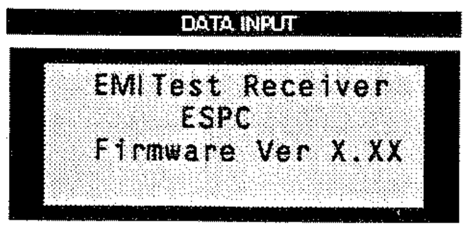
3 Operating Instructions

3.1 Explanation of Front and Rear Panel View

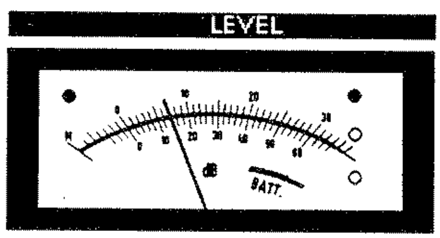
3.1.1 Front View

1



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

2



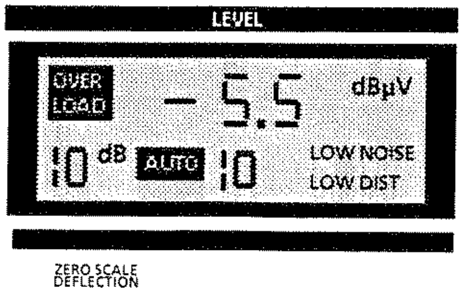
- Moving coil instrument with scales for the 30-dB- and 60-dB-operating ranges;
- Display of battery voltage and mechanical zero display;
- Setting screw for the mechanical zero;
- Yellow LEDs for indicating the operating range;
- Red LEDs for indicating whether the operating range (upper or lower limit) is exceeded (cf. section 3.2.3.6.3)

3

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

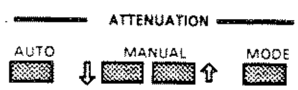
OPERATING RANGE: Key for switching-over the operating range (cf. section 3.2.3.5)

4



- 3 $^{1}/_{2}$-digit display of the level applied to RF-input, resolution 0.1 dB
  Units:
  dBµV, dBµA, dBm, dBµV/MHz, dBµA/MHz, dBµV/m, dBµV/m/MHz, dBµA/m, dBµA/m/MHz, dBpW
- Display of overload of the signal path (OVERLOAD)
- Display of measurement mode (MODE): LOW NOISE and LOW DIST (low-distortion) (sect. 3.2.3.3)
- Display of RF attenuation (RF ATT) 0 to 70 dB (cf. section 3.2.3.2)
- Display of automatic operation (AUTO) (cf. section 3.2.3.4)
- Display of lower limit of the scale span (ZERO SCALE DEFLECTION) (cf. section 3.2.3.6)

5



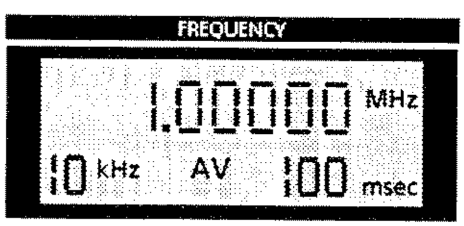
Attenuation

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

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

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

6



- 7-digit display of receiver frequency resolution 10 and 100 Hz, unit in MHz and kHz (cf. section 3.2.3.1)
- Display of measuring time, 1 ms to 100 s in 1, 2, 5-steps, (cf. section 3.2.3.9)
- Indication of detector: AV, Pk, and QP, (cf. section 3.2.3.9)
- Indication of IF-bandwidthsc 200 Hz, and 10 kHz (cf. section 3.2.3.7)

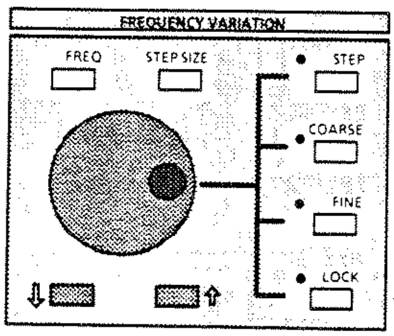
7

IF BW: Key for switching over IF-bandwidth

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

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

8



Frequency tuning knob

FREQ: key for input of frequency

STEP SIZE Input of tuning step size

STEP: Tuning in the step size entered in STEP SIZE

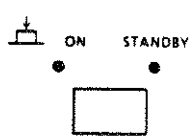
COARSE: Frequency tuning coarse (100-kHz steps)

FINE: Frequency tuning fine (10- and 100-Hz steps)

⇧ Frequency is increased by the step size entered in STEP SIZE

⇩ Frequency is reduced by the step size entered in STEP SIZE (cf. section 3.2.3.1)

9



On/Standby switch

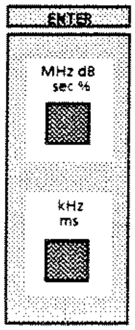
10

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

Output: + 10 V, -10 V, max. 50 mA

Input: Coding for level display (cf. section 3.2.5.1)

11



Input keys:

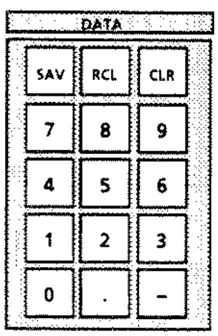
MHz dB
sec %: Input key for the units MHz, dB, seconds and % or for entries without unit

kHz
ms: Input key for the units kHz and milliseconds or for entries without unit (cf. section 3.2.2)

12

Socket for connecting measuring earth

13



Numeric keypad

SAV (0 to 9): Storing of instrument settings (cf. section 3.2.4.5)

RCL (0 to 9): Calling of stored settings (cf. section 3.2.4.5)

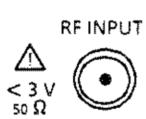
CLR: Deleting the character last entered

0 to 9: Numeric input keypad

- Minus sign

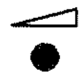
. : Decimal point (cf. section 3.2.2)

14



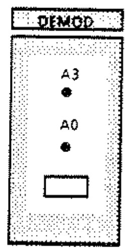
RF-input, N-input socket, 50 Ω, < 3 V (cf. section 3.2.1)

15



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

16

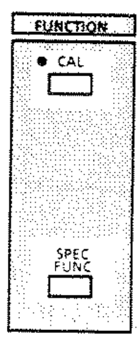


A3: Indicates when AM-demodulation is switched on

A0: Indicates when A0-demodulation is switched on

Key for switching-over the mode of demodulation
(cf. section 3.2.3.10)

17



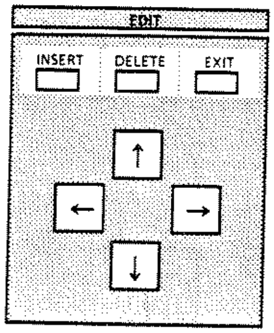
CAL: Initiating calibration process
short key depression → short CAL
long key depression → total CAL
(cf. section 3.2.3.11)

SPEC FUNC: Calling the special function menu
(cf. section 3.2.3.12)

18

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

19



Editing function of display DATA INPUT:

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

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

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

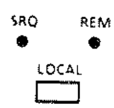
→: The cursor moves to the right or to the next submenu, (cf. section 3.2.4.1)

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

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

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

20

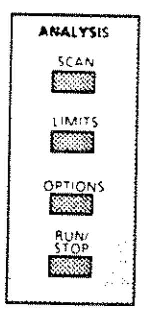


SRQ: LED indicates service request present at IEC-bus (cf. section 3.3)

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

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

21



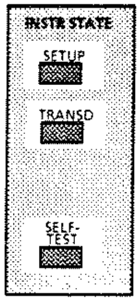
SCAN: Calling the menu for input of scan data sets (cf. section 3.2.4.1.1)

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

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

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

22

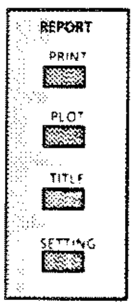


SETUP: Calling the menu for the instrument default settings (cf. section 2.1.5)

TRANSD: Calling the menu for input of transducer factors (cf. section 3.2.4.2.1)

SELF TEST: Calling the menu for instrument self-test (cf. section 3.2.4.2.2)

23



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

PLOT: Selecting plotter output (cf. section 3.2.4.4.4)

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

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

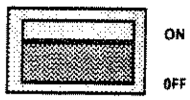
24

OOOOOOOOOOOOOOO
OOOOOOOOOOOOOOO
OOOOOOOOOOOOOOO

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

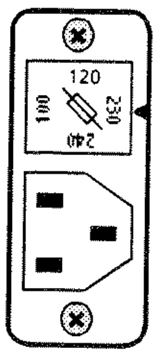
3.1.2 Rear View

25



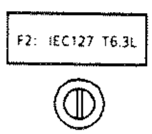
Power switch

26



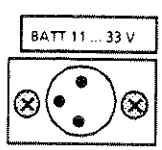
Power input with integrated voltage selector and power fuse (cf. section 2.1.3.1)

27



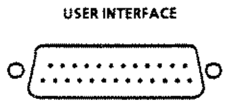
Fuse for external battery,
F2: IEC 127 T6,3L 250 V
(cf. section 2.1.3.3)

28



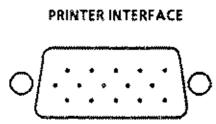
Input for an external battery 11 to 33 V,
3-pole special connector; (cf. section 2.1.3.3)

29



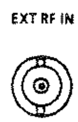
User interface with various inputs and outputs, 25-pole female connector (cf. section 3.2.6.5)

30



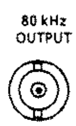
Parallel interface for connecting a printer, 15-pole female connector (cf. section 3.2.6.6)

31



BNC-socket for connecting an external reference, 5 or 10 MHz (cf. section 3.2.6.3)

32

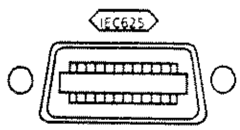


BNC-socket for output of the 2nd IF (80 kHz) (cf. section 3.2.6.2)

33

Connection for external keyboard
(cf. section 3.2.6.8)

34



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

35

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

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 described in section 3.2.3.4 (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 that an RF attenuation of 0 dB is activated during autorange operation.

With an RF attenuation > 0 dB the max. permissible pulse energy at 50 Ω is 10 mWs.

The input attenuator, pre-amplifier, preselection filter or input mixer may be destroyed, if these values are exceeded. For higher voltages as occur e. g. with measurements at ignition cables using the absorbing clamp MDS 21 it is recommended to use the external Pulse Limiter ESM3-Z2 (see Recommended extras on page 8 of EMPC data sheet). This 10-dB attenuator pad which can be switched into circuit is designed for pulse voltages up to max. 1500 V and for pulse energies up to 100 mWs. It is automatically switched on by the ESPC if RF attenuation exceeds 10 dB, thus protecting the receiver input from destruction.

3.2.2 Input of Numeric Values

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

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

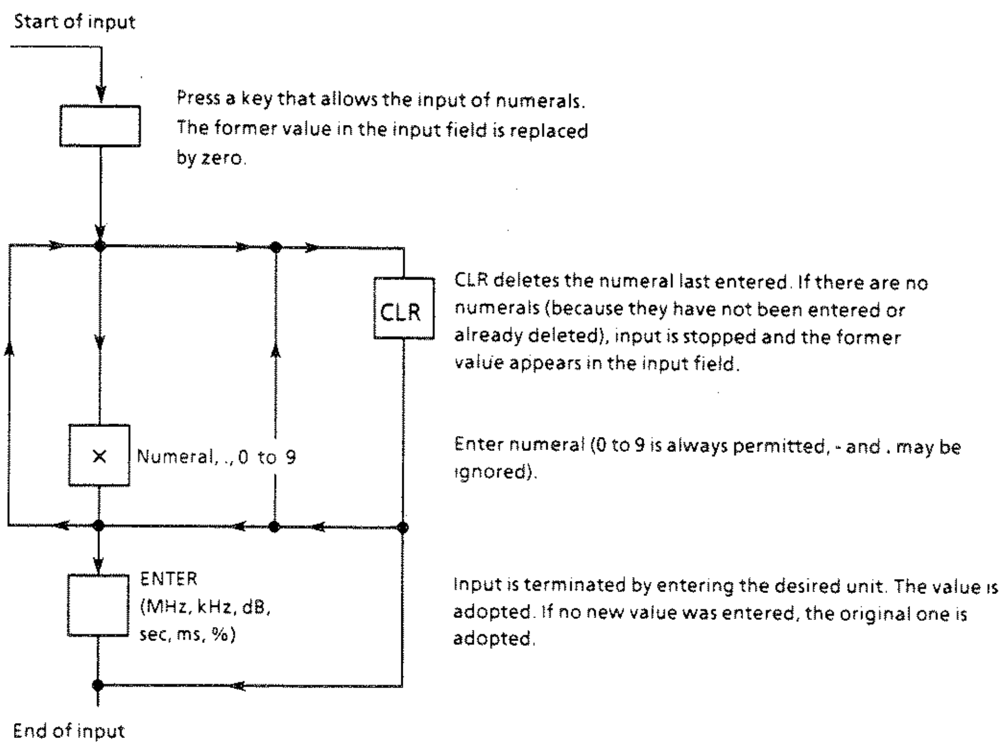


Fig. 3-3 Flowchart for the input of numeric values

3.2.3.1.3 Frequency Tuning using the ↓ and ↑ keys

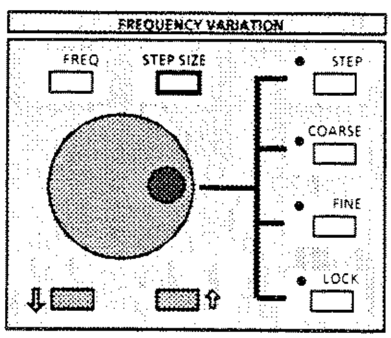
If signals in known frequency steps are to be measured, it is useful to step through the receiver frequency in their distance. This is for example the case with harmonics of the clock frequency of processors. For this purpose the ↓ and ↑ keys are provided in the keypad FREQUENCY VARIATION. Frequency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

3.2.3.1.4 Input of Tuning Step Size

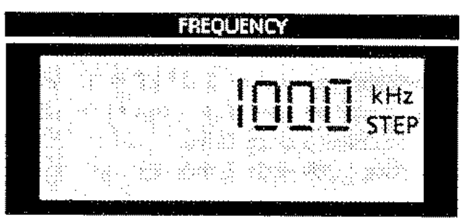
Any step size for tuning the receiver frequency can be input using the STEP SIZE key in the keypad FREQUENCY VARIATION. The defined step size is used when tuning the frequency with the ↓ and ↑ keys or with the tuning knob in the step size setting STEP.

Operation:

Step size is entered as follows:



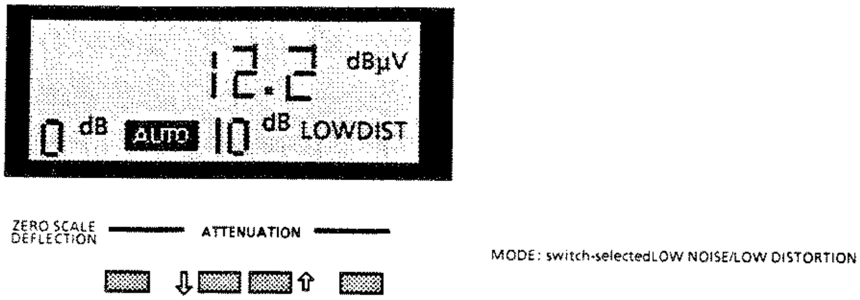
- Press STEP SIZE key.



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

The step size ist variable between 0 kHz and 1000 MHz.
After termination of input, the receiver frequency is shown again in the display FREQUENCY with the unit MHz or kHz.

Operation:



The set mode is shown in the LEVEL display.

3.2.3.4 Automatic Setting of Attenuation (Autorange Operation)

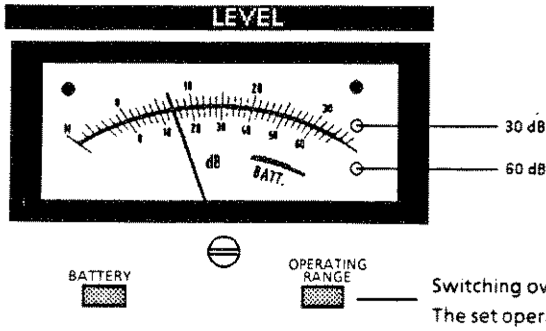
With automatic operation selected, the receiver sets the RF attenuation and the operating mode (MODE) such that the level applied to the RF input is always within the valid operating range. The input mixer has to be protected against spikes as may be caused when the DUT is switched on or upon switchover of the measurement path between phase and neutral wire with an artificial mains network connected. In the basic receiver setup (special function 00), an attenuation of at least 10 dB is permanently set in the autorange mode and after receiver switch-on. An RF attenuation of 0 dB in autorange mode is only used when this value is set when automatic operation is selected. The 0-dB setting can be cancelled by switching off the autorange mode and switching it on again after setting an RF attenuation of ≤ 10 dB. When measuring RFI voltages with an external Pulse Limiter ESH23-Z2 or in the case of RFI fieldstrength measurements, this protective measure is not appropriate for reasons of sensitivity. In this case select special function 03 (Min ATT 10 dB...on/off; see section 3.2.3.12) to allow the use of 0-dB attenuation. When the ESPC is switched off with the 0-dB attenuation set, this value is reset upon switching on the instrument again. The following criteria are of importance for setting the 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 due to varying input levels.

Operation:



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

3.2.3.6 Level Indication

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

3.2.3.6.1 Digital Level Indication

Compared to analog indication, digital level indication has the advantage of being more accurate since the correction values for the linearity of the rectifier and that of the logarithmic amplifier which are both determined during total calibration are part of the value displayed. Resolution of the digital display is 0.1 dB in a range of -200 to +200 dB. If indication exceeds the value 200 due to the theoretically possible selection of a transducer of up to ± 200 dB, the level is output with a resolution of 1 dB on the LEVEL display. The unit of the measured quantity is also indicated. The basic unit of the indication is dBµV. Other units can be selected by coding the connector ANTENNA CODE (cf. section 3.2.5.1), entering a transducer factor (cf. section 3.2.4.2.1) or by way of special functions (cf. section 3.3.2.3.11). The following units are possible:

Table 3-3

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

3.2.3.7 Selecting IF Bandwidth (IF BW)

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

The 120 kHz bandwidth meets the tolerance for the bandwidth of bands C and D (30 to 1000 MHz) specified in CISPR 16 or VDE 0876.

With receiving frequencies of under 150 kHz, the 200-Hz bandwidth is always recommended for use since the oscillator for first conversion is not suppressed sufficiently with the 10-kHz bandwidth and thus the sensitivity of the receiver is considerably reduced.

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

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

In the indication mode quasi-peak (QP) bandwidth is linked to the receiver frequency. In band A (frec < 150 kHz) the 200-Hz bandwidth, in band B (f_{rec} ≥ 150 kHz) the 10-kHz bandwidth and in bands C/D (f_{rec} ≥ 30 MHz) the 120-kHz bandwidth is automatically switched on.

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

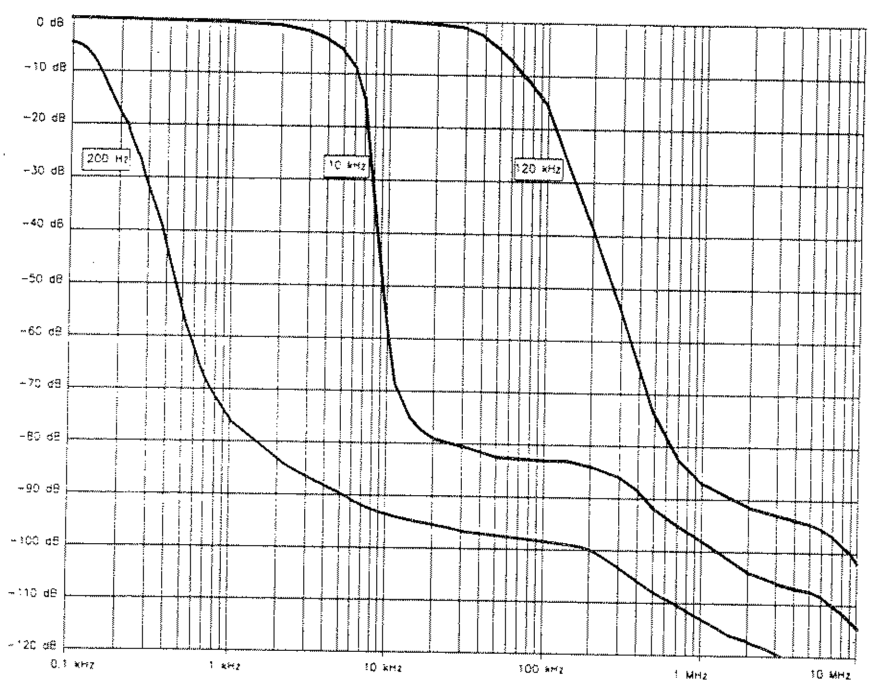


Fig. 3-4 Dynamic IF selectivity

3.2.3.8.3 Quasipeak (QP)

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

Table 3-4

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

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

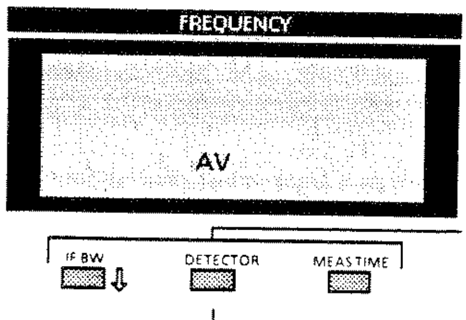
Due to the long time constants of weighting, it takes relatively long until a valid measurement result is displayed after every change in frequency or attenuation at the receiver. It is therefore futile to use measuring times of less than 1 s, especially in the case of automatic measurements.

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

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

- In quasi-peak mode (QP) level indication drops with decreasing pulse repetition frequency due to time constants specified in CISPR 16.
- 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 ESPC, the characteristic curve of average value indication (curve ④ and ⑥) is about 1 dB above the theoretical curve, however always within the error limits of +3 and -1 dB, which are agreed upon in VDE 0876 Part 3. The reason is a slight overshoot of the IF filter. Increase in indication for pulse repetition frequencies below 10 Hz is caused by internal receiver noise.

Operation:



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

AV → Pk → QP

3.2.3.9 Selecting the Measuring Time (MEAS TIME)

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

Significance with Peak Measurement:

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

Significance with Average Measurement:

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

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

3.2.3.10 Selecting AF Demodulation (DEMOD)

The ESPC offers two demodulation modes: A3 and A0.

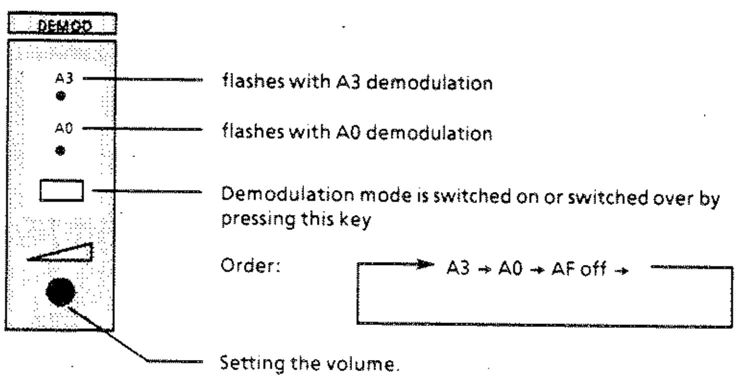
A3 stands for demodulation of AM broadcasting signals. AF bandwidth is limited to 5 kHz. In the indicating mode quasi-peak (QP), noise in the AF-branch is suppressed to some extent in order to show more clearly the devices interfering with pulses. Distortion of signals to which sine-wave modulation has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

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

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

Note: *When the beeper is activated (cf. section 3.2.3.12), AF-demodulation must be switched on, as otherwise the beeper is not audible. Nevertheless volume control knob may be at the left stop so that the demodulated AF cannot be heard.*

Operation:



WARN: Gain at 1 MHz — Basic gain of the receiver is not within the tolerance limits at the reference frequency 1 MHz. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected. The user is informed about this occurrence by another error messge.

WARN: BW 10 kHz or 200 Hz — Gain at the 200-Hz or10-kHz IF bandwidth is outside the tolerance limits. Calibration continues. It is, however, possible that another receiver parameter can no longer be corrected. The user is informed about this occurrence by another error message.

ERR: BW 120 kHz — Gain at 120-kHz IF bandwidth 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 tolerance limits, correction of total gain of the ESPC may not be possible anymore. A separate error message informs the user about this fault. Calibration continues.

ERR: IF Attenuator — The IF-gain switch is defect so that it is no longer possible to correct its gain error. Nevertheless calibration continues as the ESPC can still be used to a limited extent. When switching on the respective IF-gain, an error message (*ERR: IF ATT)* is output.

WARN: 30 dB Range
WARN: 60 dB Range — Linearity of the test detector is out of tolerance, which results in a slightly reduced total linearity as interpolation must make up for relatively great deviations between the interpolation points. Calibration continues.

ERR: 30 dB Range; or *ERR: 60 dB Range* — The 30- or 60-dB operating range is defect and can no longer be used. Calibration is aborted.

WARN: Gain at xx MHz/(kHz) — When recording frequency response of the receiver it is noted that the internal tolerance is exceeded. This may have the result that the total correction value may be too high and cannot be set anymore.

ERR: Gain at xx MHz/(kHz) — A filter range of the preselection is defect. Measurements in this range are not possible. When setting this range the error message *ERR: Gain* is output.

Error Handling during Measurement:

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

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

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

Signal-to-noise ratio	Increase in indication in dB with	
	Average value (AV)	Peak value (Pk)
0	2.28	5.10
1	1.86	4.67
2	1.50	4.27
3	1.21	3.98
4	0.98	3.54
5	0.79	3.22
6	0.63	2.92
7	0.50	2.65
8	0.40	2.39
9	0.32	2.16
10	0.26	1.95
12	0.16	1.59
14	0.10	1.28
16	0.06	1.03
18	0.04	0.83
20	0.02	0.67
25	0.01	0.38
30		0.22
40		0.07
50		0.02

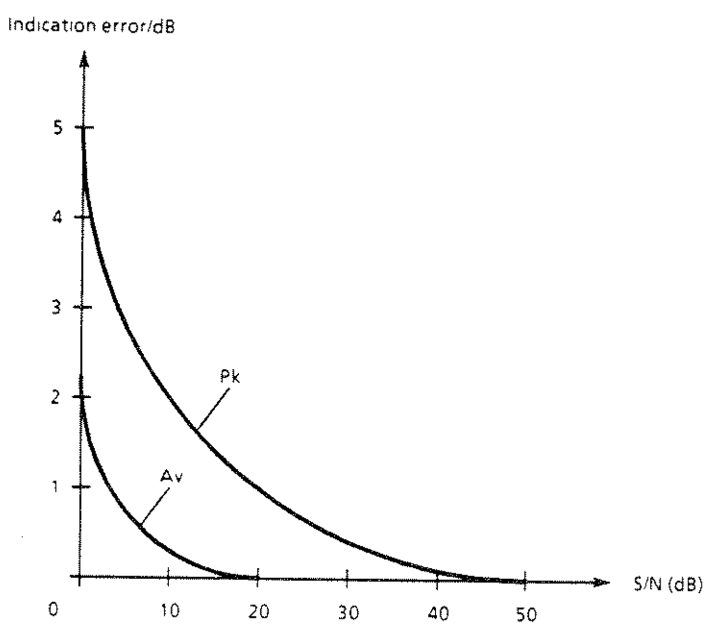


Fig. 3-6 Increase in indication of an unmodulated sinusoidal signal as a result of noise as a function of the signal-to-noise ratio.

3.2.3.12 Special Functions (SPEC FUNC)

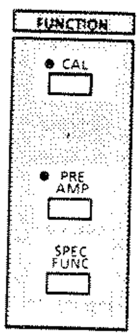
Special functions are integrated into the ESPC for applications requiring special properties of the receiver. The user, himself, can select - to a certain extent - the properties of the receiver using these special functions.

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

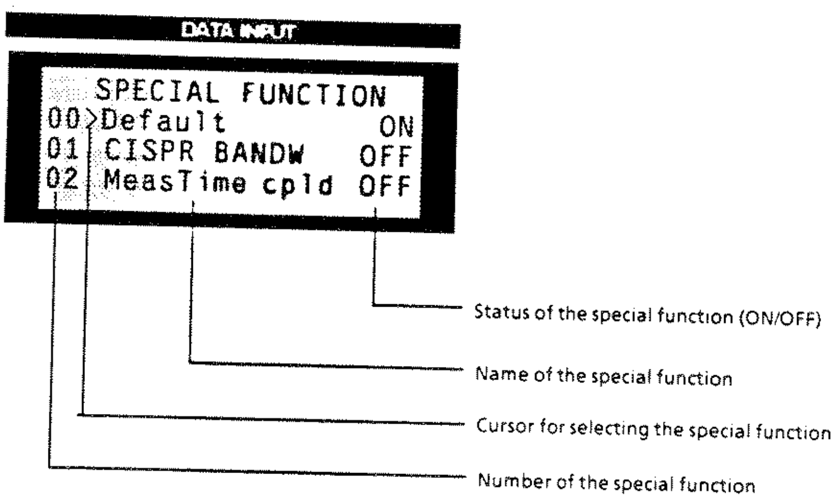
Table 3-7

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

Operation:



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



SPEC FUNC 10 Display Light

When operating with internal battery, default setting is OFF, otherwise ON.
To increase operating time when using internal battery, illumination of the LC displays is switched off. The receiver, itself recognizes by which source it is fed and switches lighting correspondingly. When operating under poor lighting conditions, it is however recommended to switch on illumination.

SPEC FUNC 11 IEC 625

When operating with internal battery, default setting is OFF, otherwise ON.
IEC-bus operation is usually not desired when operating with internal battery, as the required controller usually must be mains-operated. The IEC-bus is therefore switched off to increase operating time. The receiver, itself recognizes by which source it is fed and selects the status of the IEC-bus correspondingly.
During plotting the IEC bus cannot be switched off.

SPEC FUNC 12 Antenna Code

Default setting is ON.
Active transducers from Rohde & Schwarz, such as the loop antenna HFH2-Z2 or the rod antenna HFH2-Z1 or HFH2-Z6 are supplied by the socket ANTENNA CODE. At the same time the conversion factor of the transducer is coded using this socket. If coding of the conversion factor is not desired because e.g. an additional test cable is used, it can be switched off using this special function. The individual conversion factor can then be input via the transducer factor (cf. section 3.2.4.2.1). Coding at the ANTENNA CODE socket is then always ineffective regardless of the setting of the special function.

SPEC FUNC 13 Beeper

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

- end of a frequency scan,
- end of a plotting process,
- end of a printing process,
- Output of an error message or warning and

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

SPEC FUNC 16 Check Limit

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

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

values are measured and stored for plotter or printer output; it is however only possible to indicate every first value (example: Pk + AV → Pk is indicated). When outputting the test curve on a plotter during the scan (option "Meas.& Plot, cf. section 3.2.4.3.3) the curve for the first indicating mode is immediately displayed, the second test curve is displayed subsequently (example: QP + AV → the QP-curve is plotted during measurement and then the AV-curve). Only one of the double measurement modes can be active at one time. When switching on a new function, the one that has already been activated is automatically switched off.

SPEC FUNC 51: Ext Trigger +

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

SPEC FUNC 52: Ext Trigger -

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

3.2.4 Operation of the Menu Functions

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

3.2.4.1 Input and Editing in the Display DATA INPUT

3.2.4.1.1 Editing the Menus

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

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

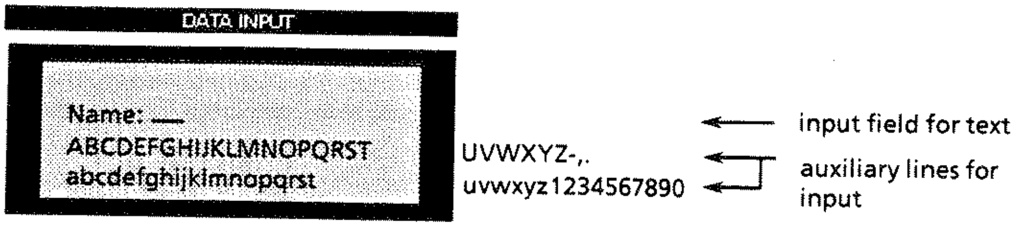


Fig. 3-10

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

3.2.4.2 Configuration of the Receiver (Keypad INSTR STATE)

The presettings

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

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

Operation is descripted in section 2.1.5.

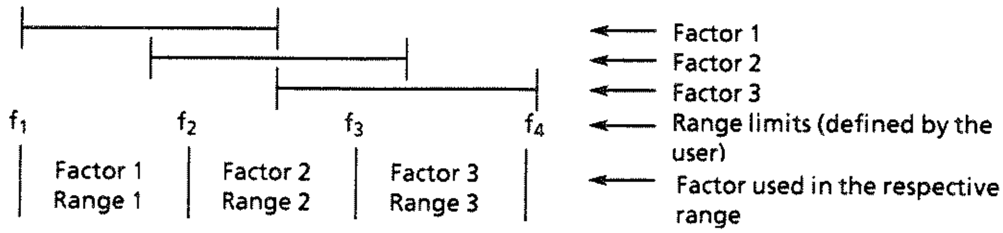
3.2.4.2.1 Entering and Calling of Transducer Factors (TRANSDUCER Menu)

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

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

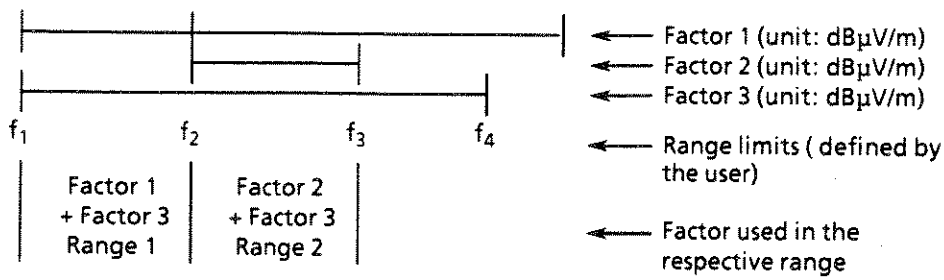
The unit of the transducer applies to the entire frequency range of the receiver, even if the transducer only covers a part of the range Outside of the definition range it is assumed that the conversion factor is 0 dB. The receiver therefore delivers illegal measurement values, if the receiver frequencies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

c) Transducer set with several overlapping factors:



With overlapping factors only those factors that cover a range completely can be activated in it. This applies for f_1 to f_4 with the above-mentioned ranges.

d) Several factors are simultaneously valid:
(set of transducers from f_1 to f_3)



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

Operation:

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

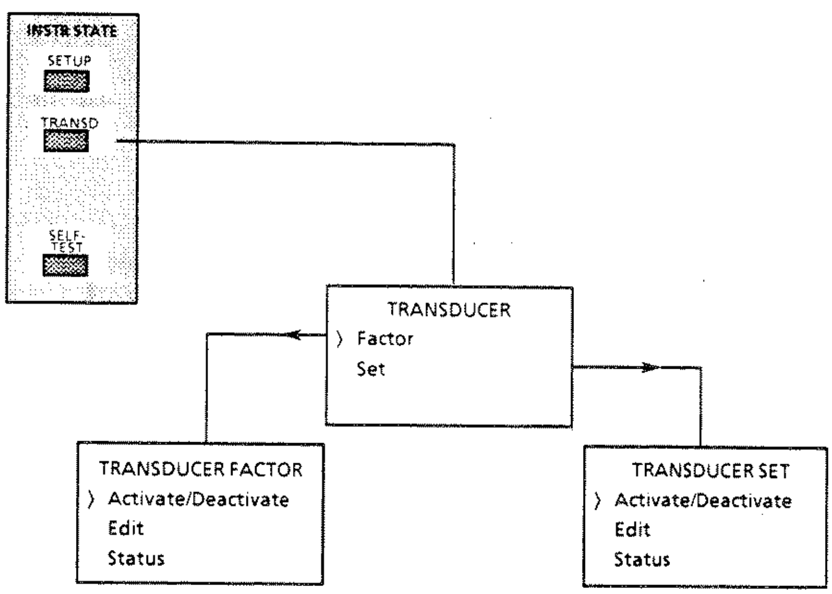


Fig. 3-13 Flowchart for calling the transducer factor

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

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

Transducer Status:

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

Edit Factor:

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

New Entry of Transducer Factors:

New entry of factors must be performed in the sequence of increasing frequencies and must be input with frequency and transducer value. The cursor is initially placed on the frequency of the first point. Following frequency input (terminated by MHz) the cursor jumps automtically on the appertaining transducer value.

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

If the increasing order is not kept, the error message *"Freq Sequence!"* is output and frequency input is ignored, i.e. the entry is not accepted and the space remains blank after having terminated the input, thus being available for a new input. If a frequency that cannot be set in the receiver is entered, the error message *"Max Freq 1000 MHz"* is output in the fourth line when the frequency is too high. When entering a too low frequency, the message *"Min Freq 20 MHz"* is output. Points that have been already present are changed by selecting them using the cursor and then entering a new value.

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

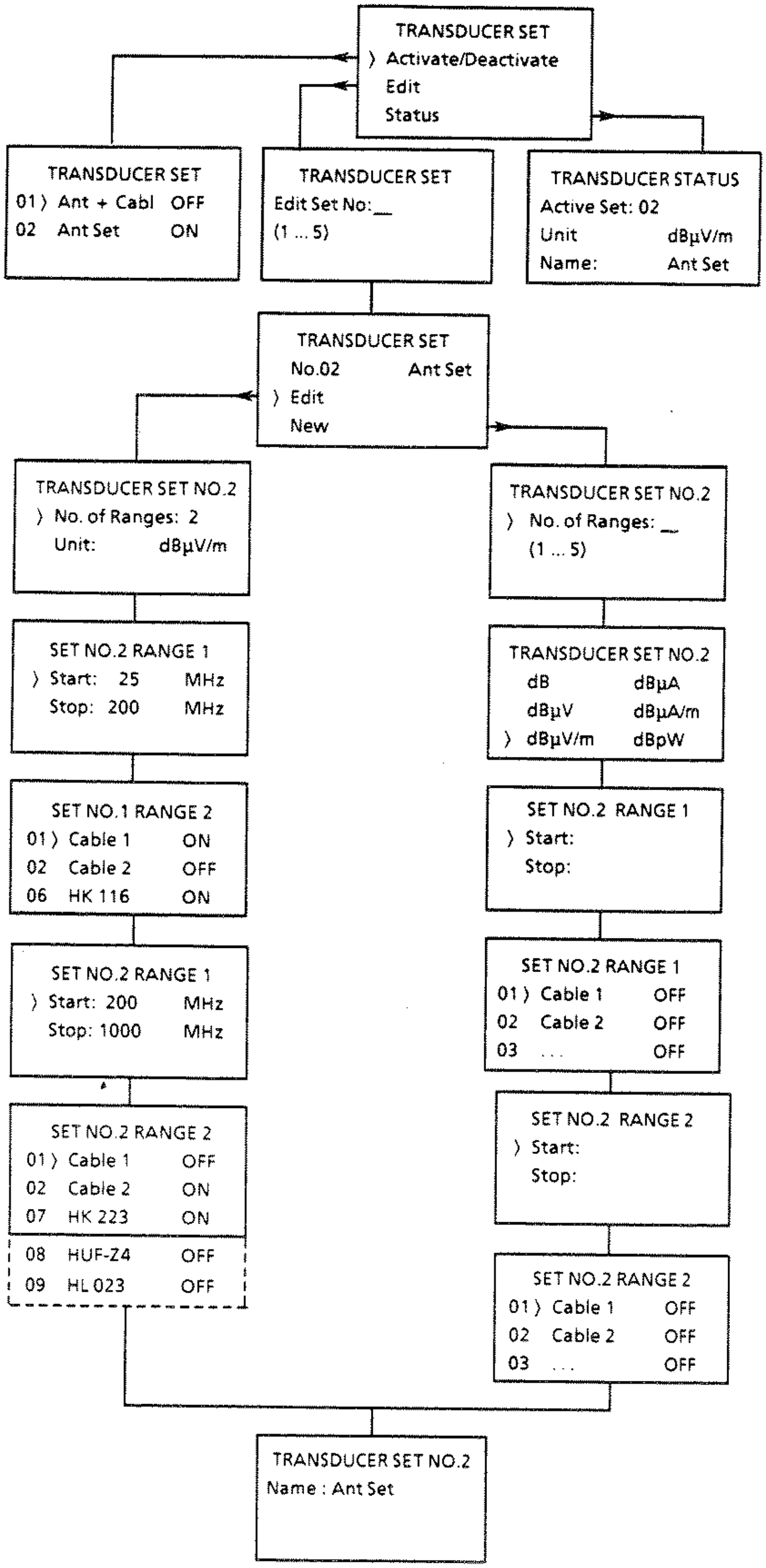


Bild 3-15 Flowchart for generating/editing a transducer set

3.2.4.2.2 Calling the Self Test (SELF TEST Menu)

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

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

Operation:

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

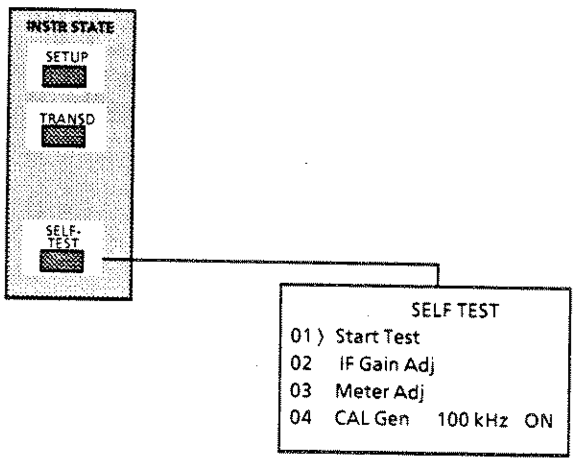


Fig. 3-16 Calling the SELF TEST menu

Operation:

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

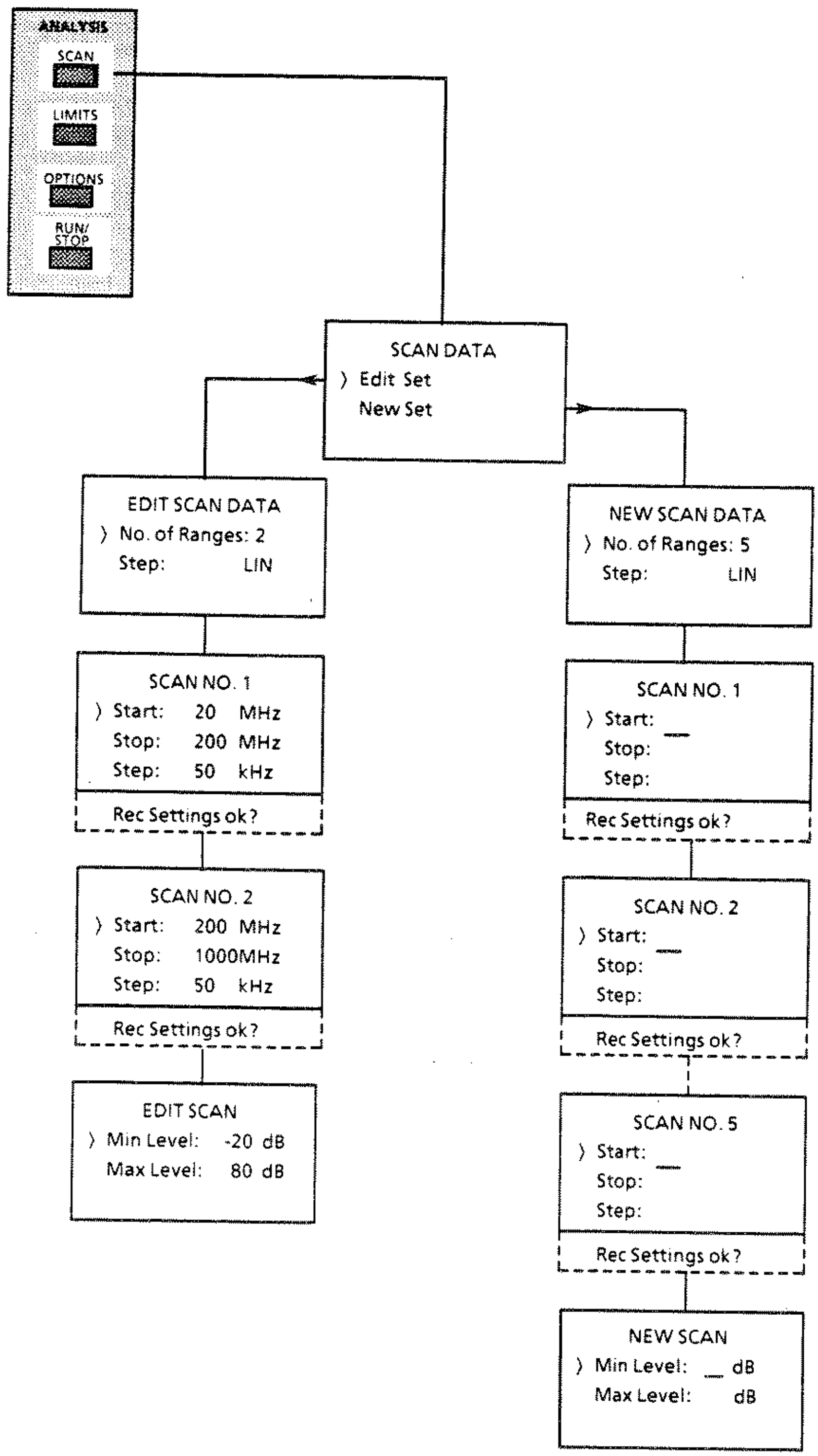


Fig. 3-17 Flowchart of the menus EDIT SET and NEW SET

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

Start
Stop If the partial scan that is to be changed is already known, the menu can be quickly scrolled through using the → key. If, however, the type of frequency scan is changed, the step size must be entered in each partial scan as it is deleted. Unless this is done, the partial scan menu cannot be exited. Start frequency, stop frequency and step size can be edited by selecting the corresponding menu point by way of the cursor and immediately entering new values. When pressing a ENTER key the old value is retained and the cursor moves to the next line.

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

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

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

Operation:

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

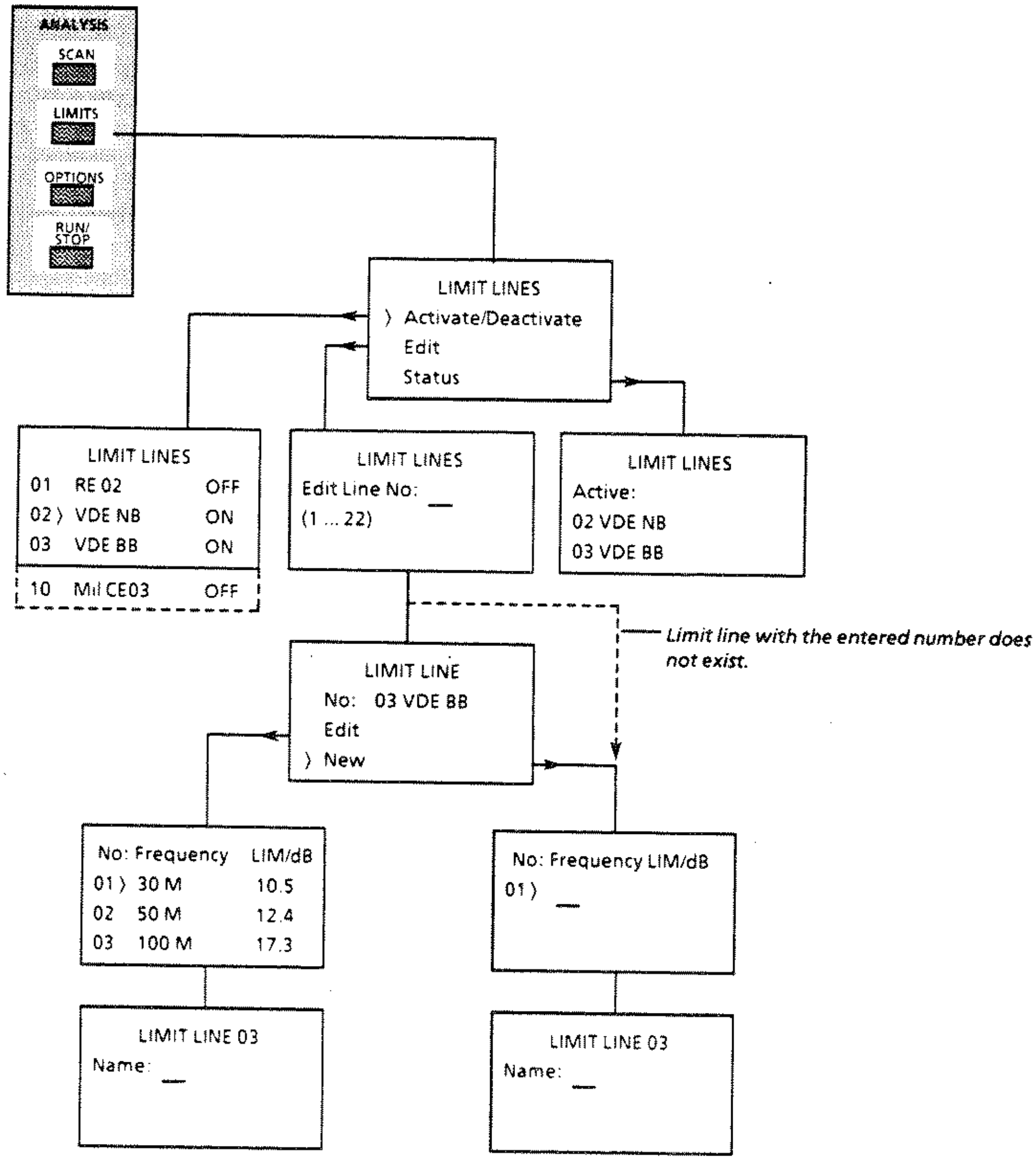


Fig. 3-18 Flowchart for new entry or editing of limit lines

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

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

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

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

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

3.2.4.3.3 Extended Functions of RF-Analysis (OPTIONS)

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

Operation:

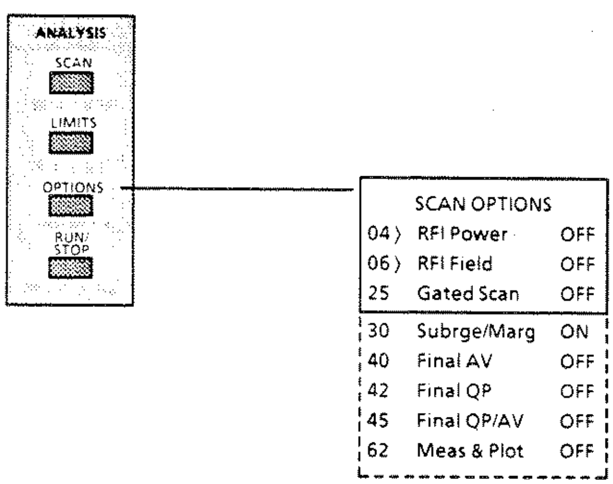


Fig. 3-19 Calling the SCAN OPTIONS menu

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

If no limit line is defined in a subrange, the final measurement is performed on all subrange maxima independently of their levels.

The menu can be exited using EXIT

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

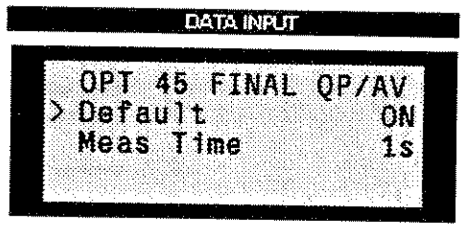
Default setting is OFF.
With the options 40, 42 and 45 ON, quasipeak measurement, average measurement or both is automatically effected at the maximum levels of the subranges following a measurement with scan. One function only can be switched on at one time. When activating one option, the other two are automatically switched off. The options directly influence th scan parameters of the final measurement. Weighting depends on the activated option and is performed using the following detectors:

Option	Detector for over-view measurement
40 Final AV	AV
42 Final QP	Pk
43 Final QP/AV	Pk + AV

Application is described in section 3.4.

Operation:

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



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

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

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

Option 62, Meas & Plot:

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

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

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

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

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

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

3.2.4.3.4 Frequency Scan

A scan is started by pressing the RUN/STOP key. It runs in accordance with the set special functions (cf. section 3.2.3.12), transducer factor or transducer set (cf. section 3.2.4.2.1) and options. If several ranges are defined in an active transducer set, the receiver stops at the range intersections and requests changing of the transducer. The data measured are stored in the internal RAM (cf. Options and section 3.4) Max. 30.000 measured data can be internally stored. If more measured values are produced, they are not available any more for further processing (e. g. subsequent output via the IEC bus). Nevertheless, a complete diagram is always output, since only the 400 upper values of the scan are required. The stored data get lost, when switching off the receiver.

Operation:

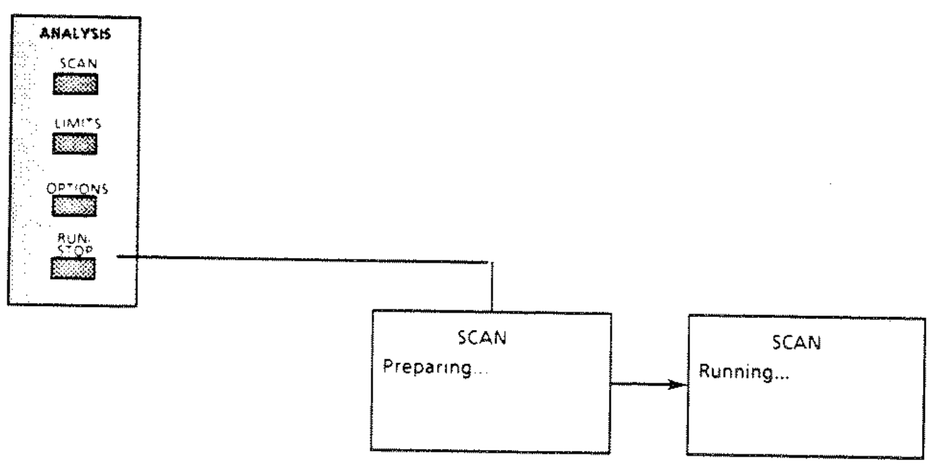


Fig. 3-21 Calling the SCAN menu

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

3.2.4.4 Generating a Test Report (Report Keypad)

The result of a measurement run can be output both on a printer with Centronics interface and via IEC bus on a plotter with HP-GL interface. Any 24-pin printer, which is EPSON-compatible, HP DeskJet or HP Laser-Jet II, may be used. The contents of the plotter or printer output can be determined by the user himself.

The following outputs are feasible:

- Measured value diagram with limit lines,
- Measurement settings of the receiver,
- Measuring curves,
- User-definable heading,
- Measuring value table and
- Date and time.

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

In addition to final results of an RF analysis scan, the results of a prescan can be copied in tabular form to a printer. The parameter *Scan Res List* in the *Printer Setting* menu has to be switched ON. If a limit line is active and a margin was defined, only those values which exceed the limit and margin during a scan are printed out.

The menu for setting the printer is displayed in the following manner:

```
DATA INPUT
   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        OFF
```

Displayed after the REPORT SETTING key has been pressed. Set cursor to Printer and press one of the ENTER keys.

Can be scrolled using ↑ and ↓ keys

3.2.4.4.1 Selecting the Pre-setting of the Printer and Plotter

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

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

- the graticule with frequency and level labelling and, if defined, the limit lines (*Diagram*),
- the heading defined by the user (*Title*, cf. section 3.2.4.1.1),
- the measured value curve(s) (*Curve*),
- the table with measured values (*Final Results*),
- the table with the list of scan and partial scan settings used with the appertaining receiver parameters (*Scan Table*) and
- date and time
- page numbering (*Page Count*)

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

Device

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

Pen Setting

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

Special Scaling

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

The following table specifies useful coordinate settings for several plotter types.

Plotter type	P1 X	P1 Y	P2 X	P2 Y
DOP (R&S)	600	610	7320	10610
R9833(Advantest)	650	610	7200	10610
Color pro (HP)	Special Scaling OFF			
HP 7475	Special Scaling OFF			

After having ended the input the status of *Special Scaling* changes to "ON".

Presetting of the Printer:

The menu for setting the printer (PRINTER SETTING) offers the selection between the various elements of a report similarly as with plotter output (see above). Default setting means output of the title with measured value table and output of the scan settings (cf. fig. 3-22) on EPSON-compatible, 24-pin printer.

3.2.4.4.3 Output of the Measurement Results on Printer

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

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

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

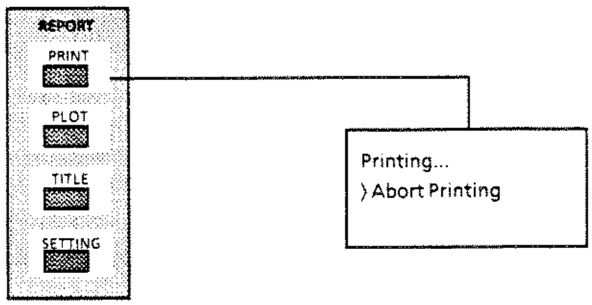


Fig. 3-24 Start of printer output

ROHDE &SCHWARZ
RFI POWER

24. Apr 91 05:13:33

EUT: Computer
Manuf: Black & White
Operator: Wolf
Test Spec: EN55014-A2
Comment: Operation without filter

Scan Settings (i Range):

Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	300M	50k	120k	PK + AV	1ms	AUTO LN	OFF	60 dB

Final Measurement: * QP + AV
Meas Time: 1 s
Subranges: 25
Acc Margin: 10 dB

Transducer No	Start/MHz	Stop/MHz	Name
1	25.000	1000.000	MDS

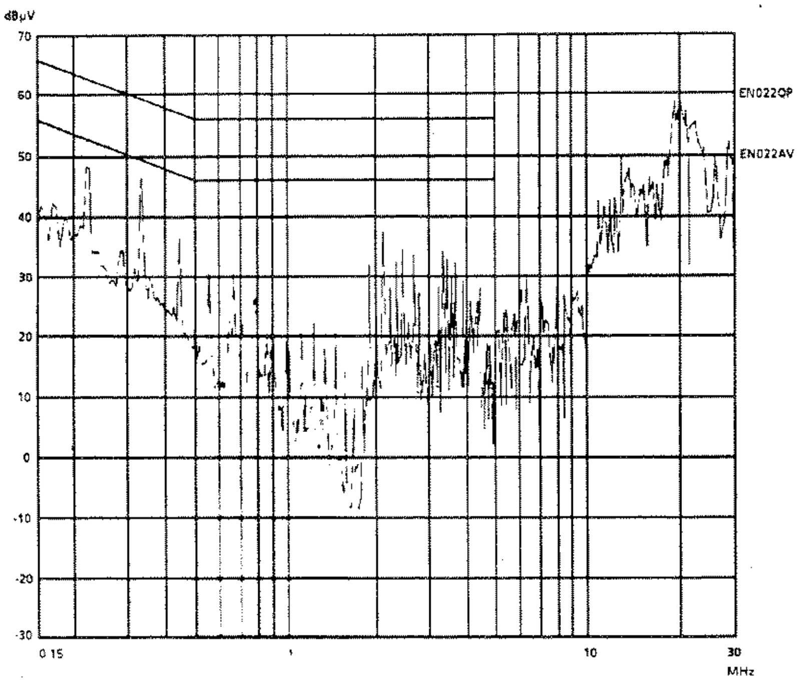


Fig. 3-26 Plotter output

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

Default setting of the ESPC (RCL 0):

Frequency:	100 MHz
Step size:	COARSE
Attenuation:	AUTO, LOW NOISE (RF-attenuation ≥ 10 dB)
Detector:	AV
IF-bandwidth:	120 kHz
Operating range:	60 dB
Measuring time:	100 ms
Pre-amplifier:	off
Special functions:	Default setting (cf. 3.2.3.13)
Setup:	is not affected
Transducer:	all the transducers defined are deactivated
Limit lines:	all the limit lines defined are deactivated
Options:	none
Scan data set:	Default data set (cf. 3.2.4.3.1)
Printer/Plotter settings:	are not affected

3.2.5 Connecting External Devices

3.2.5.1 Connecting the Transducers (ANTENNA CODE)

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

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

- Passive Probe 9 kHz to 30 MHz ESH2-Z3,
- Active Probe 9 kHz to 30 MHz ESH2-Z2,
- Rod Antenna 9 kHz to 30 MHz HFH2-Z1,
- Rod Antenna 9 kHz to 30 MHz HFH2-Z6,
- Loop Antenna 9 kHz to 30 MHz HFH2-Z2
- RF-Current Probe 100 kHz to 30 MHz ESH2-Z1
- Current probe 20 Hz ... 100 (200) MHz EZ-17
- VHF current probe 20 ... 300 MHz ESV-Z1
- Broadband dipole 20 ... 80 MHz HUF-Z1
- Preamplifier 20 ... 1000 MHz ESV-Z3

It is, however, recommended to enter the exact conversion factor via the transducer factors to achieve higher measurement accuracy (cf. section 3.2.4.2.1).

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.

3.2.6.3 USER INTERFACE

The USER INTERFACE at the rear panel of the ESPC 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. 3-29 Assignment of the user interface X 37 (USER INTERFACE)

Table 3-12

Anschluß	Signal	Bedeutung	Funktion
12	GND	Ground	---
14	PORT 1	User port 1	High: antenna active in frequency range 1
15	PORT 2	User port 2	High: antenna active in frequency range 2
16	PORT 3	User port 3	High: antenna active in frequency range 3
17	PORT 4	User port 4	High: antenna active in frequency range 4
18	PORT 5	User port 5	High: antenna active in frequency range 5
19	PORT 6	User port 6	Switching output controlled via IEC bus

3.2.6.3.2 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 3.2.3.12). The input is triggered by edges and requires TTL-level (low < 0.4 V, high > 2.0 V).

3.2.6.3.3 Analog Voltages

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

3.2.6.3.4 Supply Voltages

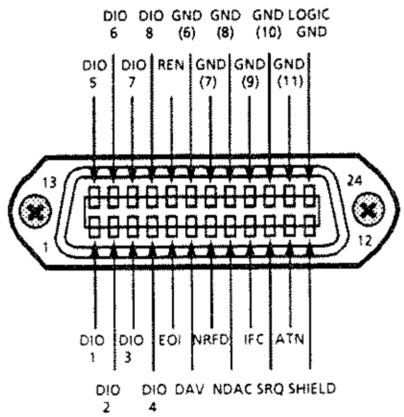
For supplying external devices with low current consumption, the device-internal supply voltages +5 V (5.0 V to 5.5 V) and + 12 V (10.8 to 15 V) are brought out. The current-carrying capacity is 100 mA for both outputs. The receiver automatically switches off in the case of a short-circuit.

Table 3-14

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

3.2.6.5 IEC-Bus

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



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

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

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

Note: *In order to achieve a long operating time per battery charge, the IEC-bus interface is switched off during operation with internal battery. If remote control via IEC-bus is desired with battery operation, it can be switched on using the Special Function 11 (cf. section 3.2.3.12).*

3.3 Remote Control (IEC-Bus)

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

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

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

2. **Control bus with 5 lines**

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

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

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

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

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

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

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

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

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

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

3.3.3 Interface Messages

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

3.3.3.1 Universal Commands

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

Table 3-15 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 3-16 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).

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 ESPC 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 ESPC. 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).

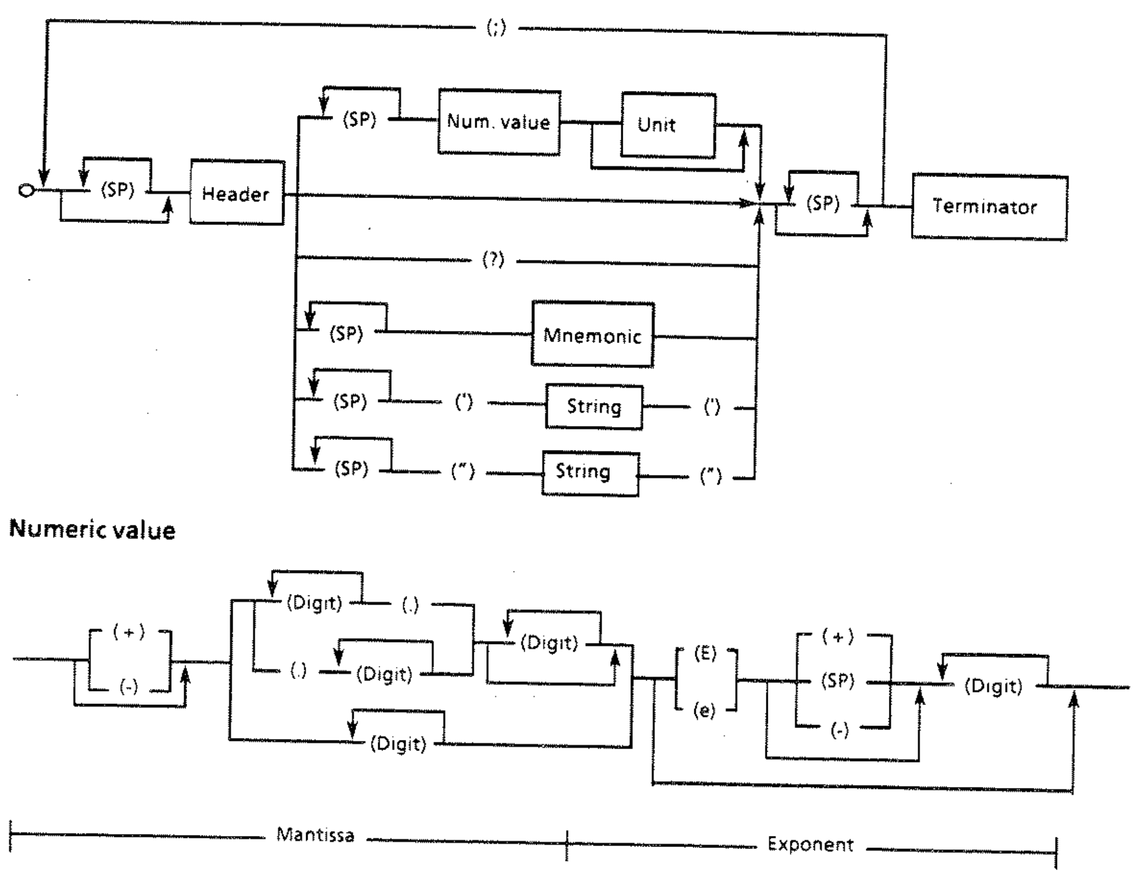
As the character <Carriage Return> (ASCII code 13 decimal) is permissible as a filler without effect before the terminator, the combination of <Carriage Return> and <New Line> that is for example sent by the R&S-Controller PCA is also permissible.

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 (;).

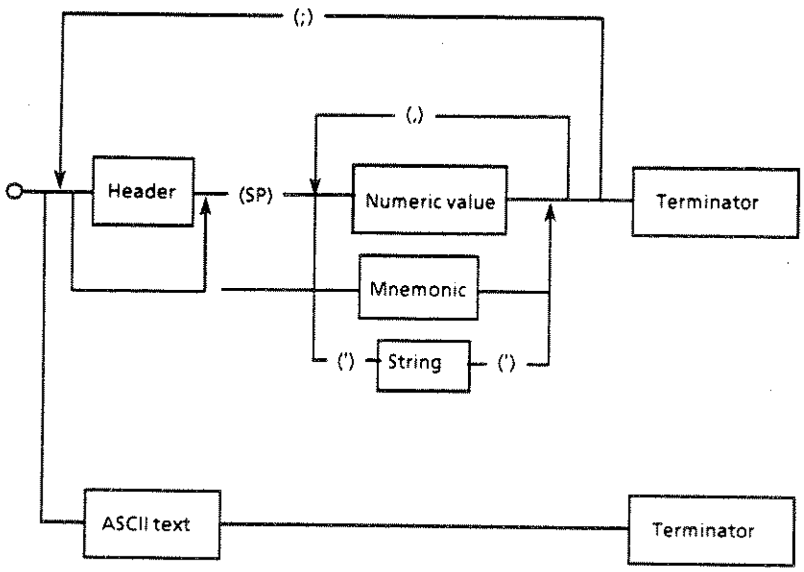
- With or without exponent to base 10, "E" or "e" can be used as the exponent character.
  Example: `451` `451E-3` `+4.51e-2`
- The exponent is permissible with or without a sign, a space is also permissible instead of the sign
  Example: `1.5E+3` `1.5e-3` `1.5E 3`
- Specification of the exponent only (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.



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

Fig. 3-33 Syntax diagram of a command line

Output message line



Numeric value

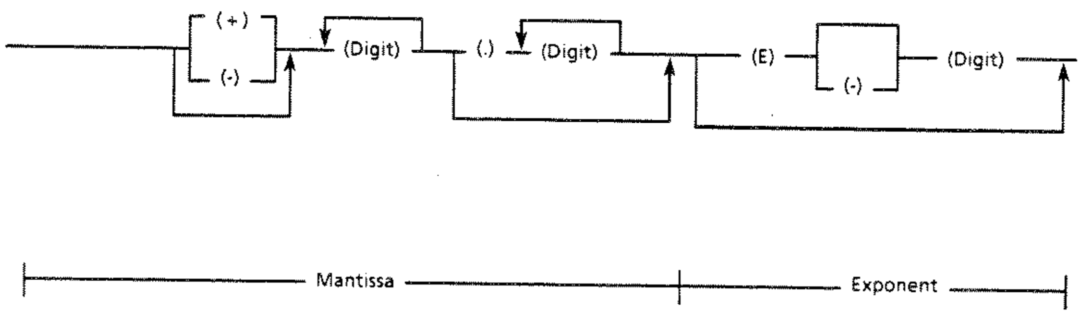


Fig. 3-35 Syntax diagram of messages sent by the receiver

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 ESPC 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 (1 to 9). *RCL 0 sets the ESPC 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 settingor a report configuration. Same function as the SAVE key.
*WAI	---	**Wait To Continue** Only processes the subsequent commands when all previous commands have been completely executed (cf. section 3.3.7).

Table 3-20 Meaning of the Error Messages during Calibration

Output value	Meaning
06	IF bandwith calibration error
25	The gain at the reference frequency 1 MHz cannot be controlled.
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.
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.

Tabelle 3-20a A filter range of the preselection is defective; frequency response at the respective frequency is more than 6 dB

Output value	Frequency
129	100 kHz
131	200 kHz
133	500 kHz
135	1 MHz
137	1,8 MHz
139	1,9 MHz
141	2,4MHz
143	2,9 MHz
145	3,9MHz
147	5,9 MHz
149	7,9 MHz
151	8,4 MHz
153	8,9 MHz
155	9,9 MHz
157	14,9 MHz
159	19,9 MHz
161	24,9 MHz
163	25,4 MHz
165	25,9 MHz
167	27,9 MHz
169	29,4 MHz
171	29,9 MHz
173	30,4 MHz
175	30,9 MHz
177	40,9 MHz
179	50,9 MHz
181	60,9 MHz
183	70,9 MHz
185	79,9 MHz

Output value	Frequency
187	80,4 MHz
189	90,9 MHz
191	100,9 MHz
193	110,9 MHz
195	120,9 MHz
197	130,9 MHz
199	140,9 MHz
201	150,9 MHz
203	160,9 MHz
205	170,9 MHz
207	180,9 MHz
209	190,9 MHz
211	199,9 MHz
213	200,4 MHz
215	210,9 MHz
217	220,9 MHz
219	230,9 MHz
221	240,9 MHz
223	250,9 MHz
225	260,9 MHz
227	270,9 MHz
229	280,9 MHz
231	290,9 MHz
233	300,9 MHz
235	310,9 MHz
237	320,9 MHz
239	330,9 MHz
241	340,9 MHz
243	350,9 MHz

Output value	Frequency
245	360,9 MHz
247	370,9 MHz
249	380,9 MHz
251	390,9 MHz
253	400,9 MHz
255	410,9 MHz
257	420,9 MHz
259	430,9 MHz
261	440,9 MHz
263	450,9 MHz
265	460,9 MHz
267	470,9 MHz
269	480,9 MHz
271	490,9 MHz
273	499,9 MHz
275	500,4 MHz
277	510,9 MHz
279	520,9 MHz
281	530,9 MHz
283	540,9 MHz
285	550,9 MHz
287	560,9 MHz
289	570,9 MHz
291	580,9 MHz
293	590,9 MHz
295	600,9 MHz
297	610,9 MHz
299	620,9 MHz
301	630,9 MHz

3.3.4.4 Device-specific Commands

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

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

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

Table 3-22 Receiver Functions

Command	Data	Unit	Meaning
ATTENUATION **A**TTENUATION?	0 to 70 dB **I**NCREMENT **D**ECREMENT	**D**B	RF-attenuation
:**A**UTO :**A**UTO?	**ON** **OF**F	---	Auto-range on off
:**M**ODE :**M**ODE?	**LOWN**OISE **LOWD**ISTORTION	---	Attenuation mode
:**Z**SD?	---		Zero Scale Deflection
BANDWIDTH:**I**F :**I**F?	200 Hz to 120 kHz	**H**Z **K**HZ **M**HZ **G**HZ	IF-bandwidth of the receiver
CALIBRATION::**C**ORRECTION	**ON** **OF**F	---	Considering the calibration correction values during level measurement on/off
DEMODULATION **DEM**ODULATION?	**A3** **A0** **F**M **O**FF	---	Demodulation mode
DETECTOR **DET**ECTOR?	**A**VERAGE **P**EAK **Q**UASIPEAK	---	Weighting mode (Detector)

Table 3-23 RF-analysis

Command	Data	Unit	Meaning
GRID:FREQAXIS GRID:FREQAXIS?	LIN LOG	—	Pitch of axes of the diagram of RF-analysis
:MINLEVEL :MINLEVEL?	-200 to +200	DB	Minimum level of the diagram of RF-analysis
:MAXLEVEL :MAXLEVEL?	-200 to +200	DB	Maximum level of the diagram of RF-analysis
LIMIT LIMIT?	1 to 22 [,ON] 1 to 22 [,OFF]	—	Selecting and switching on or off limit lines
:TEXT :TEXT?	"ASCII text" max. 8 characters	—	Name of limit line
:DEFINE :DEFINE?	Number, Frequency 1, level 1, Frequency 2, level 2,..	HZ KHZ MHZ GHZ DB	Definition of limit line by frequency-level pairs in increasing order
:VALUE?	n[,limit 1[,limit 2]] n: number of limit lines, 0 to 2 limit 1: 1st limit limit 2: 2nd limit	DB	Output of interpolated intermediate values at the current receiver frequency. The value 0 is returned if no limit lines have been switched on.
SCAN SCAN?	1 to 5	—	Selection of a partial scan
:RUN			Starting a scan
:INTERRUPT			Interrupting a scan
:CONTINUE			Continuing an interrupted scan
:STOP			Stopping a scan
:RANGES :RANGES?	1 to 5	—	Number of scans to be executed
:FREQUENCY:START :START?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Start frequency of partial scan
:STOP :STOP?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Stop frequency of partial scan
:STEPMODE :STEPMODE?	LIN LOG	—	Type of step size, the same for all partial scans
:STEPSIZE :STEPSIZE?	0 to 30 MHz 0 to 100 %	HZ, KHZ, MHZ, GHZ PCT	Step size, in Hz for linear steps, in % for logarithmic frequency switching
:SAVE		—	The scan settings for the start and stop frequency as well as the step size are adopted and checked whether they are consistent using this command. Error messages refer to the previous settings for the partial scan ranges.
:RECEIVER:MEASUREMENT:TIME :MEASUREMENT:TIME?	1 ms to 100 s	S MS	Measuring time per measured value of partial scan
:DETECTOR :DETECTOR?	AVERAGE PEAK QUASIPEAK	—	Weighting mode for partial 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 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 of subrange are combined to from a block, if the size of the size of the output buffer is suffcient.
	TRACE		Only the results of the 400 subrange maxima are transmitted..
	SUBRMAX	---	Es werden nur die Ergebnisse der mit SCAN:OPTION:SUBRANGES definierten Benutzerteilbereiche übertragen.
	DET1		Level values detector 1
	DET2		Level values detector 2
	VALID		Validizy bytes
:FORMAT :FORMAT?	ASCII BINARY DUMP SDUMP		Output format for scan results (cf. section 3.3.8.)
:SIZE?	---		Size of a block element when the measured values are output in the form of bytes (this size is variable for output in ASCII format)
:TEMPLATE?	---		Composition of the individual components of a block element (see chapter 3.3.8).
:RESULTS	--	---	Using this command, scan results can be output at a later date. This command sets the appropriate bits in the ERD register, however does not make available the data in the output buffer.
:CLEAR	---	---	Clearing the memory with measured values

Table 3-26 Test Report

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

Table 3-26 Common Commands

Command	Data	Unit	Meaning
DISPLAY	ON OFF	—	Switching on/off LCD display on front panel
ERA?	—	—	Event Status register A for specifying the instrument states
ERAE ERAE?	0 to 65535	—	Event Status Enable register A
ERB?	—	—	Event Status register B for indicating synthesizer errors.
ERBE ERBE?	0 to 65535	—	Event Status Enable register B
ERC?	—	—	Event Status register C for specifying the validity of a measured value (section 3.3.8)
ERCE ERCE?	0 to 65535	—	Event Status Enable register C
ERD?	—	—	Event Status register D for specifying the scan states
ERDE ERDE?	0 to 65535	—	Event Status Enable register D
HEADER	ON OFF	—	Switching on and off output of header during poll
LISN LISN?	ESH2Z5 ESH3Z5	—	Selecting the LISN to be controlled
:PHASE	N L1 L2 L3		Setting the phase; with ESHS3-Z5, N and L1 are permissible only
:PE	GROUNDED FLOATING		Setting the PE
PRESET	—	—	Resetting of device settings without resetting IEC-bus interface. It corresponds to the function RCL0.
SERVICE:SELFTEST:CALGEN	ON OFF	—	Switching on/off the calibration generator
SYSTEM:ERRORS?	—	—	Polling device-dependent errors (cf. table 3-31)
:DATE :DATE?	dd,mm,yy	—	Date of real-time clock
:TIME :TIME?	hh,mm,ss	—	Time of real-time clock
TERMINATOR			Listener terminator:
	LFEOI	—	Linefeed (10 decimal) with EOI
	EOI		only EOI for binary data
USERPORT	1 to 6, ON 1 to 6, OFF	—	Setting the user port

3.3.5 Service Request and Status Register

In line with the new IEC-bus standard the ESPC 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 ESPC specifies special events that can be polled by the controller. The respective bit associated with the event or status is set to 1. This bit remains set until it is cleared by reading the Event Status register (command *ESR?) or by one of the following conditions:

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

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

Bit No.	Meaning
7	**Power On** Is set when the device is switched on or the power returns following a power failure.
6	**User Request** This bit is set in the ESR by activating the LOCAL key. If the mask register is set appropriately, the ESPC 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 ESPC 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 ESPC. The output buffer is cleared in this case.
1	**Request Control** Is set, if the ESPC 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.

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 ESPC the bits 0 to 3 (ERA, ERB, ERC and ERD) are used to specify certain events and states.

e) Parallel Poll Enable Register

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

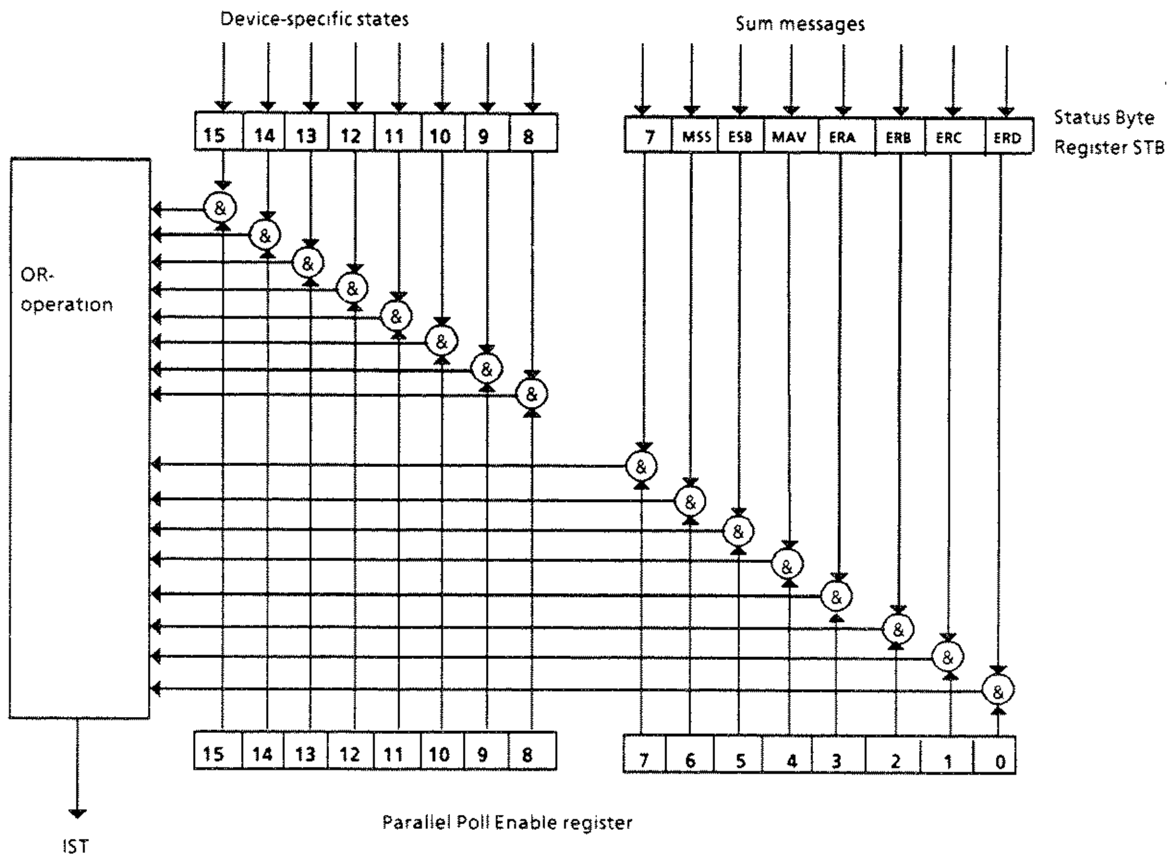


Fig. 3-36 Parallel Poll Enable Register PRE

g) Event Status Register A:

The assignment of the extended event register ERA for identifiying the device status is explained by means of the following diagram:

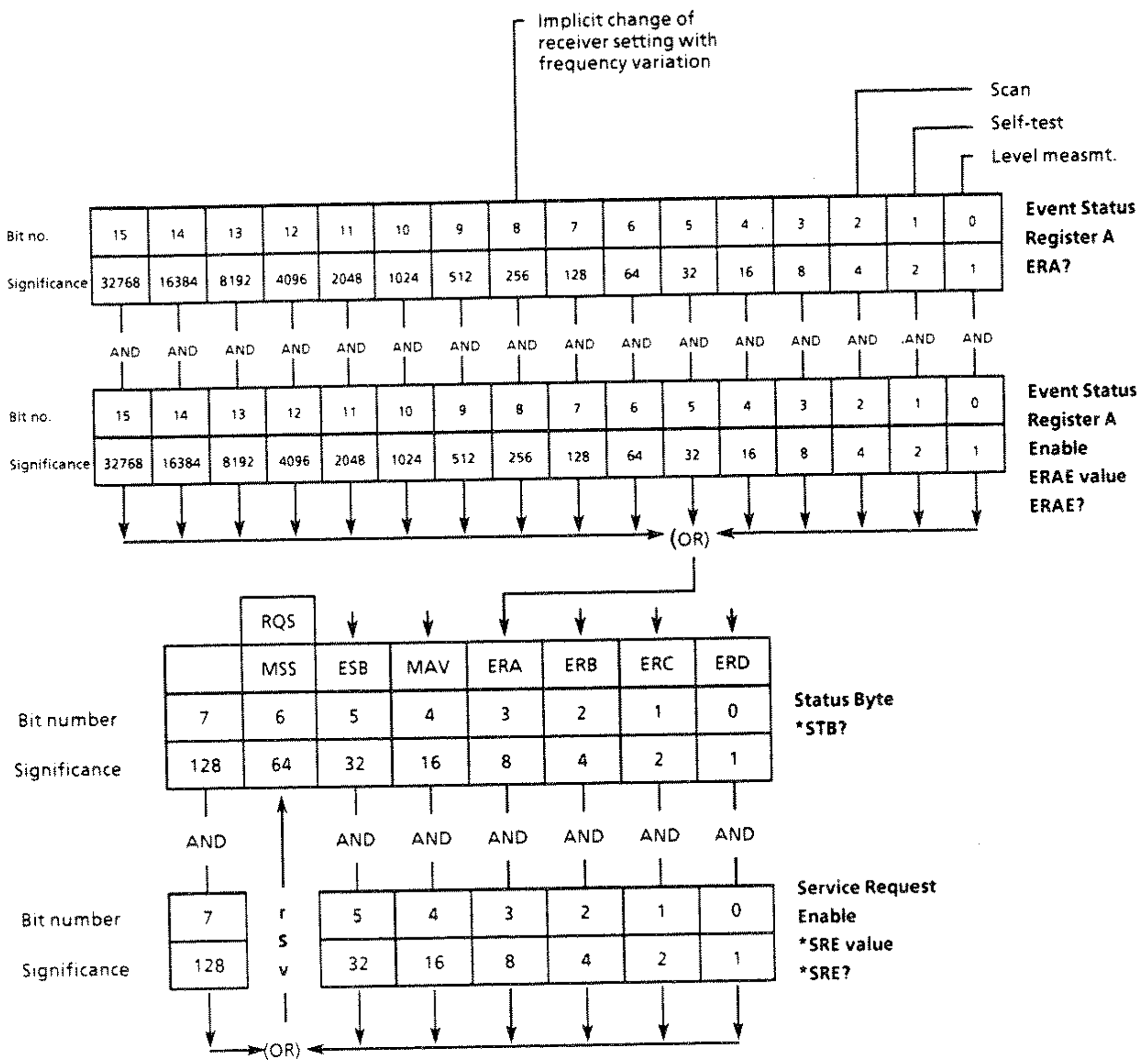


Fig. 3-37 Status register ERA

Bit 8 is set if a receiver setting other than the frequency setting has been automatically changed by a frequency variation.

The other bits indicate the active functions. They are reset after terminating these functions.

i) Event Status Register C:

The assignment of the extended event register ERC for indicating the validity of the measured values is explained by means of the following diagram:

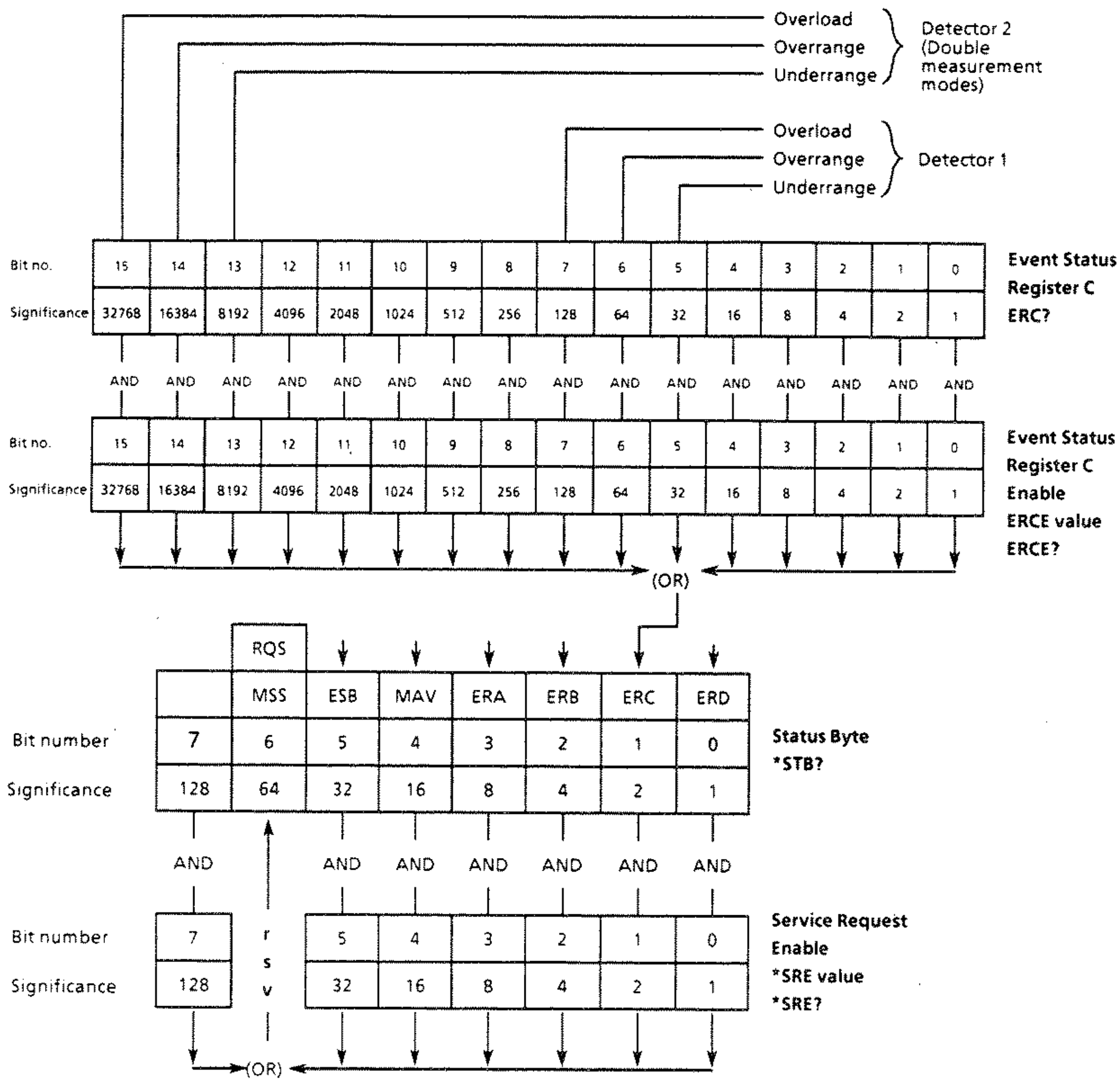


Fig. 3-39 Status register ERC

3.3.6 Resetting of Device Functions

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

Table 3-30 Resetting of various device functions

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

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

3.3.7 Command Processing Sequence and Synchronization

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

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

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

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

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

"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.

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.

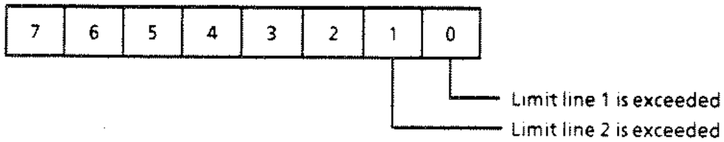


Fig. 3-45 Format of the limit byte

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 ESPC. 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.

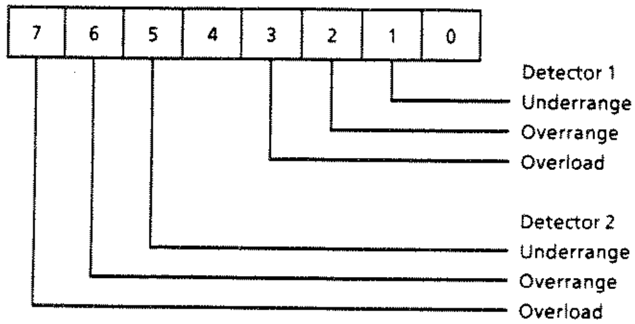


Fig. 3-46 Format of the validity byte with unformatted output of scan results.

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 ESPC 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 ESPC 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 ESPC operates in the Stand-Alone mode.

   The ESPC 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 ESPC 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").

3.4 Applications

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

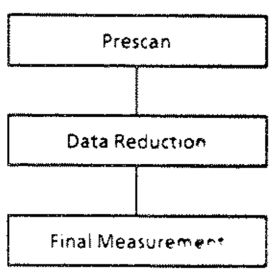
The semi-automatic measurement sequences described below can be applied when the interference is stable within the measuring time. Manual measurement is recommended to be used for intermittent, quickly drifting and cyclic interferences with long cycle times.

The most important criteria of automatic measurement are

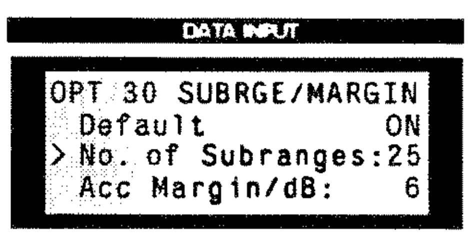
- time-efficiency
- high reliability and accuracy
- reproducability of results
- automatic and complete display of results

RFI measurements sometimes are very time-consuming due to the time-constants specified by the standard for quasi-peak weighting which cause settling procedures requiring long measuring times for each measured value. The standards furthermore prescribe search procedures to determine the interference radiation maxima such as shifting the absorbing clamp, variating the height of the measuring antenna or turning the device under test in another direction. Thus, performing measurements including quasi-peak weighting for each frequency and each setting of the measurement configuration would lead to unacceptably long measuring times. Therefore, R&S developped a system reducing the time-consuming measurement procedures to a minimum while providing high reliability concerning the acquisition of measured values.

The interference spectrum is first analyzed to optimize the measurement sequence as to time. **Data reduction** is subsequently performed so that a **final measurement** must be carried out at few frequencies only.



The data reduction is of decisive importance. Option 30 is used for this purpose (subrange maxima and acceptance analysis)



Calling the options (cf. section 3.2.4.3.3):

▶ Press the OPTIONS key.
The options are listed on the DATA INPUT display:

```
DATA INPUT
  Scan Options
>01 RFI Voltage   OFF
>04 RFI Power     OFF
 06 RFI Field ShR OFF
 26 Gated Scan    OFF
 30 Subrge/Margin  ON
 40 Final AV      OFF
 42 Final QP      OFF
 45 Final QP/AV   OFF
 62 Meas.+ Plot   OFF
 63 Special Scan  OFF
```

visible when calling via the OPTIONS key (options 01, 04, 06)

can be scrolled using the ↑ ↓ keys (options 26 to 63)

The options 01, 04 and 06 are used for defining the **measuring configurations** for the different applications of the EMI Test Receiver ESPC:

Option *01* for RFI voltage measurement using the artifical mains network
Option *04* for RFI power measurement using the absorbing clamp and
Option *06* for RFI fieldstrength measurement.

RFI voltage and RFI current measurements can be performed in the range from 30 MHz without using any specific option.

3.4.1 Measuring the RFI Voltage in the Frequency Range up to 30 MHz

RFI voltage measurements up to 30 MHz are carried out either using artificial mains networks or probes with an impedance of 1.5 kΩ or ≥ 100 kΩ.

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

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

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

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

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

ESPC 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 necessary with ESH2-Z5 with power supply of its own

Fig. 3-48 Connection between ESPC and ESH2-Z5 (cable EZ-13)

ESPC 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. 3-49 Connection between ESPC and ESH3-Z5 (cable EZ-14)

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

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

b) Setting of the Test Receiver

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

Further data:

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

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

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

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

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

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

Operation

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

DATA INPUT

```
OPT 01 RFI VOLTAGE
Type of LISN:
> ESH2-Z5         OFF
  ESH3-Z5         OFF
```

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

*** Using the ESH2-Z5:**

```
DATA INPUT

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

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

c) Measurement Sequence, Measurement and Analysis Procedure

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

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

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

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

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

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

With the Av-maximum of the subrange:

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

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

3.4.3 Measuring the RFI Voltage or the RFI Current in the Frequency Range above 30 MHz

According to commercial standards RFI voltage measurements are usually performed in the frequency range above 30 MHz using either artificial networks for this frequency range or directly at the car antenna according to VDE 0879 Part 2 (draft). Probes such as the R&S probes ESH2-Z2 and ESH2-Z3 are generally not used above 30 MHz.

The R&S accessories listed below can be used for RFI voltage measurements above 30 MHz:

- T-network ESH3-Z4
- 4-wire-T-network EZ-10
- V-network 5µH//50 Ω ESH2-Z6

The V-networks are used to test V-terminal voltages whereas the T-networks are suitable for asymmetrical ones. RFI voltage measurements are generally carried out at frequencies within the range from 9 to 30 MHz according to national and international standards. The frequency range for RFI voltage measurements at car accessories, however, extends from 150 kHz to 108 MHz. The ESPC is thus only suitable for these measurements to a limited extent.

For detailed information on which artifical mains networks to be used or on the required test setups refer to the latest versions of the standards - CISPR Publications, European Standards, VDE Regulations, FCC Rules & Regulations, VCCI Recommendations, etc.

Though not prescribed by the commercial standards, RFI current measurements using RF current probes such as the ESV-Z1 or EZ-17, are very common when **determining interference sources** and testing devices for interference suppression.

b) Setting of the Test Receiver

The scan setting of the test receiver determines the data of the prescan. For RFI voltage measurements at car accessories, e.g., it covers a range from 0.15 to 108 MHz. The remaining measuring range for the ESPC is then 30 to 108 MHz.

Scan data:

Frequency range/MHz	0,15 - 108
Stepsize/kHz	60 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 step size (LOG step) can be used instead of steps half the bandwidth.

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

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 subsequent scan options are suitable for RFI voltage and current measurements:

There is no special option for RFI voltage or current measurements in the range of > 30 MHz.
A final measurement is immediately performed at the end of each subrange, if the options 30, 40 to 45 are selected.
Phase selection as is possible with the artificial mains networks ESH2-Z5 and ESH3-Z5 below 30 MHz is not offered.
The conversion factor of the current probe or the insertion loss of the artificial mains network are to be entered via the 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 The options 40 to 45 determine the type of detector for final measurement.

3.4.4 RFI-Fieldstrength Measurements in the Frequency Range up to 30 MHz

a) Test Setup

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

Test Setup with Measurements in the Shielded Room

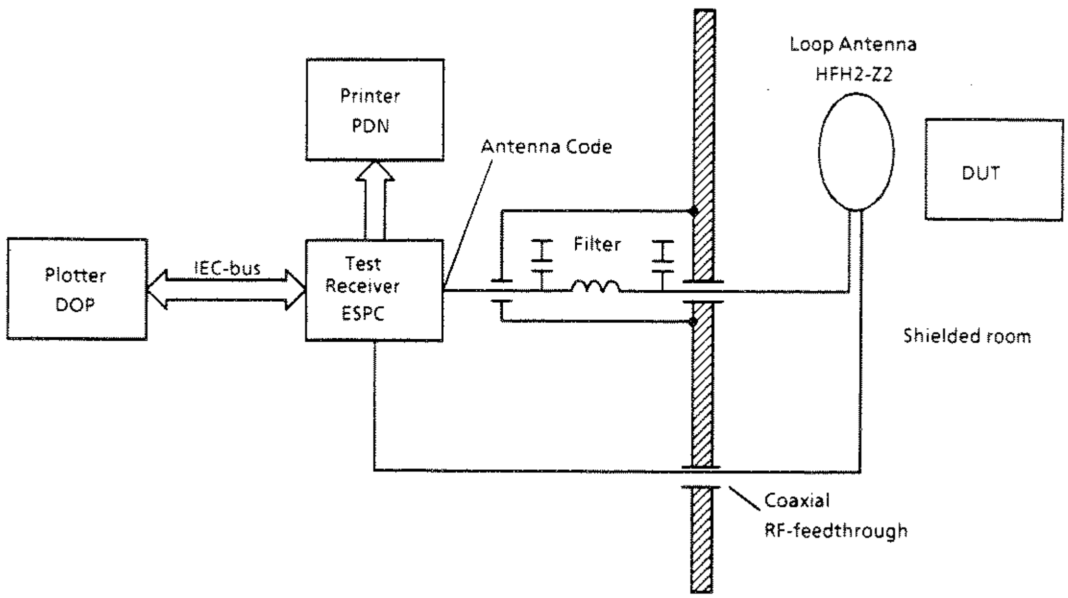


Fig. 3-54 Block diagram of a test setup with the Loop Antenna HFH2-Z2 and device under test in the shielded chamber

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

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

Test Setup with Open Air Measurements:

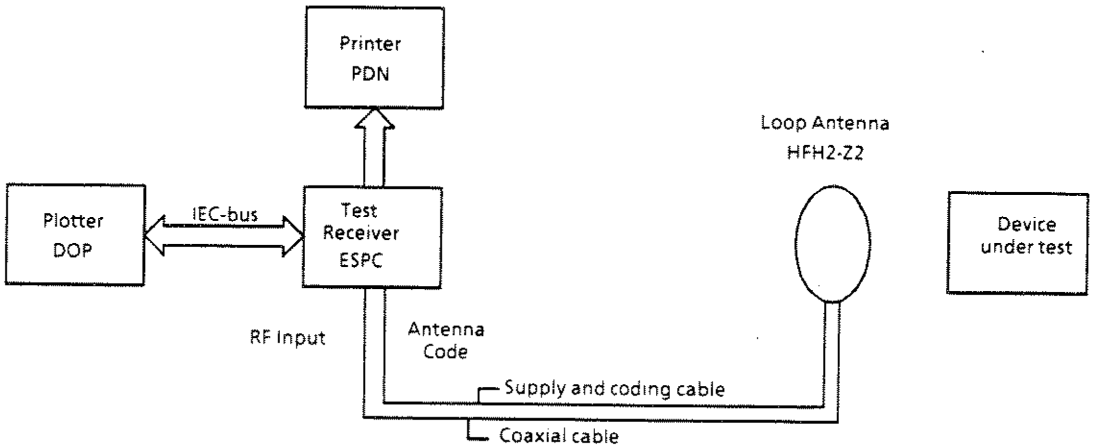


Fig. 3-56 Block diagram of a test setup with open air test. Make sure that the antenna is isolated from printer and plotter.

b) Setting of the Test Receiver

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

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

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

The **data reduction** is defined by option 30.

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

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

c) Measurement Sequence, Measurement and Analysis Procedure

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

in the valid testing 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) are reflection-free.

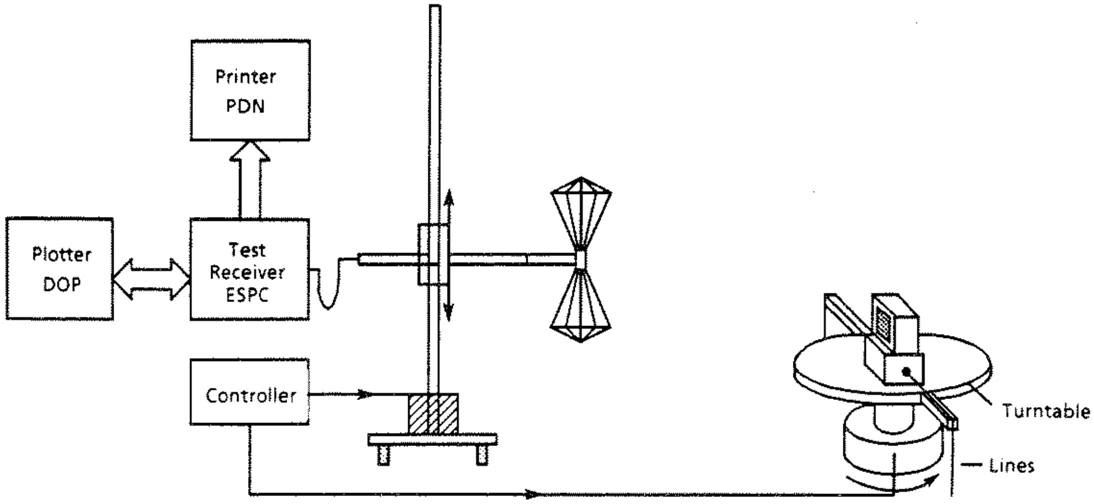
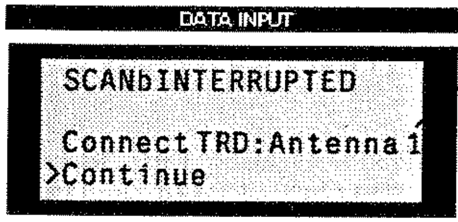


Fig. 3-58 Test setup for free-field RFI fieldstrength measurement

c) **Test Run, Measurement and Analysis Procedure**

- The prescan is initiated by pressing the RUN/STOP key.
  It can be interrupted by pressing this key once and aborted by pressing the key twice (cf. section 3.2.4.3.4).
  The following message is output at the ESPC:



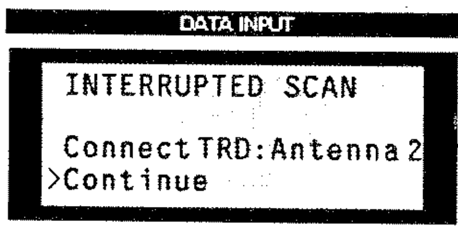
Name of the antenna [1], e.g. HK116

1) If the frequency range of only one antenna is scanned, the prescan is started immediately without this message being read out. Connection of all transducers is requested, (*"Connect Antenna 1"* and then *"Connect Cable"*), if the cable is used with the antennas.

- Press one of the ENTER keys
  The prescan runs until the frequency is reached where antennas are switched over with determination of the subrange maxima (Pk) and read-out of the message *SCAN Running....*

  Note: The RFI fieldstrength spectrum can be recorded by a plotter connected using option 62.

With the beeper activated (special function 13, beeper on) and a demodulation mode (FM, AM, ZERO BEAT) selected, the following display is output together with a beep when changing the antenna:



Name of the antenna, e.g. HL223

Press one of the ENTER keys. The prescan is continued until the end.

All subrange maxima are/will be stored in the CMOS-RAM. The list of the subrange maxima can be output as list of measured values, if required.

Upon start of the measurement the ESPC sets the frequency of the subrange maximum and the QP detector (option 42).
The display reads out:

```
DATA INPUT

OPT 06 FINAL MEASMT

Search Hor-Maximum
then press <ENTER>
```

- With horizontal polarization, the heigth of the antenna and the azimuth of the turntable have to be varied until the max. ambient interference has been found.

- Press one of the ENTER keys.
  The value indicated in the LEVEL display is stored.

  Note: *If the spurious emissions of the device under test cannot be measured due to ambient interference, another frequency can be set using the → key.*

  After storing the horizontal maximum the following request is output:

```
DATA INPUT

OPT 06 FINAL MEASMT

Search Vert-Maximum
then press <ENTER>
```

- With vertical polarization, the height of the antenna and the azimuth of the turntable have to be varied until the vertical maximum of the ambient interference has been found.

- Press one of the ENTER keys.
  The value is indicated in the LEVEL display and output on the plotter as " + ". The ESPC then sets the next frequency, etc.

  Returning to a previously set frequency is possible by pressing the ← key. The operator is thus enabled to repeat a measurement under different operating conditions of the device under test and can write a new value for a value stored inadvertently by pressing the ENTER key.

Tables of measured values with RFI fieldstrength measurement
after performing 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

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, however, for example, cellar rooms with low ambient interference are often sufficient. Due to its low radiation the test receiver ESPC can be set up inside the shielded room. Simultaneous operation of a printer and/or plotter may, however, cause problems. In this case the test report should be output subsequent to the measurement or the ESPC 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.

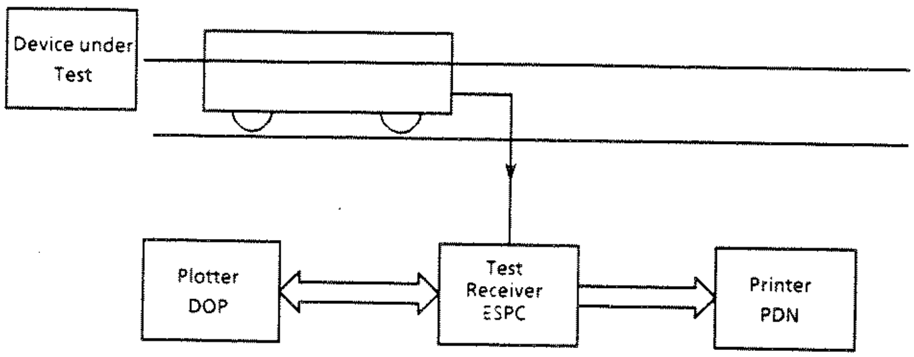


Fig. 3-60 Block diagram of a test setup with MDS clamp and device under test in a shielded room

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	60 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 step size (LOG step) can be used instead of steps half the bandwidth.

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

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).

▸ A list of the measured values can be output on plotter or on printer, as shown by the subsequent example (This table applies for 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.*

3.5.2 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_espc
160 '                                send new settings
170 IEC OUT Espc,"FREQUENCY 20 MHZ"
180 IEC OUT Espc,"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    Espc=18: '                   Receiver IEC address
10070 '
10080 '                              other initialization
10090 '
10100 RETURN
10110 '-----------------------------
11000 '
11010Init_espc:
11020 '
11030 '                              reset status registers
11040     IEC OUT Espc,"*CLS"
11050 '
11060 '                              reset Receiver settings
11070     IEC OUT Espc,"*RST"
11080 '
11090 '                              init other devices
11100 '
11110 RETURN
11120 '-----------------------------
```

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

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_espc
160 '                                      set frequency
170 IEC OUT Espc,"FREQUENCY 98.5 MHz"
180 '                                      Trigger and Wait
190 IEC OUT Espc,"*TRG;*WAI"
200 '                                      get result
210 IEC OUT Espc,"LEVEL:LASTVALUE?"
220 IEC IN Espc,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 ESVS offers the command LEVEL?, which synchronizes internally level measurement and retrieving of the measured value. It substitutes for the commands *TRG;*WAI;LEVEL:LASTVALUE?. The synchronization mechanism described above can also be applied to all other commands.

3.5.6 Synchronization with the End of the Scan using *OPC

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

```
100 '--------------------------------
110 '       Execute Scan
120 '--------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_espc
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 Espc,"*CLS;*ESE 1;*SRE 32"
3100 '                                     Init SRQ-Flag
3110    Srq%=0
3120 '                                     Start Scan
3130    IEC OUT Espc,"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
```

3.5.8 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_espc
160 '
170    GOSUB Prog_tfactor
180 '
190 END
1000 '-----------------------------------------------------
1010 '    Define Transducer Factor and activate
1020 '-----------------------------------------------------
1030Prog_tfactor:
1040    GOSUB Prolog
1050    GOSUB Init_espc
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 Espc,"TRANSDUCER:FACTOR 1"
1250 '
1260 '                                    transducer name
1270    IEC OUT Espc,"TRANSDUCER:FACTOR:TEXT 'antenna1'"
1280 '
1290 '                                    transducer unit
1300    IEC OUT Espc,"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$(Level(I))
1370    NEXT I
1380 '
1390 '                                    transmit factor
1400    IEC OUT Espc,"TRANSDUCER:FACTOR:DEFINE "+Transducer$
1410 '
1420 '                                    activate factor
1430    IEC OUT Espc,"TRANSDUCER:FACTOR:SELECT 1"
1440 '
1450 RETURN
1460 '
```

3.5.10 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_espc
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 Espc,"*PCB "+STR$(Controller)
1180 '
1190 '                                  configure Test Report
1200 '                                  diagram and heading
1210    IEC OUT Espc,"PLOTTER:CONTENT:DEFAULT ON"
1220 '
1230 '                                  select pens
1240    IEC OUT Espc,"PLOTTER:SETUP:PEN ON"
1250    IEC OUT Espc,"PLOTTER:SETUP:PEN:GRID 2"
1260    IEC OUT Espc,"PLOTTER:SETUP:PEN:LIMIT 3"
1270    IEC OUT Espc,"PLOTTER:SETUP:PEN:CURVE1 4"
1280    IEC OUT Espc,"PLOTTER:SETUP:PEN:CURVE2 5"
1290    IEC OUT Espc,"PLOTTER:SETUP:PEN:TEXT 1"
1300    IEC OUT Espc,"PLOTTER:SETUP:PEN:DATE 4"
1310 '
1320 '                                  special scaling off
1330    IEC OUT Espc,"PLOTTER:SETUP:FORMAT OFF"
1340 '
1350 '                                  header
1360    IEC OUT Espc,"REPORT:HEADER:COMPANY      'Rohde & Schwarz'"
1370    IEC OUT Espc,"REPORT:HEADER:PROGRAM      'Conformance Test'"
1380    IEC OUT Espc,"REPORT:HEADER:EUT          'Machine'"
```

3.5.11 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_espc
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 Espc,"SCAN:BLOCK:FORMAT  ASCII"
3060    IEC OUT Espc,"SCAN:BLOCK:ELEMENT COMBINED"
3070    IEC OUT Espc,"SCAN:BLOCK:COUNT   20"
3080 '                                 config registers
3090    IEC OUT Espc,"*CLS;*ESE 1;*SRE 33"
3100 '                                 enable all bits
3110    IEC OUT Espc,"ERDE 65535"
3120 '                                 init variable
3130    Erd=0
3140 '                                 waste previous results
3150    IEC OUT Espc,"SCAN:RESULTS:CLEAR"
3160 '                                 Init SRQ-Routine
3170    ON SRQ1 GOSUB Srq_routine
3180 '
3190    IEC OUT Espc,"SCAN:RUN;*OPC"
3200    PRINT "Scan is running"
3210 '
3220 '
3230    REPEAT
3240 '                                 Wait for last block
```

3.5.12 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_espc
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 Espc,"SCAN:BLOCK:FORMAT  BINARY"
3060    IEC OUT Espc,"SCAN:BLOCK:ELEMENT COMBINED"
3070    IEC OUT Espc,"SCAN:BLOCK:COUNT   20"
3080 '                                 config registers
3090    IEC OUT Espc,"*CLS;*ESE 1;*SRE 33"
3100 '                                 enable all bits
3110    IEC OUT Espc,"ERDE 65535"
3120 '                                 init variable
3130    Erd=0
3140 '                                 waste previous results
```

```
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%+1
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 '--------------------------------
```

3.5.13 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_espc
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 Espc,"SCAN:BLOCK:FORMAT DUMP"
3060    IEC OUT Espc,"SCAN:BLOCK:COUNT  100"
3070 '                                  config registers
3080    IEC OUT Espc,"*CLS;*ESE 1;*SRE 33"
3090 '                                  enable all bits
3100    IEC OUT Espc,"ERDE 65535"
3110 '                                  init variable
3120    Erd=0
3130 '                                  waste previous results
3140    IEC OUT Espc,"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 Espc,"SCAN:RUN;*OPC"
3210    PRINT "Scan is running"
3220 '
3230 '
3240    REPEAT
3250 '                                  Wait for last block
```

```
12370 '---------------------------------- check data ready bit detector 2
12380       IF (Erd AND 64) THEN
12390 '                                   configure for detector 2
12400          IEC OUT Espc,"SCAN:BLOCK:ELEMENT DET2"
12410          PRINT "Detector 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 Espc,"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 Espc,"*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
```

Error message	Cause	Section
Min Level-200 dB	With the input of a transducer factor or a limit line a value < 200 dB was entered.	3.2.4.2.2 3.2.4.3.2
Register empty	A register containing no setting data is called using RCL.	3.2.4.5
ERR: 2nd Mixer	Hardware error during self-test	4.2.4
ERR: 30 dB Range *ERR: 60 dB Range*	Error during calibration	3.2.3.1213
ERR: Detector Board	Hardware error during self-test	4.2.4
ERR: gain at 5.9 MHz	Error during total calibration	3.2.3.11.3
ERR: gain at xx MHz	Error during total calibration	3.2.3.11.3
ERR: gain at BW 10 kHz	Error during total calibration	3.2.3.11.3
ERR: IF Attenuator	Error during total calibration	3.2.3.11.3
ERR: IF Selection Board	Hardware error during self-test	4.2.4
ERR: Meas uncal	Gain of the receiver cannot be set. Measured values are not accurate.	3.2.3.11.3
ERR: Pk/MHz	Error during total calibration	3.2.3.11.3
ERR: QP	Error during total calibration	3.2.3.11.3
ERR: Synthesizer	Hardware error during self-test	4.2.4
ERR: Fronend	Hardware error during self-test	4.2.4