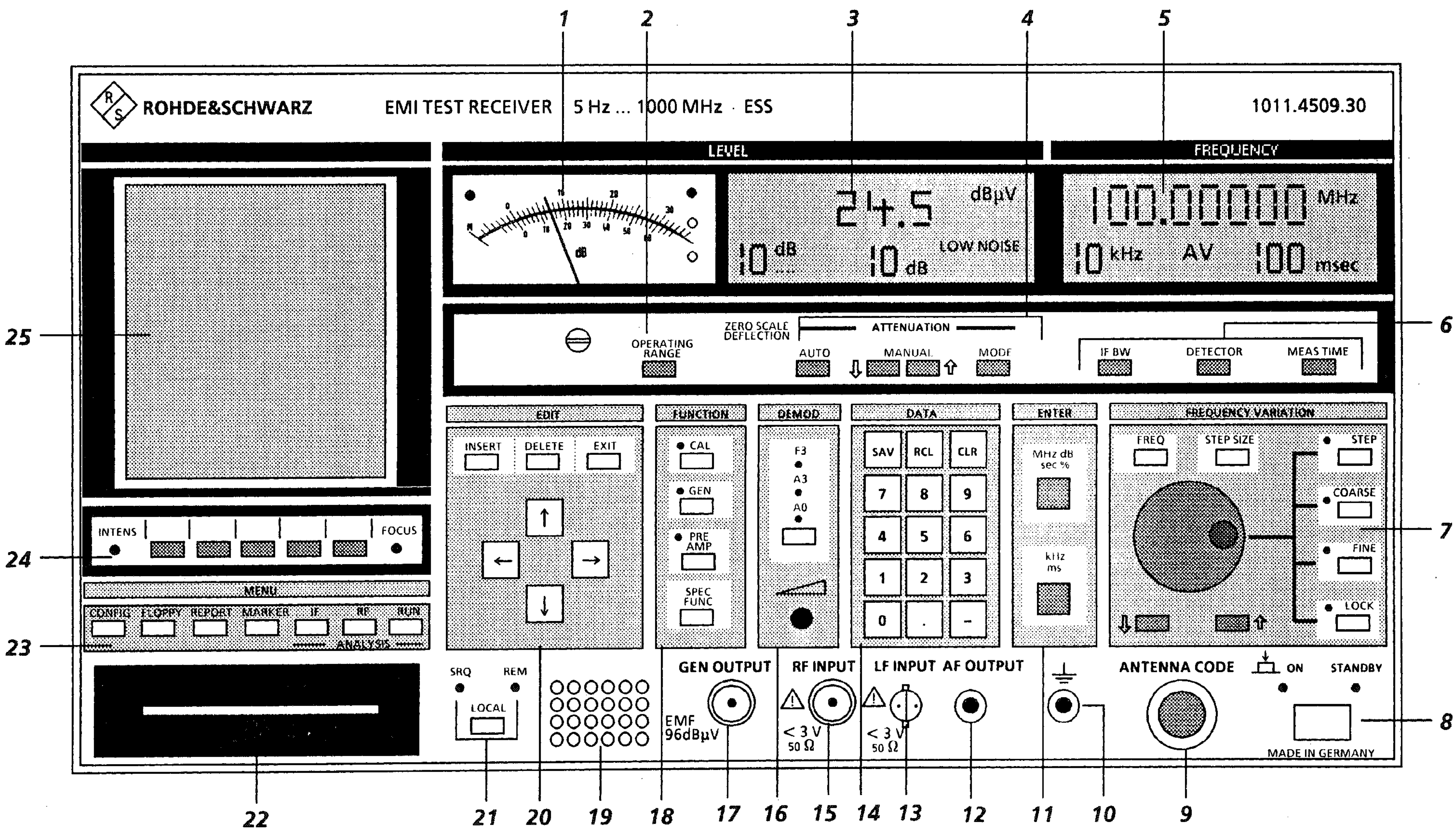
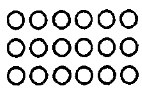


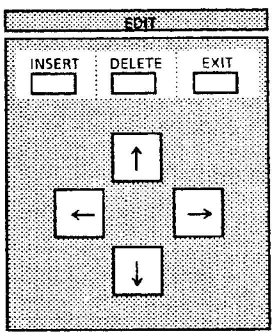
Fig. 3-1 Front panel view

19



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

20



Editing function on the screen

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)

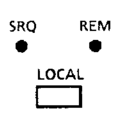
→: The cursor moves to the right or one menu further; the marker moves one position/pixel to the right (cf. section 3.2.4.1)

←: The cursor moves to the right or one menu further; the marker moves one position/pixel to the left (cf. section 3.2.4.1)

↑: The cursor moves one line up or the marker moves 40 pixels to the right (cf. section 3.2.4.1)

↓: The cursor moves one line down or the marker moves 40 pixels to the left (cf. section 3.2.4.1)

21

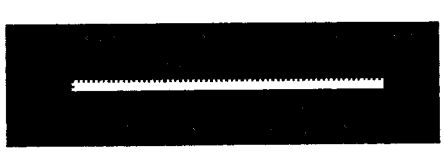


SRQ: LED indicates service request present at IEC bus (cf. section 3.3)

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

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

22



Disk drive 3 $^1/_2$", 1.44 MByte
Formatting MS-DOS-compatible
(cf. section 3.2.4.6.2)

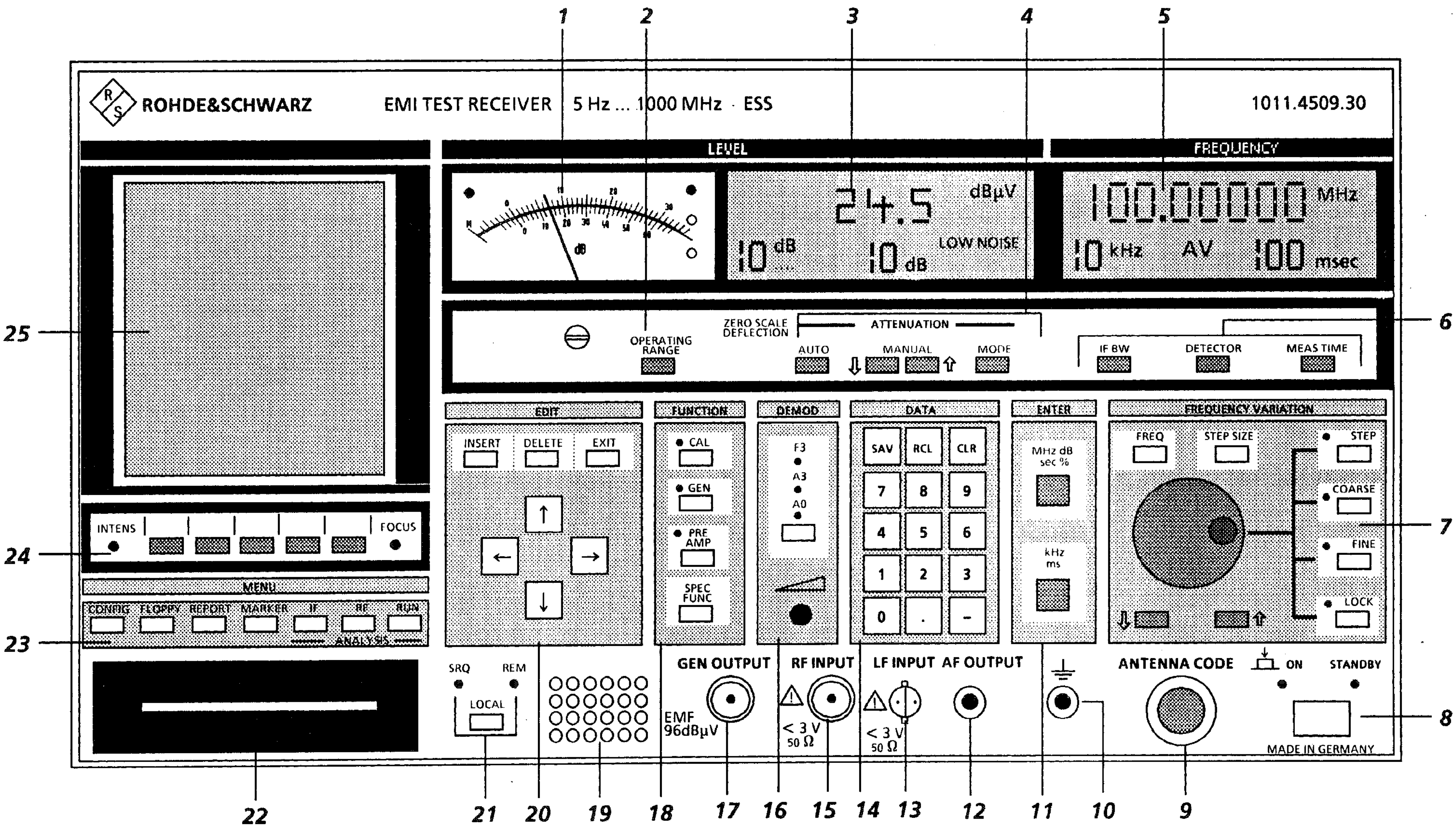
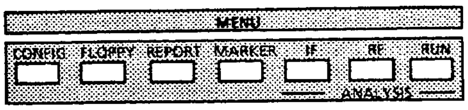


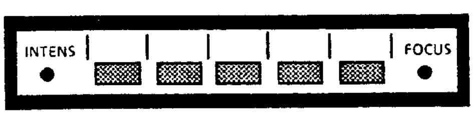
Fig. 3-1 Front panel view

23



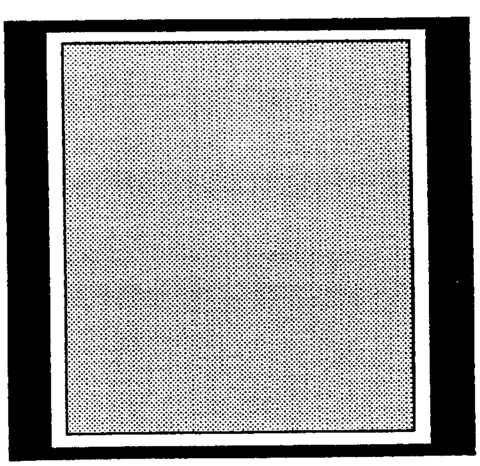
CONFIG:	Calling the softkey menu for the instrument default setting and for editing the transducer factors (Transducer, cf. section 3.2.4.2)
FLOPPY:	Calling the softkey menu for operating the disk drive (cf. section 3.2.4.6.2)
REPORT:	Calling the softkey menu for operating the printer or plotter for output of measurement results (cf. section 3.2.4.5)
MARKER:	Calling the softkey menu for operation of the marker (cf. section 3.2.4.4.2)
IF:	Calling IF analysis (cf. section 3.2.4.4)
RF:	Calling the menu for configuration of RF analysis (cf. section 3.2.4.3.1)
RUN:	Key for starting RF analysis (cf. section 3.2.4.3.4)

24



INTENS:	Rotary knob for setting the intensity
FOCUS:	Rotary knob for setting the focus
5 Softkeys:	Key function depends on the labelling above the key on the screen

25



5"- screen for display of the softkeys, operating menus and measurement results

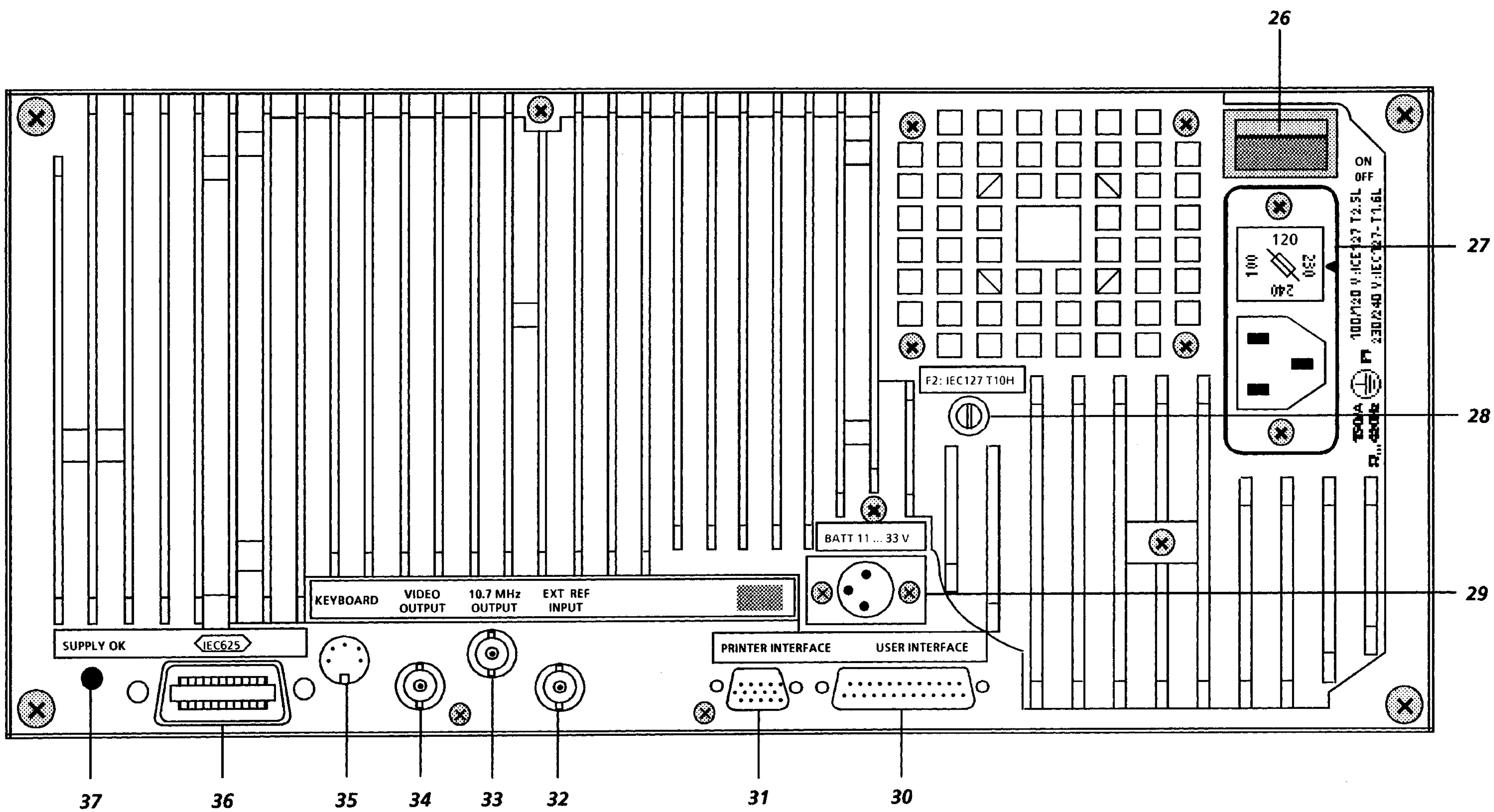
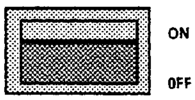


Fig. 3-2 Rear panel view

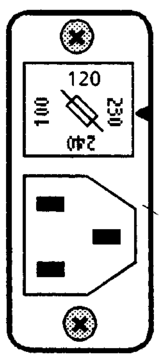
3.1.2 Rear View

26



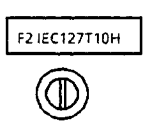
Power switch

27



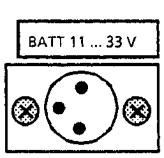
Power input with integrated voltage selector and power fuse (cf. section 2.1.3.1)

28



Fuse for external battery,
IEC 127 T10H 250 V
(cf. section 2.1.3.3)

29



Input for an external battery 11 to 33 V, 3-pole special connector; (cf. section 2.1.3.2), appropriate socket included in the accessories supplied.

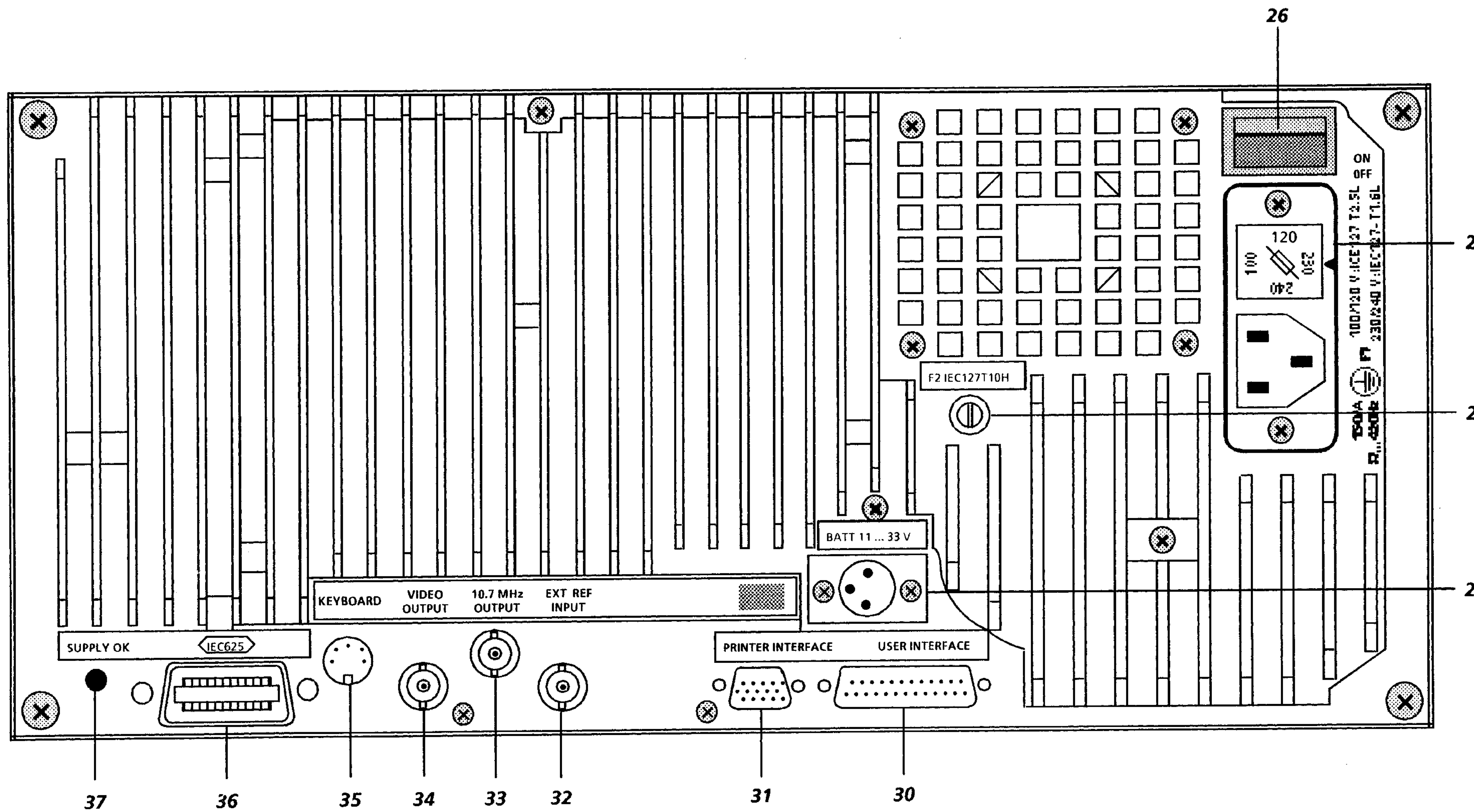
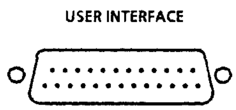


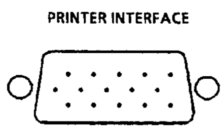
Fig. 3-2 Rear panel view

30



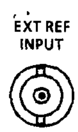
User interface with various inputs and outputs, 25-pole female connector (cf. section 3.2.6.5)

31



Parallel interface for connecting a printer, 15-pole female connector (cf. section 3.2.6.6) (suitable cable: cf. data sheet, "Recommended Accessories")

32



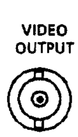
BNC socket for connecting an external reference, 5 or 10 MHz;

10-MHz reference output with the Oven-controlled Crystal Oscillator ESS-B1 (cf. section 3.2.6.4). Then the label is: 10MHz REF OUTPUT

33

BNC socket, 10.7-MHz IF output (cf. section 3.2.6.2)

34



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

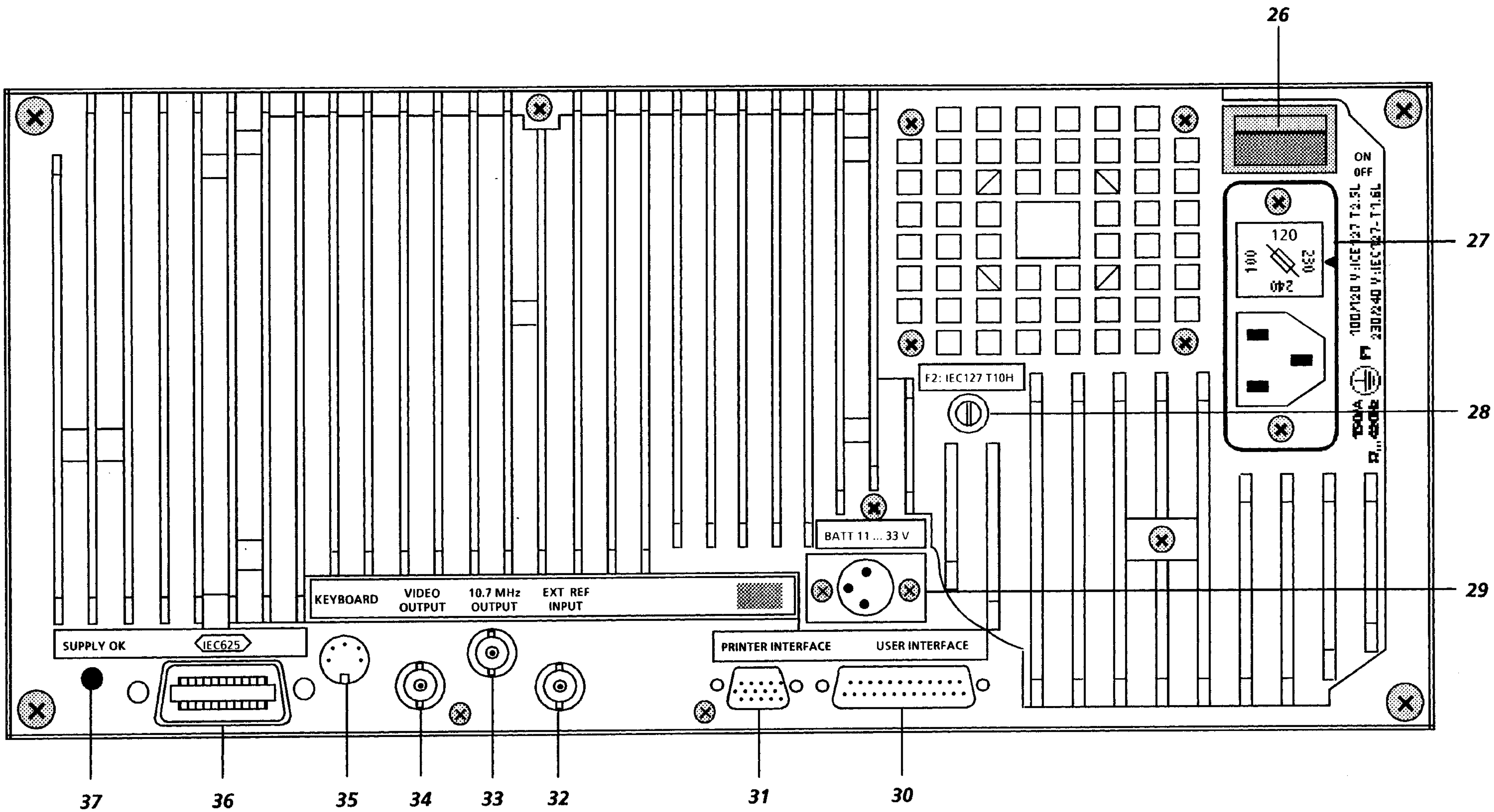
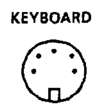


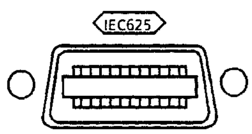
Fig. 3-2 Rear panel view

35



5-pole DIN socket for connecting a multi-function 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 ESS 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 the attenuation (RF attenuation and IF attenuation),
- selecting the IF bandwidth,
- selecting the weighting mode (detector),
- selecting the measuring time,
- selecting the operating range,
- selecting the AF demodulation,
- level indication (analog and digital),
- calibration of the receiver,
- operation with pre-amplifier and
- use of the tracking generator.

The menus include:

- selecting the receiver configuration,
- use of transducer factors (transducer),
- input of limit lines,
- setting and performing frequency scans,
- 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,
- operation of the disk drive
- carrying out the self-test and
- use of the various special functions.

3.2.1 Connecting the Voltage to be Measured

The balanced input and unbalanced input cover the frequency ranges from 5 Hz to 50 kHz and from 5 Hz to 1000 MHz, respectively. In default setting the unbalanced input (N socket) is switched on. The receiver frequency is tunable from 1 Hz to 1000 MHz.

Using a special function (SPEC FUNC 14, cf. section 3.2.4.7) the balanced input is switched on (Twinax socket with two internal conductors). The receiver frequency can then be tuned from 1 Hz to 50 kHz. Both inputs feature an impedance of 50 Ω.

To obtain the highest possible sensitivity we recommend using always the balanced input for measurements at frequencies below 1 kHz as it is the only means to avoid both receiver-internal and external system hum loops. Be sure to use balanced lines when connecting the device under test.

The voltage to be measured is connected to the unbalanced RF INPUT (N socket) via a 50-Ω coaxial cable. The input resistance of the receiver is 50 Ω. Connection to the balanced input LF INPUT (low frequency input) is made via a cable with two balanced internal conductors and a coaxial screen. The ESS measures sinusoidal and pulse voltages within the frequency range of 5 Hz to 1000 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 and DC Voltage

With an RF attenuation of 0 dB the RMS value of the total voltage applied to the RF input must not exceed 3 V into 50 Ω. For RF attenuations ≥ 10 dB the total voltage must not be more than max. 7 V (= 1 W). The instrument is designed for a max. DC voltage of 50 V irrespective of the RF attenuation (AC coupling), i. e. max. 7 V (DC coupling) with the option ESVS-B1 fitted.

3.2.1.2 Pulse Signals

With an RF attenuation of 0 dB the pulse spectral density must not exceed 97 dBµV/MHz at 50 Ω. As is 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 is switched on with an RF attenuation of 0 dB set, this value is also used in autorange operation. Manual setting of RF attenuation prevents an RF attenuation of 0 dB from being activated during autorange operation.

With an RF attenuation > 0 dB the max. permissible pulse energy at 50 Ω in the frequency range below 30 MHz is 100 mWs both with the use of the unbalanced input RF INPUT and with the balanced input LF INPUT. This means that the attenuator cannot be destroyed by pulses resulting from phase switch-over of the Artificial Mains Networks ESH2-Z5 and ESH3-Z5.

Over 30 MHz the max. permissible pulse energy is 10 mWs for 10 µs. If higher pulse energies are likely to occur, we recommend using the ESVS-B1 option. It permits pulse energies up to 100 mWs (10 µs) and pulse voltages up to 1500 V at the receiver input. With the option fitted, it is automatically switched on by the ESS if RF attenuation exceeds an input attenuation of 10 dB, thus protecting the receiver against spikes as occur e.g. with RF power measurements on ignition cables using the Absorbing Clamp MDS 21.

Exceedings of the permissible values may destroy the input attenuator, pre-amplifier, preselection filter or input mixer. This may be prevented by connecting an appropriate power attenuator pad in series.

3.2.2 Input of Numerals

The numeric keypad DATA and the unit field ENTER 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. Numerals are input in accordance with the following flowchart:

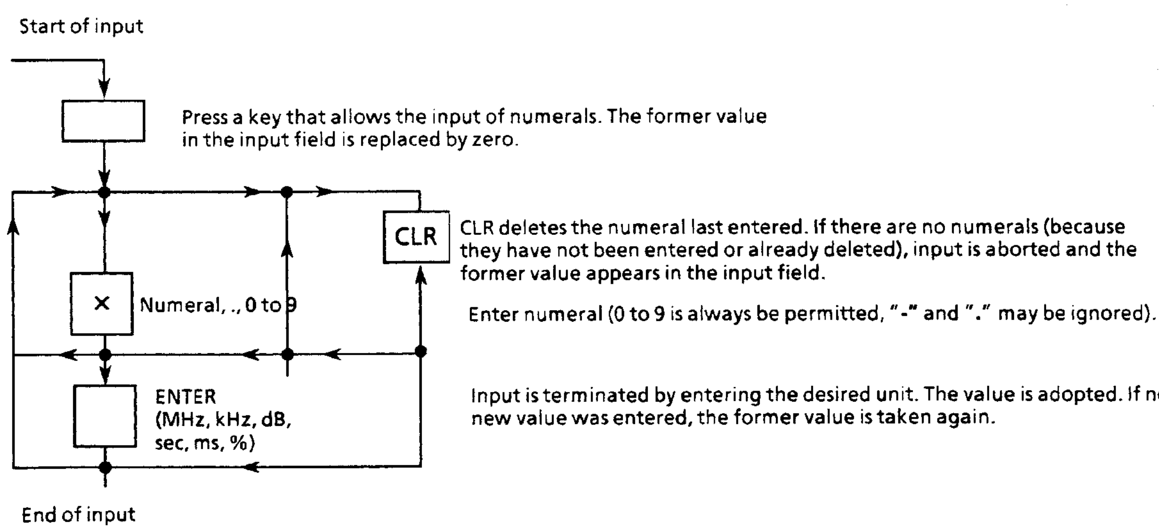


Fig. 3-3 Flowchart for the entry of numerals

3.2.3 Use of the Receiver Functions

3.2.3.1 Setting the Receiver Frequency

The entire frequency range covered by the ESS is internally divided into the following ranges:

- Range I from 5 Hz to 50 kHz (LF range, tunable up to 1 Hz)
- Range II from 9 kHz to 30 MHz (RF range) and
- Range III from 20 to 1000 MHz (VHF/UHF range)

Each range contains an individual first IF ensuring optimum characteristics as to inherent noise, intermodulationand feed-through of the 1st conversion oscillator. In the case of operation with balançed input range I is always used. Here, the ESS can be tuned from 1 Hz to 50 kHz with a minimum frequency resolution of 0.1 Hz.

With the use of the unbalanced input the ESS switches automatically between the ranges during frequency tuning. The frequency can be steadily tuned from 1 Hz to 1000 MHz.

The bandwidths and thus frequency resolution are matched to the bandwidths required in practice for interference measurements on account of the familiar regulations. Frequency resolution is:

- 0.1 Hz in the frequency range below 9 kHz and with IF bandwidths up to 20 Hz.
- 10 Hz in the frequency range of 9 kHz to 30 MHz and with IF bandwidths over 50 Hz
- 100 Hz in the frequency range over 30 MHz

The frequency-dependent availability of the various IF bandwidths is dealt with in section 3.2.3.8.

When violating the permissible frequency range for an IF bandwidth after a change in frequency the highest or lowest possible IF bandwidth is set for the new frequency. Jumping back to the former frequency means that the former bandwidth is reset unless the IF bandwidth has been changed in the meantime. Table 3-1 offers the settable frequency ranges depending on the IF bandwidth.

Table 3-1

IF bandwidth	Settable frequency range
2 Hz to 20 Hz	0.1 Hz to 50 kHz
50 Hz to 200 Hz	0.1 Hz to 30 MHz
500 Hz to 1 kHz	0.1 Hz to 1000 MHz
10 kHz	9 kHz to 1000 MHz
100 and 120 kHz	100 kHz to 1000 MHz
1 MHz	1 MHz to 1000 MHz

The following rules are applied:

- Minimum bandwidth is five times as large as frequency resolution in order to avoid measurement errors
- The minimum settable frequency is approximately identical with the IF bandwidth.

The frequency of the receiver can be entered using the rotary knob, the up/down keys or via the numeric keypad after having pressed the FREQ key. For setting the frequency by way of the rotary knob, frequency increment or decrement is selected using the functions STEP, COARSE and FINE.

3.2.3.1.1 Numeric Input of Frequency

With the ESS set to its default (RF input unbalanced), the desired receiver frequency in the range of 1 Hz to 1000 MHz can be entered directly using the FREQ key in the FREQUENCY VARIATION keypad. When using the balanced input (activation via special function 14) frequencies from 1 Hz to 50 kHz are permissible. Any other frequencies are not accepted, i.e. the former frequency is still set after the new entry.

Pressing the FREQ key serves to clear the current receiver frequency in the FREQUENCY display. It is now possible to enter a new frequency in the manner described in section 3.2.2.

3.2.3.1.2 Frequency Setting using the Rotary Knob

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

The step size with which the frequency is tuned can be selected using the STEP, COARSE, FINE and LOCK keys. 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 3-2

Tuning in position	Step size in frequency range		
	1 Hz to 9 kHz or 50 kHz with IF bandwidth 2 to 20 Hz or balanced input	9 kHz to 30 MHz	30 to 1000 MHz
COARSE	0.1 kHz	10 kHz	100 kHz
FINE	0.1 Hz	10 Hz	100 Hz
LOCK	Rotary knob is blocked	Rotary knob is blocked	Rotary knob is blocked
STEP	0 Hz to 50 kHz	0 Hz to 1000 MHz	0 Hz bis to 1000 MHz

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 can be additionally accelerated by turning the knob quickly.

3.2.3.1.3 Frequency Tuning using the ↓ and ↑ keys

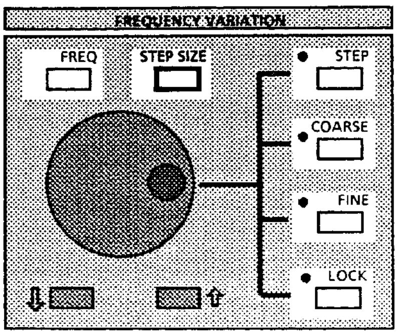
For measuring signals in known frequency steps it is useful to step through the receiver frequency in their distance. This is for example the case with harmonics of the clock frequency of processors. For this purpose the ↓ and ↑ keys are provided in the FREQUENCY VARIATION keypad. Frequency is changed 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, when for example the maximum of a harmonic occurring with a frequency-instable source is to be determined. Fine-tuning is taken into account when changing the frequency the next time using the ↓ and ↑ keys, i.e. the receiver takes the new frequency as basis.

3.2.3.1.4 Input of Tuning Step Size

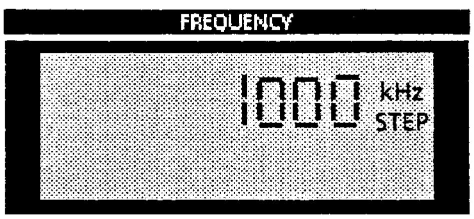
Any step size for tuning the receiver frequency can be input using the STEP SIZE key in the FREQUENCY VARIATION keypad. The defined step size is used when tuning the frequency with the ↓ and ↑ keys or with the tuning knob in the step size setting STEP.

Operation:

Step size is entered as follows:



▸ Press STEP SIZE key.



The frequency in the FREQUENCY display disappears and instead the step size currently set is indicated with the 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 conclusion of the input the receiver frequency is displayed again in the FREQUENCY display.

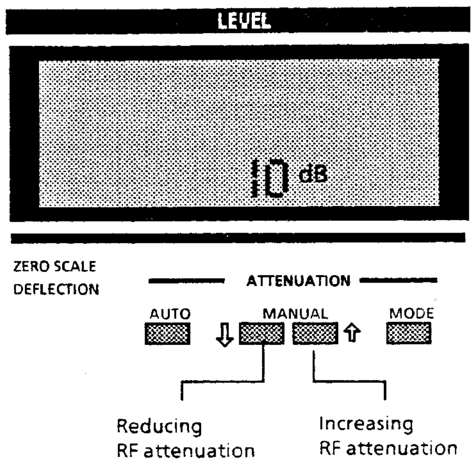
Note: *Changing the receiver frequency beyond the filter limits (cf. Specifications) may lead to a short-time increase in analog meter indication in particular in the indicating modes Pk (peak value), Pk/MHz (peak value relating to 1-MHz bandwidth) and QP (quasi-peak). The measured value read out on the LC display or output via IEC bus is however always correct taking the switch-over processes during the measurement into account.*

3.2.3.2 Selecting RF Attenuation (ATTENUATION)

Attenuation of the RF input divider is settable in the range of 0 to 120 dB using 10-dB steps. In the frequency range of 5 Hz to 50 kHz use of the balanced input makes available a balanced attenuation switch. For receiver frequencies below 30 MHz the first two 10-dB attenuator pads consist of pulse-resistant carbon film resistors both with the balanced and unbalanced input, thus preventing the attenuator from being damaged by high pulses as they may occur, e.g. during phase switch-overs of LISNs. Above 30 MHz this protective measure is usually no longer required as the energy of the occurring pulses is considerably less. For applications in which high-energy pulses occur even beyond 30 MHz we recommend the use of the Pulse Power Attenuator ESVS-B1 providing the same protective effect as is ensured in the frequency range below 30 MHz. In the 0-dB position measuring accuracy of the receiver may be slightly reduced on account of the higher input reflection coefficient (VSWR < 2). For quasi-peak measurements to CISPR 16 a minimum attenuation of 10 dB has therefore to 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. Holding down the respective key for more than a second switches on the repetition function, i.e. attenuation is switched in steps.



The RF attenuation selected is shown in the LEVEL display.

Caution: *Operation with LISNs makes it absolutely necessary to switch on an RF attenuation of at least 10 dB at the RF inputs and requires a receiver frequency <30 MHz before connecting the LISN as otherwise during switch-on of the LISN or phase switch-over the input mixer may be destroyed by high-energy pulses.*

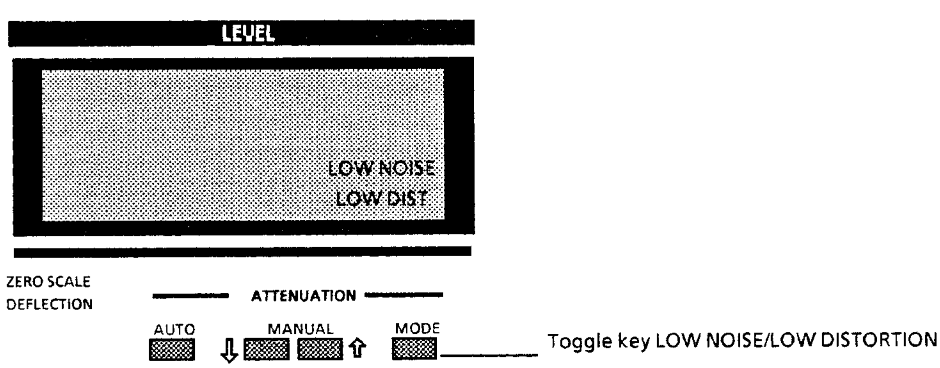
3.2.3.3 Selecting the Operating Mode (MODE)

The ESS provides the operating modes LOW NOISE (measurement) and LOW DISTORTION (measurement). During low-distortion measurement 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 with the use of an preamplifier it is set such that it is in proximity to zero scale deflection. The set IF gain depends on the indicating mode and the IF bandwidth. In LOW NOISE mode, 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 on the meter as in the operating mode LOW NOISE, RF attenuation must be selected 10 dB higher. Signals that are 10 dB lower are therefore applied to the input mixer being thus less loaded.

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

Operation:



The set mode is shown in the LEVEL display.

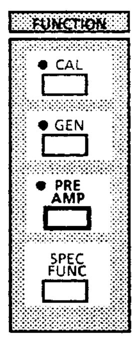
3.2.3.4 Operation with Preamplifier (PREAMP)

The preamplifier of the ESS is between preselector and first mixer. It reduces the noise figure of the receiver from typically 12 dB to typ. 8 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 reducing total loading capability by about 10 dB.

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

Use of the preamplifier is recommended 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 preamplifier state is switched over. The LED is illuminated with the preamplifier switched on.

3.2.3.5 Automatic Setting of Attenuation (Autorange Operation)

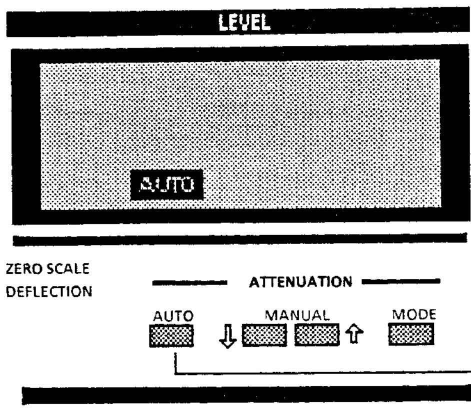
With automatic operation the receiver sets RF attenuation and operating mode (MODE) such that the level applied to the RF input is always within the valid operating range. After switching on of the receiver at least 10 dB RF attenuation are always switched on serving to protect the input mixer and preamplifier against levels inadvertently applied too high. 0 dB RF attenuation is only used in automatic operation, if it is switched on when switching to automatic operation. Use of 0 dB RF attenuation may be canceled by switching off automatic operation, activating RF attenuation and switching on again automatic operation. With the use of option 01 *RFI Voltage* (RFI voltage measurements with LISN, cf. section 3.4) an RF attenuation of 10 dB is always switched on to protect the input mixer and preamplifier against high-energy pulses during phase switch-over. In this case the limit values are as high as to provide sufficient sensitivity of the ESS with an RF attenuation of 10 dB. The following criteria are of importance for setting optimum attenuation:

- the overload 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 on account of varying input levels.

Operation:



Switch for automatic operation.
Automatic operation is indicated by inverse display of the word AUTO in the LEVEL display.

Automatic operation can be switched off by

- pressing the AUTO key or
- manual switching of attenuator

3.2.3.6 Selecting the Operating Range

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

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

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 attenuation step size and operating range is shown in the following table:

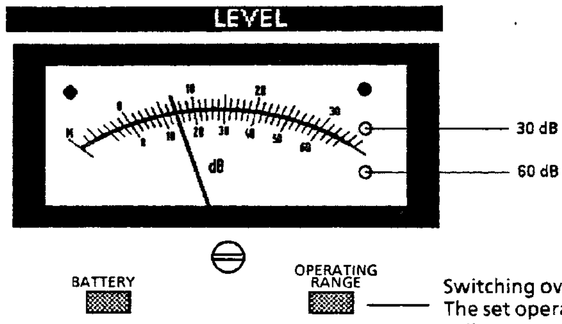
Table 3-3

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 as often as is necessary in the 30-dB range. In addition the 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 up 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 yellow LED situated at the respective meter scale.

3.2.3.7 Level Indication

The measured level is displayed both by the analog meter and in the LEVEL display.

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 displayed value. 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 selection of a transducer of up to ± 200 dB (theoretically possible), the level is output with a resolution of 1 dB in the LEVEL display. The unit of the measured quantity is also indicated. The basic indication unit is dBµV. Other units cân be selected by coding the ANTENNA CODE socket (cf. section 3.2.5.1), entering a transducer factor (cf. section 3.2.4.2.2) or using special functions (cf. section 3.3.2.3.13). The following units are possible:

Table 3-4

dBµV	Voltage into 50 Ω at RF input of receiver
dBµA	For current measurement, settable by coding at the ANTENNA CODE socket or by the unit of the transducer factor.
dBµV/m	Electrical fieldstrength, settable by coding at the ANTENNA CODE socket 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 at the ANTENNA CODE socket or by the unit of the transducer factor in indicating mode Pk/MHz
dBµV/m/MHz	Spectral pulse density of electrical fieldstrength, settable by coding at the ANTENNA CODE socket or by the unit of the transducer factor in indicating mode Pk/MHz
dBµA/m/MHz	Spectral pulse density of 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
dBpT	Magnetic flux density relating to 1 pT
dBm	Power in dB relating to 1 milliwatt, settable by way of special function 20

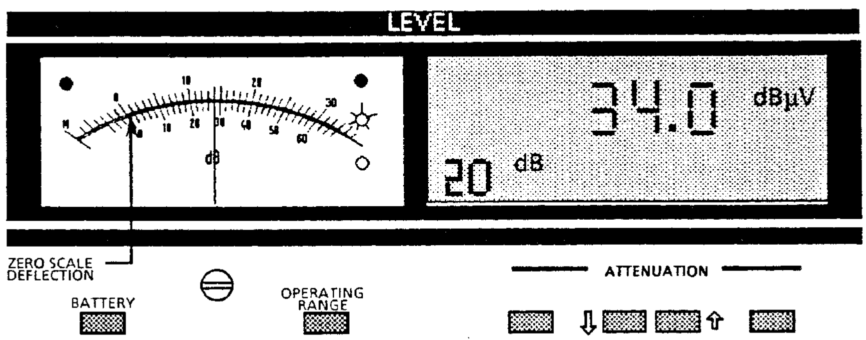
3.2.3.7.2 Analog Level Indication

The ESS-internal signal processing for level indication on the meter is purely analog permitting to eg observe settling processes directly irrespective of the selected measuring time.

The level of analog indication is the sum of the value for ZERO SCALE DEFLECTION in the LEVEL display and 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 any further means.

Example:



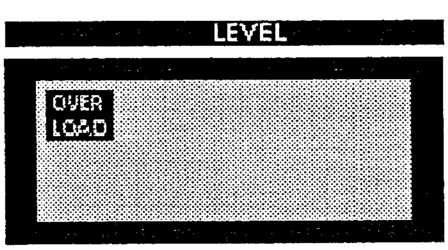
Measured value: 14 dB + 20 dB = 34 dBμV

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 represented 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 meter voltage by way of a digital/analog converter. The operating range of the meter is thus usually shifted, either upwards or downwards (max. by 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. In autorange mode (automatic RF attenuation setting) the ESS, itself makes sure that there are no exceedings of the operating range.

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 with a relatively weak signal within the measuring bandwidth (= IF bandwidth), however a strong signal being outside the range. This strong signal may overload the stages before the IF filter. For this reason, the level is monitored at the critical positions in the ESS. Overloading of a stage in the signal path is indicated by the message OVERLOAD in the LEVEL display.



To guarantee correct measurements RF attenuation must be additionally switched on until the OVERLOAD display disappears. In autorange operation, attenuation is automatically set such that no overload occurs. When, after autoranging, the signal level is reduced, another autoranging process is started only after having varied a receiver setting, eg frequency, bandwidth or detector.

3.2.3.8 Selecting IF Bandwidth (IF BW)

The ESS offers a variety of bandwidths in the range of 2 Hz to 1 MHz covering any civil and military RFI measurement regulation. In practice not all the bandwidths are required over the complete frequency range of the ESS. Availability of the individual IF bandwidths in the ESS is therefore subject to the receiver frequency. Figure 3-4 illustrates the frequency ranges in which the respective IF bandwidths can be switched on:

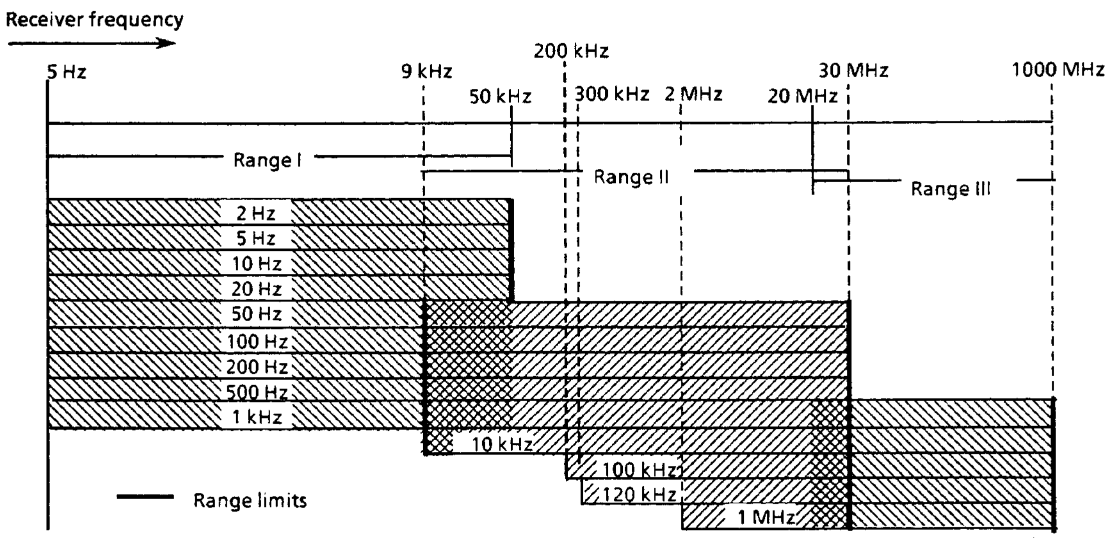


Fig. 3-4 Receiver frequencies in relation to settable IF bandwidths

The minimum settable bandwidth depends on the frequency resolution in the various frequency ranges (cf. table 3-2). The bandwidth is always at least five times the tuning step size, thus ensuring that all settable frequencies are continuously covered without any additional level measurement errors.

With an input frequency below 9 kHz the maximum settable bandwidth is 1 kHz conforming to the usually occurring signal bandwidths. With minimum frequencies, IF bandwidths higher than 1 kHz can be set according to the following table:

Table 3-5

IF bandwidth	settable
10 kHz	9 kHz
100 kHz	200 kHz
120 kHz	300 kHz
1 MHz	2 MHz

These large IF bandwidths cannot be used with frequency limits below those given in Table 3-5 as the inevitable IF feedthrough of the 1st conversion oscillator affects the dynamic range. As a rule of thumb, we recommend using a bandwidth for a measurement only when the receiver frequency is three to five times as high as the IF bandwidth. (Example: Use the 1-MHz IF bandwidth only for input frequencies over 3 MHz).

Exceedings of the range in which a bandwidth is available makes the ESS automatically set the bandwidth for the new frequency such that it is next to the former one.

Example: Set bandwidth: 10 kHz, frequency 1 MHz
New frequency 1 kHz → The bandwidth is automatically set to 1 kHz.

Switching on the former bandwidth immediately afterwards makes the ESS automatically use the former bandwidth unless the bandwidth has already been switched over at the new frequency.

As a rule selection of the IF bandwidth depends on the bandwidth of the signal to be received and required adjacent channel suppression. In the case of high demands on sensitivity, unmodulated signals and signals with narrow modulation bandwidth a bandwidth as narrow as possible is to be preferred, large bandwidths being advantageous for measurements of broadband signals, such as pulse signals.

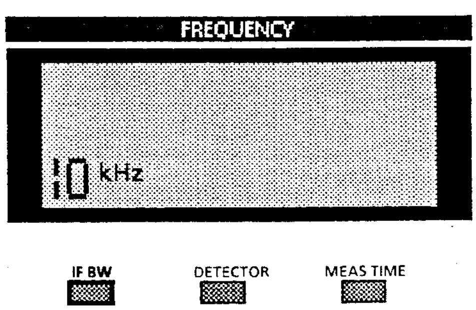
The bandwidths 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz comply with the bandwidths recommended in the MIL standards.

With quasi-peak indication the IF bandwidth depending on the frequency range specified in the CISPR standards is mandatory. With quasi-peak detector switched on the bandwidths required for the respective frequency ranges are therefore automatically set in the ESS and cannot be changed.

- Die 200-Hz bandwidth complies with the tolerance of the bandwidth for Band A (9 kHz to 150 kHz) specified in CISPR 16 or VDE 0876 and is firmly linked to quasi-peak indication in the frequency range below 150 kHz.
- The 10-kHz bandwidth meets the requirements to CISPR 16, Band B (150 kHz to 30 MHz) and VDE 0876 on account of the confined specification of the 6-dB drop as well as the tolerance of 10 % for a 10-kHz measurement bandwidth demanded in various military standards.
- The 120-kHz bandwidth fulfills the tolerance of bandwidth for Band C and D specified in CISPR 16 and VDE 0876 and is firmly linked to QP indication in the frequency range of 30 to 1000 MHz.

All the IF filters in the ESS have optimal settling characteristics thus being suitable for average measurement of pulse signals to CISPR 16.

Operation:



- Press IF BW key.
  The next lower IF bandwidth is switched on and the new one is underlined in order to show that a new entry can be made via the numeric keypad DATA.

- Press an ENTER key.
  The bar disappears again (input of bandwidth is inactive).

When switching through the bandwidth using the IF BW key only the bandwidths available at the set frequency are offered. An attempt to switch on a bandwidth not available with the set frequency via numeric input the message *Bandwidth out of range* to be output in the status line on the screen.

3.2.3.9 Selecting the Weighting Mode (DETECTOR)

Selection of the indicating mode simultaneously specifies weighting of the envelope of the IF signal. The weighting modes (detectors) average value (AV), root mean square value (RMS), peak value (Pk), peak value relating to 1-MHz bandwidth (Pk/MHz) and quasi-peak value (QP) are available in the ESS. The effects resulting from the selection of indicating mode are explained in the following sections.

3.2.3.9.1 Average Measurement (AV)

With 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. With an unmodulated sinusoidal signal being applied to the receiver input, its RMS value is indicated; if an AM signal is present, the RMS value of the carrier is indicated.

With the ESS, averaging is performed analog using lowpass filters, the time constants of which are switched over depending on measuring time (cf. section 3.2.3.10). Thus averaging is automatically visible on the meter. With measuring times over 100 ms - in addition to analog averaging - digital averaging is performed by the processor allowing correct weighting of pulses with very low pulse frequencies. Weighting of pulses is dealt with in sections 3.2.3.9.5 and 3.2.3.10.

3.2.3.9.2 RMS Value

For RMS value measurements the RMS value of the rectified voltage at the envelope demodulator output is indicated. Irrespective of the signal shape, the envelope demodulator power is indicated. RMS value generation is performed analog. The time constant for RMS value generation is set via the measuring time and is identical with the time constant of average value generation with the measuring time already specified. 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)

With peak value measurement, the maximum value of the rectified voltage at the envelope demodulator output within the selected measuring time is indicated. The demodulator is calibrated using the RMS values of an unmodulated sinusoidal signal that supplies the same rectified voltage. Average and peak values 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 3.2.3.13.4, measuring accuracy).

Peak value indication serves for determining the levels of keyed carriers, pulse signals or peak voltages of AM 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. Military test regulations usually prescribe peak value measurement.

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 assuming that pulse-shaped signals are applied to the receiver input. The pulse voltage at the IF filter output is directly proportional to the pulse bandwidth (≈ 6dB bandwidth) of the filter, provided the pulse frequency is sufficiently low so that the individual pulses at the filter output do not overlap. In indicating mode Pk/MHz the peak value is thus increased arithmetically by the bandwidth factor:

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

With an IF bandwidth of 10 kHz (nominal value, actual value of 6-dB bandwidth: 9.5 kHz) or 120 kHz this factor amounts to 40.4 dB or 18.4 dB, respectively.

Pulses with repetition frequencies below 2 kHz 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 10 kHz bandwidth than with 1 MHz. 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.

$$\text{increase} = 20 \log \sqrt{\left(\frac{1\,\text{MHz}}{9.5\,\text{kHz}}\right)} = 10 \times \log \left(\frac{1\,\text{MHz}}{9.5\,\text{kHz}}\right) = 20.2\ \text{dB}.$$

Select the bandwidth as high as possible since the measurement result then comes closest to the amount of interference. In line with the MIL standards the bandwidths 1, 10, 100 kHz and 1 MHz arranged in decades are bandwidths commonly used for broadband interferences depending on the frequency range.

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 3.2.3.9.6, 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 3-6

	CISPR Band A	CISPR Band B	CISPR Band C/D
Frequency range	9 to 150 kHz	0.15 to 30 MHz	30 to 1000 MHz
IF bandwidth	200 Hz	9 kHz	120 kHz
Charge time of QP detector	45 ms	1 ms	1 ms
Discharge time of QP detector	160 ms	500 ms	550 ms
Time constant of meter	160 ms	160 ms	100 ms

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

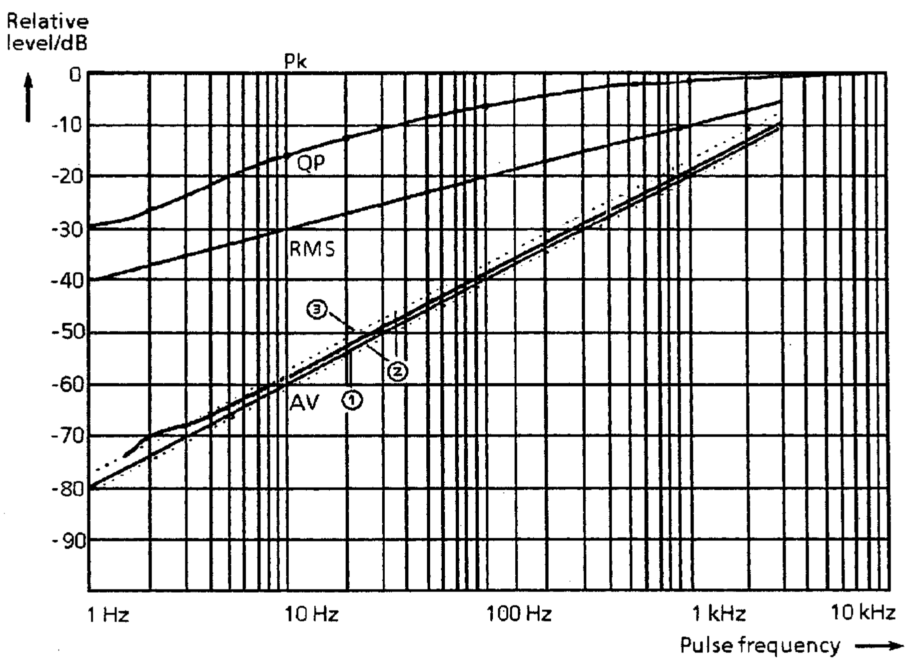
Due to the long time constants of weighting, it takes relatively long until a valid measurement result is displayed after any change in frequency or attenuation on the receiver. The ESS therefore observes indication behovior of the measurement voltage and starts the measurement only when it is almost stable or, alternatively, after approx. 5 discharge time constants with input signals varying in the level. The user need not consider the switch-over processes when selecting the measuring time. Only the interferences to be expected are of importance and should be taken into account.

The maximum level value during the set measuring time is shown by the digital level display. The time-varying quasi-peak test voltage can be observed on 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 ESS the operating range can be selected without any confinements. With low pulse frequencies the 60-dB range, however, cannot be made full use of as otherwise RF input would be overloaded. Overloads are indicated by the overload message in the LEVEL display. Increase RF attenuation to such an extent that the overload message disappears. In autorange mode the receiver, itself, sets attenuation correctly.

3.2.3.9.5 Pulse Weighting in Various Weighting Modes

Figure 3.5 shows the differences in weighting of pulses between the indicating modes average value (AV), RMS value (RMS), peak value (Pk) and quasi-peak Band B (QP) using the 10-kHz IF bandwidth as an example.



Average value: ①Nominal indication
②Error limits to VDE 0876, part 3
③Typical indication with ESS

Fig. 3-5 Differences in weighting of pulses between the indicating modes AV, Pk and QP

Table 3-7 Error limits in the indicating mode (QP) to CISPR 16, Band B and VDE 0876

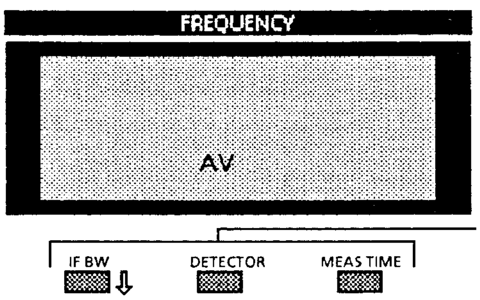
Pulse frequency	Relative level indication	Tolerance
1 kHz	-1.5 dB	± 1.0 dB
100 Hz	-6.0 dB	—
20 Hz	-12.5 dB	± 1.0 dB
10 Hz	-16.0 dB	± 1.5 dB
2 Hz	-26.5 dB	± 2.0 dB
1 Hz	-28.5 dB	± 2.0 dB

The figure above illustrates the following facts relevant for the measurement:

- Sinusoidal signals and pulses with a high repetition frequency result in the same indication irrespective of the weighting mode

- Peak value indication (Pk) always shows the peak value of the highest pulse irrespective of the number of pulses during measuring time.
- In quasi-peak mode (QP) level indication drops with decreasing pulse repetition frequency due to time constants specified in CISPR 16.
- RMS value indication weights pulses proportionally to power. Reducing the pulse frequency decreases indication by 10 dB per decade.
- Average value indication (AV) weights pulses proportionally to pulse frequency. Level indication decreases most rapidly (20 dB per decade) when pulse frequency is reduced. With the ESS, the characteristic curve of average value indication (curve ③) 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 → RMS → 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, etc.

Significance with Peak Measurement:

In indicating mode Pk the maximum level value 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 possible measuring time. With 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 before the maximum waiting time has elapsed, 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 (linear averaging).

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

With narrow bandwidths it is not useful to set short measuring times as complete settling of the IF filter cannot be guaranteed. Measuring times falsifying the measurement result are therefore blocked. Special function *02 Meas Time cpld* serves to cancel the blocking, if required (cf. section 3.2.4.7).

Both 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 3-8

Measuring time	Min. pulse frequency for correct measurements
1 ms to 20 ms	1 kHz
50 ms to 200 ms	100 Hz
≥ 0.5 s	10 Hz

The shortest possible measuring time (1 ms) can also be used for RFI measurements for the following reasons:

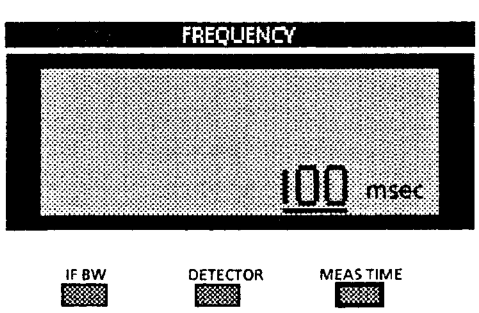
For RFI voltage measurements the difference between the limit values of quasi-peak and average value is max. 13 dB (CISPR, Publ. 22, class A instruments). According to figure 3-5 showing the weighting curves this difference is reached at a pulse frequency of 1.8 kHz. For lower pulse frequencies the quasi-peak limit value is always decisive, i.e. the quasi-peak value is more likely to exceed the quasi-peak limit value than the average value exceeds its 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, average value indication 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 to be set in order to obtain correct test results. 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. With known pulse repetition frequencies at least 5 pulses should occur within the measuring time to provide for a correct measurement result (cf. also section 3.2.3.9.5).

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. With a stable interference spectrum, ie there are no spectral components slowly varying in level, measuring times of 1 ms can be used without risking reduced accuracy.

Operation:



Note: *Measuring times below 200 ms must be entered in milliseconds whereas over 200 ms seconds must be input as the display is limited to $2^1/_2$ digits.*

- Press MEAS TIME key.
  A bar indicating that measuring time input is active appears below the measuring time displayed.
- Enter a new measuring time using numeric keypad DATA (cf. section 3.2.2).
- Complete input by the desired unit.
  The new measuring time is displayed together with the unit.

3.2.3.11 Selecting AF Demodulation (DEMOD)

The ESS offers the demodulation modes F3, A3 and A0. The IF bandwidth effective for demodulation is either 10 kHz for bandwiths set below 10 kHz or the selected bandwidth for bandwidths above 10 kHz. Use of the balanced input (LF INPUT) and frequencies below 9 kHz do not allow AF demodulation. It is automatically switched off.

Using F3 FM signals are demodulated. Bandwidth and slope of the demodulator are matched to the selected IF bandwidth in order to achieve an optimum AF signal/noise ratio. Narrowband FM signals are best demodulated with an IF bandwidth of 10 kHz, whereas an IF bandwidth of 120 kHz is optimal for FM broadcasting signals. The AF bandwidth is 5 kHz for an IF bandwidth of 10 kHz and 30 kHz for an IF bandwidth of 120 kHz.

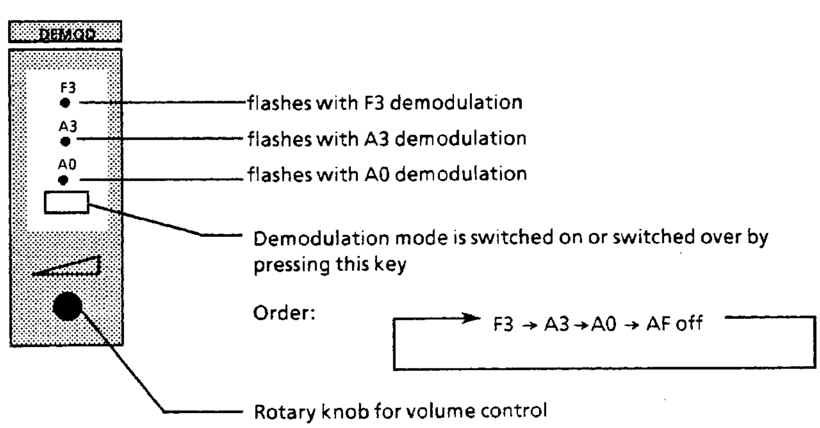
A3 stands for demodulation of AM broadcasting signals. AF bandwidth is limited to 5 kHz. In the indicating mode quasi-peak (QP), noise in the AF branch is suppressed to some extent in order to show more clearly the devices interfering with pulses. Distortion of signals to which sine-wave modulation has 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 3.2.4.7), AF demodulation must be switched on, as otherwise the beeper is not audible. With the volume control knob set to the left stop the demodulated AF still cannot be heard.*

Operation:



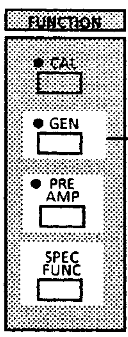
3.2.3.12 Operation with Internal Tracking Generator

Attenuation and gain measurements on four-terminal networks with a very high dynamic range can be performed using the tracking generator. It is available in the frequency range of 9 kHz to 1000 MHz (Range II and Range III).The output level amounts to 96 dBµV ± 1 dB EMF with an internal resistance of 50 Ω. The level error is typically less than 0.3 dB over the entire frequency- and operating temperature range. The measurement range comprises -126 dB to +47 dB (with preamplifier and an IF bandwidth of 10 kHz).

For four-terminal network measurements the average value detector (AV) is recommended for use. The other indicating modes provide the same measurement result, however limit the dynamic range on account of the increased basic noise. If any detector other than AV is set when switching on the generator, the hint *Select AV detector* is read out on the screen.

In autorange operation the maximum possible IF attenuation is always set irrespective of the set mode (low noise or low distortion) until RF attenuation can no longer be reduced (setting 0 or 10 dB, cf. section 3.2.3.2). Thus it is ensured that measurements are always performed with maximum signal-to-noise ratio.

Operation:



The tracking generator is switched on using the GEN key, the yellow LED lights and the indication unit changes to dB.

Pressing the GEN key again switches the generator off. Detector and unit return to their initial state.

Note: *The absolute level at the RF input can be set in the selected unit instead of attenuation or gain indication in dB using a special function (cf. section 3.2.4.7).*

3.2.3.13 Calibration and Measurement Accuracy

The ESS is calibrated using an internal sinewave generator at 64 MHz and an harmonics generator providing a 100-kHz comb spectrum that is flat up to 1000 MHz. The harmonics generator is switchable in the range of 25 Hz to 100 kHz. The 25-Hz and 100-Hz spectrum is used for calibration of quasi-peak indiction, the 10-kHz spectrum for calibration of frequency response in the Range I (5 Hz to 50 kHz) and the 100-kHz harmonics spectrum for calibration in Range II and III (9 kHz to 1000 MHz). Both short calibration at the receiving frequency and total calibration, during which the entire receiver is calibrated in a complex process is possible.

3.2.3.13.1 Short Calibration

During short calibration the gain of the receiver at the reference frequency (50 kHz, 1 MHz and 64 MHz in Range I, II and III, respectively) with and without preamplifier and gain at the two IF bandwidths are adjusted. The gain determined is maintained until the next calibration is performed. In addition gain is corrected at the 100-kHz spectral line that is closest to the current receiving frequency. This correction is not effective anymore upon a change in the receiver frequency.

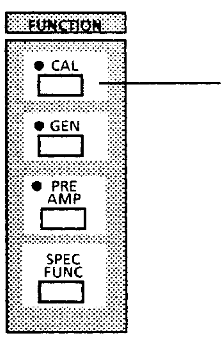
3.2.3.13.2 Total Calibration

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

- frequency response with and without preamplifier,
- correction values for 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-dB and 60-dB ranges.

Total calibration takes about 80 seconds. It eliminates the need for calibration of the receiver after having switched over a receiver setting. Thus optimal measurement speed is possible while high measurement accuracy is ensured. After an instrument warm-up time of 30 minutes a total calibration is recommendable. Due to high stability of the receiver the correction values remain constant over a long period and therefore need not be set daily anew.

Operation:



Short depression of the CAL key (< 3 s) triggers short calibration. The LED flashes during calibration and the remark *CAL SHORT* is displayed in the status line on the screen.
Longer key depression (> 3 s) initiates total calibration. The LED flashes during calibration and the information *CAL TOTAL* is displayed in the status line on the screen.
After completion of calibration, the message *CAL COMPLETE* appears in the status line on the screen.

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 (*WARN*) 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 and calibration is aborted. 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. Error messages are automatically output on a printer connected during calibration and via IEC bus (cf. section 3.3).

The following warnings and error messages are possible:

CAL TOTAL required	If, with short calibration, gain departs 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 50 kHz *ERR: Gain at 1 MHz* *ERR: Gain at 64 MHz*	Gain at the reference frequency 64 MHz cannot be controlled. Calibration is aborted.
WARN: Gain at 50 MHz *WARN: Gain at 1 MHz* *WARN: Gain at 64 MHz*	Basic gain of the receiver is not within the internal tolerance limits at one of the reference frequencies. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected which leads to another error messge.
WARN: BW xx kHz	Gain at the IF bandwidth xx (xx = 2 Hz to 1 MHz) is outside the tolerance limits. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected which leads to another error message.
ERR: BW xx kHz	Gain at IF bandwidth xx (xx = 2 Hz to 1 MHz) can no longer be corrected. Calibration is aborted.
WARN: IF ATT	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 internal tolerance limits, correction of total gain of the ESS 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 defective so that it is no longer possible to correct its gain error. Calibration is aborted.
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 defective and can no longer be used. Calibration is aborted.
WARN: Pk/MHz	With the correction value for the bandwidth in the indicating mode Pk/MHz being not within the tolerances, the permissible tolerance for the IF bandwidth 10 or 120 kHz is not adhered to.

WARN: QP Band A or *WARN: QP Band B* or *WARN: QP Band C/D*	Quasi-peak weighting is out of tolerance at the reference pulse frequency (Band A: 25 kHz, Band B and C/D: 100 Hz)
ERR: QP Band A or *ERR: QP Band B* *ERR: QP Band C/D*	Quasi-peak weighting is defective. Calibration is aborted.
WARN: Gain at xx MHz/(kHz)	When recording frequency response of the receiver the internal tolerance is exceeded. As a result the total correction value may be too high and cannot be set anymore.
ERR: Gain at xx MHz/(kHz)	A filter range of preselection is defective. Measurements in this range are not possible. Calibration is aborted.
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. In this case, the message *ERR: Meas uncal* is output in the status line on the screen. Illegal measurement values are marked with IEC bus output (cf. section 3.3).

3.2.3.12.4 Measurement Accuracy

With total calibration, all the values determined are related to the internal calibration generator and RF attenuator. Linearity of the operating ranges is recorded in 10-dB steps. Interpolation is performed between the known points. Due to the high linearity of the envelope detector and logarithmic amplifier (typ. error < 0.25 dB), the 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:

	$f_i \leq 30$ MHz	$f_i > 30$ MHz
Error limits of attenuator	0.3 dB	0.4 dB
Error limits of calibration generator	0.3 dB	0.4 dB
Setting accuracy of gain	0.05 dB	0.7 dB
Unlinearity of envelope detector	0.15 dB	0.15 dB

As the individual errors are independent of each other in terms of statistics, quadratic addition is allowed. The total error is thus 0.5 dB below 30 MHz and 0.8 dB over 30 MHz.

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 mainly 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 approximated by 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
$N_2 \approx N_1 + 11$ dB.

Table 3-9 and figure 3-6 illustrate increase in indication with average value measurement of sinusoidal signals and peak value measurement as a function of the signal-to noise ratio.

Table 3-9: Error during measurement of 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 indiation in dB with		
	Average value (AV)	RMS value (RMS)	Peak value (Pk)
0	2.28	3.00	5.10
1	1.86	2.54	4.67
2	1.50	2.12	4.27
3	1.21	1.76	3.98
4	0.98	1.46	3.54
5	0.79	1.19	3.22
6	0.63	0.97	2.92
7	0.50	0.79	2.65
8	0.40	0.64	2.39
9	0.32	0.51	2.16
10	0.26	0.41	1.95
12	0.16	0.27	1.59
14	0.10	0.17	1.28
16	0.06	0.11	1.03
18	0.04	0.07	0.83
20	0.02	0.04	0.67
25	0.01	0.01	0.38
30			0.22
40			0.07
50			0.02

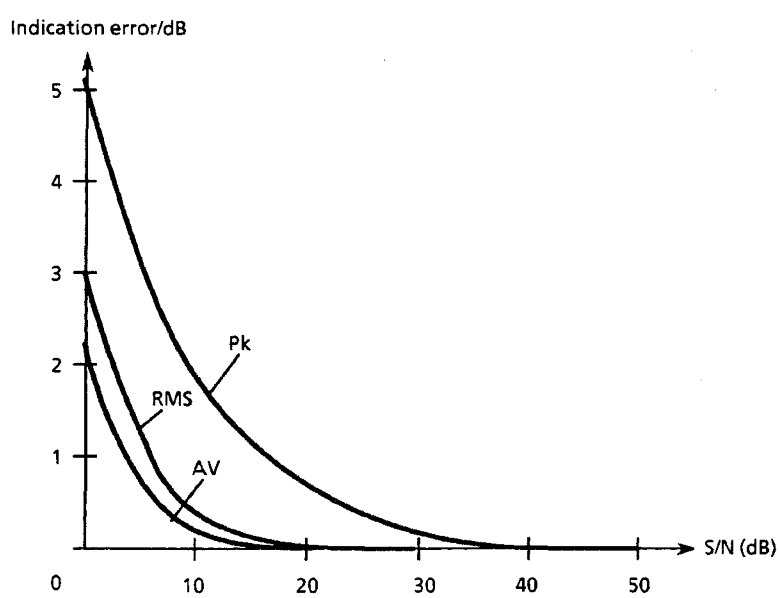
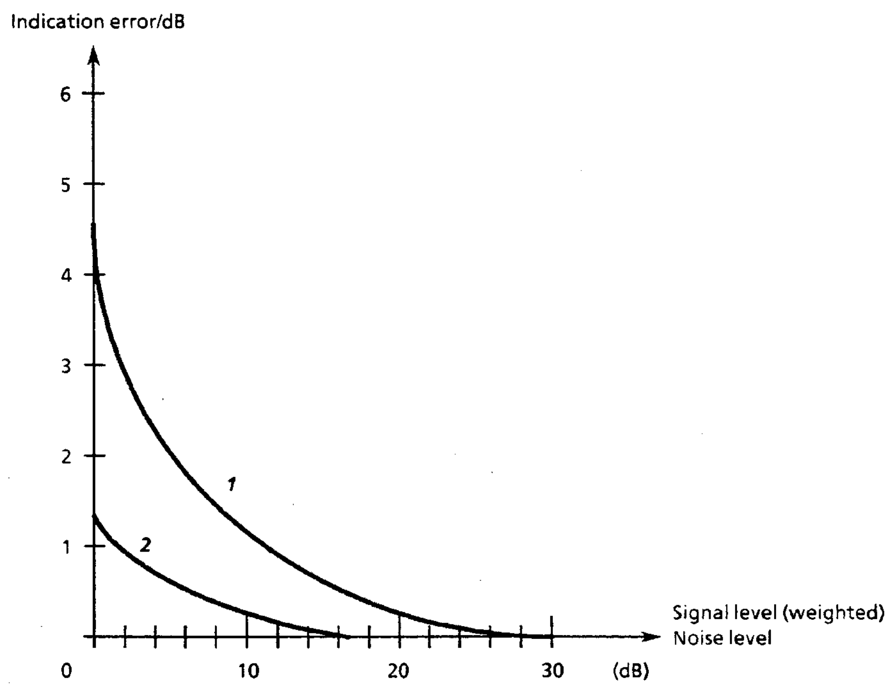


Fig. 3-6 Increase in indication of an unmodulated sinusoidal signal as a result of noise as a function of the signal-to-noise ratio.

Fig. 3-7 illustrates the increase in indication as a result of receiver-internal noise with quasi-peak indication for sinusoidal signals and pulse signals with a pulse repetition frequency of 100 Hz. On account of pulse weighting the error mainly 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.



① when measuring sinusoidal signals
② when measuring pulse signals with a pulse frequency of 100 Hz

Fig. 3-7 Increase in indication 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 offered by the ESS, perform measurements with a high signal-to-noise ratio, i.e. 60-dB range, low noise.
- Sinusoidal signals should be measured with 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 selects the suitable mode.

3.2.4 Operation of the Menu Functions

The following functions are called via the MENU keypad and the 5 softkeys below the CRT:

- Presetting of instrument parameters
- Input of limit lines and transducer factors
- Operation of the floppy disk drive
- Control of complex measurement runs of RF analysis
- Control of IF analysis
- Operation of the marker
- Calling of the instrument selftest

For operation of the functions and parameter entry, tables or input fields on the screen are used.

3.2.4.1 Input and Editing on the Screen

3.2.4.1.1 Structure of the Screen

The screen area comprises 28 lines with 40 characters each. Depending on the mode of operation, the following screen structure is obtained:

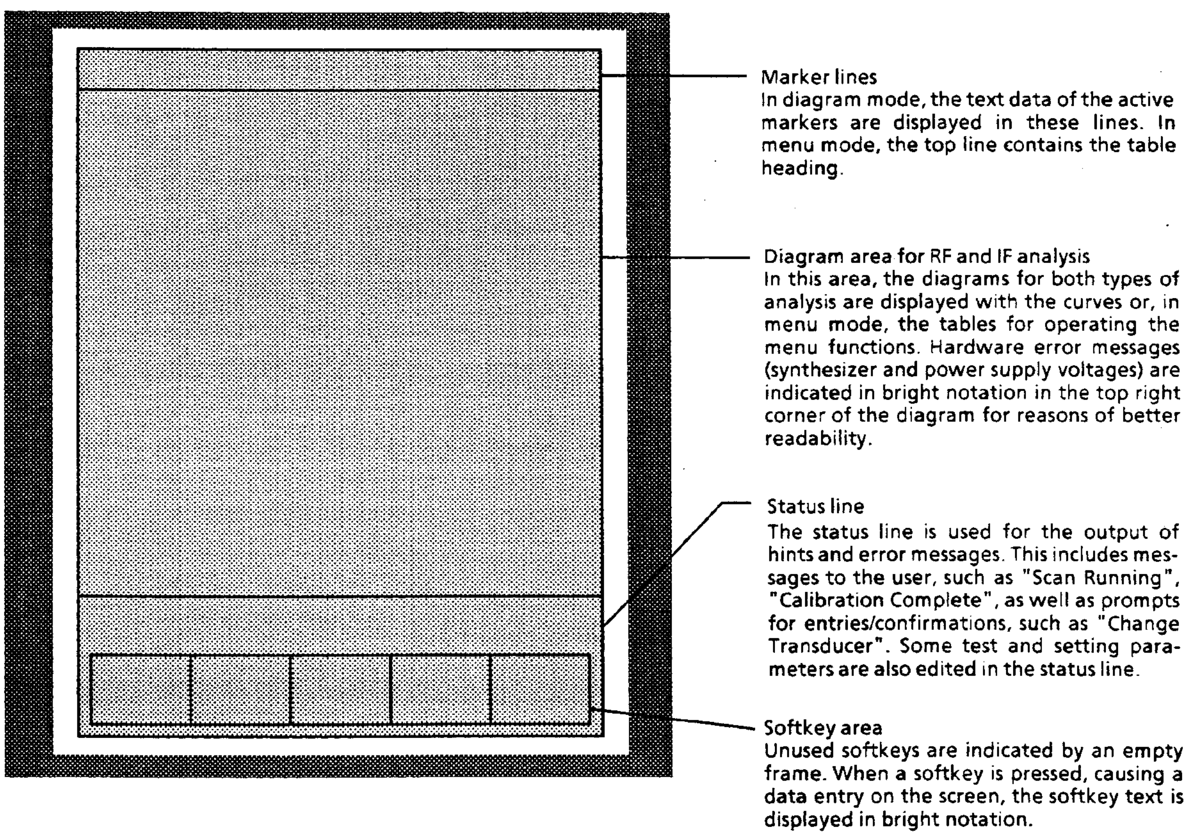


Fig. 3-8

3.2.4.1.2 Calling the Softkey Menus

By pressing a MENU key, the appropriate softkey menu is called. The screen then displays the respective diagrams of RF or IF analysis or a table that contains a data list or a function select list. The softkey menus may comprise further submenus. The limited depth of the softkey structure makes for easy and clear menu operation. Another main menu can be entered from any submenu by pressing the appropriate key.

The next higher menu level can be attained by pressing the EXIT key. The highest menu level of a table function can be left for the previously active type of analysis (RF or IF) by pressing the EXIT key.

3.2.4.1.3 Operation of the Menu Functions

For entering parameters and selecting the data and functions, the ESS uses lists which are displayed on the screen in the form of tables. The upper screen line contains the designation of the currently active menu.

Selecting the table elements

After calling a menu, a table with data or functions appears on the screen. A cursor symbol for selecting the individual table elements usually indicates the first input field. The currently active input line is shown in bright notation. Continuation of a list is marked by the symbol ↑ or ↓ at the upper or lower edge, respectively.

An element can be selected using the keys ↑ and ↓ in the EDIT keypad:

- ▸ Position the cursor (>) to the desired function or, in a table, to the appropriate data field and start the function using ENTER.

  Some tables use numbers for designation of the table elements. In this case, the elements can also be selected by directly entering numbers in the table.

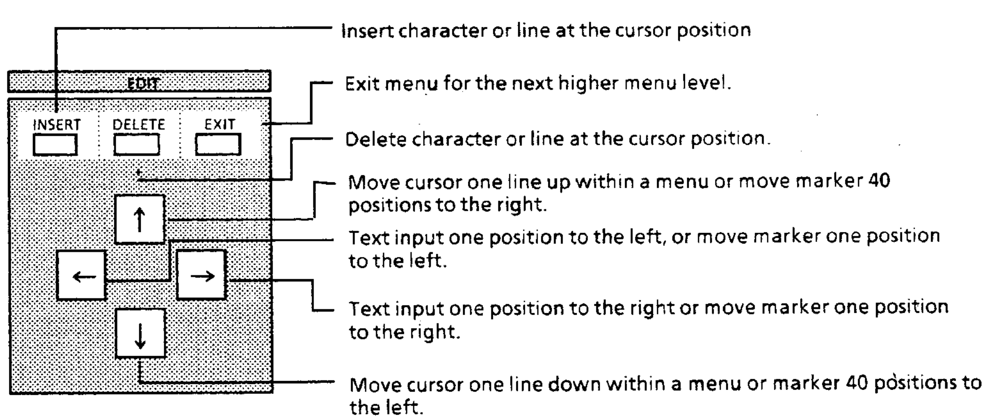


Fig. 3-9

Input of numerical values

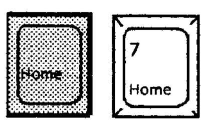
Numerical values are directly entered in the table at the current cursor position. To this end, the numerical keypad is used, and the entry is terminated using ENTER or the unit. INSERT or DELETE can be used to enter or delete a character or line at the cursor position.

If entry of a numerical value is required when switching on special functions, this is not done in the table but in the status line (e.g. entry of trigger level with "*SF 50 Internal Trigger Level*").

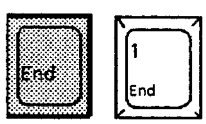
3.2.4.1.4 Input of Texts and Labellings

Transducer factors and sets, limit lines, files on floppy disk, internally stored data sets as well as test reports output on the plotter or printer can be assigned names or labelled by the user. The name or labelling can be entered via a standard MF keyboard connected to the rear panel of the receiver (cf. section 3.2.6.8) or, if no keyboard is available, via an auxiliary line editor. The use of a keyboard is recommended, in particular for labelling test reports, since this ensures a much more convenient input.

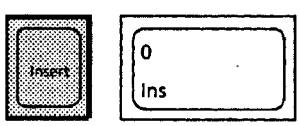
For the input with an external keyboard, the following rules should be observed to ensure more comfortable text processing:



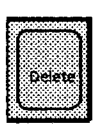
shifts the input cursor to the beginning of the text.



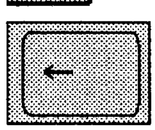
shifts the input cursor to the end of the text.



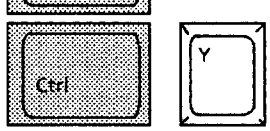
switches the input mode between "insert" (default) and "overwrite".



deletes a single character below the position of the input cursor.



deletes a single character ahead of the position of the input cursor.



completely deletes the text currently processed.

Operation of the auxiliary line editor

The auxiliary line editor can be used for labellings and text entries without an external keyboard being connected to the ESS. The selection lines with characters are always displayed automatically when text entry is possible and no external keyboard is connected. (Exception: In the menus *Floppy Store all* and *Report Title* the INSERT key must be pressed to call the auxiliary line editor.)

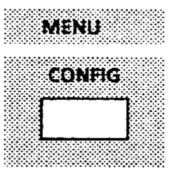
The first line with upper-case letters, blank and special characters is faded in above the status line. The two arrows at the end of the line indicate that the ↑ key serves to reach the input line and likewise the ↓ key to reach the second line (with lower-case letters). The individual characters are selected using the ← und → keys and inserted into the text in the input field using the INSERT key. Numerals in the DATA keypad can be entered at any time. Characters may be cleared using the CLR key (character ahead of the cursor) or DELETE key (character below the cursor). Text input is terminated by pressing one of the ENTER keys.

3.2.4.2 Configuration of the Receiver (CONFIG Key)

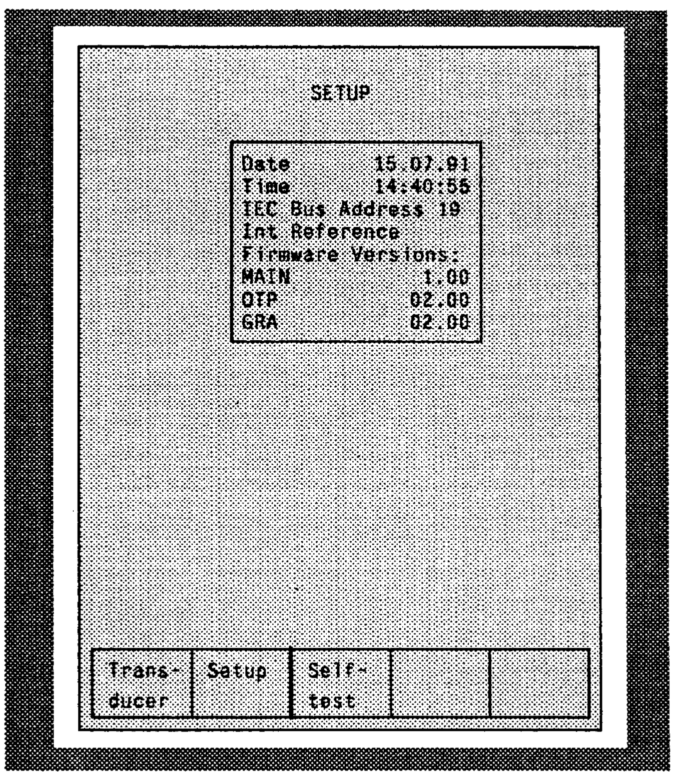
The CONFIG menu is used to display or enter the following data:

- Transducer factor
- Transducer set
- Entry of date and time
- Selection of IEC bus address (IEC bus)
- Display indicating whether operation is with internal or external reference
- Display of the firmware versions of all data sets
- Calling of the selftest functions

Operation:



▸ Press CONFIG key.
The *SETUP* menu is read out on the screen.



Designation: MAIN = Main processor
OTP = Boot-PROM; includes switch-on and firmware loading functions
GRA = Graphics-PROM, screen functions

Fig. 3-10 Setup

In the Setup table, the time is permanently updated (as is the date when exceeding a day). Besides, the currently used reference frequency (*Int Reference* with internal reference or *Ext Reference* with external reference frequency) is displayed.

By pressing the appropriate softkey, the desired menu for data entry can be called.

3.2.4.2.1 Input and Calling of Transducer Factors (TRANSDUCER Menu)

In the field of interference measurements a transducer is usually connected ahead of the receiver, converting the interfering quantity to be measured into a voltage into 50 Ω. Transducers may be antennas, artificial networks or clip-on probes. They often feature a frequency-dependent conversion factor. Transducers with a frequency-independent conversion factor can be coded in 10-dB steps at the ANTENNA CODE socket (see section 3.2.5.1). Non-decadic conversion factors are considered in the transducer factor. With the transducer activated, the receiver indicates the measured quantity at the input of the transducer.

In the case of the ESS a distinction is made between **transducer factor**, in the following text abbreviated by "factor", and **transducer set**, briefly referred to as "set". A factor consists of sampled values, which are defined by frequency and conversion factor, and the unit for the level display. For frequencies between the sampled values, the transducer factor is approximated using modified spline interpolation.

Up to 22 different factors can be defined and permanently stored in the battery-backed RAM of the ESS. They are assigned a number (1 to 22) and a user-definable name so that they can be told from each other. Besides, the data sets can be stored on floppy disk using the floppy disk drive (cf. section 3.2.4.6.2).

Since, in practice, the required number of sampled values varies for the different coupling networks, the maximum possible number is grouped according to the following table, depending on the number of the transducer.

Table 3-10

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

These 22 factors can be combined to form a maximum of 5 sets. As a prerequisite, all factors involved must have either the same unit or the unit "dB". The definition range of a set is divided into subranges. Various factors can be activated for each subrange. There must not be any gaps between the subranges, 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 if different transducers are used in the frequency range to be measured, or if cable attenuation or an amplifier are also to be considered.

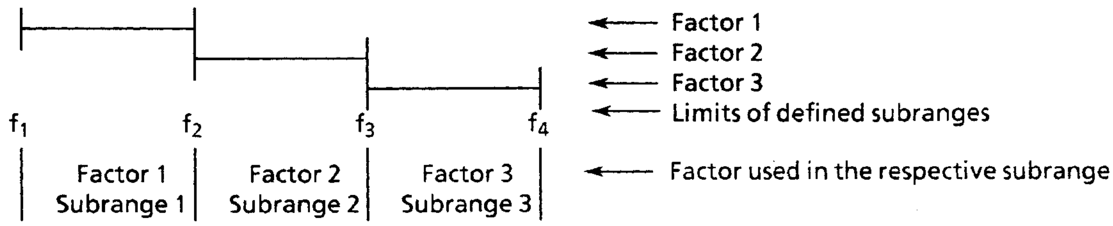
If a transducer set is defined for a frequency scan, the scan is stopped at the intersection between two subranges, and the user is requested to change the transducer. The following prompt appears in the status line:

"Connect Transducer <Transd. Name>"

If the beeper is activated (special function 13), a short beep sounds. The following examples sum up the rules used to combine transducer factors to sets. The rules are implemented in the ESS so that the user need not care whether the transducer set entered is valid.

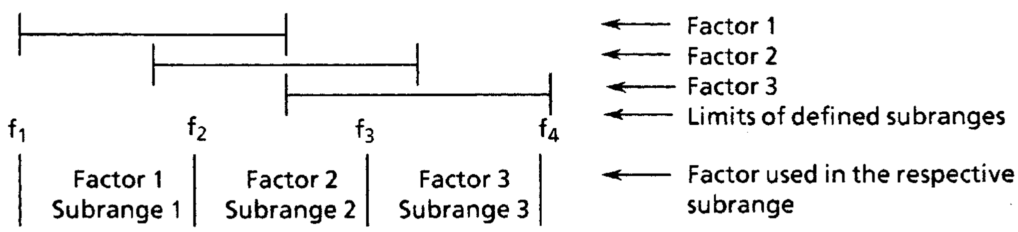
a) Only a single transducer factor is active:

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



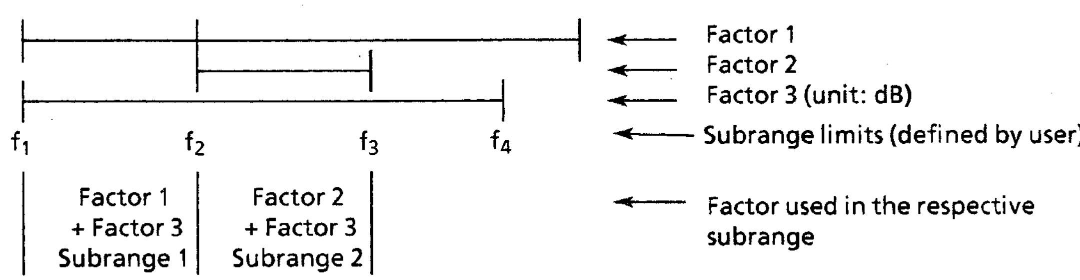
The set is valid from f_1 to f_4. The units of the individual factors are the same. There are no gaps between the individual ranges.

c) Transducer set with several overlapping factors:



With overlapping factors only those factors which completely cover the respective subrange can be activated.

d) Several factors are valid at the same time:



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

Operation:

Trans-
ducer

▸ Press *Transducer* softkey
The *Transducer* menu is called up.

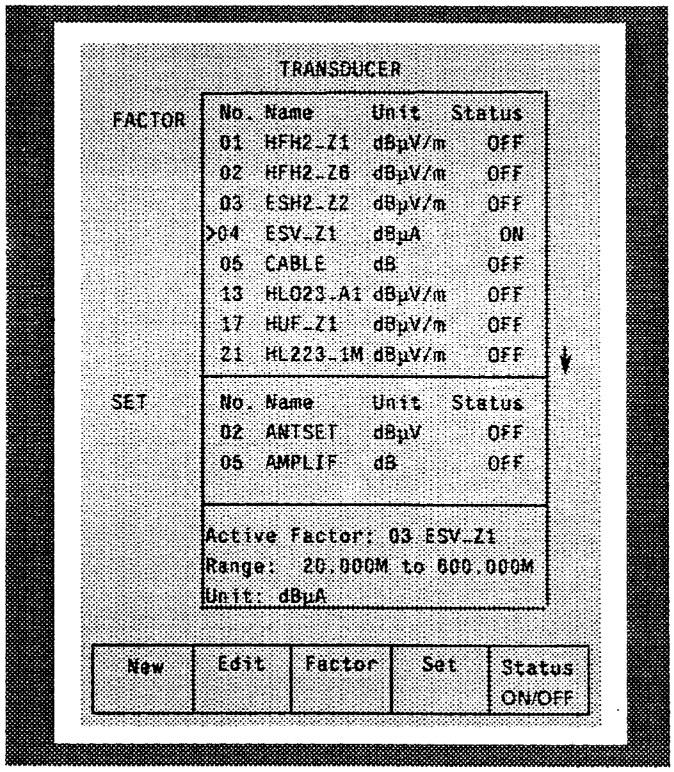


Fig. 3-11

The table lists all defined factors and sets. If no transducer is defined, *None defined* appears in the list.

When the menu is called, the cursor points to the currently active factor or set, or, if none is active, to the factor with the lowest number. The cursor is set to the factor to be modified using the keys ↑ and ↓ or by entering the two-digit number.

Factor

Set

The softkeys *Factor* and *Set* can be used to switch between the Factor and the Set table. The Set table is operated like the Factor table.

Status ON/OFF

This function permits to activate entered transducer factors or sets and deactivate activated factors. The desired factor or set can be selected using the cursor or by entering the appropriate number. By pressing the *Status ON/OFF* softkey, the status of the factor or set is switched over (ON → OFF, OFF → ON). Since only one factor or set can be active at a time, activation of a factor automatically deactivates an already active factor.

The menu is left using the EXIT key. The CONFIG main menu is then displayed (see section 3.2.4.2).

New

Edit

The *New* softkey permits to delete and redefine an existing factor or set. Using the *Edit* softkey, an existing data set can be modified or entered anew. Whether a factor or a set is entered depends on the table in which the cursor is located.

After pressing one of the two softkeys, the desired number must be entered in the status line.

Example: *Edit Factor No. (1 to 22) 17*

The number is offered at the current cursor position. It can be directly confirmed by pressing one of the ENTER keys, or a different number can be entered via the numerical keypad DATA.

When editing a transducer factor, a sampled value can be deleted, a new one inserted or a frequency or a transducer value simply modified. Insertion or deletion is possible if the cursor points to the respective sampled value. The DELETE key is used to delete the respective sampled value, the following values move up. INSERT is used to create a vacant place at the cursor position, and all following sampled values are increased by one. A frequency or a transducer value can be varied by shifting the cursor to the appropriate position and entering the new value via the numerical keypad.

If the transducer factor already has the maximum possible number of sampled values, insertion of a new value is no longer possible.

If the last sampled value or a value with the highest possible frequency has been entered, the cursor remains at the last frequency in the table.

After pressing the *New* softkey and entering the desired factor number, an empty sampled value table appears, the cursor pointing to the frequency of the first sampled value which can be directly entered. Already defined values are deleted, however, they are still present in the ESS memory until valid entry of the first sampled value is made. Thus it is possible to preserve the values if the softkey is pressed unintentionally; in this case, the menu can be left using EXIT and the table listed using *Edit*.

By pressing the *Edit* softkey, the same table can be displayed, listing the values of an existing data set:

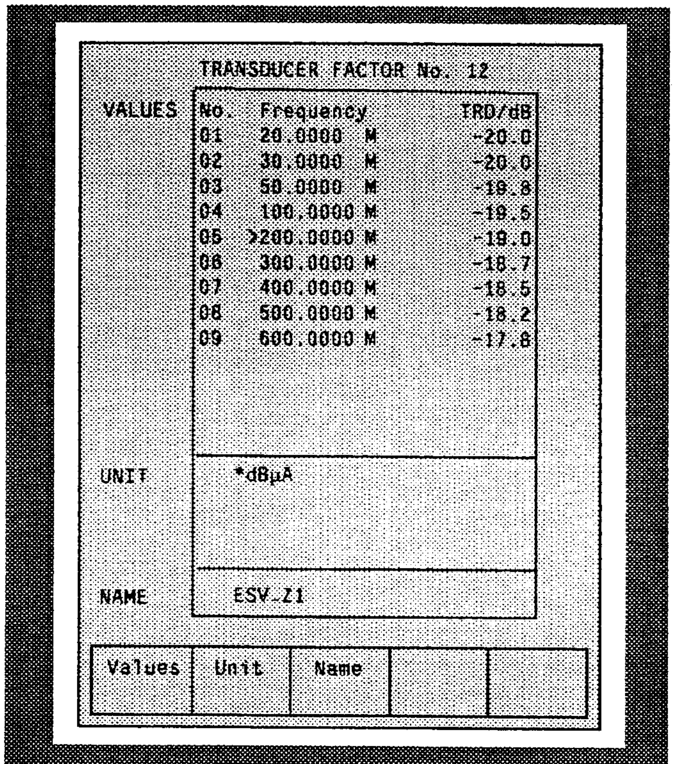


Fig. 3-12 List for transducer factor

General information on definition of a transducer factor

A transducer factor is characterized by:

- Values (sampled values with frequency and level)
- Unit (level unit)
- Name (transducer factor name, max. 8 characters)

The frequencies for the sampled values are to be entered in increasing sequence, since the input will not be accepted otherwise. If the frequencies are not entered in the correct sequence, the following hint is displayed in the status line:

Frequency Sequence.

If a frequency is entered, which cannot be set on the receiver, the following error message is displayed on the screen:

Max Freq 1000 MHz if the frequency is too high
Min Freq 1 Hz if the frequency is too low.

After the frequency has been entered (terminated with MHz or kHz), the cursor automatically jumps to the associated transducer value (TRD). Values from -200 to + 200 are permissible for the transducer. If a transducer factor greater than 200 dB or smaller than -200 dB is entered, the following error message is displayed in the status line:

Max Level 200 dB or
Min Level -200 dB.

Amplifiers feature a negative conversion factor, attenuation values are to be entered as a positive conversion factor. When the sampled value has been completely entered, the cursor automatically jumps to the next line. If not all values of a factor can be listed in the table, the list can be scrolled upwards or downwards, if required.

Values

This softkey is used to return from the unit or name menu to the table of sampled values. By pressing the *Values* softkey, the cursor > can be faded in at the position of the first sampled value.

Unit

In the table *Transducer Unit*, the already defined unit of the transducer factor is marked by an asterisk (*). The unit can be varied by pressing the softkey, shifting the cursor or confirming the new unit using ENTER. Subsequently the *Name* field is directly entered.

Name

The transducer factor can be assigned a name consisting of up to 8 characters (letters and digits). It is recommended to enter a name not only to differentiate the factor in the list, but also because the name is used when storing the data set on floppy disk. The input is made via the external keyboard or the auxiliary line editor. For input of a name, note the operating instructions for floppy menus (cf. section 3.2.4.6.2). Illegal characters are thus being ignored.

EXIT is used to terminate entry of the transducer factor and return to the next higher menu *Transducer*.

Entering a transducer set

A transducer set is characterized by the following features:

- up to 5 frequency ranges
- combination of several transducer factors per frequency range
- one transducer set name (max. 8 characters)

Transducer sets can be newly determined using *New* or revised using *Edit*. After selecting one of the two functions and entering the desired set number, the table for determination of the set unit is displayed.

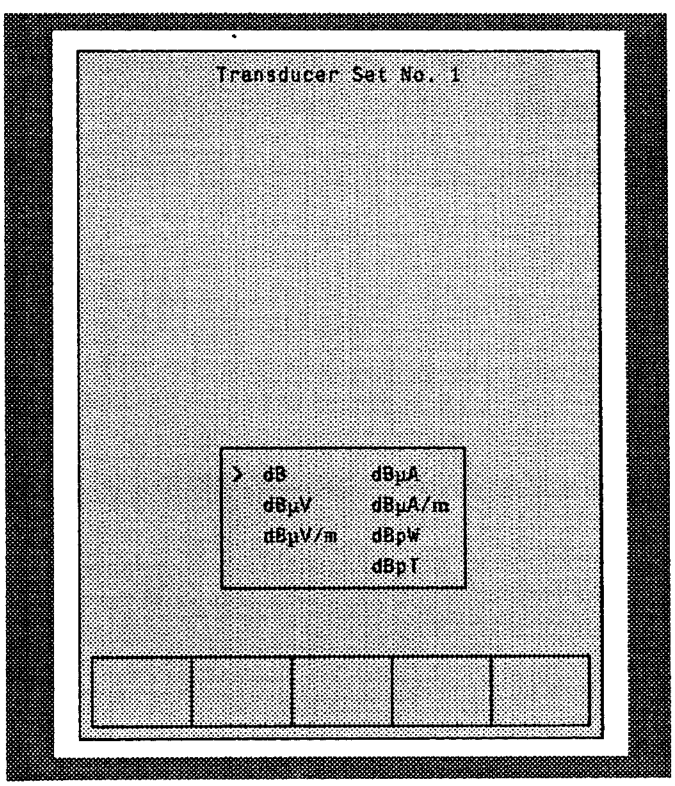


Fig. 3-13 List for transducer set

If a set has already been defined before, a * sign marks the unit valid for the set. The keys ↑ and ↓ can be used to select another unit from the list. By pressing one of the ENTER keys, the unit for the set is transferred. The screen then displays the table for definition of a set.

If the *New* function is selected, an already defined data set is deleted. The input list is displayed without values. If the *Edit* function is selected and the set number of a previously defined data set entered, the values appear in the input list.

Example:

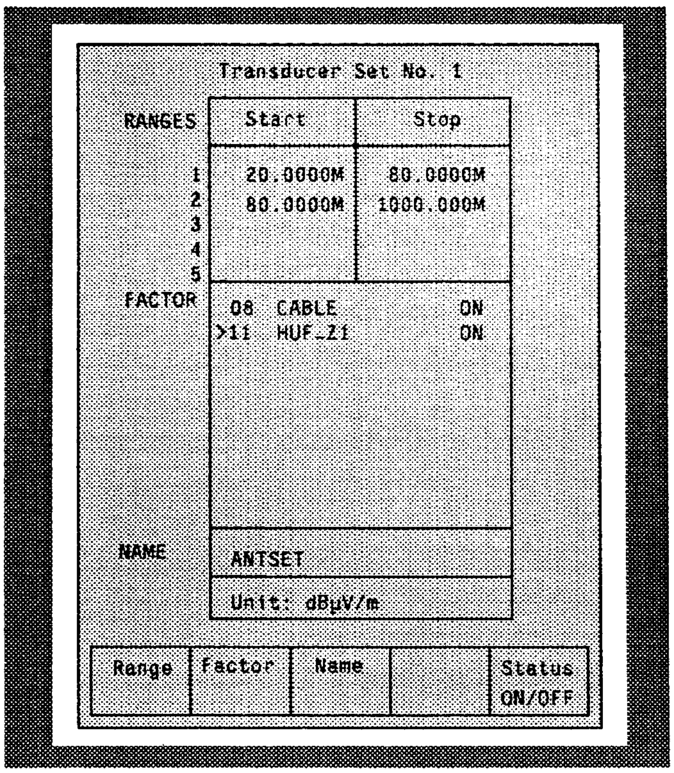


Fig. 3-14

Ranges

The cursor is located at the start frequency of the first range which can be immediately entered. The softkey is used to return from the factor or name menu to the range table. By pressing the *Ranges* softkey, the cursor > is set to the frequency field last active.

In the field for the frequency ranges, the frequency limits of the subranges within a set are determined. Since there must be no gaps between the subranges, the start frequency for the second range is already determined by the stop frequency of the preceding range. Changing a stop frequency means altering the start frequency of the next range.

When editing a transducer set, a frequency range can be deleted, inserted or a frequency varied. Pressing of the DELETE key deletes the respective frequency range, the following ranges move up. By pressing the INSERT key, all ranges starting from the cursor position are shifted one position down. In both cases, the ESS checks that there are no gaps between the ranges. Frequencies can be varied by shifting the cursor to the appropriate position and entering the new value via the numerical keypad.

Besides, the rules given for the entry of transducer factors also apply in this case (increasing sequence, receiver frequency limits).

Factor

The list for selecting the factors for the currently edited range gives only those factors that comply with the unit of the set and are defined over the entire subrange. The list only appears when a frequency range has been completely defined. Each time a frequency is entered (terminated with MHz or kHz), the ESS therefore checks the factor list and, if necessary, sets it up again.

Name

The transducer set can be assigned a name consisting of up to 8 alphanumeric characters. The entry is made via the external keyboard or the auxiliary line editor (see section 3.2.4.1.4). It is recommended to enter a name so that the sets can be told from each other, in particular if the transducer set is to be stored on a floppy disk. For input of a name, note the operating instructions for floppy menus (cf. section 3.2.4.6.2). Illegal characters are thus being ignored. The unit of the set is only displayed, but cannot be varied in this menu.

Status ON/OFF

The desired factors are selected by the cursor and their status (OFF → ON or ON → OFF) is switched using the softkey.

EXIT can be used to terminate the entry of the transducer set and return to the next higher menu *Transducer*. The cursor is located at the currently edited set, which can thus be immediately activated (see *Status ON/OFF*).

3.2.4.2.2 Selecting the Instrument Setup

For entering the date, time and IEC bus address of the ESS, the screen setup determined by the configuration (see section 3.2.4.2) is maintained. All values are directly entered in the screen table via the numerical keypad of the receiver. After pressing the *Setup* softkey, the following submenu appears:

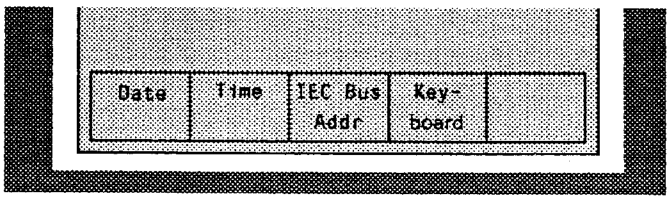


Fig. 3-14

Setting the internal clock:

The current date and the time are included in the real-time clock of the receiver and are displayed and continuously updated after calling the configuration. If a new entry is required, for example after replacement of the internal battery, the softkey for date or time has to be pressed. *Date* and *time* are continuously updated even with the receiver switched off. The values for date and time are used when generating a test report and when storing files on floppy disk.

[Date] The date is entered via the numerical keypad DATA in the format day.month.year. Invalid entries are ignored. When the entry of the date has been terminated using ENTER, the cursor jumps to the time.

[Time] The time is entered via the numerical keypad DATA in the 24-hour format in hours:minutes:seconds. After the time has been entered, the cursor is faded out, the softkey submenu *Setup* being maintained.

Selecting the IEC bus address

[IEC Bus Addr] Values between 00 and 30 are permissible for the IEC bus address. Illegal entries are ignored. The default setting for the ESS is address 19.

Selecting the external keyboard

[Key-board] By pressing the *Keyboard* softkey, the operating mode of the external keyboard is switched between *Keyboard German* and *Keyboard English*. This setting also affects the auxiliary line editor (cf. section 3.2.4.1.4)

3.2.4.2.3 Calling the Selftest

The ESS implements comprehensive selftest functions, which permit to detect an instrument error down to module level. The selftest menu is called by pressing the *Selftest* softkey:

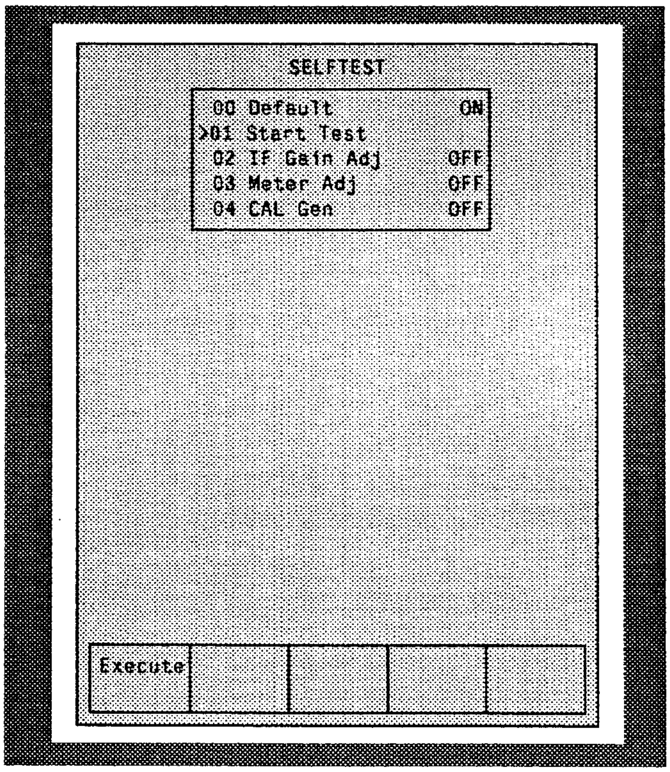


Fig. 3-15

By pressing the *Selftest* softkey, a cursor symbol (>) is displayed in the column to the left of 01. The desired function is called either by entering the associated number or via cursor selection.

00 Default — Default status of selftest settings.

01 Start Test — The selftest is started using the *Execute* softkey and runs automatically, starting from the lowest function level and consecutively checking the functions based on one another. When a faulty function is detected, the respective module is referred to in the status line *(ERR: <module>)*. Only one error can be detected, since, in the case of a faulty function, the following tests can no longer be carried out properly. To avoid unfounded error messages, the selftest is aborted following the detection of the first error.

While these longer tests are running, the receiver cannot be operated. Messages regarding the test (beginning of test, fault or end of test) are given in the status line.

02 IF Gain Adjust
03 Meter Adjust — The two functions are used to allow for convenient setting of modules that have been replaced. The instrument setting required is performed automatically. The functions are switched on and off using the softkey *Status ON/OFF*.

04 CAL Gen — This function permits to switch on and off the calibration generator installed in the ESS for test purposes.

When the menu is left using EXIT, the normal operating status is restored again.

3.2.4.3 Execution of Frequency Scans (RF Analysis)

For measuring interference spectra the most important feature of the ESS is its ability to automatically carry out frequency scans with the setting data varying from range to range. The measurement result is shown in the screen diagram using 800 pixels in the horizontal and 645 pixels in the vertical direction. Only every second pixel of the horizontal resolution is used for the display of a measured value. This results in a maximum of 401 displayed measured values per curve, the highest value of a display range being displayed (subrange maximum). All measured values of a frequency scan are stored in the volatile memory of the ESS and can be read out e.g. via IEC bus. The memory may contain a maximum of 2 x 30,000 measured values (with double measurements see section 3.2.4.7) and 2 x 400 measured values from subsequent measurements (see section 3.2.4.3.3).

For subsequent checking of a measured spectrum, comprehensive marker and zoom functions are available. In addition, the measurement result can be output in a measured value diagram and/or a measured value table either via a plotter, a printer or both.

Limit lines can also be defined according to the rules specified for the respective measurement and output. The frequency scan can be matched to the specific measurement problem with the aid of extended functions (options), or complex measurement runs can be performed, for example a complete RFI power measurement with preliminary measurement, data reduction, final measurement and output of measurement results.

By pressing the RF ANALYSIS key, the diagram of the RF analysis with the scan data is displayed on the screen. Limit lines are drawn in, if defined and activated. If measurement results from a preceding frequency scan are provided, they are displayed. If activated, markers are displayed together with the text data in the marker fields.

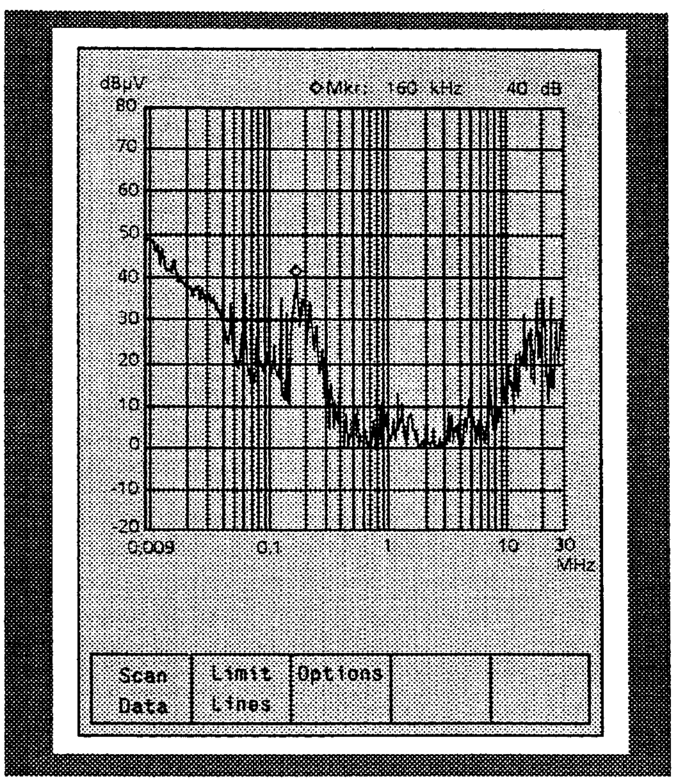


Fig. 3-16 Example of RF analysis screen

3.2.4.3.1 Generation and Editing of Data for a Frequency Scan (Scan Data)

A data set for a frequency scan consists of a maximum of five subscans, which are defined by the start and stop frequency and the step size. The step size can be set linearly (*LIN*) or logarithmically (*LOG*). A logarithmic step size is entered as a percentage of the respective receiver frequency. The remaining receiver parameters such as bandwidth, detector, operating range, attenuation, mode and measuring time are set on the receiver during definition of the subscan as in manual operation, i.e. those receiver parameters that are active on termination of the entry are set for the subscan (confirmation of the question:

Range <n> settings ok? with ENTER).

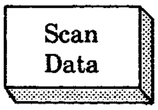
Finally, a minimum level (*Min Level*) and a maximum level (*Max Level*) must be defined for the complete scan data set. These two levels determine the diagram limits on the screen and also those for plotter or printer output. They are always entered in dB. The level unit results from the unit valid for the measurement, which depends on the transducer, antenna code or on special functions set.

The complete scan data set is stored in the battery-backed RAM. Thus it is available again even following switch-off of the receiver. Likewise, it is possible to store a complete measurement configuration on floppy disk and load it from there (see section 3.2.4.6.2). Upon delivery, the default data set is automatically set after loading a new firmware or calling the default setting using RCL0. It consists of 3 subranges with the following settings:

Table 3-11

	Scan No. 1	Scan No. 2	Scan No. 3
Start frequency	9 kHz	150 kHz	30 MHz
Stop frequency	150 kHz	30 MHz	1000 MHz
Step size	100 Hz	5 kHz	50 kHz
IF bandwidth	200 Hz	10 kHz	120 kHz
Attenuation	AUTO, Low Noise	AUTO, Low Noise	AUTO, Low Noise
Operating range	60 dB	60 dB	60 dB
Detector	Pk	Pk	Pk
Measuring time	100 ms	20 ms	1 ms
Preamplifier	off	off	off

Operation:



- Press the RF key.
  The *RF Analysis* menu is displayed on the screen.

- Press *Scan Data* softkey.
  The table for entering the subscan ranges is displayed on the screen.

***Note:** The softkey has a different function if option 63 (Special Scan) is activated.*

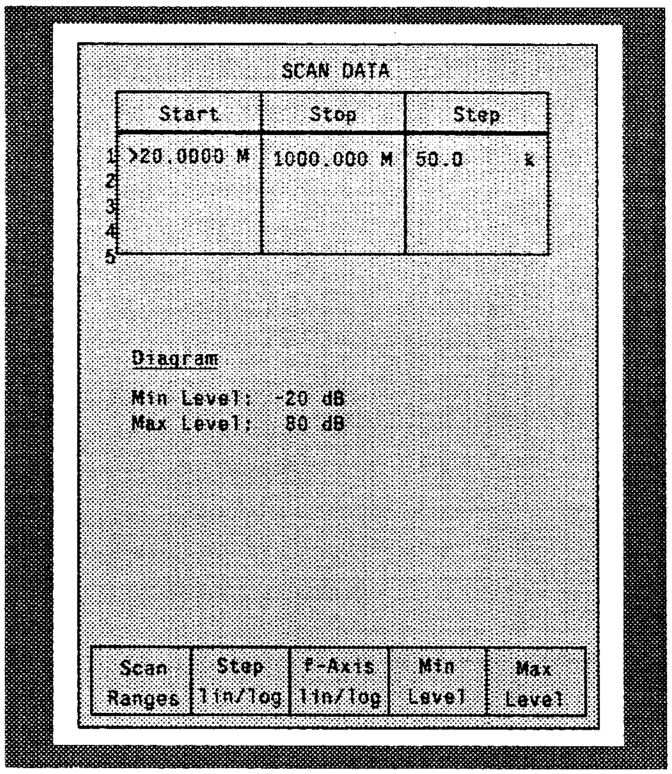


Fig. 3-17 Scan data table

For each subscan, the start and stop frequency as well as the step size are given. Besides, the range of the level axis (*Min and Max Level*) is indicated. These values can be varied via softkeys and numerical entry.

The cursor is first located on the start frequency of the first subscan. It can be moved between *start* frequency, *stop* frequency and *step size* using the cursor keys ← and → and between the subranges using the cursor keys ↑ and ↓. The numerical values can be varied by a new entry. Pressing one of the ENTER keys retains the previous value, and the cursor jumps to the next field. It is only possible to jump to the next subscan when the values for a subscan have been completely entered.

Frequency resolution for step size entry depends on the range including the stop frequency. The step sizes listed in table 3-2 (cf. section 3.2.3.1.2) are valid.

When selecting the receiver settings for the respective subscan start and stop frequency determine the selection of the following parameters:

- Bandwidth: The maximum settable bandwidth is determined by the start frequency, the minimum settable bandwidth by the stop frequency (see also section 3.2.3.8). If the currently set bandwidth is too large, the ESS automatically sets the maximum possible one.

  Example: Start frequency = 1 kHz
  Stop frequency = 5 MHz
  Selectable bandwidths: 50 Hz to 1 kHz

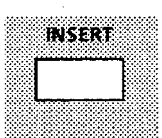
  In case another bandwidth is required, the subscan data set must be divided into several individual data sets (INSERT).

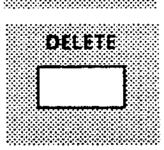
- Tracking generator: The generator can only be switched on with the start frequency of the subscans being at least 9 kHz. Upon entry of a lower start frequency the generator is automatically switched off, the message *Freq < 9 kHz: no tracking gen* is displayed in the status line on the screen. Attempts to switch on the tracking generator also result in this message.

- AF demodulation: AF demodulation is not available in the frequency range under 9 kHz or, alternatively for IF bandwidths below 50 Hz. With a lower start frequency or, alternatively lower bandwidth the AF path is automatically switched off, or, cannot be switched on. In both cases the message *Freq < 9 kHz: no AF demod* or *IF BW < 50 Hz: no AF demod* is displayed.

Before the subscan range is left from the *Step* field using one of the ENTER keys, the prompt *Range <n> Settings ok?* (<n> = number of subscan range) appears for confirmation of the receiver settings valid for this subscan. The line with the prompt is located directly below the range table. After pressing ENTER, the next subscan range is selected. The start frequency (= stop frequency of the preceding subscan) is already entered for a new subscan, since there must not be any gaps between the individual subscans.

When the stop frequency of a preceding subscan is already 1000 MHz, the following subscan range cannot be reached anymore using the cursor keys.





New subscan ranges can be inserted using INSERT (if less than 5 ranges are defined), if they are no longer required, they can be deleted using DELETE (at least one range must be maintained).

When a new subscan range is inserted, all ranges starting from the cursor position are shifted one position down, the new range is first assigned the stop frequency of the preceding subrange as the start and stop frequency and the start frequency of the following range if it is the first subrange.

When a subscan range is deleted, all ranges starting from the cursor position are shifted one position up, the start frequency of the next subrange is adapted to the stop frequency of the preceding range.

Scan Ranges

The *Scan Ranges* softkey is used to select the table for the subscan ranges if mininum or maximum level have just been varied.

Step lin/log

The *Step lin/log* softkey is used to determine the type of frequency stepping (common for all subscans). The table displays the associated step sizes for the individual subscans. If a logarithmic step size has been selected, the step size has to be entered in per cent in all subscans. The value range for the step size is 0.1%, 0.2% to 12.5%, 25%, 50%, 100%. If different step sizes are entered, they are rounded off to the next lower one.

f-Axis lin/log

The f-*Axis lin/log* softkey is used to determine the display of the frequency axis in the diagram. The setting is independent of the type of frequency stepping in the scan (*Step lin/log*); it simultaneously determines the frequency axis for report output. The setting *f-Axis log* is impermissible if the ratio between the highest stop frequency and lowest start frequency is less than 1.5.

Min Level

Max Level

The softkeys *Min Level* and *Max Level* can be used to define the level range for scaling the RF analysis diagram. Minimum and maximum levels are entered as multiples of 10 dB. Deviating entries are automatically rounded off for the minimum level and up for the maximum level. The minimum display level to be entered is -200 dB, the maximum one +200 dB. The level unit for the diagram is the unit that is currently valid on the receiver. The minimum display range (*Max Level - Min Level*) is 10 dB.

The entry can be terminated at any time using EXIT.

Note: *The selected settings for the diagram of RF analysis are also used for printer and plotter output.*

3.2.4.3.2 Input of Limit Lines

The various regulations covering interference measurements include limit values that must not be exceeded. Irrespective of the type of frequency display (linear or logarithmic), the limit values are composed of straight lines. In some standards, several limit values are specified, e.g. a limit value for quasi-peak and a limit value for average value measurement.

The ESS permits to define up to 22 different limit lines and permanently store them in the battery-backed RAM. They are provided with a number (1 to 22) and a user-definable name so that they can be told from one another. Besides, the data sets can be stored on floppy disk using the floppy disk drive (see section 3.2.4.6.2).

Since, in practice, the necessary numbers of sampled values for the limit values differ in the various standards, the maximum possible numbers of values are grouped according to the following table, depending on the number of the limit line:

Table 3-12

No. of limit value	Max. sampled values
1 to 10	10
11 to 20	20
21,22	50

Two of these 22 limit lines can be activated for the measurement. If a name is entered for the limit value (max. 8 characters), it is indicated in the measured value diagram output on plotter or printer.

Active limit lines are used to determine limit exceedings in the final measurements of RF analysis. They are also applied in special function 16 (*Check Limit*, see section 3.2.4.7). With double measurement modes, the test receiver automatically assigns the detector to the relevant limit line, ie the detector measuring the higher level refers to the limit line with the higher value.

Operation:

Limit Lines

- Press the RF key.
  The *RF Analysis* menu is displayed on the screen.
- Press the *Limit Lines* softkey.
  A list with all defined limit lines and their status *(On or OFF)* is displayed on the screen:

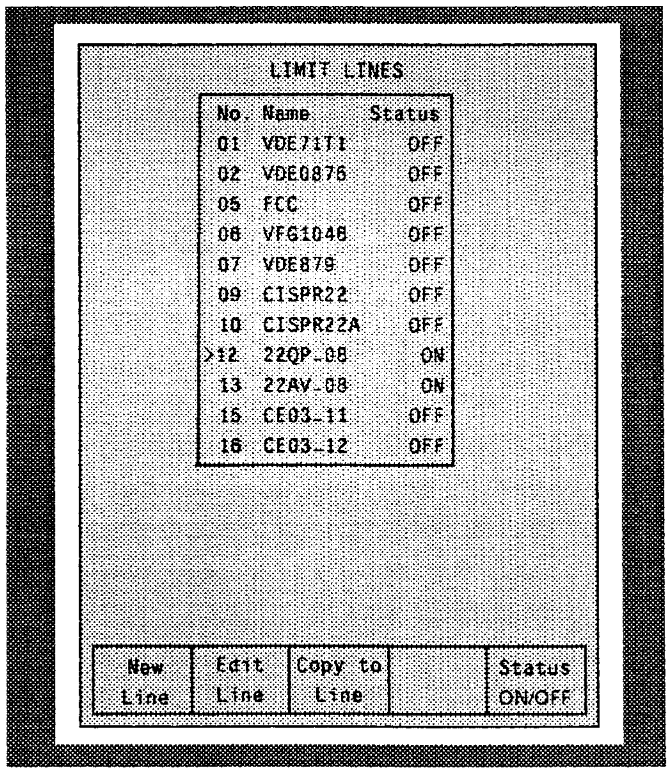


Fig. 3-18

The associated submenu permits to select between new entry *(New Line)* and editing *(Edit Line)* or switching on and off *(Status ON/OFF)* of limit lines.

If no limit line is defined, the list indicates *None defined.* In this case, the softkey *Status ON/OFF* is not labelled.

When the menu is called, the cursor indicates the first activated limit line in the list, or, if none is active, the line with the lowest number. The cursor is set to the line to be edited using the keys ↑ and ↓ or by entering the two-digit number. If the limit line with the entered number is not defined, the message *Limit <xx> undef* (<xx> = entered number) is read out in the status line.

Copy to Line

Copying of limit lines.
In the field of interference measurements, parallel limit lines are often used. An already entered limit line can be shifted by copying the data set of this line to a different data set using the function *Copy to Line*. The grouping of the sampled values is to be noted.

Operation:

- Set the cursor to the line to be copied *<nn>*.
- Press softkey *Copy to Line.*
- Enter the number of the data set to be generated in the status line:

  Copy line <nn> to line <xx>

The newly generated data set is indicated in the list of limit lines. Parallel shifting of the line is effected under *Edit Line* using the function *Shift Level.*

Status ON/OFF

This function permits to activate entered limit lines and deactivate activated lines. The desired limit line is to be selected using the cursor or by entering the appropriate number. By pressing the softkey *Status ON/OFF*, the status of the limit line is switched over (ON → OFF, OFF → ON). If two limit lines are active, the cursor automatically jumps to the second active line after the other line has been switched off.

Only two limit lines can be activated at the same time. The attempt to activate a third one produces the error message *Max 2 Limits active.* Before the desired limit line can be switched on, the already active limit line must be switched off.

When the menu is left using the EXIT key, the main menu of the RF analysis with the associated measured value diagram is displayed, modifications to the limit lines being taken into account.

General information on definition of a limit line

A limit line is characterized by:

- Values (sampled values with frequency and level)
- Name (max. 8 characters for names of the limit line)

The number of the sampled values is grouped according to Table 3-11 as with the transducer factors. The frequency of a sampled value must be at least as high as that of the preceding value in order for the entry to be accepted. If the sequence is violated, the following error message appears in the status line:

Frequency Sequence.

If a frequency is entered which cannot be set on the receiver, the following error message is displayed

if the frequency is too high:	*Max Freq 1000 MHz,*
if the frequency is too low:	*Min Freq 1 Hz.*

Following the frequency input (terminated with MHz or kHz), the cursor automatically jumps to the associated level value *(LIM)*. Values from -200 dB to + 200 dB are permissible for the level value. When a value greater than 200 dB or smaller than -200 dB is entered, the status line displays the following error message:

Max Level 200 dB or *Min Level -200 dB.*

The input unit is always dB, i.e. the unit for the limit value is matched to the unit valid during the measurement, which usually depends on the transducer used. When the sampled value has been completely entered, the cursor automatically jumps to the next line. If the table cannot display all values of a limit line, the list is scrolled up or down.

When a limit line is edited, a sampled value can be deleted, a new one inserted or a frequency or level value simply varied. Insertion or deletion is only possible if the cursor points to the respective sampled value. The DELETE key is used to delete the sampled value, the following values move up accordingly. INSERT is used to create a vacant place at the cursor position, all following sampled values being increased by one. A frequency or a level value can be varied by shifting the cursor to the respective position and entering the new value via the numerical keypad.

If the maximum possible number of sampled values has already been entered for the limit line, it is not possible to insert any more.

If the last sampled value or a value with the greatest possible frequency has been entered, the cursor remains located at the last frequency in the table.

New Line

The *New Line* softkey permits to delete an existing limit line and define a new one.

When the softkey is pressed, the status line displays a prompt to enter the number of the limit line:

New Line No. (1 to 22)

If there are entries in the list of limit lines, the number at the current cursor position is offered. This number can be directly transferred using ENTER, or a new number can be entered via the numerical keypad DATA.

By entering the limit line number, an empty sampled value table is displayed, the cursor indicating the frequency of the first sampled value, which can be directly entered. Already defined values are deleted, but are still available in the memory of the ESS until the first sampled value has been entered. This permits to preserve the values when pressing the softkey unintentionally; in this case, the menu can be left using EXIT and the sampled value table listed using *Edit Line*.

Edit Line

The *Edit Line* softkey permits to modify the data set of an existing limit line or enter a new one. In contrast to *New Line*, an already existing data set is not deleted.

When the softkey is pressed, the status line displays the prompt to enter the number of the limit line:

Edit Line No. (1 to 22):

The number is entered via the numerical keypad and confirmed using ENTER.

Table setup after pressing an ENTER key:

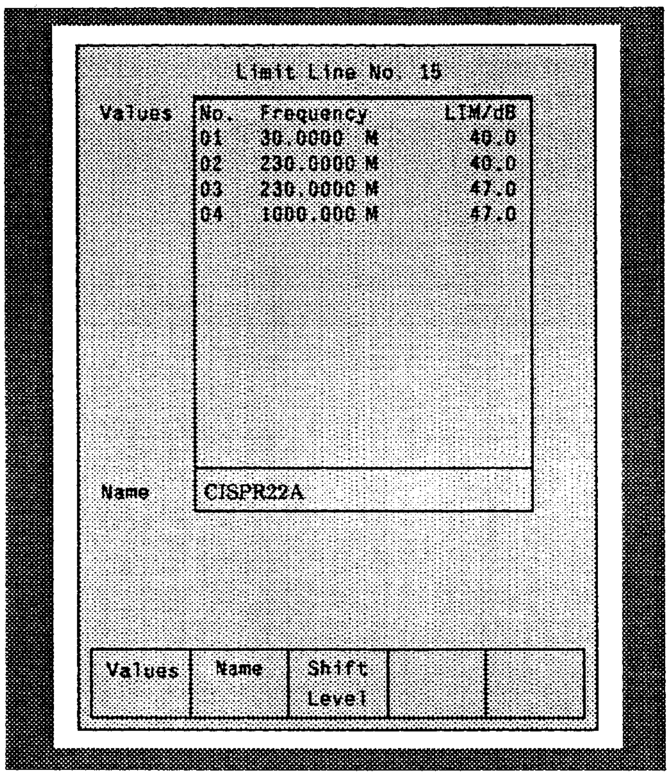


Fig. 3-19

Values

This function is used to return from the name menu into the value table. By pressing the *Values* softkey, the cursor (>) is faded in at the position of the first sampled value.

Name

The limit line can be assigned a name consisting of a maximum of 8 characters (letters and digits). Entry of a name is recommended for differentiation between the limit lines in the list. The name can also be used for the plotter and printer output and when storing the data set on floppy disk. The entry is made via the external keyboard or the auxiliary line editor. For input of a name, note the operating instructions for floppy menus (cf. section 3.2.4.6.2). Illegal characters are thus being ignored.

ENTER serves to terminate input of the name and return to the next higher menu *Limit Lines*.

EXIT can also be used to terminate the entry of the limit line.

Shift Level

This function permits parallel shifting of the level values of a limit line. This avoids complicated correction of the values after copying a data set (see *Copy to Line*). The *level offset* in dB is entered in the status line. When shifting the level values, the range limits -200 dB and +200 dB must be observed.

3.2.4.3.3 Extended Functions of RF Analysis (Options)

With the options, the ESS offers functions which permit to adapt the RF analysis to specific measurement problems or optimize measurement runs for the various fields of application. A significant feature is data reduction. It is achieved by dividing the frequency range into subranges. During a premeasurement, the maximum interference is searched for in a subrange. A measurement is immediately carried out at this maximum in the desired indicating mode - usually quasi-peak or average value. This serves to make sure that the highest interference levels are measured with weighting. The relatively time-consuming measurement procedures must however be performed only at a limited number of frequencies so that the total measuring time is considerably reduced. For RFI voltage measurements with LISNs the phase may be switched over, if required, in order to ensure that the highest interference is detected. The user largely determines the measurement run on his own by combining the various options. Thus the number of subranges (max. 400), the parameters of the premeasurement, the tpye 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:

[Options]

- Press the *Options* softkey.
  The *Options* menu appears on the screen.

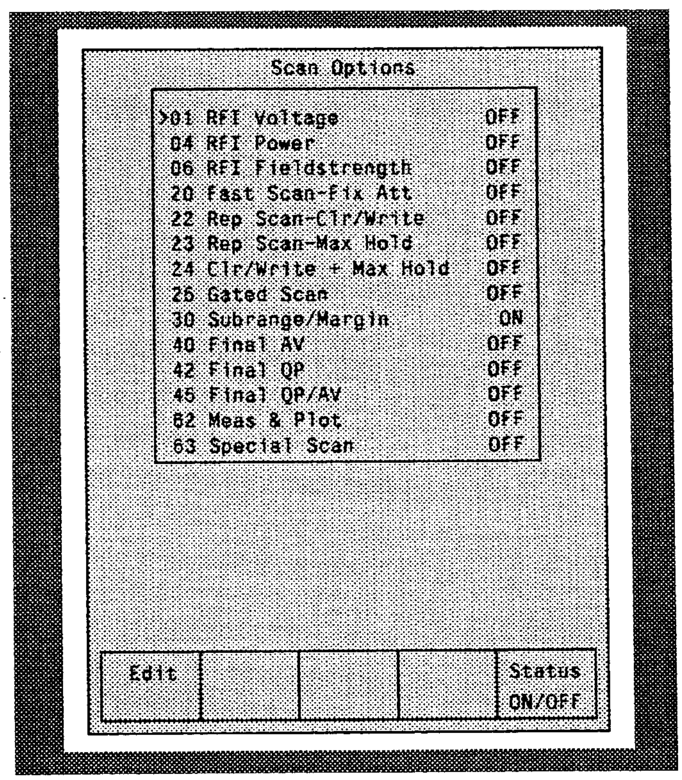


Fig. 3-20 List of options

[Status ON/OFF]

The cursor is set to the desired option using the ↑ and ↓ keys, or the number of the option is directly entered. The status of the scan options is switched over using *Status ON/OFF* (OFF → ON, ON → OFF).

[Edit]

Some of the scan options require additional entries. If the cursor is located at an option which permits further parameters to be entered, the *Edit* softkey is displayed.
In the case of options with individual parameters, these can be edited in the status line by pressing this softkey. More comprehensive inputs are made via extra menus, with new tables being set up.

Default

The *Default* softkey appears if a default setting can be selected for the input parameter.

The menu is left by calling any other menu or using the EXIT key.

OPT 01, RFI Voltage:

This option allows to perform a complete RFI voltage measurement using the ESS, an Artificial Mains Network ESH2-Z5 or ESH3-Z5 as well as a plotter and/or printer for documentation of the measurement results. (Use of the function, cf. section 3.4.).
Switching on a phase in submenu *PRESCAN/MANUAL* activates a connected LISN, enabling the manual selection of phases from the receiver. Deactivating the LISN using *OFF* means exiting the remote control mode.

OPT 04, RFI Power:

With this option, the ESS together with an absorbing clamp and a plotter and/or printer allows for semi-automatically carrying out a complete RFI power measurement with documentation of the measurement results. (How to use the function, cf. section 3.4).

OPT 06, RFI Field:

This option supports preliminary RFI fieldstrength measurements in an RF cabin and subsequent measurements in the open field. (Cf. section 3.4 for application of this option).

Option 20, Fast Scan-Fix Att

The option "Fast Scan with fixed RF attenuation" performs much faster than a "normal" scan. The fast scan might be used for the preview of an interference spectrum. The fast scan together with the options 22 to 24 is a good possibility to examine intermitting or drifting interferences. The fast scan data are entered in the main menu of the RF analysis by the softkey *Scan Data*.

In order to get the maximum speed of the *fast scan*, the following settings are fixed and cannot be changed by the user:

- RF attenuation (no auto range mode),
- operating range 60 dB,
- linear step size. The step size is coupled to the IF bandwidth of the test receiver and is automaically set to a value that guarantees a minimum of 3 measurements within the selected bandwidth.
- The measurement modes with double detectors (*Special Functions* 30 to 33) and the option 45 (QP/AV) are not allowed with *fast scan*. Therefore they are switched off automatically.
- The option 62 (*Meas & Plot*) can be switched on, however, it will be ignored during the scan. The results of a *fast scan* can be sent to the printer or plotter after the scan is finished.
- The quasi peak detector (QP) is not available with the *fast scan* because of the long delay times of the weighting circuit and of the meter display.

The attempt to switch one of those parameters on is prompted with the hint *"Not available with Fast Scan"* in the status line of the test receiver. The rest of the scan parameters (start and stop frequencies, receiver settings) can be entered as with the normal scan. The measurement time of the fast scan allows values between 0.05 ms and 20 ms.

The fast scan is started with the RUN key. During the scan the meter display is frozen.

The options 22 to 24 refer to a repetitively running scan and can be used for the normal scan as well as for the fast scan. Activation of one of these options does not allow *Option 62* (*Meas & Plot*) to be switched on. The message *Not available with Rep Scan* is output.

Option 22, Rep Scan-Clr/Write At the end of one scan, the receiver restarts automatically at the start frequency. The measurement values and the curve of the previous scan are cleared.

Option 23, Rep Scan-Max Hold This option is the same as option 22, except that the maximum values of all previous scans are stored.

Option 24, Clr/Write + Max Hold This option is a combination of options 22 and 23.The lower measurement curve overwrites the previous values while the other keeps the maximum values. Thus, the option "Clr/Write + Max Hold" can be used for example to find the maximum of an interference (moving an absorber clamp or varying the antenna height). Option 24 cannot be used together with a double detector (Special Functions 30 to 33).

Option 25, Gated Scan Default setting of the option is OFF. With the option switched on, the frequency scan starts with a positive TTL level applied to the external trigger input (pin 1) of the USER INTERFACE. The scan is continued as long as this high level is applied. When the level changes to LOW, the frequency scan stops. On the next positive edge, it continues at the place where it was interrupted.

The function contributes to a considerable reduction in measuring time in the case of equipment under test featuring intermittent interferences or systems which are only irregularly activated. The trigger level must be produced by the device under test, itself.

Option 30, Subrange/Margin This option is used in connection with option 01 (*RFI Voltage*), option 04 (*RFI Power*) or option 06 (*RFI Fieldstrength*). The user can specify the number of subranges 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 respective frequency from which onward measurement is performed. Application is described in section 3.4 in connection with option 01, 04 and 06.

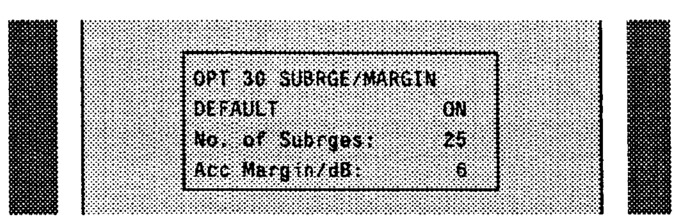


Fig. 3-22

In the basic status, the default values (25 subranges and 6 dB margin) are entered. New values are entered by setting the cursor to the desired line and entering the new value.

The permissible values for the number of subranges are 8, 16, 25, 50, 100, 200 and 400 (maximum value). When entering a value other than the ones stated above, it is rounded up or down to the next permissible one. All values between -200 and +200 dB are permissible as the margin to the limit line. A positive value leads to a margin that is above 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 or 45 ON, a quasi-peak measurement, average measurement or (with double measurement modes) both are automatically performed at the maximum levels of the subranges during a measurement with scan. One function only can be switched on at a time. When activating one of these otions, the other two options are automatically switched off. The options are used in connection with option 04 (*RFI Power*) or option 06 (*RFI Fieldstrength*). Application is described in section 3.4, options 01, 04 and 06.

Activation of *Option 24 (Clr/Write + Max Hold)* does not allow *Option 45* to be switched on. The error message *Not available with Clr/Write + Max Hold* is output.

Operation:

Pressing the *Edit* softkey with one of the options 40, 42 or 45 activated allows to specify the measuring time for the final measurement on the subrange maxima in the status line.

OPT 45 Meas Time:

The status of the option is switched over using the *Status ON/OFF* softkey.

Option 62, Meas & Plot

Default setting of the option is OFF. The option can be switched on in order to record the results of a frequency scan on a plotter during the measurement. For the plotter output, all settings selected under *Plotter Setting (Plotter Content, Pen Setting and Special Scaling,* see section 3.2.4.5.4) are used.

The plotter output starts as soon as the RUN key is pressed. If no plotter is connected or if a different IEC bus address is set on the plotter, the message *Connect Plotter* is displayed in the status line. In this case, either a plotter can be connected and the measurement continued using ENTER, or the measurement can be continued without plotter output by pressing one of the ENTER keys.

If the item *Curve* is switched off under Plotter Setting, the message *Warn: Curve OFF* is displayed.

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 a measurement result can be obtained as fast as possible with the frequencies of emitted interferences known.

Example:

Measurement of emitted interference at the line frequency plus harmonics or frequency of the switched-mode power supply plus harmonics.

Frequencies for the *Special Scan* are entered using the *Scan Data* softkey in the main menu of RF analysis, the input menus being different from those of a normal scan.

Operation:

[Scan Data]

With the option 63 activated, pressing of the *Scan Data* softkey in the *RF Analysis* menu causes the input of scan data to be different from that in the normal menu. An intermediate menu is used to determine whether an existing data set is to be edited or entered anew.

[New Set]

New entry of a frequency data set. An existing data set is deleted, however, it is retained until the first frequency is completely entered into the main memory of the ESS. In this way, deletion because of unintentional pressing of the softkey can be avoided.

[Edit Set]

An existing frequency data set is edited.

After pressing one of the two softkeys, the following table is displayed on the screen:

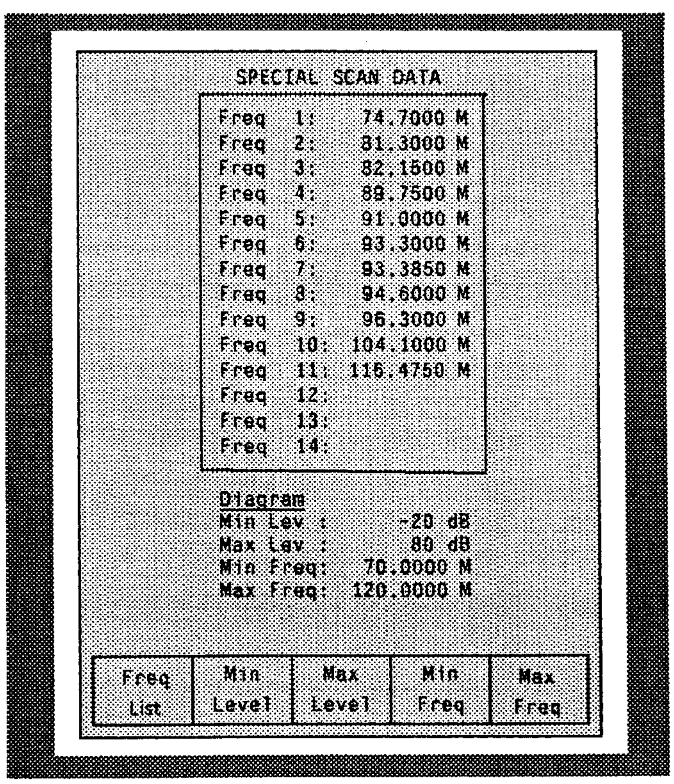


Fig. 3-22

Freq List

A maximum of 400 frequencies can be entered. The frequencies must be entered in increasing sequence. If this rule is not observed, the error message *Frequency Sequence* is output in the status line and the entered frequency is not accepted. When editing the data set, frequencies can be inserted using INSERT or deleted by way of DELETE. The frequency values can be overwritten by entering the new frequency. The individual values are selected as usual with the help of the cursor keys.

Min Level

Max Level

Min Freq

Max Freq

These softkeys are used to determine the diagram limits for the screen and the output of the test report. The values can be directly entered on the screen by pressing the respective softkey.

The complete frequency data set is stored in the battery-backed RAM. Thus, it is available even after switching off the receiver. The data set can be stored on a floppy disk under the complete instrument setting and loaded at a later time (see section 3.2.4.6.2).

3.2.4.3.4 Frequency Scan (RUN)

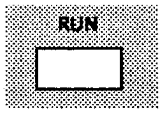
A scan is started by pressing the RUN key. It runs in accordance with the selected scan settings (see section 3.2.4.3.1), the set special functions (see section 3.2.4.7), the transducer factor or transducer set (see section 3.2.4.2.1) and the options. If several ranges are defined in an active transducer set, the receiver stops at the range intersections and requests changing of the transducer.

In the screen diagam of RF analysis max. 400 subrange maxima are displayed during one frequency scan. With a small scan step size a subrange maximum results from the maximum level values determined in a prespecified subrange. The measured values not displayed are stored in the internal, volatile RAM of the ESS (max. 2 * 30,000 values with double measurement modes) and can be displayed using the *Marker Zoom* function (cf. section 3.2.4.3.5). Start of a scan using Run leads to the hint *Insufficient RAM* in the status line when not all the measured values can be stored in the internal memory. All the measured values stored in the RAM can be saved on a diskette using the FLOPPY function. Switching off the receiver leads to the loss of measured values.

The measurement results are maintained even during IF analysis or a table entry, so that the curve is again faded in when returning to the RF diagram. However, this is no longer possible if the parameters for the frequency axis are modified.

Operation:

Start scan



- Press RUN key.
The frequency scan starts. If data are currently entered in a menu, the data input is finished and the diagram of the RF analysis is displayed.

In a scan preparation phase, the ESS ensures the fastest possible frequency scan by first calculating internal control data which include the frequency response correction values from the total calibration, the division of the frequency axis into subranges and the interpolated transducer values for all frequencies. During generation of the control data, the message *Preparing* is displayed in the status line. Subsequently, the frequency scan starts. The status line then indicates *Running*. When the frequency scan is terminated, a beep sounds if the beeper is switched on, and the message *Complete* is output in the status line.

2 softkeys are faded in for interrupting or aborting the frequency scan:

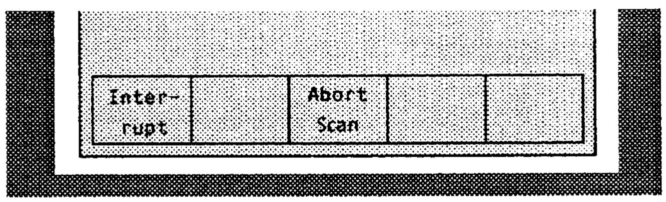
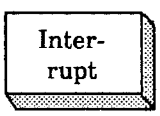


Fig. 3-23

Interrupt the scan



- Press the *Interrupt* softkey.
The 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 the measuring time. When the scan is interrupted, the receiver functions, marker and IF analysis can be operated. The following softkeys are displayed in the softkey menu:

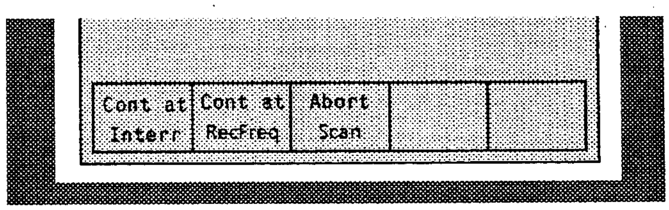
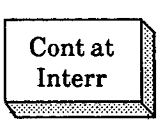


Fig. 3-24

Continue the scan



Cont at Interr. permits to continue the frequency scan with the settings defined in the scan data set at the place where it was interrupted .

If the receiver frequency is lower than that at which the scan was stopped, *Cont at Rec Freq* permits to continue the frequency scan with the settings defined in the scan data set at the current receiver position. The receiver frequency may be corrected using the scan step size so that it fits into the scan frequency pattern. In this way, 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 on a plotter, the old measured values are overwritten. If the receiver frequency is higher, the scan is started at the frequency at which it was interrupted.

Abort the scan

Abort Scan

The frequency scan can be aborted using the *Abort Scan* softkey. It can be started from the beginning by pressing the RUN key again.

Change the transducer

The message *Connect TRD: <name>* is displayed in the status line in order to request changing of the transducer at the transducer set range limits. When the transducer has been changed, the frequency scan is continued by pressing one of the ENTER keys.

Note: *If an active transducer factor or set is not defined over the complete scan range, invalid measured values are produced in the range where the transducer is not defined. This is indicated by the following error message output in the status line:*

Running... Meas invalid, transd undef

The invalidity of the spectrum is marked by an asterisk (*) in the top right corner of the diagram, which is maintained until the curve is deleted.

3.2.4.3.5 Marker in the RF Analysis

The marker is a graphical symbol in the shape of a rhombus (◊) which can be shifted on the RF analysis curves within the start and stop frequency of a scan. To examine level differences at different places of a spectrum, a second marker symbol (∇) can be used with *Delta Marker*. The marker is maintained when the marker menu is exited. In the marker text field above the diagram, the associated frequencies and levels of the curve are displayed.

With special function 16 activated, the markers are used for indication of the differences between measurement curve(s) and limit line(s) (see Section 3.2.4.7).

The marker functions are activated by pressing the MARKER key. With the marker switched off, the main marker (◊) is displayed at the subrange maxima next to the receiver frequency and at the level of the curve. The associated values for frequency and level are displayed in the marker text field.

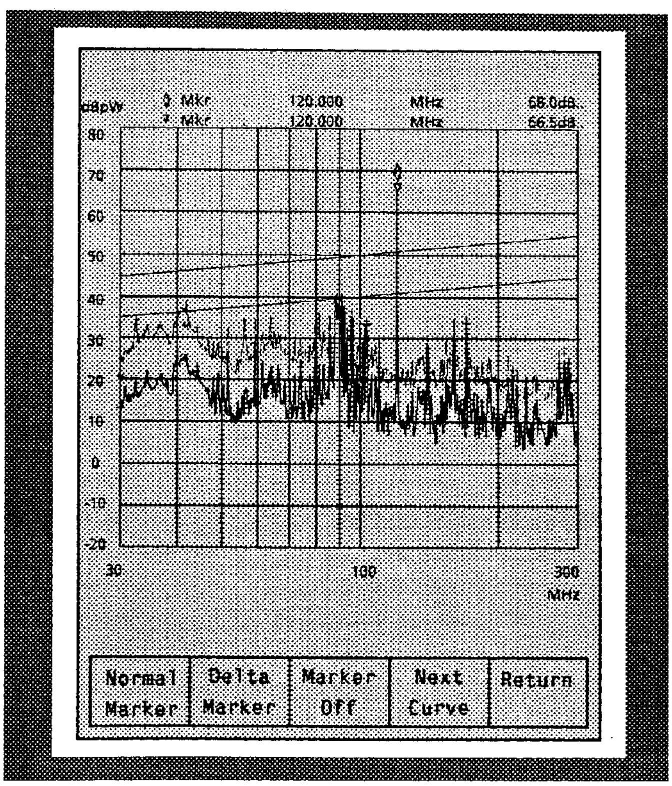


Fig. 3-26

Operation:

▸ Press MARKER key.
The marker menu of the RF analysis is displayed on the screen:

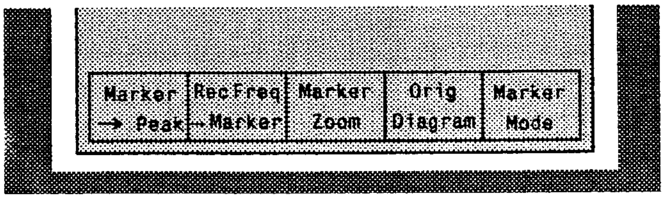


Fig. 3-27

▸ Press the *Marker Mode* softkey.
The following softkey menu is displayed on the screen:

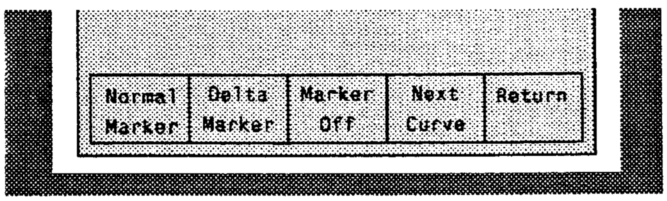


Fig. 3-28

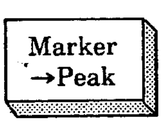
Shifting the marker:

The marker is shifted on the measurement curve from measured value to measured value using the ← and → keys and by 40 pixel positions using the ↑ and ↓ keys. Longer pressing of the key causes an accelerated marker movement. Marker movement using the cursor keys is always possible with the marker menu activated. In addition, the marker frequency can also be entered via the numerical keypad after one of the softkeys *Normal Marker* or *Delta Marker* has been pressed. The marker cannot be shifted using the rotary knob, which can be applied only for varying the receiver frequency.

Note: *The marker always moves on a curve from one subrange maximum to the next and not from pixel to pixel, i.e. there is no interpolation between 2 measured values if they are more than 2 pixels apart from each other.*

Marker on 2 curves (e.g. double measurement modes):

- Operating mode *Normal Marker:*
  The main marker (◊) is always located on the curve with the higher level (e.g. PK), the second marker (∇) is on the curve with the lower level (e.g. AV). Both markers are shifted simultaneously, frequencies and levels appertaining to each curve are indicated in the marker text field below ∇ *Mkr.*
- Operating mode *Delta Marker*:
  The two marker symbols are always located on one curve, only the variable marker is moved. The *Next Curve* softkey is used to switch the markers between the two curves.



The main marker (◊) is set to the maximum level value of the measured spectrum by pressing the softkey. With zoomed display, this is the maximum value of the zoomed section. In the event that several level values with the same maximum value are present, the marker is set to the next maximum by repeated pressing of the softkey. The associated values for frequency and level are displayed in the marker text field in the top right corner of the screen.

Rec Freq →Marker

This softkey is used to set the receiver frequency to the current marker frequency. This function saves the need for entering the receiver frequency via the keypad. It is particularly useful if a measured interference spectrum in the vicinity of a spurious signal is to be examined in greater detail with the aid of receiver tuning. At the same time, this function is used to set the scan data used in a preceding frequency scan on the receiver.

Marker Zoom

The *Marker Zoom* function can be used in order to enlarge particular areas of a measured spectrum. This is an advantage if more values were measured than can be represented in the horizontal direction (max. 400 subrange maxima per curve) because of the limited resolution. The frequency axis of the diagram including the curve(s) and the limit line(s) is expanded, whereas the level axis is not enlarged. In the case of two curves, the zoom function applies to both curves. The zoom procedure can be continued by repeated pressing of the *Marker Zoom* softkey until there is no longer a graphical compression of measured values. Since further zooming would then be useless, the ESS automatically fades out the *Marker Zoom* softkey.

The frequecy range covered by the zoom procedure depends on the currently set marker mode:

- *Normal Marker:*

  Based on the current marker frequency, a 10 % zoom is performed (10 % of 400 subrange maxima). The frequency which is located 20 pixels below the marker position is used as the lower limit for the enlarged area. The upper zoom limit is 20 pixels above the marker position. In the vicinity of the start and stop frequency of the scan, the ESS automatically performs an adaptation.

  Example:

Picture position:	x(Marker) = 184,	f(Marker) = 148.8 MHz
Diagram limits:	f(Start) = 20 MHz	
	f(Stop) = 300 MHz	
	Frequency axis lin	
	x(Zoom,left) = 184-20 = 164	f(Zoom,left) = 134.8 MHz
	x(Zoom,right) = 184 + 20 = 204	f(Zoom,right) = 162.8 MHz

- *Delta Marker:*

  The two markers determine the area for the enlarged display.

The ESS permits to fade in enlarged adjacent areas of the diagram into the enlarged display of the RF analysis spectrum. This is done either by directly entering the marker frequency in the marker text field or by shifting the marker using the cursor keys. If the marker is positioned at the left-hand diagram limit and the cursor keys ← or ↓ are pressed, the adjacent area to the left is enlarged (the same is true for the right-hand diagram limit, respectively). Adjacent areas overlap by 10 pixels (hysteresis).

In order to mark the zoomed diagram, the vertical diagram limits are shown in dashed lines. Zoomed diagrams can be output on a printer or plotter (see section 3.2.4.5).

Orig Diagram

When the softkey *Orig Diagram* is pressed, the original diagram and the curves (prior to the first zoom procedure) are displayed. This function is automatically performed when the marker menu is left using EXIT or by pressing a MENU key.

Marker Mode

This softkey is used to change to the *Marker Mode* menu with the functions *Normal Marker, Delta Marker, Marker Off* and *Next Curve.*

Normal Marker

After pressing this softkey, the marker frequency can be edited in the marker text field. The frequency is entered via the numerical keypad and terminated using ENTER. The entry is always limited to the start and stop frequency of the complete scan. The frequency entered is rounded to the next measured value in the diagram. In the case that *Delta Marker* was switched on before, the variable marker(∇-symbol) is faded out.

Delta Marker

The *Delta Marker* function permits to call 2 marker symbols for determining level or frequency differences of two signals on a curve. By pressing this softkey, an additional marker symbol (∇) is faded in at the position of the main marker(◊) in case that only one marker symbol was activated before. The main marker retains its position. Frequency and level differences are indicated in the marker text field.

By pressing this softkey, the numerical data entry is simultaneously activated. The position of the two markers remains the same with *Delta Marker* already switched on before. The frequency difference between the two markers can then be entered via the numerical keypad in the marker text field. The frequency is again rounded to the next measured value in the diagram.

Marker Off

The *Marker Off* softkey is used to fade out the marker symbol(s) and leave the marker menu. The main menu of the RF analysis is displayed. The marker texts on the screen are deleted.

Next Curve

The softkey is only displayed if there are two curves in the diagram and the delta marker is switched on. Each of the two marker symbols is set to the other curve after this softkey has been pressed. The marker text fields are updated.

Return

This softkey is used to return to the marker main menu.

Leaving the marker menu:

The marker menu can be left by pressing a different MENU key or the EXIT key; the marker(s) is (are) preserved.

When a frequency scan is started using *RUN*, the marker is set to the lower diagram limit after deletion of the previous curve, and to the new measured value at the marker frequency during the scan.

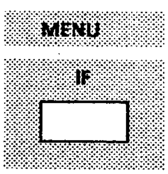
3.2.4.4 IF Analysis

In the operating mode IF analysis, the spectrum of the RF input signal is displayed in the frequency range 9 kHz to 1000 MHz in the vicinity of the receiver frequency. IF analysis is not available in the ESS in the frequency range below 9 kHz. A measurement curve is therefore not displayed in this range. The center frequency is always the set receiver frequency. An absolute level measurement is not possible using IF analysis. This is performed with simultaneous receiver operation at the center frequency. The accurate measured level is therefore to be obtained from the LEVEL display.

The level display range of IF analysis is always 80 dB, and the display of the measured levels is always relative (0 to 80 dB). The frequency axis, however, is crystal-referenced, i.e. the frequency of the displayed signals can be indicated with the accuracy of the reference used.

Since IF analysis can only provide a qualitative overview of the spectrum in the receiver frequency range, output of the measurement results on a printer or plotter and storing of results on floppy disk are dispensed with. The test parameters can be programmed via IEC bus; output of measured value does not make any sense in this case.

Operation:



- Press the MENU key IF.
  The IF analysis diagram is displayed on the screen. The previously set test parameters or the parameters of the default setting are taken into account. If markers are activated, they are displayed in the marker fields together with the text information. The test receiver starts the sweep immediately after the key has been pressed.

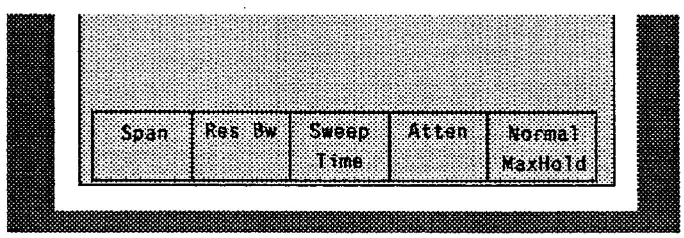


Fig. 3-29

In IF analysis, the diagram for displaying the measured values comprises 1001 pixels in the horizontal and 673 pixels in the vertical direction. However, only every second pixel is made use of in the horizontal direction, so that a maximum of 501 measured values per curve are displayed. The frequency axis is linearly divided into 10 sections and is labelled with "-Span/2" (on the left), the current receiver frequency and "+Span/2" (on the right). The current measurement bandwidth of the receiver is marked by a sign to the left and to the right of the center frequency with a spacing of IF bandwidth/2.

The level axis comprises a range of 80 dB divided into 8 sections. The upper diagram line corresponds to 80 dB.

As a particular feature of the IF analysis, the limit of a fixed preselection filter of the test receiver is marked. If one of these filters falls inside the display range of IF analysis, the 3-dB limit of this preselection filter is marked by a vertical sign on the 80-dB line and its range by a horizontal line.

The currently set test parameters of the IF analysis are displayed below the diagram. They can also be edited there.

3.2.4.4.1 Input and Editing of the Test Parameters

The IF analysis is controlled via the following test parameters:

Table 3-13

Test parameters	Default
Span (display range of the spectrum)	2 MHz
Resolution bandwidth	10 kHz
Attenuation	0 dB
Sweep Time	100 ms

2 operating modes are available for the sweep:

- *Normal* (default setting; display of a curve)
- *Normal + Max Hold* (default; a second curve additionally represents the maximum values of all sweeps).

All test parameters of the IF analysis are set via softkeys. After pressing the respective softkey, the associated input field is displayed on bright background. The attenuation and the sweep mode are simply switched by pressing the softkey.

The test parameters *Span, Resolution Bandwidth* and *Sweep Time* can be varied via the numerical keypad or via the ↑ and ↓ keys of the EDIT field. The operation for the three parameters is the same:

Numerical entry

Numerical values can be entered directly at the screen position. A new value is keyed in after pressing the softkey via numerical keys and decimal point, and the entry is terminated using the appropriate ENTER key for the unit. Numbers entered can be deleted again using the CLR key. Only a discrete number of values is available for the test parameters. If a numerical value is entered which cannot be displayed, it is automatically rounded to the next lower value. If the entry is aborted using a key other than the unit key, the previous setting is maintained and displayed again.

Input via the ↑ and ↓ keys of the EDIT field

After pressing the appropriate softkey, the parameter can also be varied up or down using the ↓ and ↑ keys of the EDIT field. The next setting value is always selected until the maximum or minimum value is obtained.

After a parameter has been entered, the respective input field remains active until another function is called.

Span

This softkey is used to determine the span of the IF analysis spectrum. The following values between 10 kHz and 2 MHz can be set for the span:

2 MHz (default)
1 MHz
500 kHz
200 kHz
100 kHz
50 kHz
20 kHz
10 kHz

After pressing the softkey, the desired value is directly entered in the field *Span* on the screen, 4 digits (numbers and/or decimal point) or the ↓ and ↑ keys being permissible. After a value has been entered, the sweep is aborted and restarted with the modified setting.

Res Bw

This softkey permits to determine the resolution bandwidth for the IF analysis. The ESS features the following bandwidths:

10 kHz (default)
3 kHz
1 kHz

After pressing the softkey, the desired value is directly entered in the field *Res Bw* on the screen, a maximum of 2 digits (without decimal point) or the ↓ and ↑ keys being permissible. When a value has been entered, the sweep is aborted and restarted with the modified setting.

Sweep Time

This softkey can be used to enter the sweep time.
The sweep time is a function of the resolution bandwidth and the span. It is automatically selected for each combination of these settings. However, it can also be manually set to another value for a particular combination. The optimum value is always marked by underlining.

The automatically selected (optimum) settings for the sweep time are to be obtained from the following table:

Table 3-14 Optimum sweep times (= minimum times)

Band-width	Span							
	2 MHz	1 MHz	0.5 MHz	0.2 MHz	0.1 MHz	50 kHz	20 kHz	10 kHz
10 kHz	100 ms	50 ms	50 ms	50 ms	50 ms	50 ms	50 ms	50 ms
3 kHz	0.5 s	200 ms	100 ms	50 ms	50 ms	50 ms	50 ms	50 ms
1 kHz	5 s	2 s	1 s	500 ms	200 ms	100 ms	50 ms	50 ms

The sweep time can be directly entered on the screen in the field *Sweep Time* by pressing the softkey, a maximum of 3 digits (no decimal point) or the ↓ and ↑

keys being permissible. The following values can be set:

10 s
5 s
2 s
1 s
500 ms
200 ms
100 ms
50 ms

When a value has been entered, the sweep is aborted and restarted with the modified sweep time.

If the span or the resolution bandwidth are varied after manual entry of the sweep time, the sweep time is set to its optimum value (see table 3-13). If a different sweep time is desired, it must be entered manually.

Atten

Switching of the input attenuation
To adapt the span of the IF analysis to the display range of the receiver, a 20-dB attenuation can be cut in at the input of the IF analyzer. This is done using the *Atten* softkey. By pressing the *Atten* softkey once, the attenuation is switched on or off. 0-dB input attenuation is set as default.

Normal + Max Hold

Operating modes for the sweep
During IF analysis, the span is continuously swept from the beginning to the end. The measured level values are displayed on a curve, the curve from a preceding sweep being continuously deleted in the operating mode *Normal*. In the operating mode *Normal+MaxHold*, a second curve is additionally displayed, which represents the maximum values from all sweeps since switching on of the mode.

For switching over the operating mode, press the *Normal+MaxHold* softkey. The text for the currently set operating mode is displayed in bright characters. The sweep is aborted, the displayed curve(s) deleted and the sweep started in the new operating mode. By pressing the softkey once again, the mode is switched back again. The default setting is *Normal*.

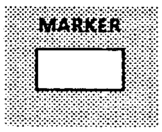
Note: *If the receiver frequency is varied during a sweep in the operating mode Normal, the sweep continues. The symbol "*" is faded in in the top right corner of the IF analysis diagram to indicate that the displayed curve is invalid. When changing the RF attenuation of the receiver, the preamplifier or the attenuation of IF analysis (Atten), this sign is also displayed. It disappears only when all displayed data are valid again (usually after completion of a new sweep).*

In the operating mode Normal+MaxHold, the sweep is aborted and restarted when changing the receiver frequency, the RF attenuation of the receiver, the preamplifier or the attenuation of the IF analysis (Atten).

3.2.4.4.2 Marker Functions in IF Analysis

To examine the curve(s) in greater detail, a marker (◊) and a Delta Marker (∇) are provided (as with RF analysis). The representation of the markers and their operation is very similar to that of RF analysis. The information about the absolute marker frequency and the level (0 to 80 dB) is displayed in the marker text field. The resolution used to display the frequency is equal to the step size used during the measurement (min. 20 Hz, max 2 kHz). With each sweep, the marker position and text are updated. The marker is maintained when the marker menu is left.

Operating:



- Press MARKER key.
  The marker menu of IF analysis appears on the screen.

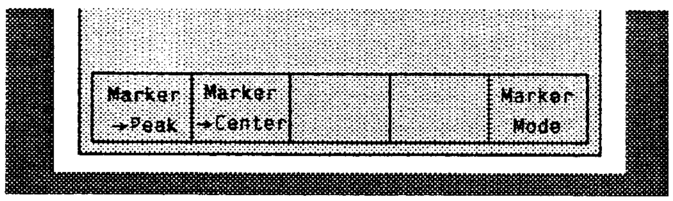


Fig. 3-30

- Press *Marker Mode* softkey.
  The following softkey menu is output on the screen:

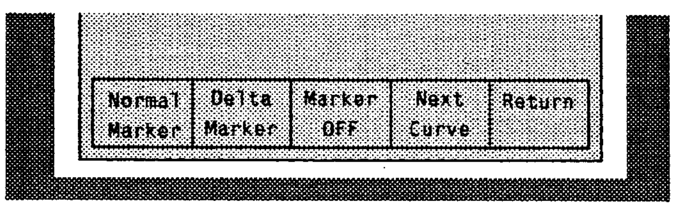
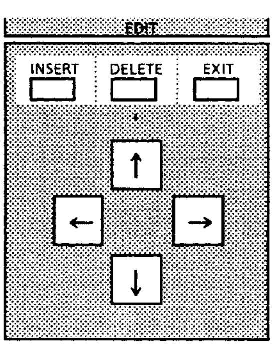


Fig. 3-31

If no marker is switched on when calling the marker menu, *Normal Marker* is automatically activated (default). The marker symbol (◊) appears on the curve in the middle of the screen (this position corresponds to the receiver frequency) after switching on.

Marker movement:



The marker is shifted on the curve from measured value to measured value using the ← and → keys and by 40 pixels using the ↑ and ↓ keys. Longer pressing of the key causes an accelerated marker movement. With the marker menu activated, it is always possible to shift the marker using the cursor keys. In addition, the marker frequency can also be entered via the numerical keypad after pressing one of the softkeys *Normal Marker* or *Delta Marker*. In order to provide for clarity as to the function of the operating controls, the marker can only be moved using the cursor keys; the rotary knob is always exclusively used for tuning of the receiver frequency.

Marker on 2 curves (operating mode: Normal + MaxHold):

In this operating mode, 2 marker symbols are always indicated.

- *Normal Marker*:
  The main marker (◊) is always located on the MaxHold curve, the other marker (∇) on the continuously running sweep curve. The markers are shifted simultaneously, the associated frequencies and level values are displayed in the marker text field.

- *Delta Marker*:
  The two marker symbols are always located on a curve, only the variable marker is shifted. The marker can be switched between the two curves using the softkey *Next Curve*.

Softkeys:

[Marker →Peak]

This softkey is used to set the main marker (◊) to the maximum level of the displayed curve. The associated values for frequency and level are displayed in the marker text field. By combining the softkeys *Marker → Peak* and *Marker → Center*, the receiver frequency can be easily set to the maximum value of the measured spectrum.

[Marker →Center]

This function is used to measure the level at the marker frequency using the test receiver. By pressing this softkey, the current marker frequency becomes the center frequency of IF analysis. At the same time, the receiver frequency is also set to the marker frequency.

[Marker Mode]

This softkey is used to change to the *Marker Mode* menu which provides the functions *Normal Marker, Delta Marker, Marker Off* and *Next Curve*.

[Normal Marker]

After this softkey has been pressed, the marker frequency can be edited in the marker text field. The absolute frequency of the marker is entered via the numerical keypad DATA and terminated using ENTER. The entry is always restricted to the span of the IF analysis. The frequency entered is rounded to the next measured value in the diagram. With the *Delta Marker* switched on before, the variable marker (∇) is faded out when the softkey is pressed.

[Delta Marker]

The *Delta Marker* function permits to call 2 marker symbols for determining level differences or frequency differences of two signals on a curve. After pressing this softkey , an additional marker symbol(◊) is faded in at the position of the main marker if only one marker symbol was activated before. The frequency and level differences are displayed in the marker text field.

Pressing of this softkey simultaneously activates the numerical data input. The position of the two markers remains unchanged with the delta marker already switched on before. The frequency difference between the two markers can then be entered in the marker text field using numerical keys. Again, the frequency is rounded to the next measured value in the diagram.

Marker Off — This softkey is used to fade out the marker symbol(s) and leave the marker menu. The main menu of RF analysis is displayed. The marker texts on the screen are deleted.

Next Curve — This softkey only appears if the function *Delta Marker* is switched on in the operating mode *Normal + MaxHold*. The two marker symbols are set to the other curve after pressing the softkey. The marker text fields are updated.

Return — This softkey is used to return to the marker main menu.

Exiting the marker menu:

The marker menu can be exited via *Marker Off*, by pressing another key or via EXIT. When pressing the EXIT key or a key other than *Marker Off*, the marker(s) is (are) maintained.

3.2.4.5 Generation of a Test Report

The result of a measurement run of RF analysis can be output both on a printer with Centronics interface and via IEC bus on a plotter with ***HP-GL*** standard. The contents of the plotter or printer output can be determined by the user himself. In IF analysis, no test report can be generated. The following outputs are feasible:

- Measured value diagram with limit lines (*Diagram*)
- Measurement settings of the receiver (*Scan Table*)
- User-definable title (*Title*)
- Measured value tables (*Meas Values*)

This permits e.g. simultaneous output of the diagram on plotter and the measured value table on printer. Plotting is also possible during a frequency scan (see section 3.2.4.3.3., option 62). When one of the options 22 to 24 is switched on, activation of *Option 62* (*Meas & Plot*) is not possible. The message *Not available with Rep Scan* is output on the screen.

Operation:

MENU **REPORT**

- Press the MENU REPORT key.
  The RF analysis diagram appears on the screen unless already displayed and the softkey menu for printer and plotter output is activated.

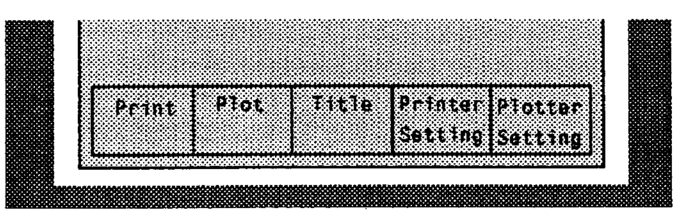


Fig. 3-32

3.2.4.5.1 Output of the Measurement Results on a Printer

Print

Abort Print

By pressing the *Print* softkey in the Report menu, the measurement results are immediately printed out in the form defined in the menus *Printer Setting* and *Title*. The beginning of the printing procedure is indicated in the status line by the message *Printing*, the text of the softkey is changed to *Abort Print* to allow for the printing to be aborted. After printing has been aborted, the output must be restarted.

If no printer is connected, the error message *Connect Printer* is output in the status line. After connecting a printer, printing must be restarted.

Printing is performed in the background, i.e. the receiver can still be operated during printing. Fast measurements, however, take somewhat longer.

EXIT is used to return to the main menu of RF analysis.

3.2.4.5.2 Output of the Measurement Results on a Plotter

Plot

Abort Plot

By pressing the *Plot* softkey in the Report menu, the ESS immediately starts to plot the measurement results in the form as selected in the menus *Plotter Setting* and Title. The beginning of the plotting procedure is indicated in the status line by the message *Plotting*; the text of the softkey is changed to *Abort Plot* to allow for the plotting to be aborted. After the plotting has been aborted, the output must be restarted.

If no plotter is connected or the connected plotter has an IEC bus address different from that indicated in *Plotter Setting*, the message *Connect Plotter* appears in the status line. After connecting a plotter or changing the IEC bus address of the plotter (see section 3.2.4.5.4), the output must be restarted.

No other controller may be connected to the bus when starting the plotter output, as otherwise the ESS is not able to take over IEC bus control. The receiver outputs in the status line *"Bus Control required"*. In this case the controller must be disconnected from the IEC bus.

With the IEC bus switched off (Spec Func 11, cf. section 3.2.4.7) the message *IEC bus off(SF11)* is displayed.

Starting a plotter output before the plotting process initiated by option 62 (*Meas&Plot*) has been concluded results in the message *WARN: Plotter active*.

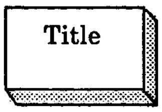
The message *WARN: No Pen selected* indicates that an element of the test report is to be output, however no pen is selected (*Pen = 0* in *PEN SETTING*).

Plotting is performed in the background, i.e. the receiver can still be operated during plotter output. Fast measurements, however, take a bit longer as long as the ESS transfers data to the plotter.

If the output of a measured value diagram and a measured value table is specified, the diagram is plotted on the first page and the table on the following pages. The user is requested to change the sheet on the plotter by the message *"Insert new sheet, press ENTER"*. Labelling is repeated on all pages.

Note: *The ESS permits simultaneous output of the measurement results on a printer and plotter. This feature is useful in particular if a diagram with curves is to be output on the plotter and a list of measured values on the printer at the same time.*

3.2.4.5.3 Input of Labelling for Printer and 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 under Test
- Manufacturer
- Operating Condition
- Operator
- Test Specification and
- Comment 1 und Comment 2.

Operation:

▸ Press the *Title* softkey.
The screen is deleted and the list with the possible labelling elements displayed.

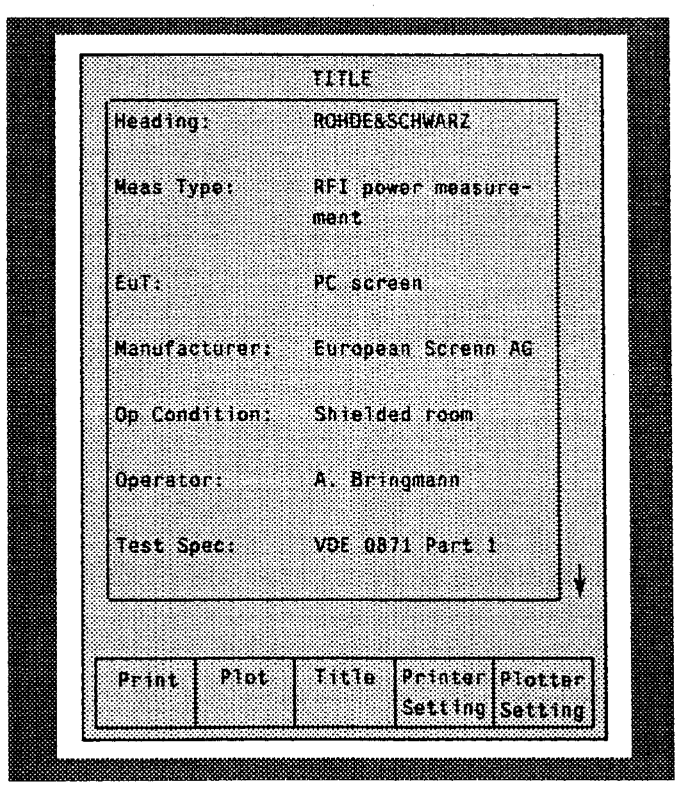


Fig. 3-33

▸ Select the desired text using the cursor keys.
The cursor always jumps to the beginning of the text. The respective element is displayed in bright notation. The desired text is entered either via an external keyboard connected or via the two auxiliary lines faded in. Notes on text input as well as the operation of the auxiliary line editor are to be found in section 3.2.4.1.4.

A maximum of 40 characters is possible per labelling element in both input modes. The comment may comprise two lines with 60 characters each. Further characters are not accepted.

3.2.4.5.4 Selecting the Presetting of the Printer and Plotter

By selecting the presetting of the printer or plotter, the user can to a large extent determine the appearance of his test report on his own. For the sake of clarity, individual colour selection is possible for the individual components of a plotter output.

The presettings are stored in the battery-backed RAM of the ESS so that it is usually sufficient to perform the settings only once. They are maintained even after calling the default setting of the ESS using RCL 0. The floppy functions permit to store the settings for the printer and plotter on floppy disk (see section 3.2.4.6.2).

The diagram limits for the output of the test report are determined by entering the scan data (*Scan Data*, see section 3.2.4.3.1). This has the advantage that the diagram on the printer and on the plotter is always identical with the screen display.

Printer Setting

Printer Setting

The menu for the printer settings permits to determine the various components of a test report. The default setting causes the output of the heading *(Title)* with scan settings (*Scan Table)* and output of the measured value table *(Meas Values)*.

Operation:

- Press the *Printer Setting* softkey.
  The screen is completely deleted and the list for the output of measured values and the printer settings are displayed:

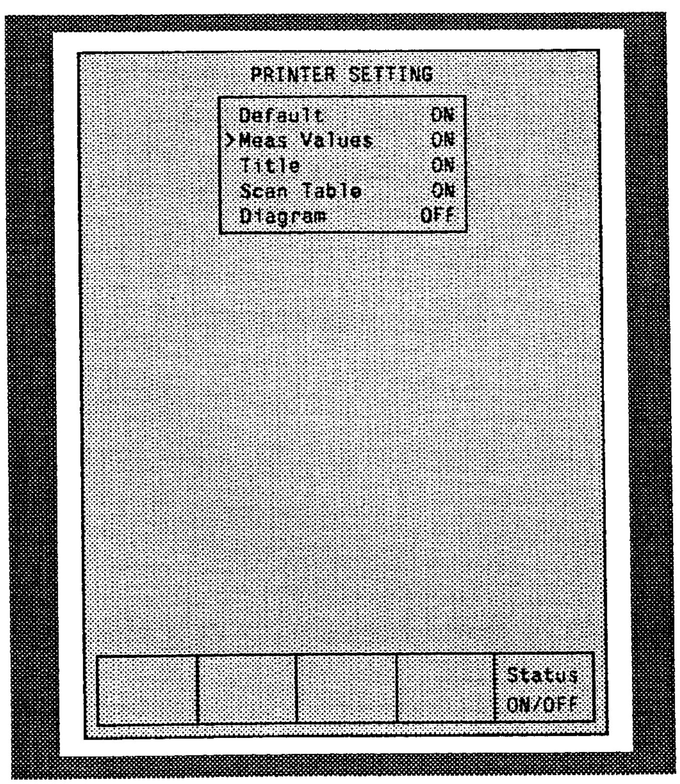


Fig. 3-34

Status ON/OFF

The desired element is selected using the cursor and the current status is changed using the *Status ON/OFF* softkey (ON → OFF, OFF → ON).

Note: With the default setting for the printer output (Default ON) selected, the cursor directly jumps to the element *Meas Values* when *Printer Setting* is called.

Plotter Setting

Plotter Setting

The menu *Plotter setting* permits to determine the contents of the test report and perform the instrument settings for the plotter.

Operation:

▸ Press the *Plotter Setting* softkey.
The screen displays the lists for defining

- Plotter Content
- Pen Setting
- Special Scaling and
- the IEC Bus Address of the plotter:

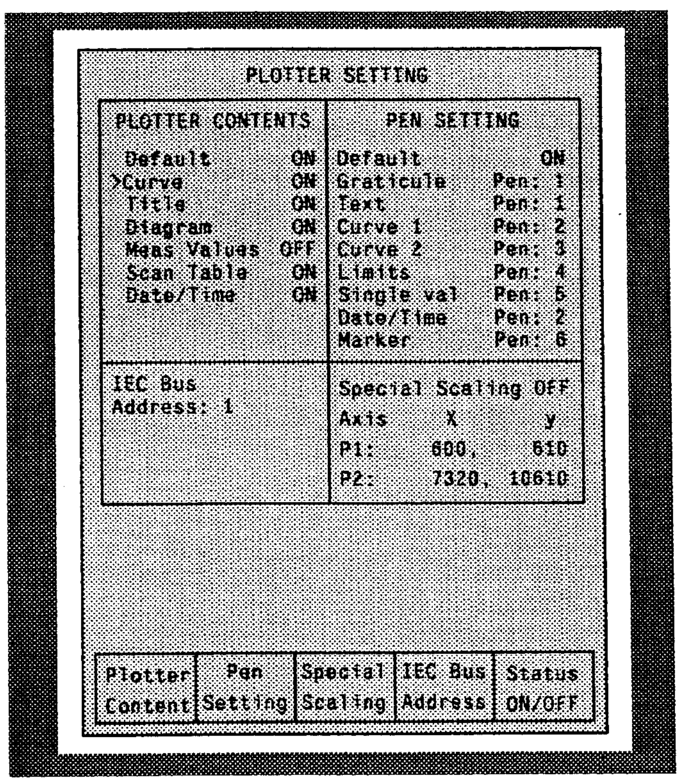


Fig. 3-35

Note: *With the default setting for the plotter output (Default ON) selected, the cursor immediately jumps to the Curve element when Plotter Setting is called.*

Plotter Content

Plotter Content

The *Plotter Content* menu permits to switch on or off the various plot components, i.e.:

- measured value curve(s) with graphical representation of the single measurement results (*Curve*),
- user-defined heading (*Title*, see section 3.2.4.5.3),
- diagram with frequency and level labelling and, if defined, the limit lines (*Diagram*),
- table with measured values (*Meas Values*),
- table listing the scan and subscan settings with the associated receiver parameters (*Scan Table*) and
- date and time (*Date/Time*).

The default setting causes the output with diagram including labelling, heading and curves. The table with the measured values is omitted, since it can better and faster be output on a printer.

Operation:

▸ The cursor is set to the desired plot element using the key ↑ or ↓.

Status ON/OFF

▸ The Status *ON/OFF* softkey is used to switch over the status of the output (OFF → ON, ON → OFF).

Pen Setting

The *Pen Setting* softkey permits to assign the plotter pens to the individual components of the test report. With the default setting (*Default ON*), the pens are selected as in fig. 3-35. When the pen assignment is changed, *Default* changes to *OFF*. The cursor is set to the desired plot element using the ↑ and ↓ keys. The pen numbers can assume values between 0 and 8. "0" means that no pen is selected leading to the hint *"Warn: No pen selected"* in the status line. The respective element is not plotted.

The default setting (*Default ON*) is selected by setting the cursor to the respective line and pressing the *Status ON/OFF* softkey.

Special Scaling

If a test report setting other than defined by the default setting of the used plotter is desired, the *Special Scaling* softkey permits to individually set the bottom left (P1) and the top right (P2) corner of the test report. To activate the desired scaling, set the cursor to the *Special Scaling* line and subsequently press the *Status ON/OFF* softkey. To switch off the scaling, press the ENTER key again. The current setting is indicated with *ON* or *OFF*. To change the x and y-coordinates of points P1 and P2, shift the cursor using the keys ↑, ↓, ← and → and enter the desired value for each case. The values between -32768 and +32767 are permissible for the coordinates. Illegal values are not accepted. The values for the coordinates depend on the plotter used and are to be obtained from the respective manual. The ESS is preset for the R&S plotter DOP.
The following table specifies useful coordinate settings for some plotters. After termination of the entry 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	

IEC Bus Address

The *IEC bus address* softkey permits to vary the IEC bus address of the plotter from 0 to 30. The value is directly entered in the screen line provided for this purpose. Other entries are not accepted, i.e. the original value is maintained.

3.2.4.6 Memory Functions

3.2.4.6.1 Saving of Data Sets in the Internal RAM (SAVE/RECALL)

In the ESS, a maximum of 9 complete instrument setups can be saved. The setting 0 contains the default setting of the receiver and cannot be modified. It is used to set all settings to their default values. The settings are stored in the internal CMOS RAM with battery back-up and are thus maintained even after the instrument has been switched off. The settings for measurements that are performed repeatedly must only be entered once and can be recalled at any time.

Saving the receiver configuration (SAV)

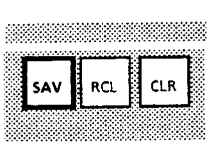
The following parameters are saved:

- All current receiver settings, such as frequency, attenuation, operating range, detector, etc.
- the special functions activated,
- the currently valid transducer settings (no sampled values),
- the limit lines (no sampled values)
- the scan data set
- the set scan options
- the marker settings and
- the setting of the IF analysis.

To facilitate the recovery of settings saved, they can be assigned a data set name (max. 8 letters or digits).

Note: ***Since the limit lines and the transducer 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 and transducers. If they are changed later, it may occur that the initial transducer or limit cannot be restored when recalling an instrument setting.***

Operation:



▸ Press the SAV key (DATA keypad).
The list with the 9 data sets is displayed on the screen. Data sets already stored are listed with their names (if available, otherwise with the * sign). In the case of unused memory registers, the field for the name remains empty.

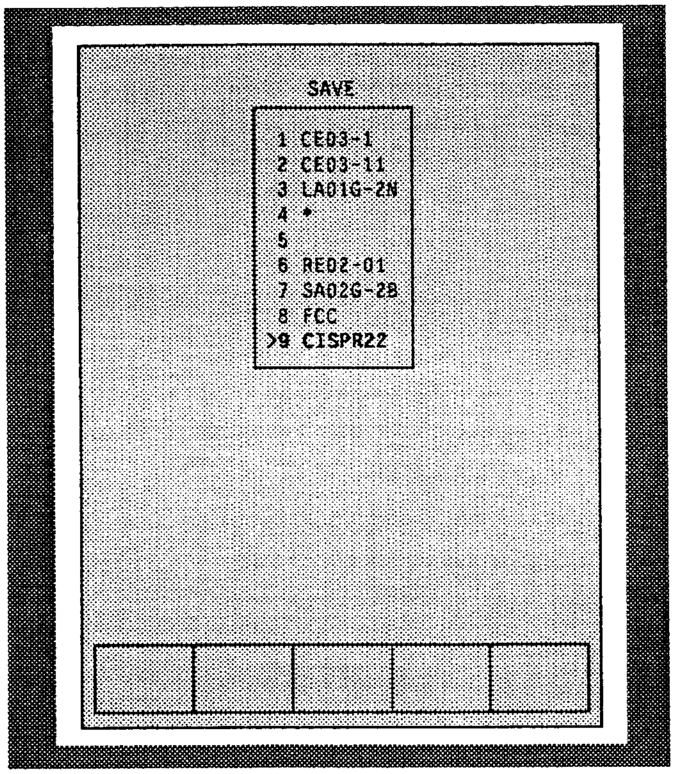
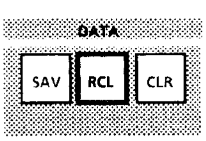


Fig. 3-36

The input cursor indicates the number of the first data set. The number can be confirmed using ENTER. It is likewise possible to shift the cursor to the desired data set using the ↑ or ↓ key and confirm using ENTER or to directly enter one of the digits 1 to 9. The cursor will then jump to the first character of the associated data set name. The name for the selected register can be entered via the external keyboard or the auxiliary line editor (see section 3.2.4.1.4). After terminating the input using ENTER, the currently valid configuration is saved. When the ← key is pressed, the cursor returns to the data set number. This allows to cancel operating errors.

After terminating the saving procedure, the receiver changes to the type of analysis that was active prior to calling of the save function.

Recalling a receiver configuration (RCL)



- Press the RCL key (DATA keypad).
  The screen displays the list with the 10 data sets and the associated names.
  Filled memory registers which are not provided with a name are marked by the "*" sign.

The input cursor indicates the number 0 of the default data set. The number can be confirmed using ENTER. It is likewise possible to shift the cursor to the desired data set using the ↑ or ↓ key and confirm using ENTER, or to directly enter a digit from 0 to 9. The associated data set will then be immediately loaded into the main memory of the ESS. The receiver subsequently changes to the type of analysis stored in the data set. The default setting RCL0 switches to RF analysis.

The selection of unused memory registers is indicated in the status line by the message *Register empty.*

3.2.4.6.2 Saving Data on Floppy Disk (FLOPPY)

The Test Receiver ESS is equipped with a 3 $^1/_2$" floppy disk drive. The floppy disk is used as a mass storage unit for instrument settings and measurement results as well as for complete graphics in HP-GL file format. Furthermore, the ESS permits to format floppy disks, list floppy disk contents on the screen and delete individual files.

There was no need to implement a computer operating system in the ESS, since the floppy disk functions (saving, loading, formatting, listing floppy disk contents) can be accessed via easy-to-operate softkey menus.

During execution of saving and loading processes as well as while formatting floppy disks, all other receiver functions (e.g. calibration, printer output) are disabled.

Floppy disk format:

Before a floppy disk can be used in the ESS, it must be formatted (cf. softkey *Disk Service*). The 3 1/2-inch floppy disks are formatted in a format compatible with industrial standard so that the floppy disk can be used both for personal computers (AT-compatible, DOS version up to 3.3) and for the ESS. In the ESS, the floppy disks can be formatted either in the high-density format (1.44 Mbyte available memory capacity) or in the double-density format (720 kbyte). The ESS is thus able to work with the two commonly used 3 $^1/_2$-inch formats.

Note: *Insert the floppy disk carefully into the drive, the labelled side of the floppy disk pointing upwards and the arrow pointing into the direction of the drive. The floppy disk can be removed from the drive by pressing the eject key; however, this must not be done during a floppy disk access. Observe the control lamp on the drive. The floppy disk should never remain in the drive when the receiver is switched on or off, since the read/write head may fall down on the floppy disk due to current surges.*

File organization:

Each data set is stored in a file on the floppy disk. The file name consists of a maximum of 8 characters entered by the user and an extension which is automatically appended by the system when the file is saved.

Table 3-15

Data set	Extension
Complete instrument setting (comprising receiver status and all partial data sets such as settings for report output) Only specification (without measurement results) Specification + measurement results	 *.SPC *.RES
Limit lines	*.LLI
Transducer factor	*.TDF
Transducer set	*.TDS
Reports in HP-GL format	*.GRA

The files are always stored in the root directory in the ESS. A maximum of 224 files can be generated in the root directory on a floppy disk in DOS format. The data are stored in the ESS-internal data format (exception: graphics are stored on floppy disk as ASCII files in HP-GL format).

General operating instructions for the floppy menus:

a) Input of data names

Each file to be stored on floppy disk must be provided with a file name consisting of a maximum of 8 characters. The floppy disk can be assigned a name (Volume name, max. 11 characters) when it is formatted so that the floppy disks can be easily distinguished.

The names are entered via an external keyboard or an auxiliary line editor. In the ESS, only names consisting of letters and/or digits are permissible. In contrast to the operating system MS-DOS, the ESS accepts only the following special characters: @ # $ % _

This restriction is to be taken into account if the file name has been generated or modified on a personal computer.

b) Scrolling of lists

For the save and load functions, the files contained on the floppy disk are always listed on the screen. Since this list cannot be displayed completely if there is a large number of files, a continue symbol appears at the end of the list. If the cursor is located at the end of the list, the list can be scrolled by pressing the cursor key. The same applies to the beginning of the list.

c) Messages and error messages with floppy disk operations

Most accesses to the floppy disk drive are commented by messages and error messages. All messages which may appear in the status line of the ESS during floppy disk operations are summed up in the following:

- While data are being saved on floppy disk, the following message is always displayed:Saving data on disk

  Storing <filename> on disk

- While data are being loaded from the floppy disk, the following message is always displayed:Loading data from disk

  Loading <filename> from disk

- Each time the floppy disk is changed, the file management system of the ESS must remount the floppy disk. This procedure takes about 5 s and is indicated by the following message in the status line:

  Reading disk, please wait ...

These messages disappear again after the function has been performed.

- When listing disk directories, the ESS determines and displays the space available on the floppy disk *(e.g 168960 Bytes free).*

- If the drive is not ready for write or read accesses, the following error message appears:

  Drive not ready

  Possible causes: the drive contains an unformatted floppy disk or none at all.

- If the write protection of the floppy disk is effective during write accesses, the following error message appears:

  Write protect error

- When an invalid file name is entered (see input of file names), the following error message is displayed:

  Insufficient disk space

- When an invalid file name is entered (see input of file names), the following error message is displayed:

  Invalid file name

  The message is deleted after 2 s, and another prompt to make an entry appears.

- If a non-existing file name is entered during loading, the following error message is displayed: *File doesn't exist*

When an error occurs, the user must eliminate the error cause and press the softkey for the desired function again.

Operation:

▸ Press FLOPPY key.
The following softkey menu appears on the screen:

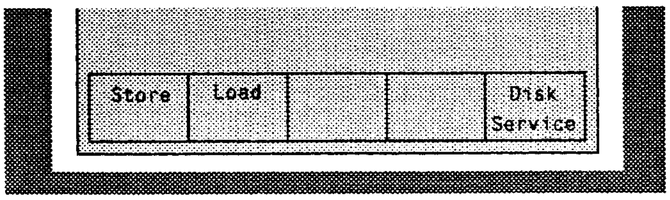


Fig. 3-37

The screen contents is maintained until a softkey for execution of a save or load function is pressed.

This softkey calls a submenu to determine which data set of the receiver is to be stored on the floppy disk.

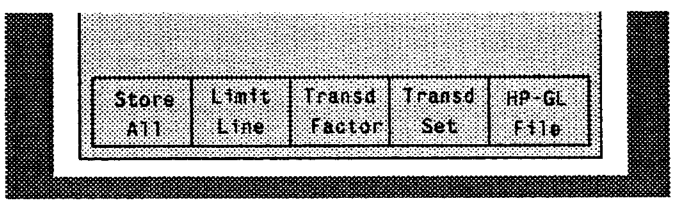


Fig. 3-38

In detail, these data sets comprise the storage of

- complete instrument settings (*Store All*),
- Limit Lines,
- Transducer factor (*Transd Factor*),
- Transducer set (*Transd Set*)
- Plotter graphics (*HP-GL File*)

All storage functions in the ESS have the following characteristics in common:

After one of the softkeys from the *Store* submenu has been pressed, the ESS checks whether a formatted, readable floppy disk is installed in the drive. Then all files stored on the floppy disk with the respective extension of the partial data set are indicated on the screen.

If there is no file on the floppy disk, the table remains empty. The softkey menu is maintained so that all other floppy functions can be directly accessed.

The status line displays a prompt to enter the file name under which the file is to be stored on floppy disk (see Input of File Names).

It is also possible to overwrite the contents of an already existing file. Select the file from the list using the ↑ and ↓ keys and confirm using ENTER. The status line displays the prompt

Overwrite existing file?(ENTER/EXIT)

This prompt is also displayed if the file is found to already exist on the floppy disk when a name is directly entered. The file is stored by pressing one of the ENTER keys. If the file is not to be overwritten, the function can be aborted using EXIT. The floppy menu is then left and the original display (before the floppy function was called) appears again.

Store All

Storing of a complete instrument setting.
The floppy function *Store All* is used to store the complete instrument setting of the ESS and (if available) measurement results in a file on the floppy disk. The following data are stored:

- All receiver settings (includ. special functions)
- The currently selected type of analysis
- Report configuration
- Limit lines (currently activated)
- Transducer factor (currently activated)
- Transducer set (only associated factors of the activated set)

- Measurement results comprising
  - all measured values from a preceding scan (level 1st detector + level 2nd detector + validity byte)
  - all (max.) 400 subrange maxima for both detectors (frequencies, levels and exceeding of limit lines)
  - all (max.) 400 measurement results from subsequent measurements, if available (frequencies, levels and phases)
- Associated scan data sets (including options) used to record the measured values
- Marker settings
- All settings of IF analysis

The advantage of this procedure is that, when loading a curve from the floppy disk, the associated scan parameters are also loaded so that no conflict arises with the currently set scan data. The measurement results loaded from the floppy disk can subsequently be processed in the ESS (marker, zoom, plot, etc.).

Limit Line

Transd Factor

Transd Set

Limit lines, transducer factors and transducer sets can be stored separately and also loaded separately later. All data sets defined at this point in time can be stored on floppy disk. The status *(ON/OFF)* of the respective data set is not stored.

After pressing one of the 3 softkeys, the list of the defined limit lines, transducer factors or transducer sets is displayed on the screen.

Example:

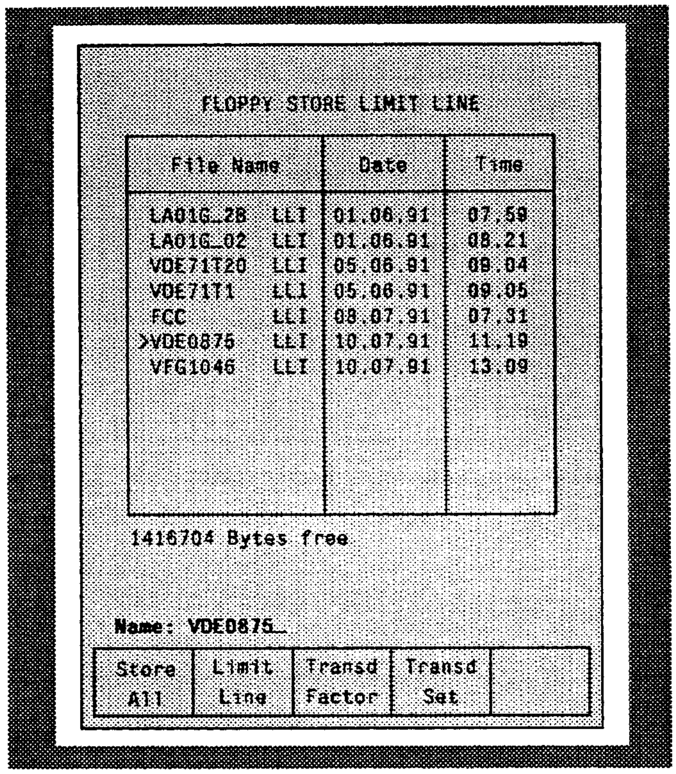


Fig. 3-39

A data set can be selected from the list either directly or using the ↑ and ↓ keys. After the cursor has been positioned and one of the ENTER keys pressed, the data set is stored on diskette. If no name was entered for the data set, the ESS issues a prompt to enter a file name in the status line:

Name:

The partial data set is subsequently stored on the floppy disk using the defined name. The extension *.LLI, *.TDF or *.TDS is automatically appended. A data set already stored on the floppy disk can be overwritten.

After the function has been executed, the screen contents and the softkey menu are maintained in order to allow further data sets to be immediately stored. By pressing EXIT or another function key, the menu can be left and a different menu displayed on the screen.

HP-GL File

This softkey permits to store the complete plotter graphics as ASCII file in the HP-GL format on floppy disk. After pressing of the softkey, the ESS behaves as if a plotter output was started, except that the output is not performed via the plotter interface, but on the floppy disk. Depending on the user-defined plotter setting (see section 3.2.4.5.4), the file contains the following items:

- Title
- Scan Table
- Diagram
- Curve(s)
- Subsequent measurement results (graphical)
- Subsequent measurement results (tabular)
- Date and time

Note: *The files stored like this cannot be loaded back into the ESS. They are intended for further processing on an external computer. They may be used by word processing or graphics programs which are able to import graphics files in the HP-GL format. The easiest way to use the file is to output it via the respective PC interface on a connected plotter.*

Load

This softkey calls a submenu which determines the data set to be loaded from the floppy disk into the receiver.

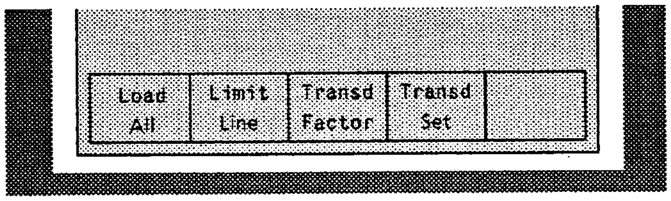


Fig. 3-40

Operation and procedure when loading the data sets largely correspond to storing.

Load All

The floppy function *Load All* is used to load a complete receiver setting and, if available, measurement results from the floppy disk into the ESS. All files previously stored using *Store All* are loaded.

If a valid floppy disk is installed in the drive of the ESS, all files with the extension *SPC* (only test specification) and *RES* (test specification and results) are listed on the screen. If no file is stored on the floppy disk, the list remains empty.

Example:

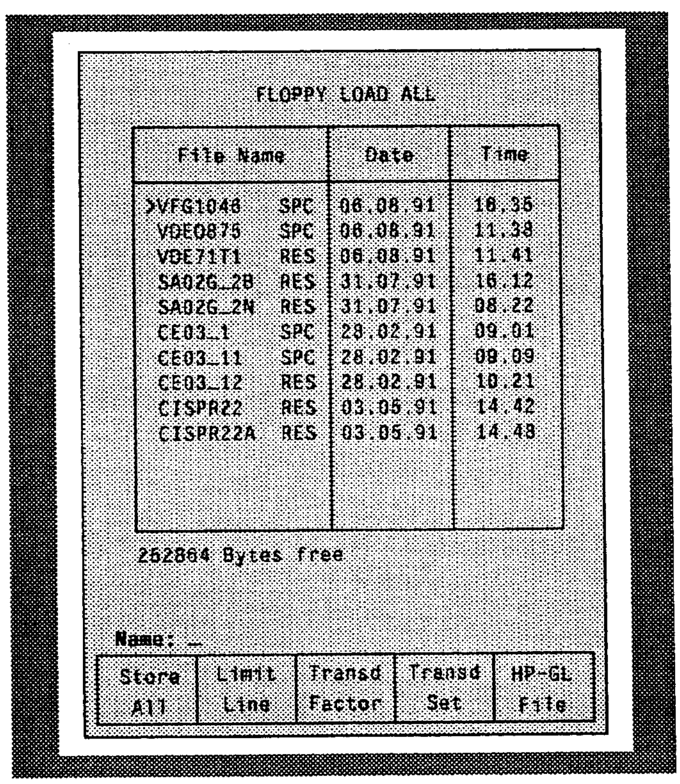


Fig. 3-41

Loading of the files is started by pressing the ENTER key. After the function has been successfully executed, the floppy menu is left, the loaded operating mode (RF or IF analysis) activated, and the stored measurement results are displayed.

Note: *All instrument settings valid before calling of the load function are overwritten by the loaded data set.*

Limit Line

Transd Factor

Transd Set

The other softkeys of the Load submenu permit partial data sets of limit lines, transducer factors and sets to be loaded into the ESS. The status of the loaded data sets is always *OFF* in order to avoid a conflict with already active limit values or transducers.

After pressing one of the 3 softkeys, the files with stored limit lines (LLI), transducer factors (TDF) or transducer sets (TDS) contained on the floppy disk are listed on the screen.

A file is selected from the list by entering the file name or via the ↑ and ↓ keys. After the file name has been confirmed using ENTER, the number of the data set into which the data are to be loaded is requested:

Load into factor no. (1 to.22): __ (example of a transducer factor)

Illegal numerical entries are ignored.

When the data set number has been entered correctly, loading of the data is started. After the function has been successfully executed, the screen contents and the softkey menu are maintained to allow for immediate loading of further data sets. The floppy menu is left using EXIT or any function key leading to a different screen contents or menu.

Note: *Already existing data sets are completely overwritten.*

Disk Service

The *Disk Service* function is used to

- format floppy disks
- list files and
- delete files.

After pressing of the softkey, the screen contents are maintained first, and the following submenu is displayed.

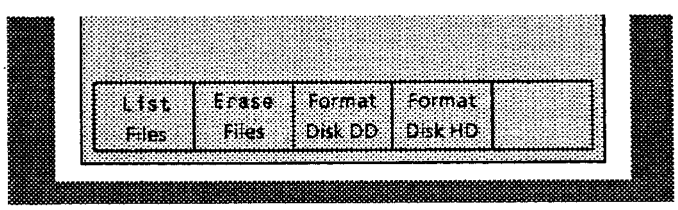


Fig. 3-42

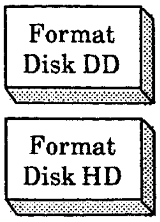
List Files

Pressing of this softkey causes all files on the floppy disk to be listed on the screen. The list can be scrolled using the ↑ and ↓ keys.

Erase Files

Pressing of this softkey causes all files on the floppy disk to be listed on the screen (without subdirectories). Individual files can be selected using the cursor keys or by entering the file name and deleted by pressing the ENTER key. Before the file is definitely deleted, the following prompt is displayed in the status line *Press ENTER to erase file*

Note: *In the event that a file is unintentionally deleted in spite of this prompt, there are utility programs for personal computers, which are able to restore the file under certain conditions. However, no further file may be stored on the floppy disk in the meantime.*



Before data can be stored on a floppy disk, it must be formatted, i.e. divided into tracks and sectors. In the ESS, this is done in a format compatible with industrial standard. Floppy disks may be formatted either with 1.44 Mbyte (high density, HD) or 720 kByte (double density, DD).

Pressing of this softkey causes the following prompt to appear in the status line:

Insert disk and press ENTER

- Insert the floppy disk to be formatted into the drive and press the ENTER key. Before formatting starts, it is possible to enter a disk name *(Volume name)* consisting of max. 11 characters (letters and digits) via the external keyboard or the auxiliary line editor:

  Volume name (11 char)__

Then formatting is started. During this procedure, which takes less than 2 minutes, all receiver functions are disabled.

Note: Files already stored on the floppy disk are deleted during formatting.

3.2.4.7 Special Functions (SPEC FUNC)

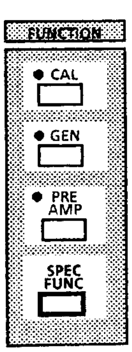
For applications requiring special characteristics of the receiver , special functions are implemented in the ESS. They enable the user to select the characteristics of the receiver as required.

To facilitate operation, each special function is assigned a number. The special functions are divided into groups, each group starting with a new tens digit.

Table 3-16

Special function groups	Call
Test parameters	SPEC FUNC 01, 02,
Switch functions	SPEC FUNC 10, 11, 12, 13,14, 16, 17, 18
Measured value output	SPEC FUNC 20, 21
Special types of measurement	SPEC FUNC 30, 31, 32, 33, 34, 35, 36
Trigger functions	SPEC FUNC 51, 52.

Operation:



- Press SPEC FUNC key.
  The list for selecting the special functions is read out on the screen:

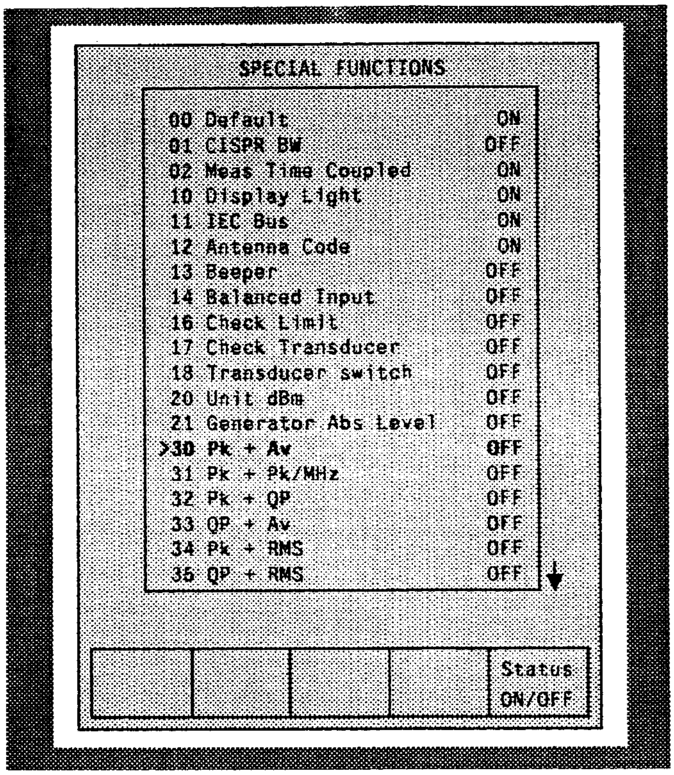


Fig. 3-43

By pressing the Status *ON/OFF* softkey, the status of the special function is switched over (ON → OFF, OFF → ON). The cursor remains at the selected position after switchover. Pressing the softkey again switches the special function on or off.

Explanation of the various special functions:

SPEC FUNC 00 Default — The special function "00 Default" is used to set all special functions to their default.

SPEC FUNC 01 CISPR BW — The default setting is OFF.
With "CISPR BW ON", depending on the receiver frequency, the bandwidth specified for quasi-peak is switched on not only in the quasi-peak mode, but also with average-value (AV) and peak-value display (Pk) (see section 3.2.3.9.4).

SPEC FUNC 02 MeasTime Coupled — The default setting is ON.
In the default setting, the measuring time is coupled with the IF bandwidth to ensure settling of the signal. Under certain conditions, it may be useful to do without coupling.
Example: A sinewave signal is measured with fixed receiver frequency.

SPEC FUNC 10 Display Light — The default setting is ON.
To increase operating time when using external battery, illumination of the LC displays can be switched off. When operating under poor lighting conditions, it is however re-commended to switch on illumination.
Power consumption of the LCD illumination: about 5 W.

SPEC FUNC 11 IEC Bus — The default setting is ON.
The IEC bus of the ESS can be switched off by way of this special function, which may be useful when operating with external battery. Power consumption of IEC bus module: about 1.2 W. The IEC bus cannot be switched off during plotting.

SPEC FUNC 12 Antenna Code

The default setting is ON.
Transducers from Rohde & Schwarz such as the VHF Current Probe ESV-Z1 or the Broadband Dipole HUF-Z1 feature a nearly constant conversion factor in their specified frequency ranges. This can be taken into account by a coding connector at the ANTENNA CODE socket. If the coding of the conversion factor is not wanted, e.g. because an additional cable is used, it can be switched off using this special function. The individual conversion factor can be entered via the transducer factor (see section 3.2.4.2.1). Irrespective of the setting of the special function, the coding at the ANTENNA CODE socket is always ineffective with active transducer.

SPEC FUNC 13 Beeper

The default setting is OFF.
The ESS contains an internal beeper which draws the attention of the user to various instrument settings. A beep sounds in the following cases:

- Termination of a frequency scan
- Request to change the transducer with activated transducer set
- Termination of plotting
- Termination of printing
- Limit line exceeded with special function 16 activated
- Output of an error message or warning

  As a prerequisite, the AF must be cut in. The volume of the beep is independent of the volume setting, i.e. the volume control can be completely turned off if the demodulated AF signal is not wanted.

SPEC FUNC 14 Balanced Input

The default setting is OFF.
This special function serves to switch between balanced and unbalanced RF input (cf. section 3.2.1).

Switching on special function 14 causes the complete scan data set to be deleted (temporarily) when a scan with the defined data cannot be executed (eg stop frequency > 50 kHz). The attempt to start a scan the scan data set of which has been deleted is acknowledged by the message *Scan Data invalid*. The data set just deleted can be restored by immediately switching off special function 14. There is also the possibility of defining a scan data set for the balanced input. In this case, the present data are overwritten by the new data set.

SPEC FUNC 16 Check Limit

The default setting is OFF.
This function is effective in receiver mode only (not in the scan).

If a limit line is active, each measured value is compared with the limit value when the special function is activated. When the limit is exceeded, the message *Limit exceeded* is output in the status line. If the value falls below the limit value, the message disappears again. With the beeper switched on (*Spec Func 13*), a beep sounds when the limit value is exceeded during the first measurement at a new frequency.

With a double measurement mode switched on in receiver mode (special functions 30 to 36), a message as to the exceeding of a limit is output when at least one of the two measured values exceeds the appertaining limit. Assignment of the detectors to the limits is dealt with in Section 3.2.4.3.2. In standards, limits for the peak or quasi-peak value always exceed the limit for the average value.

With special function 16 being switched on, the markers serve to indicate differences between measured value curve(s) and limit line(s) in the graphical representation. In *Marker Normal* mode, the main marker moves on the measurement curve, the second marker moving on the limit line. The respective frequency and level values are indicated in the marker fields. The hint *Chk Lim* in the upper, right-hand edge of the diagram shows that special function 16 is active. In the case of double measurement modes, the two markers can be shifted to the second curve and second limit line using the softkey *Next Curve*.

SPEC FUNC 17 Check Transducer

The default setting is OFF.
If special function 17 is activated, not the measured value, but the transducer value with its unit calculated at the set receiver frequency is output on the level display. No level measurement is performed. With transducer output, the display for ZERO SCALE DEFLECTION, ATTENUATION and MODE remains empty in the LEVEL display and the display for the bandwidth, the detector and the measuring time remains empty in the FREQUENCY display. Thus, the transducer activated can be manually checked by tuning the frequency of the receiver. Using a scan, the transducer curve can also be output in a graph on the screen or on the plotter or printer. The frequency axis and level axis are determined by the values defined in the scan data set (see section 3.2.4.3.1). The output is started in the report menu using the softkeys PLOT or PRINT (see section 3.2.4.5).

SPEC FUNC 18 Transducer switch

Default setting is OFF.
A port of the USER INTERFACE on the rear panel of the ESHS 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 to the number of the range at 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, when different antennas are switched by an antenna matrix during a scan or with manual frequency variation.
The message Change Transducer is suppressed when working with special function 18.
Special function 18 is ignored with the scan option 01 RFI Voltage being.

The maximum current capacity has to be taken into account when supplying an external switch with the device supply voltages + 5 V or + 12 V. The peak current must not exceed 500 mA, and the permanent current capacity is 200 mA. The maximum current for the control ports is 4 mA..

SPEC FUNC 20 Unit dBm

The default setting is OFF.
The unit dBm specifies the power level into 50 Ω. However, this does not turn the ESS into an rms value meter. The voltage displayed in the selected type of display with the nominal input impedance of 50 Ω is only converted into the associated power level. Only the power of a signal which is not amplitude-modulated is displayed correctly.
Since the unit can only be used for power levels referred to 1 mW, the special function is only effective if no unit is encoded

at the ANTENNA CODE socket. Likewise, it is only active for transducer factors with the unit dB, i.e. only twoport networks with defined power attenuation or amplification can be taken into account.

When encoding 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 21 Generator Abs Level

The default setting is OFF.
When a tracking generator is used (see section 3.2.3.13), the relative level referred to 96 dBµV EMF is normally displayed in the unit dB. With special function 21, the absolute level at the input of the receiver and the current unit instead of the unit dB are displayed.

SPEC FUNC 30 Pk + AV
SPEC FUNC 31 Pk + Pk/MHz
SPEC FUNC 32 Pk + QP
SPEC FUNC 33 QP + AV
SPEC FUNC 34 Pk + RMS
SPEC FUNC 35 QP + RMS
SPEC FUNC 36 RMS + AV

The default setting is OFF.
With these combined measurement modes, two different detectors are simultaneously switched on during the measurement. They permit to detect for example broadband interference with the peak-value detector and narrowband interference with the average-value detector at the same time. Thus only one automatic frequency scan is necessary. During a scan, 2 curves are displayed on the screen; the LEVEL display, however, indicates only the first value (example: Pk + AV → Pk is displayed). The measurement results are stored and can be subsequently output on a plotter or printer. When the curve is output on a plotter during the scan (Option 62 *Meas&Plot*, see section 3.2.4.3.3), the curve for the first display mode is immediately displayed, followed by the second curve (example: QP + AV → during the measurement, the QP curve is plotted, then the AV curve).

Only one of the double measurement modes can be active at a time. Switching on a new function automatically switches off an already activated function.

SPEC FUNC 51: ExternalTrigger +

The default setting is OFF.
The ESS starts a measurement on a positive signal edge (TTL level) at the input EXT TRIG of the USER INTERFACE, pin 1 (pin assignment, see section 3.2.6.5.4). This is useful if, e.g., a test item issues interferences at a certain point in time and an appropriate trigger pulse can be derived from the test item. It is recommended to set the attenuation of the ESS to an optimum setting before, if no sufficient time for autoranging is provided. The special function is automatically switched off when special function 52 is switched on.

SPEC FUNC 52: ExternalTrigger -

The default setting is OFF.
As with SPEC FUNC 51, except that the ESS starts a measurement on a negative signal edge (TTL level) at the input EXT TRIG of the USER INTERFACE, pin 1 (pin assignment, see section 3.2.6.5.4). The special function is automatically switched off when special function 51 is switched on.

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 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:

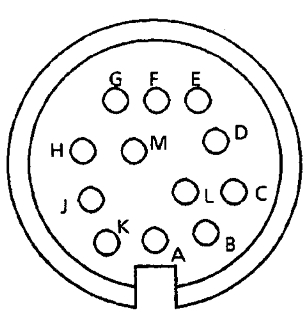
- Passive Probe 9 kHz to 30 MHz ESH2-Z3
- Aktive Probe 9 kHz to 30 MHz ESH2-Z2
- Rod Antenna 9 kHz to 30 MHz HFH2-Z1
- Rod Antenna 9 kHz to 30 MHz HFH2-Z6
- Loop Antenna 9 kHz to 30 MHz HFH2-Z2
- Broadband Dipole 20 to 80 MHz HUF-Z1
- RF Current Probe 100 kHz to 30 MHz ESH2-Z1
- VHF Current Probe 20 to 300 MHz ESV-Z1
- Current Probe 20 Hz to 100 MHz EZ-17
- Preamplifier 10 to 1000 MHz ESV-Z3

As the conversion factor of the RF Current Probe EZ-17 rises by 20 dB per decade with decreasing frequencies, it is however more useful 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 ESS is operated outside the room. The use of an active antenna requires the shield of the supply and coding cable to be fed through the screen of the room, such that there is no emitted interference inside the room.

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. 3-44 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, the output voltage is higher than 1.5 V (EMF). If a connector is inserted, the internal loudspeaker is automatically switched off.

3.2.6 Inputs and Outputs at the Rear Panel

3.2.6.1 IF Output 10.7 MHz (10.7 MHz OUTPUT)

The 10.7-kHz output is suitable for tests with oscilloscope, spectral analysis, examination and measurement of the input signal modulation eg using a modulation analyzer. For IF bandwidths over 10 kHz the bandwidth is equal to the selected IF bandwidth. For IF bandwidths below 10 kHz the output bandwidth is equal to the 10-kHz bandwidth

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

3.2.6.2 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 set IF bandwidth.

3.2.6.3 Input for External Reference (EXT REF INPUT)

(only without the Oven-controlled Crystal Oscillator ESS-B1)

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

The ESS, itself detects whether an external reference with a sufficient level is connected. This is checked by the switch-on routine and the hint *"EXT REF"* is entered in the SETUP menu by the ESS (cf. section 3.2.4.2.1). If a reference is connected during operation, the hint *"EXT REF"* is output in the status line on the screen and simultaneously entered in the SETUP menu. If a signal is not suitable for synchronization, an error message is output (*EXT REF UNLOCK*).

3.2.6.4 Reference Output (10 MHz REF OUTPUT)

(only with the use of the Oven-controlled Crystal Oscillator ESS-B1)

With the Oven-controlled Crystal Oscillator ESS-B1 integrated in the receiver, the reference socket at the rear panel is used as an output. The internal 10-MHz reference signal is led through. The level is 1 V EMF with an internal resistance of 50 Ω.

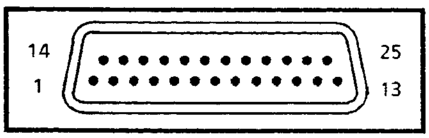
Synchronization of the ESS with an external frequency standard is not possible in this case.

3.2.6.5 USER INTERFACE

The USER INTERFACE at the rear panel of the ESS 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,
- 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, I_{max} = 0.1 A
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, I_{max} = 0.1 A

Fig. 3-45 Assignment of the USER INTERFACE X 37

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 without opening the instrument using an IBM-AT compatible personal computer and its serial interface. For more details refer to section 4.

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

Table 3-17

Pin	Signal	I/O	Meaning
2	RxD	I	Received Data: transmits ASCII data from computer to ESS
3	TxD	O	Transmitted Data: transmits ASCII data to computer
4	$\overline{\text{DSR}}$	I	Data Set Ready
5	$\overline{\text{DTR}}$	O	Data Terminal Ready
6	$\overline{\text{RTS}}$	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 instrument modules, is free for control of accessories. The bus has a high impedance in the undriven state (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 3-18

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	$\overline{\text{Strobe}}$	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 external devices such as the Artificial Mains Networks ESH2-Z5 and ESH3-Z6. The lines serve to switch over the phases and the reference ground. The level corresponds to that of TTL-logic (low < 0.4 V, high > 2.0 V).

Table 3-19

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 REC2 output containing a low-pass with the instrument time constant demanded in CISPR 16 (160 ms in the range below 30 MHz, 100 ms above 30 MHz). The outputs provide a dB-linear voltage with 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 analog meter 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

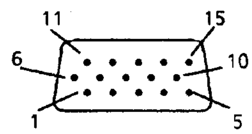
To supply external devices with low current consumption, the device-internal supply voltages +5 V (5.0 V to 5.5 V) and + 12 V (10.8 to 15 V) are brought out. The current-carrying capacity is 100 mA for both outputs. The receiver automatically switches off in the case of a short-circuit.

Table 3-20

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):

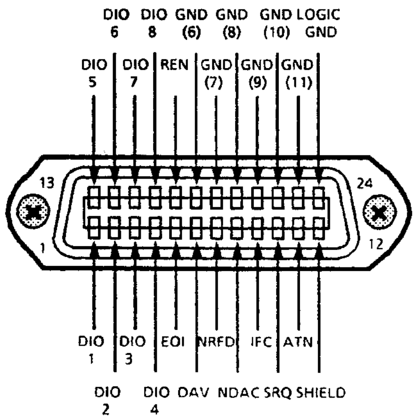


Pin	Signal	I / O	Meaning
1	$\overline{\text{PRISTB}}$	O	Pulse for transmitting a data byte
2	PRIDAT2	O	Data line 2
3	PRIDAT5	O	Data line 5
4	$\overline{\text{PRIACK}}$	I	Indicates that the printer is ready for reception of the next byte
5	PRISEL	I	The printer supplies HIGH, when it is selected
6	PRIDAT0	O	Data line 0
7	PRIDAT3	O	Data line 3
8	PRIDAT6	O	Data line 6
9	$\overline{\text{PRIBUSY}}$	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	$\overline{\text{PRIFAU}}$	I	Fault of printer (active Low)

Fig. 3-46 Pin assignment of the Printer Interface

3.2.6.7 IEC Bus

The ESS is equipped with a remote control interface according to the IEC 625 standard. It is connected to the socket 36 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

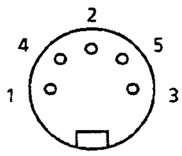
Fig. 3-47 Pin assignment of the IEC bus socket

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 the use of the Keyboard PSA-Z1 is recommended (see data sheet, recommended accessories). It is also possible to use any MF-compatible keyboard.



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

Fig. 3-48 Assignment of the KEYBOARD socket

*) German Industrial Standard

3.3 Remote Control (IEC bus)

The Test Receiver ESS features an IEC bus device as standard equipment. The interface complies with the IEEE 488.1 and IEC 625-1 standards. The ESS furthermore considers the "IEEE Standard Codes, Formats, Protocols, and Common Commands ANSI/IEEE Std 488.2 - 1987" standard also approved of by the IEC commission. The IEEE 488.2 standard 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 socket for connection of the IEC bus is situated on the rear panel of the ESS. 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 3-24.

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 ESS:

Table 3-21 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 ESS is set to address 19 (upon delivery, cold start or firmware update).

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

3.3.2 Local / Remote Switchover

The ESS is always in the "Local" state at turn-on (manual operation). If the ESS 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 by the "REMOTE" LED on the front panel.

Note: *If the ESS 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 ESS should be stopped before by pressing the LOCAL key, as otherwise the ESS 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 is 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 3-22 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 3-23 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 3-24 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:

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 ESS 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 ESS. 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.

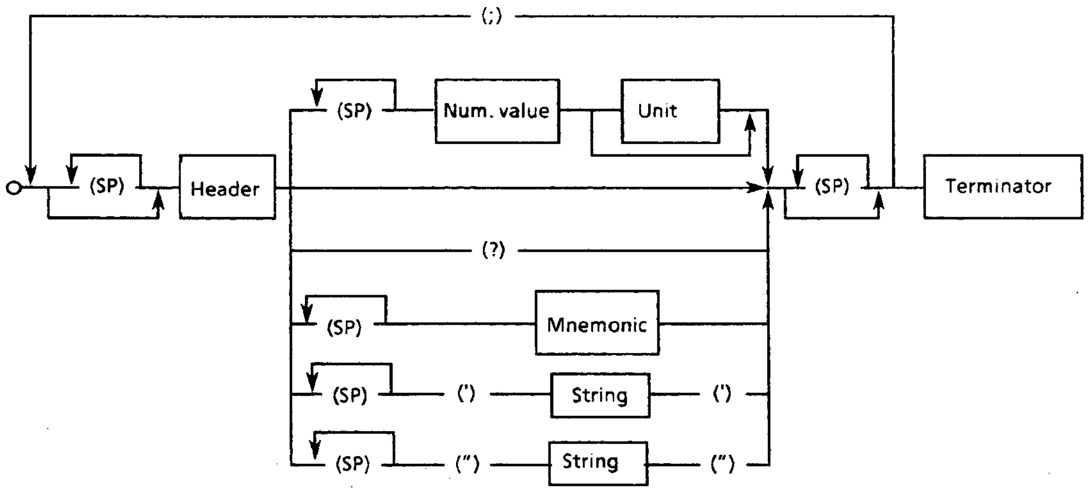
Numeric values:

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

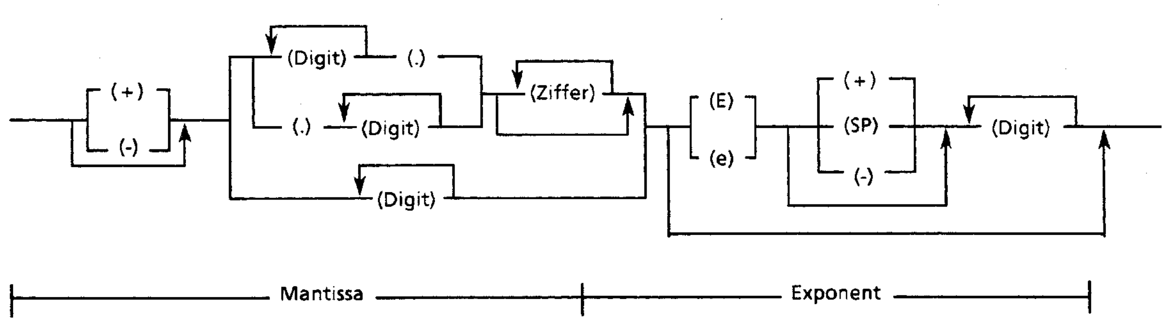
- With and without sign
  Example: `10, +10, -10`
- With and without decimal point, any position of the decimal point is permissible.
  Example: `1.234     -200.5     .123`

- 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. 3-49 Syntax diagram of a command line

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

The ESS 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 ESS 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 ESS. <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 ESS 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 ESS receives several query messages, it also returns several messages within one line separated by semicolons (;).*

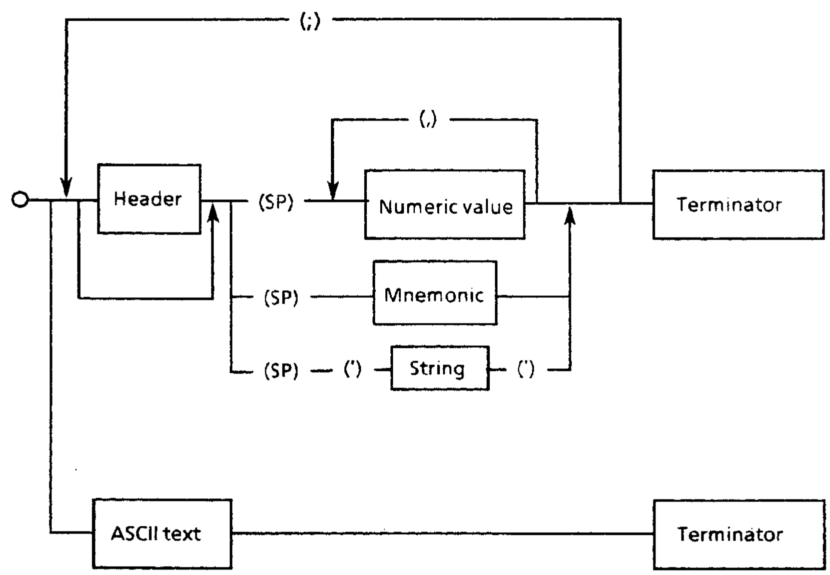
Several numeric values (day, month and year) can be sent as a reply to certain query messages (e.g. SYSTEM:DATE?). They are separated by commas (,).

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 ESS 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

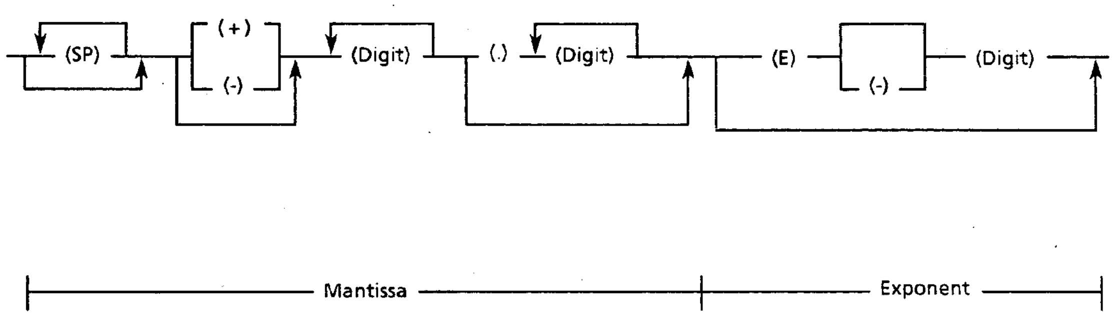


Fig. 3-50 Syntax diagram of messages sent by the receiver

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 3-25 Device-independent commands (common commands) received by the ESS

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	-32767 to 32767	**Power On Status Clear** (reset on power-up) If the numeric value is unequal to 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 ESS 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 9	**Recall** Recalls a stored device setting. *RCL 0 sets the ESS to its default status analog to the command *RST. The command has the same function as the RCL key.
*SAV	1 to 9	**Save** Saves a current device. 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 3-26 Common Commands leading to data output

Command	Output message Data value		Meaning
	No. of digits	Range	
*IDN?	36	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, ESS, 0, 2.00, 02.00, 02.01 Rohde&Schwarz = manufacturer ESS = model 0 = reserved for serial number, (not used with ESS) 2.00 = firmware version (for example) 02.00 = version of boot-EPROM firmware 02.01 = version of graphics firmware
*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. 3-51).
*TST?	1 to 3	cf. table 3-28	**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	0 or 1	**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	cf. table 3-27	**Calibration Query** The receiver is calibrated. If the calibration is completed successfully, "0" is output as a reply; otherwise a number between 27 and 391 the meaning of which can be learnt from table 3-27 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 3-27 Meaning of the error messages during calibration

Output value	Meaning
23	The gain at the reference frequency 30 kHz cannot be controlled.
25	The gain at the reference frequency 1 MHz cannot be controlled.
27	The gain at the reference frequency 64 MHz cannot be controlled.
39 41 43 45	IF bandwidths 1 kHz 10 kHz 100 kHz 1 MHz
65	The IF gain switch is defective so that its gain error cannot be corrected.
81	The 30-dB operating range is defective and cannot 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	Quasi-peak weighting in Band A is defective.
105	Quasi-peak weighting in Band B is defective.
107	Quasi-peak weighting in Band C is defective.
	A filter range of the preselection is defective; frequency response at the respective frequency is more than 6 dB:
113	10 kHz
113	20 kHz
117	30 kHz
119	40 kHz
121	50 kHz
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

Output value	Meaning	Output value	Meaning	Output value	Meaning
177	20.0 MHz	249	310.0 MHz	321	660.0 MHz
179	30.0 MHz	251	320.0 MHz	323	670.0 MHz
181	40.0 MHz	253	330.0 MHz	325	680.0 MHz
183	50.0 MHz	255	340.0 MHz	327	690.0 MHz
185	51.2 MHz	257	350.0 MHz	329	700.0 MHz
187	51.3 MHz	259	360.0 MHz	331	710.0 MHz
189	60.0 MHz	261	370.0 MHz	333	717.2 MHz
191	64.0 MHz	263	380.0 MHz	335	717.3 MHz
193	70.0 MHz	265	390.0 MHz	337	720.0 MHz
195	80.0 MHz	267	400.0 MHz	339	730.0 MHz
197	90.0 MHz	269	410.0 MHz	341	740.0 MHz
199	100.0 MHz	271	420.0 MHz	343	750.0 MHz
201	110.0 MHz	273	430.0 MHz	345	760.0 MHz
203	120.0 MHz	275	440.0 MHz	347	770.0 MHz
205	125.2 MHz	277	450.0 MHz	349	780.0 MHz
207	125.3 MHz	279	470.0 MHz	351	790.0 MHz
209	130.0 MHz	281	480.0 MHz	353	800.0 MHz
211	140.0 MHz	283	490.0 MHz	355	810.0 MHz
213	150.0 MHz	285	495.2 MHz	357	820.0 MHz
215	160.0 MHz	287	495.3 MHz	359	840.0 MHz
217	170.0 MHz	289	500.0 MHz	361	850.0 MHz
219	180.0 MHz	291	510.0 MHz	363	860.0 MHz
221	190.0 MHz	293	520.0 MHz	365	870.0 MHz
223	200.0 MHz	295	530.0 MHz	367	880.0 MHz
225	210.0 MHz	297	540.0 MHz	369	890.0 MHz
227	220.0 MHz	299	550.0 MHz	371	900.0 MHz
229	230.0 MHz	301	560.0 MHz	373	910.0 MHz
231	240.0 MHz	303	570.0 MHz	375	920.0 MHz
233	250.0 MHz	305	580.0 MHz	377	930.0 MHz
235	260.0 MHz	307	590.0 MHz	379	940.0 MHz
237	270.0 MHz	309	600.0 MHz	381	950.0 MHz
239	273.2 MHz	311	610.0 MHz	383	960.0 MHz
241	273.3 MHz	313	620.0 MHz	385	970.0 MHz
243	280.0 MHz	315	630.0 MHz	387	980.0 MHz
245	290.0 MHz	317	640.0 MHz	389	990.0 MHz
247	300.0 MHz	319	650.0 MHz	391	1000 MHz

Note: *Warnings are not considered and lead to the return value 0.*

For a more detailed description of the error messages, please refer to section 3.2.3.12.3, "Error Messages during Calibration".

Table 3-28 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
16	Static RAM is defective
17	Dynamic RAM is defective
18	Real-time clock assembly is defective
19	Serial bus is defective
20	Wrong checksum of flash-EPROM
22	MUART device is defective
23	Interrupt controller is defective
24	UART device is defective
25	Floppy controller is defective
44	VHF synthesizer is defective
45	FRN synthesizer is defective
46	RF synthesizer is defective
47	IF amplifier is defective
104	LF module is defective
105	VHF preselector is defective
106	IF selection board is defective
107	2nd mixer is defective
108	IF analysis module is defective
109	IF 80-kHz module is defective
110	RF 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 ESS 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 "IEEE 488.2" standard 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 make sure that the terminator settings 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 3-29 to 3-32.

Table 3-29 Receiver Functions

Command	Data	Unit	Meaning
ATTENUATION **A**TTENUATION?	0 to 120 dB **I**NCREMENT **D**ECREMENT	DB	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:**IF** :**IF**?	10 Hz to 1 MHz	HZ KHZ MHZ GHZ	IF bandwidth of the receiver
CALIBRATION:**S**HORT :**T**OTAL	--- ---	--- ---	Short calibration Configure total calibration (cf. *CAL? table 3-27)
:**C**ORRECTION	**ON** **OF**F	---	Considering the calibration correction values during level measurement on/off
DEMODULATION **DEM**ODULATION?	**FM** **A3** **A0** **O**FF	---	Demodulation mode
DETECTOR **DET**ECTOR?	**A**VERAGE **PEA**K **Q**UASIPEAK **PEAKM**HZ **R**MS	---	Weighting mode (Detector)
GENERATOR	**ON** **OF**F	---	Switching on and off the tracking generator

Command	Data	Unit	Meaning
FREQUENCY FREQUENCY?	1 Hz to 1 GHz	Hz KHz MHz GHz	Receiver frequency
	INCREMENT DECREMENT		Step up Step down
:STEPSIZE :STEPSIZE?	0 Hz to 1 GHz	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
	14		Balanced input
	16		Limit check
	17		Transducer check
	18		User port coupled to transducer
	20		Unit dBm
	21		With the tracking generator switched on the level can be displayed relative in dB as attenuation value in the case of a two-port measurement (= OFF) or absolute in the set unit (= ON)
			Double measurement modes:
	30		Peak + AV
	31		Peak + Pk/MHz
	32		Peak + quasi-peak
	33		Quasi-peak + AV
	34		RMS
	35		Quasi-peak + RMS
	36		RMS + AV
	51		External trigger positive edge
	52		External trigger negative edge
UNIT?	---	---	Polling the level unit

Table 3-30 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?	1 Hz to 1 GHz	HZ, KHZ, MHZ, GHZ	Start frequency of the selected transducer set range
:STOP :STOP?	1 Hz to 1 GHz	HZ, KHZ, MHZ, GHZ	Stop frequency of the selected transducer set range
:DEFINE :DEFINE?	Number, factor1, factor2, ...	---	Selecting the transducer factors that are combined in a transducer set range.
:SAVE	---	---	Saving the transducer set defined before, error messages refer to the settings performed before
: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 3-31 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?	---		Output of interpolated intermediate values at the current receiver frequency
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 1000 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 RMS	---	Weighting mode for partial scan
:BANDWIDTH:IF :BANDWIDTH:IF?	10 kHz to 120 kHz	HZ, KHZ, MHZ, GHZ	IF bandwidth for partial scan

Command	Data	Unit	Meaning
: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?	FM, A3, A0, OFF		Demodulation for partial scan
:GENERATOR :GENERATOR	ON OFF		Tracking generator for partial scan on/off
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		Gated Scan option
:SPECIALSCAN :SPECIALSCAN?	ON OFF		Switching on/off the Special Scan option.
:STYLE :STYLE?	CURVE LINE	---	The measurement curves can be represented either in the form of a closed curve (CURVE) or vertical lines (LINE).
:MAXFREQ :MAXFREQ?	Receiver frequency range	HZ, KHZ, MHZ, GHZ	Diagram limits for the Special Scan option
:MINFREQ :MINFREQ?	Receiver frequency range	HZ, KHZ, MHZ, GHZ	
:MAXLEVel :MAXLEVEL?	-200 to 200 dB	DB	
:MINLEVEL :MINLEVEL?	-200 to 200 dB	DB	
:FREQUENCIES :FREQUENCIES?	Number, Frequency1, Frequency2, ...,	HZ, KHZ; MHZ, GHZ	Frequency values for Special Scan option; max. 400 values in increasing order
FASTSCAN	ON OFF	---	Switching on/off option 20.
:REPETITIVE :REPETITIVE?	CLRWRITE MAXHOLD MAXCLR OFF		Switching on option 22. Switching on option 23. Switching on option 24. Switching on normal scan.

Command	Data	Unit	Meaning
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		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.
:ELEMENT	COMBINED		All level values measured including the frequency and different additional information are transmitted.
	TRACE		Only the results of the 400 subrange maxima are transmitted.
	SUBRMAX		Only the results of the user subranges defined using SCAN:OPTION:SUBRANGES are transmitted.
	DET1		Level values detector 1
	DET2		Level values detector 2
	VALID		Validity bytes
:FORMAT :FORMAT?	ASCII BINARY DUMP SDUMP		Output format for scan results (cf. section 3.3.8.6)
: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 parts of a block element (cf. section 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 3-32 IF analysis

Command	Data	Unit	Meaning
SWEEP:MODE SWEEP:MODE?	NORMAL MAXHOLD	---	Operating mode of IF analysis With NORMAL a curve is displayed. With MAXHOLD a second curve, which shows the maximum values of all the sweeps performed since the start of this operating mode, is displayed in addition to the normal curve
:TIME :TIME?	20 ms to 10 s	MS S	Time required for a sweep of IF analysis
:RUN	0 to 65536	---	Starting a number of sweeps. If the number is 0, the sweeps are terminated only by switching off IF analysis.
:STOP	---	---	Stopping IF analysis.
SPAN SPAN?	10 kHz to 2 MHz	HZ KHZ MHZ GHZ	Display span
ATTENUATION:IF ATTENUATION:IF?	ON OFF	---	20 dB input attenuation for IF analysis
BANDWIDTH:RESOLUTION BANDWIDTH:RESOLUTION?	1 kHz to 10 kHz	HZ KHZ MHZ GHZ	Resolution bandwidth

Table 3-33 Marker functions

Commands for control of the marker. They can be used in RF analysis and IF analysis.

Command	Data	Unit	Meaning
MARKER MARKER?	ON OFF	---	Switching on/off the marker function
:DELTA :DELTA?	ON OFF	---	Switching on/off the delta marker
:POSITION?	frequency, level [,frequency, level]	HZ DB	Polling the current marker position. With the delta marker switched on, its frequency and level are sent to the main marker.
:FREQUENCY	Receiver frequency range	HZ KHZ MHZ GHZ	Setting the marker to a frequency. If the delta marker is switched on, it is set.
:PEAK	---	---	The main marker is set to the highest level value of the measurement curve.
:RECEIVER	---	---	The receiver is set to the frequency on which the main marker is positioned.
:ZOOM	---	---	The spectrum is shown in zoomed display: if only the main marker is switched on, 10 % of the spectrum is displayed; with the delta marker switched on, the range between the markers is zoomed and displayed (only in the RF analysis).
:ORIGINAL	---	---	The complete spectrum is displayed. (only in the RF analysis)
:CURVE	1 to 2	---	If several curves, on which the marker can be moved, are displayed, this command is used to select the curve. 1 = NORMAL 2 = MAXHOLD In the RF analysis with double measurement modes 1 = first detector 2 = second detector

Table 3-34 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:FORMAT :SETUP:FORMAT?	ON OFF	---	Special scaling of plotter output on/off
			Definition of the limits P1 and P2:
:LEFT :LEFT?	-99.999 to 99.999 Plotter units	---	Left margin
:RIGHT :RIGHT?		---	Right margin
:TOP :TOP?		---	Top margin
:BOTTOM :BOTTOM?		---	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	---	Date
:Marker :Marker?	0 to 8	---	Marker
: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	---	Date

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
: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 3-35 Disk drive

Command	Data	Unit	Meaning
FLOPPY :INITIALIZE	size, "label" size: DD 720 KB HD 1.44 MB		Formatting a diskette in the specified size. "label" is the name of the diskette. It can consist of max. 11 characters.
:DELETE	"filename.extension"		Deleting a file
:CATALOG	used_space, available_space [file1,size1[,file2,size2 [,filen,sizen]]]		List of all the files: used_space = storage capacity used available_space = free storage capacity filen = file name sizen = file size
:STORE	"filename", type [,n]		Storing instrument data in a file. "filename" is automatically provided with the correct extension.
	type: ALL		Data: Receiver settings Report configuration Activated limit lines Activated transducer factor Activated transducer set Measurement results of RF analysis Scan data sets Marker settings
	LIMIT		Limit line selected by n
	TFACTOR		Transducer factor selected by n
	TSET		Transducer set selected by n
	HPGL		Plotter commands in HPGL format as output to the specified plotter at the start of a plot via IEC bus.
:LOAD	"filename", type [,n]		Reading and setting instrument data from a file.
	type: ALL		Complete test receiver setting, which may include results of RF analysis
	LIMIT		Loading a limit line and storing it internally under the number n.
	TFACTOR		Loading a transducer factor and storing it internally under the number n.
	TSET		Loading a transducer set and storing it internally under the number n. Note, that with limit lines and transducer factors the number of points is graduated (10, 20 or 50)! If the data set to be loaded has more components than can be stored, an error message results.

Table 3-36 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** **OF**F	---	Switching on and off output of header during poll
LISN **LIS**N?	**ESH2**Z5 **ESH3**Z5	---	Selecting the LISN to be controlled
:**PH**ASE	**N** **L1** **L2** **L3**		Setting the phase; with ESHS3-Z5, N and L1 are permissible only
:**PE**	**GR**OUNDED **FL**OATING		Setting the protective earth
PRESET	---	---	Resetting of device settings without resetting IEC bus interface. It corresponds to the function RCL0.
SYSTEM:**S**ETUP:**B**ANDWIDTH?	---	---	Polling the bandwidths of the IF filters integrated in the instrument.
ERRORS?	---	---	Polling device-dependent errors (cf. table 3-39)
:**D**ATE :**D**ATE?	dd,mm,yy	---	Date of real-time clock
:**T**IME :**T**IME?	hh,mm,ss	---	Time of real-time clock

Table 3-36a 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.
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

3.3.5 Service Request and Status Register

In line with the new IEC bus standard the ESS 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 ESS 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 3-37 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 ESS 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 ESS 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 ESS. The output buffer is cleared in this case.
1	**Request Control** Is set, if the ESS 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) and the 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 3-38 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 6	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 specification 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 ESS 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 3-48 illustrates the relations.

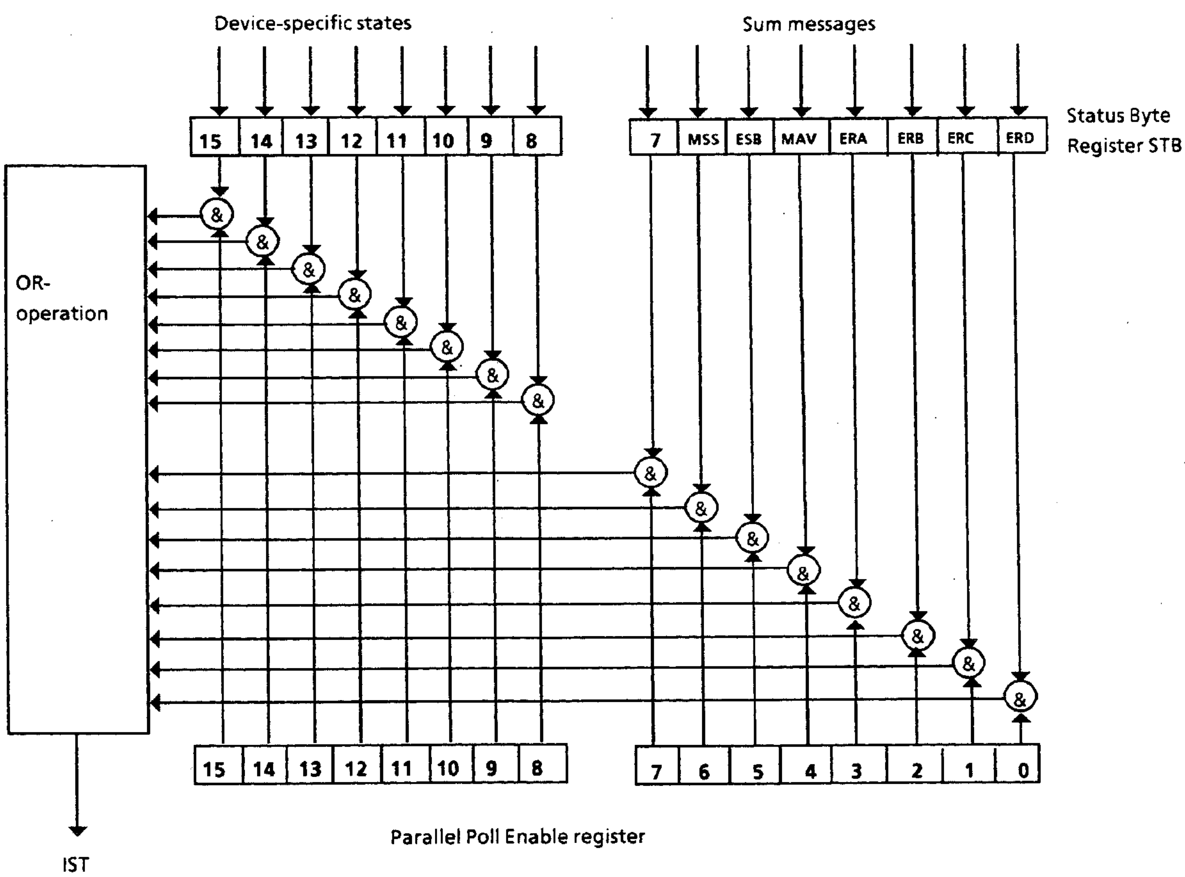


Fig. 3-51 Parallel Poll Enable Register PRE

f) Assignment and relation of the individual registers

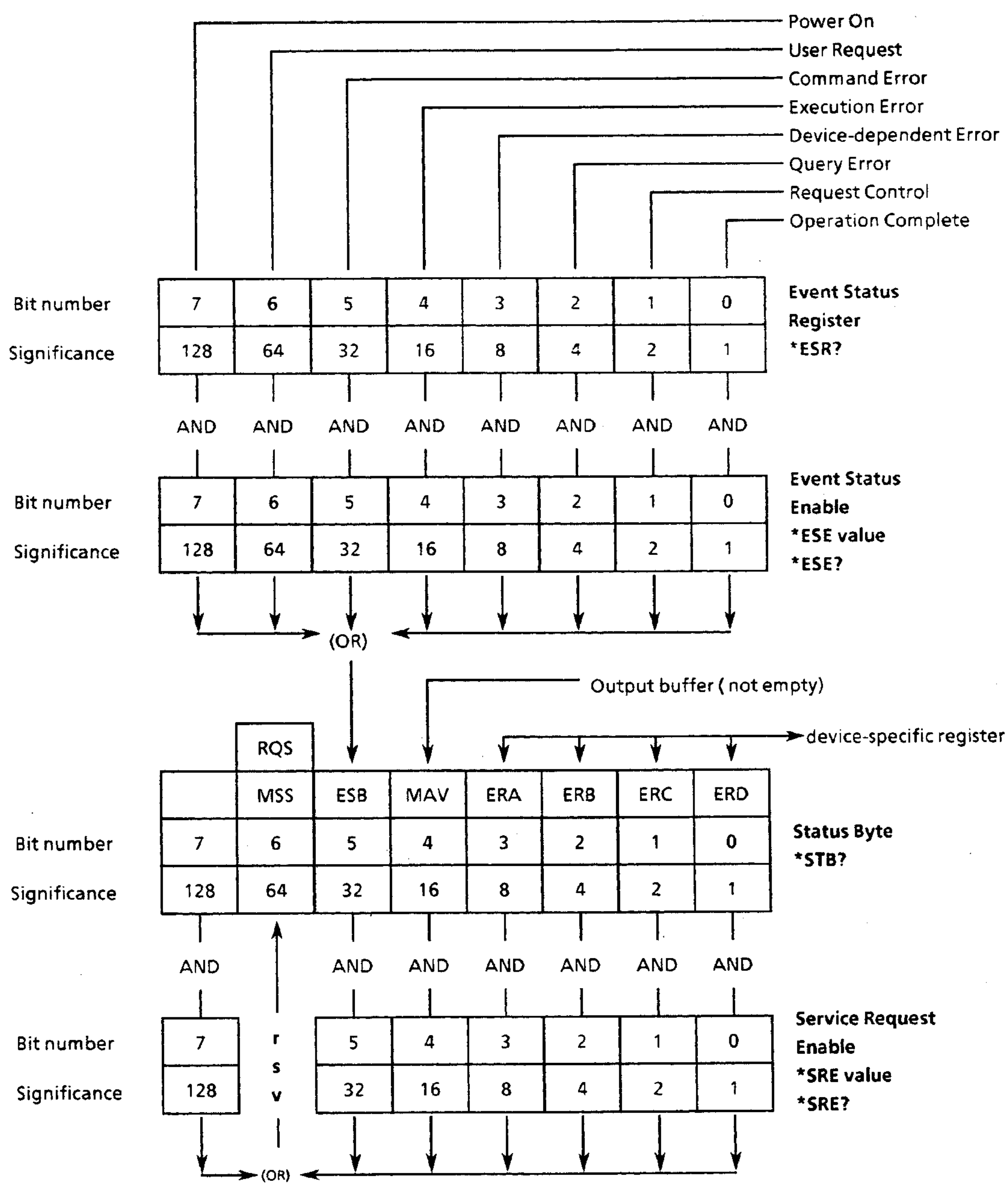


Fig. 3-52 Status register

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

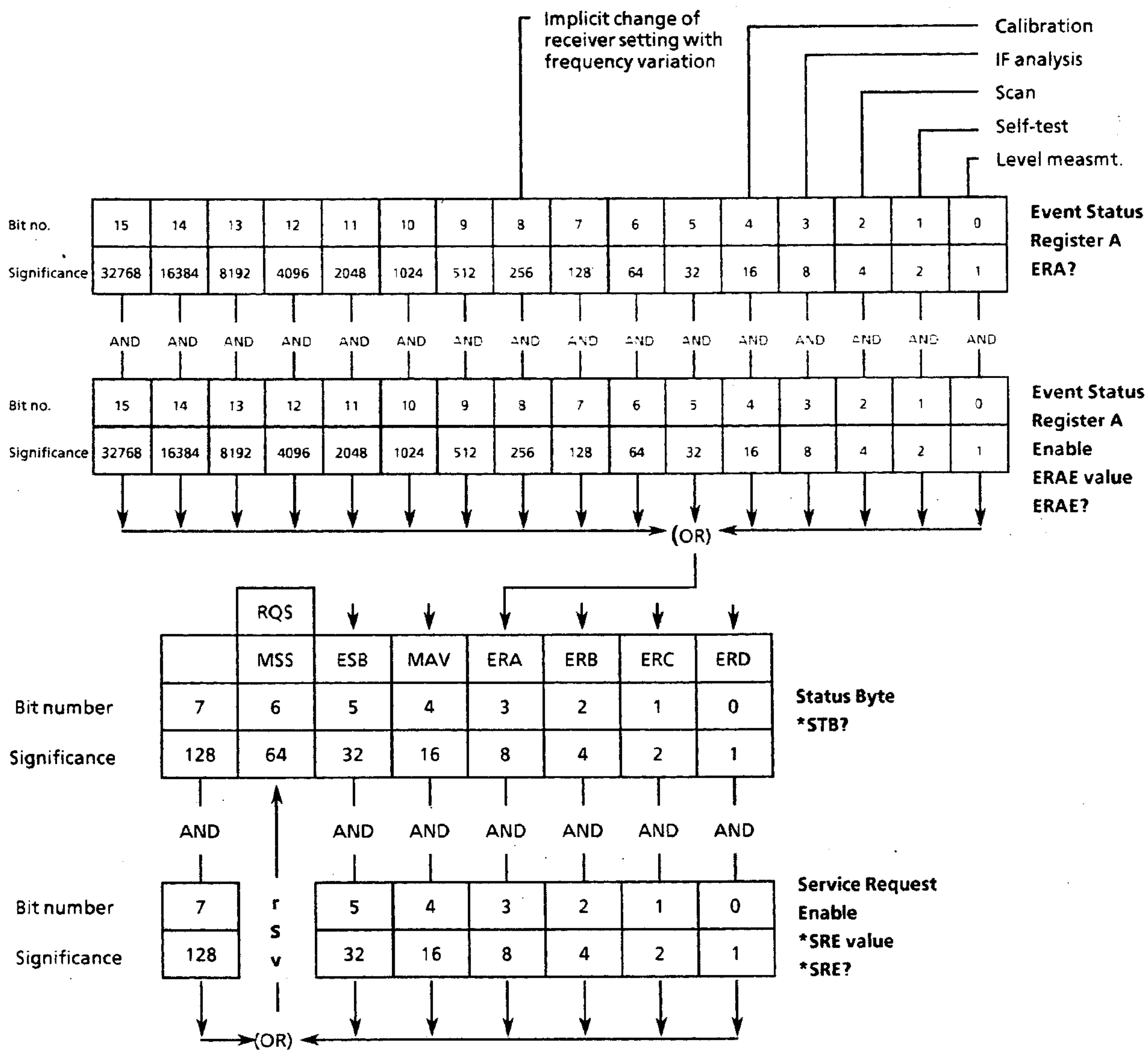


Fig. 3-53 Status register ERA

The assignment of the extended Event Register ERB, display of the synthesizer loop error and switching on/off the external reference are shown in the following diagram:

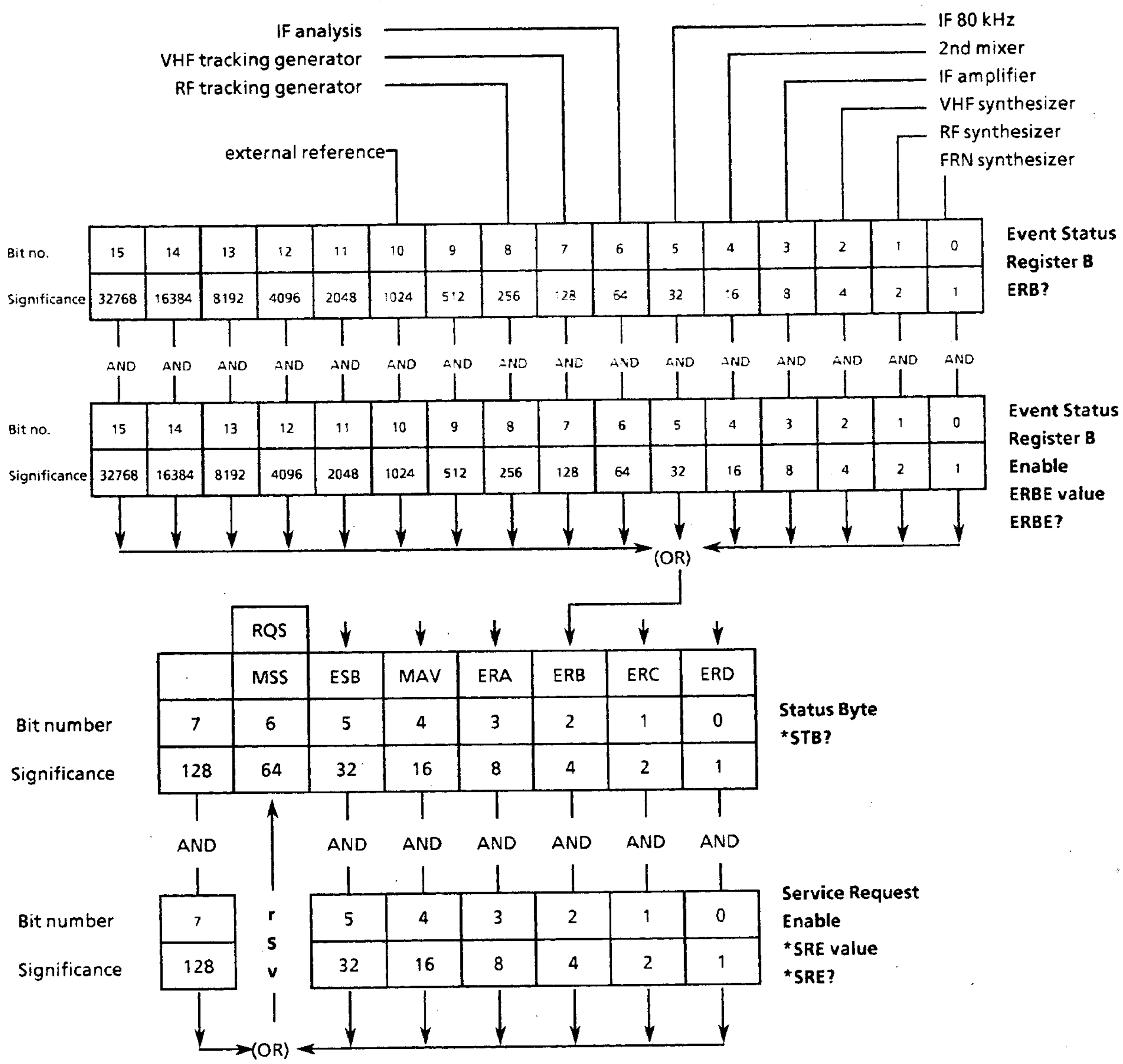


Fig. 3-54 Status register ERB

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

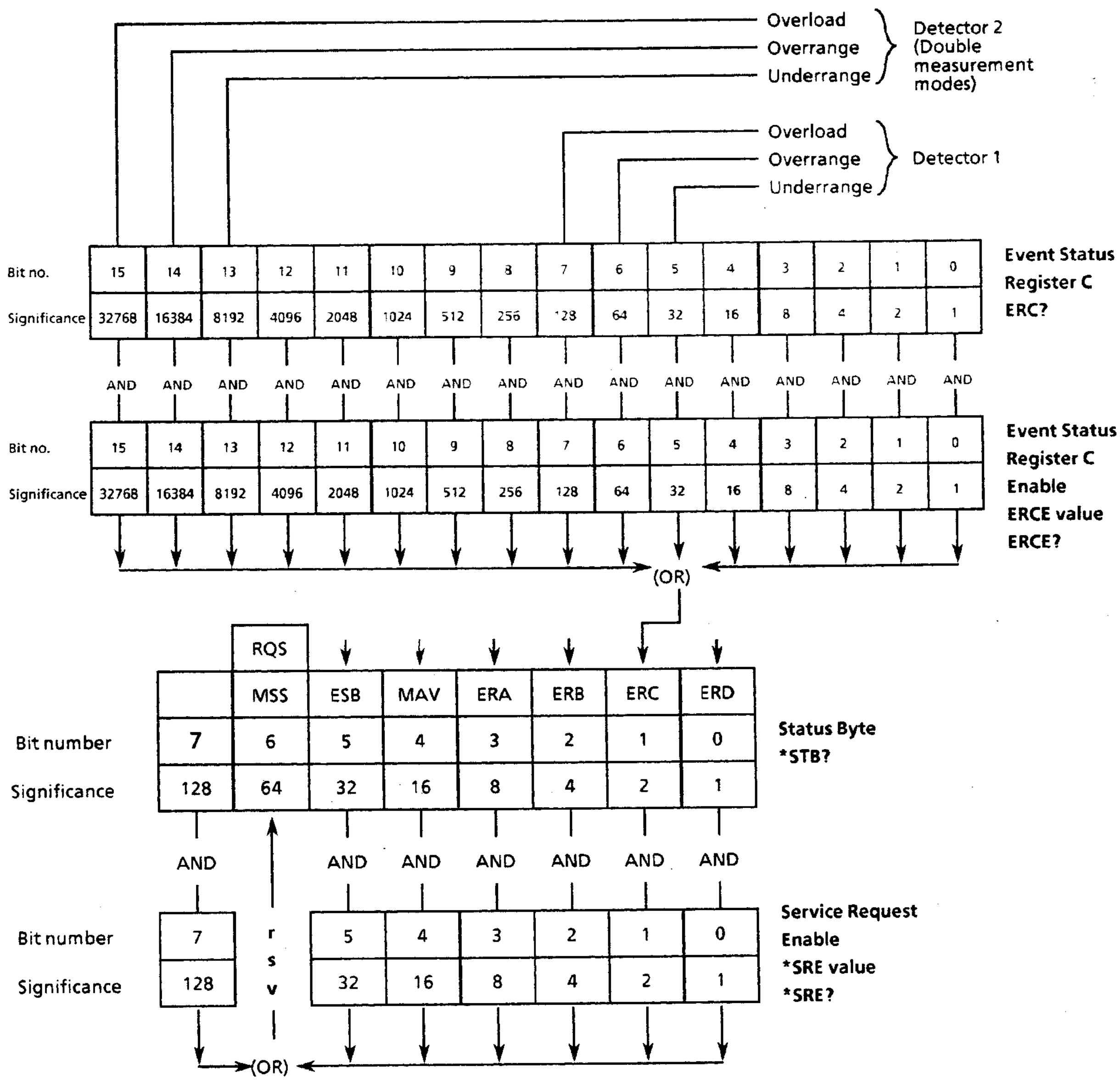


Fig. 3-55 Status register ERC

The assignment of the extended Event Register ERD and the identification of the scan states are illustrated in the following diagram:

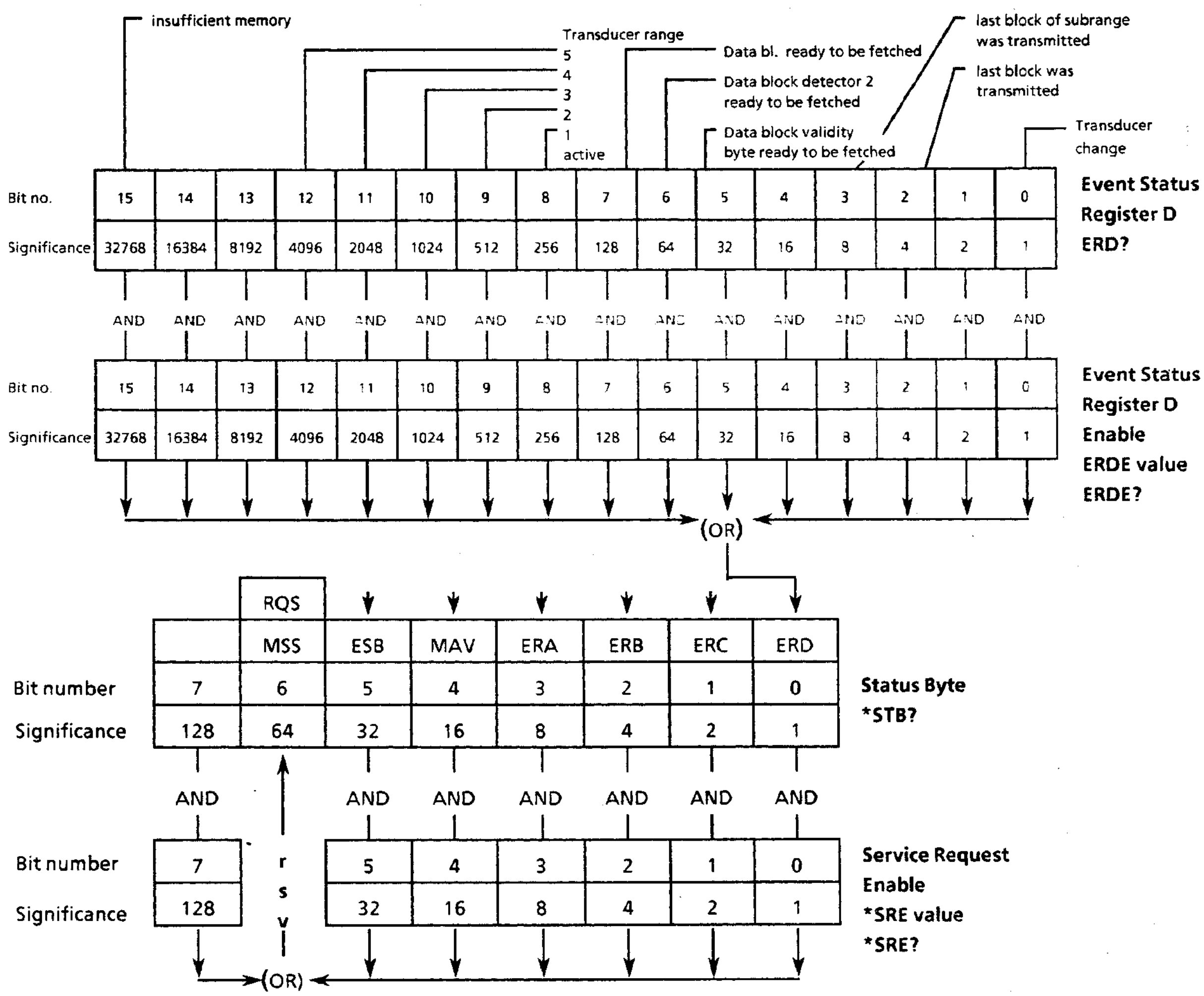


Fig. 3-56 Event Status register D

Reaching an antenna switch-over point during a scan causes the "transducer change" bit to be set in the Event Status Register D.

The index of the active antenna range (Transducer Range) is identified by setting the appertaining bit in the register.

With the set number of measured values (SCAN:BLOCK:COUNT) being ready for output during a scan, the "data block ready to be fetched" bit is set in the Event Status Register D.

With unformatted output selected (SCAN:BLOCK:FORMAT DUMP) bit 7 indicates the availability of results for detector 1. Bit 6 and Bit 5 have this function for detector 2 and the validity byte, respectively.

3.3.6 Resetting of Device Functions

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

Table 3-39 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 ESS 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 feedback 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.

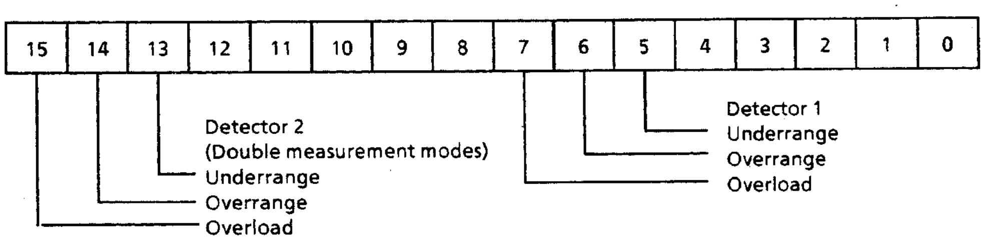


Fig. 3-57 Assignment of the Event Register ERC

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.

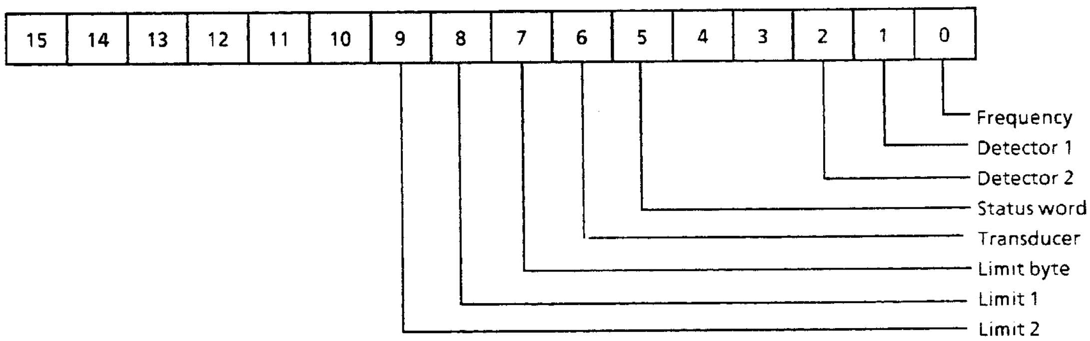
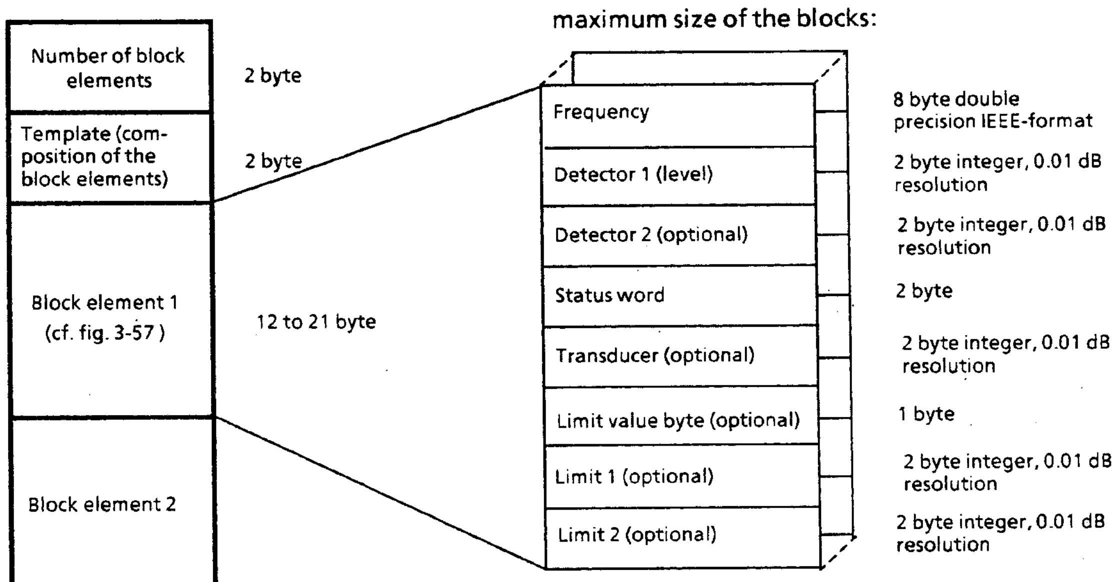


Fig. 3-58 Format of template word



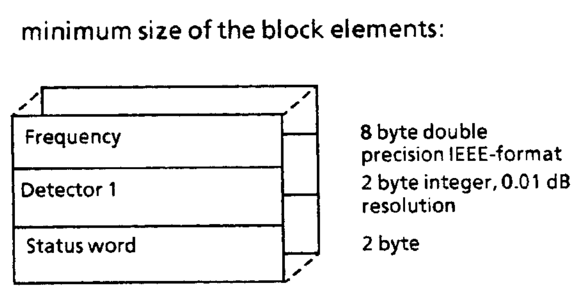


Fig. 3-59 Composition of a data block in binary format

Fig. 3-60 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.

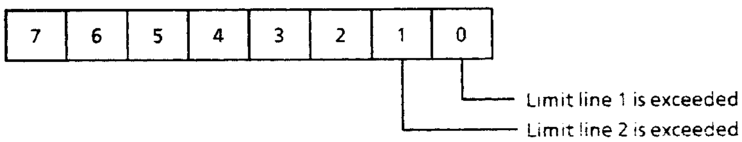


Fig. 3-61 Format of the limit byte

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 ESS. 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.

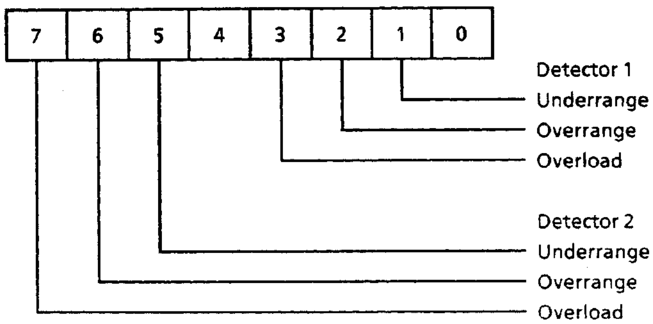


Fig. 3-62 Format of the validity byte with unformatted output of scan results.

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 ESS 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 ESS 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 ESS is in Stand-Alone mode.

   The ESS 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 ESS 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 the following table.

Table 3-40 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

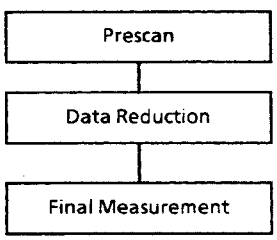
3.4 Applications

3.4.1 Introduction: Automatic and Interactive Measurements

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

Automatic measurements can be applied if the interference can be detected within the measuring time. An interactive or a manual measurement is recommended to be used for intermittent, quickly drifting and cyclic interferences with long cycle times.

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



The scan data set specifies the prescan. Option 30 is used for data reduction (subrange maxima and acceptance analysis). With the cursor placed on option 30, softkey *Edit* is displayed and when pressing the same the following menu is read out :

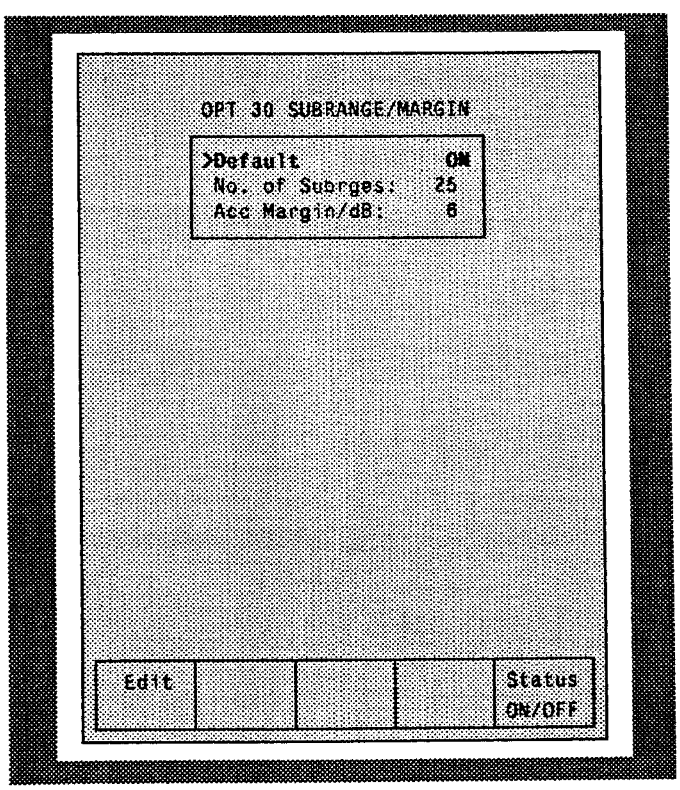


Fig. 3-63

Frequencies with especially high interference levels can be determined already during prescan with the help of option 30.

The entire frequency range is divided into up to 400 subranges. A subrange maximum can be determined for each subrange during the prescan. In order to prevent that measurement has to be carried out again at frequencies the interference levels of which are far below the limit, only the frequencies the interference levels of which exceed a value determined by the limit minus a freely definable safety margin *Acceptance Margin* are used for the final measurement..

Two values have to be specified:

- The number of *subranges* (a value out of 8, 16, 25, 50 to 400; default value: 25)
- The *margin* in dB (assumed line that is n dB below the limit line(s); a different *margin* for different limit lines is not provided; default value: 6 dB)

For this reason, a menu is used for selecting and entering these values when calling option 30. With the option switched on, the cursor is automatically placed on the line *>Default* if *Default* is not *ON*. If *Default* is set to *OFF*, the default values can be activated using softkey *Status ON/OFF*. The cursor moves further to the field *No of Subrges* and *acceptance margin* when pressing keys ↑ and ↓. The values can be set using the numeric keys and are accepted by way of ENTER. If the numeric values deviate from the default values, *Default* is automatically set to *OFF*.

Options 40 to 45 serve to specify the detectors with which the final measurement is to be carried out at the frequencies determined during the data reduction.

Option 62 specifies that the interference spectrum is output on plotter simultaneously with the measurement.

Calling the Options (see also Section 3.2.4.3.3):

- Press RF key.
- Press OPTIONS softkey.
  The list of options is displayed:

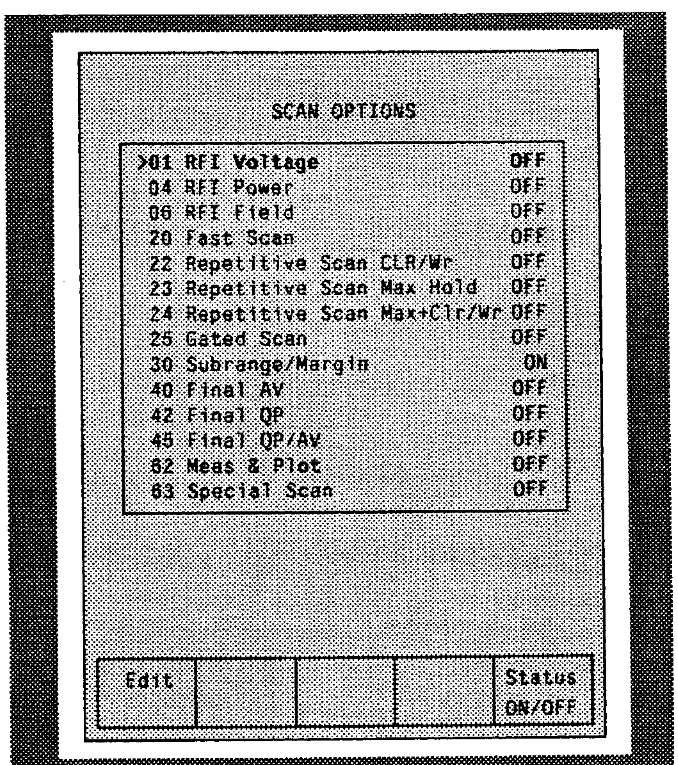


Fig. 3-64

Measurement of Stable Interferences by Means of a Single Prescan and Automatic Final Measurement

If the type of interference is known - narrowband and broadband interference that is constant as to time or fluctuating for short periods - the measuring time can be set such that the maximum values of the interference are recorded in a single prescan. If the frequencies of the subrange maxima further remain unchanged between prescan and final measurement, neither the frequency nor the point of time of the final measurement need to be controlled by the operator, that is to say, the entire measurement sequence can be performed automatically.

Measurement of Instable and Unknown Interferences by Means of Repetitive Prescan and Interactive Final Measurement

The screen of the ESS is ideal when observing the interference spectrum is important and when the point of time for a measurement is critical, i.e., when the interference is intermitting or drifting. If, e.g., the cycle time of an interference is more than a second, it is not very likely to find the true subrange maxima at the correct frequency with a single frequency sequence and short measuring time.

For this reason a list of options for making the prescan more flexible are offered:

Option 20 Fast Scan using a detector with fixed RF attenuation for certain ranges

Option 22 Repetitive Scan in clear/write mode for test and adjustment purposes

Option 23 Repetitive Scan in Max Hold mode for prescan in the case of an instable interference

Option 24 Repetitive Scan using a detector in the clear/write mode and additional Max Hold curve for determining and finding again adjustment and antenna positions for maximum emission.

Option 25 Gated Scan with control of the frequency sequence by means of a signal characteristic of the presence of the interference spectrum.

Option 20 can be combined with options 22/23/24. The optimal setting for observing a spectrum can be made, e.g., by combining options 20 and 23.

Option for Data Reduction

Option 30 Determination of subrange maxima using acceptance analysis as described above. Here the number of subranges and the acceptance margin are determined.

Options for Final Measurement

For automatic final measurement the detector must be defined before. Further, a generally longer measuring time is fixed for the final measurement than for prescan.

Option 40 Final measurement using average detector
Option 42 Final measurement using quasi-peak detector
Option 45 Final measurement using quasi-peak and average detector
(not to be used with Fast Scan (option 20))

These instruments can also be used to detect **instable interferences** and weight them correctly. A **typical measurement sequence** is as follows:

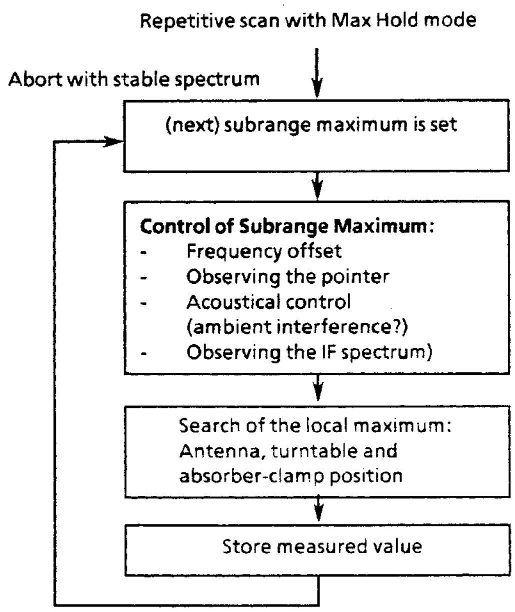


Fig. 3-65 Sequence scheme for the measurement of instable interferences

- Prescan using options 20 and 23 (a normal scan with simultaneous peak and average measurement in connection with option 23 is also permissible).

The repetitive frequency sequence is aborted when the spectrum is stable. This will be the case very fast with a narrowband interference spectrum, with a pulse interference spectrum is may take a relatively long time.

- Analysis of the spectrum and final measurement

  If scan option 30 is in operation, the marker is automatically positioned to the first critical frequency when starting the final measurement, the receiver frequency is set to it and the level display of the receiver is compared with the marker level. Observing the analog level display and listening in to the AF demodulation also serves to judge the interference signal.

  The measurement result displayed last is stored by pressing one of the ENTER keys. In the case of an instable interference frequency a correction of the receiver frequency is possible. The actual receiver frequency is registered with the final measurement. The spectrum near the marker can be investigated using marker zoom (Fig. 3-67). With the ESS very fast switching between the RF-analysis and the IF-analysis picture is possible. The "living" IF analysis facilitates finding the maximal emitted interference and, in the case of measurements in the open field, identifying the object measured.

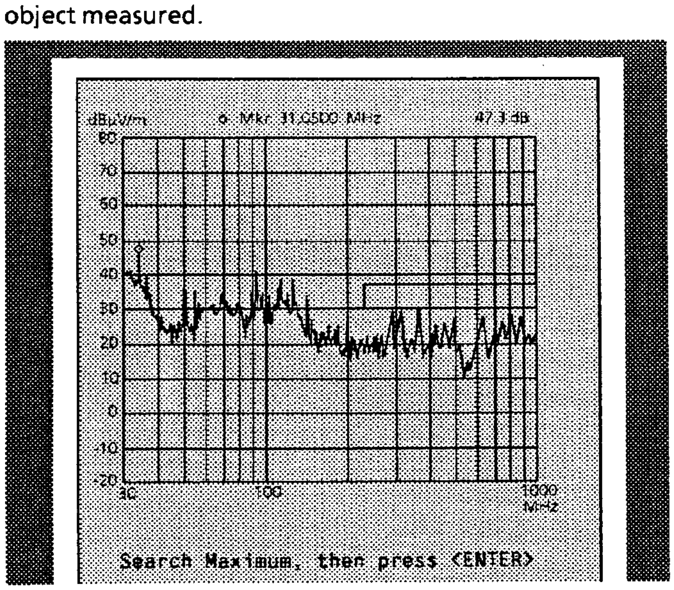


Fig. 3-66 RF-analysis spectrum with marker

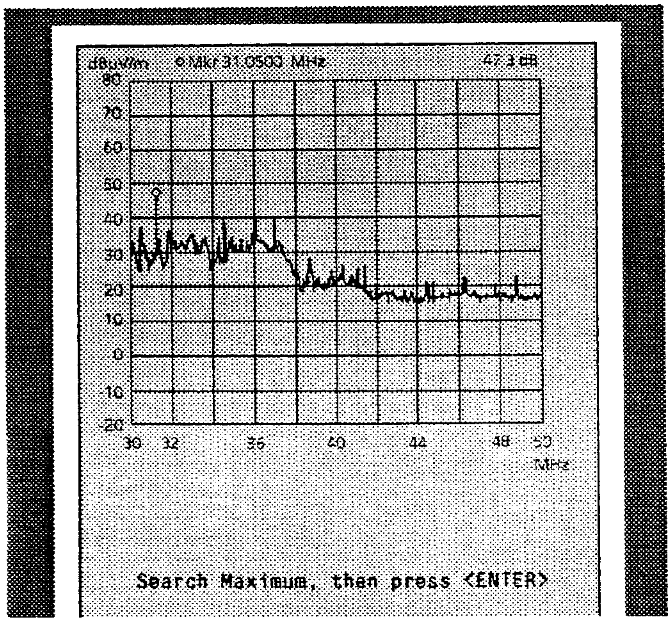


Fig. 3-67 Zoomed RF analysis spectrum with marker frequency of Fig. 3-66

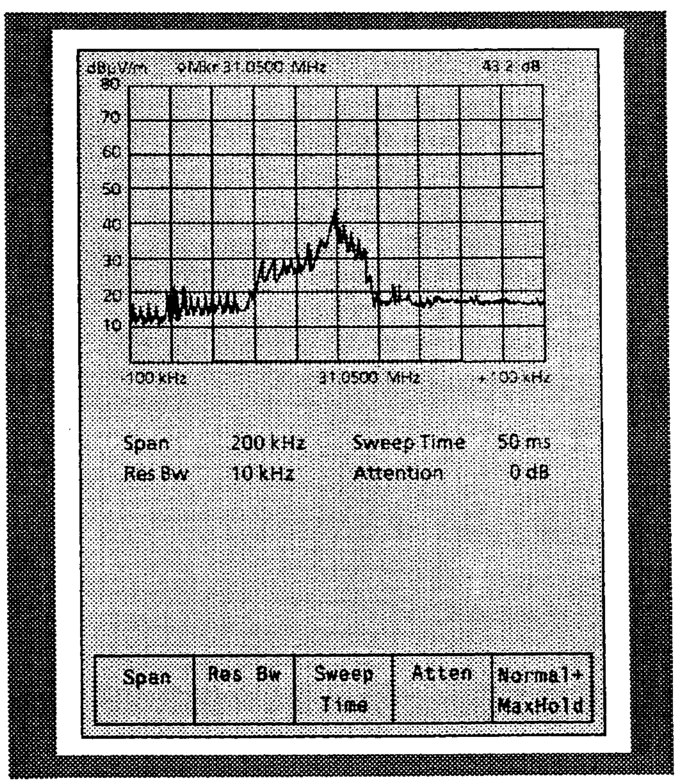


Fig. 3-68 IF analysis spectrum with marker frequency of Fig. 3-67

3.4.2 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:

- Aktive probe, R_e ≥ 100 kΩ — ESH2-Z2
- Passive probe, R_e = 1.5 kΩ — ESH2-Z3
- Four-line V-network — ESH2-Z5
- Two-line V-network — ESH3-Z5
- V-network 5 µH//50 Ω — ESH2-Z6
- T-network — ESH3-Z4
- 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 frequency range 9 kHz to 30 MHz in national and international standards. RFI voltage measurements on automotive accessories involve frequencies of up to 108 MHz.

Detailed information on which artificial mains networks are to be used in the respective case is given in the latest versions of the standards - CISPR Standards, European Standards, VDE-Regulations, FCC Rules & Regulations, VCCI recommendations, 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 a shielded room, whereas the test receiver together with printer and plotter should be set up outside the room.

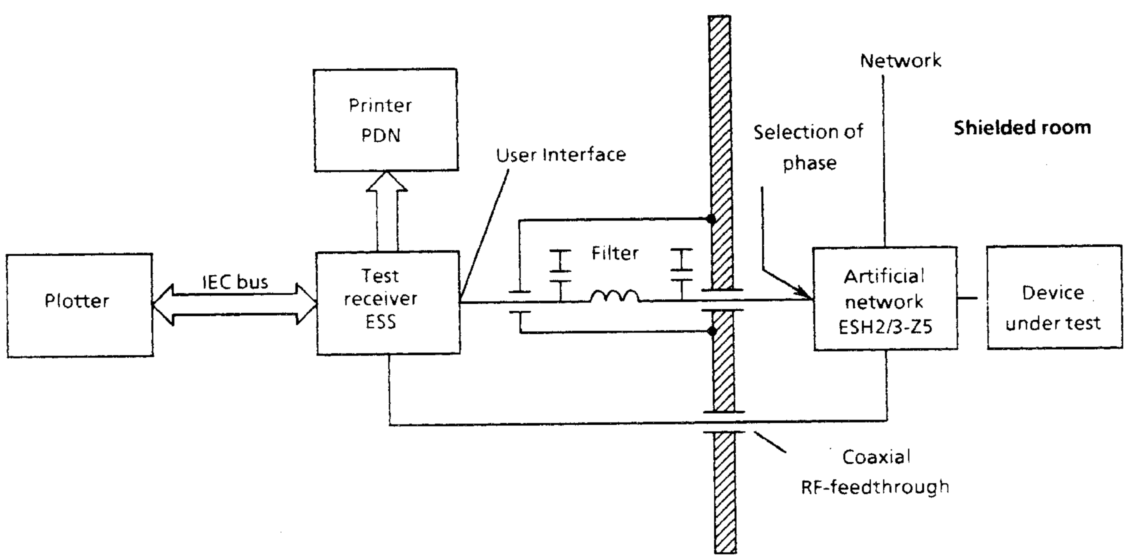


Fig. 3-65 Block diagram of a test setup with artificial mains network and device under test in a shielded room

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

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

ESS user interface	pin		ESH2-Z5-Pin	
N	14	Filter	46	N
L1	15		21	L1
L2	16		22	L2
L3	17		23	L3
GND	12		50	GND
PE fl.	18		47	PE fl.
+5 V	13		48	+5 V *)

*) not applicable with ESH2-Z5 with an own power supply

Fig. 3-66 Connection between ESS and ESH2-Z5 (cable EZ-13)

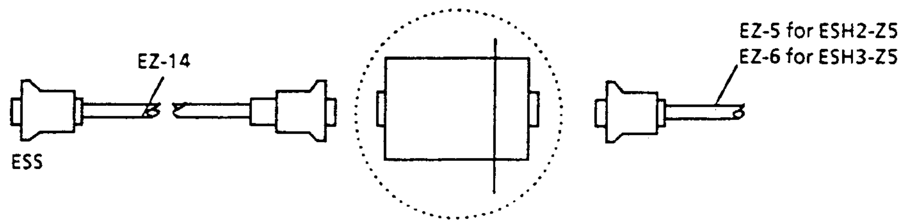
ESS user interface	pin		ESH3-Z5-Pin	
N	14	Filter	2	N
L	15		6	L
PE fl.	18		3	PE fl.
DGND	12		8	DGND
+5 V	13		1	+5 V

Fig. 3-67 Connection between ESS 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-Z and ESH3-Z5.

Connecting cables EZ-14 and EZ-5 can be supplied for four-line network ESH2-Z5, cables EZ-14 and EZ-6 for two-line network ESH3-Z5.

Proposed arrangement of connecting cables EZ-14 / EZ-5 / EZ-6



Filter arrangement

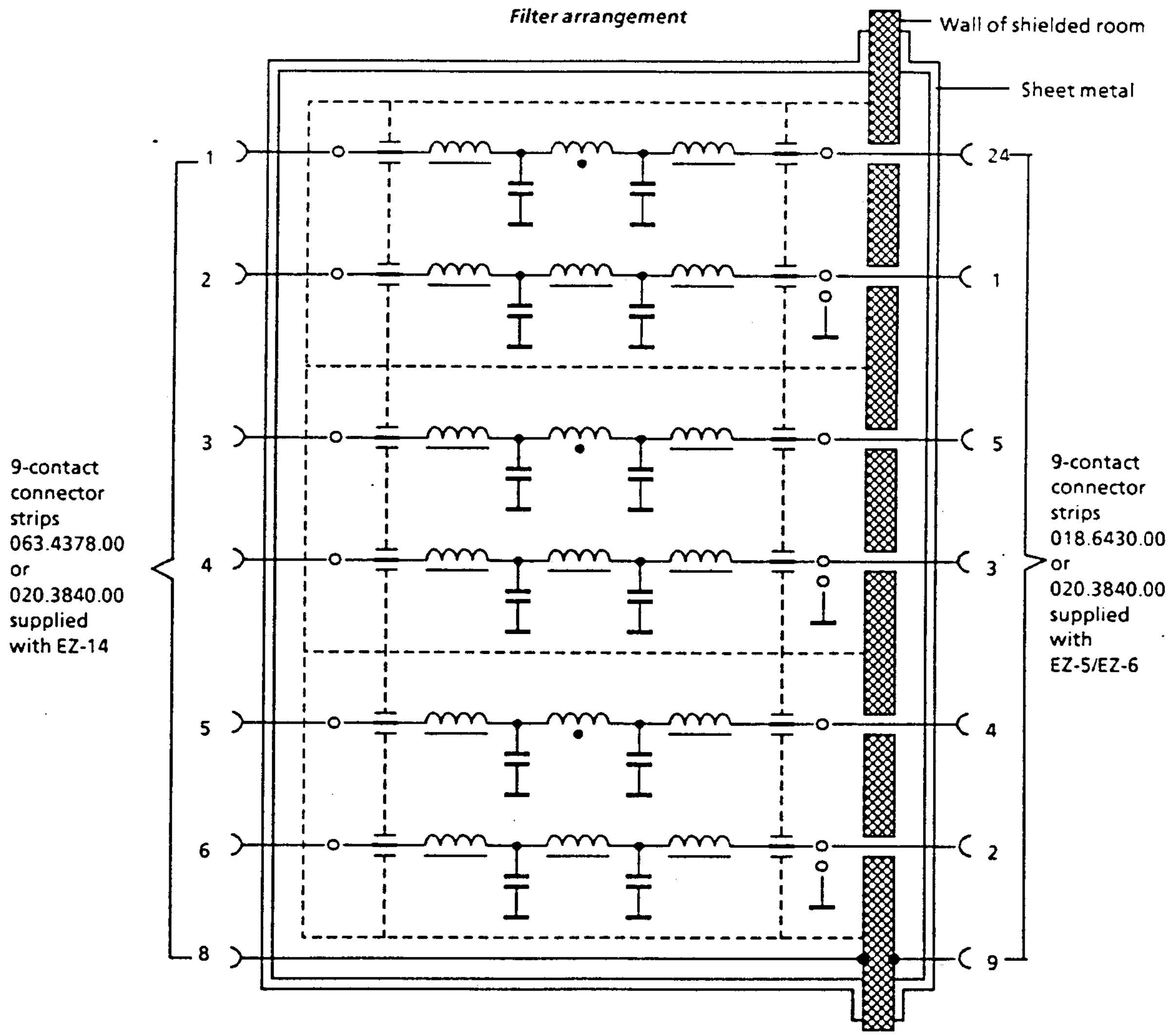


Fig. 3-72 Arrangement of connecting cables EZ-5, 6 and 14 with lowpass filters to provide the 5-V supply and control information for artificial mains networks ESH2-Z5 and ESH2-Z5 in a shielded room.

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

Recommended lowpass filters used for the feedthrough into the shielded room:
Siemens order no.: B 84311-C30-B3 contains the lowpass filters for two lines. 3 units are therefore necessary for ESH2-Z5, 2 units for 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 generally 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. For measurements according to VDE0879 part 1 two ranges from 0.15 to 30 MHz and from 30 to 108 MHz are to be set at the bandwidths of 10 and 120 kHz.

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 [4)]
Operating range/dB	60	60

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

2) For measurements according to standards with narrowband and broadband interference limits or average and quasi-peak limits, special function 30 with which it is possible to simultaneously measure peak and average value during one scan is useful. If there is only one limit, 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 in time. Minimum measuring times of 20 or 10 ms are therefore required for network-synchronous pulse interferences (50 Hz or 100 Hz).

4) *Caution: With an RFI voltage measurement with V-networks, high-energy switch-on and off pulses can destroy the input of the test receiver if no RF attenuation is switched on. For this reason, the minimal RF attenuation is always to be switched on in RFI voltage measurement. This minimal RF attenuation is automatically switched on using option 01. Further an RF attenuation of 10 dB increases the measuring accuracy because the VSWR is improved.*

Scan option 01 serves to carry out RFI voltage measurements. It is used to specify the following features:

- The 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).
- Details relating to the sequence (phase on which the preanalysis is carried out; phases on which the final measurement is to be performed).

Operation

- Press the OPTIONS softkey.
  The menu *SCAN OPTIONS* is called.
- Select *OPT 01* using keys ↑ or ↓.
- Switch *OPT 01 RFI VOLTAGE* to *ON* using softkey *Status ON/OFF*.
- Press the *Edit* softkey.
  The following menu is displayed:

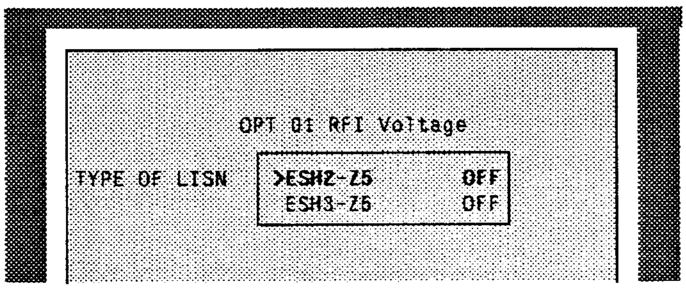


Fig. 3-73

- 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. This 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 can maximally be selected. If a second one is switched *ON*, the first one automatically becomes *OFF*. Only when one of the two LISNs is selected, the next menu appears.
- Press the *Status ON/OFF* softkey to select the LISN.
- The configuration of the LISN for the prescan can be specified by moving the cursor into the field prescan.

  If both LISNs are *OFF*, the parts of the menu *Prescan* and *Final Meas* are rendered unnecessary.
  If *ESH2-Z5 = ON*, Prescan and Final Meas constitute the phase selection for these LISNs:

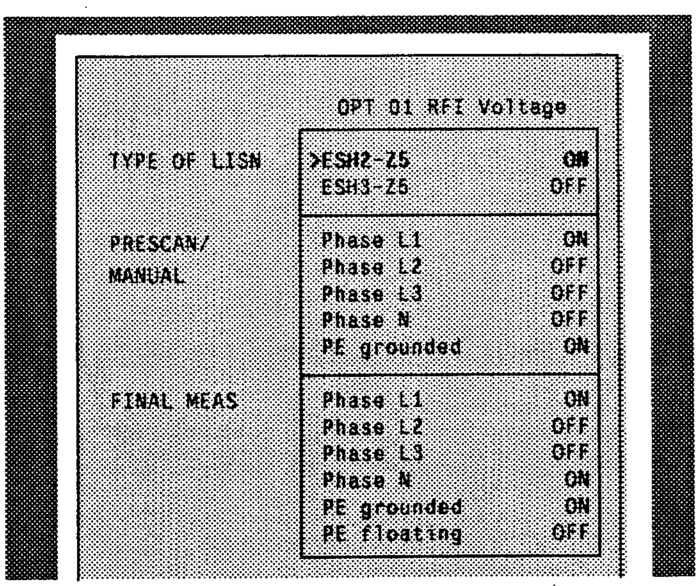


Fig. 3-74

For ESH3-Z5 = ON:

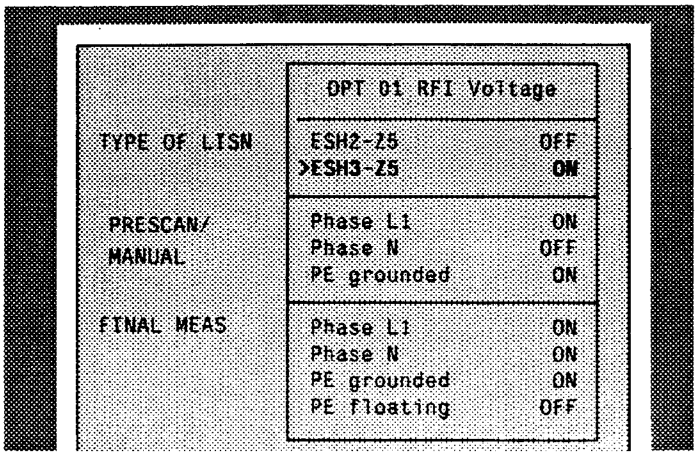


Fig. 3-75

As the RFI voltage on the phases of the supply cables are closely coupled, it is sufficient to perform prescan on one phase. In manual mode (scan inactive), the configuration of the prescan is switched on. Only one phase can be switched on. If *PE grounded* is *OFF*, the PE simulating network is switched on.

▸ Moving the cursor to the field *Final Meas* allows specification of the various phases on which final measurement is to be performed.

In the above example measurement is carried out on both phases. If both *PE grounded* and *PE floating* are set to ON, four measurements are performed on each frequency determined by data reduction to find out the configuration with the highest RFI voltage. According to VDE 8878 part 30, measurement is carried out on both phases only using a PE simulating network, i.e. *PE grounded OFF* and *PE floating ON*.

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

c) Measurement Sequence, Measurement and Analysis Procedure

▸ Press the RUN key.
The following softkey menu is displayed.

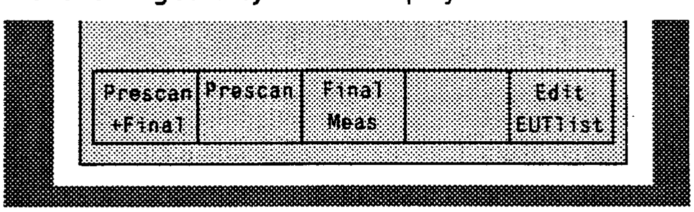


Fig. 3-76

The following settings can be made by pressing the respective softkey:

Softkey	Action
Prescan + Final	Prescan*) is started. When prescan is terminated, the final measurement starts automatically.
Prescan	Prescan*) is started. This operating mode also allows a repeated measurement without final measurement.
Final Meas	Serves to start the final measurement. This can also be repeated. (Softkey is only displayed after prescan.)

*) Prescan can be interrupted by pressing the *Interrupt* softkey and aborted by pressing the *Abort Scan* softkey. The *Final Meas* softkey is used to switch to final measurement in the case of repetitive *Prescan*.

At the end of each subrange the phase with the highest RFI voltage is determined if one of the following options is selected (the measuring time for the final measurement can be set separately in each case, cf. Section. 3.2.4.3.3):

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

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

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

Comparison of the Pk-values of the RFI voltage on all phases provided in the menu *Final Meas* 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.

Further Options:

Option 62 Meas. + Plot = ON: Plotting of the interference spectrum during 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.

3.4.3 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.

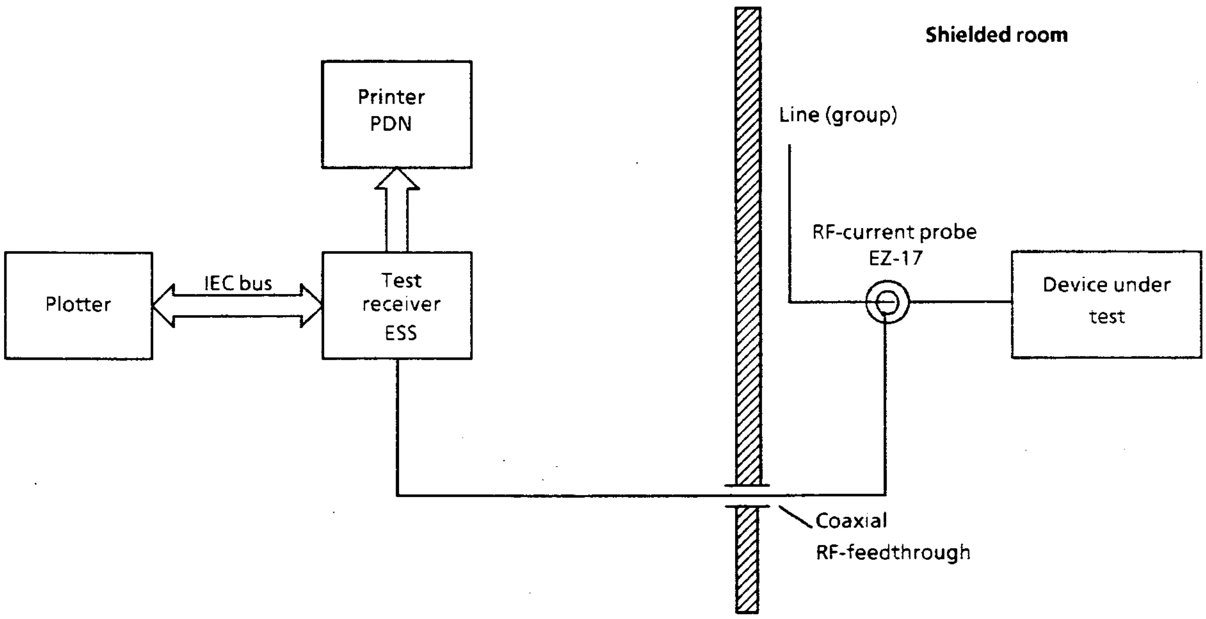


Fig. 3-77 Block diagram of a test setup with RF-current probe EZ-Z17 and device under test in a shielded chamber

b) Setting of the Test Receiver

The **measurement configuration** is specified by option 01. If, as described in section 3.4.2, no artificial mains network is selected, preparation can be made for RF-current measurements by selecting the transducer with the unit dBµA.

The scan setting specifies the sequence of the **prescan** (Recommended setting data, cf. Section 3.4.2).

Data reduction is defined by option 30.

For **final measurement** options 40 to 45 are significant.

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.

3.4.4 RFI Power Measurement Using the Absorbing Clamp

According to standards CISPR 14 and VDE 0875 part 14, the RFI power at the signal and supply lines exceeding a length of 1 m is to be measured within the frequency range 30 to 300 MHz. The absorbing clamp MDS 21 is used for this measurement. It is supplied with the transducer factor for determining the RFI power in dBpW using the RFI voltage indicated by the test receiver in dBµV. The signal and supply lines are lengthened to approx. 6 m (= half the wavelength at 30 MHz (5m) + length of the clamp). The clamp has to be slid by half the wavelength up to the maximum indication at the test receiver, respectively. Strictly speaking, the complete spectrum would have to be measured at each position (every 10 cm). This would, however, lead to unacceptably long measuring times.

Instead, the entire frequency range is divided up into a sufficient amount of subranges, featuring nearly the same conditions for all frequencies (i.e. source and load impedances are nearly equal).

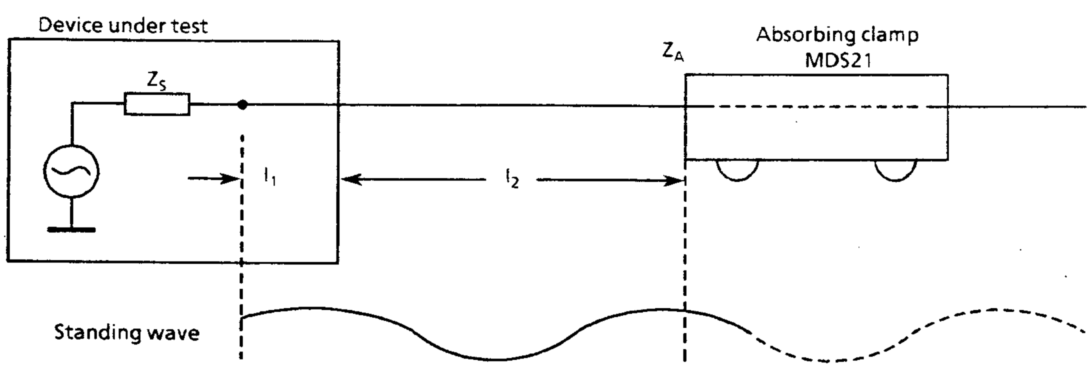


Fig. 3-78 Impedances Z_S and Z_A and lengths of the lines l_1 und l_2 with RFI power measurement. Z_S, Z_A and l_1 are nearly constant within one subrange; it is thus sufficient to determine the local maximum l_2 of the subrange maximum.

It can be assumed that the standing wave of the subrange maximum (maximum level of the subrange spectrum with fixed clamp) has its local maximum (the first maximum occurring with sliding the clamp) at the same location as all the other frequencies of this subrange and that all level relations within the frequency subrange remain nearly constant. That is why it is not necessary to determine the local maximum for each frequency of the subrange since the levels are always below the level of the local maximum of the frequency subrange maximum. The subrange maximum thus becomes the representative frequency of the frequency subrange.

The current entering into the clamp never becomes 0 since the clamp does not terminate the interference source at high impedance. That is why the entire spectrum can be covered at one position by an acceptance margin of approx. 10 dB - most definitely at 0-position. Entering 16 or 25 for the number of subranges, e.g., is sufficient to minimize the amount of errors.

a) Test Setup

To avoid measurement errors due to ambient interference the device under test and the measuring sensor (absorbing clamp) should be operated in a shielded room. Due to its low radiation the test receiver ESS can be set up inside the shielded room. Simultaneous operation of a printer and/or plotter or the keyboard may, however, cause problems. In this case the test report should be output subsequent to the measurement or the ESS together with printer and plotter should be operated outside the shielded room.

It should be possible to move the absorbing clamp at the test receiver. This could be achieved by rollers supporting the clamp and a cord connecting the clamp to the test receiver.

It is useful to mark the measuring table with a frequency scale such that the frequency value is entered at a distance of half the wavelength from the device under test, respectively, i.e., 300 MHz with 0.5 m; 200 MHz with 0.75 m; 150 MHz with 1 m; 100 MHz with 1.5 m; 30 MHz with 5 m. The operating range of the clamp decreases with increasing frequency.

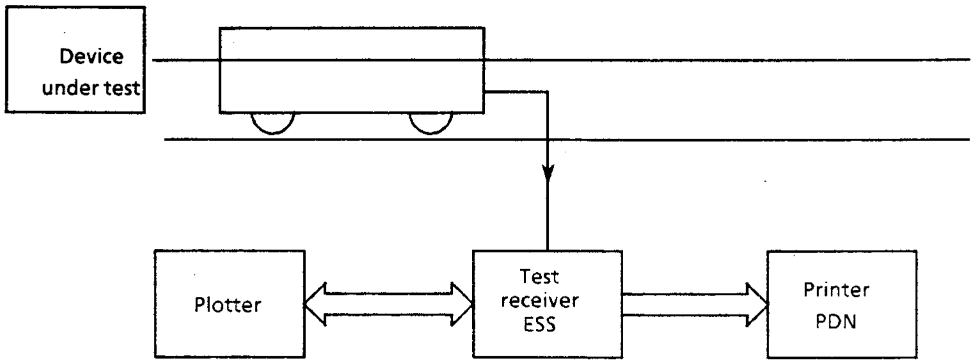


Fig. 3-79 Block diagram of a test setup with MDS clamp and device under test in a shielded room

Detailed information on the height of the measuring table, the distance between MDS clamp and wall etc., can be looked up in the latest versions of the respective standards.

b) Setting of the Test Receiver

The scan setting of the test receiver determines the data of the prescan. For RFI power measurements it covers a range from 30 to 300 MHz.

Scan data:

Frequency range/MHz	30 - 300
Stepsize/kHz	40 1)
Bandwidth (IF BW)/kHz	120
Detector	Pk + Av 2)
Meas. Time/s	.02 3)
Attenuation	Auto Low Noise
Operating range/dB	60

1) With pure broadband interference, frequency-proportional stepsize (LOG step) can be used instead of steps a third of the bandwidth.

2) For measurements according to standards with narrowband and broadband interference limits or average and quasipeak limits, the special function 30 allowing simultaneous measurement of peak and average value during one scan is useful. If there is only one limit, it is sufficient to switch on one detector only, e.g. Pk.

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

The following scan options are used for RFI power measurements:

04 RFI Power — RFI power measurement
Enables interactive measurement at the subrange maxima subsequent to the prescan if one of the options 40 to 45 is selected.
The conversion factor of the MDS clamp is to be entered as transducer factor.

30 Subrge/Margin — is determined as explained in the introduction to section 3.4.
Suitable settings: *No of Subranges 16* or *25*
Acc. Margin/dB 10

40, 42, 45 — These options determine the type of detector for final measurement. (Option 45 cannot be applied with fast scan.)

c) Test Run, Measurement and Analysis Procedure

▸ Press the RUN key.

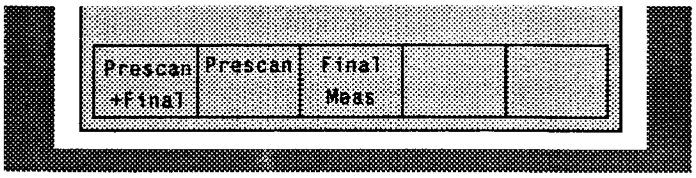


Fig. 3-80

The following settings can be made by pressing the respective softkey:

Softkey	Action
Prescan +Final	Prescan*) is started. When prescan is terminated, final measurement is started automatically.
Prescan	Prescan*) is started. This operating mode allows repeated measurement without final measurement.
Final Meas	Serves to start the final measurement. This can also be repeated. (Softkey is only displayed after prescan.)

*) The prescan can be interrupted by pressing the *Interrupt* softkey and aborted by pressing the *Abort Scan* softkey (cf. Section 3.2.4.3.4). After pressing the *Prescan* or *Prescan+Final* softkeys, the following request is displayed:

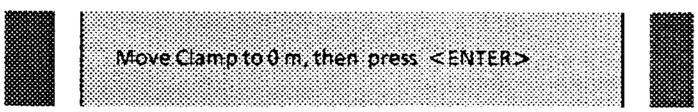


Fig. 3-81

▸ Move the clamp to the device under test as close as possible and press one of the ENTER keys. Prescan including the determination of subrange maxima is continued until the stop frequency (Pk and/or Av) displaying the message *SCAN Running ....* Using option 62, the interference spectrum is recorded by means of a plotter. A beep is to be heard at the end. After starting the final measurement, the test receiver is set to the frequency of the first subrange maximum (with setting of the marker). Measurement is carried out by means of the detector of option 40 to 45.

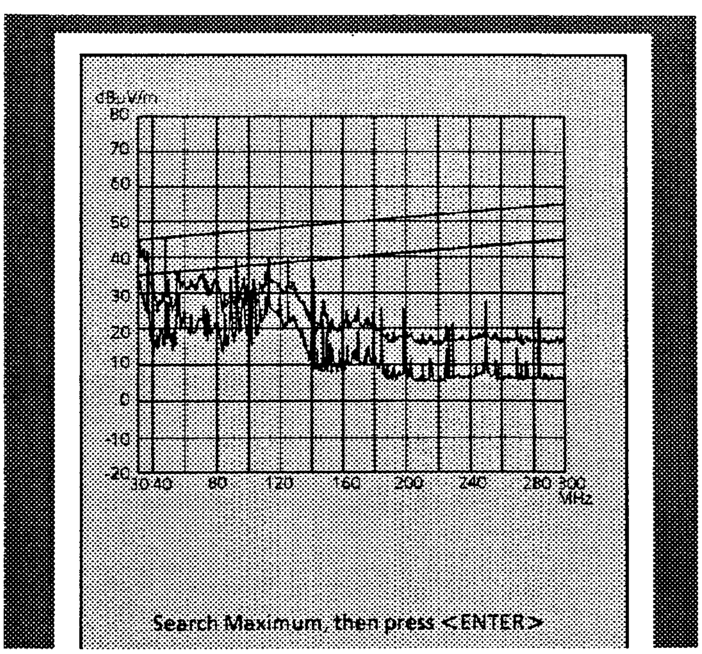


Fig. 3-82

- If necessary, vary the frequency using the rotary knob to trace drifting interferences. IF analysis can be switched on for orientation. In order to make better visible the details of the RF analysis spectrum, zoom can be effected after switching on the marker. IF analysis is exited using the RF-analysis key, the marker menu using the exit key.

  The currently set frequency is always displayed in the list of measured values. If the same frequency with the same detector (criterion: test bandwidth) has been set twice during the searching procedure, the frequency value with the lower level is suppressed. For this reason, a list of measured values does not contain the same frequency twice.

- Slide the clamp while watching the pointer of the instrument until the maximum has been found.

- Press one of the ENTER keys.
  The value currently indicated on the LEVEL display is transferred to the measured-value memory and output on the plotter as * or +. Then the ESS sets the next frequency etc. (It is also possible to perform two measurements at the same frequency if AV subrange maximum and PK subrange maximum with SF 30 are at the same frequency).

- A list of the measured values can be output by means of a plotter or a printer, as shown by the following example (This table applies to option 45 by way of example. The AV table is not listed when option 42 is selected. When option 40 is selected, the QP table is omitted.):

Frequency MHz	QP Level dBpW	QP Limit dBpW
31.3000	41.4	45.1
37.4500	47.3*	45.7
51.3500	44.5	46.5

Frequency MHz	AV Level dBpW	AV Limit dBpW
34.25	38.3*	35.3
37.45	43.5*	35.7

* limit exceeded

Note: *With option 45 the higher limit is always the QP limit. If no limit value line is activated, the respective column heading is omitted.*

3.4.5 RFI Fieldstrength Measurement

RFI fieldstrength measurements are usually performed at open air test systems in the range from 9 kHz to 1000 MHz at a distance of 3, 10 or 30 m from the device under test. Linearly polarized broadband dipoles are used as antennas with horizontal and vertical polarization. Generally, two antennas are used, e.g. a HK116 (30 to 300 MHz) together with a HL 223 (200 to 1000 MHz) or the broadband dipole HUF-Z1 (30 to 80 MHz) together with the log-periodic antenna HL 023 A1 (80 to 1000 MHz).

The fieldstrength measuring systems of more than 30 MHz provide a conductive basal surface and must provide a system attenuation within narrow tolerance limits. There are only few perfect test systems in shielded (absorber) halls, since the required absorbers are quite expensive. Due to the conductive surface the fieldstrength does not only depend on polarization but also on height. Therefore, the antenna must be varied in height between 1 and 4 m. Since the device under test itself emits a directional radiation, it has to be turned in the various directions and, if necessary, be operated at different operating modes and with different cord arrangements. The influence of ambient interferences, which are often intermittent, i.e. not time-constant, on free-field test systems must also be taken into account.

A fully automatic measuring sequence using a test receiver without the aid of a controller is thus not suitable. This is why R&S offers the following solution using the ESS:

A prescan is performed inside an acceptably shielded absorber hall without varying the height of the antenna (e.g. in the near-field at a distance of 1 m from the device under test) for searching the subrange maxima, which are then stored in the CMOS-RAM for subsequent manual open air measurement. If a semi-anechoic chamber is available, the optimum height should be selected.

a) Test Setup for the Range of 9 kHz to 30 MHz

Measurement in the shielded chamber:

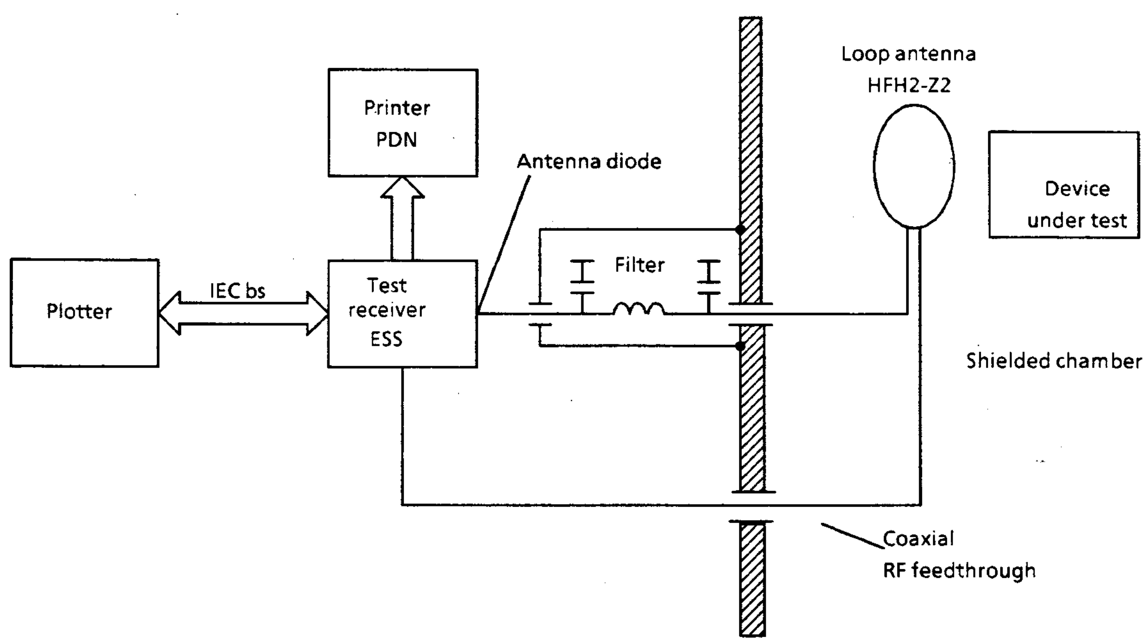
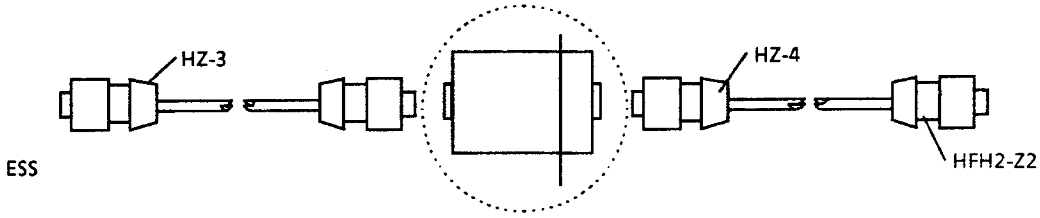


Fig. 3-83 Block diagram of a test setup including loop antenna HFH2-Z2 and device under test in the shielded chamber

Supply voltages + 10 V and -10 V, the coding of the antenna factor and the dimension "electric fieldstrength" (dBµV/m) are to be fed through the wall of the shielded chamber for loop antenna HFH2-Z2. Connecting cables HZ-3 (3 m) and HZ-4 (10 m) are used.

When the magnetic field strength is displayed in dBµA/m a transducer factor of -31.5 dB is to be entered.

Proposed arrangement of connecting cables HZ-3, HZ-4



Filter arrangement

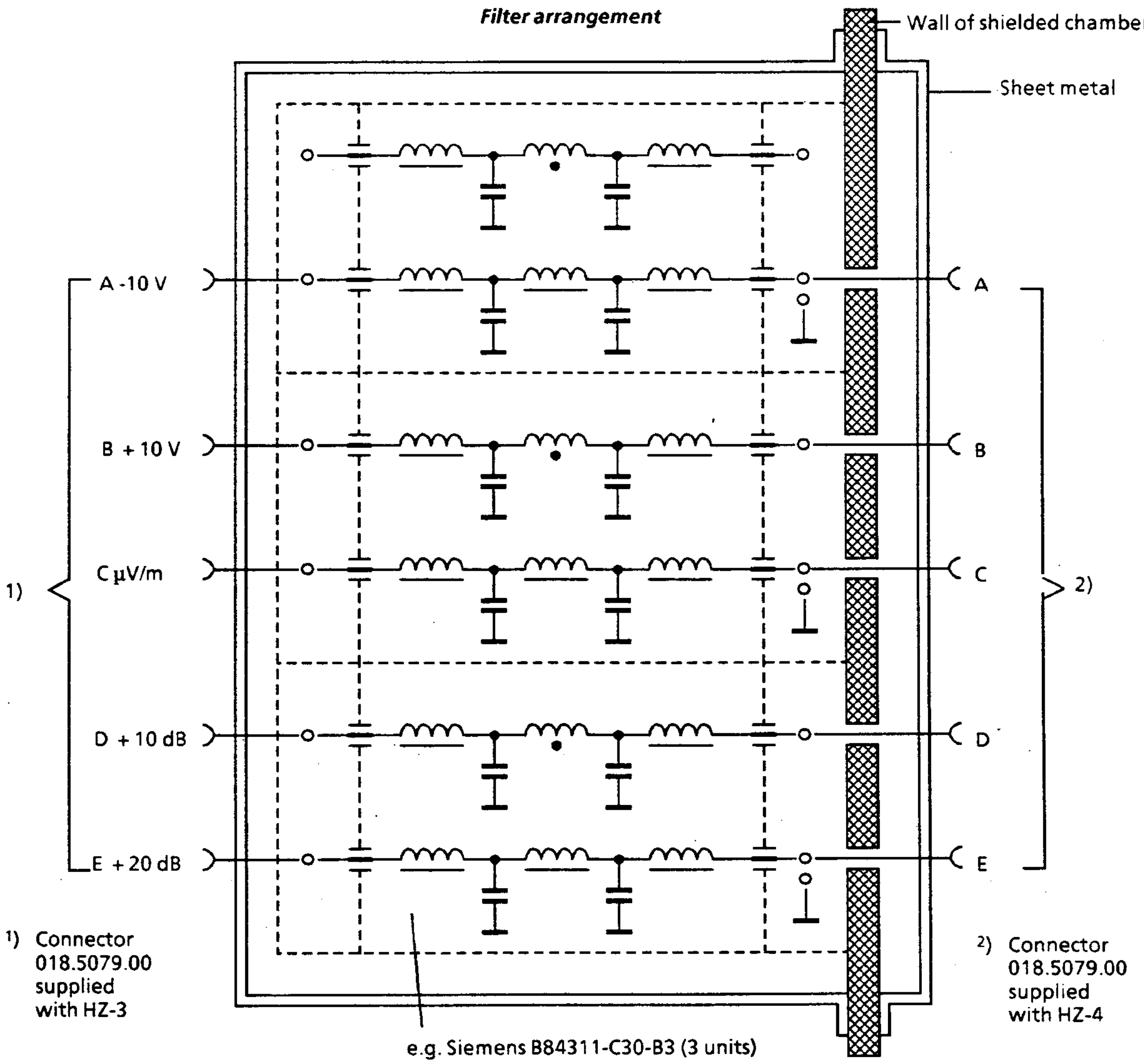


Fig. 3-84 Arrangement of connecting cables HZ-3/4 with AF filters for supplying and coding active antenna HFH2-Z2 in shielded rooms

Note: *If the AF filters are arranged favourably, they 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 active antenna HZ-9 inside the shielded room, the feedthroughs for the supply voltages can also be dispensed with.

Open Air Measurement:

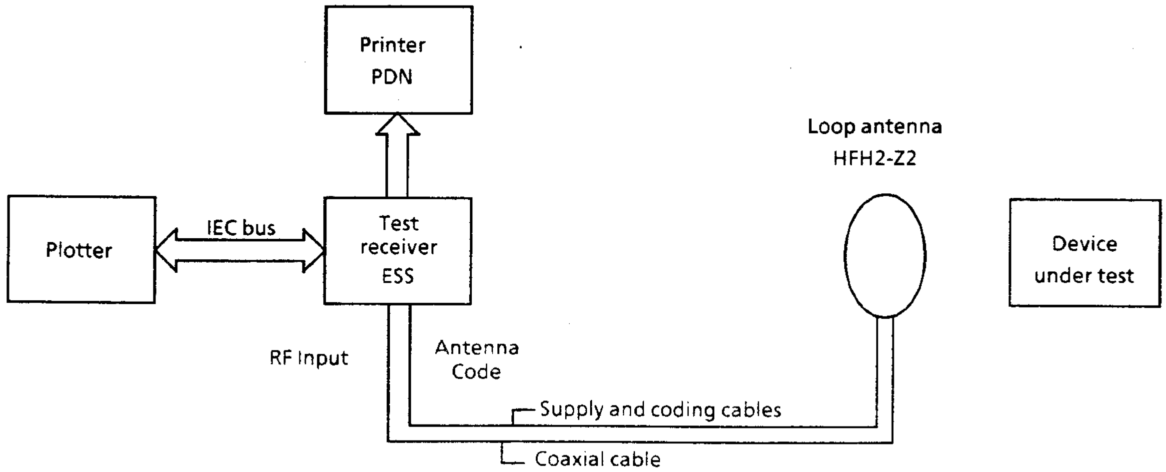


Fig. 3-85 Block diagram of a test setup with open air test. Make sure that the antenna is decoupled from printer and plotter, e.g. by grounding the cable insulation wall and by means of sheeth current stop filters.

b) Test Setup for the Range of 30 to 1000 MHz

The device under test together with the antenna are placed in a shielded room, whereas the test receiver with its peripherals should be placed outside. The arrangement of the device under test including all lines connected should be identical with that of the free-field measurement. The antenna should be situated in the main radiation direction of the device under test.

The position of the antenna is recommended to be below 45 degrees (i.e. not horizontal or vertical) for the prescan. In this case one test run is sufficient.

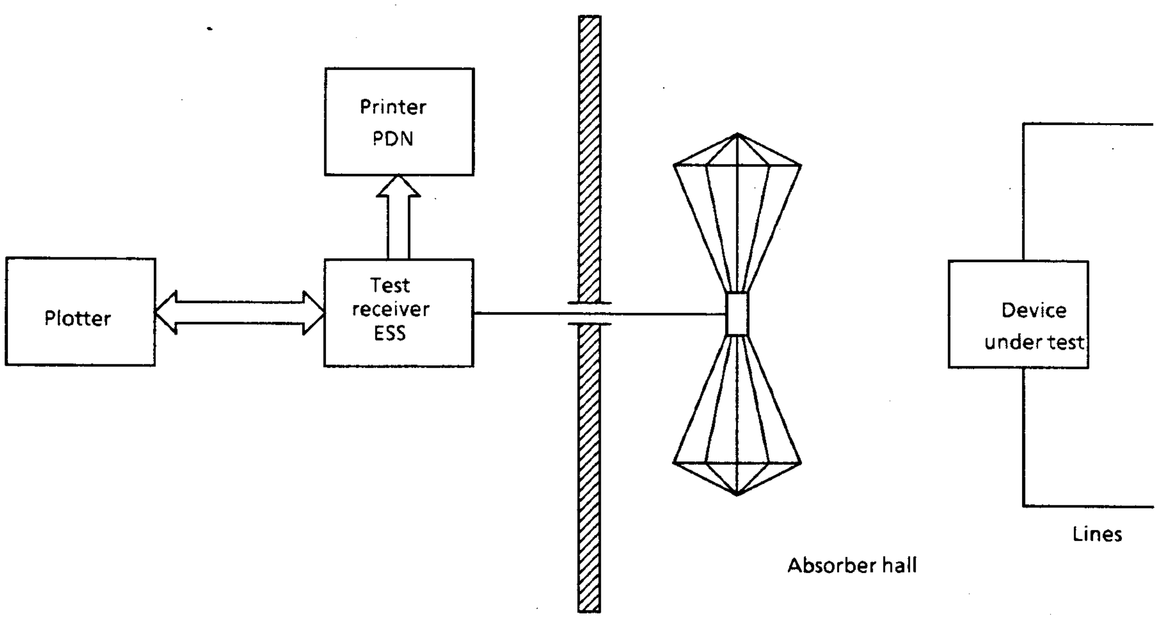


Fig. 3-86 Test setup for RFI fieldstrength measurement in an absorber hall.

In the case of measurements in the open field, the device under test may be positioned on a manually or remote-controlled turntable. The arrangement of lines to the device under test is to be looked up in the valid test regulations. The mast of the antenna and the turntable should be controllable at the test receiver location. Make sure that the test system (test receiver and peripherals) is reflection-free.

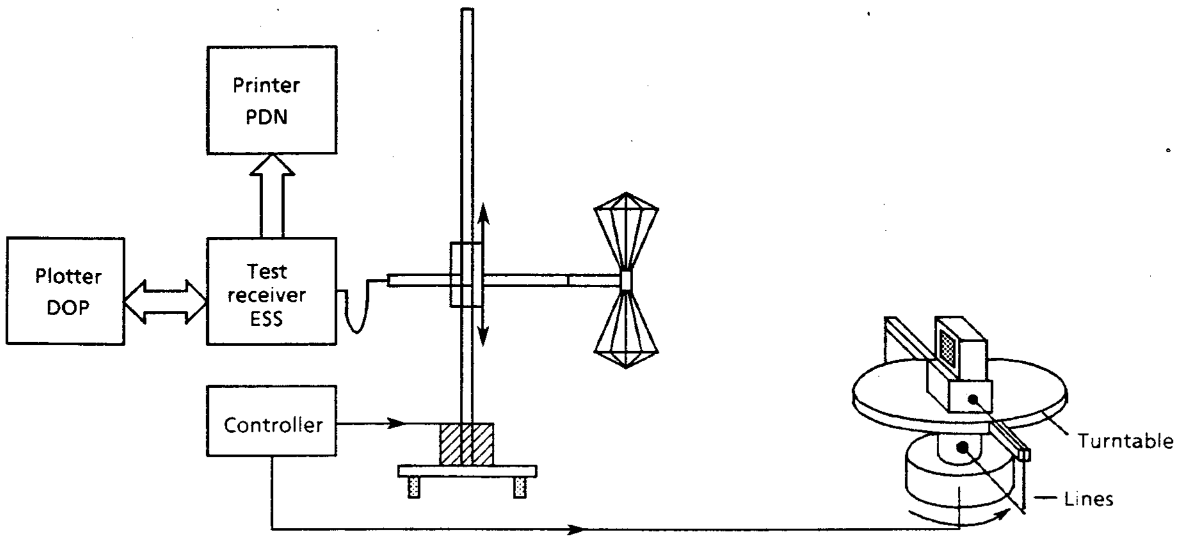


Fig. 3-87 Test setup for free-field RFI fieldstrength measurement

c) Setting of the Test Receiver

The scan setting of the test receiver determines the data of the prescan. For RFI fieldstrength measurements using ESS it covers one of the three ranges from 9 kHz to 1000 MHz as already mentioned.

Scan data:

Frequency range/MHz	9 kHz - 150 kHz	0.15 - 30	30 - 1000
Stepsize/kHz	0.1	3	40 1)
Bandwidth (IF BW)/kHz	0.2	10	120
Detector	Pk	Pk	Pk
Meas. Time/s	0.02	0.02	.02 2)
Attenuation	Auto Low Noise	Auto Low Noise	Auto Low Noise
Operating range/dB	60	60	60

1) With pure broadband interference, frequency-proportional stepsize (LOG step) can be used instead of steps of a third of the bandwidth.

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

The following scan options are used for RFI fieldstrength measurements:

06 *RFI-Field*
A pre-measurement of the fieldstrength spectrum is performed in a shielded room which is subsequently repeated semi-manually at a free-field test system.

30 *Subrge/Margin* is determined as explained in the introduction to this section.
Useful settings:

No of Subranges 25, 50 or *100*
Acc. Margin/dB 6 depending on the accuracy with which the limit value has to be observed

40 Options 40 to 45 determine the type of detector for final measurement. Fieldstrength limit values generally apply for the QP detector. For this reason, option 42 should be activated together with option 06.

Note: *As the prescan is often carried out in the near-field of the device under test, it is permissible to set another limit value curve for prescan and free-field measurement. A new limit definition has to be effected then in the final measurement.*

c) Test Run, Measurement and Analysis Procedure (Example: Range 30 to 1000 MHz)

▸ Press the RUN key.
If there are no measurement data, this immediately starts the prescan. If there are measurement data already, the following softkey menu is displayed:

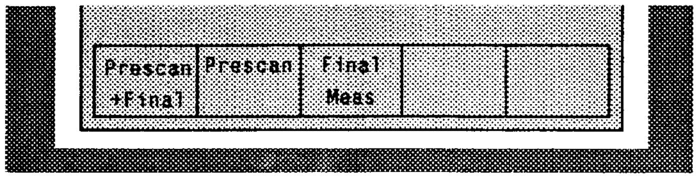
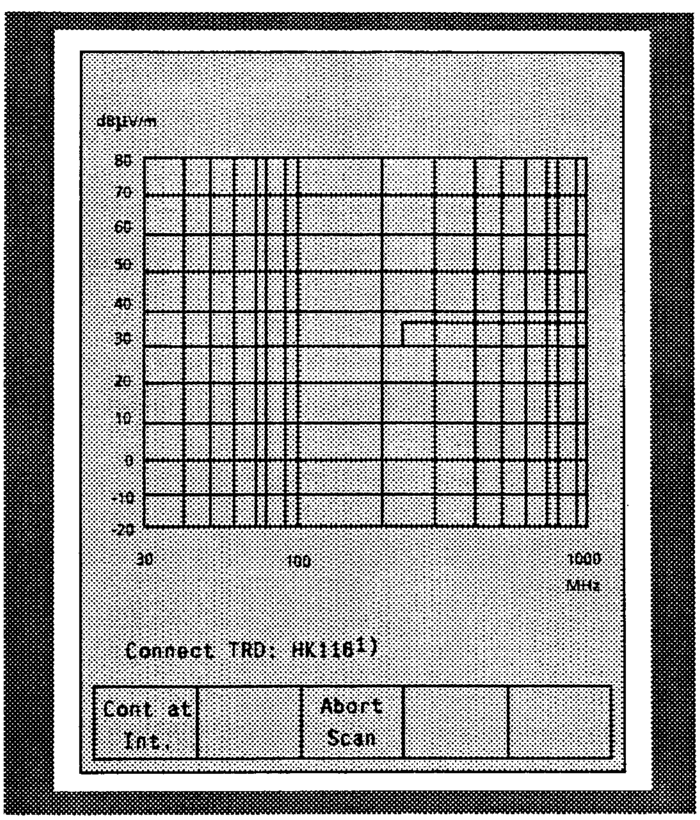


Fig. 3-88

The following settings can be made by pressing the respective softkey:

Softkey	Action
Prescan + Final	Prescan*) is started. Final measurement is automatically started on terminating the prescan.
Prescan	Prescan*) is started. This operating mode also allows a repeated measurement without final measurement.
Final Meas	Serves to start the final measurement. This can also be repeated. (Softkey is only displayed when a frequency list is stored.)

The prescan can be interrupted by pressing the *Interrupt* softkey once and aborted by pressing the *Abort Scan* softkey (cf. Section 3.2.4.3.4). If antennas are to be exchanged in the course of the measurement, the following is displayed on the screen:



[1]) If only the frequency range of one antenna is scanned, there is no message and the prescan starts immediately.

Fig. 3-89

▸ Press the *Cont at Int.* softkey.
The prescan is continued until the frequency of antenna exchange including the known determination of subrange maxima displaying the message *SCAN Running ....*

Note: *The RFI fieldstrength spectrum is recorded by means of a connected plotter using option 62.*

For exchange of the antenna, there is a beep with the request:

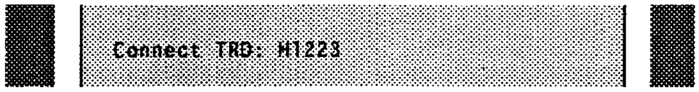


Fig. 3-90

▸ Press the *Cont at Int* softkey.
The prescan is continued until the end. All subrange maxima are stored in the CMOS-RAM. The list of subrange maxima can be output as list of measured values if required.

Tables of measured values in RFI fieldstrength measurement (after the prescan):

Frequency MHz	Pk Level dBµV/m	Pk Limit dBµV/m
31.3000	41.4	45.1
37.4500	47.3*)	45.7
51.3500	44.5	46.5

*) limit exceeded

After starting free field, the final measurement can be carried out using *Final Test*:

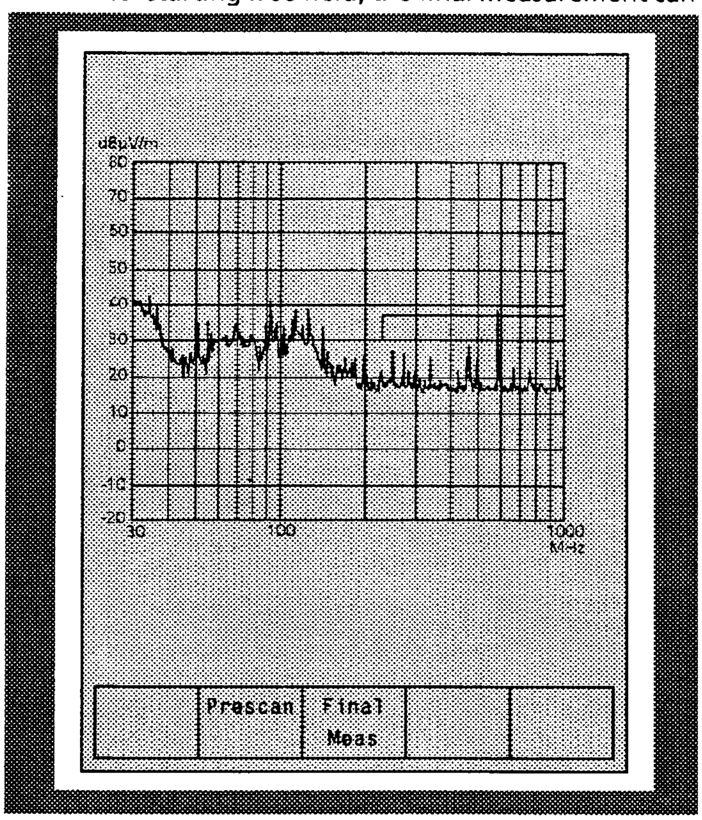


Fig. 3-91

▸ Press the RUN softkey (only necessary if the softkey menu is not displayed using *Prescan+Final*, Prescan and Final Test).

▸ Press the *Final Meas* softkey. The first frequency of the final measurement is set.

Note: If the prescan is started inadvertently, the stored measured values of the previous prescan are lost.

If a transducer set with more than one subrange is active, there is a beep with the request (example):

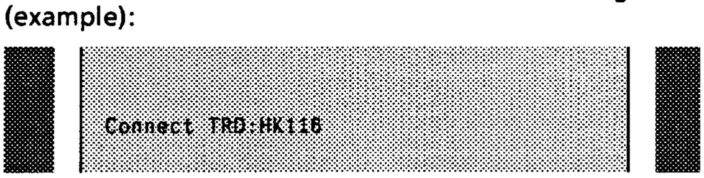


Fig. 3-92

- Vary the frequency by means of the rotary knob in order to trace drifting interferences. For better orientation, IF analysis can be switched on. In order to make better visible details of the RF analysis spectrum, zoom can be effected after switching on the marker. The IF analysis is exited using the RF-analysis key, the marker menu using the exit key. The frequency actually set is displayed in the list of measured values. If the same frequency has been set twice in searching (criterion test bandwidth), the frequency value with the lower level is suppressed. Thus a list of measured values doen not contain the same frequency twice. The following is displayed:

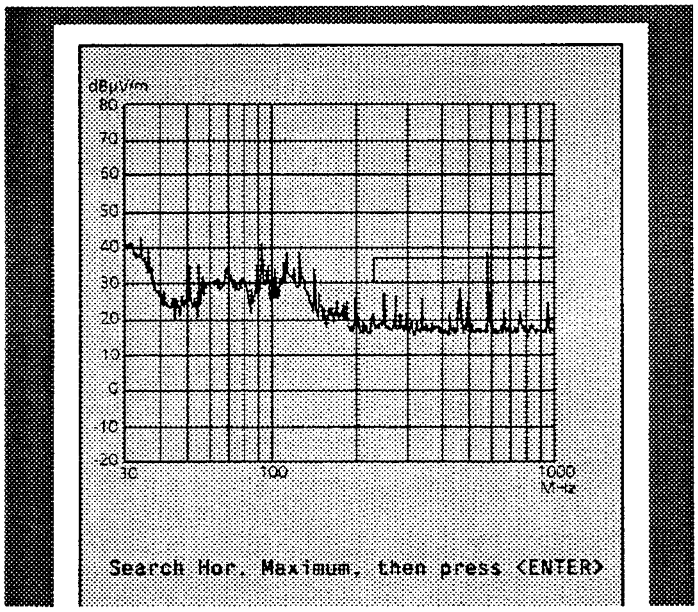


Fig. 3-93

- With horizontal polarization, alter the height of the antenna and the turntable azimuth until the maximum ambient interference has been found

- Press one of the ENTER keys.
  The value in the LEVEL display is transferred into the measured-value memory.

  Note: *If the measurement of the interference of the device under test is not possible at a frequency due to an ambient interference, another frequency can be set using the → key.*

  After accepting the horizontal maximum, the following request is displayed:

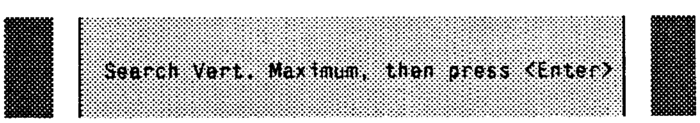


Fig. 3-94

- With vertical polarization, alter the height of the antenna and the turntable azimuth again until the vertical maximum of the ambient interference has been found.

- Press one of the ENTER keys.
  The value in the LEVEL display is accepted and output as " + " at the plotter. The ESS sets the next frequency etc. Using the ← key, a previous frequency can be set again. Thus a measurement can be repeated under altered operating conditions of the device under test and a value which has inadvertently been stored using the ENTER key be overwritten. The → *key* can be used to skip a frequency set.

Tables of measured values in RFI fieldstrength measurement (after the final test):

Frequency MHz	**QP Level hor. dBµV/m**	**QP Level vert. dBµV/m**	**QP Limit dBµV/m**
31.3000	41.4	39.1	45.5
37.4500	47.3*	43.3	45.7
51.3500	44.5	47.6*	46.5

* limit exceeded

3.4.6 General Information as to Emitted Interferences According to Military Standards

Due to its large frequency range of 5 Hz to 1000 MHz and its test bandwidths in decadic steps, EMI test receiver ESS is especially suitable for the measurement of emitted interferences according to military standards. The symmetric input serves to carry out high-sensitivity measurements in the range of 20 Hz to 50 KHz. It can be used to perform earth-free measurements and thus to avoid hum loops. Detectors Pk and Pk/MHz conform to the demands of the American MIL-STDs, detectors Pk and Av to the demands of the German VG standards. The British DEF STAN 59-41 standard only uses the Pk detector, the French standard GAM EG 13 the Pk and Av detector.

A distinction is made between the measurement of **conducted and radiated emitted interferences** (cf. Sections 3.4.7 and 3.4.8). Different **test bandwidths** are used in the individual frequency bands. While the MIL-STDs do not exactly demand the test bandwidths up to now, distinct details on test bandwidths in the individual frequency subranges are included in the VG standards, the British DEF STAN 59-41 and the GAM EG 13. Hints as to test bandwidths according to MIL-STDs are included in:

MIL-STD-462 Notice 3 (Army)

and MIL-STD-462 Application Note. Identification of Broadband and Narrowband Emissions. ASD/ENA-TR-80-3 1 May 1980, Electromagnetic and Interference Compatibility Branch, Wright-Patterson Air Force Base, Ohio

Only future MIL-STDs will contain clear details as to the test bandwidth (cf. Draft MIL-STD 462 D, Feb. 92)

Methods of **distinguishing between narrowband and broadband interferences** play an important role. Different limit values for narrowband and broadband interferences are included in the MIL-STDs, the VG standards and the GAM EG 13 standard within the frequency range 10 kHz to 1000 MHz. Only DEF STAN 59-41 (and the future MIL-STD 4620) avoid the terms of narrowband and broadband interference. The ESS does not automatically distinguish between narrowband and broadband interferences. A distinction must either be effected manually or by means of a control processor including software to analyse the measured values. Generally a measurement of broadband interferences is carried out first, then a test at all frequencies at which the interference level measured under conditions of broadband measurement exceeds the interference limit value for narrowband measurements.

According to MIL-STD-462 A, there are two possibilities of distinction:

a) Detuning method according to MIL-STD-462 A:

The test receiver is detuned by twice the pulse bandwidth up or down on the basis of the determined frequency with the level over the limit. If the level values measured there are smaller than the one in the center by more than 3 dB, there is a narrowband interference. Manual work or the computer software can be simplified by setting the scan stepsize in pre-analysis to 0.5 × B_{imp}. In this way, 4 test steps result in a value of = 2 × test bandwidth. All individual measured values of the scan (up to 30,000) are stored in the ESS (and in the external computer) and are thus available for subsequent evaluations. The marker zoom function is used for manual evaluations.

Discussion: The narrowband interference in Fig. 3-94 is correctly recognized as such, however, is evaluated too high due to the superimposed broadband interference.

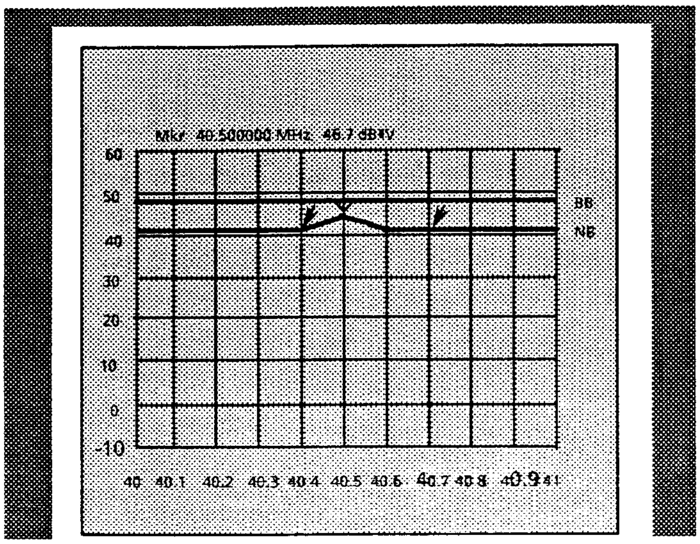


Fig. 3-95 Detuning method: narrowband interference with superimposed broadband interference, measured at a test bandwidth of 100 kHz and a stepsize of 50 kHz. The decisive adjacent levels are marked. For illustration, the extension of the frequency axis is substantially larger than using marker zoom.

b) Determination of the pulse frequency of an interference according to MIL-STD-462 A

When the interference pulse frequency is larger than the test bandwidth, a spectrum is formed whose line spacing is larger than the test bandwidth, i.e. the individual lines can be resolved by means of the test receiver using the detuning method. It is a narrowband interference. In contrast, it is a broadband interference when the interference pulse frequency is smaller than the test bandwidth. Basically, the measurement of the interference pulse frequency can be carried out manually using an oscilloscope at the IF output of the receiver. Instead of this time-consuming method we recommend to **use the difference between average and peak value indication**. Average and peak value are approximately the same when the interference pulse frequency becomes smaller than the test bandwidth (cf. Fig. 3-96). A difference of 3 dB will again serve as a criterion in general. Option 45 of the ESS presents itself for automatic sequences. Exceedings of the limit can be examined with regard to the difference between average and peak value and classified as narrowband or broadband interference manually or by means of a connected controller.

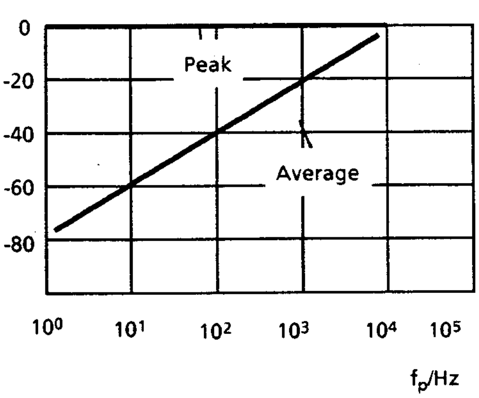


Fig. 3-96 Peak and linear average value indication as a function of the pulse frequency of an interference at a test bandwidth of 10 kHz

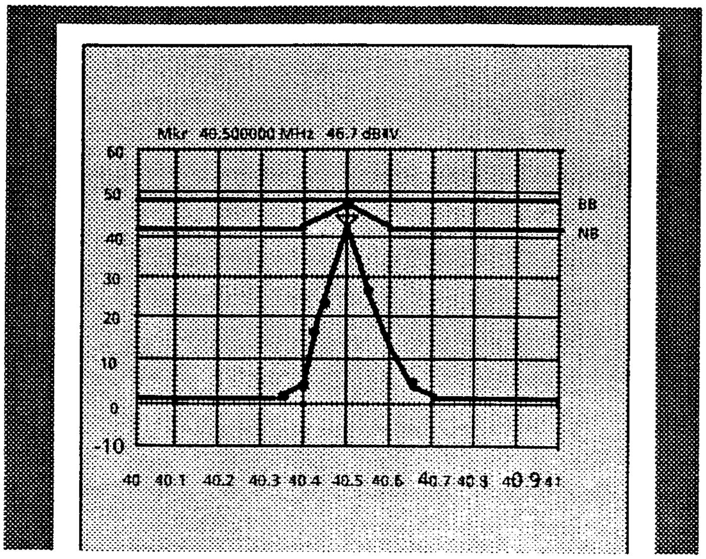


Fig. 3-97 Peak and linear average value indication of a narrowband interference with superimposed broadband interference

Discussion:
Fig. 3-97 also shows the limits of distinction method b) when a criterion of 3 dB is used: although the spectrum clearly shows a narrowband interference with average value indication, the level difference is larger than 3 dB due to the superimposed broadband interference. Thus a larger criterion is to be recommended.

Methods a) and b) both conform to MIL-STD-462, but they are not equal. For example, a pulse-modulated sinusoidal signal, which is modulated "softly" with a pulse frequency of 1 kHz (pulse duty factor 1:1), is identified as a narrowband interference according to a) and as a broadband interference according to b). User and the authority inspecting have to decide which method is to be used.

A third method is possible according to MIL-STD-462 Notice 3:

c) Distinction by altering the test bandwidth

Peak value indication of a coherent pulse interference which does not overlap changes by 20 dB when the test bandwidth changes by the factor of 10 while it is independent of the bandwidth with an unmodulated sinusoidal signal. This suggests a method of distinction: if the peak value indication changes by more than n dB with bandwidth switchover, there is a broadband interference, otherwise a narrowband interference. For execution: A scan at the narrow bandwidth has to be carried out with all questionable frequencies. Thus this method is the most time-consuming.

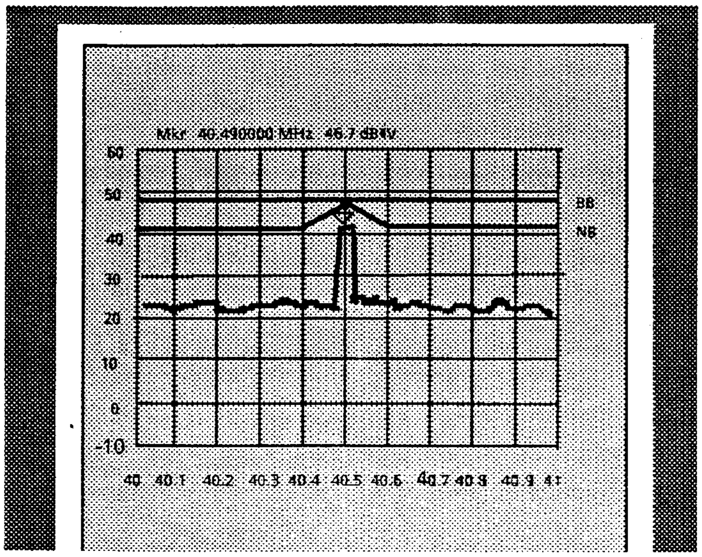


Fig. 3-98 Narrowband interference with superimposed broadband interference, measured at a bandwidth of 100 kHz (upper curve) and measured again at a bandwidth of 10 kHz (lower curve). The highest value of the broadband measurement is compared with the highest value of the narrowband measurement.

Discussion: This also shows that a criterion of 3 dB for the pattern signal does not lead to the recognition of the narrowband interference. Thus a larger value is to be recommended, e.g., 6 dB.

Exception VG Standards

The VG standards do not demand a narrowband/broadband distinction in the proper sense. Instead broadband test bandwidths are defined by the Pk detector and narrowband test bandwidths by the Av detector respectively in the range of 10 kHz to 1000 MHz for recording broadband and narrowband interferences. This results in two scans for us: a broadband scan with the broadband limit and a narrowband scan with the narrowband limit.

General Information for the Use of Detector "Pk/MHz"

First it has to be mentioned that this is no separate detector but the same detector as with Pk. However, the level displayed is increased by the so-called "bandwidth factor". It corresponds to the "broadband peak" of other manufacturers and better expresses what it is than the abbreviation "MIL" used with earlier R&S test receivers (ESH3, ESVP). It is the indication of the pulse spectral density of broadband interferences (spectral voltage density, spectral fieldstrength density of pulse interferences) and spares the user the addition of the bandwidth factor:

$$Pk/MHz = Pk + 20 \log (1\ MHz/B_{zf}),$$

with B_{zf} having to be inserted in MHz and Pk/MHz as well as Pk being understood as level quantities.

The supplement ".../MHz" or the addition of the bandwidth factor is only permissible if an interference signal is a broadband interference signal. Strictly speaking, it is only valid for a coherent signal.

Thus it is useless to scan an unknown interference spectrum using detector "Pk/MHz", because this results in a lading of the narrowband interference with the bandwidth factor. It is only justified to use it to measure an object which can only produce broadband interferences. In this case it is not necessary to limit the stepsize of the scan to less than the test bandwidth. Instead scanning can be performed in frequency-proportional steps.

In all other cases detector "Pk/MHz" should only be used for measurement if it has definitely been clarified before that the signal at the corresponding frequency is a broadband interference signal.

3.4.7 Measurement of Conducted Interferences According to Military Standards

According to military standards, conducted interferences are mainly measured as interference currents in the units dBµA and dBµA/MHz - using RF current transformers -, more rarely as interference voltages in the units dBµV and dBµV/MHz - at artificial mains networks.

The following is available from R&S:

RF current transformer 20 Hz - 100 MHz	EZ-17
T-network 9 kHz -. 150 MHz	ESH3-Z4*)
2-line V-network 9 kHz - 30 MHz	ESH3-Z5*)
V-network 5 µH//50 Ω	ESH3-Z6

*) The T-network and the 2-line V-network conform to VG standard 95377 part 14.

Further remarks:

- R&S RF-current transformers ESH2-Z1 and ESV-Z1 can be used in combination. To this effect, they are to be inserted within one transducer set. It is most useful to set the frequency limit for the change of the current transformers to approx. 1 MHz because the sensitivity of the ESV-Z1 as of 1 MHz is larger than the one of the ESH2-Z1.
- In most cases the interference spectrums on individual conductors must be logged separately. For this reason an automatic switchover is unnecessary and **one** coaxial RF feedthrough into the shielded room is sufficient.

a) Test Setup

To avoid measurement errors due to ambient interferences, the device under test and the sensor (current transformer, artificial mains network) must be operated in a shielded chamber, the test receiver, in contrast, outside.

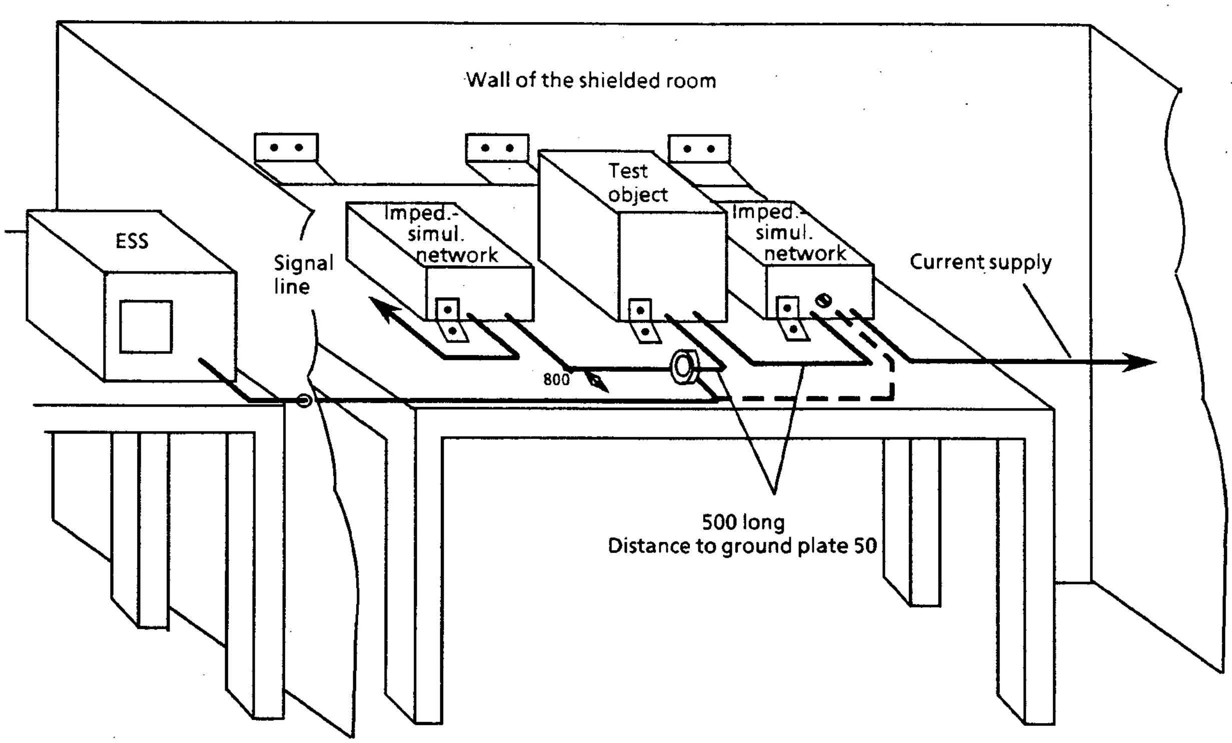


Fig. 3-99 Test setup for the measurement of interference currents and interference voltages

b) Setting of the test receiver

The principle of prescan to record the interference spectrum - data reduction - final measurement should be maintained here as well, although there is no narrowband/broadband distinction which is sometimes necessary. For survey measurements, however, the graphic display is often sufficient so that prescan alone is enough. The definition of the scan data determines the prescan. In general it comprises several subranges with a different test bandwidth.

Example for the VG standards:
for narrowband interferences

Frequency range	10 kHz - 30 MHz	30 - 1000 MHz
Stepsize/kHz	typically 0.4 - 0.5 × test bandwidth[1)]	
Bandwidth (IF BW)/kHz	0.2[2)]	10
Detector	Av	Av
Meas. Time/s	.02[3)]	.02
Attenuation	Auto Low Noise	Auto Low Noise
Operating Range/dB	60	60

for broadband interferences

Frequency range	10 kHz - 30 MHz	30 - 1000 MHz
Bandwidth (IF BW)/kHz	0.2/10	100
Detector	Pk	Pk
	all other data as above.	

1) In the case of test objects which can only produce broadband interferences, the narrowband scan is probably not necessary and only the broadband scan with frequency-proportional stepsize (log. step) is to be performed.

2) If it is possible with regard to sensitivity, the narrowband test bandwidth can be increased up to 1 kHz, which substantially increases the scan rate.

3) The measuring time per measured value is determined by the type of interference signal. It should be selected such that the highest value is recorded when there are fluctuations in time. In the case of an unknown interference a repetitive scan using Max Hold (option 23) is also to be recommend.

The following scan options are of special significance:

01 RFI Voltage — It can be used for all purposes - i.e. also for interference measurements according to military standards - if it is operated without defining an artificial mains network.

30 Subrge/Margin — including the determination of the number of subranges. For normal tests 16 or 25 subranges are sufficient. However, if all pixels are to be recorded in a list of results, as some authorities demand, this number is to be defined to be 400 and the acceptance margin to a value large enough in order to detect all interference levels. In this way the test-report specifications can be fulfilled.

40 to *45* — These options determine the type of detector to be used for final measurement.

3.4.8 Measurement of Radiated Interferences According to Military Standards

According to military standards, radiated interferences are measured as electric fieldstrength in the units dBµV/m and dBµV/m/MHz using rod, loop and dipole antennas. In the frequency range 20 Hz to 50/200 kHz, the magnetic flux density is also measured in dBpT using field coils with a distance of 5 or 7 cm from the test object.

The following is available from R&S:

Active rod antenna for MIL and VG standards 9 kHz - 30 MHz	HFH2-Z6
Active loop antenna (for VG standards) 9 kHz - 30 MHz	HFH2-Z2
Biconical antenna 20 - 300 mHz	HK116
Log.-per. antenna 200 - 1300 MHz	HL223
Con.-log. spiral antenna 200 - 1000 MHz	HUF-Z4

To follow soon:

Magnetic field pickup-coil 20 Hz - 200 kHz	HZ-10

Remarks:

- *The military standards designate only one antenna next to every test object. For this reason the question for an automatic switchover of the antennas is rendered unnecessary.*
- *In the case of linearly polarized antennas, the interference spectrums for horizontal and vertical polarization have to logged separately in general (exception: DEF Stan 59-41 with an antenna polarization of 45 degrees).*
- *Two different calibration tables are supplied for antenna types HK 116, HL 223 and HUF-Z4. The near-field antenna factors calibrated according to SAE ARP 958 are to be used for measurements according to military standards.*

a) Test Setup

To avoid measurement errors due to ambient interferences, the device under test and the sensor (antenna) should be operated in a shielded chamber, the test receiver, however, outside.

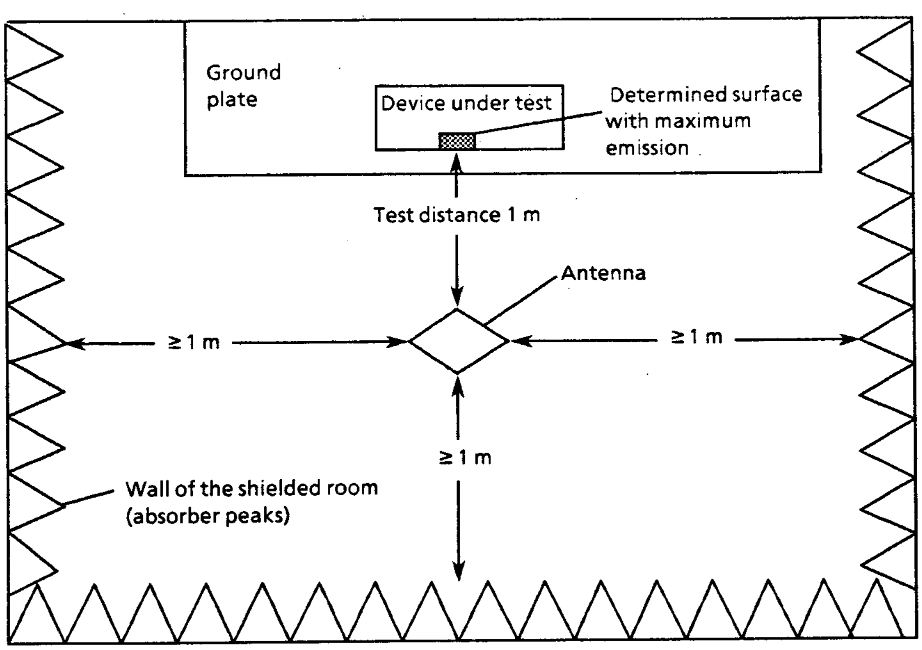


Fig. 3-100 Test setup for the measurement of interference fieldstrengths

b) Setting of the test receiver

The principle of prescan to record the interference spectrum - data reduction - final measurement should be maintained here as well, although there is no narrowband/broadband distinction which is sometimes necessary. The definition of scan data determines the prescan. In general it comprises several subranges with a different test bandwidth.

Examle for the VG standards:
for narrowband interferences

Frequency range	10 kHz - 30 MHz	30 - 1000 MHz
Stepsize/kHz	typically 0.4 - 0.5 × test bandwidth[1]	
Bandwidth (IF BW)/kHz	0.2[2]	10
Detector	Av	Av
Meas. Time/s	.02[3]	.02
Attenuation	Auto Low Noise	Auto Low Noise
Operating Range/dB	60	60

for broadband interferences

Frequency range	10 kHz - 30 MHz	30 - 1000 MHz
Bandwidth (IF BW)/kHz	0.2/10	100
Detector	Pk	
	all other data as above.	

1) In the case of test objects which can only produce broadband interferences, the narrowband scan is probably not necessary and only the broadband scan with frequency-proportional stepsize (log. step) is to be performed.

2) If it is possible with regard to sensitivity, the narrowband test bandwidth can be increased up to 1 kHz according to VG standards, which substantially increases the scan rate.

3) The measuring time per measured value is determined by the type of interference signal. It should be selected such that the highest value is recorded when there are fluctuations in time. In the case of an unknown interference a repetitive scan using Max Hold (option 23) is also to be recommend.

The following scan options are of special significance:

01 RFI Voltage — It can be used for all purposes - i.e. also for interference measurements according to military standards - if it is operated without defining an artificial mains network.

30 Subrge/Margin — including the determination of the number of subranges. For normal tests 16 or 25 subranges are sufficient. However, if all pixels are to be recorded in a list of results, as some authorities demand, this number is to be defined to be 400 and the acceptance margin to a value large enough in order to detect all interference levels. In this way the test-report specifications can be fulfilled.

40 to *45* — These options determine the type of detector to be used for final measurement.

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 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 subroutines, in this case "Prolog" and "Init_ess".

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

```
10000 '
10010Prolog:
10020 '
10030    IEC TERM 10: '                  Linefeed
10040    IEC TIME 1000: '                Timeout 1s
10050 '
10060    Ess=19: '                      Receiver IEC address
10070 '
10080 '                                  other initialization
10090 '
10100 RETURN
10110 '------------------------------
```

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

```
11000 '
11010Init_ess:
11020 '
11030 '                                  reset status registers
11040     IEC OUT Ess,"*CLS"
11050 '
11060 '                                  reset Receiver settings
11070     IEC OUT Ess,"*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_ess
160 '                                      send new settings
170 IEC OUT Ess,"FREQUENCY 20 MHZ"
180 IEC OUT Ess,"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    Ess=19: '                        Receiver IEC address
10070 '
10080 '                                    other initialization
10090 '
10100 RETURN
10110 '------------------------------
11000 '
11010Init_ess:
11020 '
11030 '                                    reset status registers
11040     IEC OUT Ess,"*CLS"
11050 '
11060 '                                    reset Receiver settings
11070     IEC OUT Ess,"*RST"
11080 '
11090 '                                    init other devices
11100 '
11110 RETURN
11120 '------------------------------
```

Subroutines "Prolog" and "Init_ess", which are still integrated in this example, will no longer be part of the following examples.

3.5.3 Reading 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 Ess,"FR?"
180 IEC IN Ess,Frequency$
190 '
200 IEC OUT Ess,"A?"
210 IEC IN Ess,Rf_attenuation$
220 '
230 IEC OUT Ess,"DET?"
240 IEC IN Ess,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_ess
160 '                                    set frequency
170 IEC OUT Ess,"FREQUENCY 98.5 MHz"
180 '                                    Trigger and Wait
190 IEC OUT Ess,"*TRG;*WAI"
200 '                                    get result
210 IEC OUT Ess,"LEVEL:LASTVALUE?"
220 IEC IN Ess,Level$
230 '                                    print result on screen
240 PRINT Level$
250 END
```

The output on the screen might be as follows:

LEVEL:LASTVALUE 23.87

To simplify this frequently used sequence, the ESS offers the command LEVEL?, which internally synchronizes 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 synchronizing sequences is offered by the service request.

It requires an interrupt routine being part of the system controller's program. The routine can be serviced asynchronously to the usual program run if a service request occurs.

In the case of this subroutine 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 Ess,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 registers or error recoveries.

If a service request is to be generated at the end of processing of a command, event-status-enable register ESE and the service-request-enable register must be configured correspondingly.

Command *OPC sets bit 0 in the event-status register. Analog to this setting, 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 command `*OPC`, is triggered. The end can be identified by flag `Srq%` which is set in the service-request routine. The registers stated in the before-mentioned example are previously configured.

```
100 '--------------------------------
110 '      Execute Scan
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Exec_scan
180 '
190 END
3000 '---------------------------------------------------
3010 '      Execute Scan and wait for Operation Complete
3020 '---------------------------------------------------
3030Exec_scan:
3060 '                                     Init SRQ-Routine
3070    ON SRQ1 GOSUB Srq_routine
3080 '                                     Config Registers
3090    IEC OUT ESS,"*CLS;*ESE 1;*SRE 32"
3100 '                                     Init SRQ-Flag
3110    Srq%=0
3120 '                                     Start Scan
3130    IEC OUT Ess,"SCAN:RUN;*OPC"
3140 '
3150 '                                     Do something useful
3160 '                                     while scanning
3170 '
3180    REPEAT
3190 '                                     Do something useful too
3200 '                                     or just wait
3210    UNTIL Srq%
3220 '                                     Scan is completed
3230 RETURN
3240 '
```

3.5.7 Programming a Scan Data Set

In this example a scan data set for RF analysis consisting of two ranges is defined. The appertaining receiver settings are made and the level range displayed in the diagram is set.

```
100 '-------------------------------
110 '      Set Scan Data
120 '-------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Prog_scan
180 '
190 END
2000 '-----------------------------------------------------
2010 '      Define Settings for RF Analysis
2020 '-----------------------------------------------------
2030Prog_scan:
2060 '
2070 '                                     define grid
2080     IEC OUT Ess,"GRID:FREQAXIS  LOG"
2090     IEC OUT Ess,"GRID:MINLEVEL -20 dB"
2100     IEC OUT Ess,"GRID:MAXLEVEL  80 dB"
2110 '
2120 '                                     2 scan ranges
2130     IEC OUT Ess,"SCAN:RANGES 2"
2140 '
2150 '                                     linear steps
2160     IEC OUT Ess,"SCAN:FREQUENCY:STEPMODE LIN"
2170 '
2180 '                                     define frequency ranges
2190     IEC OUT Ess,"SCAN 1"
2200     IEC OUT Ess,"SCAN:FREQUENCY:START      20 MHz"
2210     IEC OUT Ess,"SCAN:FREQUENCY:STOP     100 MHz"
2220     IEC OUT Ess,"SCAN:FREQUENCY:STEPSIZE 10 kHz"
2230 '
2240     IEC OUT Ess,"SCAN 2"
2250     IEC OUT Ess,"SCAN:FREQUENCY:STOP      500 MHz"
2260     IEC OUT Ess,"SCAN:FREQUENCY:STEPSIZE   100 kHz"
2270 '                                     store settings
2280     IEC OUT Ess,"SCAN:SAVE"
2290 '
2300 '                                     define receiver settings
2310     IEC OUT Ess,"SCAN 1"
2320     IEC OUT Ess,"SCAN:RECEIVER:DETECTOR         PEAK"
2330     IEC OUT Ess,"SCAN:RECEIVER:BANDWIDTH:IF     10 kHz"
2340     IEC OUT Ess,"SCAN:RECEIVER:MEASUREMENT:TIME 100 ms"
2350     IEC OUT Ess,"SCAN:RECEIVER:ATTENUATION:AUTO ON"
2360     IEC OUT Ess,"SCAN:RECEIVER:ATTENUATION:MODE LOWNOISE"
2370     IEC OUT Ess,"SCAN:RECEIVER:RANGE            60 dB"
2380     IEC OUT Ess,"SCAN:RECEIVER:PREAMPLIFIER     OFF"
2390     IEC OUT Ess,"SCAN:RECEIVER:GENERATOR        OFF"
2400 '
2410     IEC OUT Ess,"SCAN 2"
2420     IEC OUT Ess,"SCAN:RECEIVER:DETECTOR         PEAK"
2430     IEC OUT Ess,"SCAN:RECEIVER:BANDWIDTH:IF     120 kHz"
2440     IEC OUT Ess,"SCAN:RECEIVER:MEASUREMENT:TIME 20 ms"
2450     IEC OUT Ess,"SCAN:RECEIVER:ATTENUATION:AUTO ON"
2460     IEC OUT Ess,"SCAN:RECEIVER:ATTENUATION:MODE LOWNOISE"
2470     IEC OUT Ess,"SCAN:RECEIVER:RANGE            60 dB"
2480     IEC OUT Ess,"SCAN:RECEIVER:PREAMPLIFIER     OFF"
2490     IEC OUT Ess,"SCAN:RECEIVER:GENERATOR        OFF"
2500 '
2510 '
2520 RETURN
```

3.5.8 Scan Run with Subsequent Storing of the Measurement Results on Diskette

The built-in floppy disk drive offers the possibility of storing the measurement results also under IEC-bus control.
The frequency scan defined in a preceding example is performed. The end is recognized by the operation-complete mechanism already described above.
The receiver settings together with the results of RF analysis are then stored in a file on the built-in disk drive. Subsequent evaluation of the error register checks the error situations possible in connection with the disk drive.
The examples from sections 3.5.7 and 3.5.8, which are also used here, are no longer part of the program listing.

```
100 '-------------------------------
110 '        RF analysis
120 '-------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
180 '                                  Define settings for RF analysis
190    GOSUB Prog_scan
200 '
210 '                                  Execute scan
220    GOSUB Exec_scan
230 '
240 '
400    GOSUB Sto_results
410 '
420 END
1000 '-----------------------------------------------------
1010 '               store results on disk
1020 '-----------------------------------------------------
1030Sto_results:
1040 '
1050 '                                  define filename
1060    File$="RESULTS"
1070 '
1080    Srq%=0
1090 '
1100    IEC OUT ESS,"FLOPPY:STORE '"+File$+"', ALL;*OPC"
1110 '
1120 '                                  wait for operation complete
1130    REPEAT
1140    UNTIL Srq%
1150 '                                  error check
1160    IEC OUT Ess,"SYSTEM:ERROR?"
1170    IEC IN Ess,Error$
1180    Err=VAL(Error$)
1190 '
1200    IF Err=-250 THEN PRINT "cannot access drive"
1210    IF Err=-252 THEN PRINT "drive not ready"
1220    IF Err=-253 THEN PRINT "disk unusable"
1230    IF Err=-254 THEN PRINT "disk full"
1240    IF Err=-255 THEN PRINT "directory full"
1250    IF Err=-257 THEN PRINT "invalid filename"
1260    IF Err=-258 THEN PRINT "disk write protected"
1270 '
1280 RETURN
```

3.5.9 Synchronization with the End of Several Sweeps using *OPC

In this example the parameters are set for an IF analysis. A number of sweeps is subsequently started. The end of the sweeps is recognized by the operation-complete mechanism.

```
100 '--------------------------------
110 '      Execute IF Analysis
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Exec_analysis
180 '
190 END
1000 '-----------------------------------------------------
1010 '   Start IF Analysis and wait for Operation Complete
1020 '-----------------------------------------------------
1030Exec_analysis:
1060 '                                     Init SRQ-Routine
1070    ON SRQ1 GOSUB Srq_routine
1080 '                                     Config Registers
1090    IEC OUT Ess,"*CLS;*ESE 1;*SRE 32"
1100 '                                     Init SRQ-Flag
1110    Srq%=0
1120 '
1130 '                                     configure IF Analysis
1140    IEC OUT Ess,"MODE IF"
1150    IEC OUT Ess,"SPAN 2 MHz"
1160    IEC OUT Ess,"BANDWIDTH:RESOLUTION 10 kHz"
1170    IEC OUT Ess,"ATTENUATION:IF ON"
1180    IEC OUT Ess,"SWEEP:TIME 100 ms"
1190    IEC OUT Ess,"SWEEP:MODE MAXHOLD"
1200 '                                     start 20 Sweeps
1210    IEC OUT Ess,"SWEEP:RUN 20;*OPC"
1220 '
1230 '                                     Do something useful
1240 '                                     while sweeping
1250 '
1260    REPEAT
1270 '                                     Do something useful too
1280 '                                     or just wait
1290    UNTIL Srq%
1300 '                                     Sweep is completed
1310 RETURN
1320 '
```

3.5.10 Evaluation of IF Analysis Results using the Marker Functions

IF analysis is performed as described in the example before. The marker function "Marker to Peak" is then used to read out the highest value of the Max Hold curve.

```
100 '--------------------------------
110 '    IF Analysis with Marker
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170 '                                    Execute IF analysis
180    GOSUB Exec_analysis
190 '
200    GOSUB Marker_if
210 '
220 END
1000 '---------------------------------------------------
1010 '   Use IF Marker to get maximum value
1020 '---------------------------------------------------
1030Marker_if:
1090 '
1100 '                                   set marker to MAXHOLD
1110    IEC OUT Ess,"MARKER ON"
1120    IEC OUT Ess,"MARKER:CURVE 2"
1130 '
1140 '                                   marker -> peak
1150    IEC OUT Ess,"MARKER:PEAK"
1160 '
1170 '                                   get marker value
1180    IEC OUT Ess,"MARKER:POSITION?"
1190    IEC IN Ess,Marker$
1200 '
1210 '                                   print result
1300    PRINT Marker$
1310 '                                   print result
1320 RETURN
1330 '
```

3.5.11 Programming a Transducer Factor

A transducer factor for an antenna is stored as transducer factor No. 1 in this example. The name and unit are additionally specified.

```
100 '--------------------------------
110 '       Transducer Factor
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Prog_tfactor
180 '
190 END
1000 '-----------------------------------------------------
1010 '    Define Transducer Factor and activate
1020 '-----------------------------------------------------
1030Prog_tfactor:
1040    GOSUB Prolog
1050    GOSUB Init_ess
1060 '
1070 '                                  define values
1080 DIM Frequency(10)
1090 DIM Level(10)
1100 '
1110 Frequency(0)=20E6: Level(0)=15.7
1120 Frequency(1)=25E6: Level(1)=17.6
1130 Frequency(2)=30E6: Level(2)=13.6
1140 Frequency(3)=35E6: Level(3)=12.1
1150 Frequency(4)=40E6: Level(4)=12.2
1160 Frequency(5)=45E6: Level(5)=11.2
1170 Frequency(6)=50E6: Level(6)=10.3
1180 Frequency(7)=55E6: Level(7)=9.7
1190 Frequency(8)=60E6: Level(8)=8.2
1200 Frequency(9)=65E6: Level(9)=7.4
1210 '
1220 '
1230 '                                  select factor
1240    IEC OUT Ess,"TRANSDUCER:FACTOR 1"
1250 '
1260 '                                  transducer name
1270    IEC OUT Ess,"TRANSDUCER:FACTOR:TEXT 'antenna1'"
1280 '
1290 '                                  transducer unit
1300    IEC OUT Ess,"TRANSDUCER:FACTOR:UNIT DBUV_M"
1310 '
1320 '                                  build command string
1330 '
1340    Transducer$="10": '             number of values
1350    FOR I=0 TO 9 STEP 1
1360        Transducer$=Transducer$+","+STR$(Frequency(I))+","+STR$(Level(I))
1370    NEXT I
1380 '
1390 '                                  transmit factor
1400    IEC OUT Ess,"TRANSDUCER:FACTOR:DEFINE "+Transducer$
1410 '
1420 '                                  activate factor
1430    IEC OUT Ess,"TRANSDUCER:FACTOR:SELECT 1"
1440 '
1450 RETURN
1460 '
```

3.5.12 Programming a Transducer Set

A transducer set consisting of two ranges is created from transducer factors defined before.
The transducer factors used must be defined for the frequency range of the selected transducer set range.
In this example two factors each are put together to form a set range. These two factors might be an antenna with cable, for example.
The start frequency of the second range is defined by the stop frequency of the first range.

```
100 '--------------------------------
110 '      Transducer Set
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Prog_tset
180 '
190 END
1000 '--------------------------------------------------
1010 '    Define Transducer Set and activate
1020 '--------------------------------------------------
1030Prog_tset:
1040 '
1050 '                                   select set
1060    IEC OUT Ess,"TRANSDUCER:SET 1"
1070 '
1080 '                                   transducer set name
1090    IEC OUT Ess,"TRANSDUCER:SET:TEXT 'RFI test'"
1100 '
1110 '                                   transducer unit
1120    IEC OUT Ess,"TRANSDUCER:SET:UNIT DBUV_M"
1130 '
1140 '                                   define ranges
1150    IEC OUT Ess,"TRANSDUCER:SET:RANGES 2"
1160 '
1170 '                                   select transducer factor
1180 '                                   4 and 7 for range 1
1190    IEC OUT Ess,"TRANSDUCER:SET:RANGES:NUMBER 1"
1200    IEC OUT Ess,"TRANSDUCER:SET:RANGES:START  20 MHz"
1210    IEC OUT Ess,"TRANSDUCER:SET:RANGES:STOP   150 MHz"
1220    IEC OUT Ess,"TRANSDUCER:SET:RANGES:DEFINE 2,4,7"
1230 '
1240 '                                   select transducer factor
1250 '                                   5 and 9 for range 2
1260    IEC OUT Ess,"TRANSDUCER:SET:RANGES:NUMBER 2"
1270    IEC OUT Ess,"TRANSDUCER:SET:RANGES:STOP   500 MHz"
1280    IEC OUT Ess,"TRANSDUCER:SET:RANGES:DEFINE 2,5,9"
1290 '
1300 '                                   save set
1310    IEC OUT Ess,"TRANSDUCER:SET:SAVE"
1320 '                                   activate set
1330     IEC OUT Ess,"TRANSDUCER:SET:SELECT 1"
1340 '
1350 RETURN
1360 '
```

3.5.13 Output of a Test Report on Plotter

To enable the receiver to output a test report on plotter via IEC bus, the receiver must be the IEC-bus controller. If output is started by a process controller, the pass-control protocol is used for this purpose.

This means that the receiver is transferred IEC-bus control by the process controller. After completion of plotter output the controller function is returned by the ESS.
The receiver must previously be told the address of the process controller using pass-control-back command "*PCB address".

While the ESS has the controller function, the process controller is not disabled. IEC-bus functions requiring bus control are the only ones which cannot be performed by the process controller.

It waits for the receiver to return the controller function with the help of command "Wait Take Control" - WTCT.

```
100 '-------------------------------
110 '       Plot Test Report
120 '-------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170    GOSUB Plot_report
180 '
190 END
1000 '-------------------------------
1010 '       Plot_report
1020 '-------------------------------
1030Plot_report:
1120 '                                   Controller address
1130    Controller=30
1140 '
1150 '                                   configure for Pass Control Back
1160    IEC ADR Controller
1170    IEC OUT Ess,"*PCB "+STR$(Controller)
1180 '
1190 '                                   configure Test Report
1200 '                                   diagram and heading
1210    IEC OUT Ess,"PLOTTER:CONTENT:DEFAULT ON"
1220 '
1230 '                                   select pens
1240    IEC OUT Ess,"PLOTTER:SETUP:PEN ON"
1250    IEC OUT Ess,"PLOTTER:SETUP:PEN:GRID 2"
1260    IEC OUT Ess,"PLOTTER:SETUP:PEN:LIMIT 3"
1270    IEC OUT Ess,"PLOTTER:SETUP:PEN:CURVE1 4"
1280    IEC OUT Ess,"PLOTTER:SETUP:PEN:CURVE2 5"
1290    IEC OUT Ess,"PLOTTER:SETUP:PEN:TEXT 1"
1300    IEC OUT Ess,"PLOTTER:SETUP:PEN:DATE 4"
1310 '
1320 '                                   special scaling off
1330    IEC OUT Ess,"PLOTTER:SETUP:FORMAT OFF"
1340 '
1350 '                                   header
1360    IEC OUT Ess,"REPORT:HEADER:COMPANY       'Rohde & Schwarz'"
1370    IEC OUT Ess,"REPORT:HEADER:PROGRAM       'Conformance Test'"
1380    IEC OUT Ess,"REPORT:HEADER:EUT           'Machine'"
```

```
1390    IEC OUT Ess,"REPORT:HEADER:MANUFACTURER 'No Name'"
1400    IEC OUT Ess,"REPORT:HEADER:CONDITION    'green'"
1410    IEC OUT Ess,"REPORT:HEADER:OPERATOR     'M. Keller'"
1420    IEC OUT Ess,"REPORT:HEADER:SPEC         'internal #23'"
1430    IEC OUT Ess,"REPORT:HEADER:REMARK1      'comments'"
1440    IEC OUT Ess,"REPORT:HEADER:REMARK2      ''"

1450 '
1460 '                                     initiate Plot
1470    IEC OUT Ess,"PLOTTER:START"
1480 '                                     pass control to Receiver
1490    IEC TAD Ess: IEC TCT
1500 '                                     wait for plot complete
1510 '                                     and pass control back
1520    IEC WTCT
1530 '
1540    RETURN
1550 '
```

3.5.14 Block-Serial Output of the Scan Results in ASCII Format

In the following example a block-serial transfer of the measured values, which is proceeding with the measurement being executed, is carried out during the current RF analysis. The number of block elements to be simultaneously transferred is set to 20. "COMBINED" is selected for the type of data to be output, i.e. each level value measured is included in the data block together with all additional information. "ASCII" has been chosen as output format, i.e. the data are transferred in a string which can be read directly, e.g. "SCAN:BLOCK 0002,35,20000000,13.24,0,20100000,14.58,0". The first number indicates the number of following block elements, the second contains information on the composition of the block elements and is designated as template. All further numbers contain the actual measurement results, in this example frequency, level and the validity byte.

This format is most time-consuming in output, as the conversion of binary data into ASCII format requires a high amount of computing.

Extended event-status register ERD is used to indicate that enough new data have been collected. The status registers are set such that the setting of one bit in this register induces a service request. Thus the weighting of all this information is effected in the appertaining service-request routine.

A further bit of this register indicates that the last block has been transferred and thus supplies the signal for terminating the program. As soon as the poll of a block has been initiated using "SCAN:BLOCK?", the data are processed and formatted in the output buffer. In order to have sufficient time for that, the IEC-bus timeout is set to a value of 32 s.

Subroutines Prolog, Init_ess and Prog_scan have already been included in the preceding examples and are not listed here any more.

```
100 '-------------------------------------------
110 '   Transfer of Block Data in ASCII format
120 '-------------------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170 '                                    Define settings for RF analysis
180    GOSUB Prog_scan
190 '
200    GOSUB Exec_scan
210 '
220 '
230 END
3000 '---------------------------------------------------
3010 '     Execute Scan and wait for last block
3020 '---------------------------------------------------
3030Exec_scan:
3040 '                                 setup block format
3050    IEC OUT Ess,"SCAN:BLOCK:FORMAT  ASCII"
3060    IEC OUT Ess,"SCAN:BLOCK:ELEMENT COMBINED"
3070    IEC OUT Ess,"SCAN:BLOCK:COUNT   20"
3080 '                                 config registers
3090    IEC OUT Ess,"*CLS;*ESE 1;*SRE 33"
3100 '                                 enable all bits
3110    IEC OUT Ess,"ERDE 65535"
3120 '                                 init variable
3130    Erd=0
3140 '                                 waste previous results
3150    IEC OUT Ess,"SCAN:RESULTS:CLEAR"
3160 '                                 Init SRQ-Routine
3170    ON SRQ1 GOSUB Srq_routine
3180 '
3190    IEC OUT Ess,"SCAN:RUN;*OPC"
3200    PRINT "Scan is running"
3210 '
3220 '
3230    REPEAT
3240 '                                 Wait for last block
```

```
3250 '                                     of scan results
3260    UNTIL Erd AND 4
3270 '
3280    PRINT "Transfer completed"
3290 '
3300 RETURN
4000 '--------------------------------------------------
4010 '                 Get data block
4020 '--------------------------------------------------
4030Block_query:
4040 '                                     data query
4050   IEC OUT Ess,"SCAN:BLOCK?"
4060 '
4070 '                                     wait for data processing
4080   IEC TIME 32000
4090 '                                     get data
4100   IEC IN Ess,Block$
4110 '
4120 '                                     length of data block
4130   Count=LEN(Block$)
4140 '
4150 '
4160 RETURN
12000 '-------------------------------
12010 '    Service Request Routine
12020 '-------------------------------
12030Srq_routine:
12040 '                                    Serial Poll
12050  IEC SPL Ess,Sb%
12060 '                                    check SRQ bit
12070  IF (Sb% AND 64) THEN
12080 '---------------------------------- check ERD bit
12090     IF (Sb% AND 1) THEN
12100 '                                    read ERD register
12110        IEC OUT Ess,"ERD?"
12120        IEC IN Ess,Erd$
12130        Erd=VAL(Erd$)
12140        PRINT "ERD:";Erd
12150 '---------------------------------- check insufficient RAM bit
12160        IF (Erd AND 16) THEN
12170           PRINT "Insufficient RAM"
12180        ENDIF
12190 '---------------------------------- check data ready bit
12200        IF (Erd AND 128) THEN
12210 '                                    read data block
12220           GOSUB Block_query
12230           Sum=Sum+(Count-1)
12240 '                                    print results
12250           PRINT Block$
12260           PRINT
12270           PRINT "-->";Sum;" bytes up to now"
12280        ENDIF
12290     ENDIF
12300 '---------------------------------- check ESR Bit
12310     IF (Sb% AND 32) THEN
12320        PRINT "Operation complete"
12330 '                                    clear enable register
12340        IEC OUT Ess,"*ESE 0"
12350     ENDIF
12360  ELSE
12370 '---------------------------------- poll other devices
12380  ENDIF
12390 '                         enable SRQ Interrupt and return
12400 '                         in the same line to avoid nesting!
12410 '
12420 ON SRQ1 GOSUB Srq_routine: RETURN
```

3.5.15 Block-Serial Output of the Scan Results in Binary Format

In this example the data are output in binary format. Here weighting is somewhat more difficult because the binary data are combined without a significant delimiter. Further, some components of a block element cannot be assigned a fixed position in the data block, as the results can be composed differently depending on the receiver setting.

The routine listed subsequently first evaluates the first two bytes of the data block, they contain the number of block elements in the data string, and then the next two bytes from whose content the parts a block element consists of are evident.

The FOR-NEXT loop, which performs the actual analysis of the block elements, can be made so universal - using these two pieces of information - that it is true of all types of block data possible. The index% variable is a pointer which always points to the date in the result string to be analyzed next and is switched further according to the size of the respective date.

Thus this single procedure in an application program is sufficient to cover all cases.
The output of a header is switched off as it is not required and would only make the analysis of the data more complicated.

What is particular is the weighting of the frequency. The receiver transfers the values in IEEE format for floating-point variables at twice the accuracy. The R&S BASIC uses the same internal kind of display of floating-point numbers. Instead of a time-consuming conversion it is thus possible to copy the bytes of the result string directly into BASIC's internal memory of variables using the VARPTR and POKE commands.

This principle can also be used in other programming languages if they themselves or a library, which can be connected in addition, support the IEEE-Double-Precision format.

```
100 '--------------------------------------------
110 '   Transfer of Block Data in binary format
120 '--------------------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170 '                                  Define settings for RF analysis
180    GOSUB Prog_scan
190 '
200    GOSUB Exec_scan
210 '
220 '
230 END
3000 '-----------------------------------------------------
3010 '     Execute Scan and wait for last block
3020 '-----------------------------------------------------
3030Exec_scan:
3040 '                                 setup block format
3050    IEC OUT Ess,"SCAN:BLOCK:FORMAT  BINARY"
3060    IEC OUT Ess,"SCAN:BLOCK:ELEMENT COMBINED"
3070    IEC OUT Ess,"SCAN:BLOCK:COUNT   20"
3080 '                                 config registers
3090    IEC OUT Ess,"*CLS;*ESE 1;*SRE 33"
3100 '                                 enable all bits
3110    IEC OUT Ess,"ERDE 65535"
3120 '                                 init variable
3130    Erd=0
3140 '                                 waste previous results
```

```
3150    IEC OUT Ess,"SCAN:RESULTS:CLEAR"
3160 '                                   supress header
3170    IEC OUT Ess,"HEADER OFF"
3180 '                                   terminator EOI for binary data
3190    IEC TERM 1
3200 '                                   Init SRQ-Routine
3210    ON SRQ1 GOSUB Srq_routine
3220 '
3230    IEC OUT Ess,"SCAN:RUN;*OPC"
3240    PRINT "Scan is running"
3250 '
3260 '
3270    REPEAT
3280 '                                   Wait for last block
3290 '                                   of scan results
3300    UNTIL Erd AND 4
3310 '
3320    PRINT "Transfer completed"
3330 '
3340 RETURN
4000 '--------------------------------------------------------
4010 '                Get data block
4020 '--------------------------------------------------------
4030Block_query:
4040 '                                  data query
4050   IEC OUT Ess,"SCAN:BLOCK?"
4060 '
4070 '                                  wait for data processing
4080   IEC TIME 32000
4090 '                                  get data
4100   IEC IN Ess,Block$
4110 '
4120 '                                  length of data block
4130   Count=LEN(Block$)
4140 '
4150 '
4160 RETURN
5000 '--------------------------------------------------------
5010 '      Extract results from binary data block
5020 '--------------------------------------------------------
5030Block_analysis:
5040 '                                   get count of block elements
5050 '
5060    Num_of_elts%=ASC(LEFT$(Dump$,1))+ASC(MID$(Dump$,2,1))*256
5070    PRINT Num_of_elts%;" block elements received"
5080 '
5090 '                                   get template word
5100 '
5110    Template%=ASC(MID$(Dump$,3,1))+ASC(MID$(Dump$,4,1))*256
5120    PRINT "Template ";Template%
5130 '
5140    Index%=5: '                      pointer to block data
5150 '
5160 '------------------------------------ single block elements
5170    FOR I=1 TO Num_of_elts%
5180 '                                   8 byte frequency
5190 '------------------------------------ IEEE format
5200        IF Template% AND 1 THEN
```

```
5210            Addr=VARPTR(Freq)
5220            FOR J=0 TO 7
5230               POKE Addr+J,ASC(MID$(Dump$,Index%+J,1))
5240            NEXT J
5250            PRINT Freq,
5260            Index%=Index%+8
5270        ENDIF
5280 '------------------------------------ level, detector 1
5290        IF Template% AND 2 THEN
5300            Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5310            Level1=Lev%/100
5320            PRINT Level1,
5330            Index%=Index%+2
5340        ENDIF
5350 '------------------------------------ level, detector 2
5360        IF Template% AND 4 THEN
5370            Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5380            Level2=Lev%/100
5390            PRINT Level2,
5400            Index%=Index%+2
5410        ENDIF
5420 '------------------------------------ status word
5430        State%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5440        PRINT State%,
5450        Index%=Index%+2
5460 '------------------------------------ transducer
5470        IF Template% AND 64 THEN
5480            Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5490            Trd=Lev%/100
5500            PRINT Trd,
5510            Index%=Index%+2
5520        ENDIF
5530 '------------------------------------ limit byte
5540        IF Template% AND 128 THEN
5550            Lim%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5560            PRINT Lim%,
5570            Index%=Index%+2
5580        ENDIF
5590 '------------------------------------ limit 1
5600        IF Template% AND 256 THEN
5610            Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5620            Limit1=Lev%/100
5630            PRINT Limit1,
5640            Index%=Index%+2
5650        ENDIF
5660 '------------------------------------ limit 2
5670        IF Template% AND 512 THEN
5680            Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5690            Limit2=Lev%/100
5700            PRINT Limit2,
5710            Index%=Index%+2
5720        ENDIF
5730        PRINT
5740    NEXT I
5750 RETURN
12000 '--------------------------------
12010 '    Service Request Routine
12020 '--------------------------------
```

```
12030Srq_routine:
12040 '                                  Serial Poll
12050  IEC SPL Ess,Sb%
12060 '                                  check SRQ bit
12070  IF (Sb% AND 64) THEN
12080 '---------------------------------- check ERD bit
12090     IF (Sb% AND 1) THEN
12100 '                                  read ERD register
12110        IEC OUT Ess,"ERD?"
12120        IEC IN Ess,Erd$
12130        Erd=VAL(Erd$)
12140        PRINT "ERD:";Erd
12150 '---------------------------------- check insufficient RAM bit
12160        IF (Erd AND 16) THEN
12170           PRINT "Insufficient RAM"
12180        ENDIF
12190 '---------------------------------- check data ready bit
12200        IF (Erd AND 128) THEN
12210 '                                  read data block
12220           GOSUB Block_query
12230           Sum=Sum+(Count-1)
12240 '                                  convert binary data
12250           GOSUB Block_analysis
12260 '
12270           PRINT "-->";Sum;" bytes up to now"
12280        ENDIF
12290     ENDIF
12300 '---------------------------------- check ESR Bit
12310     IF (Sb% AND 32) THEN
12320        PRINT "Operation complete"
12330 '                                  clear enable register
12340        IEC OUT Ess,"*ESE 0"
12350     ENDIF
12360  ELSE
12370 '---------------------------------- poll other devices
12380  ENDIF
12390 '                        enable SRQ Interrupt and return
12400 '                        in the same line to avoid nesting!
12410 '
12420 ON SRQ1 GOSUB Srq_routine: RETURN
```

3.5.16 Block-Serial Output of Scan Results in the Internal Data Format (Dump)

With this format the weighting of results is very easy as the data with increasing frequency are simply sequenced successively.

The appertaining frequency can be calculated from start frequency, stop frequency and step width by the application program if required.

The service-request routine is designed such that it weighs event-status register ERD and can thus respond to which kind of results - detector 1, detector 2 or validity byte - is ready to be fetched. This means that this routine can be applied universally as well.

In comparison to the two others, this format offers the largest advantages as to speed on the receiver side as no formatting has to be performed. Contrary to the two data formats described before, the selection of the date to be transferred is effected immediately before polling the data block. This is necessary to ensure that access to all three kinds of results is possible during the scan. The data block can be fetched immediately after the command "SCAN:BLOCK?".

```
100 '-------------------------------------------
110 '   Transfer of unformatted Block Data
120 '-------------------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_ess
160 '
170 '                                 Define settings for RF analysis
180    GOSUB Prog_scan
190 '
200    GOSUB Exec_scan
210 '
220 '
230 END
3000 '----------------------------------------------------
3010 '     Execute Scan and wait for last block
3020 '----------------------------------------------------
3030Exec_scan:
3040 '                                setup block format
3050    IEC OUT Ess,"SCAN:BLOCK:FORMAT DUMP"
3060    IEC OUT Ess,"SCAN:BLOCK:COUNT  100"
3070 '                                config registers
3080    IEC OUT Ess,"*CLS;*ESE 1;*SRE 33"
3090 '                                enable all bits
3100    IEC OUT Ess,"ERDE 65535"
3110 '                                init variable
3120    Erd=0
3130 '                                waste previous results
3140    IEC OUT Ess,"SCAN:RESULTS:CLEAR"
3150 '                                terminator EOI for binary data
3160    IEC TERM 1
3170 '                                Init SRQ-Routine
3180    ON SRQ1 GOSUB Srq_routine
3190 '
3200    IEC OUT Ess,"SCAN:RUN;*OPC"
3210    PRINT "Scan is running"
3220 '
3230 '
3240    REPEAT
3250 '                                Wait for last block
```

```
3260 '                                       of scan results
3270    UNTIL Erd AND 4
3280 '
3290    PRINT "Transfer completed"
3300 '
3310 RETURN
4000 '--------------------------------------------------------
4010 '                  Get data block
4020 '--------------------------------------------------------
4030Block_query:
4040 '                                      data query
4050   IEC OUT Ess,"SCAN:BLOCK?"
4060 '
4070 '                                      get data
4080   IEC IN Ess,Block$
4090 '
4100 '                                      length of data block
4110   Count=LEN(Block$)
4120 '
4130 '
4140 RETURN
12000 '--------------------------------
12010 '    Service Request Routine
12020 '--------------------------------
12030Srq_routine:
12040 '                                     serial poll
12050  IEC SPL Ess,Sb%
12060 '                                     check SRQ bit
12070  IF (Sb% AND 64) THEN
12080 '---------------------------------- check ERD bit
12090     IF (Sb% AND 1) THEN
12100 '                                     read ERD register
12110        IEC OUT Ess,"ERD?"
12120        IEC IN Ess,Erd$
12130        Erd=VAL(Erd$)
12140        PRINT "ERD:";Erd
12150 '---------------------------------- check insufficient RAM bit
12160        IF (Erd AND 16) THEN
12170           PRINT "Insufficient RAM"
12180        ENDIF
12190 '---------------------------------- check data ready bit detector 1
12200        IF (Erd AND 128) THEN
12210 '                                     configure for detector 1
12220           IEC OUT Ess,"SCAN:BLOCK:ELEMENT DET1"
12230           PRINT "Detecor 1: ";
12240 '                                     get data block
12250           GOSUB Block_query
12260           Sum=Sum+Count/2
12270 '                                     print level values
12280           FOR I=1 TO Count/2
12290              Lev%=ASC(MID$(Block$,I*2-1,1))+ASC(MID$(Block$,I*2,1))*256
12300 '                                     1/100 dB resolution; signed
12310              Level=Lev%/100
12320              PRINT USING "-###.## ";Level;" ";
12330           NEXT
12340           PRINT
12350           PRINT "-->";Sum;" values up to now"
12360        ENDIF
```

```
12370 '----------------------------------- check data ready bit detector 2
12380       IF (Erd AND 64) THEN
12390 '                                    configure for detector 2
12400          IEC OUT Ess,"SCAN:BLOCK:ELEMENT DET2"
12410          PRINT "Detecor 2: ";
12420 '                                    get data block
12430          GOSUB Block_query
12440 '                                    print level values
12450          FOR I=1 TO Count/2
12460             Lev%=ASC(MID$(Block$,I*2-1,1))+ASC(MID$(Block$,I*2,1))*256
12470 '                                    1/100 dB resolution; signed
12480             Level=Lev%/100
12490             PRINT USING "-###.## ";Level;" ";
12500          NEXT
12510          PRINT
12520       ENDIF
12530 '----------------------------------- check data ready bit validity
12540       IF (Erd AND 32) THEN
12550 '                                    configure for validity byte
12560          IEC OUT Ess,"SCAN:BLOCK:ELEMENT VALID"
12570          PRINT "Validity:  ";
12580 '                                    get data block
12590          GOSUB Block_query
12600 '                                    print validity bytes
12610          FOR I=1 TO Count
12620             PRINT USING "###";(ASC(MID$(Block$,I,1)));"     ";
12630          NEXT
12640          PRINT
12650       ENDIF
12660    ENDIF
12670 '----------------------------------- check ESR bit
12680    IF (Sb% AND 32) THEN
12690       PRINT "Operation complete"
12700       IEC OUT Ess,"*ESE 0"
12710    ENDIF
12720 ELSE
12730 '----------------------------------- poll other devices
12740 ENDIF
12750 '                        enable SRQ Interrupt and return
12760 '                        in the same line to avoid nesting!
12770 '
12780 ON SRQ1 GOSUB Srq_routine: RETURN
```

4 Maintenance and Troubleshooting

4.1 Maintenance

4.1.1 Mechanical Maintenance

The ESS 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 generators, a high long-term stability of the level measurement characteristics, which exclusively depends on the aging of the calibration generators, is ensured. The measurement accuracy should be checked once a year according to section 5.2.6.1.1. The re-adjustments of the calibration generators 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. There are various ways of testing and adjusting the frequency accuracy depending on the design of the reference oscillator:

a) ESS without ESS-B1 option fitted (Oven-controlled Reference Oscillator)

- Remove the instrument cover (cf. section 4.3)
- Connect the frequency counter (error $< 1\times10^{-8}$) to the socket X165 (fig. 4-1).

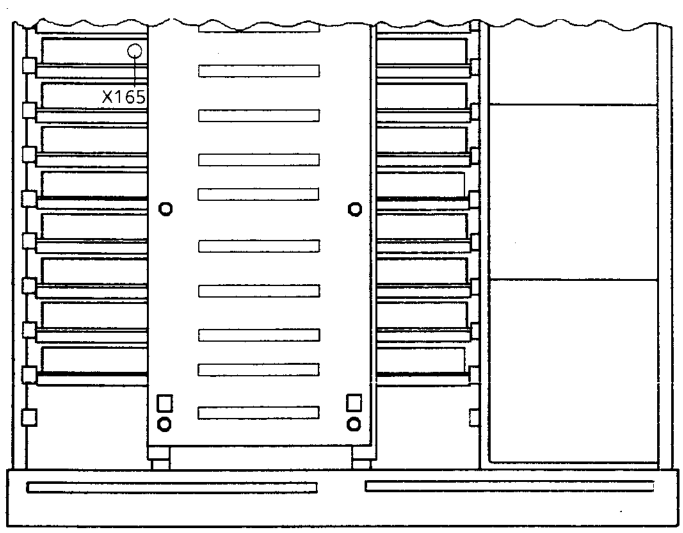


Fig. 4-1 Location of the socket X165 (instrument seen from below)

▸ Adjust the frequency accuracy to 64 MHz ± 10 Hz using the potentiometer VCXO TUNING (fig. 4-2).

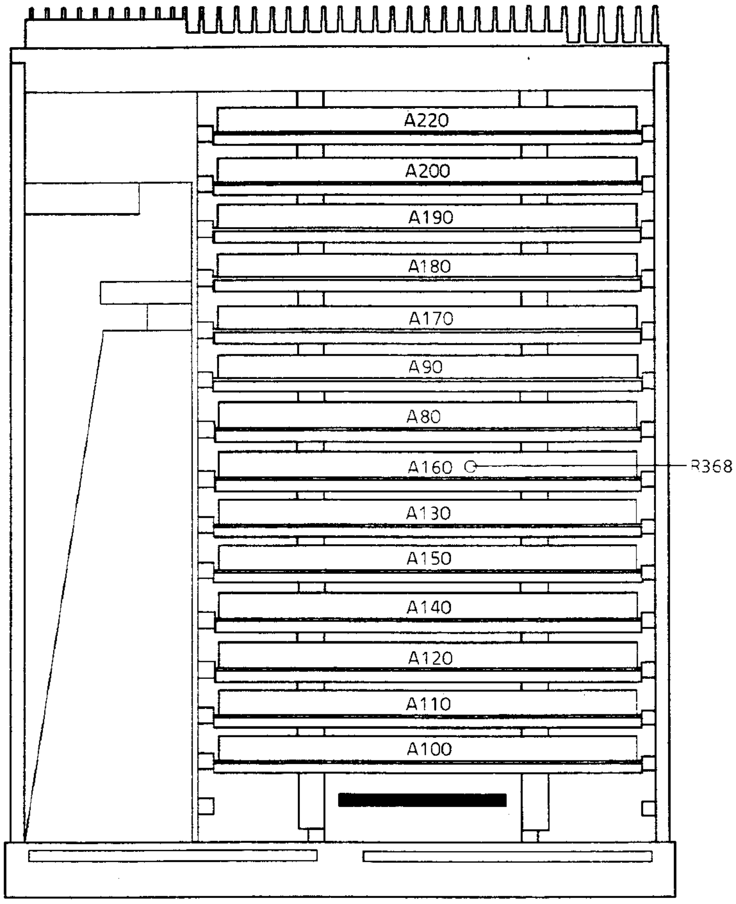


Fig. 4-2 Location of the potentiometer VCXO TUNING, R368 (instrument seen from above)

b) ESS with ESS-B1 option (Oven-controlled Reference Oscillator)

▸ Remove the instrument cover (see section 4.3).

▸ Connect the frequency counter (error < $1x10^{-8}$) to the REF OUT IN socket (rear panel).

▸ Adjust the frequency accuracy to 64 MHz ± 1.1 Hz using potentiometer OCXO TUNING (fig. 4-3).

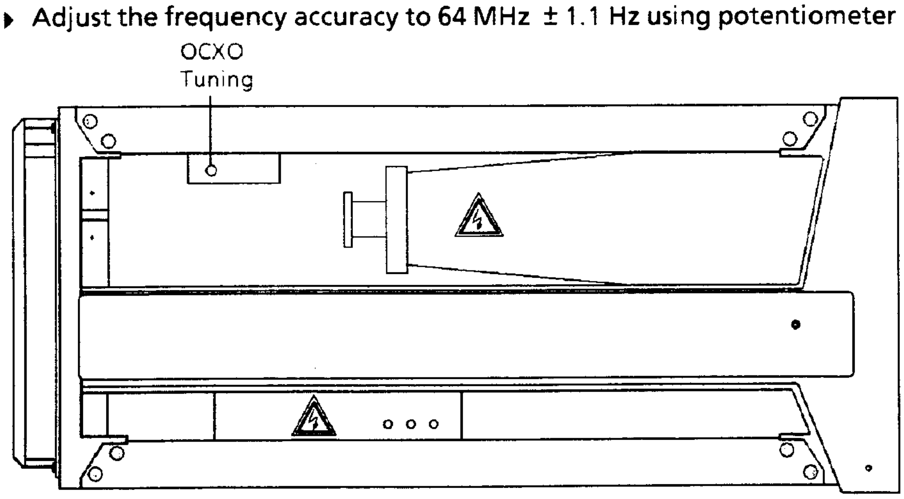


Fig. 4-3 Position of potentiometer OCXO TUNING, R368 (lateral view on instrument)

4.1.3 Replacing the Back-up Battery

The instrument contains a lithium battery for buffering the static RAM. The durability at normal ambient temperatures (<30 °C) is approx. 5 years. The back-up battery is located on the A220 module (CPU BOARD).

With the instrument being switched on the battery voltage is monitored. Decreasing voltage is indicated on the screen by the message *RAM Batt Low* after power-up. To avoid the loss of internally stored data the back-up battery can be replaced with the instrument being switched on:

- Withdraw the instrument cover.
- 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. 4-4).

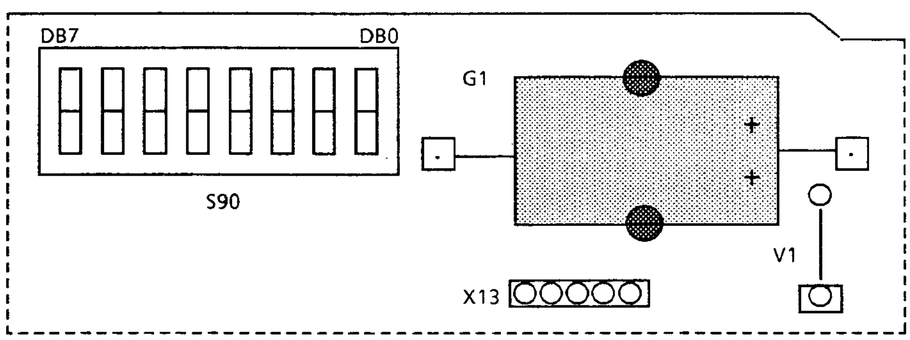


Fig. 4-4 Mounting position of the battery and DIP switch S90 for setting of the receiver configuration (cf. section 4.3.4)

4.2 Function Check and Self-Test

The ESS features extensive equipment for checks and self-test, which allow comprehensive control of the receiver functions. If there is a fault, the instrument itself is able to locate the defective 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 equipment is 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, power supply and video unit 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 performed by polling the contents of a memory location. The following 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 ESS.

4.2.2 Cold Start

An extended test of the CPU board 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 ESS.

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 defective function unit can be obtained by calling the self-test after having switched off and on again the ESS.

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, Power Supply and Video Unit

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*
- *1. LO UHF unlock*
- *2. LO UHF unlock*
- *10.62 MHz LO unlock* (only with IF bandwidths from 50 Hz to 1 kHz in the frequency range over 9 kHz)
- *4. LO unlock* (only with IF bandwidths from 2 Hz to 1 kHz)
- *LO IF Analysis unlock* (only with IF analysis switched on)
- *HF Tracking Gen unlock* (only with tracking generator switched on)
- *UHF Tracking Gen unlock* (only with tracking generator switched on)

A fault in a synthesizer module causes the corresponding error message to be displayed until a receiver setting not requiring the defective circuit component is selected.

Example: When setting a bandwidth between 2 Hz and 1 kHz is acknowledged by the error message *10.62 MHz LO unlock*, measurements using this bandwidth are not possible. The error message disappears again when a bandwidth in the range from 10 kHz to 1 MHz is set, where the ESS again supplies valid measurement results.

A hint as to the faulty module can be obtained by calling the self-test. If the level applied to the EXT REF INPUT socket is too small, the message *WARN:EXT REF LEV* is read out on the DATA INPUT display.

If the reference signal has a frequency not suitable for the ESS, the message *WARN:EXT REF FREQ* is indicated on the DATA INPUT display.

The internal supply voltages are checked both following switch-on of the instrument and permanently during 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 departs from its nominal value as well as when there is a short-circuit in the instrument or in one of the accessories supplied by the ESS. 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.

The supply voltages, which are required for operation of the cathode-ray tube and deflection amplifier and are generated in the Video Unit module, are also permanently monitored independently of the controller. As a defect in this module does not result in an error message on the screen, the LED HV SUPPLY NOT READY lights up in this case. The LED is located next to the Video Unit board and is only visible after removal of the instrument cover.

4.2.4 Self-Test

The self-test allows you 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 generators produce 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, check 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 screen.

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),
- IFPAS CONTROLLER (serial interface for control of the modules) or
- CMOS RAM (non-volatile data memory),

the instrument may not be able to output a detailed error message; the screen remains dark; the instrument can no longer be operated.

An error occurring in one of the function blocks

- DRAM (volatile data memory),
- MUART (multi-function device),
- INTERRUPT CONTROLLER or
- A/D converter

leads to the output of the message *ERR: CPU BOARD;* the instrument can no longer be operated in order to prevent faulty measurements.

A faulty function in one of the blocks

- REAL TIME CLOCK,
- 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 defective module the message *ERR:CPU BOARD* appears.
If there is no error, it is indicated by *CPU BOARD ok*.

b) Testing the Graphic Board

After the CPU Board the Graphic Board is checked as to its correct functioning. In the case of certain defects no error message can be output on the screen; it remains dark. If the output of a message is possible, the hint *ERROR:CPU BOARD* is read out. With a defect in the A/D converter for IF analysis, which is also located on the Graphic Board, IF analysis mode is no longer possible, all other receiver functions can however still be used. An error of this kind is indicated on the screen by the message *ERROR: ADC IF Ana*. Correct operation of the module is acknowledged by the ESS by *Graphic Board ok*.

c) Supply Voltage Test

The device-internal supply voltages +5 V, +10 V, -10 V and +28 V are then checked. The following messages are output on the DATA INPUT display, if the permissible ranges are exceeded:

- *ERR: +5 V*,
- *ERR: +10 V*,
- *ERR:-10 V* or
- *ERR: +28 V*;

the self-test is aborted and the message *"Test aborted"* is read out.

d) 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 ESS contains three 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 SYNTHESIZER) includes the first oscillator for the frequency range of 9 kHz to 30 MHz and the appertaining control loop.

The module A120 (UHF SYNTHESIZER) contains the VCO for controlling the first mixer from 30 MHz, the step recovery diodes multiplier circuit, sampling mixer and both a digital and analog control 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*, *ERR:HF Synth* or *ERR:UHF Synth*; the self-test is aborted and the hint *"Test aborted"* appears.

Subsequently the second conversion oscillator, which is contained on the module A 130 (2ND MIXER), and the associated control loop are checked. The message *ERR:2nd Mixer, Test aborted* is output on the screen, when there are deviations from the nominal frequency or the oscillator level falls below that required for operation of the 2nd mixer.

After the successful completion of all synthesizer tests, *"Synth Boards ok"* appears on the screen.

e) 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:

Two calibration generators providing the test signals for checking the signal-processing stages are located on the module A130 (2ND MIXER). Correct operation of the calibration generators being a prerequisite for testing the signal path, the output level and level control of the 64-MHz generator are first checked. The signal flow via the attenuator, preselection filters, preamplifier, 1st mixer and 1st 1354.7-MHz IF amplifier is checked by means of a level detector; furthermore module-internal supply voltages, the operating points of the preamplifier and of the 1st IF amplifier and the tuning voltage of the variable preselection filters are checked. Any errors detected are read out on the screen with the message *"ERR: ATTENUATOR" or "ERR:VHF PRESELECTOR", "Test aborted".*

The calibration generator available on the module A140 (HF MODULE) generates the test signal required for checking the signal-processing stages in the frequency range below 30 MHz. The signal flow via the preselection filters and the 1st mixer is checked by means of a level detector. Furthermore, the internal supply voltages, operating point of the 1st IF amplifier and the oscillator level at the 1st mixer input are furthermore checked. On the detection of a fault, the message *ERR HF Module, Test aborted* is read out on the screen.

To begin with, the d.c. operating points of the 2nd 1354.7-MHz IF amplifier and of the 74.7-MHz IF amplifier are checked on the module A130 (2ND MIXER); the control loop and the output level of the 2nd conversion oscillator (2nd LO LOOP) are subsequently tested. The output level of the LO amplifier for control of the 3rd mixer is then checked. In the case of an error the message *"ERR:"2ND MIXER", "Test aborted* is output.

The self-test of the module A170 (IF SELECTION BOARD) starts by examining the operating points of the 10.7-MHz IF amplifier. The signal level applied to the module input is scanned by a level detector. The signal flow via the IF amplifiers and main selection filters is tested by measuring the d.c. levels applied to the demodulator output. In addition the IF gain correction that can be set digitally is tested. In the case of an error the message *"ERR:IF SELECTION BD", "Test aborted"* is output on the screen.

The module A180 (DETECTOR BOARD) is then tested. After having tested the module-internal supply voltages a level detector checks the 10.7-MHz input level of the listener path. The average value (AV), peak value (PK) and quasi-peak (QP) detectors are subsequently examined. After that the logarithmic amplifier is tested. Finally the control circuit for the analog meter and the transducer correction are tested. If there is a faulty function, the message *"ERR:DETECTOR BOARD", "Test aborted"* is indicated on the screen.

The module A80 (LF MODULE) contains the signal processing for receiver frequencies below 9 kHz and the balanced input. Any defect in this module causes the message *"ERR: LF MODULE"* to be output.

In the module A90 (IF 80 KHZ), the IF bandwidths 2 Hz to 1 kHz have been implemented using a digital signal processor. Any defect in this module causes the message *"ERR: IF 80 kHz"* to be output.

After successful completion of the board test in the signal path, a total calibration of the instrument is performed to check the measurement characteristics. If any tolerance is exceeded, a hint as to the faulty module is output. The message *Signal Path ok* is displayed, when no error has been detected.

f) Testing the IF Analysis

The self-test of the A190 module (IF Analysis) starts by checking the module-internal supply voltages which are only available with the module being switched on. After the IF input level has been checked, the function test of the synthesizer is performed. The self-test of this module is completed by a check on the IF signal path with the various resolution bandwidths and by the test of the input attenuator. Any defect is indicated on the screen by *ERROR: IF Analysis*. The self-test is not aborted since it does not impair operation of the other boards in the ESS. The message *IF Analysis ok* is displayed, if no error has been detected.

g) Testing the Tracking Generator

The test of the HF tracking generator (on the HF SYNTHESIZER module, A150) and UHF tracking generator (A100) also starts by checking the module-internal supply voltages which are only available with the generator being switched on. The oscillator level and level control are then checked. Afterwards the function of the 1354.7-MHz PLL and PLL for processing of the 100-kHz reference signal is examined. In the event of an error the message *ERR: UHF Tracking Generator* or, respectively, *ERR: HF Tracking Generator* is displayed on the screen. The operability of the other modules in the instrument is not impaired. Correct operation of this module is indicated by the message *UHF Tracking Generator ok* or, as the case may be, *HF Tracking Generator ok*.

The ESS acknowledges termination of the self-test by *Selftest complete*. Correct operation of the complete instrument is indicated by the additional message *Instrument ok*. The ESS subsequently returns to its normal operating mode. The complete self-test, if terminated by *Instrument ok*, takes about 120 seconds.

4.3 Replacing the Modules

4.3.1 Opening the Instrument

- Switch off the instrument and remove the power plug.
- Unscrew the 4 Phillips 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.

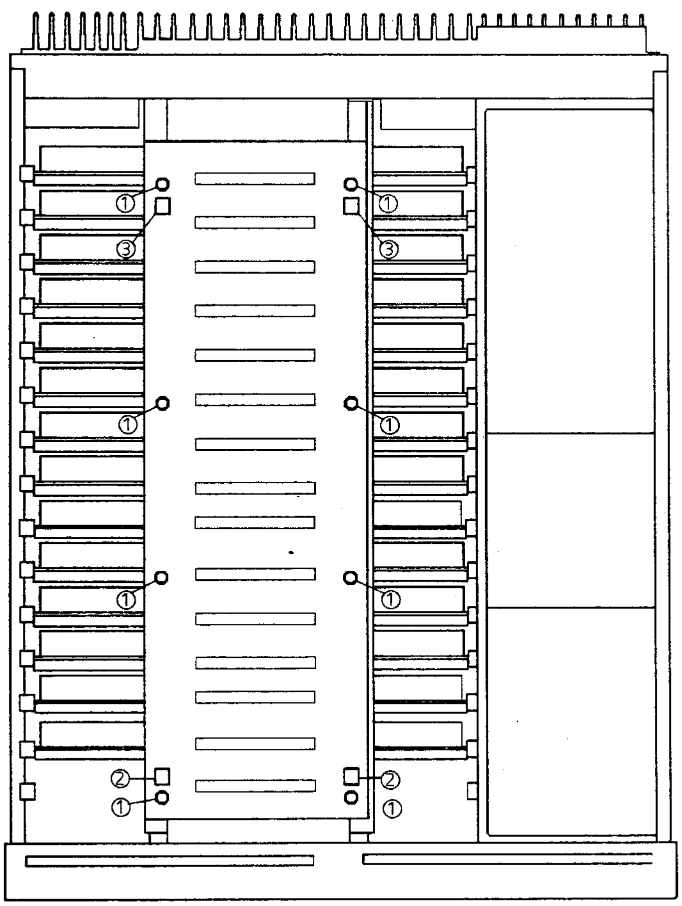


Fig. 4-6 Opened instrument seen from below

- Unscrew 6 Phillips 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 BOARD:
  - Remove two ribbon cables at the bottom and one ribbon cable on the top side of the module.
- Removing the other modules:

- Remove the SMB-RF connector from the module to be replaced; with the VHF PRESELECTOR module unscrew the SMA-RF connector.

- 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. Take care that the cables will not be squeezed. The upper side of each module (identifiable by the cover with service labelling) must point to the rear panel.

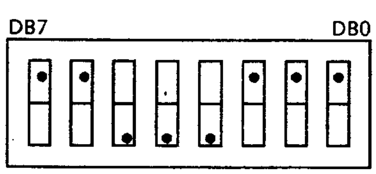
- Plug the SMA/SMB-RF connector or ribbon cable again onto its place in line with the labelling. With correctly connected RF cabling, the cables must not cross each other.

- Slide without effort the module locking rails ③ toward the rear panel using a slotted screwdriver (cf. notes "BOARDS LOCK"). If the locking rails cannot be slid easily, the module has been incorrectly inserted

- Tighten the 6 Phillips screws ①.

4.3.4 Taking the Receiver into Operation after the Replacement of a Module

- After the replacement of the CPU BOARD module set the DIP switch as follows using a pointed tool:



S90

● ≙ Switch held down

Fig. 4-7 DIP switch

- Switch on the receiver.

▮ *Caution! Mind the safety regulations for operation of the instrument without cover! In proximity to the cathode-ray tube (high-voltage connection, PCB at CRT base) hazardous voltages occur and may even remain after the instrument has been switched off.* ▮

- Press Config key and select the Self-test submenu by pressing the Self-test softkey in the Config menu.

Note: *Following the replacement of the modules **HF SYNTHESIZER 2, HF MODULE, LF MODULE, UHF SYNTHESIZER, FRN SYNTHESIZER, UHF TRACKING GENERATOR** and **CPU BOARD** no adjustment is required. Replacing the GRAPHIC BOARD is possible, several settings must however be performed on the cathode-ray tube in order to achieve optimum picture quality. We therefore recommend having the module replaced in an R&S servicing shop.*

In the case of a defect on the VIDEO UNIT module, repair or replacement must always be performed in an R&S servicing shop for safety reasons.

- Only when replacing the modules **VHF PRESELECTOR, 2ND MIXER** or **IF SELECTION BOARD**:

  - Call the *IF Gain Adj* function in the self-test menu and activate by pressing one of the ENTER keys.

  - With the LEVEL display indicating a value in the range of 89.0 to 91.0 dBµV, no re-adjustment is necessary.

  - In the case of an indication outside this range the level display must be set to 90 dBµV ± 0.2 dB by turning the potentiometer IF GAIN ADJ R300 (cf. fig. 4-8).

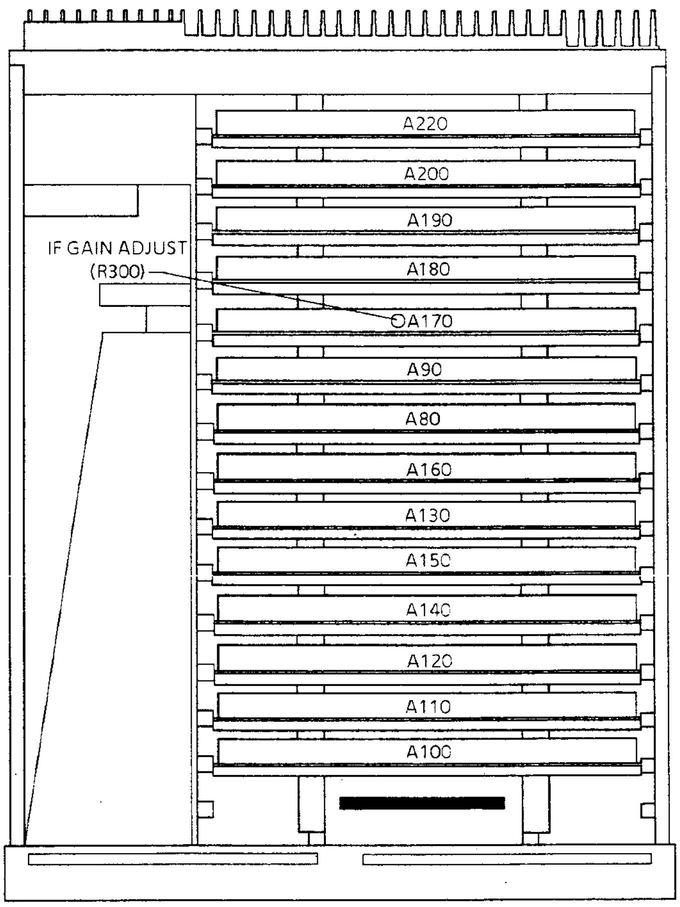


Fig. 4-8 Position of the potentiometer IF GAIN ADJUST, R300 (instrument seen from above)

- Start self-test.
  When all the modules operate correctly and the RF cabling has been connected properly, the message *Instrument ok* is read out on the screen after completion of the self-test.

- Only when replacing the **DETECTOR BOARD** module:

  - Call the *Meter Adj* function in the self-test menu and activate by pressing one of the Enter keys.

  - Turn the potentiometer "METER FULL SCALE" R654 ② (fig. 4-9) such that the meter display is identical with the 50-dB mark.

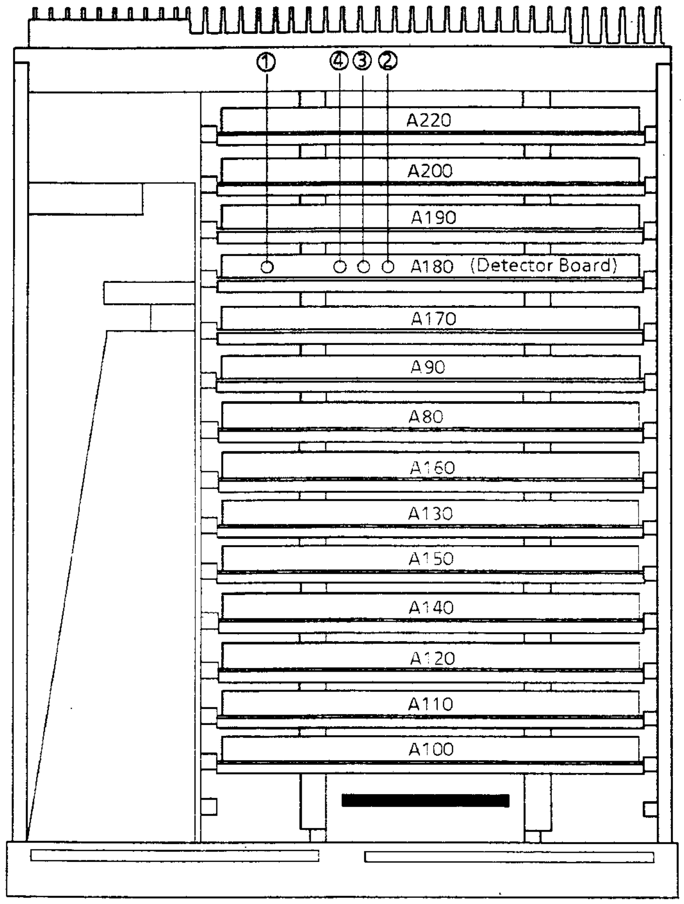


Fig. 4-9 Position of the adjustment points for the DETECTOR BOARD module

- Set RF attenuation to 80 dB.
- Set the needle to 0 dB using the potentiometer "METER ZERO 60 dB" (R 631) ③.
- Set the OP RANGE to 30 dB.
- Set the needle to 0 dB using the potentiometer "METER ZERO 30 dB" (R 630) ④.
- Set the RF attenuation to 50 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 METER SPEED (R 652) ① such that the needle of the analog meter overshoots by one needle width when the calibration generator is activated.
- Reselect *Meter Adj* function and switch off by pressing one of the two Enter keys.
- Only with replacement of the **IF ANALYSIS** module:
  - Switch on *IF Gain Adjust* function in the self-test menu.
  - Press IF key.
    IF analysis is started.
  - Set span to 100 kHz, Atten 20 dB.
  - Press Marker key.

No adjustment is required if the IF marker indicates a level in the range of 59 to 61 dB.

▸ If this range is exceeded, set the marker level to 60 dB ± 0.2 dB by turning the potentiomenter GAIN (R293) (cf. fig. 4-10).

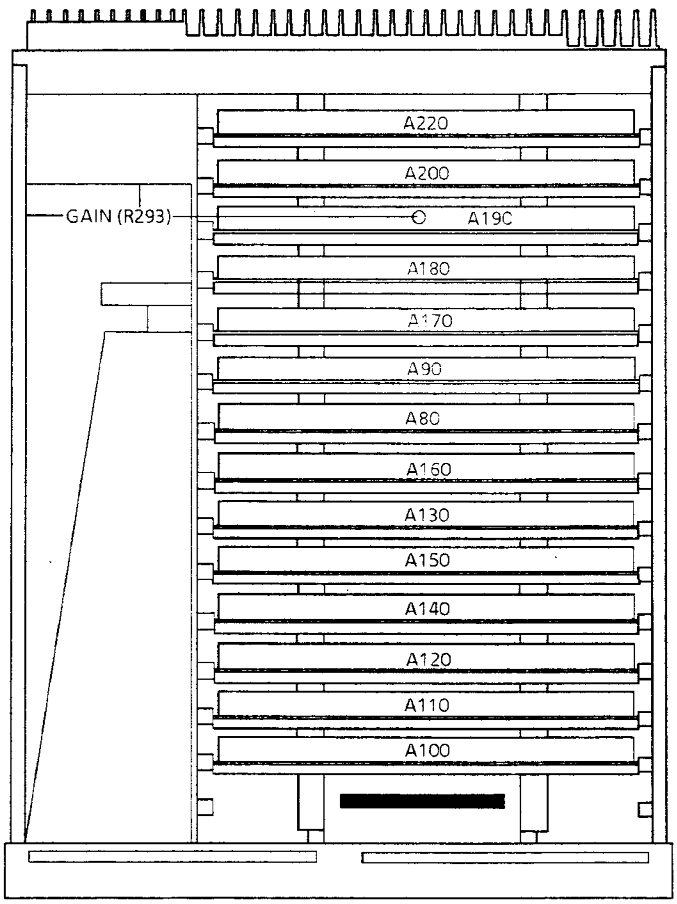


Fig. 4-10 Position of the potentiomenter GAIN R293

▸ Call the self-test menu again and switch off the *IF Gain Adjust* function.

▸ Only for replacement of the modules **IF 80 kHz**:

▸ Set the receiver frequency to 1 kHz.

▸ Switch on the function *IF GAIN ADJUST* in the self-test menu.

▸ Set the indicated level to 60 dBµV ± 0.2 dB by turning the potentiomenter GAIN (R153, see fig. 4-11).

▸ Set RF attenuation to 80 dB.

▸ Set the indicated level to 0 dBµV ± 0.3 dB by turning the potentiomenter OFFSET ADJ (R387, see fig. 4-11).

▸ Invoke the self-test menu again and switch off the *IF Gain Adjust* function.

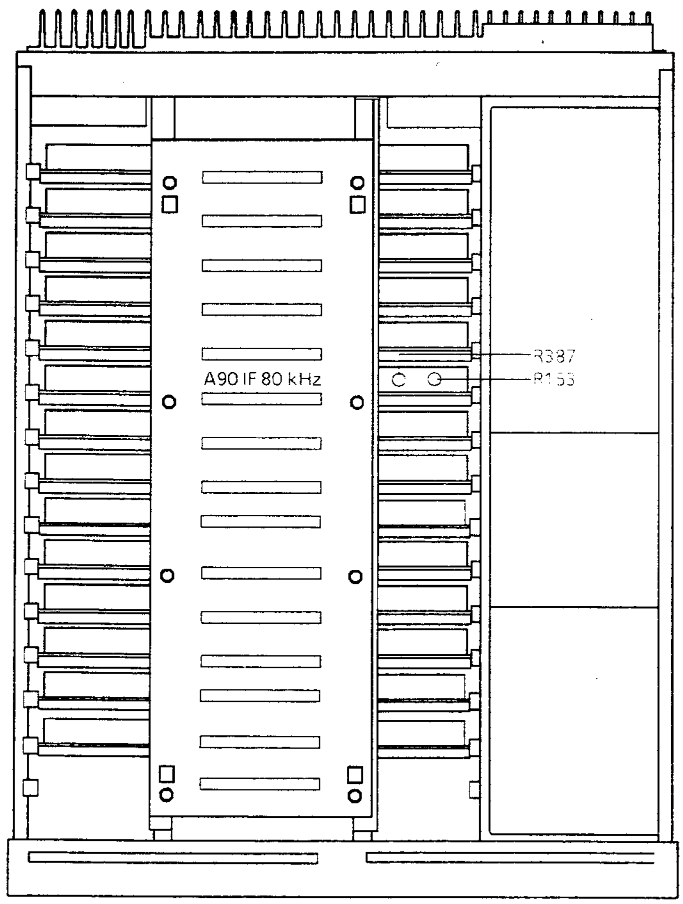


Fig. 4-11 Position of the potentiometers R153 and R387

4.4 Notes for Loading the Instrument Firmware

4.4.1 Introduction

The instrument firmware for test receivers ESS, ESHS, ESVS and ESVD is stored in non-volatile FLASH memories, which can be erased and reprogrammed inside the instrument. To carry out a firmware update, it is thus no longer necessary to open the instrument in order to exchange the components. Loading is effected by means of the "FLASHUP.EXE" program from a personal computer (AT) via the serial RS232 interface.

4.4.2 Hardware Requirements

Firmware loading program FLASHUP.EXE can be executed on any personal computer conforming to industrial standard. The hardware must comprise a floppy disk drive (3$^{1}/_{2}$" or 5$^{1}/_{4}$") as well as an RS232 interface. The use of a hard disk is recommended. No demands are made on the screen.

Each serial standard interface cable comprising a 25-pin male and a 9-pin female connector can be used to connect the test receiver to the PC, a complete wiring (cf. Fig. 4-10) being mandatory. Rohde & Schwarz offer a corresponding cable under order no. 816.1096.00 (included in service kit EZ-8)

4.4.3 Files for FLASHUP

The program package for transferring the firmware consists of the following files:

FLASHUP.EXE	main program
FLASHUPD.MSG	help texts (German)
FLASHUPD.NDX	index for German help texts
FLASHUPE.MSG	help texts (English)
FLASHUPE.NDX	index for English help texts

There are separate files for the different test receiver series ESXS10, ESXS30 and ESS in which the instrument firmware to be loaded is stored:

ESXS10.Hxx	for test receivers ESHS10 / ESVS10 / ESVD
ESXS30.Hxx	for ESHS / ESVS models 20 and 30
ESS.Hxx	for ESS

"xx" denotes a 2-digit number which is different for each firmware version.

A disk contains one of these files together with the FLASHUP program package and the release notes in which the changes and extensions of the respective firmware version are listed in brief.

4.4.4 Installation

a) Loading from the Floppy Disk Drive

- Insert floppy disk into drive A: or B:and call the program:

```
C:\>a:flashup
```

b) Loading from the Hard Disk

- Copy firmware loading program FLASHUP.EXE to a hard disk: Making a separate subdirectory is recommended.
- Insert the floppy disk containing the FLASHUP.EXE file or B: and start copying.

Example:

```
C:\>md flash
C:\>cd flash
C:\FLASH>copy a:*.* c:
```

A higher processing rate is achieved additionally if the firmware to be loaded (i.e. the ESS.Hxx file) is also copied to the hard disk.

4.4.5 Starting the Firmware Loading Procedure

Using this alternative, the execution time for the loading procedure of the instrument firmware can be shortened substantially. First the complete contents of the floppy disk has to be copied to the hard disk. Making a separate subdirectory on the hard disk is recommended

- Connect the PC to the test receiver by means of a cable.
- Switch off test receiver.
- Call *FLASHUP* program.
- Move the cursor between the different menu items by means of ← or → keys.
- Press ENTER key.
  A pull down window is displayed.
- Select the menu items using ↑ or ↓ keys.
- Press ENTER key.
  The function selected is executed or a parameter set.

The menu bar is reached or a current process aborted using the ESC key.

Help texts: A brief explanation about the contents of each function is given in the bottom line of the screen. Detailed help texts are available using the function key [F1]. The window opened can be closed again using the ESC key.

Error messages: The FLASHUP program supervises the firmware loading process which is protected by a defined protocol and by a check sum procedure. Whenever an error occurs during the transfer, the user is informed about the problem in a special window. As far as possible, the program gives hints on how to solve the problem.

Initialization:

- Select the firmware file to be loaded using menu item *File Select HEX-File* .

- Press ENTER.
  The name of the file which was loaded last (if there is any) is displayed. If no file has been loaded, a selection list can be set up by simultaneously pressing the CTRL (or Strg) and ENTER keys. The drive can be changed by pressing the [F3] function key. This is necessary if the firmware is to be loaded from the floppy disk.

- Select the file using the cursor keys and confirm using ENTER.

- Select the serial interface at the PC to which the cable is connected (COM1 to COM4) and set the baud rate. The other RS232 parameters (word length, start/stop bit, etc.) are fixedly set.

The language for outputting help texts and error messages can be chosen between German and English.

The extensions and changes the firmware version contains are displayed under menu item *Info - Release Notes* (German or English).

Note: *All program parameters (set baud rate, HEX-file loaded, etc.) are saved in the FLASHUP.INI file and stored anew when exiting the program using QUIT.*

- Starting the loading procedure:

  - Select menu item *Execute* using the cursor keys.

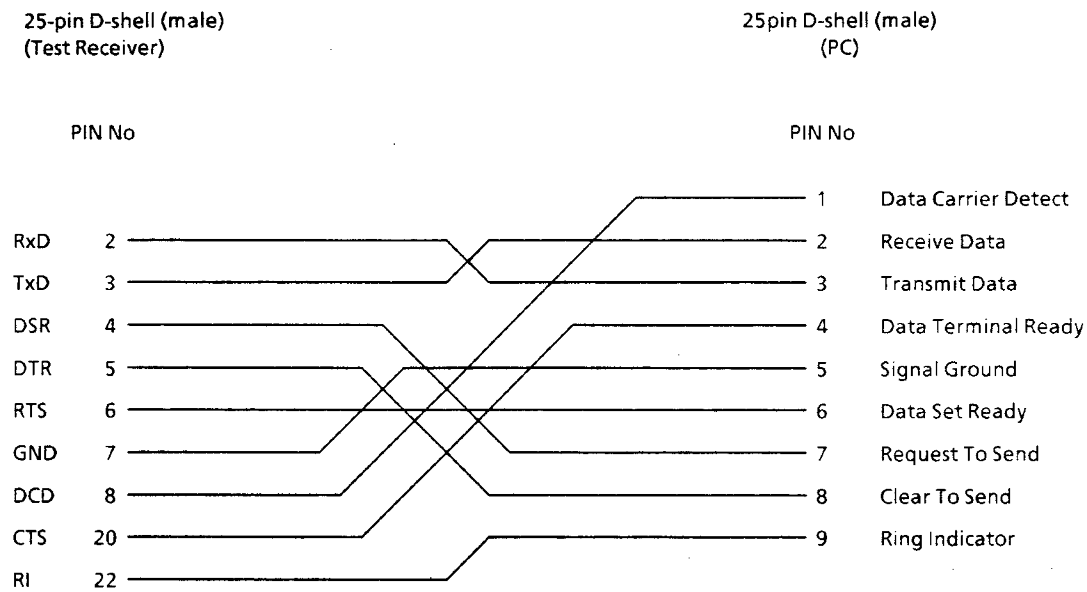
  - The firmware loading procedure is started by pressing the ENTER key twice.

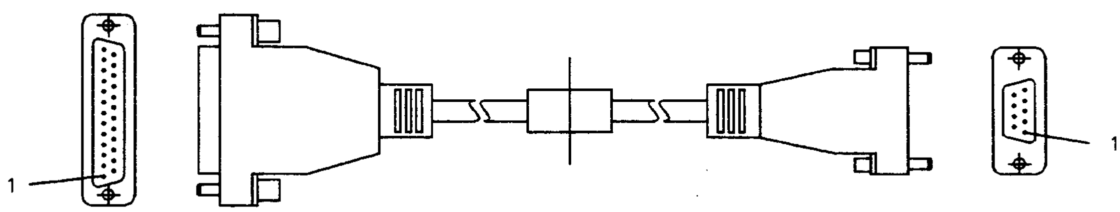
- Switch on test receiver.
  The loading procedure runs automatically, the run is displayed by a bar display on the PC screen. The program signals the end of the transfer, the receiver automatically starts in its normal operating mode. The loading procedure can be aborted using the ESC key.

Note: *When aborting the loading procedure, the test receiver has no valid firmware. Thus it is inoperative. In order to load the firmware anew, menu item Execute* has to be selected and the receiver to be switched off and on again.

Exiting the program:

Exit firmware loading program FLASHUP by selecting menu item *QUIT* and pressing the ENTER keys.





Design:
Shielded cable
Cast-on fittings permissible
Temperature resistance 80 °C

Fig. 4-12 Adapter cable for serial interface

5 Testing the Rated Specifications

5.1 Required Measuring Equipment

Item	Required equipment, characteristics	Type	Order no.	Use Section
1	Frequency counter up to 100 MHz Error < 1x10 $^{-8}$, resolution 0.1 Hz			5.2.1
2	Digital multimeter, 4 1/2-digit	UDS5	349.1510.02	5.2.8.5 5.2.8.6.1 5.2.8.6.2 5.2.9.2.1 5.2.9.2.2 5.2.9.3
3	Signal generator 9 kHz to 1000 MHz Level: -130 to 13 dBm Frequency error < 1x10 $^{-8}$	SMG	801.0001.52	5.2.1 5.2.2.3 5.2.2.3.1 5.2.2.3.2 5.2.2.4.1 5.2.9.1
4	Signal generator 9 kHz to 3710 MHz Level: -130 to 13 dBm	SMHU	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 5.2.6.2.2 5.2.6.3 5.2.8.2 5.2.8.3 5.2.8.4 5.2.8.5 5.2.8.6.1
5	3-dB coupler 9 kHz to 1000 MHz Decoupling > 20 dB			5.2.2.4.1
6	Reflection coefficient meter, 10 Hz to 1000 MHz	ZPV	291.4012.92	5.2.2.1
7	50-Ω termination, 5 Hz to 1000 MHz		272.4510.50	5.2.4
8	Spectrum analyzer, 9 kHz to 2400 MHz Sensitivity: -127 dBm	FSB	848.0020.52	5.2.2.2
9	Power meter 9 kHz to 1000 MHz, Z = 50 W -30 to 10 dBm, error < 0,1 dB	NRV	828.2511.02	5.2.6 5.2.8.1 5.2.8.2
10	Pulse generator, Schwarzbeck 3-standard pulse gen. IGUS, calibrated to < 0.1 dB			5.2.6.1.2 5.2.6.1.3
11	Attenuator, 5 Hz to 1000 MHz Attenuation error < 0.1 dB	RSP	831.3515.02	5.2.6.2 5.2.6.3
12	Oscilloscope, f_{max} = 10 MHz			5.2.8.2
13	Signal generator 10 Hz to 140 MHz Level -100 to + 19 dBm	SMH	348.0010.03	5.2.6.3 5.2.2.4
14	Power supply unit 0 to 35 V, 8 A	NGB 70	177.7227.90	5.2.8.2.1 5.2.8.2.2

5.2 Test Run

Test the rated specifications of the receiver only following a warm-up time of at least 30 minutes 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; the specifications stated in the data sheet are binding only.

Note: *Via IEC bus, the digital level values are output with a resolution of 0.01 dB, thus ensuring better reading accuracy of the measured values.*

5.2.1 Frequency Accuracy

5.2.1.1 ESS-B1 (Oven-controlled Reference Oscillator) not Fitted

Measuring equipment: Frequency counter
Signal generator, frequency error < $1 \cdot 10^{-8}$

Test setup: Connect signal generator (1000 MHz, 90 dBµV) to RF input of ESS.

Connect frequency counter to 10.7-MHz output (rear panel).

ESS settings:

Frequency	1000 MHz
RF ATT	20 dB
MODE	LOW NOISE
IF BW	120 kHz
OP RANGE	60 dB

Test: Frequency counter indication .... 10.7 MHz ± 3 kHz

5.2.1.2 ESS-B1 (Oven-controlled Reference Oscillator) Fitted

Measuring equipment: Frequency counter, 10 MHz, error < 1×10^{-10}

Test setup: Connect frequency counter to 10-MHz reference output.

Test: Measure the frequency using frequency counter.
Rated frequency .... 10 MHz ± 1 Hz

5.2.2 RF Input

5.2.2.1 Input VSWR

Measuring equipment: Network analyzer

Test setup: Connect network analyzer to RF input of ESS via low-reflection cable.

Test: Measure return loss of ESS with the following settings:

IF BW range I: 20 Hz
ranges II and III: 10 kHz

RF ATT 0 dB, PREAMP OFF .... a_r < 9.5 dB
RF ATT 10 dB, PREAMP OFF .... a_r < 20.8 dB
RF ATT 0 dB, PREAMP ON .... a_r < 9.5 dB
RF ATT 10 dB, PREAMP ON .... a_r < 20.8 dB

Measure at min. 3 frequency points (at the beginning, center and end of range) per input filter range (see data sheet).

Note: *Return loss of 9.5 dB corresponds to a VSWR of 2*
Return loss of 20.8 dB corresponds to a VSWR of 1.2.

5.2.2.2 Interference Voltage of Oscillator

Measuring equipment: Spectrum analyzer (80 kHz to 2400 MHz)

Test setup: Connect spectrum analyzer to RF input of ESS.
Receiver settings:
RF ATT 0 dB

Analyzer settings:

Indication in	dBµV
Reference level	60 dBµV
Scale	10 dB/DIV
Bandwidth	1 kHz
Mode	Max Hold

Set start and stop frequency of analyzer depending on receiver frequency according to the following table:

ESS frequency range	Start frequency	Stop frequency
5 Hz to 50 kHz	80 kHz	130 kHz
9 kHz to 30 MHz	74.7 MHz	104.7 MHz
30 to 1000 MHz	1384.7 MHz	2354.7 MHz

Test: Tune the receiver frequency on the ESS in the three frequency ranges in line with the settings given in the following table and measure the level on the analyzer at each frequency.

ESS frequency range	Start frequency	IF bandwidth
5 Hz to 50 kHz	5 kHz	20 Hz
9 kHz to 30 MHz	1 MHz	1 kHz
30 to 1000 MHz	50 MHz	1 kHz

Level indicated on analyzer:
without preamplifier (Preamp OFF) .... < 20 dBµV
with preamplifier (Preamp ON) .... < 10 dBµV

5.2.2.3 Interference Immunity

Measuring equipment: Signal generator (80 kHz to 2400 MHz)

Note: *To avoid that the sideband noise of the generator is measured at the receiver frequency, the sideband signal-to-noise ratio of the generator should be higher than 140 dBc/Hz. This can be achieved by cutting in a 1-GHz high-pass filter between generator output and receiver input, if required.*

Test setup: Connect signal generator to RF input of ESS.
Level: 100 dBµV

ESS settings:

Input	unbalanced (default setting)
RF ATT	0 dB
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB

5.2.2.3.1 Image of the 1st IF

Setting: Set generator frequency and IF bandwidth of ESS in the three receiving ranges in line with the following table:

ESS frequency f_{rec}	Generator frequency	IF bandwidth
5 Hz to 49.9 kHz	f_{rec} + 160 kHz	20 Hz
9 kHz to 30 MHz	f_{rec} + 149.4 MHz	1 kHz
30 to 1000 MHz	f_{rec} + 2709.4 MHz	1 kHz

Test:

- Measure level P_{ind} on receiver frequency f_{rec}.

Image frequency rejection is given by: 100 - P_{ind}/dBµV

Level indication on receiver .... < 10 dBµV
(PREAMP OFF and ON)

5.2.2.3.2 Image of 2nd IF

Setting: Set frequency of generator and ESS in line with the following table:

ESS frequency f_{rec}	Generator frequency
1 MHz	22.4 MHz
100 MHz	249.4 MHz

Test:
- Measure level at f_{rec} (P_{ind}).

  Image frequency rejection is given by: $100 - P_{ind}$ /dBµV

  Level indication of receiver .... < 10 dBµV
  (PREAMP OFF and ON)

5.2.2.3.3 Image of 3rd IF

Setting: Set frequency of generator and ESS in line with the following table:

ESS frequency f_{rec}	Generator frequency
10 MHz	10.16 MHz
100 MHz	121.4 MHz

Test:
- Measure level at f_{rec} (P_{ind}).

  Image frequency rejection is given by: $100 - P_{ind}$ /dBµV

  Level indication on receiver .... < 10 dBµV
  (PREAMP OFF and ON)

5.2.2.3.4 IF Interference Immunity

Setting: Set frequency of generator and ESS in line with the following table:

ESS frequency f_{rec}	Generator frequency	IF bandwidth
5 Hz to 50 kHz	80 kHz	20 Hz
9 kHz to 30 MHz	74.7 MHz	1 kHz
30 to 1000 MHz	1354.7 MHz	1 kHz

Test:
- Measure level P_{ind} at the respective receiver frequencies.

  IF interference immunity is given by: $100 - P_{ind}$ /dBµV

  Level indication on receiver .... < 10 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 pcs)
3-dB coupler

Test setup: Connect signal generator to RF input of ESS via 3-dB coupler and lowpass filters for harmonics suppression.

Level on ESS : 97 dBµV with f_{g1} and f_{g2}, respectively

The intercept point of third order of the test setup must be > 30 dBm in order not to falsify the measurement (level of the interference products < 17 dBµV).

ESS settings:		
	RF ATT	0 dB (PREAM OFF) / 10 dB (PREAMP ON)
	MODE	LOW NOISE
	DETECTOR	AV
	OP Range	60 dB
	IF BW Range I	20 Hz
	Range II and III	1 kHz

Test: Set the generator frequencies f_{g1} and f_{g2} in the receiver frequency range using the steps $|f_{g1} - f_{g2}|$ according to the following table:

Range no.	Frequency range	$\|f_{g1} - f_{g2}\|$
I	5 Hz bis 50 kHz	5 kHz
II	9 kHz bis 30 MHz	2 MHz
III	30 bis 1000 MHz	5 MHz

Measure level of generators at the respective frequency, (rated value: 97 dBµV).
Measure the interference products at the frequencies

$f_{rec1} = 2 \cdot f_{g1} - f_{g2}$ and

$f_{rec2} = 2 . f_{g2} - f_{g1}$.

The intercept IP3 is given by the following equations:

- without preamplifier (PREAMP OFF):
  IP3/dBm = (97 dBµV-(level at f_{rec}) /dBµV) /2-10 dBm
- with preamplifier (Preamp ON):
  IP3/dBm = (97 dBµV-(level at f_{rec}) /dBµV) /2-20 dBm

Rated values:

Range	Preamplifier	
	off	on
I	>15 dBm typ. 20 dBm	> 5 dBm typ. 10 dBm
II, f_{rec} <2 MHz	15 dBm typ.	5 dBm typ.
II, f_{rec} >2 MHz	>15 dBm typ. 20 dBm	> 0 dBm typ. 5 dBm
III	>15 dBm typ. 20 dBm	> 5 dBm typ. 10 dBm

5.2.2.4.2 Intercept of Second Order

Measuring equipment: Signal generator (1 kHz to 500 MHz)

Test setup: Connect signal generator to RF input of ESS.
Level at ESS: 90 dBµV
The harmonics suppression of the generator signal must be > 70 dB to avoid falsification of the measurement. To this end, use lowpass filters which attenuate the first harmonic of the generator signal.

ESS settings:

RF ATT	0 dB (PREAMP OFF) 10 dB (PREAMP ON)
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB
IF BW Range I	20 Hz
Range II and III	1 kHz

Test:

- Set the generator frequency in the range from 1 kHz to 500 MHz.
- Measure level at generator frequency (rated value: 90 dBµV).
- Set receiver frequency f_{rec} to first harmonic of generator frequency and measure the level.
- The intercept IP2 is given by the equation:

PREAMP OFF: $IP2/dBm = (90\ dB\mu V\text{-(level at } f_{rec})\ /dB\mu V)\text{-}17\ dBm$

PREAMP ON: $IP2/dBm = (90\ dB\mu V\text{-(level bei } f_E)\ /dB\mu V)\text{-}27\ dBm$

Rated values:

Range	Preamplifier	
	off	on
I	>35 dBm	> 25 dBm
II	>35 dBm	> 25 dBm
III	>35 dBm	> 25 dBm

5.2.3 IF Bandwidths

Measuring equipment: Signal generator

Test setup: Connect signal generator to RF input of ESS.

Level: 90 dBµV
Frequency: 30 kHz or 10 MHz

ESS settings:

Frequency	30 kHz for IF bandwidths up to 20 Hz 10 MHz for IF bandwidths from 50 Hz onward
RF ATT	AUTO
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB

Test: Set the receiver frequency such that level indication assumes its maximum value. Measure the 3-dB, 6-dB and 60-dB bandwidths according to the following table by tuning the generator frequency up and down and reading off the level indication at the receiver.

nom. bandwidth	3-dB bandwidth	6-dB bandwidth	Shape factor (typ. value) B_{6dB}/B_{60dB}
2 Hz	1.4 Hz ±20 %	2 Hz ±10 %	1:2.5
5 Hz	3.5 Hz ±20 %	5 Hz ±10 %	1:2.5
10 Hz	7 Hz ±20 %	10 Hz ±10 %	1:2.5
20 Hz	14 Hz ±20 %	20 Hz ±10 %	1:2.5
50 Hz	35 Hz ±20 %	50 Hz ±10 %	1:2.5
100 Hz	70 Hz ±20 %	100 Hz ±10 %	1:2.5
200 Hz	140 Hz ±20 %	200 Hz ±10 %	1:2.5
500 Hz	350 Hz ±20 %	500 Hz ±10 %	1:2.5
1 kHz	700 Hz ±20 %	1 kHz ±10 %	1:2.5
10 kHz	7 kHz ±20 %	9.0...10.0 kHz	1:4
100 kHz	70 kHz ±20 %	100 kHz ±10 %	1:5
120 kHz	90 kHz ±20 %	120 kHz ±10 %	1:5
1 MHz	700 kHz ±20 %	1 MHz ±10 %	1:5

5.2.4 Noise Indication

Measuring equipment: 50-Ω termination, balanced or unbalanced

Test setup: Terminate RF input (RF INPUT or LF INPUT) of ESS against 50 Ω.

ESS settings:

RF ATT	0 dB
MODE	LOW DISTORTION
OP RANGE	60 dB
MEAS TIME	100 ms
DETECTOR	AV

Test: Measure noise indication according to the following table:

Frequency range	Input	IF BW	Noise indication	
			PREAMP OFF	PREAMP ON
5 to 30 Hz	balanced	2 Hz	typ.-38 to -48 dBµV	typ. -38 to -52 dBµV
30 Hz to 50 kHz	balanced	10 Hz	< -40 dBµV	< -44 dBµV
9 kHz to 50 kHz	unbalanced	200 Hz	<-24 to <-30 dBµV	<-30 to <-36 dBµV
50 kHz to 30 MHz	unbalanced	10 kHz	< -14 dBµV	<-20 dBµV
30 to 1000 MHz	unbalanced	120 kHz	< -1 dBµV	< -5 dBµV

5.2.5 Testing the Inherent Spurious Responses

Test setup: Connect RF input of ESS against 50 Ω.

ESS settings:

RF ATT	0 dB
Mode	Low Distortion
OP Range	60 dB

Define frequency scan with the settings given in the following table:

Start	Stop	Step	IF BW	Meas Time
10 Hz	1 kHz	1 Hz	10 Hz	1 s
1 kHz	10 kHz	10 Hz	100 Hz	100 ms
10 kHz	30 MHz	100 Hz	1 kHz	10 ms
30 MHz	1000 MHz	1 kHz	10 kHz	1 ms

Settings of level and frequency axis:

Min level	-50 dB
Max level	30 dB
Frequency axis	LOG

Test: Start scan; after its conclusion, measure inherent spurious responses using the marker. The level indicated as a result of inherent spurious responses must not exceed the following values:

Receiver frequency 5 Hz to 30 MHz .... -10 dBµV
Receiver frequency >30 MHz .... 0 dBµV

5.2.6 Measuring Accuracy

Level measuring accuracy of ESS is given by:

- accuracy of built-in calibration generator,
- accuracy of RF attenuator,
- linearity of demodulator and log amplifier
- residual calibration error and
- signal-to-noise ratio.

With a sufficient signal-to-noise ratio, the total error is less than ± 1 dB (typ. 0.5 dB).

Measuring equipment:
Signal generator
Power meter
Pulse generator: level 60 dBµV/MHz ± 0.1 dB (with 100 MHz),
selectable pulse frequency (1 Hz to 1 kHz)
frequency response < ± 0.2 dB (9 kHz to 30 MHz)

Calibrate the output level of the signal generator to its rated value at each frequency set using the thermal power meter (error < 0.1 dB).

5.2.6.1 Frequency Response

5.2.6.1.1 Indicating Mode AV

Test setup: Connect signal generator to RF input of ESS.
Level 90 dBµV ± 0.1 dB

ESS settings:

MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB
PREAMP	OFF/ON

Frequency-dependent settings according to following table:

Frequency range	Input	RF ATT		IF BW	Meas Time
		PREAMP OFF	PREAMP ON		
5 Hz to 100 Hz	balanced	70 dB	70 dB	2 Hz	2 s
100 Hz to 50 kHz	balanced	60 dB	60 dB	100 Hz	200 ms
5 Hz to 100 Hz	unbalanced	70 dB	70 dB	2 Hz	2 s
100 Hz to 9 kHz	unbalanced	60 dB	60 dB	100 Hz	200 ms
9 kHz to 30 MHz	unbalanced	40 dB	50 dB	1 kHz	100 ms
30 to 1000 MHz	unbalanced	30 dB	40 dB	10 kHz	100 ms

Test: Check level measuring accuracy in the frequency range from 5 Hz to 1000 MHz. Perform a short calibration before every measurement.

Nominal indication (digital) .... 90 dBµV
Permissible error digital indication:

Range no.	Input	Max. error
I	balanced	±0.5 dB
I	unbalanced(f_{rec} <9 kHz)	±0.5 dB
II	unbalanced	±0.4 dB
III	unbalanced	±0.7 dB (0 to 55 °C) ± 1.2 dB (-10 to 0 °C)

5.2.6.1.2 Indicating Modes Pk and Pk/MHz

a) Accuracy for sinewave signals

Test setup: Connect signal generator to RF input of ESS.
Level 90 dBµV ±0.1 dB

ESS settings:

RF ATT	50 dB
MODE	LOW NOISE
DETECTOR	Pk
OP RANGE	30 dB
IF BW	10 kHz
MEAS TIME	100 ms

Test: Check level measuring accuracy at 100 MHz. Perform a short calibration before every measurement.

Nominal indication (digital) .... 90 dBµV
Permissible error digital indication .... 0.7 dB

b) Accuracy for pulse signals (Pk)

In the case of pulse signal measurements, the tolerance of the 6-dB bandwidth of the IF filter is part of the measurement result. The permissible error is thus increased by the bandwidth tolerance.

Test setup: Connect pulse generator to RF input of the ESS.
Pulse frequency: 100 Hz
Level: 80 dBµV/MHz

ESS settings: Frequency 100 MHz

IF bandwidth	1 kHz	10 kHz	100 kHz	120 kHz	1 MHz
RF ATT	0 dB	0 dB	10 dB	10 dB	20 dB
Mode	Low Noise	Low Noise	Low Noise	Low Noise	Low Noise
Detector	Pk	Pk	Pk	Pk	Pk
OP Range	60 dB	60 dB	60 dB	60 dB	60 dB
Meas Time	100 ms	100 ms	100 ms	100 ms	100 ms

Test: Measure level on ESS.
Rated values:

IF BW	Rated level	Permissible error Digital indication
1 kHz	20 dBµV	± 2 dB
10 kHz	39.5 dBµV	± 2 dB
100 kHz	60 dBµV	± 2 dB
120 kHz	62 dBµV	± 2 dB
1 MHz	80 dBµV	-3/+1 dBµV

c) **Accuracy for pulse signals (Pk/MHz)**

ESS settings: DETECTOR Pk/MHz
other settings as under b).

Test: Measure level on ESS.
Rated values:

IF BW	Rated level	Permissible error Digital indication
1 kHz	80 dBµV/MHz	± 1 dB
10 kHz	80 dBµV/MHz	± 1 dB
100 kHz	80 dBµV/MHz	± 1 dB
120 kHz	80 dBµV/MHz	± 1 dB
1 MHz	80 dBµV/MHz	± 1 dB

5.2.6.1.3 Indicating mode QP

a) **Accuracy with pulses**

Test setup: Connect pulse generator to RF input of ESS.
Pulse frequency Band A: 25 Hz
Band B/C/D: 100 Hz
Level 80 dBµV/MHz ± 0.1 dB

ESS settings:

RF ATT	10 dB
Mode	Low Noise
Detector	QP
OP Range	60 dB
Meas Time	500 ms

Test: Check level measuring accuracy at 100 kHz, 1 MHz and 100 MHz.
Rated level at 100 kHz .... 0.4 dBµV ± 1 dB
at 1 MHz .... 33 dBµV ± 1 dB
at 100 MHz .... 50 dBµV ± 1 dB

b) Accuracy for sinewave signals

Test setup: Connect signal generator to RF input of ESS.
Level: 90 dBµV ± 0.1 dB

ESS settings:

ATTENUATION	AUTO
MODE	LOW NOISE
DETECTOR	QP
OP RANGE	30 dB
MEAS TIME	500 ms

Test: Check measuring accuracy at 100 kHz, 1 MHz and 100 MHz.
Rated level .... 90 dBµV ± 1.5 dB

c) Quasi-peak weighting curve

Test setup: Connect pulse generator to RF input of ESS.
Level: 80 dBµV/MHz ± 0.1 dB

ESS settings:

Frequency	100 kHz, 1 MHz and 100 MHz
RF ATT	0 dB
MODE	LOW NOISE
DETECTOR	QP
OP RANGE	60 dB
MEAS TIME	2 s

Test: Measure level on ESS depending on pulse frequency of pulse generator according to the following tables. The reference value is the level at 100 Hz.

Rated values at receiver frequency of 100 kHz:

Pulse frequency	ESS indication Rated value	Standard values to VDE0871/Part 1 and CISPR 16	
		Rated value	Tolerance
25 Hz	0.4 dBµV	----	± 0.5 dB
100 Hz	4.4 dBµV	+ 4.0 dB	± 1 dB
60 Hz	3.4 dBµV	+ 3.0 dB	± 1 dB
10 Hz	-3.6 dBµv	-4.0 dB	± 1.5 dB
5 Hz	-7.1 dBµV	-7.5 dB	± 1.5 dB
2 Hz	-12.6 dBµV	-13.0 dB	± 2.0 dB
1 Hz	-15.6 dBµV	-17.0 dB	± 2.0 dB
Single pulse	-17.6 dBµV	-19.0 dB	± 2.0 dB

Rated values at receiver frequency of 1 MHz (CISPR Band B):

Pulse frequency	ESS indication Rated value	Standard values to VDE0871/Part 1 and CISPR 16	
		Rated value	Tolerance
100 Hz	33.0 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	23.0 dBµv	-10.0 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

Rated values at 100 MHz (CISPR Band C/D):

Pulse frequency	ESS indication Rated value	Standard values to VDE0871/Part 1 and CISPR 16	
		Rated value	Tolerance
100 Hz	50 dBµV	----	± 0.5 dB
1000 Hz	58 dBµV	+ 8.0 dB	± 1 dB
20 Hz	41 dBµV	-9.0 dB	± 1 dB
10 Hz	36 dBµv	-14.0 dB	± 1.5 dB
2 Hz	23.5 dBµV	-26.5 dB	± 2.0 dB
1 Hz	21.5 dBµV	-28.5 dB	± 2.0 dB
Single pulse	18.5 dBµV	-31.5 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 signal generator to RF input of ESS via attenuator.

Signal generator level 83 dBµV
Basic attenuation of attenuator 3 dB

a) **30-dB range**

ESS settings:

Frequency	100 MHz
RF ATT	50 dB with IF BW = 10 kHz 60 dB with IF BW = 1 kHz
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	30 dB
IF BW	10 kHz and 1 kHz
MEAS TIME	100 ms

Test:

- Indication linearity is measured at IF bandwidths of 10 kHz and 1 kHz since two different envelope demodulators are used.
- Set level on signal generator such that ESS indicates full-scale deflection (80.0 dBµV).
- Increase attenuation of attenuator to 33 dB using 2-dB steps and measure level indication at each setting. At the same time, check level analog indication on instrument.
- Level indication is reduced by 2 dB with each attenuation step.

Permissible level error:
Digital indication .... ≤ 0.4 dB
Analog indication .... ≤ 1.0 dB

b) 60-dB range

ESS settings:

Frequency	100 MHz
RF ATT	20 dB with IF BW = 10 kHz 30 dB with IF BW = 1 kHz
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB
IF BW	10 kHz and 1 kHz
MEAS TIME	100 ms

Test:

- Measure indication linearity at IF bandwidths of 10 kHz and 1 kHz since two different envelope demodulators are used.
- Set level on signal generator such that ESS indicates full-scale deflection (80.0 dBµV).
- Increase attenuation of attenuator to 3 to 63 dB using 5-dB steps and measure level indication at each setting. At the same time, check level analog indication on instrument.

Level indication decreases by 5 dB with each attenuation step.

Permissible linearity error:
Digital indication .... ≤ 0.4 dB
Analog indication .... ≤ 1.0 dB

5.2.6.3 Error of Attenuator

The ESS contains 3 different attenuators, a symmetrical one for the frequency range from 5 Hz to 50 kHz and two unsymmetrical ones for the frequency ranges from 5 Hz to 30 MHz and 30 to 1000 MHz.

Measuring equipment: Signal generator
Attenuator, attenuation corrected, max. permissible error < 0.1 dB

Test setup: Connect signal generator to RF input of ESS via attenuator.
Signal generator level: 123 dBµV
Attenuation of attenuator: 80 dB

ESS settings:

RF ATT	40 dB
PREAMP	ON
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	30 dB
IF BW	1 kHz
MEAS TIME	100 ms

Set receiver and generator frequencies to following table:

Attenuator	Frequency
Symmetrical 5 Hz to 50 kHz	40 kHz
Unsymmetrical 5 Hz to 30 MHz	20 MHz
Unsymmetrical 30 to 1000 MHz	100 MHz

Test:

- Set level on signal generator such that ESS indicates 43.0 dBµV.
- Set attenuator to 120 dB and RF attenuation of ESS to 0 dB.
- Decrease attenuation of attenuator to 0 dB using 10-dB steps.
- At the same time, increase RF attenuation of ESS in 10-dB steps.
- Measure deviation of level indication at each attenuation setting.

  Rated level .... 3 dBµV + RF attenuation
  Permissible attenuation error .... ≤ 0.4 dB

5.2.7 IF Analysis

5.2.7.1 Gain and Linearity

Measuring equipment: Signal generator

Meßaufbau: Connect signal generator to RF input of ESS.

Generator level	65 dBµV ± 0.1 dB
Frequency	100 MHz

ESS settings:

Frequency	100 MHz
RF attenuation	10 dB
IF Analysis:	
Span	10 kHz
Res Bandw	1 kHz
Sweep Time	100 ms
Attenuation	0 dB
Marker	Peak

Test: Measure marker level.
Rated value .... 75 ± 3 dB

- Set generator level such that marker level is 78 dB ± 0.2 dB
- Increase RF attenuation of receiver to 70 dB using 10-dB steps.
- Marker level decreases by 10 dB with each 10-dB step,
  Tolerance .... 2.5 dB

5.2.7.2 20-dB Input Attenuation

Measuring equipment: Signal generator

Test setup: see Section 5.2.7.1

Test: Measure marker level (P_{0dB}).

- Set attenuation on ESS to 20 dB in the IF Analysis menu.
- Increase signal generator level to 88 dBµV ± 0.1 dB.
- Measure marker level (P_{20dB}).
  Input attenuation error is given by: $E_{20dB} = P_{0dB} - P_{20dB}$

Permissible error .... ≤0.5 dB

5.2.7.3 Resolution Bandwidths

Measuring equipment: Signal generator

Test setup: Connect signal generator to RF input of ESS.

Generator level	70 dBµV ± 0.1 dB		
Frequency	100 MHz		
ESS settings:		Frequency	100 MHz
		RF attenuation	20 dB
		IF Analysis:	
		Span	10 kHz
		Sweep Time	50 ms
		Attenuation	0 dB
		Marker	Peak

Test: Effect the following measurements with resolution bandwidths of 10 kHz, 3 kHz and 1 kHz:

- Measure marker level (P_{center}).
- Increase signal generator level by 3 dB ± 0.1 dB.
- Tune receiver frequency down until marker level P_{center} reaches ± 0.1 dB, frequency = f_{3dB-}.
- Tune receiver frequency up until marker level P_{center} reaches ± 0.1 dB, frequency = f_{3dB+}.
- The 3-dB bandwidth is given by $B_{3dB} = f_{3dB+} - f_{3dB-}$.
  Rated values:

Nominal bandwidth	Min. value	Max. value
10 kHz	8 kHz	12 kHz
3 kHz	2.4 kHz	3.6 kHz
1 kHz	0.8 kHz	1.2 kHz

5.2.7.4 Shape Factor of IF Filters

Measuring equipment: Signal generator

Test setup: Connect signal generator to RF input of ESS.

Generator level	70 dBµV ± 0.1 dB		
Frequency	100 MHz		
ESS settings:		Frequency	100 MHz
		RF attenuation	10 dB
		IF Analysis	
		Span	50 kHz
		Sweep Time	50 ms
		Attenuation	0 dB
		Marker	Peak

Test: Perform the following measurements with resolution bandwidths of 10 kHz, 3 kHz and 1 kHz:

- Measure marker level (P_{center}).
- Set generator level such that P_{center} = 80 dB ± 0.5 dB.
- Tune receiver frequency down until receiver indicates a marker level of 20 dB ± 0.5 dB, receiver frequency = f_{60dB-}.
- Tune receiver frequency up until receiver indicates a marker level of 20 dB ± 0.5 dB, receiver frequency f_{60dB+}.
- The 60-dB bandwidth is given by: $B_{60dB} = f_{60dB+} - f_{60dB-}$.
  The shape factor is thus: B_{60dB} / B_{3dB}.
  Rated values:

Bandwidth	Shape factor 3:60 dB
10 kHz	<4
3 kHz	<8
1 kHz	<9

5.2.7.5 RF Bandwidth

Measuring equipment: Signal generator

Test setup: Connect signal generator to RF input of ESS.

Generator level:	70 dBµV ± 0.1 dB	
Frequency:	100 MHz	
ESS settings:	Frequency	100 MHz
	RF attenuation	10 dB
	IFAnalysis	
	Span	2 MHz
	Res Bandw	10 kHz
	Sweep Time	500 ms
	Attenuation	0 dB
	Marker	Peak

Test:

- Measure indication level (P_{center}).
- Set signal generator level to 99 MHz and measure indication level (P_{lower}).
- Set signal generator level to 101 MHz and measure indication level (P_{upper}).
- Gain drop is given by $P_{center} - P_{lower}$ or $P_{center} - P_{upper}$.
- Gain drop at 99 or 101 MHz .... <4 dB

5.2.8 Testing the Outputs

5.2.8.1 Generator Output

Measuring equipment: Power meter

Test setup: Connect power meter to generator output of ESS.
ESS settings: Generator ON

Test: Measure generator output level in the range from 9 kHz to 1000 MHz. Measure at least at the following frequencies:
9, 100 kHz, 1, 2, 5, 10, 20, 50, 100, 200, 500, 750, 1000 MHz
Rated level .... -17 dBm
Tolerance .... ± 1 dB

5.2.8.2 AF Output

Measuring equipment: Signal generator
Oscilloscope

Test setup: Connect signal generator to RF input of ESS.
Frequency: 100 MHz, 30 %-AM-modulated, AF = 1 kHz
Level: 80 dBµV

Connect oscilloscope to AF output of ESS via jack plugs.

ESS settings:

Frequency	100 MHz
RF ATT	20 dB
MODE	LOW NOISE
DETECTOR	AV
OP RANGE	60 dB
IF BW	10 kHz
MEAS TIME	100 ms

Test: Set voltage on oscilloscope using volume control such that distortions are only just not visible.
Settable voltage (peak value) .... > 1.5 V

5.2.8.3 10.7 MHz Output

Measuring equipment: Signal generator
RF millivoltmeter (AC)

Test setup: Connect signal generator to RF input of ESS.
Frequency: 100 MHz
Level: 80 dBµV ± 0.2 dB

Connect RF millivoltmeter to the 10.7-MHz output on the rear panel of the ESS.

ESS settings:	Frequency	100 MHz
	RF ATT	20 dB
	OP RANGE	60 dB
	DETECTOR	AV
	PREAMP	OFF

Test: Measure output level using RF millivoltmeter.
Rated value: .... typ. 1000 mV

5.2.8.4 Video Output

Measuring equipment: Signal generator
Digital voltmeter

Test setup: Connect digital voltmeter to VIDEO OUTPUT on rear panel of ESS.

Connect signal generator to RF input of ESS.
Frequency: 100 MHz
Level: 80 dBµV ± 0.2 dB

ESS settings:	Frequency	100 MHz
	RF ATT	20 dB
	OP RANGE	60 dB
	DETECTOR	AV

Test: Measure output voltage using digital voltmeter.
Rated value .... + 4 V typ.

5.2.8.5 Reference Output (10 MHz REF OUTPUT)

(available only with ESS-B1 option fitted)

Measuring equipment: Power meter

Test setup: Connect power meter to reference output.

Test: Perform a level measurement:
Rated level .... ≥ 7 dBm

5.2.8.6 User Port

5.2.8.6.1 Analog Outputs

Measuring equipment: Signal generator
Digital voltmeter

Test setup: Connect signal generator to RF input of ESS.
Frequency: 100 MHz
Level: 80 dBµV ± 0.2 dB.

ESS settings:

Frequency	100 MHz
RF ATT	20 dB
MODE	LOW NOISE
IF BW	10 kHz
PREAMP	OFF
Transducer	OFF

Test:

- Connect digital voltmeter to USER PORT between pin 24 (Gnd) and pin 23 (Recorder 1).
  Voltage on digital voltmeter .... 3.75 V
  Permissible error .... ± 100 mV
- Set level on signal generator to 20 dBµV ± 0.2 dB.
  Voltage on digital voltmeter .... 0.75 V
  Permissible error .... ± 100 mV
- Connect digital voltmeter to USER PORT between pin 24 (Gnd) and pin 11 (Recorder 2).
  Set level on signal generator to 80 dBµV ± 0.2 dB.
  Voltage on digital voltmeter .... 3.75 V
  Permissible error .... ± 100 mV
- Set level on signal generator to 20 dBµV ± 0.2 dB.
  Voltage on digital voltmeter .... 0.75 V
  Permissible error .... ± 100 mV

5.2.8.6.2 Supply Outputs

Measuring equipment: Digital voltmeter

Test setup: Connect digital voltmeter to user port, + 5-V output or 12-V output.

Test: Measure voltage at + 5-V or + 12-V output.
Rated value + 5 V .... 5.0 V to 5.5 V
Rated value + 12 V .... 10.8 to 15 V

5.2.9 Testing the Inputs

5.2.9.1 Checking the External Reference

(only when no option oven-controlled crystal oscillator ESS-B1 is fitted)

Measuring equipment: Signal Generator

Test setup: Connect signal generator to Ext Ref input.
Frequency 5/10 MHz
Level > 4 dBm

Test:

- After having connected the generator *Ext Ref on* is read out on the screen.
  Ext Reference is entered in the Setup menu.
- Switch off the level on the signal generator.
  Int Reference is entered in the Setup menu, *Ext Ref on* disappears.
- Set signal generator to 5 MHz.
  Ext Ref on is read out on the ESS screen.

5.2.9.2 Checking the External Battery Supply

Measuring equipment: Power supply unit
Digital voltmeter

Test setup: Connect power supply unit to EXT BATT input of ESS.
Voltage: 12 V

Test:

- Turn on ESS.
  The receiver is activated.
- Vary the voltage in the range between 11 and 33 V.
  The ESS remains activated.
- Reduce the voltage on the power supply unit.
  The ESS switches off when the following voltage is reached .... 11 V ± 0.2 V
- Increase the voltage to 12 V ± 0.5 V.
  The ESS switches on again.

Note: *When varying the supply voltage, an instrument reset may occur at approx. 15.5 V or, as the case may be, 14.5 V.*

5.2.9.3 Testing the Antenna Code Socket

Measuring equipment: Digital voltmeter

Test setup: ESS settings:

RF ATT	10 dB
MODE	LOW DISTORTION
DETECTOR	AV
PREAMP	OFF

Test:

- Connect digital voltmeter between X3/A (Gnd) and X3/B (+ 10 V) and measure the voltage.
  Rated value .... + 10 V ± 50 mV
- Connect digital voltmeter between X3/A (Gnd) and X3/K (-10 V) and measure the voltage.
  Rated 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 in 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 Test Report

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
1	Frequency accuracy without ESS-B1	5.2.1.1	10.697	....	10.703	MHz
	with ESS-B1	5.2.1.2	10.9999999	....	10.000001	MHz
2	Input VSWR RF ATT: 0 dB PREAMP: OFF	5.2.2				
	Range I					
	9 kHz		9.5	....	-	dB
	20 kHz		9.5	....	-	dB
	30 kHz		9.5	....	-	dB
	40 kHz		9.5	....	-	dB
	49.9 kHz		9.5	....	-	dB
	Range II/III					
	9 kHz		9.5	....	-	dB
	100 kHz		9.5	....	-	dB
	149.9 kHz		9.5	....	-	dB
	150 kHz		9.5	....	-	dB
	2 MHz		9.5	....	-	dB
	4.04 MHz		9.5	....	-	dB
	4.05 MHz		9.5	....	-	dB
	8 MHz		9.5	....	-	dB
	12 MHz		9.5	....	-	dB
	12.1 MHz		9.5	....	-	dB
	16.5 MHz		9.5	....	-	dB
	21.5 MHz		9.5	....	-	dB
	21.55 MHz		9.5	....	-	dB
	26 MHz		9.5	....	-	dB
	26.9 MHz		9.5	....	-	dB
	30 MHz		9.5	....	-	dB
	40 MHz		9.5	....	-	dB
	51 MHz		9.5	....	-	dB
	52 MHz		9.5	....	-	dB
	90 MHz		9.5	....	-	dB
	125 MHz		9.5	....	-	dB
	126 MHz		9.5	....	-	dB
	200 MHz		9.5	....	-	dB
	273 MHz		9.5	....		dB
	274 MHz		9.5	....	-	dB
	380 MHz		9.5	....	-	dB
	495 MHz		9.5	....	-	dB
	610 MHz		9.5	....	-	dB
	717 MHz		9.5	....	-	dB
	860 MHz		9.5	....	-	dB
	1000 MHz		9.5	....	-	dB

Item no.	Characteristics		Test according to Section	Min. value	Actual value	Max.value	Unit
3	Input VSWR		5.2.2.1				
	RF ATT: 0 dB						
	PREAMP: ON						
	Range I						
	9	kHz		9.5	....	-	dB
	20	kHz		9.5	....	-	dB
	30	kHz		9.5	....	-	dB
	40	kHz		9.5	....	-	dB
	49.9	kHz		9.5	....	-	dB
	Range II/III						
	9	kHz		9.5	....	-	dB
	100	kHz		9.5	....	-	dB
	149.9	kHz		9.5	....	-	dB
	150	kHz		9.5	....	-	dB
	2	MHz		9.5	....	-	dB
	4.04	MHz		9.5	....	-	dB
	4.05	MHz		9.5	....	-	dB
	8	MHz		9.5	....	-	dB
	12	MHz		9.5	....	-	dB
	12.1	MHz		9.5	....	-	dB
	16.5	MHz		9.5	....	-	dB
	21.5	MHz		9.5	....	-	dB
	21.55	MHz		9.5	....	-	dB
	26	MHz		9.5	....	-	dB
	29.9	MHz		9.5	....	-	dB
	30	MHz		9.5	....	-	dB
	40	MHz		9.5	....	-	dB
	51	MHz		9.5	....	-	dB
	52	MHz		9.5	....	-	dB
	90	MHz		9.5	....	-	dB
	125	MHz		9.5	....	-	dB
	126	MHz		9.5	....	-	dB
	200	MHz		9.5	....	-	dB
	273	MHz		9.5	....	-	dB
	274	MHz		9.5	....	-	dB
	380	MHz		9.5	....	-	dB
	495	MHz		9.5	....	-	dB
	610	MHz		9.5	....	-	dB
	717	MHz		9.5	....	-	dB
	860	MHz		9.5	....	-	dB
	1000	MHz		9.5	....	-	dB

Item no.	Characteristics		Test according to Section	Min. value	Actual value	Max. value	Unit
4	Input VSWR RF ATT: 10 dB Preamp: OFF		5.2.2.1				
	Range I						
	9	kHz		20.8	....	-	dB
	20	kHz		20.8	....	-	dB
	30	kHz		20.8	....	-	dB
	40	kHz		20.8	....	-	dB
	49.9	kHz		20.8	....	-	dB
	Range II/III						
	9	kHz		20.8	....	-	dB
	100	kHz		20.8	....	-	dB
	149.9	kHz		20.8	....	-	dB
	150	kHz		20.8	....	-	dB
	2	MHz		20.8	....	-	dB
	4.04	MHz		20.8	....	-	dB
	4.05	MHz		20.8	....	-	dB
	8	MHz		20.8	....	-	dB
	12	MHz		20.8	....	-	dB
	12.1	MHz		20.8	....	-	dB
	16.5	MHz		20.8	....	-	dB
	21.5	MHz		20.8	....	-	dB
	21.55	MHz		20.8	....	-	dB
	26	MHz		20.8	....	-	dB
	29.9	MHz		20.8	....	-	dB
	30	MHz		20.8	....	-	dB
	40	MHz		20.8	....	-	dB
	51	MHz		20.8	....	-	dB
	52	MHz		20.8	....	-	dB
	90	MHz		20.8	....	-	dB
	125	MHz		20.8	....	-	dB
	126	MHz		20.8	....	-	dB
	200	MHz		20.8	....	-	dB
	273	MHz		20.8	....	-	dB
	274	MHz		20.8	....	-	dB
	380	MHz		20.8	....	-	dB
	495	MHz		20.8	....	-	dB
	610	MHz		20.8	....	-	dB
	717	MHz		20.8	....	-	dB
	860	MHz		20.8	....	-	dB
	1000	MHz		20.8	....	-	dB

Item no.	Characteristics		Test according to Section	Min. value	Actual value	Max. value	Unit
5	Input VSWR RF ATT: 10 dB Preamp: ON **Range I**		5.2.2.1				
	9	kHz		20.8	....	-	dB
	20	kHz		20.8	....	-	dB
	30	kHz		20.8	....	-	dB
	40	kHz		20.8	....	-	dB
	49.9	kHz		20.8	....	-	dB
	Range II/III						
	9	kHz		20.8	....	-	dB
	100	kHz		20.8	....	-	dB
	149.9	kHz		20.8	....	-	dB
	150	kHz		20.8	....	-	dB
	2	MHz		20.8	....	-	dB
	4.04	MHz		20.8	....	-	dB
	4.05	MHz		20.8	....	-	dB
	8	MHz		20.8	....	-	dB
	12	MHz		20.8	....	-	dB
	12.1	MHz		20.8	....	-	dB
	16.5	MHz		20.8	....	-	dB
	21.5	MHz		20.8	....	-	dB
	21.55	MHz		20.8	....	-	dB
	26	MHz		20.8	....	-	dB
	29.9	MHz		20.8	....	-	dB
	30	MHz		20.8	....	-	dB
	40	MHz		20.8	....	-	dB
	51	MHz		20.8	....	-	dB
	52	MHz		20.8	....	-	dB
	90	MHz		20.8	....	-	dB
	125	MHz		20.8	....	-	dB
	126	MHz		20.8	....	-	dB
	200	MHz		20.8	....	-	dB
	273	MHz		20.8	....	-	dB
	274	MHz		20.8	....	-	dB
	380	MHz		20.8	....	-	dB
	495	MHz		20.8	....	-	dB
	610	MHz		20.8	....	-	dB
	717	MHz		20.8	....	-	dB
	860	MHz		20.8	....	-	dB
	1000	MHz		20.8	....	-	dB
6	Interference voltage of oscillator Preamp: OFF		5.2.2.2				
	5 Hz to 50 kHz			-	....	20	dBµV
	9 kHz to 30 MHz			-	....	20	dBµV
	30 to 1000 MHz			-	....	20	dBµV
	Preamp: ON						
	5 Hz to 50 kHz			-	....	10	dBµV
	9 kHz to 30 MHz			-	....	10	dBµV
	30 to 1000 MHz			-	....	10	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
7	Interference immunity					
	Image of 1st IF	5.2.2.3.1				
	5 Hz to 50 kHz		-	....	10	dBµV
	9 kHz to 30 MHz		-	....	10	dBµV
	30 to 1000 MHz		-	....	10	dBµV
	Image of 2nd IF	5.2.2.3.2				
	f_{rec} = 1 MHz		-	....	10	dBµV
	f_{rec} = 100 MHz		-	....	10	dBµV
	Image of 3rd IF	5.2.2.3.3				
	f_{rec} = 10 MHz		-	....	10	dBµV
	f_{rec} = 100 MHz		-	....	10	dBµV
	IF interference immunity	5.2.2.3.4				
	5 Hz to 50 kHz		-	....	10	dBµV
	9 kHz to 30 MHz		-	....	10	dBµV
	30 to 1000 MHz		-	....	10	dBµV
8	Intercept of 3rd order	5.2.2.4.1				
	PREAMP: OFF					
	Range I					
	10/15 KHz		15	....	-	dBm
	25/30 kHz		15	....	-	dBm
	40/45 kHz		15	....	-	dBm
	Range II					
	2.5/4.5 MHz		15	....	-	dBm
	8.6/10.6 MHz		15	....	-	dBm
	17.5/19.5 MHz		15	....	-	dBm
	25.9/27.9 MHz		15	....	-	dBm
	Range III					
	35/40 MHz		15	....	-	dBm
	57/62 MHz		15	....	-	dBm
	115/120 MHz		15	....	-	dBm
	131/136 MHz		15	....	-	dBm
	263/268 MHz		15	....	-	dBm
	485/490 MHz		15	....	-	dBm
	500/505 MHz		15	....	-	dBm
	707/712 MHz		15	....	-	dBm
	723/728 MHz		15	....	-	dBm
	990/995 MHz		15	....	-	dBm

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
9	Intercept					
	of 3rd order	5.2.2.4.1				
	PREAMP: ON					
	Range I					
	10/15 KHz		5	....	-	dBm
	25/30 kHz		5	....	-	dBm
	40/45 kHz		5	....	-	dBm
	Range II					
	2.5/4.5 MHz		0	....	-	dBm
	8.6/10.6 MHz		0	....	-	dBm
	17.5/19.5 MHz		0	....	-	dBm
	25.9/27.9 MHz		0	....	-	dBm
	Range III					
	35/40 MHz		5	....	-	dBm
	40/45		5	....	-	dBm
	57/62 MHz		5	....	-	dBm
	115/120 MHz		5	....	-	dBm
	131/136 MHz		5	....	-	dBm
	263/268 MHz		5	....	-	dBm
	485/490 MHz		5	....	-	dBm
	500/505 MHz		5	....	-	dBm
	707/712 MHz		5	....	-	dBm
	723/728 MHz		5	....	-	dBm
	990/995 MHz		5	....	-	dBm

Item no.	Characteristics		Test according to Section	Min. value	Actual value	Max. value	Unit
10	Intercept						
	of 2nd order		5.2.2.4.2				
	PREAMP: OFF						
	Range I						
	1	KHz		35	....	-	dBm
	5	kHz		35	....	-	dBm
	10	kHz		35	....	-	dBm
	20	kHz		35	....	-	dBm
	25	kHz		35	....	-	dBm
	Range II						
	9	KHz		35	....	-	dBm
	20	kHz		35	....	-	dBm
	50	kHz		35	....	-	dBm
	100	kHz		35	....	-	dBm
	200	kHz		35	....	-	dBm
	500	kHz		35	....	-	dBm
	1	MHz		35	....	-	dBm
	2	MHz		35	....	-	dBm
	5	MHz		35	....	-	dBm
	10	MHz		35	....	-	dBm
	15	MHz		35	....	-	dBm
	Range III						
	15	MHz		35	....	-	dBm
	25	MHz		35	....	-	dBm
	26	MHz		35	....	-	dBm
	62	MHz		35	....	-	dBm
	136	MHz		35	....	-	dBm
	137	MHz		35	....	-	dBm
	247	MHz		35	....	-	dBm
	248	MHz		35	....	-	dBm
	358	MHz		35	....	-	dBm
	359	MHz		35	....	-	dBm
	500	MHz		35	....	-	dBm

Item no.	Characteristics		Test according to Section	Min. value	Actual value	Max. value	Unit
11	Intercept						
	of 2nd order		5.2.2.4.2				
	PREAMP: ON						
	Range I						
	1	KHz		25	....	-	dBm
	5	kHz		25	....	-	dBm
	10	kHz		25	....	-	dBm
	20	kHz		25	....	-	dBm
	25	kHz		25	....	-	dBm
	Range II						
	9	KHz		25	....	-	dBm
	20	kHz		25	....	-	dBm
	50	kHz		25	....	-	dBm
	100	kHz		25	....	-	dBm
	200	kHz		25	....	-	dBm
	500	kHz		25	....	-	dBm
	1	MHz		25	....	-	dBm
	2	MHz		25	....	-	dBm
	5	MHz		25	....	-	dBm
	10	MHz		25	....	-	dBm
	15	MHz		25	....	-	dBm
	Range III						
	15	MHz		25	....	-	dBm
	25	MHz		25	....	-	dBm
	26	MHz		25	....	-	dBm
	62	MHz		25	....	-	dBm
	136	MHz		25	....	-	dBm
	137	MHz		25	....	-	dBm
	247	MHz		25	....	-	dBm
	248	MHz		25	....	-	dBm
	358	MHz		25	....	-	dBm
	359	MHz		25	....	-	dBm
	500	MHz		25	....	-	dBm

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
12	IF bandwidths	5.2.3				
	2 Hz					
	3-dB bandwidth		1.12 Hz	....	1.68 Hz	
	6-dB bandwidth		1.8 Hz	....	2.2 Hz	
	60-dB bandwidth		-	....	typ. 5 Hz	
	5 Hz					
	3-dB bandwidth		2.8 Hz	....	4.2 Hz	
	6-dB bandwidth		4.5 Hz	....	5.5 Hz	
	60-dB bandwidth		-	....	typ. 12.5 Hz	
	10 Hz					
	3-dB bandwidth		5.6 Hz	....	8.4 Hz	
	6-dB bandwidth		9 Hz	....	11 Hz	
	60-dB bandwidth		-	....	typ. 25 Hz	
	20 Hz					
	3-dB bandwidth		12.6 Hz	....	16.8 Hz	
	6-dB bandwidth		18 Hz	....	22 Hz	
	60-dB bandwidth		-	....	typ. 55 Hz	
	50 Hz					
	3-dB bandwidth		28 Hz	....	42 Hz	
	6-dB bandwidth		45 Hz	....	55 Hz	
	60-dB bandwidth		-	....	typ. 140 Hz	
	100 Hz					
	3-dB bandwidth		56 Hz	....	84 Hz	
	6-dB bandwidth		90 Hz	....	110 Hz	
	60-dB bandwidth		-	....	typ. 275 Hz	
	200 Hz					
	3-dB bandwidth		112 Hz	....	168 Hz	
	6-dB bandwidth		180 Hz	....	220 Hz	
	60-dB bandwidth		-	....	typ. 550 Hz	
	500 Hz					
	3-dB bandwidth		280 Hz	....	420 Hz	
	6-dB bandwidth		450 Hz	....	550 Hz	
	60-dB bandwidth		-	....	typ. 1.4 kHz	
	1 kHz					
	3-dB bandwidth		560 Hz	....	840 Hz	
	6-dB bandwidth		900 Hz	....	1.1 kHz	
	60-dB bandwidth		-	....	typ. 2.5 kHz	
	10 kHz					
	3-dB bandwidth		5.6 kHz	....	8.4 kHz	
	6-dB bandwidth		9 kHz	....	10 kHz	
	60-dB bandwidth		-	....	typ. 40 kHz	
	100 kHz					
	3-dB bandwidth		56 kHz	....	84 kHz	
	6-dB bandwidth		90 kHz	....	110kHz	
	60-dB bandwidth		-	....	typ. 500 kHz	
	120 kHz					
	3-dB bandwidth		72 kHz	....	108 kHz	
	6-dB bandwidth		108 kHz	....	132 kHz	
	60-dB bandwidth		-	....	typ. 500 kHz	
	1 MHz					
	3-dB bandwidth		560 kHz	....	840 kHz	
	6-dB bandwidth		900 kHz	....	1.1 MHz	
	60-dB bandwidth		-	....	typ. 5 MHz	

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
13	Noise indication	5.2.4				
	Preamp: OFF					
	Detector AV					
	5 to 30 Hz:					
	5 Hz		-	....	-35	dBµV
	30 Hz		-	....	-45	dBµV
	30 Hz to 50 kHz:					
	30 Hz		-	....	-40	dBµV
	100 Hz		-	....	-40	dBµV
	500 Hz		-	....	-40	dBµV
	1 kHz		-	....	-40	dBµV
	5 kHz		-	....	-40	dBµV
	10 kHz		-	....	-40	dBµV
	20 kHz		-	....	-40	dBµV
	50 kHz		-	....	-40	dBµV
	9 kHz to 50 kHz:					
	9 kHz		-	....	-24	dBµV
	50 kHz		-	....	-30	dBµV
	50 kHz to 30 MHz:					
	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
	30 MHz		-	....	-14	dBµV
	30 to 1000 MHz:					
	30 MHz		-	....	-1	dBµV
	50 MHz		-	....	-1	dBµV
	100 MHz		-	....	-1	dBµV
	200 MHz		-	....	-1	dBµV
	300 MHz		-	....	-1	dBµV
	400 MHz		-	....	-1	dBµV
	500 MHz		-	....	-1	dBµV
	600 MHz		-	....	-1	dBµV
	700 MHz		-	....	-1	dBµV
	800 MHz		-	....	-1	dBµV
	900 MHz		-	....	-1	dBµV
	1000 MHz		-	....	-1	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
14	Noise indication	5.2.4				
	Preamp: ON					
	Detector AV					
	5 to 30 Hz:				-35	
	5 Hz		-	....	-49	dBµV
	30 Hz		-	....		dBµV
	30 Hz to 50 kHz:				-44	
	30 Hz		-	....	-44	dBµV
	100 Hz		-	....	-44	dBµV
	500 Hz		-	....	-44	dBµV
	1 kHz		-	....	-44	dBµV
	5 kHz		-	....	-44	dBµV
	10 kHz		-	....	-44	dBµV
	20 kHz		-	....	-44	dBµV
	50 kHz		-	....		dBµV
	9 kHz to 50 kHz:					
	9 kHz		-	....	-30	dBµV
	50 kHz		-	....	-36	dBµV
	50 kHz to 30 MHz:					
	50 kHz		-	....	-20	dBµV
	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
	30 MHz		-	....	-20	dBµV
	30 to 1000 MHz:					
	30 MHz		-	....	-5	dBµV
	50 MHz		-	....	-5	dBµV
	100 MHz		-	....	-5	dBµV
	200 MHz		-	....	-5	dBµV
	300 MHz		-	....	-5	dBµV
	400 MHz		-	....	-5	dBµV
	500 MHz		-	....	-5	dBµV
	600 MHz		-	....	-5	dBµV
	700 MHz		-	....	-5	dBµV
	800 MHz		-	....	-5	dBµV
	900 MHz		-	....	-5	dBµV
	1000 MHz		-	....	-5	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
16	Inherent spurious	5.2.5				
	responses		-	....	-10	dBµV
	Range I		-	....	-10	dBµV
	Range II		-	....	0	dBµV
	Range III		-	....	0	dBµV
17	Measurement error	5.2.6.1.1				
	Frequency response					
	Preamp: OFF					
	5 Hz to 50 kHz:					
	5 Hz		89.5	....	90.5	dBµV
	10 Hz		89.5	....	90.5	dBµV
	50 Hz		89.5	....	90.5	dBµV
	100 Hz		89.5	....	90.5	dBµV
	500 Hz		89.5	....	90.5	dBµV
	1 kHz		89.5	....	90.5	dBµV
	5 kHz		89.5	....	90.5	dBµV
	10 kHz		89.5	....	90.5	dBµV
	50 kHz		89.5	....	90.5	dBµV
	9 kHz to 30 MHz:					
	9 kHz		89.6	....	90.4	dBµV
	100 kHz		89.6	....	90.4	dBµV
	200 kHz		89.6	....	90.4	dBµV
	500 kHz		89.6	....	90.4	dBµV
	1 MHz		89.6	....	90.4	dBµV
	2 MHz		89.6	....	90.4	dBµV
	5 MHz		89.6	....	90.4	dBµV
	10 MHz		89.6	....	90.4	dBµV
	15 MHz		89.6	....	90.4	dBµV
	20 MHz		89.6	....	90.4	dBµV
	25 MHz		89.6	....	90.4	dBµV
	29.9 MHz		89.6	....	90.4	dBµV
	30 to 1000 MHz:					
	30 MHz		89.3	....	90.7	dBµV
	50 MHz		89.3	....	90.7	dBµV
	100 MHz		89.3	....	90.7	dBµV
	200 MHz		89.3	....	90.7	dBµV
	300 MHz		89.3	....	90.7	dBµV
	400 MHz		89.3	....	90.7	dBµV
	500 MHz		89.3	....	90.7	dBµV
	600 MHz		89.3	....	90.7	dBµV
	700 MHz		89.3	....	90.7	dBµV
	800 MHz		89.3	....	90.7	dBµV
	900 MHz		89.3	....	90.7	dBµV
	1000 MHz		89.3	....	90.7	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
17	Measurement error Frequency response Preamp: ON	5.2.6.1.1				
	5 Hz to 50 kHz:					
	5 Hz		89.5	....	90.5	dBµV
	10 Hz		89.5	....	90.5	dBµV
	50 Hz		89.5	....	90.5	dBµV
	100 Hz		89.5	....	90.5	dBµV
	500 Hz		89.5	....	90.5	dBµV
	1 kHz		89.5	....	90.5	dBµV
	5 kHz		89.5	....	90.5	dBµV
	10 kHz		89.5	....	90.5	dBµV
	50 kHz		89.5	....	90.5	dBµV
	9 kHz to 30 MHz:					
	9 kHz		89.6	....	90.4	dBµV
	100 kHz		89.6	....	90.4	dBµV
	200 kHz		89.6	....	90.4	dBµV
	500 kHz		89.6	....	90.4	dBµV
	1 MHz		89.6	....	90.4	dBµV
	2 MHz		89.6	....	90.4	dBµV
	5 MHz		89.6	....	90.4	dBµV
	10 MHz		89.6	....	90.4	dBµV
	15 MHz		89.6	....	90.4	dBµV
	20 MHz		89.6	....	90.4	dBµV
	25 MHz		89.6	....	90.4	dBµV
	29.9 MHz		89.6	....	90.4	dBµV
	30 to 1000 MHz:					
	30 MHz		89.3	....	90.7	dBµV
	50 MHz		89.3	....	90.7	dBµV
	100 MHz		89.3	....	90.7	dBµV
	200 MHz		89.3	....	90.7	dBµV
	300 MHz		89.3	....	90.7	dBµV
	400 MHz		89.3	....	90.7	dBµV
	500 MHz		89.3	....	90.7	dBµV
	600 MHz		89.3	....	90.7	dBµV
	700 MHz		89.3	....	90.7	dBµV
	800 MHz		89.3	....	90.7	dBµV
	900 MHz		89.3	....	90.7	dBµV
	1000 MHz		89.3	....	90.7	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
19	Measurement accuracy Detector: Pk 100 MHz	5.2.6.1a	89.3	....	90.7	dBµV
	Detector: Pk	5.2.6.1b				
	IF BW: 1 kHz		18	....	22	dBµV
	IF BW: 10 kHz		37.5	....	41.5	dBµV
	IF BW: 100 kHz		58.0	....	62.0	dBµV
	IF BW: 120 kHz		60.0	....	64.0	dBµV
	IF-BW: 1 MHz		77.0	....	81.0	dBµV
	Detector: Pk/MHz	5.2.6.1c				
	IF BW: 1 kHz		79.0	....	81.0	dBµV/MHz
	IF BW: 10 kHz		79.0	....	81.0	dBµV/MHz
	IF BW: 100 kHz		79.0	....	81.0	dBµV/MHz
	IF BW: 120 kHz		79.0	....	81.0	dBµV/MHz
	IF-BW: 1 MHz		79.0	....	81.0	dBµV/MHz

Item no.	Characteristics	Testz according to Section	Min. value	Actual value	Max. value	Unit
20	Measurement error	5.2.6.1.3a				
	Detector: QP					
	100 kHz		-0.6	....	1.4	dBµV
	1 MHz		32.0	....	34.0	dBµV
	100 MHz		49.0	....	51.0	dBµV
	Detector: QP	5.2.6.1.3b				
	100 kHz		88.5	....	91.5	dBµV
	1 MHz		88.5	....	91.5	dBµV
	100 MHz		88.5	....	91.5	dBµV
	Detector: QP	5.2.6.1.3c				
	Frequency: 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
	Frequency: 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
	Frequency: 100 MHz	5.2.6.1.3c				
	Pulse frequency:					
	100 Hz		50.0	....	50.0	dBµV
	1000 Hz		57.0	....	59.0	dBµV
	20 Hz		40.0	....	42.0	dBµV
	10 Hz		34.5	....	37.5	dBµV
	2 Hz		22	....	26	dBµV
	1 Hz		19.5	....	23.5	dBµV
	Single pulse		16.5	....	20.5	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
21	Indication linearity Digital indication **IF BW: 1 kHz** 30-dB range Attenuation of attenuator	5.2.6.2.a				
	3 dB			80.0		dBµV
	5 dB		77.6	....	78.4	dBµV
	7 dB		75.6	....	76.4	dBµV
	9 dB		73.6	....	74.4	dBµV
	11 dB		71.6	....	72.4	dBµV
	13 dB		69.6	....	70.4	dBµV
	15 dB		67.6	....	68.4	dBµV
	17 dB		65.6	....	66.4	dBµV
	19 dB		63.6	....	64.4	dBµV
	21 dB		61.6	....	62.4	dBµV
	23 dB		59.6	....	60.4	dBµV
	25 dB		57.6	....	58.4	dBµV
	27 dB		55.6	....	56.4	dBµV
	29 dB		53.6	....	54.4	dBµV
	31 dB		51.6	....	52.4	dBµV
	33 dB		49.6	....	50.4	dBµV
21	Indication linearity Digital indication **IF BW: 10 kHz** 30-dB range Attenuation of attenuator:	5.2.6.2.1				
	3 dB			80.0		dBµV
	5 dB		77.6	....	78.4	dBµV
	7 dB		75.6	....	76.4	dBµV
	9 dB		73.6	....	74.4	dBµV
	11 dB		71.6	....	72.4	dBµV
	13 dB		69.6	....	70.4	dBµV
	15 dB		67.6	....	68.4	dBµV
	17 dB		65.6	....	66.4	dBµV
	19 dB		63.6	....	64.4	dBµV
	21 dB		61.6	....	62.4	dBµV
	23 dB		59.6	....	60.4	dBµV
	25 dB		57.6	....	58.4	dBµV
	27 dB		55.6	....	56.4	dBµV
	29 dB		53.6	....	54.4	dBµV
	31 dB		51.6	....	52.4	dBµV
	33 dB		49.6	....	50.4	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
21	Indication linearity Digital indication **IF BW: 1 kHz** 60-dB range Attenuation of attenuator	5.2.6.2.b				
	3 dB			80.0		dBµV
	8 dB		74.6	....	75.4	dBµV
	13 dB		69.6	....	70.4	dBµV
	18 dB		64.6	....	65.4	dBµV
	23 dB		59.6	....	60.4	dBµV
	28 dB		54.6	....	55.4	dBµV
	33 dB		49.6	....	50.4	dBµV
	38 dB		44.6	....	45.4	dBµV
	43 dB		39.6	....	40.4	dBµV
	48 dB		34.6	....	35.4	dBµV
	53 dB		29.6	....	30.4	dBµV
	58 dB		24.6	....	25.4	dBµV
	63 dB		19.6	....	20.4	dBµV
21	Indication linearity Digital indication **IF BW: 10 kHz** 60-dB range Attenuation of attenuator	5.2.6.2.b				
	3 dB			80.0		dBµV
	8 dB		74.6	....	75.4	dBµV
	13 dB		69.6	....	70.4	dBµV
	18 dB		64.6	....	65.4	dBµV
	23 dB		59.6	....	60.4	dBµV
	28 dB		54.6	....	55.4	dBµV
	33 dB		49.6	....	50.4	dBµV
	38 dB		44.6	....	45.4	dBµV
	43 dB		39.6	....	40.4	dBµV
	48 dB		34.6	....	35.4	dBµV
	53 dB		29.6	....	30.3	dBµV
	58 dB		24.6	....	25.4	dBµV
	63 dB		19.6	....	20.4	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
23	Error of attenuator Frequency: 40 kHz Attenuation:	5.2.6.3				
	0 dB		-	3.0	-	dBµV
	10 dB		12.6	....	13.4	dBµV
	20 dB		22.6	....	23.4	dBµV
	30 dB		32.6	....	33.4	dBµV
	40 dB		42.6	....	43.4	dBµV
	50 dB		52.6	....	53.4	dBµV
	60 dB		62.6	....	63.4	dBµV
	70 dB		72.6	....	73.4	dBµV
	80 dB		82.6	....	83.4	dBµV
	90 dB		92.6	....	93.4	dBµV
	100 dB		102.6	....	103.4	dBµV
	110 dB		112.6	....	113.4	dBµV
	120 dB		122.6	....	123.4	dBµV
23	Error of attenuator Frequency: 20 MHz Attenuation:	5.2.6.3				
	0 dB		-	3.0	-	dBµV
	10 dB		12.6	....	13.4	dBµV
	20 dB		22.6	....	23.4	dBµV
	30 dB		32.6	....	33.4	dBµV
	40 dB		42.6	....	43.4	dBµV
	50 dB		52.6	....	53.4	dBµV
	60 dB		62.6	....	63.4	dBµV
	70 dB		72.6	....	73.4	dBµV
	80 dB		82.6	....	83.4	dBµV
	90 dB		92.6	....	93.4	dBµV
	100 dB		102.6	....	103.4	dBµV
	110 dB		112.6	....	113.4	dBµV
	120 dB		122.6	....	123.4	dBµV
23	Error of attenuator Frequency: 1000 MHz Attenuation:	5.2.6.3				
	0 dB		-	3.0	-	dBµV
	10 dB		12.6	....	13.4	dBµV
	20 dB		22.6	....	23.4	dBµV
	30 dB		32.6	....	33.4	dBµV
	40 dB		42.6	....	43.4	dBµV
	50 dB		52.6	....	53.4	dBµV
	60 dB		62.6	....	63.4	dBµV
	70 dB		72.6	....	73.4	dBµV
	80 dB		82.6	....	83.4	dBµV
	90 dB		92.6	....	93.4	dBµV
	100 dB		102.6	....	103.4	dBµV
	110 dB		112.6	....	113.4	dBµV
	120 dB		122.6	....	123.4	dBµV

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
24	IF analysis					
	Gain	5.2.7.1				
	Marker level		72	....	78	dB
	Linearity	5.2.7.1				
	RF attenuation					
	10 dB			78		dB
	20 dB		65.5	....	70.5	dB
	30 dB		55.5	....	60.5	dB
	40 dB		45.5	....	50.5	dB
	50 dB		35.5	....	40.5	dB
	60 dB		25.5	....	30.5	dB
	70 dB		15.5	....	20.5	dB
25	IF analysis	5.2.7.2				
	Input attenuation					
	Error			....	0.5	dB
26	IF analysis					
	Resolution bandwidth					
	3-dB bandwidth	5.2.7.3				
	10 kHz		8	....	12	kHz
	3 kHz		2.4	....	3.6	kHz
	1 kHz		0.8	....	1.2	kHz
	Shape factor	5.2.7.4				
	10 kHz		-	....	4	-
	3 kHz		-	....	8	-
	1 kHz		-	....	9	-
27	IF analysis					
	RF bandwidth	5.2.7.5				
	Gain drop with					
	99 MHz		3	....	-	dB
	101 MHz		3	....	-	dB
28	Generator output	5.2.8.1				
	9 kHz		-18	....	-16	dBm
	100 kHz		-18	....	-16	dBm
	1 MHz		-18	....	-16	dBm
	5 MHz		-18	....	-16	dBm
	10 MHz		-18	....	-16	dBm
	20 MHz		-18	....	-16	dBm
	30 MHz		-18	....	-16	dBm
	50 MHz		-18	....	-16	dBm
	100 MHz		-18	....	-16	dBm
	200 MHz		-18	....	-16	dBm
	500 MHz		-18	....	-16	dBm
	750 MHz		-18	....	-16	dBm
	1000 MHz		-18	....	-16	dBm
29	AF output	5.2.8.2	2	....	-	V

Item no.	Characteristics	Test according to Section	Min. value	Actual value	Max. value	Unit
31	10.7 MHz output	5.2.8.3	800	....	1200	mV
32	Video output	5.2.8.4	3.5	....	4.5	V
32	Reference output (ESS-B1 fitted)	5.2.8.5	+7	....	-	dBm
33	User Port					
	Recorder 1	5.2.8.6.1				
			3.65	....	3.85	V
			0.65	....	0.85	V
	Recorder 2	5.2.8.6.1				
			3.65	....	3.85	V
			0.65	....	0.85	V
	+ 5-V output	5.2.8.6.2	5.0	....	5.5	V
	+ 12-V output	5.2.8.6.2	10.8	....	15.0	V