

If the level is reduced using the tuning knob, a continuous (electronic) fine level variation free from interruptions is guaranteed within a range up to 20 dB. The position of the electronic attenuator is output in the analog display 13 for orientation purposes (bar display from right to left corresponds to 0 to 20 dB attenuation). The attenuator is switched over if the bar reaches the end points of the analog display (with AM, the center $\hat{=}$ -10 dB).

If the level is increased using the tuning knob, the mechanical attenuation set switches over when the fine variation range is left (0 dB attenuation) as in the case of level inputs via the keyboard.

All RF level inputs and outputs produce the voltage or power with a terminating resistor of 50 Ω . The actual output voltage is always displayed, the EMF has doubled this value.

The synthesizer output level can be displayed in μ V, mV or dB μ V, dBm.

The conversion is carried out using the following equations:

$$\begin{aligned} U \text{ [dB}\mu\text{V]} &= 20 \log (U \text{ [\mu V]} / 1 \text{ }\mu\text{V}) \\ P \text{ [dBm]} &= 20 \log (U \text{ [mV]} / 223.6 \text{ mV}) \end{aligned}$$

The remaining power is decreased by reflection if the connected test object or the load is incorrectly matched. Depending on the standing wave ratio s , the output power is then:

$$P \text{ (load)} = p \text{ (display)} * 4 s / (1 + s)^2$$

2.3.4.3 Probe Measurements

The RF millivoltmeter is switched on using the key PROBE 17 provided the CMT is fitted with the CM-B8 option, otherwise an error message is output in the α display.

If the probe measurement is switched off in the receiver test by pressing keys 14 and 15, power measurements are active again when switching to the transmitter test.

The data output can be matched via the SPEC functions 111 to 115 when using probes with different impedances (50/75 Ω) or different sensitivities (1:1 / 10:1 / 100:1) (see also Section 2.3.8).

When the instrument is switched on, the setting corresponds to a 1:1 probe with 50- Ω impedance.

111 SPEC	1:1 (0 dB)	Default
112 SPEC	10:1 (-20 dB)	
113 SPEC	100:1 (-40 dB)	
114 SPEC	75- Ω impedance	
115 SPEC	50- Ω impedance	Default

2.3.4.4 Adjacent-Channel Power Measurements (ACP)

The adjacent-channel power meter is switched on by pressing the key ACP 15 if the CMT is fitted with the CMT-B6 option, otherwise an error message is output in the α display.

The centre frequency of the useful channel is determined by the input SET f TX 6, the channel width by Δf 6.

ACP measurements can be carried out with channel spacings of 10, 12.5, 20 or 25 kHz. If a different channel spacing has been entered, a request to set the correct spacing (" **CH. SP.** " in the α display) appears when ACP measurements are called and 3 dashes appear in the digital display.

Any channel spacing can be entered using (cancel using) and the test bandwidth is made to be approx. 4 kHz. The channel spacing then only defines the respective deviation from the useful channel.

The channel to be measured is selected by entering a number before pressing the ACP key.

The following inputs are permissible:

Noise power
two channels below useful channel $f = f_0 - 2 \Delta f$

Noise power
in bottom adjacent channel $f = f_0 - \Delta f$

Noise power
in top adjacent channel (default) $f = f_0 + \Delta f$

Noise power
two channels above useful channel $f = f_0 + 2 \Delta f$

The adjacent-channel power (μW , mW or W) is output following the instruction , provided the measurement at the input RF IN/OUT is performed with at least 0 dBm in the useful channel.

The adjacent-channel power spacing (dB) can be called by

.

The combined inputs or are also permissible.

At specific RF frequencies (integer multiples of 100 MHz), selection of the ACP measurement may cause the measured value to fluctuate in some cases. These fluctuations occur only if the option CM-B9 (Duplex Modulation Meter) is fitted and if, in addition, the frequency of the internal RF synthesizer is a multiple of 100 MHz. These fluctuations can be avoided by selecting a different frequency setting of the RF synthesizer.

2.3.4.5 Selective RF Millivoltmeter

2.3.4.5.1 General Information

If the option CMT-B6 is fitted in the CMT, the selective voltmeter can be switched on using 0 ACP. The result can be displayed in mV, dBm, W, μ V or dB μ V according to the input.

Example:

0	W	ACP
↑	↑	
Selective voltmeter selected	Display unit (watts)	

The measuring bandwidth is approx. ± 2 kHz about the set receive frequency (SET f TX 6).

The source is selected by means of INPUT SELECT.

The dynamic range differs according to the input:
(internal 20-dB attenuator not switched on!)

- a) RF IN/OUT: = 50 μ V to 500 mV Can be extended up to 50 W
- b) INPUT 2: = 0.5 μ V to 5 mV using external attenuators!

The sensitivity is frequency-dependant to a small degree, ie if the test frequency is varied by more than 10 MHz, the voltmeter should be calibrated again.

If the option CM-B9 (Duplex Modulation Meter) is fitted, make sure when measuring via the socket RF IN/OUT that the signal generator of the CMT does not operate with a high level at the test frequency of the voltmeter, since this would falsify the result.

Note: Harmonic measurements are not possible!

2.3.4.5.2 Calibration through Entry of Currently Applied Power (applicable to both inputs)

Procedure:

→ Select input

(Switch off internal 20-dB attenuator first)

→ Only if socket RF IN/OUT is used:
(Switch off automatic control of internal attenuator according to the power applied)

→ Enter appropriate RF frequency

→ Switch on voltmeter ()

→ Apply signal with test frequency and known amplitude to the selected input (RF IN/OUT or INPUT2).

→ In the event that the message "*RED.RF-POWER*" is displayed, the sensitivity can be reduced by about 20 dB by means of (internal attenuator on).

If this is not sufficient, an additional external attenuation facility must be provided (Δ ATT.).

→ The key sequence <power/dBm> can be used to enter on the CMT the RF power (in dBm) to which the currently measured voltage corresponds

e.g. (13.5 dBm)

It is irrelevant whether the power applied actually corresponds to 13.5 dBm. Thus, attenuators or amplifiers connected to the input can be included in the reference measurement and thus in the subsequent measurement results.

When the input of the CMT is changed (via INPUT SELECT), the measurement result obtained is either 40 dB too low (calibration at INPUT 2, measurement at RF IN/OUT) or too high (calibration at RF IN/OUT, measurement at INPUT 2) owing to the difference in sensitivity between the two inputs.

2.3.4.5.3 Calibration through Reference Measurement Using the RF Power Meter

For calibration using the RF power meter, the amplitude of the RF voltage applied need not be known and entered.

Procedure:

- Select input RF IN/OUT
- (switch off internal 20-dB attenuator first)
- (switch off automatic control of internal attenuator according to the power applied)
- Enter appropriate RF frequency.
- Switch on voltmeter ()
- Apply signal with test frequency to the selected input (RF IN/OUT or INPUT 2 in combination with RF IN/OUT, e.g. directional coupler).
- In the event that the message "*RED.RF-POWER*" is displayed, the sensitivity can be reduced by about 20 dB by means of (internal attenuator on).

If this is not sufficient, the external attenuation of the CMT must be increased at the input.

- By means of , the RF power measured at socket RF IN/OUT is defined as reference level.

If the power applied to RF IN/OUT is smaller than 0 dBm when is called, the user is prompted to increase the RF power by means of "INC. RF POWER".

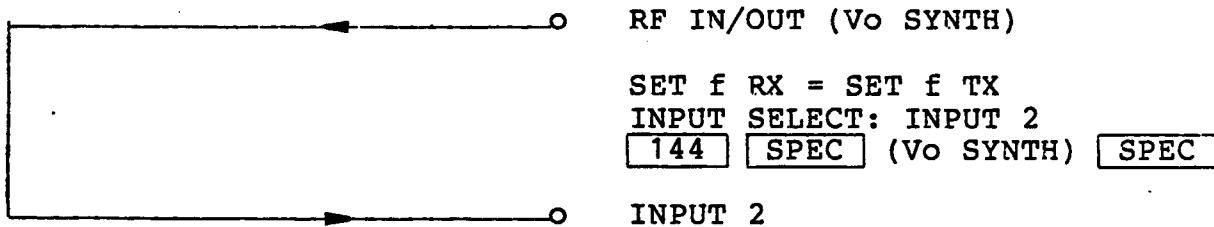
When the input of the CMT is changed (via INPUT SELECT), the measurement result obtained is either 40 dB too low (calibration at INPUT 2, measurement at RF IN/OUT) or too high (calibration at RF IN/OUT, measurement at INPUT 2) owing to the difference in sensitivity between the two inputs.

2.3.4.5.4 Calibration Sources

When using , an RF power of at least 10 mW (possible from 1 mW onwards) is required for the power measurement in the selected frequency range.

When using , a calibrated RF signal in the range 50 μ V to 5 mV is all that is needed.

If the option CM-B9 (Duplex Modulation Meter) is fitted, the signal of the built-in signal generator is also sufficient for calibration.



2.3.4.5.5 Error Handling

As long as an error condition exists when using the selective voltmeter, the output of the measurement result on the RF level display is suppressed, and three strokes are displayed instead!

Following "RAM-ERROR", which may occur when switching on the instrument for the first time or after replacing the battery, no reference value is available. After the measurement has been called, the CMT indicates the lacking reference value by reading out the request »CALIBRATE« on the alphanumeric display.

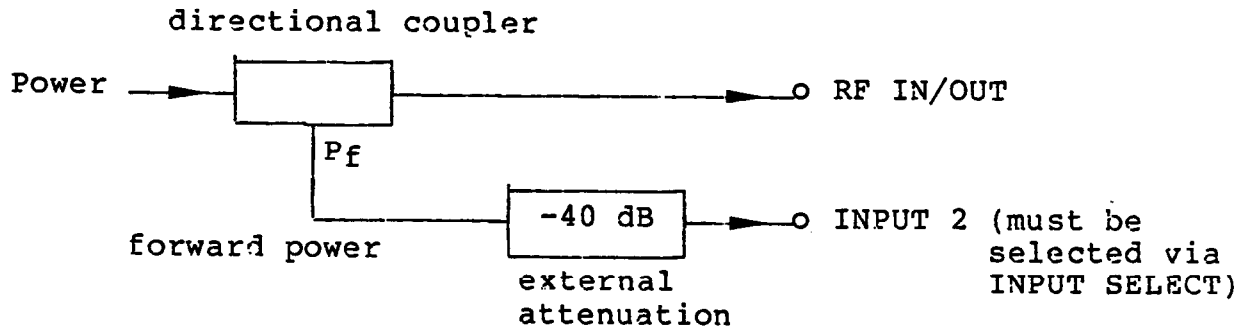
The input of xx or , respectively, causes the measurement result to be immediately read out on the alphanumeric display.

If the maximum permissible input voltage of the voltmeter is exceeded, the user is prompted to reduce the input power by the message "*RED.RF-POWER*".

2.3.4.5.6 Application Hint: Measurement of Forward and Reflected Power

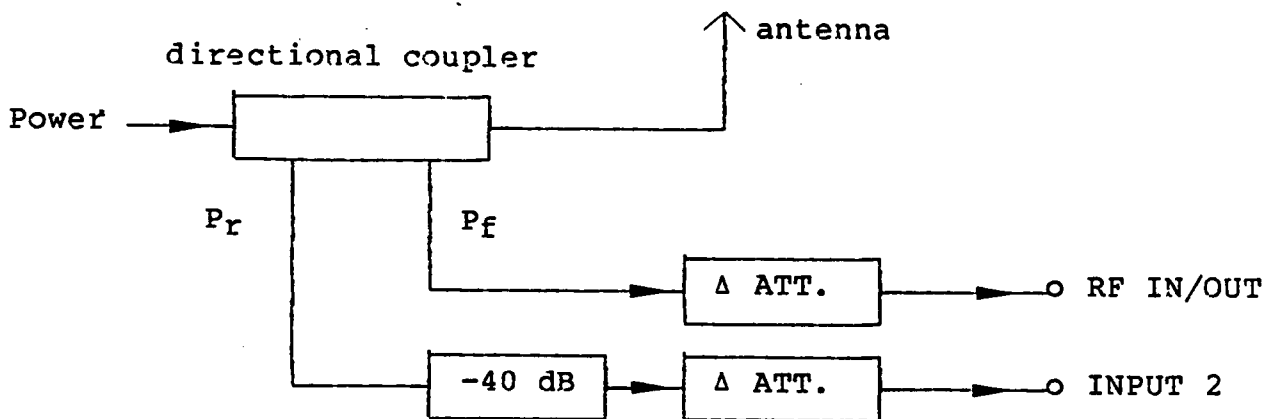
Calibration:

- Enter appropriate RF frequency.
- Switch on voltmeter (0 ACP).
- Apply the greatest occurring signal.



- 145 SPEC (power measurement + forward power)

Measurement:



By inserting an additional 40-dB attenuator, the difference in sensitivity between both inputs is balanced.

By switching between the two inputs via INPUT SELECT, the forward and reflected power can be measured separately; it is however possible that different coupling factors are not taken into account then. This error source can be eliminated by using only one coupling line and reversing the directional coupler for measurement of the forward and reflected wave.

2.3.5 Demodulation/Modulation

The analysis of the transmitter modulation and the settings of the RF test generator modulation are combined in the modulation field (Fig. 2-3).

If the adjacent-channel power meter (option CMT-B6) is fitted, self-reception at the transmitter test operating frequency may give rise to disturbances at low RF input levels.

2.3.5.1 Modulation Selection

The possible types of modulation AM, FM and ϕ M are selected using the following key combinations:

<input data-bbox="99 615 164 653" type="text" value="%"/>	<input data-bbox="217 615 375 653" type="text" value="MAX PK"/>	/	<input data-bbox="469 615 610 653" type="text" value="INT 1"/>	→	AM
<input data-bbox="99 678 196 716" type="text" value="kHz"/>	<input data-bbox="217 678 375 716" type="text" value="MAX PK"/>	/	<input data-bbox="469 678 610 716" type="text" value="INT 1"/>	→	FM
<input data-bbox="99 741 180 779" type="text" value="Hz"/>	<input data-bbox="217 741 375 779" type="text" value="MAX PK"/>	/	<input data-bbox="469 741 610 779" type="text" value="INT 1"/>	→	FM
<input data-bbox="99 804 196 842" type="text" value="rad"/>	<input data-bbox="217 804 375 842" type="text" value="MAX PK"/>	/	<input data-bbox="469 804 610 842" type="text" value="INT 1"/>	→	ϕ M

If the selection is made in the receiver test (function INT 1), input of the deviation or the modulation depth is also possible simultaneously using the 1st modulation generator:

<input data-bbox="99 1035 180 1073" type="text" value="50"/>	<input data-bbox="217 1035 277 1073" type="text" value="%"/>	<input data-bbox="331 1035 472 1073" type="text" value="INT 1"/>	→	AM, 50 % modulation depth
<input data-bbox="99 1098 164 1136" type="text" value="1"/>	<input data-bbox="217 1098 315 1136" type="text" value="kHz"/>	<input data-bbox="331 1098 472 1136" type="text" value="INT 1"/>	→	FM, 1 kHz deviation
<input data-bbox="99 1161 196 1199" type="text" value="2.5"/>	<input data-bbox="217 1161 315 1199" type="text" value="rad"/>	<input data-bbox="331 1161 472 1199" type="text" value="INT 1"/>	→	ϕ M, 2.5 rad deviation

All set values are stored in the RAM with battery backup when the modulation mode is changed. These values include:

INT 1, INT 2, EXT:	Setting value
	REF value
	Δ VAR value
	Δ VAR memory on/off
	Display unit (Hz/kHz)

MAX PK, +PK, +/-2PK, -PK:	REF value
	RANGE HOLD value
	RANGE HOLD on/off
	Display unit (Hz/kHz)

The corresponding parameters of the new modulation mode are then fetched from the memory and set. MAX PK is always switched on in the transmitter test following selection, and the RF synthesizer is only modulated by the AF generator 1 (INT 1).

The set modulation mode applies to both transmitter and receiver tests. A modulation mode deviating from the complete mode is only possible with modulation of the RF synthesizer by an external source (connector MOD EXT 82).

Possible combinations with double modulation:

INTERNAL	EXTERNAL
FM / ϕ M	AM
AM	FM / ϕ M

The selection takes place according to the overall mode selected whilst using the characteristic units:

Mode: transmitter test, FM

- % EXT → AM with modulation depth last stored
- 50 % EXT → 50 % AM via external modulation source

Mode: transmitter test, AM

- kHz EXT → FM with FM deviation last stored
- 1 kHz EXT → 1 kHz deviation via external modulation source
- rad EXT → ϕ M with ϕ M deviation last stored

If double modulation is set as a result of changing the overall operating mode, the value of the EXT modulation is not stored.

2.3.5.2 Modulation Meter

The modulation meter is accessed using the keys MAX PK, POLARITY SELECT and PK HOLD. The output is made simultaneously in the digital display 21 and in the quasi-analog display 22.

In order for the demodulators to work properly, the appropriate operating frequency must be correctly set, i.e. either the RF counter can count the receive signal (counter status $\langle \rangle$ 0), or the correct RF frequency has been set manually via SET f TX.

Besides, it is to be noted that the function is active following master reset. It is therefore possible that the (RF) limit sensitivity is not reached. The demodulated output signal can be connected through via .

MAX PK The positive and negative peak modulations are measured alternately, but only the larger of the two results is displayed.

POLARITY SELECT This is a toggle key with which specific measurement of the positive peak modulation (+PK), negative peak modulation (-PK) or arithmetic mean of both (+-/2PK) can be selected.

PK HOLD Even short modulation peaks are stored and can be displayed if the PK HOLD key is pressed (important with short modulation bursts such as tone sequences etc.). This is only possible in +PK or -PK mode; if the MAX PK or +/-2PK function is active when PK HOLD is switched on, an automatic switchover is made to +PK.

PK HOLD is an analog memory circuit which guarantees acquisition of all modulation peaks without gaps. This also means, however, that the peak-value meter is no longer available for other purposes such as e.g. peak-weighted AF level measurements (see Section 2.3.6.2).

Modulation measurements can be made with peak weighting or RMS weighting. When the instrument is switched on or a master reset made, a frequency deviation < 100 Hz or a phase deviation < 0.1 rad and a modulation depth < 1 % are considered as spurious modulation and automatically RMS weighted; peak weighting is selected if these limits are violated.

This automatic function can be switched off using

(only RMS weighting)

and

(only peak weighting)

and switched on again using

.

2.3.5.3 Transmitter Distortion

Measurement of the transmitter distortion is called by pressing the key DIST 26. The frequency of the first modulation generator is automatically set to the value entered via 65 SPEC <f (Hz) > SPEC (and displayed). It is factory-set to 1 kHz (operating frequency of distortion meter), but it can be matched to a frequency conversion in the transceiver (e.g. voice encoding) in the range from 20 Hz to 9.999 kHz. Modulation of the transmitter must also be ensured by the signal at connector MOD GEN (no two-tone).

If the transceiver is also modulated by a pilot tone (< 300 Hz), this signal must be suppressed by switching on the 300-Hz high-pass filter (see Section 2.3.5.4).

Logarithmic or linear output of the result can be selected by entering the unit % or dB before pressing the DIST key.

The receiver distortion measurement or SINAD measurement is switched off when the transmitter distortion measurement is selected.

In order to examine the signal/noise ratio of the transmitter signal, the DIST key can be assigned to the transmitter S/N measurement by 55 SPEC. Subsequent pressing of this key does not call, as described previously, the transmitter distortion measurement but calls the transmitter S/N measurement.

The output signal at the MOD GEN connector is switched on and off alternately, and the FM deviation and the spurious FM with an unmodulated carrier measured. The ratio of these two measurements results in the displayed S/N value in % or dB.

Peak-value measurement by means of 36 SPEC

rms measurement by means of 35 SPEC and 37 SPEC

Distortion measurements are selected again using 56 SPEC and by subsequent pressing of the key DIST.

2.3.5.4 Filter Weighting of the Demodulated Signal

The frequency response of the demodulated signal (50 Hz to 20 kHz) can be clipped using two filters:

- By a highpass with a cut-off frequency of 300 Hz, especially to suppress pilot tones.
- By a bandpass (300 Hz to 3 kHz) according to the CCITT standard.

Switching on and off is carried out by repeatedly pressing the keys HP (= highpass) and CCITT (= filter to CCITT standard).

Cutting the CCITT filter into the demodulation branch switches off the filter in the AF voltmeter branch.

2.3.5.5 Modulation of the RF Test Generator

The RF test generator can be modulated with up to three sources:

Modulation source	Modulation mode
Modulation generator 1	AF INT 1 Frequency setting INT 1 Deviation or modulation depth
Modulation generator 2 *)	AF INT 2 Frequency setting INT 2 Deviation or modulation depth
Signal at connector MOD EXT	EXT Deviation or modula- tion depth 1 Vrms

*) Only if option CMT-B7 fitted

The two modulation generators INT 1 and INT 2 always have the same modulation mode (AM, FM or ϕ M), the respective modulation intensity is adjustable independently.

In order to modulate the generator with very low AF frequencies (<150 Hz) in FM, it is necessary to slow down the RF synthesizer control loop.

This is done by means of 17 SPEC .



In this operating mode, the setting time of the RF frequency is 3 s (except an offset from the final frequency of 2×10^{-6} or 250 Hz for RF <31.25 MHz). This is independent of the type of modulation (AM, FM, ϕ M) or the operating mode (transmitter test/receiver test).

This operating mode is switched off via

16 SPEC (default following switch-on)

A large number of combinations is possible when using the modulation input MOD EXT; the possibilities are listed in Table 2-1.

Table 2-1

INT 1	INT 2	EXT
AM1	AM2	$A_{Me} = AM1$ $AM1 > AM2$ $A_{Me} = AM2$ $AM1 < AM2$ A_{Me} any $AM1 = AM2 = 0$ F_{Me} any ϕ_{Me} any
FM1	FM2	A_{Me} any $F_{Me} = FM1$ $FM1 > FM2$ $F_{Me} = FM2$ $FM1 < FM2$ F_{Me} any $FM1 = FM2 = 0$ ϕ_{Me} not permissible
$\phi M1$	$\phi M2$	A_{Me} any F_{Me} not permissible $\phi_{Me} = \phi M1$ $\phi M1 > \phi M2$ $\phi_{Me} = \phi M2$ $\phi M1 < \phi M2$ ϕ_{Me} any $\phi M1 = \phi M2 = 0$

The respective modulation is switched on by pressing the key INT 1, INT 2 or EXT. The deviation or the modulation depth and the key acknowledgement appear in the digital display 21 (the key acknowledgements indicate which modulation sources are used to modulate the RF generator).

The complete modulation is switched off using the key MOD OFF 26, individual modulation sources can be switched off using the key sequences 0 INT 1 / 0 INT 2 or 0 EXT .

Since peak deviations or modulation depths are involved, the total of the individual modulations must not exceed the respective limit value; all entries which do not satisfy this condition are rejected.

Example:

Maximum deviation
in frequency range 31.25 to 62.5 MHz 50 kHz
Switched on modulation INT 1 30 kHz

The instruction **20 kHz INT 2** (connection of INT 2 with 20 kHz deviation) is permissible (total deviation 50 kHz).

The instruction **30 kHz INT 2** (connection of INT 2 with 30 kHz deviation) would exceed the limit of 50 kHz and is rejected.

FM with an external signal is not possible in this example since the additional condition EXT = INT 1 applies in this case and the limit value of 50 kHz would be exceeded if EXT were connected ($2 * INT 1 = 60 \text{ kHz}$).

Depending on the frequency range, the RF generator has a maximum deviation of 50 to 800 kHz or 5 to 80 rad (see data sheet). If this limit is exceeded by the frequency variation, the deviations of all connected modulation sources must be reduced by the same factor until the limit value condition is fulfilled.

Example:

Test frequency 550 MHz

INT 1	.....	300 kHz	
INT 2	.....	200 kHz	
EXT	.....	300 kHz	
Total	.....	<u>800 kHz</u>	permissible: 800 kHz

Test frequency 450 MHz

The deviations are reduced by half:

INT 1	.....	150 kHz	
INT 2	.....	100 kHz	
EXT	.....	150 kHz	
Total	.....	<u>400 kHz</u>	permissible: 400 kHz

The EXT modulation depth/deviation is always equal to the larger value of INT 1 and INT 2 in the case of double or tripple tone modulation between EXT and INT 1, INT 2 or INT 1 + INT 2. If INT 1 or INT 2 is now varied, the messages

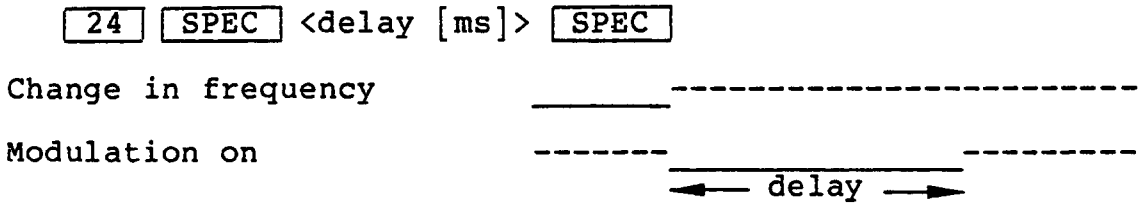
EXTMOD - INT1MOD or EXTMOD - INT2MOD

in the α display indicate the coupling of two modulations.

If EXT is displayed in the alphanumeric display and INT1 or INT2 in the modulation display, this message is suppressed and the indication in the alphanumeric display remains unchanged even if EXT is varied (by varying INT1 or INT2)

With EXT, the VAR symbol has no meaning in this case.

→ The modulation switch-off time (FM, low modulation frequencies) when changing the RF frequency is adjustable; it is factory-set to 40 ms (default).



2.3.5.6 Calibration of the Modulation Sensitivity of the External Input

The display of the modulation depth or deviation in the case of external modulation is referred to an input level of 1 Vrms, deviations from this standard level lead to differences between the displayed modulation and the actually set modulation.

If the level at connector MOD EXT is in the range 0.1 V to 2 V, the modulation sensitivity of the external input can be tuned to the respective level by pressing the key EXT CAL 28.

If, however, the level does not lie within the permissible range, the gain setting is calibrated only as far as possible and no error message is produced.

The modulation sensitivity is set back to the standard level of 1 Vrms by pressing the key 1 VRMS 27 (display in each case via key acknowledgement).

Example:

```

Level at connector MOD EXT ... 0.5 Vrms
Display 21 ..... 3 kHz
Actual deviation ..... 1.5 kHz

Command: EXT CAL
Actual deviation ..... 3 kHz

Command: 1 VRMS
Actual deviation ..... 1.5 kHz

```

Since parts of the adjustable amplifier simultaneously act on the internal modulation sources when using external modulation, a deviation between the displayed modulation and the actually set modulation by INT 1 / INT 2 of up to ± 30 % is possible in the position EXT CAL.

2.3.5.7 Modulation Sensitivity

The automatic modulation sensitivity measurement is selected by indication of a rated value in the MAX PK measurement:

	Number	[unit]	MAX PK
e.g	<input type="text" value="2.8"/>	<input type="text" value="kHz"/>	<input type="text" value="MAX PK"/>

Starting from the currently set value, the AF level at socket MOD GEN is increased or reduced according to the following formula until the measured value of the modulation (MAX PK) corresponds to the rated value ($\pm 2\%$):

$$\text{New level} = \frac{\text{rated modulation}}{\text{actual modulation}} * \text{old level}$$

The end of the search routine is indicated in the alphanumeric display by the message "DONE", the associated AF level can then be read on the AF level display.

This search routine is aborted and an error message output on the following conditions:

- AF level is $<10 \mu\text{V}$ or $>2.5 \text{ V}$ → CHECK INST.
- The modulation measurement result is 0% / kHz / rad → CHECK INST.
- The rated value ($\pm 2\%$) is not achieved after 2 minutes.
- AF level or type of modulation has been changed during a running search routine → PARAMCHANGED

The running modulation sensitivity routine can be switched off again by pressing

MAX PK (without numbers!)
+ $\pm/2$ - PK
DIST (TK)

as well as via function .



The rated value entered always refers to peak weighted signals. If the measurement result delivered by the MAX PK measurement is rms weighted, it is converted to the peak value for comparison with the rated value (MAX PK peak = $\sqrt{2}$ * MAX PK rms).

2.3.6 Modulation Generator Level/AF Voltmeter

The evaluation of the AF signals applied to the connector AF VOLTM 84 and the level setting of the AF signal from connector MOD GEN 83 are presented in the AF level field (Fig. 2-4).

2.3.6.1 AF Generator Level

An AF signal with a frequency of 20 Hz to 30 kHz in the range from 10 μ V to 5.1 V is available at connector MOD GEN 83. The frequency of this signal is determined in the frequency field using the key AF INT 1 9 (with double tone also AF INT 2 10), the level can be adjusted using the keys V_0 MOD GEN 32, V_0 MOD +20 dB 33 and V_0 OFF 35.

The AF level can be directly entered in μ V, mV, dB μ V and dBm (at 600 Ω) via the key V_0 MOD GEN. The RMS voltage is displayed at the output (this corresponds to the EMF with an output impedance of 0 Ω).

The displayed value is multiplied by 10 by pressing the key V_0 MOD +20 dB and the associated key acknowledgement appears. Settings and variations can still be carried out as before. Pressing the key V_0 MOD +20 dB again reduces the currently displayed value by a factor of 10 and the key acknowledgement is switched off.

Exceeding limits when using this key results in the maximum possible value, subsequent pressing reduces this voltage to one tenth.

The key V_0 OFF can be used in the transmitter and receiver tests to switch off the AF level and to switch it on again (toggle key).

If the option CMT-B7 is fitted, a double tone can be generated at the connector MOD GEN by pressing or . The output level displayed corresponds to the total RMS value of the added signal in the case of . When using , it corresponds to the RMS value of an individual signal, in which case the individual amplitudes of the two tones are always the same.

: $V_{\text{disp}} = V_{\text{tot}} = \sqrt{2} \cdot V_1 = \sqrt{2} \cdot V_2$

: $V_{\text{disp}} = V_1 = V_2 = V_{\text{tot}} / \sqrt{2}$

: V_2 is switched off again.

Two-tone (at socket MOD GEN) is indicated by "1.2.MOD" on the AF level display.

2.3.6.2 AF Voltmeter

The AF voltmeter is switched on by pressing the key LEVEL. All voltages at the connector AF VOLTM are measured in the range from 0.1 mV to 35 V and output in digital and analog form in the AF level display 30/31 in the units μV , mV, V, dB μV or dBm (600 Ω).

This measurement can be switched between RMS and peak weighting or various measuring rates can be selected using the following SPEC functions (see also Section 2.3.8).

RMS measurements

40 **SPEC**

Two measuring rates can be selected for RMS measurements:

26 **SPEC** : SLOW (default setting following switch-on)

25 **SPEC** : FAST

The selected speed also applies to modulation measurements if these are RMS weighted.

Peak-value measurements

41 **SPEC** : Positive half-wave

42 **SPEC** : Negative half-wave

The peak-value weighting of the AF level can only be switched on with the PK HOLD function (modulation measurement) switched off.

Table 2-2

Measurement	RMS		Peak
	Fast	Slow	
Lower frequency limit	150 Hz	50 Hz	20 Hz
Maximum measuring speed	80 ms	220 ms	80 ms

43 **SPEC** <R (Ω)> **SPEC** : Setting of reference resistance with AF voltmeter measurements ($2 \Omega < R < 3000 \Omega$).

2.3.6.3 Receiver Distortion Depth (SINAD/DIST)

Measurements

The SINAD measurement (unit dB) is switched on by pressing the key SINAD·DIST. The receiver distortion depth (unit %) is displayed if this key is pressed again.

The frequency of the first modulation generator is automatically set to the value entered via <f (Hz)> (and displayed). It is factory-set to 1 kHz (operating frequency of the distortion meter) but can be matched to a frequency conversion in the transceiver (e.g. voice encoding) in the range from 20 Hz to 9.999 kHz.

It is also possible to directly select the distortion measurement without using the toggle function by additionally entering the unit %.

If a number is entered before the key SINAD·DIST (unit dB) is pressed, the output level of the test generator is varied until the SINAD result reaches the preset value (± 1 dB or 2 dB).

The DIST measurement is correspondingly called instead of the SINAD measurement if the unit for the entered number is %.

These search routines can be influenced by the following SPEC functions:

- : The search routine is terminated if the result falls within the tolerance window of the desired SINAD value (default).
- : The search routine is also activated again when the preset value is reached and the output level of the test generator is adjusted correspondingly if the parameters are changed.
- : The tolerance window of the preset value is ± 1 dB.
- : The tolerance window of the preset value is ± 2 dB (default).

The search routines are switched off by pressing the key SINAD·DIST again, influencing the RF test generator level (adjustment, switch-off, variation) or the modulation or switching off the SINAD·DIST measurement.

Further abort conditions for the search routines are the attainment of the time limit (approx. 2 min) and increasing of the RF level to > -27 dBm.

In the case of jumps in input voltage, the internal control of the CMT requires max. 6 s until a stable measurement result can be displayed.



As a result of this, it is possible that the first measurement result does not correspond to the actual value in IEC-bus operation and operation with the autorun control.

2.3.6.4 Signal-to-Noise Measurements

The receiver signal-to-noise measurement is switched on by pressing the key S/N 34.

If a number is entered before pressing the key S/N (unit dB), the output level of the signal generator is varied until the S/N result reaches the preset value (± 1 dB or 2 dB).

The search routine remains activated even after the preset value has been reached if 59 SPEC was previously entered, otherwise only the S/N measurement is continued and the RF signal generator level is no longer influenced (58 SPEC, see SINAD search routines, Section 2.3.6.3).

As with the SINAD search routine, the tolerance window can also be switched in this case to ± 2 dB by 61 SPEC and to ± 1 dB by 60 SPEC.

The search routine is switched off by pressing the key S/N again, influencing the RF signal generator level (adjustment, switch-off, variation) or switching off the S/N measurement.

Further abort conditions for the search routine are the attainment of the time limit (approx. 2 min) and increasing of the RF level to > -27 dBm.

The modulation of the RF signal generator is constantly switched on and off with the S/N measurement. Since the CMT has three modulation sources (INT 1, INT 2 and EXT), influencing of INT 2 and EXT can be controlled using the following SPEC functions:

50 SPEC : INT 2 remains uninfluenced (default).

51 SPEC : INT 2 is also switched on and off.

52 SPEC : EXT remains uninfluenced (default).



This only applies if $\text{INT } 2 > \text{INT } 1$ or $\text{INT } 2 = 0$ since otherwise the EXT value is switched between $\text{EXT} = \text{INT } 1$ and $\text{EXT} = \text{INT } 2$ by the condition $\text{EXT} = \text{INT } 1$ or $\text{INT } 2$ (maximum value in each case).

53 SPEC : EXT is also switched on and off.

For the noise measurement (modulation of signal generator switched off), the control loop is usually switched to "loop fast" which improves the broadband spurious FM of the signal generator and thus the measurement limit of the S/N measurement.

However, if this measurement is performed with the CCITT filter switched on, it is often better to switch the control loop to "loop slow" even if the modulation is switched off. Though the broadband spurious FM is somewhat deteriorated, the spurious FM in the transmission range of the filter and thus the measurement limit of the S/N measurement is improved.

This special operating mode is switched on via 105 SPEC and switched off via 104 SPEC (default).

2.3.6.5 Filter Weighting of the AF Signal

The AF signal at connector AF VOLTM is analyzed for all frequencies up to approx. 100 kHz min. (depending on measurement).

This wide test bandwidth can be limited to the frequency range from 300 Hz to 3 kHz by switching on the CCITT filter (key CCITT RX 36). This also switches the filter out of the demodulator branch (key acknowledgement via CCITT TX 28 extinguished).

The filter is switched off again by pressing the key CCITT RX or CCITT TX again.

2.3.6.6 Averaging of Noisy Signals at AF VOLTM Input and Demodulator Input

For stable measurement of noisy signals, measurement repetition and averaging (arithmetic mean) can now be selected in four steps:

<input type="checkbox"/> 45	<input type="checkbox"/> SPEC	no averaging (default after switching on)
<input type="checkbox"/> 46	<input type="checkbox"/> SPEC	30 measurements
<input type="checkbox"/> 47	<input type="checkbox"/> SPEC	60 measurements
<input type="checkbox"/> 48	<input type="checkbox"/> SPEC	140 measurements
<input type="checkbox"/> 49	<input type="checkbox"/> SPEC	255 measurements

This averaging refers to all measurements performed using the rms meter (also for search routines):

AF voltmeter (if "RMS" is displayed)
S/N
SINAD
DIST (RX)
DIST (TX)
MAX PK (if "RMS" is displayed)
±1/2 - PK (if "RMS" is displayed)

The relatively high number of measurement repetitions reduces the measuring rate accordingly!

2.3.7 Numeric Keypad + Special Functions

2.3.7.1 Numeric Keypad

This keypad is used for entering the required numerical values. The inputs are evaluated in such a manner that incorrect entries are corrected as far as possible.

Setting values

Setting values can be entered as a unit, numbers or unit + numbers.

Although a unit is usually specified before or after the number, units (also minus) entered between the individual numbers are also evaluated by the CMT; the last entered unit is then valid.

If the decimal point is pressed several times by mistake, the first one is assumed to be the separation between the digits before and after the decimal point.

Example:

Input:

1 . 3 2 5 kHz INT 1

kHz 1 . 3 2 5 INT 1

1 . kHz 3 2 . 5 INT 1

1 . 3 Hz 2 . 5 % kHz INT 1

Following evaluation:

1.325 kHz modulation (FM) by 1st modulation generator (INT 1) in all 4 cases.

The number of times keys can be pressed before the terminating key is limited to 25; further inputs are ignored.

Irrelevant or meaningless inputs are also ignored:

- 100 μ V V₀ MOD GEN : Minus sign is ignored (AC voltage)

100 Hz MAX PK : 100 is ignored since only units are permissible for the modulation switchover.

- - + - not + ! A minus sign once entered cannot be cancelled by pressing it again.

Control values (e.g. SPEC number)

In the case of control values such as numbers of the SPEC function or with STORE/RECALL, entered decimal points and the minus sign are ignored and the unit keys always have the meaning A to D.

Code/Decode

When entering code numbers, the keypad has the same function as the corresponding keyboard on the transceiver:

0 to 9 A B C D E F or
0 to 9 A B C D * #

Each input generates the corresponding tone in the standard series. Leading zeros are not suppressed.

2.3.7.2 Δ VAR

The key Δ VAR 53 can be used to assign any step size (within the limits listed below) to all setting values which can be varied using the spin wheel. The input corresponds to a normal numerical input (see Section 2.3.7.1) prior to key Δ VAR.

Δ VAR can be used:

SET f TX	<u>6</u>	10 Hz to 500 MHz	Increment
SET f RX	<u>5</u>	10 Hz to 500 MHz	Increment
AF INT 1	<u>9</u>	0.1 Hz to 15 kHz	Increment
AF INT 2	<u>10</u>		
V ₀ SYNTH	<u>14</u>	0.1 dB to 100 dB 0.01 μ V to 0.5 V	Increment (log) Increment (lin)
INT 1	<u>23</u>	1 Hz to INT 1 max./2 kHz	Increment (FM)
INT 2	<u>24</u>	0.001 rad to INT 1 max./2 rad	Increment (ϕ M)
EXT	<u>25</u>	0.001 % to 50 %	Increment (AM)
V ₀ MOD GEN	<u>32</u>	10 μ V to 2.5 V 0.1 dB to 50 dB	Increment (lin) Increment (log)

The variation is made using the smallest step size which can be represented in the display if the minimum resolution of the display is larger than the entered step size.

Command: Δ VAR CLEAR Terminating key

Response: The variation is made again using the original step size, the contents of the Δ VAR memory are not destroyed.

- Example: AF INT 1
- + Variation of 1st modulation generator frequency 0.3/0.6/1/1.25/2.7/3/6 kHz
 - 100 Hz Δ VAR AF INT 1 + Variation in 100-Hz steps
 - Δ VAR CLEAR AF INT 1 + Variation in standard tone sequence again
 - Δ VAR AF INT 1 + Variation in 100-Hz steps again



The CLEAR key does not have a command abort function in this case. A command abort following Δ VAR can only take place with an illegal input or by pressing the key CLEAR twice.

Example: [10] [μ V] [Δ VAR] [CLEAR] [CLEAR]
 [1] [kHz] [Δ VAR] [AF LEVEL]
 [Δ VAR] [CLEAR] [CCITT RX]

Special features of the Δ VAR memory with level settings (V_0 MOD GEN, V_0 SYNTH):

The output voltage changes logarithmically if a logarithmic step size is entered into the Δ VAR memory of V_0 MOD GEN or V_0 SYNTH (e.g. 3.01 dB) and the level display is linear (e.g. 1.00 mV).

Example: Display of V_0 MOD GEN: \rightarrow 1.00 mV

[6.02] [dB] [Δ VAR] [V_0 MOD GEN] \rightarrow 6.02 dB
 corresponds to doubling of the value

Variation:

e.g. 6.02 dB	e.g. 20 dB
+ 8.00 mV	+ 1000.00 mV
+ 4.00 mV	+ 100.00 mV
+ 2.00 mV	+ 10.00 mV
1.00 mV	1.00 mV
- 500 μ V	- 0.10 mV
- 250 μ V	- 0.01 mV



The internal accuracy of the calculation is 0.01 dB, i.e. an input of 6 dB would not exactly lead to doubling (= 6.02 dB).

2.3.7.3 RANGE HOLD

The measurement range of the analog displays can be set to a specific value using the key RANGE HOLD 50 (corresponds to switching off of function AUTO RANGE). Larger values (up to 1999) can be output in the associated digital display despite an overflow in the analog display (full analog bar), but the unit is no longer automatically switched over (e.g. $\mu\text{V} \leftrightarrow \text{mV} \leftrightarrow \text{V}$).

RANGE HOLD can be used for:

POWER	<u>14</u>	
ACP	<u>15</u>	
PROBE	<u>17</u>	
MAX PK	<u>23</u>	] same measurement range
+ +/2 -	<u>24</u>	
DIST	<u>26</u>	
LEVEL	<u>32</u>	
SINAD·DIST	<u>33</u>	(each function individually)
S/N	<u>34</u>	

Command: RANGE HOLD Terminating key

Response: The measurement range just set is retained, the symbol RANGE HOLD appears in the associated display.

Example: Measured value: . 0.35 V with RF level measurement
(PROBE)
Measurement range: 0.50 V
Command: RANGE HOLD PROBE

The range of 0.50 V is now retained (identified by symbol RANGE HOLD). Values from 0.001 V to 1999 V (theoretically) can be output in the digital display, the analog display is limited to values from 0.005 to 0.5 V.

Command:

Response: The measurement range is set corresponding to the entered number and then retained, the current unit remains unchanged. The symbol RANGE HOLD appears.

The entered number must not exactly correspond to the possible ranges (0.025 - 0.05 - 0.1 - ... - 100 - 250 - 500 - 1000), the CMT automatically rounds up.

Example: Measured value: 0.35 V with RF level measurement (PROBE)

Measurement range: 0.50 V

Command:

The measurement range is fixed to 1.00 V.

Command:

The measurement range is fixed to 2.5 V.

Command:

Response: Additional input of a unit causes the measured values to be output in the new unit in the range defined by the number.

Example: Measured value: 0.15 V with RF level measurement (PROBE)

Measurement range: 0.25

Command:

The measurement range is fixed to 500 mV. The output in the digital display is also in mV (in this case: 150 mV).