ROHDE&SCHWARZ

Measuring Instruments
and Systems Division

Operating Manual

RADIOCOMMUNICATION ANALYZER

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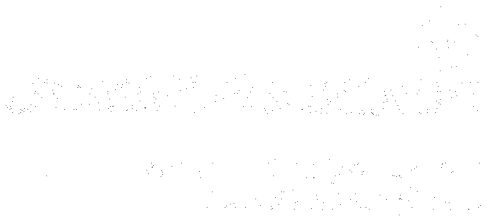

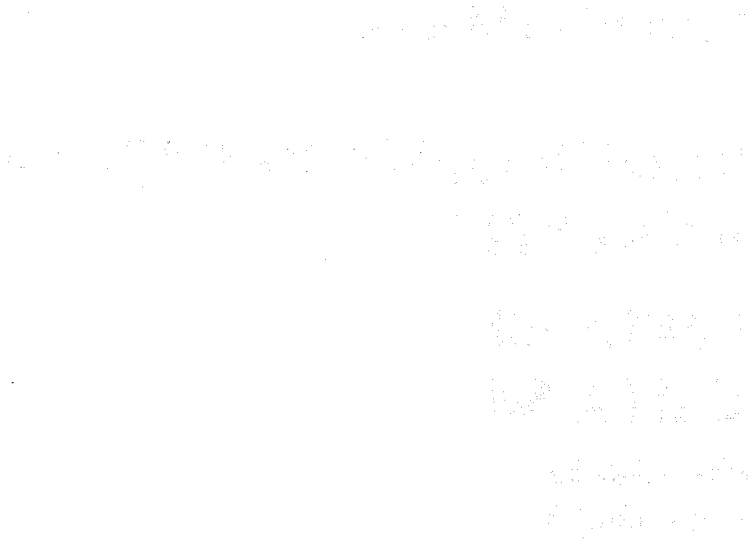

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Qualitätszertifikat

Sehr geehrter Kunde,

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

Certificate of quality

Dear Customer,

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

Certificat de qualité

Cher client,

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

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Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen die Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr MEZ besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder E-Mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Um Ihr Gerät stets auf dem neuesten Stand zu halten, abonnieren Sie bitte Ihren persönlichen Newsletter unter

http://www.rohde-schwarz.com/www/response.nsf/newsletterpreselection.

Sie erhalten dann regelmäßig Informationen über Rohde & Schwarz-Produkte Ihrer Wahl, über Firmware-Erweiterungen, neue Teiber und Applikationsschriften.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00 CET.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

To keep your instrument always up to date, please subscribe to your personal newsletter at

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As a subscriber, you will receive information about your selection of Rohde & Schwarz products, about firmware extensions, new drivers and application notes on a regular basis.

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ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 9502122

This is to certify that:

Equipment type	Order No.	Designation
CMTAxx	0834.0000.xx	Radiocommunication Analyzer
CMTA-B5	0835.3661.02	Autoruncontrol
CMTA-B9	0835.3510.02	Duplex Modulationmeter
CMTA-B13	0835.3810.02	Cellular Simulator
CM-B4	0803.3914.02	IEC/IEEE Bus Control Interface
CMT-B7	0803.2618.02	Second AF Synthesizer

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

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)

- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC)

Conformity is proven by compliance with the following standards:

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

Affixing the EC conformity mark as from 1995

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

Munich, 30.10.95

Central Quality Management FS-QZ / Becker

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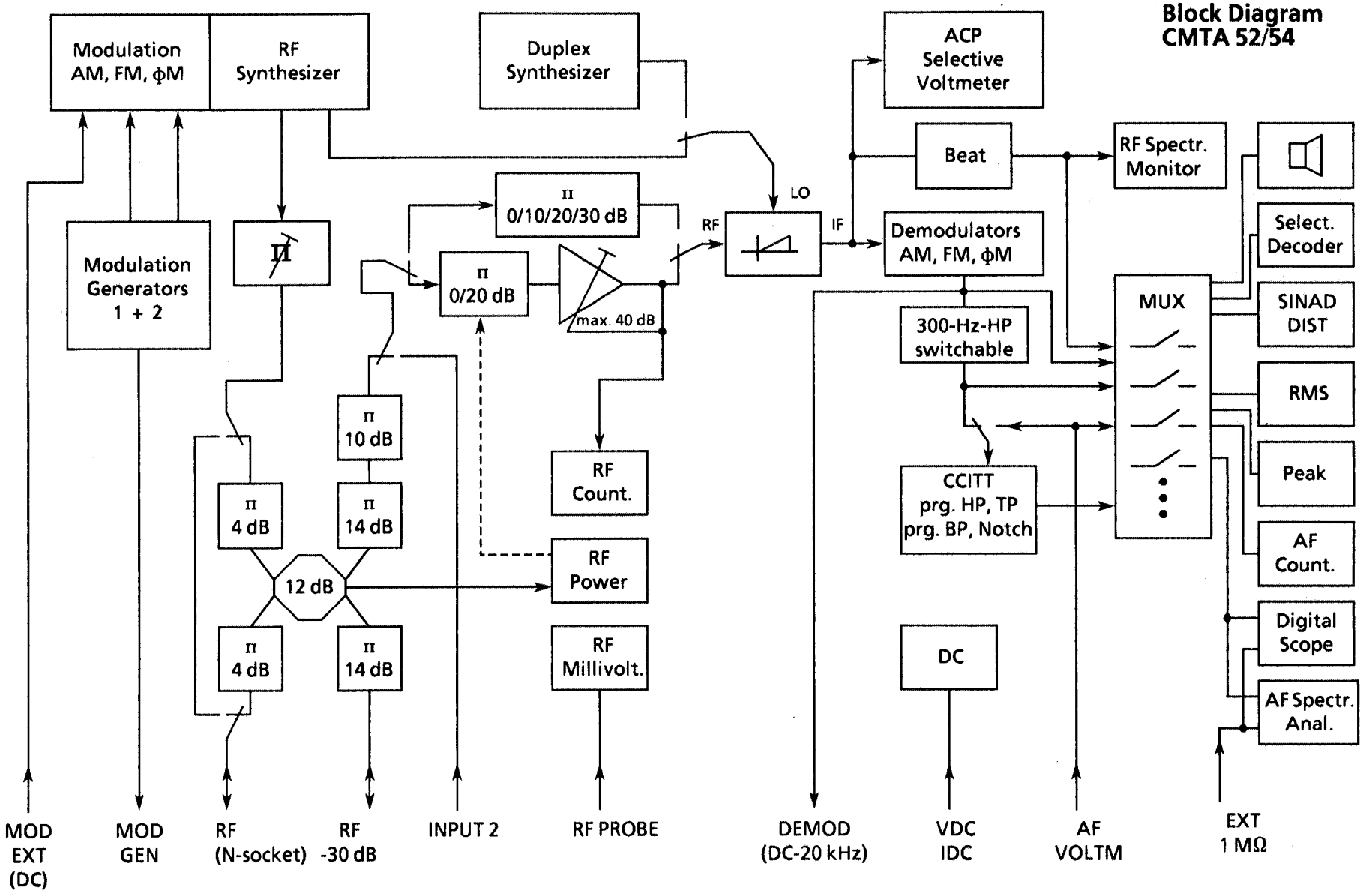
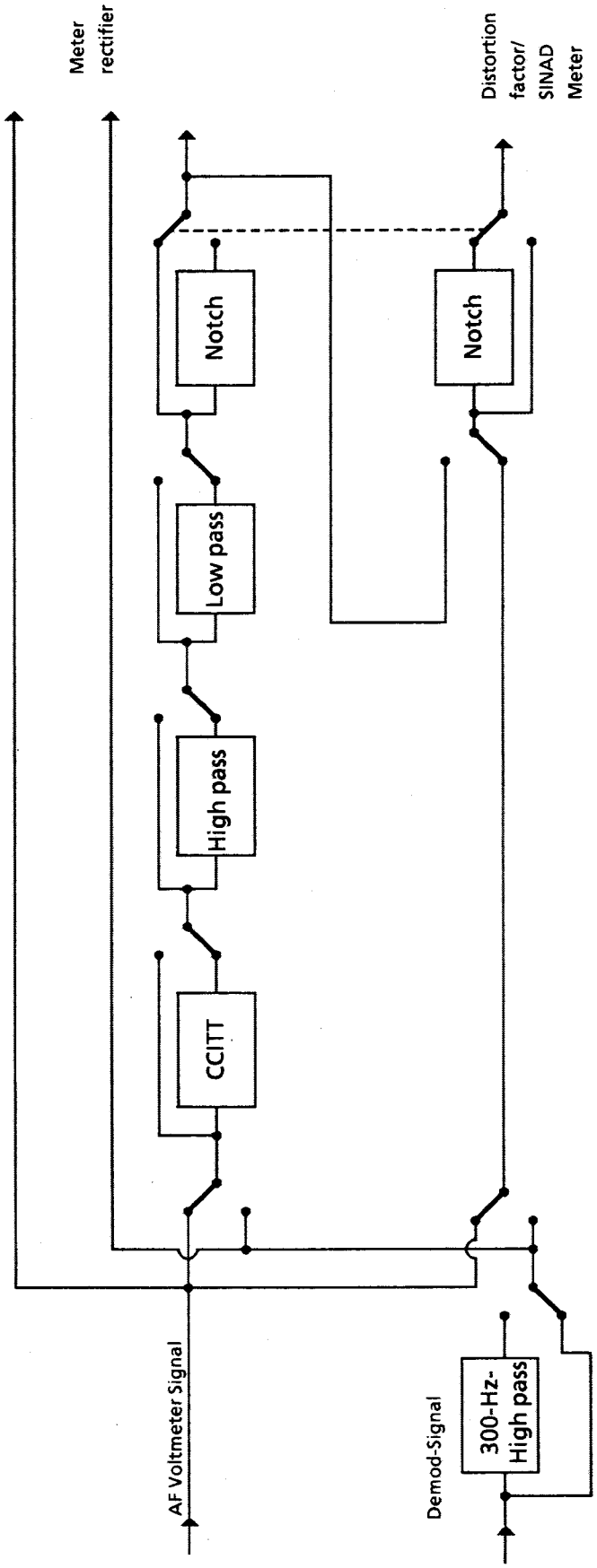
Block Diagram CMTA 52/54



Block Diagram
Possible weighting filter configuration



Supplement
to Operating Manual
RADIOCOMMUNICATION ANALYZER
CMTA52/54

Supplementary Notes:

Section 2.3.4.3.1 PROBE Measurement
Section 2.3.8.1 General Instrument Functions

Additional SPEC function:

110 SPEC <attenuation (dB)> SPEC:
Selection of attenuation between 0 and 80 dB with 0.1-dB resolution when using probes.

Section 2.3.9.5.2 Special Settings (Single-Shot)

In the menus 2.2.1 to 2.2.3 and 2.2.5 to 2.2.6, also power trigger can be selected as trigger source. Triggering is effected when the power at the RF socket exceeds a specific previously defined value (0 to 49.3 W).

Note that power triggering is effected only with dynamic violation of the set trigger level.

Hints as to Frequency Settling Time Measurements:

- We recommend measuring via the attenuator (0, 10, 20, 30 dB acc. to 200, 201, 202, 203 SPEC) instead of the controlled RF amplifier (default 204 SPEC).
- Switch off the squelch function (72 SPEC) to ensure fast response time of the FM demodulator.

2 Operating Instructions

(See Figs. 2-1 to 2-10 in Appendix)

The bold and italic numbers refer to the numbers in the Figs. 2-1 to 2-10.

The values specified in this section are not guaranteed; only the specifications in the data sheet shall be binding.

Note: ***Refer to section 2.2 "Preparations for Use" before connecting the supply voltage.***

2.1 Explanation of Front Panel and Rear Panel

2.1.1 Front Panel

(See Figs. 2-1 to 2-9 in Appendix)

The front panel is subdivided into differently coloured fields to facilitate operation of the instrument. The individual front-panel controls are described below according to this layout.

In addition to being assigned a reference number, the front-panel controls are also clearly labelled.

Fig. 2-1 ***Frequency field***

RF · FREQUENCY · AF

- For setting and measuring all frequencies used.
- Alphanumeric display for various applications (code, alternative display, status signals).

1

Frequency display:

10-digit display for measured or set RF values.

2

α display:

14-digit alphanumeric display for measured or set AF frequencies and selective call.

Additional display for status signals or measured/ setting values from other fields.

3

Key acknowledgement:

A bar is indicated above each key as long as the respective function is switched on.

4

Red LED: (transmitter test)
Green LED: (receiver test)

If the red LED lights, the keys have the red-labelled functions.

If the green LED lights, the keys have the green-labelled functions.

Black-labelled functions are valid for transmitter and receiver testing.

5

COUNT f: (transmitter test)

Switching on the built-in RF counter.

After each frequency count, the operating frequency is automatically set to the corresponding value in the transmitter test mode.

Readout on frequency display.

SET f RX: (receiver test)

Setting the output frequency of the RF signal generator to preset values.

Readout on frequency display.

6

SET f TX: (transmitter test)

Setting the transmitter test frequency to preset values.

Readout on frequency display.

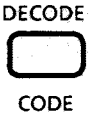
7

Δf: (transmitter test)

Setting the channel spacing (important for ACP measurement).

Readout on α display.

8



DECODE: (transmitter test)

Switching on the tone sequence evaluation circuit. The contents of a received data telegram is indicated on the α display.

CODE: (receiver test)

Sending a data telegram to the device under test. The contents of the sent telegram is indicated on the α display.

9

DEMOD · BEAT: (transmitter test)

If this key is actuated once, the demodulated AF is measured (DEMOD is indicated ahead of the measured value on the α display).

If the SET f TX function has been activated, BEAT measurement (counting the difference between operating and input frequency of the CMTA) can be called by actuating the key again (BEAT plus measured value on α display).

The BEAT function is switched off by actuating the same key again or another key in the modulation field (Fig. 2-3).

AF EXT: (receiver test)

Measuring the frequency at AF VOLTM. input.

Readout on α display.

10

AF INT

1

AF INT 1: (transmitter/receiver test)

Setting the modulation generator frequency 1.

Readout on α display.

11

AF INT

2

AF INT 2: (transmitter/receiver test)

Setting the modulation generator frequency 2.

Readout on α display.

Fig. 2-2 **RF level field**

RF POWER · RF LEVEL

For setting and measuring the RF levels used as well as measured DC values:

- RF output level of signal generator
- RF output power of transceiver
- Results of current or voltage measurement
- Results of RF millivoltmeter
- Adjacent-channel power ratio

12

RF level display:

$3^1/_2$-digit display for readout of RF level in W, dBm, V and dBμV as well as of current and voltage measurement results.

13

RF level display:

Analog display,

with quasi-analog indication of the digital RF level display (for exception see section 2.3.7.5).

14

POWER

V_0

POWER: (transmitter test)

Calling RF power measurement.
Readout on RF level display.

V_0 SYNTH.: (receiver test)

This key can be used to set the output level of the RF signal generator in the CMTA.

Readout on RF level display.

The analog display shows the level at which the RF attenuator switches (with short interruption in output signal).

15

ACP: (transmitter test)

Calling adjacent-channel power measurement. The signal-to-interference ratio is measured in the upper or lower 1st or 2nd adjacent channel (option CMT-B6).

The selective RF millivoltmeter can be switched on via 0 ACP .

Readout on RF level display.

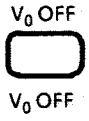
V_0 SYNTH. + 6 dB: (receiver test)

The level of the RF signal generator is increased by 6 dB when this key is actuated.

The original value is restored by actuating the key again.

Selected key function indicated by bar.

16

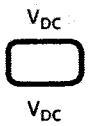


V_0 OFF:

The level of the RF synthesizer can be switched off with this key both for transmitter and receiver testing.

Selected key function indicated by bar.

17



V_{DC} :

Calling DC voltage measurement.

Readout on RF level display.

18

I_{DC} :

Calling DC current measurement.

Readout on RF level display.

19

PROBE :

Calling RF level measurement with RF millivoltmeter (option CM-B8).

Readout on RF level display.

Fig. 2-3 Modulation field

DEMODULATION · MODULATION

- Transmitter modulation analysis (transmitter test, DEMOD function) and signal generator modulation setting (receiver test, MOD function) are combined here. The unit indicated on the display identifies the modulation mode of the CMTA, % standing for AM, kHz or Hz for FM and rad for ϕM.

20

Modulation display:

$3^1/_2$-digit display of modulation in %, kHz, Hz or rad, or of modulation distortion in % (dB).

21

Modulation display:

Analog display

with quasi-analog indication of the digital modulation display (for exception see section 2.3.7.5).

22

MAX PK: (transmitter test)

Calling modulation measurement.

The maximum value is indicated on the modulation display. By entering a unit, the type of modulation (AM, FM, ϕM) is determined both for transmitter and receiver testing.

Readout on modulation display.

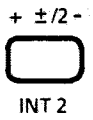
Entering a numerical value with or without a unit triggers a search routine, which varies the modulation generator output level until the desired modulation is obtained.

INT 1: (receiver test)

This key allows the modulation depth of the signal generator to be indicated and varied via the built-in first AF generator. Additional entry of a unit determines the type of modulation (AM, FM, ϕM) both for transmitter and receiver testing.

Readout on modulation display.

23

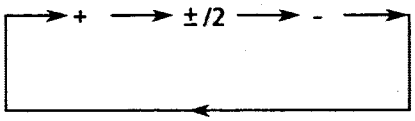


POLARITY SELECT : (transmitter test)

Calling modulation measurement.

The positive or negative peak, or the average peak modulation can be evaluated by actuating this key (several times if necessary).

Sequence:



Entry of a unit is ignored, since this is determined by MAX PK or INT 1.

Readout on modulation display.

INT 2 : (receiver test)

This key allows the modulation of the signal generator to be entered via the second AF generator.

Two-tone modulation is only possible in conjunction with INT 1, ie the unit and hence the type of modulation is determined by INT 1.

Readout on modulation display.

24

PK HOLD

EXT

PK HOLD : (transmitter test)

This function is for detecting the maximum of short modulation peaks and can be switched on or off by actuating this key.

Selected key function indicated by bar.

EXT : (receiver test)

This key enables AC-coupled modulation of the signal generator with a signal applied to the MOD EXT socket. Double modulation AM + FM/ϕM is possible in addition to two-tone-modulation.

For INT 1 and INT 2, the type of modulation is determined by the unit of INT 1 or MAX PK, for EXT by the unit entered.

Readout on modulation display.

25

DIST

OFF

DIST: (transmitter test)

Transmitter modulation distortion measurement is called via the DIST key. Entry of a frequency (numerical value plus frequency unit) determines the bandstop filter frequency. Normally, the modulation generator frequency is also set to this value. Entry of % or dB determines the unit of display. Continuous bandstop filter weighting in the demodulation section (see special functions, section 2.3.8).

Readout of measurement result on modulation display.

Readout of test frequency for approx. 1 second on modulation display.

MOD OFF: (receiver test)

For switching off all types of signal generator modulation.

Selected key function indicated by bar.

26

HP

FM DC

HP TX: (transmitter test)

This key is for switching a highpass filter into the path of the demodulated signal. By entering a frequency in Hz or kHz, the cutoff frequency of the highpass filter is selected. Selection of the highpass filter frequency may influence the lowpass filter frequency under certain circumstances (see section 2.3.5.3.3). The filter is switched off by entering 0 frequency or by switching a filter into the AF measuring circuit for receiver testing.

Indication of cutoff frequency for approx. 1 second on modulation display.

Selected key function indicated by bar.

FM DC: (receiver test)

The signal applied to the MOD EXT socket is used for DC-coupled FM.

Note: External calibration is not possible. In the FM mode, there is two-tone modulation, in the AM mode, there is double modulation. The key has no function in the ϕM mode.

Readout on modulation display.

27

LP

1 V_{RMS} EXT

LP TX: (transmitter test)

This key is for switching a lowpass filter into the path of the demodulated signal. The cutoff frequency of the lowpass filter is selected by entering a frequency in Hz or kHz. The filter is switched off by entering 0 frequency or by switching a filter into the AF measuring section for receiver testing.

Indication of cutoff frequency for approx. 1 second on the modulation display.

Selected key function indicated by bar.

1 V_{RMS}: (receiver test)

When this key has been actuated, the indicated EXT modulation corresponds to a nominal level of 1 V_{RMS} at the MOD EXT socket.

Selected key function indicated by bar.

28

CCITT

EXT CAL

CCITT TX: (transmitter test)

This key is for switching a weighting filter to CCITT filter specifications into the demodulation circuit.

Switching on a filter in the TX section causes the filter in the RX section to be switched off.

Selected key function indicated by bar.

EXT CAL: (receiver test)

When actuating the EXT CAL key, the AF voltage at the MOD EXT input is measured and an internal calibration carried out if it differs from the nominal level of 1 V_{RMS}.

Selected key function indicated by bar.

Fig. 2-4 AF level field

MODULATION GEN · AF VOLTMETER

- This field provides for the analysis of the AF signal applied to the AF VOLTM socket and setting the modulation generator level at the MOD GEN socket.

30

AF level display:

$3^1/_2$-digit display of modulation generator level or AF input level/SINAD/DIST/S/N.

31

AF level display:

Analog display

with quasi-analog indication of the digital AF level display (for exception see section 2.3.7.5).

32

V_0

LEVEL

V_0 MOD GEN: (transmitter test)

Setting and indicating the output level at MOD GEN socket.

A double tone can be generated at MOD GEN socket with the aid of a SPEC function.

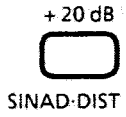
Readout on AF level display.

AF LEVEL: (receiver test)

Calling AF level measurement at AF VOLTM socket.

Readout on AF level display.

33



V_0 MOD + 20 dB: (transmitter test)

The level at MOD GEN socket can be increased by a factor of 10. The original level can be restored by actuating the key again.

Selected key function indicated by bar.

SINAD: (transmitter test)

This key is for calling SINAD measurement at the AF VOLTM input.

Entry of a frequency (numerical value **plus** Hz or kHz) determines the bandstop filter frequency. Normally, the modulation generator frequency is also set to this frequency.

Entry of a unit (% or dB **without** numerical value) determines the unit of display.

Entry of a numerical value with unit (eg 20 dB) triggers the search routine, which varies the RF level of the CMTA until the desired SINAD value is obtained (receiver sensitivity).

Readout of measured SINAD value on AF level display.

Indication of receiver sensitivity on RF level display.

Indication of test frequency for approx. 1 second on AF level display.

Continuous bandstop filter weighting in AF signal section (see special functions section 2.3.8).

34

S/N: (receiver test)

For calling signal-to-noise measurement.

If a numerical value is entered before actuating the S/N key (unit dB), the signal generator output level is varied until the S/N result reaches the preset value.

Readout on AF level display.

35

V_0 OFF: (transmitter/receiver test)

Switching off the modulation generator.

Selected key function indicated by bar.

36

HP RX: (receiver test)

This key is for switching a highpass filter into the AF measuring circuit. By entering a frequency in Hz or kHz, the cutoff frequency of the highpass filter is selected. Selection of the highpass filter frequency may influence the lowpass filter frequency under certain circumstances (see section 2.3.6.3.3). The filter is switched off by entering 0 frequency or by switching a filter into the demodulation circuit.

Indication of filter cutoff frequency for approx. 1 second on AF level display.

Selected key function indicated by bar.

37

LP RX: (receiver test)

This key is for switching a lowpass filter into the AF circuit. By entering a frequency in Hz or kHz,

the cutoff frequency of the lowpass filter is selected. The filter is switched off by entering 0 frequency or switching a filter into the demodulation circuit.

Indication of filter cutoff frequency for approx. 1 second on AF level display.

Selected key function indicated by bar.

38

CCITT

CCITT RX: (receiver test)

This key is for switching a weigthing filter to CCITT filter specification ahead of the AF voltmeter on or off.

Switching a filter into the RX section causes the filter in the TX section to be switched off.

Selected key function indicated by bar.

Fig. 2-5 Numeric field

- Numeric keypad for entry of any numerical values (25 digits max.).
- Control keys, units keys

39

0 ... 9

Numbers 0 to 9

for all inputs

40

* E

Negative sign:

(A number is always positive if the minus sign is not entered)

Input of tone sequences:

*	for DTMF code
E	for all other codes

41

F

Decimal point:

Input of tone sequences:

#	for DTMF code
F	for all other codes

42

MHz mV %

A

Units key:

Frequency	MHz
Level	mV
Modulation	% (AM)
Distortion	%
Code	A

43

kHz µV W

B

Units key:

Frequency	kHz
Level	µV
Modulation	kHz (FM)
Power	W
Code	B

44

Hz dB(µ)V

C

Units key:

Frequency	Hz
Level (AF)	dBV
Level (RF)	dBµV
Modulation	Hz (FM)
Code	C

45

dB dBm rad

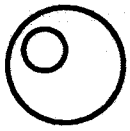
D

Units key:

Level	dBm (50 Ω RF, 600 Ω AF)
Power	dBm
SINAD, S/N	dB
Modulation	rad (φM)
Code	D

46

VAR



Spinwheel:

Any set value can be varied using the tuning knob. The step size can be set as required using the ΔVAR key.

The spinwheel is always assigned to the last setting.

47

LOCAL

LOCAL:

The CMTA can be switched from REMOTE mode back to manual operation using this key.

48

REMOTE

REMOTE:

The CMTA only accepts commands via the IEC bus if the REMOTE LED lights up; the front panel keys, except LOCAL, are disabled.

49

CLEAR

CLEAR:

A command can be aborted using the CLEAR key as long as it is incomplete (terminating key not yet pressed).

Certain functions (such as ANALOG SELECT, ΔVAR, REF) can be switched off by subsequently pressing the CLEAR key.

50

RANGE HOLD

RANGE HOLD:

This key can be used to fix the measuring range of the analog displays to a desired value.

The AUTO RANGE function is then disabled.

51

ANALOG SELECT

ANALOG SELECT:

In conjunction with certain terminating keys (calling measurements), this key enables analog displays to be used independent of the associated digital displays.

Function cleared using:

`ANALOG SELECT  CLEAR  Terminating key`

52

α-DISPL SELECT

α-DISPL SELECT:

In conjunction with certain terminating keys (settings), this key enables the display to be transferred to the α display. The display which has now become free can be used for other measurements or settings.

Function cleared by pressing a key in frequency field which uses the α display.

53

Δ VAR

ΔVAR:

By entering ΔVAR before certain terminating keys (settings), the spinwheel increment is set to the value entered last.

Exception: In the case of frequency settings for AF INT 1 and AF INT 2, a series of fixed frequencies is used as the default step size and not the minimum increment.

The parameter increment can be freely selected by additional entry of a numerical value.

54

REF

REF:

In conjunction with certain terminating keys (settings and measurements), the result (or setting parameter) is displayed relative to a reference value by pressing the REF key. The reference value is either the current value in the display or an entered value.

55

SPEC

SPEC:

Certain functions are combined using this key in conjunction with command numbers (see section 2.3.8).

56

STORE

STORE:

Used to store complete instrument settings (in conjunction with memory numbers) or individual parameters. See section 2.3.10 for particular function with the AUTOTEST function.

57

RECALL

RECALL:

Used to recall stored instrument settings.

Fig. 2-6 Changeover

- Changeover of all settings or of individual fields.

58

XMITTER

XMITTER TEST LED:

Lights up if the CMTA is in transmitter test mode.

59

RECEIVER

RECEIVER TEST LED:

Lights up if the CMTA is in receiver test mode.

60

XMITTER

RECEIVER

TXRX key:

For manual changeover from transmitter test to receiver test and vice versa.

61

LOCK

LOCK LED:

The CMTA remains in the current mode (transmitter or receiver test) irrespective of the entered RF power as long as this LED lights up.

62

LOCK key:

To define the mode (transmitter or receiver test) independent of the applied RF power.

The function is cleared by pressing the key again.

63

DUPLEX LED:

Lighting of this LED means that the Duplex Modulation Meter CMTA-B9 is used as the local oscillator for the transmitter test.

The tester has in this case full duplex capability.

If the LED does not light, the synthesizer of the basic unit is used for the transmitter test.

Generally, results of greater accuracy are obtained (spurious FM, ACP limit).

64

DUPLEX key:

For selecting the Duplex Modulation Meter CMTA-B9 or the synthesizer of the basic unit as the local oscillator for the transmitter test.

65

ACK TEST LED:

Lights up if the ACK TEST (acknowledgement test) function is activated.

66

ACK TEST key:

The CMTA is prepared for measurement of transient data telegrams of the transceiver at the start of each transmission by pressing the ACK TEST key (acknowledgement call test).

(PK HOLD, SET f TX, DECODE and LOCK are automatically activated when switching from RX to TX test.)

67

DISPLAY CHANGE:

This key is used together with the dark grey keys (items ***5, 14, 22, 32***) to change the operating mode of the respective field (transmitter test ↔ receiver test).

Fig. 2-7 AUTOTEST

- All controls for automatic mode are combined in this field (option CMTA-B5).

68

START LED:

Lights as long as a test program is running.

69

START key:

Starting programmed test sequences. A start address must always be entered.

70

CONT:

A program which has been interrupted can be continued by pressing the CONT key.

71

STOP LED:

This LED lights when a test program is interrupted.

72

STOP key:

This key is used to interrupt a test program. The STOP and START LEDs light up simultaneously when the key is actuated once and the program can be further executed using CONT.

The AUTOTEST function is switched off by pressing the STOP key twice. The test program can be recalled using START.

73

PRINT LED:

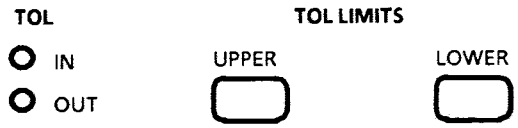
This LED lights as long as data are output to the printer port.

74

PRINT key:

Program listings or test logs can be output on a printer (Centronics interface) using this key.

75 **76** **77**



TOL IN/OUT LED, TOL LIMITS:

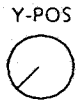
An upper tolerance limit can be set during programming of a test program using the UPPER key and a lower tolerance limit using the LOWER key.

The TOL OUT LED lights if a measured value is outside the defined range, otherwise the TOL IN LED lights.

Fig. 2-8 Connector strip

- This field contains the most important connectors for the device under test and a number of control keys.

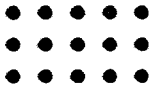
78



Y POSITION:

For shifting the oscilloscope reference line on the graphics display vertically.

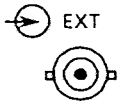
79



Loudspeaker:

For monitoring various AF signals (demodulated signals, BEAT, signals at the AF VOLTM input) depending on the AF counter assignment to the AF signals.

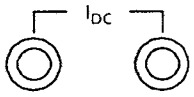
80



INPUT EXT:

AF signal input for display on storage oscilloscope or on AF analyzer or for use as trigger input.

81 82

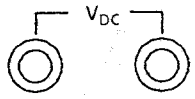


I_{DC}:

Connectors for DC current measurement (50 mΩ impedance).

⚠ *Caution:* Floating measurement!
V ≤ 30 V referred to ground according to specifications in data sheet.

82 83

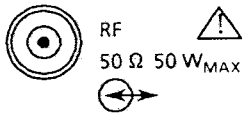


V_{DC}:

Connectors for DC voltage measurement.

⚠ *Caution:* Floating measurement!
V ≤ 30 V referred to ground according to specifications in data sheet.

84



RF IN/OUT:

RF input/output which is usually connected to the antenna connector of the transceiver.

⚠ *Caution:* Danger! Very high power may cause destruction. Observe specifications in data sheet.

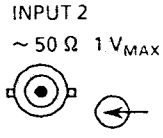
85

INPUT SELECT:

Selection of required input (RF IN/OUT ↔ INPUT 2).

The selected input is displayed by the LED next to the INPUT SELECT key.

86



INPUT 2:

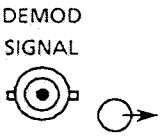
Second RF input for low input powers (especially for remote measurements).

87

NARROW:

Switching a narrowband IF filter into the demodulation circuit to increase the selectivity (indicated by the LED above the key).

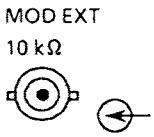
88



DEMOD SIGNAL:

Output for the demodulated AF signal.

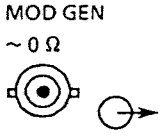
89



MOD EXT:

Input for external modulation signals.

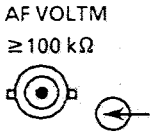
90



MOD GEN:

Output of the AF generator.

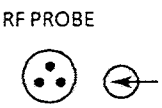
91



AF VOLTM:

The level, distortion and S/N ratio of an AF signal connected to this input are analyzed. The frequency of the input signal can also be measured.

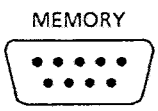
92



RF PROBE:

Connector for the various RF millivoltmeter probes (option CM-B8).

93



MEMORY:

Connector for "Transfer memory" (CM-Z1); accessory used to transfer test programs between various CMTAs.

94

VOLUME:

Volume control

95

STANDBY

ON

STANDBY key:

The instrument is switched on and off by pressing the STANDBY key.

Important note: The STANDBY key is not for disconnecting the instrument from the power supply.

96

STANDBY

STANDBY LED:

The LED lights if the complete instrument is switched off except for the crystal reference (STANDBY mode).

Fig. 2-9 Graphics unit

(model 54)

- For spectral display of test signals or display in time domain.

97

Graphic display:

Display of RF spectrum.

Display of various AF signal in time domain or spectrum.

The horizontal and vertical scales are displayed on the screen.

100

SOFTKEY

CHANGE

SOFTKEY CHANGE:

If more than five softkey functions are required in one menu item, further functions can be recalled by actuating this key and the softkey labelling at the lower screen edge be varied. The original five functions are restored by actuating the key again.

101 102 103 104 105

Softkeys:

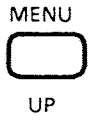
The function of these keys changes according to the device status (menu operation). The valid function is indicated at the lower screen edge.

106

MENU HOME:

Key for returning to menu origin.

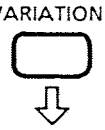
107



MENU UP:

Key for changing to next higher menu level.

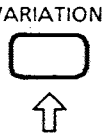
108



VARIATION DOWN:

Selected parameters can be varied in steps down.

109



VARIATION UP:

Selected parameters can be varied in steps up.

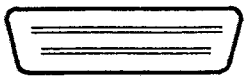
2.1.2 Rear Panel

(See Fig. 2.10 in Appendix)

Fig. 2-10 ***Rear panel***

- Connectors for power supply, printer (option CMTA-B5), IEC/IEEE bus
- Control outputs of CMTA

111



Printer output: (Centronics, parallel)

(Only if option CMTA-B5 is fitted)

112

IEC/IEEE-bus connector

113

Ground:

Reference for sockets ***115, 117, 119***

115

X deflection:

For hardcopy output, an X-proportional voltage (-2.5 V < V <2.5 V) can be obtained here.

For oscilloscope or spectrum display, a time- or frequency-proportional voltage can be derived here.

117

Y deflection:

For hardcopy output, an Y-proportional voltage (-2.5 V < V <2.5 V) can be obtained here.

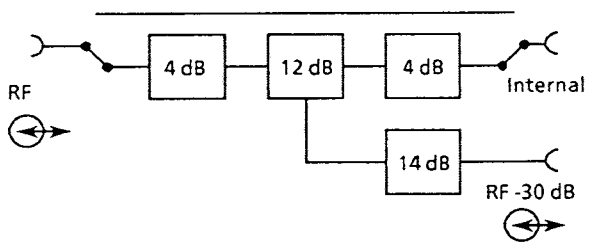
119

PEN LIFT:

For hardcopy output, the PEN LIFT signal can be derived here with positive or negative polarity.

120

Bidirectional RF connector for other measuring instruments, such as 2nd signal generator. The block diagram below shows the interconnection between the three ports:



If used as input:
P ≤ 0.1 W

121

INTENSITY

Intensity control

for graphic display.

122

FOCUS

Focus control

for graphic display.

123

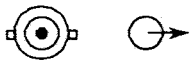
Blower:

Since in addition to the heat dissipation of the CMTA, the output power of the transceiver must also be converted into heat, sufficient cooling of the CMTA must be provided. The air flow along the rear panel, through the louvres at the sides and behind the blower must be ensured at all times.

124

The 10-MHz reference signal for synchronizing further instruments can be obtained here or fed in from an external source (input/output can be controlled via SPEC function: level >100 mV, max. TTL levels).

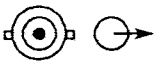
125



10 MHz OUT:

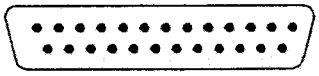
The internal 10-MHz reference signal or the external reference signal fed in via socket ***124*** can be obtained from this socket for further use.

126



High potential (TTL levels) at this socket indicates that an RF signal with sufficent level for transmitter/receiver test switchover is present at RF socket ***84***.

127



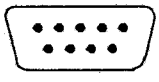
CONTROL B

8 programmable control outputs

All switches are floating (relays) with a max. switchable power of 25 V/0.25 A.

If required, the make contact can be replaced by a changeover contact.

128



CONTROL A

3 programmable control outputs (only if option CMTA-B5 is fitted).

Design same as of ***127***.

129

Power fuse:

The fuse to be inserted depends on the local AC supply:

T 4 A for 100/120 V
T 2 A for 220/240 V

130

47...420 Hz

AC supply connector

Important note: This connector is for disconnecting the instrument from the power supply. Therefore it must be easily accessible at all times.

131

Voltage selector:

100/120 V
220/240 V

For setting to local AC supply voltage.

2.2 Preparations for Use

The CMTA can be connected to any power supply with protective earth and a voltage of 100 V, 120 V, 220 V or 240 V (rated values ± 10%) at 50 to 440 Hz. The power consumption of the basic model is approx. 150 VA.

Fuses required:

T4A for 100 V/120 V
T2A for 220 V/240 V

Note:

Before connecting the instrument to the power supply, make sure that it is set to the correct supply voltage and that the correct fuse is inserted.

To change the factory-set value, the required voltage must be set on selector ***131*** and the power fuse ***129*** replaced.

After connection to the power supply, the instrument is in STANDBY or ON mode acc. to the position of the STANDBY switch ***95***. This has the advantage that the frequency accuracy and stability of the reference crystal remains unaffected by frequent switching on and off.

The CMTA is switched on and off by actuating the STANDBY key.

Note:

Even in STANDBY mode, certain parts of the instruments are operative (temperature-controlled oscillator); for complete switchoff, the instrument must be disconnected from the power supply (connector 130). Therefore the AC supply connector must be easily accessible at all times.

2.3 Operating Instructions

The terms used in this section and in the following sections for the controls and displays largely correspond to the labelling on the front panel. Certain designations which would not be clearly enough emphasized in the text (no coloured printing) have been replaced by the terms defined in section 2.1.

2.3.1 General Operating Instructions

2.3.1.1 Switch-on Status, Permanent Memory and Master Reset

After connection to the power supply and with the STANDBY switch ***95*** actuated the instrument is in STANDBY mode and the STANDBY LED ***96*** lights; the reference crystal is already now in operation.

The complete instrument is switched on if the STANDBY key ***95*** is actuated.

All front-panel displays (LEDs and LCD segments) are switched on for testing for the first half of the self-test routine which the instrument carries out during each switch-on phase. All displays are switched off again after approx. 1 second.

Continuation of the self-test is signalled in the α display ***2*** and the IEC/IEEE-bus address is output in the frequency display ***1***.

The CMTA outputs "CMTA OK" in the α display ***2*** if the self-test has been completed without faults and the display illumination is switched on. The CMTA then assumes one of the following defined switch-on states:

- **Operating mode: transmitter test**

Demodulation: FM

Results / setting parameters in the displays:

Frequency display *1*	Output frequency of device under test (if the input signal is sufficiently strong, the RF frequency meter sets the operating frequency of the fully automatic modulation meter)
α display *2*	Frequency of the modulation generator
RF level display *12, 13*	RF power of device under test
Modulation display *20, 21*	Modulation meter The type of modulation is defined by the unit in this field (kHz for FM, % for AM, rad for φM)
AF level display *30*	Output level of the modulation generator

- **Operating mode: receiver test**

Results / setting parameters in the displays:

Frequency display *1*	Output frequency of RF signal generator
α display *2*	Frequency of modulation generator 1
RF level display *12*	Output level of RF signal generator
RF level display *13*	Position of the electronic level control in the attenuator of the RF signal generator (see also sections 2.3.1.5, 2.3.4.2)
Modulation display *20*	Modulation of the RF signal generator. The type of modulation is determined by the unit in this field (kHz for FM)
AF level display *30, 31*	AF level at AF VOLTM socket *91*

In order to ensure clear operation, the display assignment is fixed as described in the switch-on status.

All setting parameters such as generator level, frequencies or modulation are not affected by switching off and on, however (memory with battery back-up).

In order to reestablish the condition upon delivery, it is also possible to carry out a master reset (99 SPEC, see also section 2.3.8).

Complete instrument settings can be stored using STORE *56* and recalled using RECALL *57* (see section 2.3.7.7).

- Instrument PRESET (also via autorun control and IEC/IEEE bus)

  Function: 95 SPEC

  The presetting of the CMTA instrument functions corresponds to the factory setting (cf. 99 SPEC):

- Switching on of the appropriate measurements
- Switching on of all default special functions
- Front-panel settings
  (e.g. INPUT SELECT key *85* → selection of RF input *84*)

As opposed to master reset,

- IEC/IEEE bus (remote/local, address)
- autorun control (LEARN mode, RUN mode, etc.)
- user-specific standard-tone sequences USER0 to USER2, "double-SPEC" values,
  e.g. 30 SPEC <value> SPEC

remain uninfluenced in the instrument PRESET mode (95 SPEC).

2.3.1.2 Transmitter Test / Receiver Test

The CMTA has two main operating modes, the transmitter test and the receiver test.

The set mode is indicated by the XMITTER TEST LED *58* or RECEIVER TEST LED *59*. In addition, red or green LEDs *4* in the frequency, RF level, modulation and AF level fields indicate the operating mode of the respective field independent of the complete instrument.

Switching between the receiver and transmitter tests can be carried out in two ways:

- Press key TXRX *60*
- Apply an RF signal of sufficient power to RF connector *84*

The CMTA automatically switches back to the receiver test if the applied RF power falls below a certain level.

The automatic switchover can be suppressed by actuating the LOCK key ***62***. As long as the LOCK LED ***61*** lights, the operating mode can only be changed using the TXRX key ***60***.

The LOCK function is cancelled by pressing the LOCK key ***62*** again.

If it is necessary in practice to display or call a function associated with the opposite mode (especially with duplex radio sets), each of the four fields can be switched over individually using the DISPLAY CHANGE key ***67***.

Command syntax:

DISPLAY CHANGE COUNT f/f	(frequency field)
DISPLAY CHANGE POWER/V_0 SYNTH	(RF level field)
DISPLAY CHANGE MAX PK/INT 1	(modulation field)
DISPLAY CHANGE V_0 MOD GEN/AF LEVEL	(AF level field)

2.3.1.3 General Syntax Rules for Entries

The CMTA is controlled manually using the front panel keyboard by combining various keys (= command). A command may consist of up to 4 syntax elements:

Numerical value Unit Special function Terminating key

- **Terminating key**

The instrument evaluates all previous inputs as soon as the terminating key has been pressed and executes the command. All keys are terminating keys except the numeric keys, unit keys and the special functions (RANGE HOLD ***50***, ANALOG SELECT ***51***, α DISPL SELECT ***52***, ΔVAR ***53***, REF ***54*** and DISPLAY CHANGE ***67***).

- **Special function**

Special functions such as RANGE HOLD 50, ΔVAR ***53*** and REF ***54*** must be entered immediately before the respective terminating key. No numerical inputs are permissible with the special functions ANALOG SELECT ***51***, α DISPL SELECT 52 and DISPLAY CHANGE ***67***. Only one special function is permissible per command.

- **Numerical value/unit:**

Setting values may be a numerical value, a unit or a combination of both and must always be entered first.

Incomplete commands can be aborted at any point using the CLEAR key ***49***.

The following command is used to switch off the special functions RANGE HOLD, ANALOG SELECT, ΔVAR and REF:

```
Special function  CLEAR  Terminating key
```

Single-element commands:

- **Terminating key**

The associated measurement is called by pressing the terminating key assigned to a measurement.

A terminating key which refers to settings causes the current setting to be displayed.

In the case of toggle keys such as POLARITY SELECT ***23*** or DEMOD·BEAT ***9***, repeated pressing of the same key switches between the various functions.

This toggle function is switched off with longer commands (two-element, three-element and four-element commands).

Examples:

V_0 MOD GEN ***32***

Setting value of modulation generator level is displayed and set.

Repeated pressing does not lead to any further reaction.

POLARITY SELECT ***23***

Calling modulation measurement, the positive peak modulation is displayed.

Repeated pressing switches between positive, average and negative peak modulation.

Two-element commands:

- **Unit / terminating key**

If output of a measuring/setting parameter is meaningful in different units (e.g. power in dBm or W), the unit to be displayed can be selected as required by entering the unit before the terminating key.

It should be noted that changing a unit with key ***22*** (MAX PK in transmitter test or INT 1 in receiver test) switches the operating mode of the CMTA (FM, ΦM, AM) and the units of POLARITY SELECT ***23*** and INT 2 ***23*** are also changed.

Example:

`dBm POWER`

Display of RF power in dBm

- **Numerical value / terminating key**

Numerical values are entered using the numeric keypad ***39*** (including the decimal point ***41*** and the minus sign ***40***).

Leading zeros before the decimal point need not be entered.

The nearest possible value is set and displayed if the value entered cannot be set (e.g. with output levels of the RF synthesizer whose minimum increment is 0.1 dB).

Inputs without a minus sign are always evaluated as positive numbers. Repeated input of the minus sign also results in a negative value.

$$- - \Rightarrow - \text{ (not +)}$$

The unit can be obtained from the display (or memory).

Example:

(Unit from display or memory: µV)

`10.0 V0 SYNTH`

Synthesizer level is set to 10.0 µV.

- **Special function / terminating key**

Special functions must always be entered last before the terminating key.

Example:

`RANGE HOLD AF LEVEL`

The analog value in the AF level display is fixed to the current measurement range.

Three-element commands:

- **Numerical value / unit / terminating key**

The additional input of a unit is useful when changing the unit or if a value is entered for the first time which has not yet been displayed (unit is only in the memory).

Examples:

`10.0 µV V0 SYNTH`

Synthesizer level is set to 10.0 µV even if the value in the RF level display is in dBm.

`1.25 kHz INT1`

The synthesizer is modulated with a deviation of 1.25 kHz and the CMTA is in FM mode independent of the previous status.

- **Numerical value / special function / terminating key**

The entered number refers to the special function in this case (e.g. RANGE HOLD).

The unit can be obtained from the display (or memory).

Example:

Measured value in display: 3.05% (distortion)

`10 RANGE HOLD SINAD·DIST`

The measurement range is defined at 10% full-scale.

- **Special function / CLEAR / terminating key**

The special functions

RANGE HOLD	***50***
ANALOG SELECT	***51***
ΔVAR	***53***
REF	***54***

can be cancelled using the CLEAR key ***49***. The associated values (e.g. 20 kHz for ΔVAR SET f TX) remain unaffected.

Four-element commands:

- **Numerical value / unit / Special function / terminating key**

The numerical value and the unit refer here to the special function.

Input of the unit has the same effect as with the two-element and three-element commands, i.e. measured values are displayed in the new unit, and the operating mode of the CMTA is also switched over (FM, ϕM or AM).

Example:

Current unit for power measurement: dBm

```
1   W   RANGE HOLD   POWER
```

The measurement range of the power measurement is fixed at 1 W, the display is also in W.

2.3.1.4 Variation of SettingValues

The setting values are mainly varied using the spinwheel.The spinwheel ***46*** is always assigned to the setting parameter displayed last by pressing a key (identified by the symbol "VAR" next to the associated display). The value is increased by rotating the wheel clockwise and decreased by rotating counterclockwise.

Any increment can be entered using the ΔVAR key ***53*** (special function) which remains unchanged until the next input independent of whether the instrument is switched on and off.

Example:

```
10   µV   ΔVAR   V0 SYNTH
```

The RF synthesizer level is increased or decreased in 10-µV steps if the resolution of the 3-digit RF level display is less than the entered 10 µV.

As soon as the 10-µV steps can no longer be output in the display (10.00 mV, 10.01 mV, 10.02 mV etc.), the variation is made with the smallest step value which can be displayed (in this case with 100-µV steps: 10.1 mV, 10.2 mV, 10.3 mV etc.).

It is possible to return to the minimum step level by entering `ΔVAR CLEAR Terminating key .`

The smallest possible step is set for each value when the instrument leaves the factory and after a master reset.

If a continuous variation is not required, any required value can of course be set by direct input (including any possible unit).

Special cases:

- **Modulation generator frequency**

It is often useful to set the frequency of the modulation generator in a standard tone sequence,

e.g. upon delivery:
0.3/0.6/1/1.25/2.7/3/6/10 kHz

The tuning steps of the modulation generator frequency therefore always correspond to this frequency sequence unless a different increment has been requested using the ΔVAR key ***53***.

Examples:

```
100   Hz   ΔVAR   AF INT1
```

The frequency is set in steps of 100 Hz.

```
ΔVAR   CLEAR   AF INT1
```

The frequency can be varied again in the standard tone sequence following the command.

- **Graphic display**

(See section 2.3.9)

2.3.1.5 Display of Measured Values/ Setting Values

The display of the individual measured/setting parameters can be divided into four groups:

- **Frequencies**

All used frequencies are represented on the frequency display ***1*** and on the α display ***2***. The resolution of the RF counter is 1 Hz or 10 Hz; MHz is the selected unit.

The resolution is 10 Hz or 100 Hz depending on the frequency range used if the operating frequency of the CMTA (function SET f TX, SET f RX) is output in the frequency display ***1***; the unit can be selected as required using the unit keys (Hz, kHz, MHz).

The AF counter is output in the α display ***2*** (max. 10 digits, right-justified) with the unit kHz and a resolution of 0.1 Hz (AF < 4 kHz) or 1 Hz (AF > 4"kHz, via SPEC or also 0.1 Hz selectable with 10-s gate time).

The AF settings are displayed in kHz or Hz (depending on the input) with the maximum resolution which can be achieved in each case.

- **Outputs on the α display**

In addition to AF outputs, the α display ***2*** is used to output all instrument messages (ready message, error messages) in English and to alternately output the measured/setting values from the other displays.

The code of the respective measured/setting parameter (corresponding to the front panel designation), the unit and the numerical value (3 (4) digit) appear at the start of the line if the α display ***2*** is used as an alternate display.

- **Display of setting values:**
  Frequency, RF level, modulation and AF level

Setting values are output in the 3 $^1/_2$-digit display, the associated analog display on the right remains switched off (unless used for other purposes, see ANALOG SELECT, section 2.3.7.5).

The entered unit is used in the display provided a value of 100 (unit e.g. Hz) is not exceeded. The instrument otherwise converts the value into a suitable format.

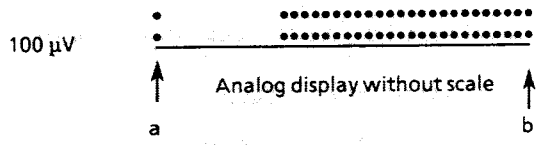
Example:

1200 Hz ⇒ display = 1.20 kHz

Special case V_0 SYNTH:

V_0 SYNTH is the only setting value which uses the analog display. A continuous attenuator and a stepped attenuator are used to vary the level of the signal generator. A brief drop in the output level of the RF signal generator cannot be avoided at the switchover points. The position of the continuous attenuator is therefore output in the analog display (bar display from right to left corresponding to 0 to 20 dB attenuation). The attenuator switches over if the bar reaches the end points of the analog display (with AM: center ≙ 10-dB attenuation) (important with squelch measurements).

Example:



A brief drop in the RF level must be expected at points a and b.

- **Display of results:**
  Frequency, RF level, modulation and AF level

Results are always output simultaneously in the digital and analog displays, the unit in between applies to both displays. If the RANGE HOLD function is not switched on, the scale and thus the display range of the analog display changes continuously in steps of 1/2.5/5 according to the measured value (AUTO RANGE with 15 ranges).

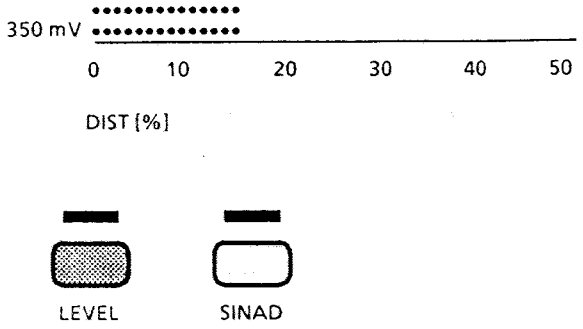
Note:

If the magnitude of the displayed value is greater than 100, the scale 0 to 25 (corresponding to 0 to 250) or 0 to 50 (corresponding to 0 to 500) or 0 to 100 (corresponding to 0 to 1000) is used.

- **Two measured values in one display**

If an analog display is set for a fixed measured value using the ANALOG SELECT key ***51*** (only permissible for certain parameters, see section 2.3.7.5), the second measured/setting value of the same display is only output in the digital diplay with the associated unit.The unit and code of the measured value in the analog display are additionally output underneath the bargraph.

Example:



2.3.2 Connection Between CMTA and Device Under Test

(See Figs. 2-11 and 2-12)

All connections between the CMTA and the device under test are made via the connectors on the front panel (Fig. 2-8).

At least three connections are necessary:

Connection 1:

- **Bidirectional RF connection between antenna connector of the transceiver and RF connector *84* of the CMTA**

⚠ ***Caution:*** Danger! Very high power may cause destruction. Observe specifications in data sheet.

The CMTA automatically switches to the transmitter test mode if an RF signal >0.5 W is applied to this connector. The power, frequency, spectral purity (adjacent channel power measurement) and maximum modulation (positive, negative and average modulation peaks) of the applied signal can be examined.

Connection 3 must also be made if the CMTA modulation signal is to be externally applied to the transmitter, e.g. to measure the transmitter modulation distortion (DIST key ***25***).

The CMTA switches back to the receiver test mode if the RF power drops. The RF test signal is then applied to the receiver via this connection. All necessary receiver measurements are possible via connection 2 if the signal generator has been correctly set to the receiver frequency of the transceiver.

Only this input/output must be used with duplex radio sets and the receiver test mode (also for reasons of RF power compatibility), in the case of transmitters with a lower power (e.g. radiotelephone) or coupling of the CMTA to a transmitter via antenna (telemetry) it may be more favourable to use the more sensitive input (INPUT 2 ***86***). RF power measurements are not possible in this case.

- When the RF input INPUT 2 ***86*** is used, the 20-dB attenuator at the CMTA input can be switched on and off by means of

```
20  SPEC / 21  SPEC  .
```

When the RF input ***84*** is used, this is done automatically according to the result of the RF power measurement.

The automatic 20-dB attenuation can be switched off by means of

```
19  SPEC  (automatic 20-dB attenuation off)
```

The settings

```
20  SPEC  (20-dB attenuation on)
21  SPEC  (20-dB attenuation off)
```

can then be performed even when the RF input ***84*** is used.

The automatic 20-dB attenuation can be switched on again by means of

```
18  SPEC  (automatic 20-dB attenuation on
(default)).
```

Connection 2:

- **AF output signal of transceiver to AF voltmeter (AF VOLTM connector *91*) of the CMTA**

The level of any AF signal, even weighted by various filters, can be measured at this connector.

The receiver sensitivity (keys SINAD *33*, S/N *34*) and the receiver distortion (DIST key *33*) can only be measured if connection 1 is present.

Other connections:

- **Measurement of various RF levels in the device under test**

RF levels from 1 mV to 100 V (depending on probe) in the frequency range from 10 kHz to 2000 MHz can be measured via various probes at RF PROBE connector *92* if the RF millivoltmeter option (CM-B8) is fitted.

Connection 3:

- **Modulation signal of CMTA (MOD GEN connector *90*) to microphone input of transceiver**

A defined modulation signal must be applied to the microphone input of the transceiver in order to measure the modulation sensitivity and the transmitter modulation distortion via this connection.

- **Measurement of operating current and voltage**

Connectors *81* to *83* are provided for measuring the operating current and voltage of the transceiver. Normally, the current is applied to the transceiver via connectors *81* and *82* while connector *83* is at ground potential.

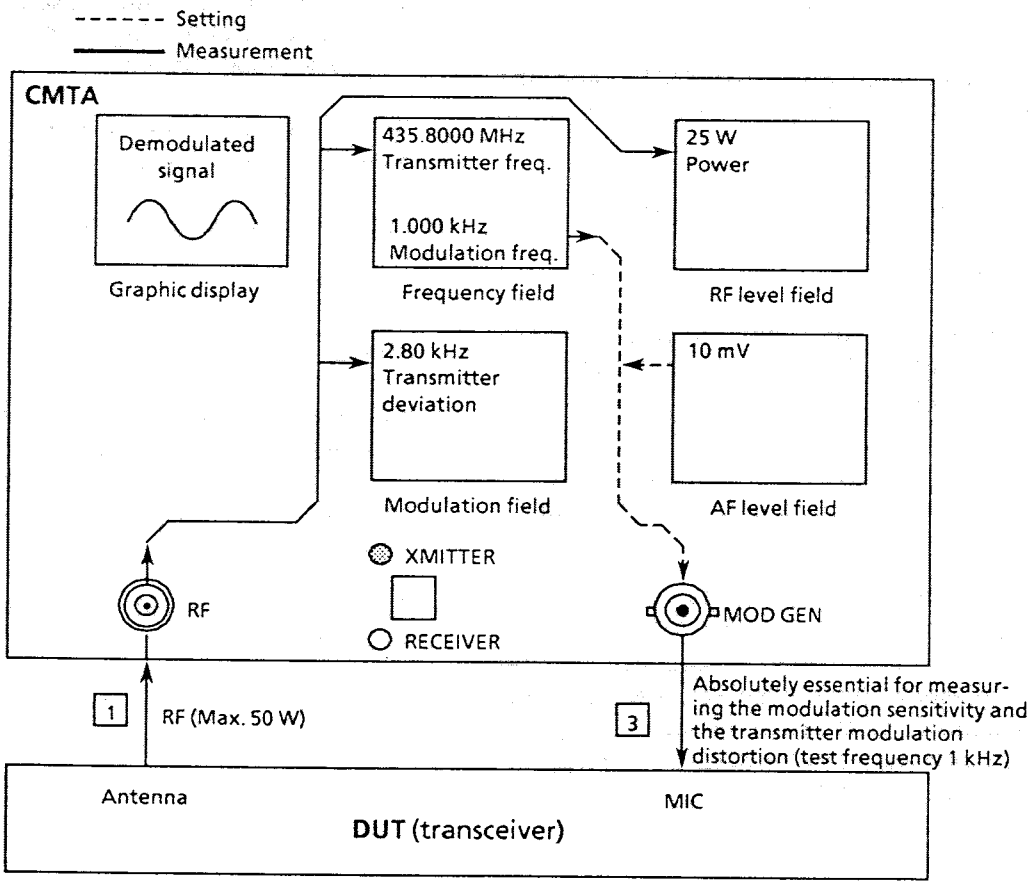


Fig. 2-11 Transmitter test

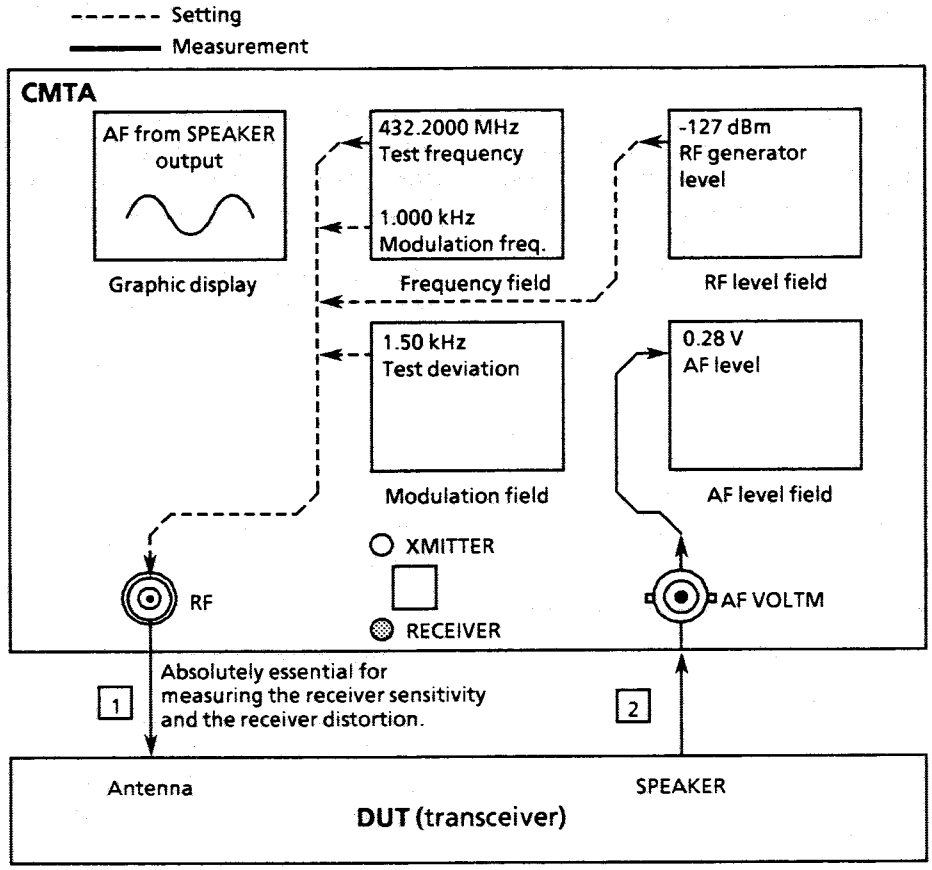


Fig. 2-12 Receiver test

2.3.3 Frequencies

All frequencies are input and output in the frequency field (Fig. 2-1).

2.3.3.1 RF Frequency Counter

The RF counter is switched on when the instrument is switched on for the first time or when the COUNT f key ***5*** is pressed. It processes input signals between 0.4 MHz and 1000 MHz if the level is high enough (min. 5 mV at RF INPUT 2 ***86*** or 5 mW at RF connector ***84***) and outputs the result in frequency display ***1*** with a resolution of 10 Hz.

0.00000 MHz appears in the display if the level is too small or if no signal is present.

In addition to the frequency measurement, the counter correctly sets the operating frequency of the fully automatic modulation meter in the transmitter test mode. This operating frequency is therefore undefined at a count of 0.00000 MHz.

The gate time is 100 ms up to a frequency of 400 MHz and 400 ms at higher frequencies (4:1 prescaler). The controller carries out the switchover fully automatically.

The gate time can be increased to ten times this value using C 20 SPEC in order to switch the resolution of the results from 10 Hz to 1 Hz.

BEAT and ACP measurements are not possible in this mode.

If the 2nd attenuator is selected via the special funtions 200 SPEC ...203 SPEC RF frequency count is not possible!

2.3.3.2 Operating Frequency in Transmitter Test Mode

The operating frequency can also be entered directly if the level is too low to permit correct operation of the RF counter or if there are other reasons (e.g. telemetry) why automatic operation of the modulation meter is not possible.

Example:

`145.8 MHz SET f TX`

The RF counter is switched off and the local oscillator is set according to the entered frequency; the oscillator frequency is calculated as follows:

Entered frequency	Modulation measurement	BEAT measurement
f_{in} <3.65 MHz	$f_{osc} = f_{in} + 455$ kHz	$f_{osc} = f_{in}$
f_{in} >3.65 MHz	$f_{osc} = f_{in} - 455$ kHz	$f_{osc} = f_{in}$

The IF offset of 455 kHz is automatically taken into account by the controller and the entered operating frequency is always displayed.

Example:

Frequency from the RF counter or set by hand:	438.95 MHz
Displayed frequency:	438.9500 MHz
Frequency of local oscillator:	438.4950 MHz

2.3.3.3 Operating Frequency in Receiver Test Mode

The synthesizer output frequency must always be entered manually using the SET f RX key **5** since the receiver frequency of the transceiver cannot be automatically determined.

The displayed frequency then always corresponds to the frequency of the output signal.

Example:

`153.3 MHz SET f RX`

The frequency of the generator signal is 153.3 MHz.

- **Frequency transfer function:**

This function permits the RF frequency measured or set in the transmitter test to be transferred into the receiver test. The duplex spacing, if required, may be taken into account as well.

Each time the operating frequency of the transmitter test is set (SET f TX or COUNT), the new frequency is automatically stored. When switching from transmitter test to receiver test (manually or automatically), the value stored last is modified according to the duplex spacing entered (`C 52 SPEC`) and the resulting operating frequency of the receiver test is automatically set (SET f RX).

The duplex spacing between transmit and receive frequency is entered via `C 52 SPEC <Dup.-Δf> (kHz) SPEC`. Positive values result in a receive frequency of the transceiver that lies above the transmit frequency, negative values produce one that lies below.
The values range from -99999.99 kHz to 0 to +99999.99 kHz.

This function is switched on via `C 50 SPEC`

and off via `C 51 SPEC`

2.3.3.4 Operation Without Duplex Modulation Meter

The RF synthesizer is used as the local oscillator in the transmitter test as well as the RF signal generator in the receiver test if the duplex modulation meter (option CMTA-B9) is not fitted or has not been activated by the DUPL key ***64***.

The frequency is automatically switched over depending on SET f RX, SET f TX or COUNT f when a change is made from transmitter test to receiver test or vice versa.

The frequency of the RF synthesizer remains unchanged, however, if the mode of the frequency field is changed individually using the DISPLAY CHANGE key ***67***.

The message "Add-b9" appears in the frequency display ***1*** with the functions SET f RX and SET f TX to indicate this special case.

SET f TX or SET f RX can still be used after switching over the frequency display ***1*** and the oscillator frequency is correspondingly adjusted when these keys are pressed.

Examples:

Operating mode: receiver test
Signal generator frequency: 145.2 MHz

An operating frequency of 145.8 MHz was previously set in the transmitter test mode.

`DISPLAY CHANGE COUNT f ⇒ frequency field in the transmitter test`

COUNT f is switched on:

The frequency of an RF signal is measured, the signal generator frequency (145.2 MHz) remains unaffected.

SET f TX is switched on:

The message "Add-b9" appears in the frequency display.

The signal generator frequency is set to 145.8 MHz if the key SET f TX is now pressed.

Since the frequency may no longer agree with the receive frequency, the relevant measurements (SINAD, S/N etc.) can no longer be made.

Operating mode: transmitter test
Operating frequency: 145.8 MHz

A signal generator frequency of 438.5 MHz was previously set in the receiver test mode.

`DISPLAY CHANGE SET f RX ⇒ frequency field in the receiver test`

The message "Add-b9" appears in the frequency display, the transmitter test frequency (145.8 MHz) remains unaffected, the modulation meter continues to operate at the set frequency.

The frequency is set to 438.5 MHz and displayed if the SET f RX key is pressed.

2.3.3.5 AF Frequency Counter

The counter operates on the principle of period measurements (0.1 Hz resolution) in the range from 10 Hz to 4 kHz. It has therefore been possible to reduce the time per measuring cycle to a minimum (< 100 ms at 1 kHz) despite the high accuracy of 0.1 Hz.

The counter can be switched to gate-time frequency counting (measuring cycle 1 s, resolution 1 Hz) using `C 10 SPEC` to achieve greater insensitivity to noise pulses in this frequency range. A return to period measurement is made using `C 11 SPEC` .

The principle of gate time frequency counting is always used for frequencies > 4 kHz.

The resolution of the gate time frequency measurement can be increased from 1 Hz (measuring cycle > 1 s) to 0.1 Hz (measuring cycle > 10 s) in the complete frequency range using `C 12 SPEC` .

The AF counter can be operated from three different sources:

DEMOD	Measurement of the demodulated AF frequency
BEAT	Measurement of the difference between the set operating frequency and the RF input signal frequency
AF EXT	Measurement of the AF at AF VOLT connector

DEMOD measurements are only meaningful if the transmitter test operating frequency is correctly set which is usually the case when using COUNT f.

On the other hand, BEAT measurements can only be called if a transmitter test operating frequency has previously been set using SET f TX.

Independent of any other settings, the measurement AF EXT is always available for analysis of the signals applied to the AF VOLTM connector ***91***.

Note:

The graphic display 97 and the monitoring loudspeaker 79 are automatically operated from the same source if the AF counter is switched on.

The graphic display and the loudspeaker can only be operated as desired using the three available sources (selection using softkeys 101 to 105) if the counter has been switched off by pressing AF INT 1, AF INT 2 or Δf.

2.3.3.6 AF Generator Settings

The CMTA possesses two AF generators whose frequency can be set in the range from 20 Hz to 30 kHz using the keys AF INT 1 ***10*** and AF INT 2 ***11***.

Variation with the spinwheel ***46*** takes place according to a standard tone sequence with 8 frequencies which can be defined as required:

Factory setting:

1st tone	0.3	kHz
2nd tone	0.6	kHz
3rd tone	1.0	kHz
4th tone	1.25	kHz
5th tone	2.7	kHz
6th tone	3.0	kHz
7th tone	6.0	kHz
8th tone	10.0	kHz

These frequencies can be reprogrammed as required at any time using the key SPEC ***55*** (see section 2.3.8).

Furthermore, a continuous variation with any increments is possible using the ΔVAR key ***53***.

Examples:

`1 kHz AF INT 1`

- Modulation generator 1 is set to 1 kHz.
- Variation using spinwheel in standard tone sequence.

`0 ΔVAR AF INT 1`

- Variation with smallest possible resolution (0.1, 1 or 10 Hz)

`ΔVAR CLEAR AF INT 1`

- Variation in standard tone sequence

`ΔVAR AF INT 1`

- Variation with smallest possible step size

`500 Hz ΔVAR AF INT 1`

- Variation now in 500-Hz steps

`ΔVAR CLEAR AF INT 1`

- Variation in standard tone sequence again

The generated AF signal is available directly at MOD GEN connector ***90*** or internally for modulation of the RF signal generator (INT 1).

The modulation generators can be switched off completely by entering `0 AF INT 1` or `0 AF INT 2` independent of the settings V_0 MOD GEN and INT 1.

Important with CODE:

Since the level settings by V_0 MOD GEN and INT 1 refer to the data telegram when using CODE, muting of the generator before and after transmission of a tone sequence can only be achieved using `0 AF INT 1` .

The 2nd AF generator is operated in the same way using the AF INT 2 key ***11*** except that the signal of this AF generator is not usually available at MOD GEN connector ***90*** but is primarily used to modulate the synthesizer.

The signal of the 2nd AF generator can be added to the signal of the first using 122 SPEC if a two-tone signal is required at this connector (see section 2.3.6.1).

2.3.3.7 CODE/DECODE

The CMTA can transmit and receive single-tone sequences to all common standards.

The different tone sequence standards are selected using

C 110 SPEC CODE and DECODE (if possible)
C 111 SPEC DECODE only

where the different standard codes are represented by the following numbers:

Fixed single-tone sequences

Code number (No)	
00	ZVEI 1 (default after master reset)
01	ZVEI 2
02	CCIR
03	CCIR 70 ms
04	EEA
05	EIA
06	VDEW
07	EURO
08	CCITT
09	NATEL
10	reserved
11	reserved

Fixed double-tone sequences

Code number (No)	
15	DTMF (DECODE)
16	VDEW direct dialling (DECODE)
17	reserved
18	reserved
19	reserved

Freely programmable tone sequences (single tones)

Code number (No)	
20	USER 0
21	USER 1

Freely programmable double-tone sequence

Code number (No)	
22	USER 2

2.3.3.7.1 Selection of a Particular Code

It is possible to select a standard (Active Code) from the fixed codes and the freely programmable codes USER 0 to USER 2 using C 110 SPEC <No> SPEC ($0 \leq No \leq 22$). In the case of single-tone sequences, this Active Code applies to both CODE and DECODE.

Example:

Set standard: No = 2 (CCIR)

Input: C 110 SPEC 5 SPEC

New standard: No = 5 (EIA)

Following selection of the CODE/DECODE tone-sequence standard using C 110 SPEC <No> SPEC , another standard can be selected for CODE reception (DECODE) only using C 111 SPEC <No> SPEC (0 ≤ No ≤ 22). The selected standard is retained for the tone sequencer. Using these two SPEC functions, the standards selected can also be displayed:

Input	α display	Remark
C 110 SPEC SPEC	C110 * 5 ----	(5 = EIA)
C 111 SPEC SPEC	C111 * 4 ----	(4 = EEA)

2.3.3.7.2 CODE Transmission

If Active Code is loaded with the desired code via C 110 SPEC <No> SPEC , a selective call can be sent by entering the call number and pressing the CODE key ***8***. The call number is displayed in the α display ***2*** and remains stored until the next input so that the call can be repeated as often as desired by pressing the CODE key ***8***.

If the tone sequence is to be sent as a burst, the modulation generators 1 and 2 can be switched off using 0 AF INT 1 and 0 AF INT 2 .

The modulation setting of the signal generator is not internally checked. The 1st AF generator and with DTMF also the 2nd AF generator should therefore be set to standard deviation before pressing the CODE key ***8***. The selective call is also sent at the MOD GEN connector ***90*** with automatic switchover to double tone.

Example:

Input	α display	Remark
345705509 CODE	345705509	This selective call is sent simultaneously.
CODE	345705509	(call number entered last) This call is sent simultaneously.

The sent tones can be varied with regard to frequency and tone duration using the following SPEC functions:

C 160 SPEC <t(ms)> SPEC

Duration of first tone in ms
(10 ms ≤ t ≤ 5000 ms)

C 161 SPEC <t(ms)> SPEC

Duration of following tones in ms
(10 ms ≤ t ≤ 5000 ms)

C 162 SPEC <t(ms)> SPEC

Pause duration in ms
(t = 0 and 10 ms ≤ t ≤ 5000 ms)

C 163 SPEC <Δf(%)> SPEC

Frequency deviation of the sent tones from the nominal frequency in %
(-10 % to + 10 %)

These SPEC functions always refer to the standard code selected using C 110 SPEC .

With each new call of C 110 SPEC , the parameters tone duration of 1st tone, tone duration of all following tones, pause duration and frequency deviation are cancelled again by the default values of the selected standard.

Examples:

a)

C 110 SPEC 2 SPEC

CCIR standard is selected

The telegram 12345 is sent as follows:
Each tone is 100 ms long, no pauses, all tone frequencies correspond to the respective nominal frequencies.

b)

Input	α display	Remark
C 160 SPEC 500 SPEC	C160 * 100 ms	Duration of 1st tone: 100ms now: 500 ms
C 161 SPEC 80 SPEC	C161 * 100 ms	Tone duration: 100ms now: 80 ms

The telegram 12345 is sent as follows:
Tone 1 is 500 ms long, tones 2, 3, 4, 5 are 80 ms each, no pauses, all tone frequencies correspond to the respective nominal frequencies.

c)

Input	α display	Remark
C 162 SPEC 50 SPEC	C162 * 0 ms	Pause duration: 0 ms now: 50 ms
C 163 SPEC -4 SPEC	C163 * 0 PERC	Tone duration: ±0 % now: -4 %

The telegram 12345 is sent as follows:

1 500 ms long, frequency 4 % bel. nom. freq.
P 50 ms pause

2 80 ms long, frequency 4 % bel. nom. freq.
P 50 ms pause

3 80 ms long, frequency 4 % bel. nom. freq.
P 50 ms pause

4 80 ms long, frequency 4 % bel. nom. freq.
P 50 ms pause

5 80 ms long, frequency 4 % bel. nom. freq.

Input: C 110 SPEC 2 SPEC

CCIR standard is reloaded, the changes produced by C 160 SPEC to C 163 SPEC are cancelled.

2.3.3.7.3 CODE Reception

By pressing the DECODE key ***8***, the selective-call decoder is switched on and its readiness to receive signals indicated in the α display ***2*** by the message "DECODE". Provided that the tone is applied constantly for more than 30 ms, the signal which is demodulated or applied to the AF VOLTM connector ***91*** is assigned to a code number of the standard sequence defined by C 110 SPEC / C 111 SPEC and subsequently output using the code numbers 0 to 9 and A to F.

Pauses (50 ms <pause <100 ms) are marked in the display by means of "P", tones not in line with the standard are handled as errors and marked by an "X".

Since the decoding only starts when the first valid tone has arrived, faulty tones can only be marked within a tone sequence.

If automatic repeat is switched on (section 2.3.3.7.4), E (repeat tone) is not displayed, but the previous code number is displayed twice instead.

Pauses longer than 100 ms cause the tone sequence evaluation to be aborted. The tones received until then are output in the α display ***2***.

Further pressing of the DECODE key ***8*** clears the call number in the α display ***2*** and reactivates the tone-sequence decoder.

Example:

C 111 SPEC 2 SPEC

Tone sequence to CCIR standard is selected

DECODE

Tone-sequence decoder waits for reception of a selective call (max. 1 min.).
Output in the α display: *DECODE*

The transceiver sends 123E3 567 (frequency outside the standard) 9ABC.

100 ms after reception of the last tone, the call number can be read on the α display ***2*** as follows:
1 2 3 3 3 P 5 6 7 X 9 A B C

If a continuous tone remains applied after the last call number, decoding is only aborted after 250 measurements. The associated wait time is about: $t_w = 1300 \times (1/f)$

t_w = wait time until decoding is aborted (s)
f = frequency of continuous tone (Hz)

e.g.: $f_{cont.tone} = 310$ Hz ⇒ t_w = approx. 4.2 s
$f_{cont.tone} = 4$ kHz ⇒ t_w = approx. 330 ms

- **Reducing the decoding time:**

Enter: C 180 SPEC <t (ms)> SPEC

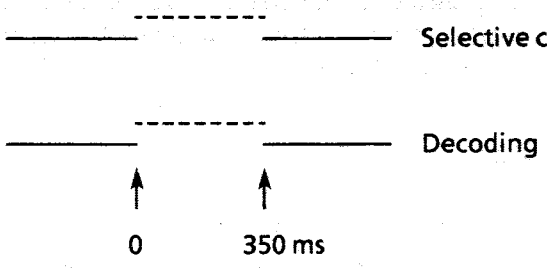
This special function can be used to reduce the decoding time following the arrival of the first valid tone to t (10 ms <t<10000 ms). Thus the call is evaluated and displayed after max. t ms.

For t = 10000 ms (e.g. after 99 SPEC or master reset), this function is switched off.

Example:

A five-digit telegram (each tone 70 ms) is expected.

When C 180 SPEC 350 SPEC is entered (≙ 350 ms total duration), the end of decoding coincides exactly with the end of the last tone.



Advantage of this operating mode:

After the selective call has been started, the CMTA will again be able to execute autorun control commands (or IEC/IEEE-bus commands) at a defined point in time and thus respond faster (useful for NATEL).

Accuracy:

± 10 ms after detection of the first tone.

The detection of the first tone may be delayed by up to 12 periods (AF frequency/1st tone).

- **Extension of permissible pauses between two tones or telegrams (selective-call decoder)**

The detection of the end of telegram is delayed in order to bridge possible pauses between the tones. After switching on the instrument, the maximum permissible pause is set to approx. 100 ms (no AF signal during the pause).

The delay time can be adjusted in three stages:

C 173 SPEC

Decoding aborted approx. 100 ms (single tones) or 800 ms (double tones) after last tone (default after switching on)

C 174 SPEC

Decoding aborted approx. 400 ms (single tones) or 800 ms (double tones) after last tone

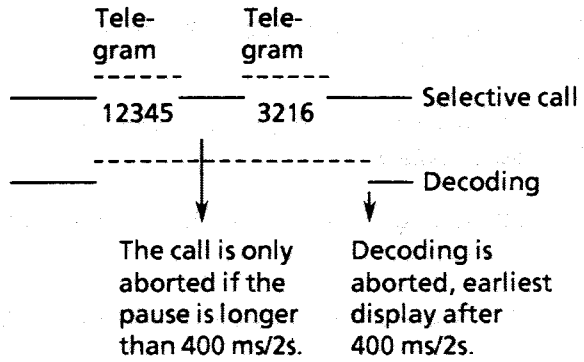
C 181 SPEC

Decoding aborted approx. 2 s after last tone.

It is thus possible to simultaneously display several telegrams arriving in quick succession (pause <400 ms/2s).

Example:

C 174 SPEC Pause<400 ms
C 181 SPEC Pause<2 s



Readout on α display: 1 2 3 4 5 P 3 2 1 6

Extension of the maximum permissible pauses can also be employed in combination with limitation of the decoding time (C 180 SPEC <t(ms)> SPEC).

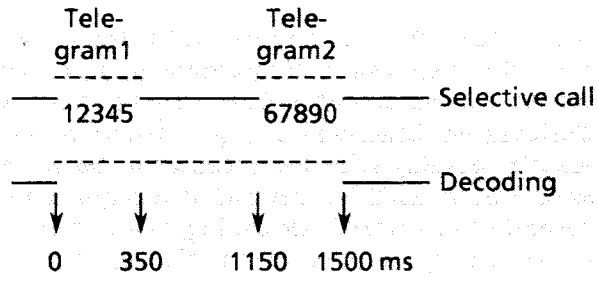
Example:

Two five-tone sequences with a pause of 800 ms are to be decoded. At the end of the last tone, the CMTA (autorun control, IEC/IEEE bus) is to respond immediately. The duration of a tone is 70 ms.

Total decoding time
= (2 x 5 x 70 ms) + 800 ms = 1500 ms

Enter:

C 180 SPEC 1500 SPEC
C 181 SPEC Pause >400 ms



Readout on α display: 1 2 3 4 5 P 6 7 8 9 0

- **Source selection of the decoder:**

Although, in general, the demodulated signal is fed to the tone-sequence decoder, the signal applied to the AF VOLTM connector ***91*** can also be used for testing:

`C 171 SPEC` Signal at the AF VOLTM connector is evaluated.

`C 170 SPEC` DEMOD signal is evaluated (default following switch-on).

Note:

Switching between the signal sources has also effect on the graphic display in internal mode, i.e., with the decoder switched on, only the internal signal which is also fed to the decoder can be displayed on the screen. This means that the source for the graphic display can no longer be selected freely under these circumstances. Similar to the source selection for the single-tone decoder, which influences the graphic display, the source selection for the DTMF decoder also influences the signal for the filters. If the DTMF coder is used for the DEMOD signal, the filters can also only be used for the DEMOD signal and not for the AF signal (and vice versa).

Frequency tolerances:

The single-tone decoder (code numbers 0 to 9 and 20, 21), detects only the tones whose frequency falls within the tolerance window of the nominal value. This tolerance is ±2% after switching on and master reset, but can be easily changed using the command `C 172 SPEC <fTol. (%)> SPEC` (0,5 % < fTol. < 10 %).

The DTMF decoder enables decoding of DTMF signals. With double tones, the dynamic range ensuring correct evaluation is smaller than with single tones. Therefore, depending on the selected source and the type of modulation, preamplification of the signal is matched to the current conditions.

- **VDEW direct dialling:**

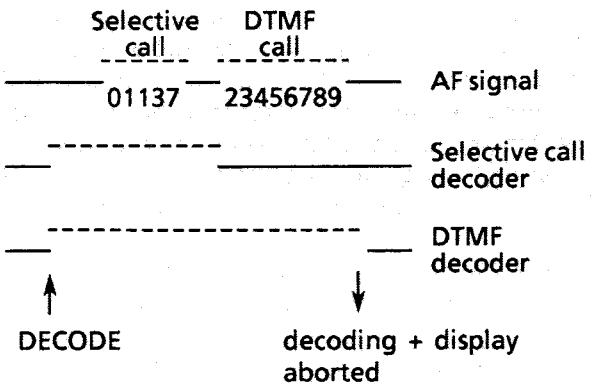
(5-tone sequence to ZVEI1, then DTMF signalling)

Code number 16 is provided for the signalling of VDEW direct dialling:

`C 111 SPEC 16 SPEC`
(16 ≙ VDEW decoding)

Selective-call decoder and DTMF decoder are simultaneously started when pressing the DECODE key ***8*** (selective call standard = ZVEI1). The selective-call decoder is immediately switched off by the first incoming DTMF tone. After the last DTMF tone, the results of the selective-call decoder and the DTMF decoder are combined (a hyphen is used as separator) and indicated on the alphanumeric display ***2***.

Example:



Readout on α display (and test report or IEC/IEEE bus): 01137-23456789

The tone combination 697 Hz/1633 Hz (= 'A'in the CMTA) is used as a separator in the VDEW direct dialling system. Therefore, the facility to suppress the display of separators is provided.

C	190	SPEC	The separators are also displayed.
C	191	SPEC	The display of separators is suppressed. (Default, only with VDEW signalling, code number 16 effective)

2.3.3.7.4 Automatic Repeat

If the repeat tone (E) is to be used automatically for CODE transmission of two identical successive tones, the automatic repeat facility must be switched on. Otherwise, a single tone with over-length (possibly with short pauses in between) would be transmitted instead of a sequence of several call numbers. For testing, this automatic repeat facility can be switched off using C 151 SPEC .

To switch it on again, C 150 SPEC is entered.

Example:

Selective call:
111233

Automatic repeat on:
1E123E is sent

Auomatic repeat off:
1 (triple-tone duration)
2
3 (double-tone duration)

During DECODE, with automatic repeat switched off, the repeat tone (E) is directly displayed; otherwise, the last sent tone is doubled.

Example:

Received telegram:
1E2E345E5E

Automatic repeat on:
1122345555 displayed

Automatic repeat off:
1E2E345E5E displayed

2.3.3.7.5 Frequency Tables of Fixed Tone-sequence Standards

All frequencies are given in Hz.

Code Tone dur. Pause	ZVEI 1 70 ms 0 ms	ZVEI 2 70 ms 0 ms	CCIR 100 ms 0 ms	CCIR 70 ms 0 ms	EEA 40 ms 0 ms	EIA 33 ms 0 ms	VDEW 100 ms 0 ms	EURO 100 ms 0 ms	CCITT 100 ms 0 ms	NATEL 70 ms 0 ms	Code Tone dur. Pause	DTMF 70 ms 0 ms	
Number											Number	Tone 1	Tone 2
0	2400.0	2200.0	1981.0	1981.0	1981.0	600.0	2280.0	979.8	400.0	1633.0	0	941.0	1336.0
1	1060.0	970.0	1124.0	1124.0	1124.0	741.0	370.0	903.1	697.0	631.0	1	697.0	1209.0
2	1160.0	1060.0	1197.0	1197.0	1197.0	882.0	450.0	832.5	770.0	697.0	2	697.0	1336.0
3	1270.0	1160.0	1275.0	1275.0	1275.0	1023.0	550.0	767.4	852.0	770.0	3	697.0	1477.0
4	1400.0	1270.0	1358.0	1358.0	1358.0	1164.0	675.0	707.4	941.0	852.0	4	770.0	1209.0
5	1530.0	1400.0	1446.0	1446.0	1446.0	1305.0	825.0	652.0	1209.0	941.0	5	770.0	1336.0
6	1670.0	1530.0	1540.0	1540.0	1540.0	1446.0	1010.0	601.0	1335.0	1040.0	6	770.0	1477.0
7	1830.0	1670.0	1640.0	1640.0	1640.0	1587.0	1240.0	554.0	1477.0	1209.0	7	852.0	1209.0
8	2000.0	1830.0	1747.0	1747.0	1747.0	1728.0	1520.0	510.7	1633.0	1336.0	8	852.0	1336.0
9	2200.0	2000.0	1860.0	1860.0	1860.0	1869.0	1860.0	470.8	1800.0	1477.0	9	852.0	1477.0
10 (A)	2799.9	2599.9	2400.0	2400.0	1055.0	2151.0	2000.0	433.9	1900.0	1633.0	10 (A)	697.0	1633.0
11 (B)	810.0	2799.9	930.0	930.0	930.0	2432.9	2100.0	400.0	2000.0	600.0	11 (B)	770.0	1633.0
12 (C)	970.0	810.0	2246.9	2246.9	2246.9	2010.1	2200.0	368.7	2100.0	1995.0	12 (C)	852.0	1633.0
13 (D)	886.0	886.0	991.0	991.0	991.0	2292.0	2300.0	1153.1	2200.0	2205.0	13 (D)	941.0	1633.0
14 (E)	2599.9	2400.0	2110.0	2110.0	2110.0	459.0	2400.0	1062.9	2300.0	1805.0	14 (*)	941.0	1209.0
15 (F)	0	0	0	0	0	0	0	339.9	0	0	15 (#)	941.0	1477.0

2.3.3.7.6 Programming the User Codes USER 0 to USER 2

Following master reset, the standard tone sequences USER 0 and USER 1 are loaded according to ZVEI1, USER 2 is loaded according to DTMF. There are two ways of programming special tone sequences:

a) Setting all tone sequence parameters individually

Each user code has the following individual parameters:

16 × tone frequency (tones 0 to F)
16 × 2nd tone frequency
(only with two-tone sequences, USER 2)
1 × tone duration of the first sent tone
1 × tone duration of the following tones
1 × pause duration

For USER 0 to USER 2, these parameters can be varied at any time by means of the following SPEC functions:

C 500 SPEC to C 599 SPEC (USER 0)
C 600 SPEC to C 699 SPEC (USER 1)
C 700 SPEC to C 799 SPEC (USER 2)

Each of the 16 different tones can be assigned a frequency in the range from 310 Hz to 4 kHz in any sequence desired using

C 5xx SPEC <f(Hz)> SPEC (USER 0)
C 6xx SPEC <f(Hz)> SPEC (USER 1)
C 7xx SPEC <f(Hz)> SPEC (USER 2)

(310 Hz <f <4 kHz and f = 0 kHz). xx corresponds to one of the tones as shown in the following table:

xx	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tone	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Example:

USER 0 is to be loaded (first digit: 5)

Tone	Input	Call No.	Frequency
0	C 500 SPEC 3150 SPEC	0	≙ 3.15 kHz
1	C 501 SPEC 1200 SPEC	1	≙ 1.2 kHz
5	C 505 SPEC 800 SPEC	5	≙ 800 Hz
B	C 511 SPEC 960 SPEC	B	≙ 960 Hz
F	C 515 SPEC 3400 SPEC	F	≙ 3.4 kHz

In the case of USER 2, it is additionally required to enter the frequency of the second tone generator (double tone) using C 720 SPEC to C 735 SPEC <f (Hz)> SPEC for the different tones (see table).

xx	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Tone	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Example:

Key 0 is to be assigned two frequencies:

C 700 SPEC 340 SPEC
Frequency of generator 1: 340 Hz

C 720 SPEC 2300 SPEC
Frequency of generator 2: 2.3 kHz

The other parameters of USER 0 to USER 2 can be checked and set using similar SPEC functions.

Tone duration of the first sent tone:

C 560 SPEC <t(ms)> SPEC (USER 0)
C 660 SPEC <t(ms)> SPEC (USER 1)
C 760 SPEC <t(ms)> SPEC (USER 2)
(10 ms ≤ t ≤ 5000 ms)

Tone duration of all following tones:

C 561 SPEC <t(ms)> SPEC (USER 0)
C 661 SPEC <t(ms)> SPEC (USER 1)
C 761 SPEC <t(ms)> SPEC (USER 2)
(10 ms ≤ t ≤ 5000 ms)

Pause duration:

C 562 SPEC <t(ms)> SPEC (USER 0)
C 662 SPEC <t(ms)> SPEC (USER 1)
C 762 SPEC <t(ms)> SPEC (USER 2)
(10 ms ≤ t ≤ 5000 ms and t = 0 ms)

b) Setting all parameters according to a standard tone sequence

If the special code differs from a fixed standard tone sequence in a few parameters only, the latter can be loaded into USER 0 to USER 2 (two-tone sequences only into USER 2). All that remains to be entered then are the variations as indicated under a).

The parameters frequency, tone duration of 1st tone, tone duration of the following tones and pause duration are defined as required using the following SPEC functions:

C 100 SPEC <No> SPEC (No = 0 to 11) USER 0

C 101 SPEC <No> SPEC (No = 0 to 11) USER 1

C 102 SPEC <No> SPEC (No = 15 to 19) USER 2

Variation of these tone sequences has an effect only when the code is loaded into Active Code using C 110 / 111 SPEC <No> SPEC .

Example:

Loading USER 0

Definition of frequency:

C 500 SPEC <f(Hz)> SPEC to
C 515 SPEC <f(Hz)> SPEC

Tone duration:

C 560 SPEC 500 SPEC
Tone duration of 1st tone: 500 ms

C 561 SPEC 100 SPEC
Tone duration of the following tones: 100 ms

C 562 SPEC 0 SPEC
No pauses.

This standard tone sequence determined by the user is available at any time until a further variation is made, but does not act directly on the current setting, even if USER 0 is loaded in Active Code. Only following C 110 SPEC 21 SPEC do the changed parameters take effect. These relationships are shown in detail in Fig. 2-13.

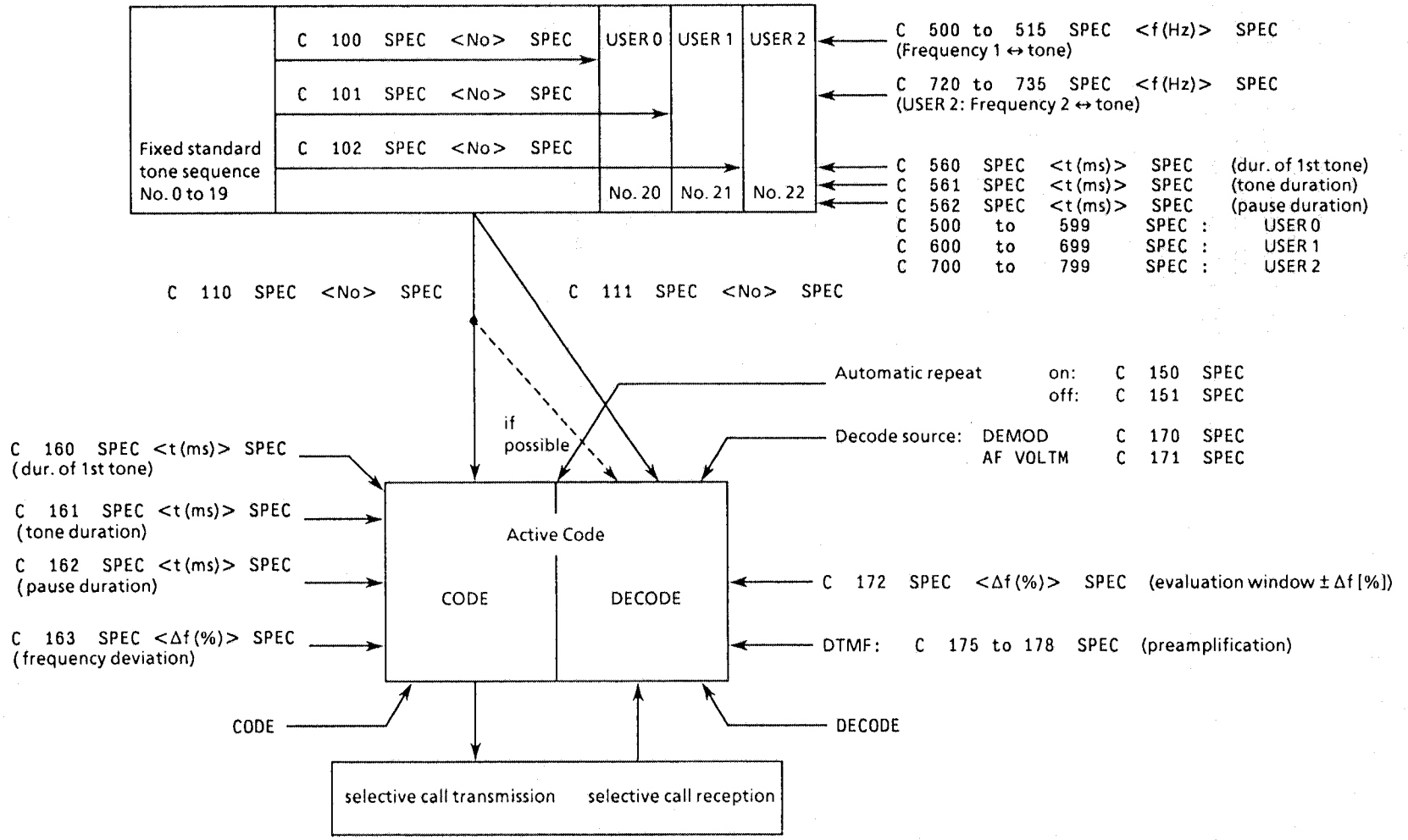


Fig. 2-13 Relationships and control of CODE/DECODE

2.3.3.7.7 Measurements on Transceivers with Acknowledgement Call

The acknowledgement call test is carried out as follows:

a) Set the expected transmit frequency of the transceiver in the transmitter test, e.g.:

`148.33 MHz SET f TX`

b) Switch over to receiver test and switch on the acknowledgement call test function (ACK TEST)

`TXRX`
`ACK TEST` (ACK TEST LED lights up)

c) Call the transceiver by sending the selective call, e.g.:

`12345 CODE`

After sending the last tone (5), the CMTA automatically switches over from receiver to transmitter test if ACK TEST is activated. Furthermore, the following preparations for reception of the transceiver reply are made:

- Set the transmitter test operating frequency (SET f TX) to be able to demodulate as fast as possible.
- Switch on the PK HOLD function to store the maximum deviation or modulation depth of the transmission.
- Switch on the tone sequence evaluation (DECODE).
- Switch on the LOCK function to prevent the CMTA from returning to the receiver test mode if the RF power decreases after reception of the transceiver reply.

2.3.4 RF Power / RF Level

All RF level measurements and settings are made in the RF level field (Fig. 2-2).

2.3.4.1 RF Power Measurements

RF power measurements are called when the instrument is switched on or when the POWER key ***14*** is pressed. All levels in the range from 1 mW to 50 W (0 to 47 dBm) are measured at high accuracy and simultaneously output in digital and analog form in the displays ***12*** and ***13***.

⚠ ***Caution:*** Danger! Very high power may cause destruction. Observe specifications in data sheet.

A linear or logarithmic representation according to the following relationship can be selected using the commands `W POWER` and `dBm POWER` :

$P\,[dBm] = 10 \log (P\,[mW]/1\,[mW])$

Since the power display 0.00 W corresponds to a level of -∞ dBm, the display "Negative overflow" appears with the logarithmic scale if the input signal is missing (-1 in the digital display ***12*** and full analog bar in display ***13***).

The test diode of the power meter can be removed from the circuit using `28 SPEC` in order to prevent RF distortion at the RF connector - 30 dB ***120***. Power measurements are then no longer possible (identified by three dashes in the digital display ***12***). The function is switched on again using `29 SPEC` .

An attenuating element of 0 to 40 dB connected to RF connector ***84*** can be taken into account during power measurements. The attenuation value is entered using the SPEC function `30 SPEC <Attenuation value (dB)> SPEC` .

The basic status is restored by entering `30 SPEC 0 SPEC` .

If required, temperature influences on small RF levels can be largely compensated using an offset adjustment.

The RF connector ***84*** must be terminated with 50 Ω in this case (an RF power must not be present) and the key sequence `1 D SPEC` entered. The offset voltage of the equipment measured in this way is stored and taken into account during the following power measurements.

If the RF input is thermally overloaded, the messages "OVERHEAT" and "REMOVE RF-POWER" are alternately output on the α display **2**. In this case, immediately switch off the RF power source and make sure that sufficient ventilation is provided (ventilating louvres on the rear of the instrument). When the message "OK, TEMP NORMAL" appears, the measurement can be continued where interrupted.

If the 2nd attenuator is selected via the special functions 200 SPEC... 203 SPEC instead of the controlled RF amplifier RF frequency is not possible. Power measurements are less accurate since correction of the frequency responses is not carried out.

2.3.4.2 RF Synthesizer Output Level

The built-in RF synthesizer provides signals between 0.032 µV (-137 dBm, -30 dBµV) and 1 V (+13 dBm, +120 dBµV), but the maximum level is limited to 0.5 V (+7 dBm) in AM mode.

The RF synthesizer level is reduced to a maximum of 1 mV (-47 dBm) by switching from receiver test to transmitter test or applying an RF signal >0.5 W.

The synthesizer level is doubled (= +6.02 dB) by pressing the key V_0 SYNTH. +6 dB ***15*** and the acknowledgement appears above this key.

Adjustments and variations can still be carried out as usual and the current synthesizer level is always halved by pressing the key V_0 SYNTH. +6 dB again and the key acknowledgement is switched off. The maximum level is set if the limit is exceeded by pressing this key; half of this voltage is obtained if the key is pressed again.

The key V_0 OFF ***16*** can be used to switch the synthesizer level off and on again (toggle key) in both transmitter and receiver tests. The minimum level is 0.032 µV (-137 dBm, -30 dBµV).

The mechanical attenuation set is activated if the synthesizer output level is changed using the keys V_0 SYNTH. ***14***, V_0 SYNTH. +6 dB ***15*** and V_0 OFF ***16***; short interruptions in the output level are possible at the switchover points.

The function 30 SPEC <attenuation (dB)> SPEC also produces an effect on the synthesizer output level, i.e. the actually set level is increased by the value of the attenuator connected ahead and the maximum level is reduced correspondingly.

If negative attenuation values (0 to -40 dB) are entered (corresponds to preamplification), the actually set synthesizer level is reduced by this value. This can be used e.g. for representing the RF level in EMF.

Example:

```
30  SPEC  -6.02  SPEC                    (gain 6 dB)
 1  µV  V0 SYNTH
```

RF level setting: 0.5 μV_{RMS} = 1 μV_{EMF}
Readout: 1 µV

If the level is reduced using the tuning knob ***46***, 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 ≙ -10 dB).

If the level is increased using the tuning knob ***46***, 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 (voltage or power) are correct for a terminating resistor of 50 Ω. The actual output voltage is always displayed, the EMF has double this value.

The synthesizer output level can be displayed in µV, mV or dBµV, dBm.

The conversion is carried out using the following equations:

$U\,[dB\mu V] = 20 \log (U\,[\mu V] / 1\,\mu V)$
$P\,[dBm] = 20 \log (U\,[mV] / 223.6\,mV)$

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:

$P\,(load) = P\,(display) * 4s / (1 + s)^2$

Note:

Frequent level variations in automatic test systems might reduce the life utility of the attenuator. It is therefore recommended to carry out the level settings in few steps only, using the electronic level variation if possible.

2.3.4.3 Measurement of PROBE and DC

2.3.4.3.1 PROBE Measurement

The RF millivoltmeter is switched on using the PROBE key ***19*** provided the CMTA is fitted with the CM-B8 option, otherwise an error message is output in the α display ***2***.

If the probe measurement is switched off in the receiver test by pressing keys ***14*** and ***15***, power measurement is 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).

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)

2.3.4.3.2 Measurement of DC voltage and current

⚠ ***Caution:*** Floating measurement!
V ≤ 30 V referred to ground according to specifications in data sheet.

- The DC voltage measurement is initiated by pressing the V_{DC} key The voltage between the V_{DC} sockets. ***82, 83*** is displayed in the RF level field with the right polarity.
- By pressing the I_{DC} key the power measurement is initiated. The current is determined using a shunt of 50 mΩ between the I_{DC} sockets ***81, 82*** and displayed in the RF level field.

2.3.4.4 Adjacent-Channel Power Measurements (ACP)

The adjacent-channel power meter is switched on by pressing the ACP key ***15*** if the CMT-B6 option is fitted, otherwise an error message is output in the α display ***2***.

The centre frequency of the useful channel is determined by entering SET f TX ***6***, the channel spacing by Δf 7.

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 ***1***.

Any channel spacing can be entered using 140 SPEC (cancel using 141 SPEC) and the test bandwidth is set to 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 ***15***.

The following inputs are permissible:

-2 ACP

Noise power
two channels
below useful channel ..... f = fo -2 Δ f

-1 ACP

Noise power
in lower useful channel ..... f = fo -Δ f

1 ACP

Noise power
in upper useful channel ..... f = fo + Δ f
(default)

2 ACP

Noise power
two channels
above useful channel ..... f = fo +2 Δ f

The adjacent-channel power (µW, mW or W) is output following the instruction W ACP , provided the measurement at the RF input ***84*** is performed with at least 0 dBm in the useful channel.

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

Combined inputs -1 dB ACP 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 CMTA-B9 (Duplex Modulation Meter) is fitted or activated using the DUPL key ***64*** 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 Voltmeter

2.3.4.5.1 General Information

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

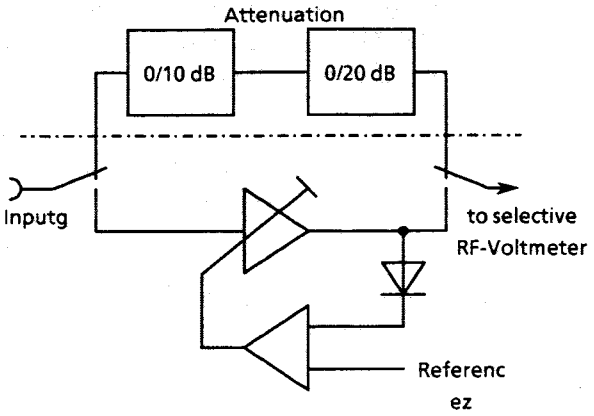
Example:

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 the INPUT SELECT key ***85***.

There are two different applications of the selective RF voltmeter:



CMTA models with graphics unit comprise all features shown in the picture above. CMTA models without graphics unit, however, are only equipped with the lower part. The upper part allows for absolute, selective RF-level measurements without calibration. The lower part allows for highly sensitive RF-level measurements, however, only relative measurements or with reference to a calibration voltage.

The type of application is selected by special functions:

200 SPEC: absolute measurement with 0 dB attenuation,
max. level approx. 0.05 W or 15.8 mV

201 SPEC: absolute measurement with 10 dB attenuation,
max. level approx. 0.5 W or 50 mV

202 SPEC: absolute measurement with 20 dB attenuation,
max. level 5 W or 158 mV

203 SPEC: absolute measurement with 30 dB attenuation,
max. level approx. 50 W or 0.5 V

Note: ***The selective measurement by 200...203 SPEC allows for RF-harmonic measurements; dynamic range of 60 dB, if used efficiently. (The high-pass filters CM-Z11 to CM-Z13 may be used for increasing the dynmaic range!)***

204 SPEC: Relative measurement via the controlled RF amplifier.

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

RF : ≙ 50 µV to 500 mV
INPUT 2: ≙ 0.5 µV to 5 mV

There are two different applications of the selective RF voltmeter:
Can be extended up to 50 W using external attenuators!The sensitivity is frequency-dependent to a small degree, i.e. if the test frequency is varied by more than 10 MHz, the voltmeter should be recalibrated.

If the option CMTA-B9 (Duplex Modulation Meter) is fitted and activated using the DUPL key ***84***, make sure that, when measuring via the RF socket ***84***, the signal generator of the CMTA does not operate with a high level at the test frequency of the voltmeter, since this would falsify the result, i.e. SET f TX should be equal to SET f RX.

Note:

Harmonic measurements via the controlled RF amplifier (204 SPEC) 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 (21 SPEC)
- Only if RF socket ***84*** is used:
  19 SPEC (Switch off automatic control of internal attenuator according to the power applied).
- Enter appropriate RF frequency
- Switch on voltmeter (0 ACP)
- Apply signal with test frequency and known amplitude to the selected input (RF 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 20 SPEC (internal attenuator on).
  If this is not sufficient, an additional external attenuation facility must be provided (Δatt.)
- The key sequence 144 SPEC <power (dBm)> SPEC can be used to enter on the CMTA the RF power (in dBm) to which the currently measured voltage corresponds e.g.

  144 SPEC 13.5 SPEC (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 also in the subsequent measurement results.

When the input of the CMTA is changed (via INPUT SELECT ***85***), the measurement result obtained is either 40 dB too low (calibration at INPUT ***2***, measurement at RF) or too high (calibration at RF, 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 RF input
- Switch off internal 20-dB attenuator first (21 SPEC)
- Switch off automatic control of internal attenuator according to the power applied (19 SPEC)
- Enter appropriate RF frequency.
- Switch on voltmeter (0 ACP)
- Apply signal with test frequency to the selected input (RF or INPUT 2 in combination with RF, 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 20 SPEC (internal attenuator on).
  If this is not sufficient, the external attenuation of the CMTA must be increased at the input.
- By means of 145 SPEC , the RF power measured at the RF socket is defined as reference level.

If the power applied to the RF socket is smaller than 0 dBm when 145 SPEC is called, the user is prompted to increase the RF power by means of "INC. RF POWER".

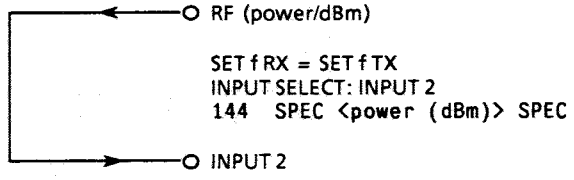
When the input of the CMTA is changed (via INPUT SELECT ***85***), the measurement result obtained is either 40 dB too low (calibration at INPUT 2, measurement at RF) or too high (calibration at RF, measurement at INPUT 2) owing to the difference in sensitivity between the two inputs.

2.3.4.5.4 Calibration Sources

When using 145 SPEC , 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 144 SPEC , a calibrated RF signal in the range 50 µV to 5 mV is all that is needed.

If the option CMTA-B9 (Duplex Modulation Meter) is fitted and activated with DUPL key ***64***, 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 ***12*** is suppressed, and three dashes 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 CMTA indicates the lacking reference value by reading out the request >>CALIBRATE<< on the alphanumeric display ***2***.

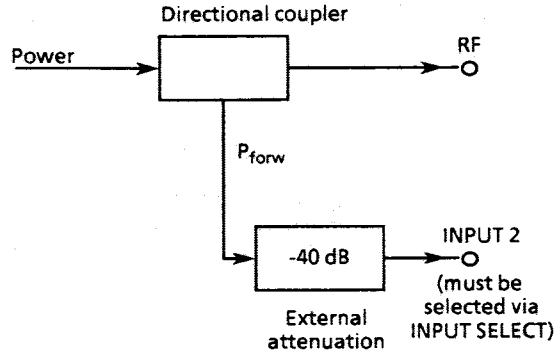
The input of 144 SPEC <power (dBm)> SPEC or 145 SPEC , respectively, causes the measurement result to be immediately read out on the alphanumeric display ***12***.

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

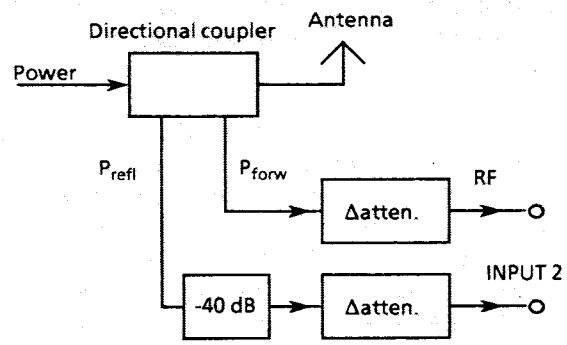
Calibration:

- Enter appropriate RF frequency.
- Switch on voltmeter (0 ACP).
- Apply maximum 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 ***85***, 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 signal generator modulation are combined in the modulation field (Fig. 2-3).

If the adjacent-channel power meter (option CMT-B6) is fitted, inherent spurious signals at the transmitter test operating frequency of 800 MHz may occur at low RF input levels.

2.3.5.1 Modulation Selection

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

```
%     MAX PK/INT 1   → AM
kHz   MAX PK/INT 1   → FM
Hz    MAX PK/INT 1   → FM
rad   MAX PK/INT 1   → ϕM
```

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

```
50    %    INT 1  → AM, 50 %
                    modulation depth
 1    kHz  INT 1  → FM, 1 kHz deviation
2.5   rad  INT 1  → ϕM, 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
ΔVAR value
ΔVAR memory on/off
Display unit (Hz/kHz)

MAX PK, + PK, + -/2PK, -PK:
REF value
RANGE 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 if the RF synthesizer is modulated by an external source (MOD EXT connector ***89***).

Possible combinations with double modulation:

INTERNAL	EXTERNAL
FM/ϕM	AM
AM	FM/ϕM

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

Mode: transmitter test, FM

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

Mode: transmitter test, AM

kHz EXT	→ FM with FM deviation stored last
1 kHz EXT	→ 1 kHz deviation via external modulation source
rad EXT	→ ϕM with ϕM deviation stored last

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

If external FM is selected, this modulation signal can be used for DC-coupled modulation upon actuating the FM DC key ***26*** (VCO operation, data streams containing DC or very low modulation frequencies). The FM-DC coupling is reset to AC coupling by actuating again the FM DC key ***26***. With FM-DC coupling, the following has to be observed:

- Calibration (EXT CAL) is not possible.
- FM-DC can only be used as single modulation mode, as double modulation with internal AM and as two-tone modulation with 1 or 2 AC-coupled internal modulation sources.

2.3.5.2 Modulation Meter

The modulation meter is accessed using the keys MAX PK ***22***, POLARITY SELECT ***23*** and PK HOLD ***24***. The output is made simultaneously in the digital display ***20*** and in the quasi-analog display ***21***.

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 (count ≠ 0), or the correct RF frequency has been set manually via SET f TX ***6***.

Besides, it is to be noted that the function 70 SPEC is active following master reset. It is therefore possible that the (RF) limit sensitivity is not reached. The demodulated output signal can be through-connected via 72 SPEC.

MAX PK

The positive and negative peak modulation is 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 ***24*** 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

37 SPEC (only RMS weighting)

and

36 SPEC (only peak weighting)

and switched on again using

35 SPEC .

2.3.5.3 Filter Weighting of Demodulated Signal

A great variety of filters is available for weighting the demodulated signal (see block diagrams in chapter 1):

- 300-Hz highpass filter (fixed cutoff frequency, independent of AF voltmeter signal weighting by filter),
- CCITT filter (can be used either for the demodulated signal or for the AF voltmeter signal),
- highpass filter with programmable cutoff frequency (influences the programmable lowpass filter, can be used for demodulated or AF voltmeter signal),
- lowpass filter with programmable cutoff frequency (can be used for demodulated or AF voltmeter signal),
- notch filter with programmable stop frequency (can be used for demodulated or AF voltmeter signals; suitable for use as a continuous weighting filter or as a distortion filter).

2.3.5.3.1 CCITT Filter

A CCITT filter is switched into the AF signal path by actuating the CCITT key ***28*** and switched off by actuating the same key again. As soon as the CCITT filter or any other filter (except: 300-Hz highpass filter) is switched on, the filter weighting in the AF voltmeter signal path is cancelled.

2.3.5.3.2 Lowpass Filter

The lowpass filter is switched on by entering a cutoff frequency via the keypad ***39***, optionally with the unit Hz or kHz, and then by actuating the LP key ***27***. The CMTA selects the next higher frequency, sets it and reads it out for approx. 1 second on the modulation display ***20***. The set filter frequency can be displayed again for approx. 1 second when actuating once more the LP key ***27***. The bar above the key acknowledges that the lowpass filter is switched on. The lowpass filter is switched off by entering zero frequency. Switching off the lowpass filter causes any active highpass filter also to be switched off (except: 300-Hz highpass filter). Switching any filter into the demodulated signal path (except: 300-Hz highpass filter) causes all filters in the AF voltmeter signal path to be switched off.

Example:

Switching on	3.5 kHz LP
Switching off	0 LP

2.3.5.3.3 Highpass Filter

The highpass filter is switched on by entering a cutoff frequency via the keypad ***39***, optionally with the unit Hz or kHz, and then by actuating the HP key ***26***. The CMTA selects the next lower frequency, sets it and reads it out for approx. 1 second on the modulation display ***20***. The set filter frequency can be displayed again for approx. 1 second by actuating once more the HP key ***26***. Switching on the highpass filter causes the lowpass filter to be switched on if it is not on already.

The lowpass cutoff frequency is defined as follows:

LP not preset:
The LP is set to max. 11 × HP (21 kHz at max.)

LP preset:
The low-pass frequency remains unchanged. Inputs of high frequencies are rejected, if LP < 11 × HP does not apply.

The resulting lowpass cutoff frequency can be displayed as described above. The highpass filter is switched off again by entering zero frequency. The bar indicated above the key acknowledges that the highpass filter (and also lowpass filter) is switched on. Contradictory entries of HP and LP, e.g. HP > TP or TP > 11 x HP will not be accepted.

Switching of any filter into the demodulated signal path cancels the filter weighting in the AF voltmeter signal path.

Exception: If a frequency of 300 Hz or 0.3 kHz is exactly preset, the non-programmable highpass filter is switched on, which can be switched on and off independent of the other filters and irrespective of the filter weighting in the AF voltmeter signal path. If a frequency of 299 Hz or 301 Hz is preset, the programmable highpass filter will be switched on again.

2.3.5.3.4 Notch Filter

The notch filter is mainly intended for SINAD or distortion measurement. It can continuously be switched into the demodulation path by means of the special function C25 SPEC <frequency (Hz)> SPEC and switched off by C25 SPEC 0 SPEC .

The closest frequency is set then and indicated on the α display ***2***. This filter also cancels filter weighting in the AF voltmeter signal path as well as distortion or SINAD measurement of the demodulated signal.

2.3.5.4 Transmitter Distortion (Transmitter S/N)

Transmitter distortion measurement is called by actuating the DIST key ***25*** and the result read out on modulation display ***20***. The test frequency selected in previous settings is recalled for this purpose. Modulation generator 1 is also set to this frequency which is read out in frequency field ***1***. Modulation of the transmitter by the signal from MOD GEN socket ***90*** must be ensured (no two-tone).

Control or pilot tones that may also be sent can be prevented from being weighted by the distortion meter through the use of suitable filters or filter combinations.

To enter or vary the test frequency, the frequency must be entered via keypad ***39***, the unit in Hz or kHz (mandatory) and finally the DIST key ***25*** be actuated. The test frequency is indicated for approx. 1 second in the modulation field, whereupon the measurement results are displayed.

The test frequency can be displayed again for approx. 1 second upon entering once more the unit Hz or kHz and actuating the DIST key ***25***. The distortion measurement is switched off by selecting modulation measurement, e.g. with MAX PK key ***22***.

If the distortion is to be read out in dB, dB DIST must be entered. Indication is in % again when entering % DIST.

Coupling of the modulation generator frequency to the test frequency of the distortion meter is cancelled by 66 SPEC , i.e. the modulation generator can be set to any AF frequency before or after the distortion measurement (e.g. for transmitters with scramblers). Coupling of the frequencies is restored by 65 SPEC .

If the transmitter S/N ratio is to be measured instead of the transmitter distortion, special function 55 SPEC must be recalled (back to transmitter distortion by 56 SPEC). Preset frequencies are irrelevant for the transmitter S/N ratio and will be ignored. The preselected unit will however be accepted.

The output signal at the MOD GEN socket ***90*** is alternately switched on and off. The S/N ratio is derived from the ratio of the useful and the spurious modulation measured. Both the useful and the spurious modulation are measured with peak weighting when entering 36 SPEC and with rms weighting when entering 35 SPEC or 37 SPEC. Special functions 50 to 53 allow further variations of S/N measurement.

2.3.5.5 Modulation of RF Signal Generator

The RF signal generator can be modulated by up to three sources:

Modulation source	Modulation mode	Coupling
Modulation generator 1	AF INT 1 Frequency setting INT 1 Deviation or modulation depth	AC
Modulation generator 2	AF INT 2 Frequency setting INT 2 Deviation or modulation depth	AC
Signal at MOD EXT connector	EXT Deviation or modulation depth 1 V_{RMS}	AC with AM, FM, ϕM DC or AC with FM

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

A large number of combinations is possible when using the modulation input MOD EXT ***89***; the possibilities are listed in the table below.

INT 1	INT 2	EXT	
AM1	AM2	AMe = AM1 AMe = AM2 AMe any FMe any (AC- or DC-coupled) ϕMe any	AM1 > AM2 AM1 < AM2 AM1 = AM2 = 0
FM1	FM2	AMe any FMe (AC or DC) = FM1 FMe (AC or DC) = FM2 FMe (AC or DC) any ϕMe NOT PERMISSIBLE	 FM1 > FM2 FM1 < FM2 FM1 = FM2 = 0
ϕM1	ϕM2	AMe any FMe NOT PERMISSIBLE ϕMe = ϕM1 ϕMe = ϕM2 ϕMe any	 ϕM1 > ϕM2 ϕM1 < ϕM2 ϕM1 = ϕM2 = 0

The respective modulation is switched on by pressing the key INT 1 ***22***, INT 2 ***23*** or EXT ***24***. The deviation or the modulation depth and the key acknowledgement appear in the digital display ***20*** (the key acknowledgements indicate the modulation sources used to modulate the RF generator). The acknowledgement above the FM DC key ***26*** indicates FM-DC coupling.

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

The DC coupling is switched off by actuating once more the FM DC key ***26***.

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 the frequency range 31.25 to 62.5 MHz ..... 50 kHz

Switched on modulation INT 1 ..... 30 kHz

The instruction `20 kHz INT 2` (switching on INT 2 with 20 kHz deviation) is permissible (total deviation 50 kHz).

The instruction `30 kHz INT 2` (switching on 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 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.

Examples:

Test frequency 550 MHz

INT 1	300	kHz	
INT 2	200	kHz	
EXT	300	kHz	
Total	800	kHz	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	400	kHz	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 two-tone or three-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 ***2*** indicate the coupling of two modulations.

If EXT is displayed in the α display ***2*** and INT1 or INT2 in the modulation display ***20***, 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.

2.3.5.6 Calibration of External Input Modulation Sensitivity

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

If the level at MOD EXT connector ***89*** 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 EXT CAL key ***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 V_{RMS} by pressing the key 1 V_{RMS} ***27*** (display in each case via key acknowledgement).

Example:

Level at MOD EXT connector ***89*** .	0.5 V_{RMS}
Display ***20***	3 kHz
Actual deviation	1.5 kHz
Command: EXT CAL	
Actual deviation	3 kHz
Command: 1 V_{RMS}	
Actual deviation	1.5 kHz

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

2.3.5.7 Modulation Sensitivity

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

	Numerical value	[unit]	MAX PK
e.g.	2.8	kHz	MAX PK

Starting from the currently set value, the AF level at the MOD GEN socket ***90*** is increased or reduced according to the following formula until the measured value of the modulation (MAX PK) corresponds to the rated value (± 2%):

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

The end of the search routine is indicated in the α display ***2*** by the message "DONE", the associated AF level can then be read on the AF level display ***30***.

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

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

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

MAX PK (without numerical values!)
+ ±/2 - PK
DIST (TX)

as well as via function 85 SPEC .

Note:

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 analysis of the AF signals applied to the AF VOLTM connector ***91*** and the level setting of the AF signal from MOD GEN connector ***90*** 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 10 µV to 5.1 V is available at the MOD GEN connector ***90***. The frequency of this signal is determined in the frequency field using the key AF INT 1 ***10*** (with two-tone also AF INT 2 ***11***), 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 µV , mV, dBµV and dBm (at 600 Ω) via the V_0 MOD GEN key ***32***. 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 V_0 MOD + 20 dB key ***33*** 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 V_0 OFF key ***35*** can be used in the transmitter and receiver tests to switch off the AF level and to switch it on again (toggle key).

Two tones can be generated at the MOD GEN connector ***90*** by pressing 122 SPEC or 123 SPEC . The output level displayed corresponds to the total RMS value of the added signal in the case of 122 SPEC . When using 123 SPEC , it corresponds to the RMS value of an individual signal, in which case the individual amplitudes of the two tones are always the same.

122 SPEC:

$$V_{display} = V_{total}\sqrt{2} \cdot V_1 = \sqrt{2} \cdot V_2$$

123 SPEC:

$$V_{display} = V_1 = V_2 = V_{total}/\sqrt{2}$$

121 SPEC:

V2 is switched off again.

Two-tone (at MOD GEN socket ***90***) 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 LEVEL key ***32***. All voltages at the AF VOLTM connector ***91*** 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 W, mV, V, dBµV 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 weighting of the AF level can only be switched on with the PK HOLD function (modulation measurement) switched off.

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

2.3.6.3 Filter Weighting of AF Signal

A great variety of filters is available for weighting the AF signal (see also block diagrams in chapter 1):

- CCITT filter
- lowpass filter with programmable cutoff frequency
- highpass filter with programmable cutoff frequency (may influence the lowpass filter)
- notch filter with programmable stop frequency (for continuous AF signal weighting or for use as a distortion filter).

All the above filters can only be used for the AF signal or for the demodulated signal.

2.3.6.3.1 CCITT Filter

A CCITT filter is switched into the AF signal path by actuating the CCITT key ***38***. The weighting bandwidth extending from approx. 50 Hz to 100 kHz is thus limited to 300 Hz to 3 kHz. All filters in the demodulation circuit (except: 300-Hz highpass filter) are switched off. The CCITT filter is switched off again by actuating once more the CCITT key.

2.3.6.3.2 Lowpass Filter

The lowpass filter is switched on by entering a cutoff frequency via the keypad ***39***, optionally with the unit Hz or kHz, and then by actuating the LP key ***37***. The CMTA selects the next higher frequency, sets it and reads it out for approx. 1 second on the AF level display ***30***. The set filter frequency can be displayed again for approx. 1 second by actuating once more the LP key ***37***. The bar above the key acknowledges that the lowpass filter is switched on.

The lowpass filter is switched off by entering zero frequency. Switching off the lowpass filter causes any active highpass filter also to be switched off. Switching any filter into the AF circuit causes all filters in the demodulation circuit to be switched off (except: 300-Hz highpass filter).

2.3.6.3.3 Highpass Filter

The highpass filter is switched on by entering a cutoff frequency via the keypad ***39***, optionally with the unit Hz or kHz, and then by actuating the HP key ***36***. The CMTA selects the next lower frequency, sets it and reads it out for approx. 1 second on the AF level display ***30***. The set filter frequency can be displayed again for approx. 1 second by actuating once more the HP key ***36***. Switching on the highpass filter causes the lowpass filter to be switched on if it is not on already.

The lowpass cutoff frequency is defined as follows:

LP not preset:
The LP is set to a max. frequency of 11 x HP (21 kHz at max.).

LP preset:
The low-pass frequency remains unchanged. Inputs of high frequencies are rejected, if LP < 11 x HP does not apply.

The resulting lowpass cutoff frequency can be displayed as described in section 2.3.6.3.2. The bar indicated above the key acknowledges that the highpass filter (and also lowpass filter) is switched on. The highpass filter is switched off by entering zero frequency. Contradictory entries, such as HP >LP or LP >11 x HP, will be rejected. Switching any filter into the AF circuit cancels the entire filter weighting in the demodulation circuit (except: 300-Hz highpass filter).

Example:

Switching on highpass filter:	`350 Hz HP`	
Display:		320 Hz and bar above HP key.
Input:	`Hz HP`	Display: 0.320 kHz
Input:	`Hz LP`	Display: 3.50 kHz

Switching off lowpass filter: `0 Hz LP`
Bar above LP key disappears
(highpass filter is also switched off and bar above HP key disappears)
or
Switching off highpass filter: `0 Hz HP`
Bar above HP key disappears
(lowpass filter remains switched on and bar above LP key remains indicated).

2.3.6.3.4 Notch Filter

The notch filter is mainly intended for SINAD or distortion measurement. It can continuously be switched into the AF voltmeter circuit by means of the special function `C26 SPEC <frequency (Hz)> SPEC` and switched off by `C26 SPEC 0 SPEC`. The closest frequency set is indicated on the α display ***2***. This filter also cancels filter weighting in the demodulation circuit as well as distortion or SINAD measurement in the AF circuit.

2.3.6.4 Receiver SINAD or Distortion Measurement

SINAD measurement is triggered by actuating the SINAD key ***33***. Normally, the test frequency is coupled to the frequency of the 1st modulation generator and indicated on frequency display ***1***. Since there are exceptions, however, the test frequency can be caused to be displayed for approx. 1 second on AF level display ***30*** by entering a frequency (in Hz or kHz) and then actuating the SINAD key ***33***. Thereupon, SINAD measurement is continued. The test frequency can be varied by entering a new test frequency via keypad ***39***, the unit Hz or kHz (mandatory) and finally by actuating the SINAD key ***33***. The closest new test frequency actually set by the CMTA is indicated for approx. 1 second on the AF level display ***30***. Entering % as the unit and actuating the SINAD key ***33*** causes switchover to distortion measurement or distortion measurement in %.

Entering a numerical value via keypad ***39***, selecting the unit % or dB and actuating the SINAD key ***33*** triggers the automatic SINAD (with dB) or distortion (with %) search routine: the RF level is varied until the preset SINAD or distortion value is obtained. Normally, the measurement is stopped when the result is accurate to ± 2 dB.

Coupling of the modulation generator frequency to the SINAD or distortion test frequency can be cancelled by 65 SPEC , i.e. the modulation generator can be set to any frequency before or after the SINAD or distortion measurement (e.g. for receiver with scramblers). Normally, modulation generator frequency and SINAD/distortion test frequency are coupled, however, using 66 SPEC .

Residual control and pilot tones affecting the measurements can be prevented from being weighted by the SINAD or distortion meter through the use of suitable filters or filter combinations.

The search routines can be influenced by the following SPEC functions.

58 SPEC: The search routine is terminated if the result falls within the tolerance window of the desired SINAD value (default).

59 SPEC: The search routine remains activated when the preset value is reached and the output level of the signal generator is adjusted correspondingly if the parameters are changed.

60 SPEC: The tolerance window of the preset value is ± 1 dB.

61 SPEC: The tolerance window of the preset value is ± 1 dB.

The search routines are switched off by pressing the SINAD key ***33*** again, influencing the RF signal generator level (adjustment, switch-off, variation) or the modulation or switching off the SINAD measurement.

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

Note:

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

As a result of this, the first measurement result may not correspond to the actual value in IEC-bus operation and in autorun control mode.

2.3.6.5 Signal-to-Noise Measurements

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

If a numerical value is entered before pressing the S/N key ***34*** (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 2.3.6.4).

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

The search routine is switched off by pressing the S/N key 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 reaching the time limit (approx. 2 min) and an RF level increase to >-27 dBm.

The modulation of the RF signal generator is constantly switched on and off with the S/N measurement. Since the CMTA 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).

Note:

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

53 SPEC: EXT is also switched on and off.

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:

45 SPEC: no averaging (default after switching on)

46 SPEC: 30 measurements

47 SPEC: 60 measurements

48 SPEC: 140 measurements

49 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)
+ ±/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 numerical value, units (also minus) entered between the individual numbers are also evaluated by the CMTA; the unit entered last 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 µV V_0 MOD GEN:

Minus sign is ignored (AC voltage)

- - → - 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 ΔVAR

The ΔVAR ***53*** can be used to assign any step size (within the limits listed below) to all setting values which can be varied using the spinwheel ***46***. The input corresponds to a normal numerical input (see section 2.3.7.1) prior to ΔVAR ***53***.

ΔVAR can be used for:

SET f TX	***6***	10 Hz to 500 MHz	Increment
SET f RX	***5***	10 Hz to 500 MHz	Increment
AF INT 1	***10***	0.1 Hz to 15 kHz	Increment
AF INT 2	***11***		
V_0 SYNTH	***14***	0.1 dB to 100 dB	Incr. (log)
		0.01 µV to 0.5 V	Incr. (lin)
INT 1	***22***	1 Hz to INT 1 max./2 kHz	Incr. (FM)
INT 2	***23***	0.001 rad to INT 1 max./2 rad	Incr. (ϕM)
EXT	***24***	0.001 % to 50 %	Incr. (AM)
V_0 MOD GEN	***32***	10 µV to 2.5 V	Incr. (lin)
		0.1 dB to 50 dB	Incr. (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.

```
ΔVAR   CLEAR   Terminating key
```

The variation is made again using the original step size, the contents of the ΔVAR 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   ΔVAR   AF INT 1
```

Variation in 100-Hz steps

```
ΔVAR   CLEAR   AF INT 1
```

Variation in standard tone sequence again

```
ΔVAR   AF INT 1
```

Variation in 100-Hz steps again

Note:

The CLEAR key 49 does not have a command abort function in this case. A command abort following ΔVAR can only take place with an illegal input or by pressing the CLEAR key twice.

Example:

```
10   µV   ΔVAR   CLEAR   CLEAR
1   kHz   ΔVAR   AF LEVEL
ΔVAR   CLEAR   CCITT RX
```

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

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

Example:

Display of V_0 MOD GEN → 1.00 mV

```
6.02   dB   ΔVAR   V0 MOD GEN
```

6.02 dB corresponds to doubling of the value

Variation:

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

Note:

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 RANGE HOLD key ***50*** (corresponds to switching off AUTO RANGE function. 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. µV ↔ mV ↔ V).

RANGE HOLD can be used for:

POWER	***14***	
ACP	***15***	
PROBE	***19***	
MAX PK	***22***	⎫ same measurement
+ ±/2 -	***23***	⎭ range
DIST	***25***	
AF LEVEL	***32***	
SINAD	***33***	
S/N	***34***	

`RANGE HOLD  Terminating key`

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
Input:	`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.

`Num. value  Unit  RANGE HOLD  Terminating key`

Additional input of a unit causes the measured values to be output in the new unit in the range defined by the numerical value.

Example:

Measured value:	0.15 V with RF level measurement (PROBE)
Measurement range:	0.25 V
Input:	`500  mV  RANGE HOLD  PROBE`

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

`Numerical value  RANGE HOLD  Terminating key`

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

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

Example:

Measured value:	0.35 V with RF level measurement (PROBE)
Measurement range:	0.50 V
Input:	`1.0  RANGE HOLD  PROBE` The measurement range is fixed to 1.00 V.
Input:	`1.1  RANGE HOLD  PROBE` The measurement range is fixed to 2.5 V.

`Unit  RANGE HOLD  Terminating key`

The output is made in the new unit, the current range is retained. (Caution with linear and logarithmic units!)

Example:

Measured value:	120 mV with RF level measurement (PROBE)
Measurement range:	250 mV
Input:	`dBm  RANGE HOLD  PROBE` The measurement range is fixed to 250 dBm (!).

Switching off RANGE HOLD:

The RANGE HOLD function is switched off when the unit is changed since the measurement ranges are bound to the associated unit.

Example:

Measured value:	1.5 W with RF level measurement (POWER)
Measurement range:	10 W with RANGE HOLD active
Input:	dBm POWER
Measured value:	+ 31.8 dBm
Measurement range:	50 dBm, no RANGE HOLD

Switching off is also possible by entering

RANGE HOLD CLEAR Terminating key

Note:

The CLEAR key 49 does not have a command abort function in this case. A command abort following RANGE HOLD can only take place with an illegal input or by pressing the CLEAR key twice.

Example:

```
10 µV RANGE HOLD CLEAR CLEAR
1 kHz RANGE HOLD TXRX
RANGE HOLD CLEAR CCITT RX
```

Note:

The ranges 0 to 250, 0 to 500 and 0 to 1000 can still be directly selected even though they are only required in exceptional cases. The scales 0 to 25, 0 to 50 and 0 to 100 are used in the displays in these cases.

2.3.7.4 α DISPL SELECT

The α DISPL SELECT function ***52*** α display ***2*** is used for transferring the following setting parameters to the α display ***2***:

V_0 SYNTH.	***14***
INT 1	***22***
INT 2	***23***
EXT	***24***
V_0 MOD GEN	***32***

If one of these parameters is output in the α display ***2*** using the command α-DISPL SELECT Terminating key , the display which has now become free can be used for other measured/setting parameters of the corresponding setting field.

Furthermore, the output in the α display ***2*** is retained even when switching from transmitter to receiver test or vice versa, thus enabling variation (using the spinwheel ***46***) and checking of this setting value in both modes. When calling up measured/setting parameters which can only be output in the α display ***2***, the α-DISPLAY SELECT function ***52*** is switched off again.

This applies to the following parameters:

DEMOD · BEAT	***9***
AF EXT	***9***
CODE	***8***
DECODE	***8***
AF INT 1	***10***
AF INT 2	***11***
Δf	***7***

Example:

10 µV V_0 SYNTH

Signal generator output level is indicated in the RF level display.

α-DISPL SELECT V_0 SYNTH

Signal generator output level is indicated in the RF level display and in the α display.

PROBE

Result of RF millivoltmeter is indicated in the RF level display, signal generator output level only in the α display.

TXRX

In the transmitter test, the output level of the signal generator is also indicated in the α display.

1 kHz AF INT 1

Frequency of 1st modulation generator is indicated in the α display, the α-DISPL SELECT function is switched off.

2.3.7.5 ANALOG SELECT

Using ANALOG SELECT ***51***, two measured/setting parameters can be simultaneously output in the RF level, modulation and AF level displays. This is done by splitting up the displays into digital and analog display.

Using `ANALOG SELECT` `Terminating key` , one of the parameters

DIST TX	***25***
SINAD	***33***
ACP	***15***

is assigned the associated analog display (marked by the unit and code of the measured value displayed underneath the bargraph, see section 2.3.1.5).

The digital display remains available for indication of other measured/setting parameters.

This function is switched off again using `ANALOG SELECT` `CLEAR` `Terminating key` .

Example:

`MAX PK`

The result of the modulation measurement is output in the digital and anlog display.

`ANALOG SELECT` `DIST TX`

The result of the transmitter distortion measurement is output in the analog display, the result of the modulation measurement is further indicated in the digital display.
(The ANALOG SELECT function is marked by DIST (%) displayed underneath the bargraph).

`ANALOG SELECT` `CLEAR` `DIST TX`

The transmitter distortion measurement result is now output in both the digital and the analog display.

2.3.7.6 REF

The REF function ***54*** is used for displaying measured/setting values relative to a reference value and can be applied to the following functions:

POWER	***14***
V_0 SYNTH.	***14***
PROBE	***19***
MAX PK	***22***
+ ±/2 -	***23***
INT 1	***22***
INT 2	***23***
EXT	***24***
V_0 MOD GEN	***32***
AF LEVEL	***32***

Using `REF` `Terminating key` , the measured/setting value just visible in the display is defined as reference value (new display: 0.0 dB). All following measured values or settings are referred to this value and output in the display according to the following formula:

$$Displayed\ value\ (dB) = 20 \times log\left(\frac{new\ value}{ref.\ value}\right)$$

It is likewise possible to enter the appropriate reference value using `Numerical value` `Unit` `REF` `Terminating key` (e.g., if the reference value is not displayed yet and can only be taken from the memory).

The REF function (marked by the unit dB which usually is not used for these parameters) can be switched off by `REF` `CLEAR` `Terminating key` .

Example:

Display of AF voltmeter: 1.00 V

Input: `REF` `LEVEL`
Display: 0.0 dB

Variation of AF level to 0.5 V

Display: -6.0 dB

Variation of AF level to 3 V

Display: 9.5 dB

Input:	REF CLEAR LEVEL
Display:	3.00 V
RF level:	100 mV
Displayed:	PROBE measurement result
Input:	200 mV REF V_0 SYNTH
Display:	-6.0 dB
Input:	10 µV V_0 SYNTH
Display:	-86.0 dB
Input:	REF V_0 SYNTH
Display:	0.0 dB
Input:	REF CLEAR V_0 SYNTH
Display:	10.0 µV

Example:

1 STORE	The current instrument status is loaded into memory 1.
	The CMTA is now reset, e.g. for another measurement.
1 RECALL	The stored instrument status is recalled.

2.3.7.7 STORE/RECALL

2.3.7.7.1 Storing Complete Instrument Setups

Each of the memories 1, 2 and 3 contains the complete information on an instrument status.

For storing, the command

1 STORE to 3 STORE

and for recalling the stored setting, the command

1 RECALL to 3 RECALL

is used.

When storing complete instrument setups, all parameters of the transmitter and receiver test are stored:

- All functions indicated by the key acknowledgements and LEDs (transmitter/receiver test of the individual fields and the complete instrument, INPUT SELECT, HP, CCITT etc.)
- Type of modulation (AM, FM, ϕM)
- Setting values (also ΔVAR, RANGE HOLD and REF values)
- SPEC functions
- Graphic display settings

The user-specific standard tone sequences USER 0 to USER 2 and RF levels >-27 dBm (protection of receiver) are not stored.

2.3.7.7.2 Storing RF Frequencies

Memories 10 to 30 contain an RF frequency setting and are loaded with the value indicated in the frequency display *1* (COUNT f / SET f TX in the transmitter test or SET f RX in the receiver test) using 10 STORE to 30 STORE .

When reading out the memory content using 10 RECALL to 30 RECALL , the corresponding value is loaded into SET f TX (transmitter test) or SET f RX (receiver test) and set at once.

If the RF counter is switched on in the transmitter test, the command 10 RECALL to 30 RECALL is ignored; an internal setting which cannot be controlled by the user is not made.

Example:

COUNT f switched on and 438.5 MHz displayed

10 STORE	This value is loaded into memory 10.
TXRX	Switchover to receiver test SET f RX (synthesizer output frequency is displayed).
10 RECALL	The synthesizer output frequency is now 438.5 MHz.

All memories can be read as often as required; the content is only cleared by overwriting (STORE) or master reset.

2.3.7.8 Squelch Measurement

The squelch measurement is called up by entering 80 SPEC . The level of the RF signal generator is reduced from the currently set value until the squelch responds. Then, the level is increased again until the squelch is switched off. The squelch hysteresis is now output in the α display ***2***; the level at which the squelch is switched off again is indicated on the RF level field.

Manual variation of the modulation, the RF frequency or the RF level immediately switches off the current measurement.

Likewise, the measurement is aborted on the following conditions:

- The level is 0.032 µV and the squelch does not respond.
- The squelch is already switched off when calling up the measurement.
- The level is 10 mV and the squelch is not switched off.
- After 2 minutes at the latest ("TIMEOUT ERROR")

When the measurement is aborted for these reasons, the error message "CHECK INST." is output in the α display ***2***.

Example:

Output level: 1.5 µV

80 SPEC Switching on the squelch measurement

The signal generator level is reduced in steps of 0.1 dB, provided that a sufficient AF signal is applied to the AF VOLTM connector ***91*** (loudspeaker socket of transceiver).

The squelch responds at 0.75 µV; no signal is applied to the AF VOLTM connector 91 any longer.

The signal generator level is now increased in steps of 0.1 dB until a signal can again be measured at the AF VOLTM connector ***91***.

The squelch is switched off at 1.2 µV.

The squelch hysteresis can be read on the α display ***2*** ("SQUELCH 4 dB"), the switch-off level of the squelch is output in the RF level field.

2.3.7.9 Bandwidth Measurement

The bandwidth measurement is called up in the receiver test using 84 SPEC . The two -6-dB points (sensitivity loss of receiver) are found from the currently set output frequency of the RF signal generator. After completion of the measurement, the bandwidth is output in the α display ***2*** and the deviation from the centre frequency can be read on the RF frequency display ***1***. Note that the signal generator modulation must be switched off when calling up the bandwidth measurement and not switched on again when the routine is finished.

2.3.7.10 Quieting Measurement

The interesting result of the quieting measurement is the RF level at which the receiver noise has decreased by a particular rated value (mainly 12 dB or 20 dB) compared with the noise without RF signal. The rated value can be set to values between 6 dB and 30 dB via

83 SPEC <rated value (dB)> SPEC

(factory setting: 20 dB).

The measurement is called up via 82 SPEC in the receiver test. The synthesizer level is switched off (-137 dBm) and the receiver noise measured at the loudspeaker output.

The receiver noise being continuously monitored, the RF level is then increased in 5-dB steps, reduced in 1-dB steps and finally increased again in 0.1-dB steps until the noise has been reduced by the rated value (e.g. 20 dB). The exact quieting measurement result is indicated in the alphanumeric display "QUIET. 20.2 dB", the associated RF level in the RF level display.

If the modulation, the RF frequency or the RF level are manually changed while a search routine is running, it is immediately switched off (error message "PARAMCHANGED" in the alphanumeric display).

The measurement is also aborted on the following conditions:

- Synthesizer level increases to over -10 dBm
- Final value is not yet obtained after approx. 2 min.
- The noise voltage measured at the AF VOLTM input ***91*** is <-40 dBm (into 600 Ω).

When the measurement is aborted for one of these reasons, the error message "CHECK INST" or "TIMEOUT" appears in the alphanumeric display ***2***.

It should be noted that the signal generator modulation is switched off when the quieting measurement is selected and not switched on again at the end of the routine!

Note:

A squelch which may be fitted in the transceiver must be switched off for this measurement.

2.3.7.11 Aborting Search Routines

Each running search routine can be aborted via the function `85 SPEC` .

This applies to

`80 SPEC`	Squelch measurement
`82 SPEC`	Quieting measurement
`84 SPEC`	Bandwidth measurement
`2.8 kHz MAX PK`	Modulation measurement
`20 dB SINAD`	Receiver sensitivity

Note:

When aborting search routines, any variations of RF and AF level values, signal generator modulation and frequency variations (bandwidth measurement) are not reset to their original status.

2.3.8 SPEC Function

The SPEC function incorporates various instrument functions which have not been assigned separate keys because they are only used rarely.

The functions are selected by entering a code number from 1 to 10000, in certain cases one of the unit keys now meaning A to D must be additionally entered before the SPEC key ***55***.

2.3.8.1 General Instrument Functions

11 SPEC : Display illumination is switched on/off (default: illumination on)

18 SPEC : Automatic 20-dB attenuation on (RF connector ***84***) (Default)

19 SPEC : Automatic 20-dB attenuation off (RF connector ***84***)

20 SPEC : The RF signal applied to INPUT 2 ***86*** attenuated by 20 dB

21 SPEC : The 20-dB attenuator at INPUT 2 ***86*** switched off (default)

22 SPEC : 10-MHz crystal reference synchronized with external signal source. (Apply 10-MHz signal > 100 mV to REF 10 MHz connector ***124***).

23 SPEC : Internal 10-MHz reference signal output at REF 10 MHz connector ***124*** (default).

25 SPEC : RMS measurement switched to FAST mode (80 ms) (only possible for input frequencies >150 Hz).

26 SPEC : RMS measurement switched to SLOW mode (250 ms) (default).

28 SPEC : Test diode of power meter (low distortion) switched off.
Harmonic measurement switched on.

29 SPEC : Power diode switched on (default).
Harmonic measurement switched off.

30 SPEC <attenuation (dB)> SPEC: Input of attenuation value (attenuation = 0 to 40 dB) of an external attenuator at RF connector ***84***. (protect, 0 default).

35 SPEC : Modulation measurement with RMS or peak weighting depending on result (default setting)
AM : < 1 % (RMS)
FM : < 100 Hz (RMS)
ϕM : < 0.1 rad (RMS)

36 SPEC : Modulation measurement always peak-weighted.

37 SPEC : Modulation measurement always RMS-weighted.

40 SPEC : AF voltmeter measurement RMS-weighted (default).

41 SPEC : AF voltmeter measurement peak-weighted (positive).

42 SPEC : AF voltmeter measurement peak-weighted (negative).

43 SPEC <Z (Ω)> SPEC: Input of reference impedance (Z = 2 to 3000 Ω) for AF voltmeter measurement (default = 600 Ω).

45 SPEC : No averaging for all RMS-weighted measurements (default after switching on).

46 SPEC : Averaging over 30 measurements for all RMS-weighted measurements.

47 SPEC : Averaging over 60 measurements for all RMS-weighted measurements.

48 SPEC : Averaging over 140 measurements for all RMS-weighted measurements.

49 SPEC : Averaging over 255 measurments for all RMS-weighted measurements.

50 SPEC : Modulation of the synthesizer by the 2nd AF generator INT 2 remains uninfluenced with the S/N measurement (default).

51 SPEC : INT 2 is also switched on and off with the S/N measurement.

52 SPEC : Modulation of the synthesizer by the external modulation input MOD EXT ***89*** remains uninfluenced with the S/N measurement (default).

53 SPEC : EXT is also switched on and off with the S/N measurement.

55 SPEC : Switching on transmitter S/N measurement instead of DIST measurement.

56 SPEC : Switching off transmitter S/N measurement (DIST measurement again) (default).

58 SPEC : S/N, SINAD, DIST measurement:
Search routine is terminated when the preset value is reached.

59 SPEC : S/N, SINAD, DIST measurement:
Search routine is continued even when the tolerance window is reached.

60 SPEC : Tolerance window of the final value of the SINAD, DIST and S/N measurement is ± 1 dB.

61 SPEC : Tolerance window of the final value of the SINAD, DIST and S/N measurement is ± 2 dB.

65 SPEC : Frequency of 1st modulation generator is coupled to notch filter frequency in SINAD/ DIST measurements (default).

66 SPEC : Coupling of 1st modulation generator frequeny to notch filter frequency is cancelled.

70 SPEC : Demodulator control: squelch on (default).

71 SPEC : Demodulator control: switching off output signal.

72 SPEC : Demodulator control: through-connecting output signal.

75 SPEC : Switching on 750-µs deemphasis with FM (Γ symbol in the display).

76 SPEC : Switching on 750-µs deemphasis (default).

80 SPEC : Starting squelch measurement.

82 SPEC : Switching on quieting measurement.

83 SPEC <rated value (dB)> SPEC : Entry of rated value for quieting measurement (20-dB default).

84 SPEC : Starting bandwidth measurement.

85 SPEC : Switching off all running search routines, the currently set instrument status being retained.

95 SPEC : Instrument preset (also via autorun control and IEC/IEEE bus).

99 SPEC : Master reset (factory setting) of instrument (protect).

111 SPEC : 0-dB attenuation for probes selected (default).

112 SPEC : 20-dB attenuation for probes selected.

113 SPEC : 40-dB attenuation for probes selected.

114 SPEC : Probe measurement: the output in dBm is referred to 75 Ω.

115 SPEC : Probe measurement: the output in dBm is referred to 50 Ω (default).

121 SPEC : Single tone at MOD GEN connector ***90***.

122 SPEC : Double tone at MOD GEN connector ***90*** (both tones have the same level, the RMS value of the total signal is displayed).
$V_{display} = V_1 \cdot \sqrt{2}$

123 SPEC : Double tone at MOD GEN connector ***90*** (both tones have the same level, the RMS value of one signal is displayed).
$V_{display} = V_1$

140 SPEC : Any channel spacing ACP.

141 SPEC : Fixed channel spacing ACP: 10, 12.5, 20 or 25 kHz.

144 SPEC <RF level (dBm)> SPEC: Calibration of the selective RF voltmeter (0 ACP) by means of the currently applied power.

145 SPEC : Calibration of the selective RF voltmeter (0 ACP) by means of the power applied to RF input ***84***.

180 SPEC : Collection of the PK HOLD measurement result via IEC/IEEE bus and autorun control.

181 SPEC <waiting time (s)> SPEC: Setting the waiting time between PK HOLD command and start of PK HOLD measurement. Works only in remote control mode (IEC/IEEE bus and autorun control) (0.5 s default).

182 SPEC <measuring time (s)> SPEC: Setting the measuring time of PK HOLD measurement. Works only in remote control mode (IEC/IEEE bus and autorun control) (0.5 s default).

200 SPEC : RF signal via 2nd attenuator: 0 dB attenuation (model 54 only)

201 SPEC : RF signal via 2nd attenuator: 10 dB attenuation (model 54 only)

202 SPEC : RF-signal via 2nd attenuator: 20 dB attenuation (model 54 only)

203 SPEC : RF-signal via 2nd attenuator: 30 dB attenuation (model 54 only)

204 SPEC : RF-signal via controlled RF amplifier (default)

210 SPEC : Starting XY recorder for graphic plot, Pen-Lift-TTL-signal active Low.

211 SPEC : Starting XY recorder for graphic plot, Pen-Lift-TTL-signal active High.

212 SPEC : Switching off XY recorder mode.

220 SPEC : The LO is below the suppressed carrier in the SSB analyzer (preferably for signals in the upper side band). (default)

221 SPEC : The LO is above the suppressed carrier in the SSB analyzer (preferably for signals in the lower side band).

967 SPEC : All settings and parameters not visible are protected against being changed unintentionally.

Protected parameters:
→ programs of the autorun control
→ all store facilities of the STORE key ***56***
→ all SPEC functions that are particularly marked (protect)

968 SPEC : All parameters can be changed as required (switching off 967 SPEC) (default).

2.3.8.2 Control Functions for Autorun Control Option CMTA-B5 (A...SPEC)

A 00 SPEC to A 31 SPEC

Three programmable control outputs are available if the CMTA-B5 option is fitted (CONTROL A).

1st digit: 1 to 3 corresponds to control output 1 to 3
0 means all control outputs 1 to 3 simultaneously

2nd digit: 0 corresponds to "N/O contact open"
1 corresponds to "N/O contact closed"

Example:

A	1	0	SPEC
CONTROL A	N/O contact 1	Open	
A	0	1	SPEC
CONTROL A	N/O contacts 1 to 3	Close	

A 800 SPEC STORE : Initialization of autorun control. Required after each battery replacement and new fitting of option (only in manual mode).

A 100 SPEC to
A 199 SPEC : Start of program = switchover to LEARN mode.
100 to 199 = program 00 to 99 (only in manual mode).

A 200 SPEC : End of programming = switchover to manual mode (only in LEARN mode).

A 300 SPEC STORE to A 399 SPEC STORE :	Deletion of a program 300 to 399 = program 00 to 99 (only in manual mode).
A 500 SPEC :	Start of message entry (only in LEARN mode).
A 505 SPEC 1 SPEC to A 505 SPEC 1000 SPEC :	Start of a repetition block to be executed 1 to 1000 times (only in LEARN mode).
A 506 SPEC :	End of a repetition block (only in LEARN mode).
A 510 SPEC :	If the tolerance is exceeded during the program run (red LED lights up), the program is interrupted (default).
A 511 SPEC :	Exceeding of the tolerance is only stored in the protocol, the program run is continued without interruption.
A 512 SPEC :	After calling up this special function, the memory capacity still available is indicated (in blocks). Each command line consists of at least one block.
A 513 SPEC :	Small format of test reports.
A 514 SPEC :	Medium format of test reports.
A 515 SPEC :	Large format of test reports.
A 520 SPEC :	Start of message input with input request in RUN mode (only in LEARN mode).
A 525 SPEC :	Editing the printer configuration string.
A 526 SPEC :	Output of printer configuration string to the printer (string is generated before by A 525 SPEC).
A 527 SPEC :	Entering a control character sequence for the autotest. In RUN mode, the programmed string is output to the printer.
A 530 SPEC :	Copying CMTA program to transfer memory.
A 531 SPEC :	Copying transfer memory program to CMTA.
A 532 SPEC :	Appending transfer memory program to CMTA program.

A 533 SPEC :	Deleting transfer memory program.
A 540 SPEC :	Initializing transfer memory.
A 600 SPEC 0 SPEC to A 600 SPEC 10000 SPEC :	Setting a minimum time between execution of the individual commands. 0 to 10000 = 0 to 10000 ms (only in manual mode and HOLD mode).
A 605 SPEC :	Indication of program directory in the α display ***2*** (only in manual mode).
A 606 SPEC :	Directory switched off.
A 607 SPEC :	Display of transfer memory directory.
A 610 SPEC :	Output of the Autorun Control Directory on a printer
A 611 SPEC :	Output of the Transfer Memory Directory on a printer
A 1000 SPEC to A 1999 SPEC :	Selection of a particular line. 1000 to 1999 = line 000 to 999 (only in LEARN mode).
A 2000 SPEC to A 2999 SPEC :	Deletion of a program block. 2000 to 2999 = deletion of lines 000 to 999 from the set position (only in LEARN mode).

The error message "ADD OPT. CMTA-B5" is output in the α display ***2*** if the option CMTA-B5 is not fitted and the corresponding SPEC function is called.

"ADD OPT. CMTA-B5"

2.3.8.3 Control Functions for IEC/IEEE Bus (B...SPEC)

```
B  00  SPEC  to  B  81  SPEC
```

8 freely programmable control outputs are available. Control takes place via the SPEC function as with CONTROL A:

Example:

B	8	1	SPEC
CONTROL B	N/O contact 8	Close	
B	0	0	SPEC
CONTROL B	N/O contacts 1 to 8	Open	

`B 100 SPEC to B 1000 SPEC :`	Control functions of IEC/IEEE bus
`B 100 SPEC <xx> SPEC :`	Setting of IEC/IEEE-bus address in listener and talker mode. ($0 \leq xx \leq 30$).
`B 101 SPEC :`	The CMTA only sends CR/LF to the controller at the end of a string (default).
`B 102 SPEC :`	In addition to CR/LF, the CMTA also sends EOI to the controller at the end of a string.

2.3.8.4 Control Functions for Frequency Counter and CODE(DECODE) (C...SPEC)

AF counter

`C 10 SPEC :`	Gate time counting also in range from 7 Hz to 4 kHz (1 Hz or 0.1 Hz resolution) Advantage: high S/N ratio Disadvantage: relatively low measuring rate
`C 11 SPEC :`	Period measurement in frequency range from 7 Hz to 4 kHz (0.1 Hz resolution) Advantage: very high measuring rate Disadvantage: slightly more susceptible to interference
`C 12 SPEC :`	Gate time counting of AF counter with resolution of 0.1 Hz (10 s gate time).

C 13 SPEC :	Gate time counting of AF counter with resolution of 1 Hz (1 s gate time).
C 25 SPEC <f (Hz)> SPEC :	Notch filter switched into the demodulation circuit for weighting (f = 100 Hz to 5000 Hz; f = 0 = switching off).
C 26 SPEC <f (Hz)> SPEC :	Notch filter switched into AF voltmeter circuit for weighting (f = 100 Hz to 5000 Hz; f = 0 = switching off).
C 30 to C 37 SPEC <f> SPEC:	Modification of variation sequence of 1st modulation generator (f = frequency in the range of the 1st modulation generator).
C 40 to C 47 SPEC <f> SPEC:	Modification of variation sequence of 2nd AF synthesizer (f = frequency in the range of the 2nd AF synthesizer).

RF counter

C 20 SPEC :	RF counting with resolution of 1 Hz (measuring cycle <1.2 s or 4.2 s depending on frequency range).
C 21 SPEC :	RF counting with resolution of 10 Hz (measuring cycle <300 ms or 700 ms depending on frequency range).
C 50 SPEC :	Switching on frequency transfer function
C 51 SPEC :	Switching off frequency transfer function
C 52 SPEC <Δf> SPEC :	Duplex spacing for frequency transfer function
	-99999.99 to 0 kHz receive frequency of transceiver below transmit frequency
	0 to 99999.99 kHz receive frequency of transceiver above transmit frequency

Control functions CODE/DECODE

C 100 SPEC <xx> SPEC :	Loading the user-specific standard tone sequence USER 0 with a fixed sequence (xx = 0 to 10) (Protect)
C 101 SPEC <xx> SPEC :	Loading the user-specific standard tone sequence USER 1 with a fixed sequence (xx = 0 to 10) (Protect)

C 102 SPEC <xx> SPEC :	Loading the user-specific standard tone sequence USER 2 with a fixed sequence (xx = 15 to 19) (Protect)
C 110 SPEC <xx> SPEC :	Activating a standard tone sequence for CODE/DECODE (xx = 0 to 10, 15, 20 to 22)
C 111 SPEC <xx> SPEC :	Activating a standard tone sequence for DECODE exclusively (xx = 0 to 10, 15, 20 to 22)
C 150 SPEC :	Automatic repeat on (E = repeat tone) 11111 → 1E1E1 123322444 → 123E2E4E4
C 151 SPEC :	Automatic repeat off 11111 → 11111
C 160 SPEC <t (ms)> SPEC :	Duration of 1st tone in ms (t = 10 ms to 5000 ms)
C 161 SPEC <t (ms)> SPEC :	Duration of the following tones in ms t = 10 ms to 5000 ms)
C 162 SPEC <t (ms)> SPEC :	Pause duration in ms (t = 0 and 10 ms to 5000 ms)
C 163 SPEC <f-TOL (%)> SPEC :	Frequency deviation of the sent tones from the nominal frequency in % (-10% to + 10%).
C 170 SPEC :	DECODE in demodulation circuit: (DEMOD SIGNAL socket ***88***) (default)
C 171 SPEC :	DECODE in AF voltmeter circuit: (AF VOLTM socket ***91***)
C 172 SPEC <f-TOL (%)> SPEC :	Evaluation window for selective call decoder (± 1% to ± 10%)
C 173 SPEC :	Decoding aborted approx. 100 ms (single tones) or 800 ms (double tones) after the last tone (default values after switching on).
C 174 SPEC :	Decoding aborted approx. 400 ms (single tones) or 800 ms (double tones) after the last tone.
C 180 SPEC <t (ms)> SPEC :	Decoding is restricted to time t (ms) (default: 1000 ms corresponds to switching off this function).
C 181 SPEC :	Decoding aborted approx. 2 s after the last tone.
C 185 SPEC :	Decoding started via IEC/IEEE bus and autorun control (= DECODE command) with the possibility of sending further commands to the CMTA before the end of decoding.

C 186 SPEC :	Readout of DECODE result via IEC/IEEE bus and autorun control without restart of decoding.
C 190 SPEC :	The separators are also displayed.
C 191 SPEC :	The display of separators is suppressed. (Default, only with VDEW signalling, code number 16 effective!)
C 500 SPEC <f> SPEC to C 515 SPEC <f> SPEC :	Loading the frequency of each call number (0 to F) of the sequence USER 0 in Hz (300 Hz < f < 4 kHz and f = 0) (Protect)
C 560 SPEC <t (ms)> SPEC :	Tone duration of the 1st tone sent 10 ms to 5000 ms (USER 0) (Protect)
C 561 SPEC <t (ms)> SPEC :	Tone duration 0 and 10 ms to 5000 ms (USER 0) (Protect)
C 562 SPEC <t (ms)> SPEC :	Pause duration of the following tones 10 ms to 5000 ms (USER 0) (Protect)
C 600 SPEC <f> SPEC to C 615 SPEC <f> SPEC :	Loading the frequency of each call number (0 to F) of the sequence USER 1 in Hz (300 Hz < f < 4 kHz and f = 0) (Protect)
C 660 SPEC <t (ms)> SPEC :	Duration of the 1st tone sent 10 ms to 5000 ms (USER 1) (Protect)
C 661 SPEC <t (ms)> SPEC :	Duration of the following tones 10 ms to 5000 ms (USER 1) (Protect)
C 662 SPEC <t (ms)> SPEC :	Pause duration 0 and 10 ms to 5000 ms (USER 1) (Protect)
C 700 SPEC <f> SPEC to C 715 SPEC <f> SPEC and C 720 SPEC <f> SPEC to C 735 SPEC <f> SPEC :	Loading the frequency of each call number (0 to F) of the sequence USER 2 in Hz (300 Hz < f <4 kHz and f = 0). (Protect) where C 700 SPEC to C 715 SPEC corresponds to the nominal frequency of AF INT 1 and C 720 SPEC to C 735 SPEC corresponds to the nominal frequency of AF INT 2.
C 760 SPEC <t (ms)> SPEC :	Duration of the 1st tone sent 10 ms to 5000 ms (USER 2) (Protect)
C 761 SPEC <t (ms)> SPEC :	Duration of the following tones 10 ms to 5000 ms (USER 2) (Protect)
C 762 SPEC <t (ms)> SPEC :	Pause duration 0 and 10 ms to 5000 ms (USER 2) (Protect)

2.3.8.5 Control Functions to Call Calibration Routines and Self-test (D...SPEC)

D 0 SPEC :	Offset adjustment of DC measuring circuit (A/D converter and DC preamplifier). This offset adjustment is automatically repeated at certain intervals. Calling this function also produces an offset adjustment at the defined point in time.
D 1 SPEC :	Offset adjustment of power measurement. Before calling this function, it must be ensured that an RF power is not applied to the RF input ***84***. The level of the RF signal generator is reduced to -47 dBm if it is >-47 dBm.
D 5 SPEC :	Automatic offset adjustment in CMTA switched off.
D 12 SPEC :	All LCD segments are switched on for approx. 5 s for checking.
D 13 SPEC :	All LEDs are switched on for approx. 5 s for checking.
D 14 SPEC :	Checking the spinwheel. The analog bar in the RF level field is increased by rotating the spinwheel clockwise and decreased by rotating counterclockwise. This test mode is switched off by pressing the key "0".
D 15 SPEC :	Checking the keyboard. After switching on this test mode, the key code of each key pressed is output in the α display ***2*** corresponding to the numbers in Fig. 2-1 to 2-9. This test mode is switched off by pressing the key "0".
D 20 SPEC :	Measuring the battery voltage in the basic unit. This voltage is output in the α display ***2***; nominal value: 3.6 V; at voltages <2.4 V, the battery should be replaced.
D 21 SPEC :	Measuring the battery voltage of Autorun Control CMTA-B5. This voltage is output in the α display ***2***; nominal value 3.6 V; at voltages <2.4 V, the battery should be replaced.
D 22 SPEC :	Measuring the battery voltage of Transfer Memory CM-Z1. This voltage is output in the α display ***2***; nominal value: 3.6 V; at voltages <2.4 V, the battery should be replaced.
D 25 SPEC :	Memory test of Transfer Memory (CM-Z1). The state of the memory is indicated in the α display ***2***. Note that the memory test overwrites the transfer memory contents.

D 30 SPEC :

Offset adjustment of RMS meter (DEMOD or AF voltmeter). After replacement of the battery and when maximum accuracy of the AF voltmeter in the 50-mV range is required, this adjustment is to be carried out as follows:

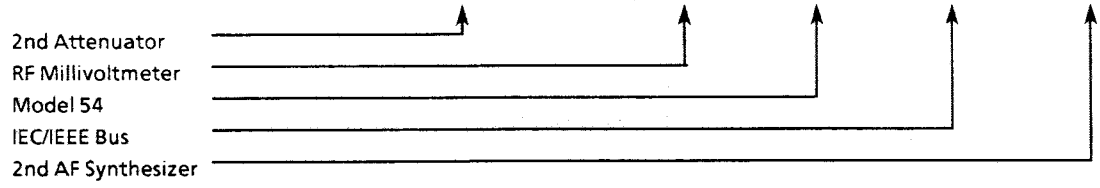
→ Switch on level measurement
→ Switch off CCITT filter, if required
→ Apply 40.00 mV RMS/800 Hz sinewave to AF VOLTM connector ***91*** with maximum accuracy (error <0.1%)
→ D 30 SPEC

2.3.8.6 Display of Options Fitted

Enter: 50113 SPEC

The options are indicated on the alphanumeric display ***2*** in hexadecimal form (4 bits are combined to one digit 0 to F):

Module		Bit No. 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2nd AF Synthesizer	1)																1
-																0	
Autorun Control	CMTA-B5														1		
IEC/IEEE Bus	1)													1			
Duplex Modulation Meter	CMTA-B9												1				
Model 52	without graphics unit											1					
Model 54	with graphics unit										1						
-										0							
-									0								
RF Millivoltmeter	CM-B8							1									
Adjacent-channel Power Meter	CMT-B6						1										
-						0											
-					0												
-				0													
2nd Attenuator	in model 54 1)		1														
-		0															
Example:																	
Readout on a display (hex)			4				2				4				9		
Binary		0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1



1) Fitted as standard

,2.3.9 Graphics Units
(model 54 only)

See also menus appended to section 2.3.9

2.3.9.1 General

Screen ***97*** of the CMTA allows menu-driven display of test signals either in time or spectrally.

The digital storage oscillocope features two operating modes:

The scope mode is a repetitive waveform acquisition (approx. 2 to 3 new displays per second) with autosweep function.

In the single-shot mode, a signal is recorded once upon a keystroke (ARM → ARMED) followed by a trigger event (without autosweep function) and can then be displayed and analyzed.

The AF spectrum analyzer has a bandwidth of 20 kHz with logarithmic and linear level scaling.

Signals up to 1 GHz can be displayed on the RF spectrum monitor.

Displays of measuring curves can be directly copied to an XY recorder. The XY recorder must be connected to the sockets ***113, 115, 117*** and ***119*** on the rear panel of the instrument. The graphic plot is started by means of the two special functions 210 SPEC and 211 SPEC. The special function 210 SPEC is selected for an XY recorder with PEN-LIFT-TTL signal active low, whereas 211 SPEC..is selected , if the PEN-LIFTTTL signal is active high. A graphic plot can be aborted using the special function 212 SPEC. As long as the XY recorder is switched on, the screen is dark.

Measuring curves can also be transferred to a controller via the IEC bus. Thsi applies to stored spectrum displays (marker mode) as well as to stored signals in single shot mode (see chapter 2.4.).

2.3.9.2 Keypad for Menu Operation

The graphics unit is menu-controlled using five screen-labelled softkeys ***101*** to ***105*** and another five keys ***100*** and ***106*** to ***109*** with fixed function. The currently valid function of the softkeys is indicated on the lower screen edge. The softkey functions can be changed by actuating SOFTKEY CHANGE ***100***, so that a total of ten screen-labelled keys is available in one menu. When actuating the MENU HOME key ***106***, the socalled home menu is obtained (highest menu level). When the level is to be changed within the menu tree, the next higher level is reached by MENU UP ***107***. For switching to the next lower menu level, the softkeys must be used. The variation keys ***108*** and ***109*** allow setting values to be reduced or increased.

A bar superimposed above the softkey labelling indicates the parameter that can presently be changed. The CMTA does not respond to softkeys that are not labelled. The same applies to keys ***100*** and ***106*** to ***109***.

Generally, different menus are displayed depending on the basic device status (setting of AF counter, transmitter or receiver test, 1st or 2nd input, AF or DEMOD distortion). Furthermore, the units and ranges of the measured values depend on the type of demodulation (AM, FM or ϕM) as well as on the attenuators or amplifiers that can be switched into circuit.

Note: (referring to menus appended to section 2.3.9)

A three-digit code number is assigned to each menu in the menu tree. The first digit identifies the branch, the second the menu level and the third is only for continuous numbering.

2.3.9.3 Home Menu (0.0.0)

When the instrument is switched on and the MENU HOME key ***106*** actuated, the home menu is displayed.

For displaying the test pattern (0.0.1), softkey ***105*** (not labelled) must be actuated. For returning to the home menu, keys ***100*** to ***109*** must be used.

Starting from the home menu, the menu tree of the CMTA graphics unit branches into three main menus:

Softkey ***101*** → scope mode
Softkey ***102*** → single-shot mode
Softkey ***103*** → spectrum mode

2.3.9.4 Scope Mode

2.3.9.4.1 Basic Settings

Starting from the home menu (0.0.0), the scope branch is reached by actuating the SCOPE softkey ***101***. Depending on the setting of the AF counter (keys ***9***, ***10*** and ***11***), one of the menus 1.1.1 to 1.1.4 is displayed.

Note:

If the basic device status (setting of AF counter) changes, display of the menus 1.1.1 to 1.1.4 is changed automatically.

The signal to be displayed is selected using the softkeys:

Menu 1.1.1

Internal signals:

- AF (AF VOLTM socket ***91***) → menu 1.2.1
- demodulated signal → menu 1.2.3
- distortion signal

External signal:

- (EXT socket ***80***) → menu 1.2.8

Menu 1.1.2

Internal signals:

- AF (AF VOLTM socket ***91***) → menu 1.2.1
- distortion signal

External signal:

- (EXT socket ***80***) → menu 1.2.8

Menu 1.1.3

Internal signal:

- demodulated signal → menu 1.2.3
- distortion signal

External signal:

- (EXT socket ***80***) → menu 1.2.8

Menu 1.1.4

Internal signal:

- BEAT signal → menu 1.2.7

External signal:

- (EXT socket ***80***) → menu 1.2.8

Note: (referring to distortion signal).

The signal from which the fundamental has been eliminated (notch filter with programmable centre frequency from 100 Hz to 5 kHz) is displayed. Depending on the device status (DIST key 25 and SINAD key 33), menu 1.25 (AF distortion) or menu 1.2.6 (DEMOD distortion) is displayed.

By selecting the signal to be displayed using the softkeys ***101, 102,103*** and ***105***, the second menu level (menus 1.2.1 to 1.2.9) is reached, where the signal appears on the screen and is updated about one to three times per second.

Note:

If the basic device status changes (setting of AF counter, keys 9, 10 and 11), the internal signal is always indicated automatically, i.e. there is a changeover between the menus 1.2.1 to 1.2.7 (second level).

The signal source and the operating mode can be changed by MENU UP ***107*** and MENU HOME ***106***.

The time base covers the range 0.05 ms/div to 50 ms/div with 1-2-5 division. The X deflection factors can be reduced or increased using the softkey >< ***101*** or <> ***102***.

Note:

With large time-base values, high signal frequencies cause aliasing.

The Y scale is superimposed on the screen and can be varied using the screen-labelled keys ***103*** and ***104***.

Signal	Min. range	Max. range	Unit	Remarks
EXT AC/DC	2 mV/DIV	5 V/DIV	mV, V	Amplitude
AF	1 mV/DIV	20 V/DIV	mV, V	Amplitude
DEMOD				
AM	0.1 %/DIV	40 %/DIV	%	Modulation depth
FM	20 Hz/DIV	40 kHz/DIV	Hz, kHz	Peak deviation
ΦM	0.01 rad/DIV	10 rad/DIV	rad	Peak deviation
BEAT, AF DIST DEMOD DIST	-	-	-	Y scale variable, but not labelled

Note:

Due to amplifiers and attenuators that can be switched into circuit, the minimum or maximum range cannot always be selected for large or small signals.

The CMTA features an autorange function for displaying the internal AF and DEMOD signals (menus 1.2.1 and 1.2.3). When actuating the BEST softkey ***105***, the most favourable display range is selected automatically. BEST is indicated in the headline of the screen. This continuously performed process can be switched off by actuating the MAN softkeys ***105***, ***103*** or ***104***. The scale can then be switched manually again using the softkeys ***101*** to ***104***.

Note:

The autorange function only works when the AF voltmeter or deviation meter is switched on.

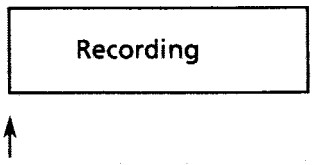
For displaying the external signal present at EXT socket ***80*** (menus 1.2.8 and 1.2.9), the signal coupling is selected by means of the AC/DC softkey ***105*** (toggle function; indication in headline).

2.3.9.4.2 Special Settings

- **Pre-trigger**

The digital storage oscilloscope of the CMTA allows waveforms occurring before the trigger event to be displayed. The pre-trigger can be adjusted in steps of 12.5%.

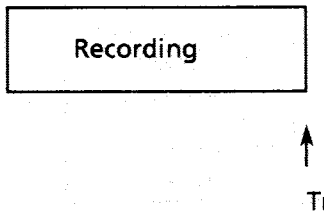
Normal function (pre-trigger = 0%)



Trigger point

Signals occurring after the trigger event are recorded only.

Pre-trigger function (pre-trigger = 100 %)

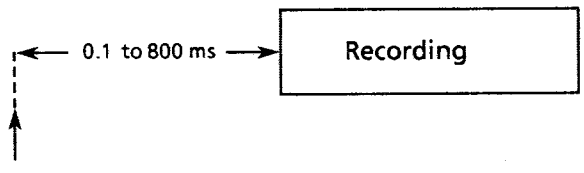


Trigger point

Signals occurring before the trigger event are recorded only.

- **Trigger delay**

The delay trigger allows recording to be started 0.1 to 800 ms after the occurrence of the trigger event.



Trigger point

A pre-trigger of greater than 0% necessitates a trigger delay time of 0 ms. Vice versa, the pre-trigger is set to 0% as soon as a trigger delay of greater than 0 ms is selected.

- **Trigger slope and trigger level**

Triggering is possible both on the positive and on the negative slope of the signal. The trigger level can be set from -8 divisions (DIV) to +8 divisions (referred to signal ground). It is independent of the setting of Y POS ***78***.

The Y POS control ***78*** is used for positioning the trace horizontally.

The following fixed settings apply to BEAT, AF distortion and DEMOD distortion signals (menus 1.2.5 to 1.2.7):

- positive trigger slope
- trigger level = 0 DIV (i.e. ground)
- pre-trigger = 0%
- delay time = 0 m

For AF, DEMOD and EXT signals (menus 1.2.1, 1.2.3 and 1.2.8), the enhanced functions can be selected by actuating SOFTKEY CHANGE ***100*** in the respective menu, thus switching over to the menus 1.2.2, 1.2.4 and 1.2.9. The original menu is restored by actuating again SOFTKEY CHANGE ***100***.

- **Settings**

Selecting the trigger slope

The trigger slope is selected by the SLOPE softkey ***101*** (toggle function).

Selecting the pre-trigger

Input:

(e.g. 50 %) 5 0 PRE-T ***102***

(the unit need not be entered, automatic rounding to 12.5% steps)

Variation:

- Actuate PRE-T softkey ***102*** (a bar is displayed above PRE-T)
- Use the two variation keys ***108*** and ***109*** (labelling is displayed) to vary the pre-trigger as appropriate

Selecting the trigger level

Input:

(e.g. -3.1 DIV) - 3 . 1 T-LEV ***103***

(the unit need not be entered)

Variation:

- Actuate the T-LEV softkey ***103*** (a bar is displayed above T-LEV)
- Use the two variation keys ***108*** and ***109*** to vary the trigger level (in steps of 0.1 DIV)

Selecting the delay time

Input:

(e.g. 25.1 ms) 2 5 . 1 DELAY ***104***

(the unit need not be entered)

Variation:

- Actuate DELAY softkey ***104*** (a bar is displayed above DELAY)
- Use the two variation keys ***108*** and ***109*** to vary the trigger delay time (in steps of 0.1 ms or 1 ms for valuts greater than 100 ms)

2.3.9.5 Single-Shot Mode

2.3.9.5.1 Basic Settings

Starting from the home menu (0.0.0), the single-shot branch is reached by actuating the SINGLE softkey ***102***. Depending on the setting of the AF counter (keys ***9***, ***10*** and ***11***), one of the menus 2.1.1 to 2.1.4 is displayed.

Note:

If the basic device status changes (setting of AF counter or demodulation)), display of the menus 2.1.1 to 2.1.6 is changed automatically.

At this first menu level, the signal to be recorded is selected by means of the softkeys:

Menu 2.1.1

Internal signals:

- AF (AF VOLTM socket ***91***) → menu 2.2.1
- demodulated signal → menu 2.2.2

External signal:

- (EXT socket ***80***) → menu 2.2.4

Menu 2.1.2

Internal signal:

- AF (AF VOLTM socket ***91***) → menu 2.2.1

External signal:

- (EXT socket ***80***) → menu 2.2.4

Menu 2.1.3

Internal signal:

- demodulated signal → menu 2.2.2

External signal:

- (EXT socket ***80***) → menu 2.2.4

Menu 2.1.4

Internal signal:

- (BEAT signal) → menu 2.2.3
- RF-LEV (transient RF-level-measurement) menu 2.2.6

External signal:

- (EXT socket ***80***) → menu 2.2.4

Menu 2.1.5

internal signals:

- AF (AF VOLTM socket ***91***) → menu 2.2.1
- demodulated signal → menu 2.2.2
- FM-DC (frequency settling) → menu 2.2.5

external signal:

- (EXT socket **80**) → menu 2.2.4

Menu 2.1.6

internal signals:

- demodulated signal → menu 2.2.2
- FM-DC (frequency settling) → menu 2.2.3

external signal:

- (EXT socket **80**) → menu 2.2.4

By selecting the signal to be displayed using the softkeys ***101***, ***102***, ***103*** and ***105***, the second menu level is reached, where the trigger source is selected. The signal itself (AF, DEMOD,FM-DC,BEAT, RF-LEV) or a voltage at the EXT socket ***80*** (with AC or DC coupling) are available as a trigger source.

AC or DC coupling of the signal is selected in menu 2.2.4.

Note:

If the setting of the AF counter or the demodulation changes (basic device status, keys 9, 10,11 and 22), it may be possible, that the selected internal signals will not be recorded. Therefore, the first menu level is automatically restored (signal selection, menus 2.1.1 to 2.1.6).

2.3.9.5.2 Special Settings

By selecting the trigger source in menu 2.2.6 (RF-LEV) menu 2.2.7 is reached, where the input attenuator is selected.

By selecting the trigger source in menus 2.2.1 to 2.2.5 or by selecting an attenuator pad in menu 2.2.7 using the softkeys ***101*** to ***105***, the third menu level is reached, the so-called setting menu.

The following settings can be made:

- **Storage time**

Ten ranges (3.2 ms to 3200 ms) with 1-2-5 division are available.

Input:

(e.g. 3.2 ms) 3 . 2 TIME ***101***
(the unit need not be entered, automatic rounding to 1-2-5-division.)

Variation:

- Actuate TIME softkey ***101*** (a bar is displayed above "TIME")
- Use the two variation keys ***108*** and ***109*** to select the desired storage time

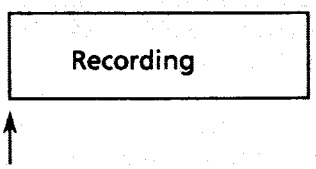
Note:

With long storage times, high signal frequencies cause aliasing.

- **Pre-trigger**

With the aid of the pre-trigger, the recording times before and after the trigger event can be set. The pre-trigger can be set in steps of 12.5%.

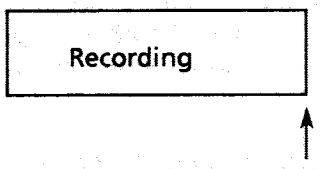
Normal function (pre-trigger = 0%)



Trigger point

Signals occurring after the trigger event are recorded only.

Pre-trigger function (pre-trigger = 100%)



Trigger point

Signals occurring before the trigger event are recorded only.

Selecting the pre-trigger

Input:

(e.g. 50 %) 5 0 PRE-T ***102***

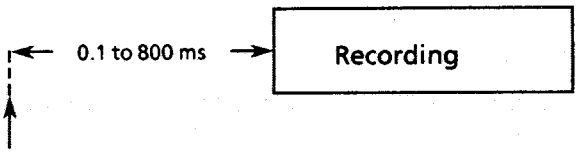
(the unit need not be entered, automatic rounding to 12.5% steps)

Variation:

- Actuate the PRE-T softkey ***102*** (a bar is displayed above PRE-T)
- Use the two variation keys ***108*** and ***109*** to vary the value displayed on the screen as appropriate

- **Trigger delay**

The delay trigger allows recording to be started 0.1 to 800 ms after the occurrence of the trigger event.



Trigger point

A pre-trigger of greater than 0% necessitates a trigger delay time of 0 ms. Vice versa, the pre-trigger is set to 0% as soon as trigger delay time of greater than 0 ms is selected.

Selecting the delay time

Input:

(e.g. 25.1 ms) 2 5 . 1 DELAY ***103***

(the unit need not be entered)

Variation:

- Actuate the DELAY softkey ***103*** (a bar is displayed above DELAY)
- Use the two variation keys ***108*** and ***109*** to vary the trigger delay time (in steps of 0.1 ms or 1 ms for values greater than 100 ms).

For setting the trigger slope, the trigger level and the amplitude, SOFTKEY CHANGE ***100*** must be actuated first. The original values are restored by actuating SOFTKEY CHANGE again.

- **Trigger level**

The trigger level can be adjusted from -8 divisions (DIV) to +8 divisions (referred to signal ground). It is independent of the setting of Y POS ***78***. If at the second menu level a voltage at the EXT socket ***80*** rather than the signal itself has been selected as the trigger source, the trigger level is fixed to 0 V (AC coupling) or 1.2 V (DC coupling).

Selecting the trigger level

Input:

(e.g. -3.5 DIV) - 3 . 5 T-LEV ***101***

(the unit need not be entered)

Variation:

- Actuate T-LEV softkey ***101*** (a bar is displayed above T-LEV)
- Use the two variation keys ***108*** and ***109*** to vary the trigger level (in steps of 0.1 DIV)

- **Trigger slope**

The trigger slope is selected using the SLOPE softkey ***102*** (toggle function).

- **Amplitude**

The possible ranges and units correspond to those in scope mode (see table in section 2.3.9.4.1). The amplitude of the BEAT signal is however labelled as relative value in dB. The value range of the RF-LEV signal depends on the attenuator selected in menu 2.2.7 and on the input selection (INPUT SELECT ***85***).

Input:

(e.g. 100 mV/DIV) 100 mV AMPL ***103***
(the unit need not be entered, automatic rounding to 1-2-5-division)

Variation:

- Actuate AMPL softkey ***103*** (a bar is displayed above AMPL)
- Use the two variation keys ***108*** and ***109*** to vary the amplitude as appropriate.

Note:

If the setting of the AF counter or the demodulation is changed (basic device status, keys 9, 10, 11 and 22), it may be possible that the selected internal signal will not be recorded. Therefore, the first menu level is automatically restored (new signal selection, menus 2.1.1 to 2.1.6). IN RF-LEV mode a switchover is made to menu 2.2.7 upon INPUT SELECT 85 (new selection of the input attenuator).

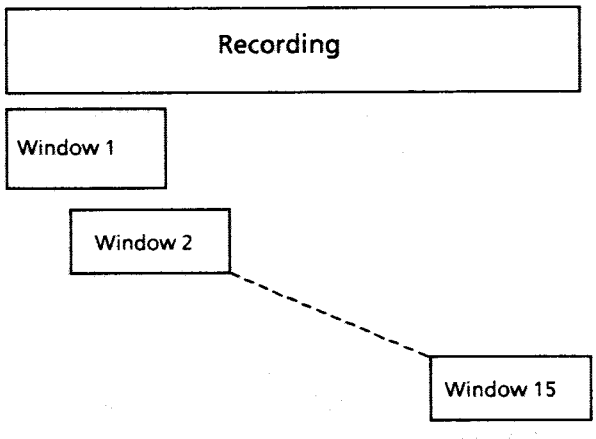
When all settings have been made, recording can be started by actuating the ARM softkey ***105***, which is then labelled "ARMED".

As soon as a valid trigger event occurs, switch-over is made to the fourth menu level and the recorded signal displayed on the screen (menus 2.4.1 to 2.4.13).

If no trigger pulse occurs, the softkeys ***101*** to ***103*** and SOFTKEY CHANGE ***100*** can be used to vary the settings (e.g. the trigger level). Softkey ***105*** is then labelled "ARM" again. Another trigger source can, for instance, also be selected using MENU UP ***107***.

The display at the fourth menu level shows only one eighth of the total memory and hence also only one eighth of the signal recorded. This displayed window can be shifted over the entire recorded range in a total of fifteen subranges with 50% overlapping.

The displayed window is shifted using the softkeys < 101 and > 105.



The width of the displayed window is one eighth of the recording period, i.e. 1/8 of the storage time (storage time see setting menu). The time 0 ms refers to the trigger point. Negative times refer to events before the trigger pulse. The pre-trigger and delay-time settings influence the window times.

Examples:

Delay time:		0 ms	
Pre-trigger:		100 %	
Storage time:		320ms	
Possible window labelling:		-320 ms	-280 ms
	to	-40 ms	0 ms
Delay time:		800 ms	
Pre-trigger:		0 %	
Storage time:		3200 ms	
Possible window labelling:		800 ms	1200 ms
	to	3600 ms	4000 ms

With a delay time of 0 ms and varied pre-trigger and when changing from the third to the fourth menu level, the default setting of the window range is selected so that the trigger point is in the display centre. The Y scale for determining the signal amplitude (except: BEAT signal indicated with relative values) is also super-imposed on the screen.

A new recording can be started using the ARM softkey ***103*** (ARMED being displayed). If settings are to be varied, the third menu level (setting menu) must be recalled using MENU UP ***107***.

Menus 2.4.2 to 2.4.14 are reached by pressing SOFTKEY-CHANGE.***100***.

By means of the two softkeys CURS 1 ***101*** and CURS 2 ***105*** two cursor lines can be output on the display allowing for time measurements of the stored signal.

Direct input of the cursor line:

(e.g.- 20 ms) - 2 0 CURS1 ***101***

(the unit need not be entered)

Variation:

- Press softkey CURS1 ***101*** (a bar is displayed above "CURS1").

- Change the position using the two variation keys ***108*** and ***109***

The second cursor line is input or varied analogously. The respective positions of the cursor lines are indicated on the screen via CURS1 or CURS2).

If the two cursors are positioned so far from each other, that they are not displayed in the same window, the window is selected such, that the cursor, which was the last to be input or varied, is displayed (indicated by the bar above "CURS1" or "CURS2").

Apart from the cursors the amplitude scale is output on the display. The difference (absolute value) between the two cursor lines is displayed upon actuating the DELTA softkey ***103***

Actuating SOFTKEY CHANGE ***100*** causes a switch-over to the menus 2.4.1 to 2.4.13.

By pressing the MENU-UP key ***107*** the third level (setting menu) is reached again.

Note: If the setting of the AF counter or the demodulation changes (basic device staturs, keys 9, 10, 11 and 22), it may be possible that the selected internal signals will not be recorded. Therefore, the first menu level is automatically restored (new signal selection, menus 2.11 to 2.1.5). In RF-LEV mode a switchover is made to menu 2.2.7 upon INPUT SELECT 85 (new selection of the input attenuator).

2.3.9.5.3 Examples for the Application of Single-Shot Mode

Measuring the frequency settling (FM-DC)

Example:

- Response of the HF-Synthesizer when set to a new output frequency
- Changing the channel on a transceiver

Frequency changes in the ± 120 kHz range , i.e. a maximum deviation of 240 kHz, are directly visible on the screen.

The following adjustment s are necessary:

- Select 1st or 2nd input (INPUT SELECT ***85***)
- Set the transmitting frequency of the transceiver using the SET key f ***6***
- Select Scope mode and center the trace by means of the Y POS control ***78***
- Call Home menu (MENU HOME key ***106***)
- Select Single-Shot Mode (Softkey ***102***)
- Signal: FM-DC (Softkey ***103***)
- Trigger source: FM-DC (Softkey ***101***)
- Setting menu:
  - Store-Time according to the frequency settling time
  - Pre-Trigger preferably 25%
  - Delay-Time 0 ms
- Channel change upward : positive trigger level (e.g. +1.0 DIV) positive slope
- Channel change downward : negative trigger level (e.g. -1.0 DIV) negative slope
- Amplitude: 40 kHz/DIV or 20 kHz/DIV or 10 kHz/DIV depending on the channel spacing
- Press Softkey ARM ***105***
- Switch over to another channel on the transceiver

→ Respective figure is displayed

Option:

Instead of the (FM-DC) signal the EXT ***80*** socket is used as trigger source (Set EXT DC).

If the EXT ***80*** socket is connected to the RF-Power Indication socket ***126***, the trigger is initiated as soon as power is applied.

Transient RF-Level Measurement (RF-LEV)

Example:

- Response of an RF-Synthesizer when set to a new output level (switchover time of the RF attenuator etc.)
- Increasing power at the transceiver

A beat signal with absolute level scaling in (milli-) volts is displayed on the screen of the storage oscilloscope.The envelope curve of this beat signal shows the time sequence of the RF level or the RF power.

The following adjustments are necessary:

- Select 1st or 2nd input (INPUT SELECT ***85***)
- Set the beat signal using the SET key f ***6*** (i.e. choose frequency of e.g. 1 kHz from transmitting frequency)
- Set the basic model to the BEAT position by means of the DEMOD-BEAT key ***9***
- Call Home menu (MENU HOME key ***106***)
- Select single-shot mode (Softkey ***102***)
- Signal: RF-LEV (Softkey ***103***)
- Trigger source: RF-LEV (Softkey ***101***)
- Select suitable RF attenuator
- Setting menu:
  - Store time according to the settling time and the selected beat frequency
  - Pre-Trigger preferably 25 %
  - Delay-Time 0 ms
  - Trigger-Level 0,0 DIV
  - positive slope
  - Amplitude according to the power
- Press softkey ARM ***105***
- Increase power at the test item

→ Respective figure is displayed

Note: ***The beat signal indicates even simultaneous frequency changes.***

Option:

A trigger pulse is initiated via the EXT ***80*** socket, e.g. at the moment the operating voltage of the transceiver changes.

2.3.9.6 Spectrum Mode

2.3.9.6.1 General

Starting from the home menu (0.0.0), the spectrum branch is reached by actuating the SPECT softkey ***103***. Depending on the basic device status (transmitter/receiver test (LEDs ***58***, ***59*** and key ***60***), setting of AF counter (keys ***9***, ***10*** and ***11***)), one of the menus 3.1.1 to 3.1.8 is displayed.
Note:

If this device status changes, display of the menus 3.1.1 to 3.1.8 is changed automatically.

At this first menu level, the signal to be displayed is selected using the softkeys:

Transmitter test (menus 3.1.1 to 3.1.4)

AF	Signal of AF voltmeter (AF VOLTM ***91***)	Menu 3.2.1
DEMOD	Demod. signal	Menu 3.2.3
BEAT	BEAT signal	Menu 3.2.5
EXT	Signal at EXT socket ***80***	Menu 3.2.7
SSB	Single sideband RF signal, see section 2.3.9.6.3	Menu 3.2.21 or 3.2.22
RF	RF signal (RF spectrum analyzer), see section 2.3.9.6.4	Menu 3.2.23 or 3.2.24

Receiver test (menus 3.1.5 to 3.1.8)

AF	Signal of AF voltmeter (AF VOLTM ***91***)	Menu 3.2.1
DEMOD	Demodulated signal	Menu 3.2.3
BEAT	BEAT signal	Menu 3.2.5
EXT	Signal at EXT socket ***80***	Menu 3.2.7
LSB	Lower sideband signal of AF voltmeter (AF VOLTM ***91***), see sections 2.3.9.6.2 and 2.3.9.6.3	Menu 3.2.9
USB	Upper sideband signal of AF voltmeter (AF VOLTM ***91***), see sections 2.3.9.6.2 and 2.3.9.6.3	Menu 3.2.11

By selecting the signal to be displayed using the softkeys ***101*** to ***105***, the second menu level is reached. With SSB analyzer (transmitter test) and RF spectrum analyzer (basic device status: transmitter test) switched on, the setting menus 3.2.21 to 3.2.24 (see sections 2.3.9.6.3 and 2.3.9.6.4) are displayed.

If the Adjacent-channel Power Meter CMT-B6 is fitted, the RF spectrum monitor and the SSB spectrum analyzer (transmitter test) exhibit spurious responses at 800 MHz and partly at the associated subharmonics in the form of interference lines.

After selection of the AF, DEMOD, BEAT, EXT, LSB or USB signals, the AF spectrum analyzer (see section 2.3.9.6.2) is put into operation (menus 3.2.1 to 3.2.12).

Note:

If the setting of the AF counter is changed (keys 9 to 11), the spectrum of the internal signal (AF, DEMOD or BEAT) is displayed automatically, i.e. there is a changeover of the menus at the second level. The instrument switches to a menu at the first level when it changes from receiver test to transmitter test whilst in single-sideband signal analysis (LSB or USB).

2.3.9.6.2 AF Spectrum Analyzer

The AF spectrum analyzer features three different amplitude scales. It is possible to choose between linear display and logarithmic scale with 10 dB per division or 2 dB per division. The uppermost grid line is the adjustable reference level.

Three resolution filters are available for the AF spectrum analyzer (menus 3.2.1 to 3.2.12) which are selected automatically depending on the set frequency span. The relationship between frequency span, resolution filter bandwidth and sweep time is shown in the following table.

Span	Resolution filter bandwidth	Sweep time
0 to 3.2 kHz	narrow	long
1.6 to 8 kHz	medium	medium
4 to 20 kHz	broad	short

- **Reference level**

Selecting the reference level

The level can be entered in dBV or in mV.

Input:

(e.g. -6 dBV) `- 6 dBV REF-LEV` ***103***

(e.g. 25 mV) `2 5 mV REF-LEV` ***103***

Variation :

- Actuate REF LEV softkey ***103*** (a bar is displayed above REF LEV)
- Use the two variation keys ***108*** and ***109*** to vary the reference level (in 1-dB steps).

When entering `dBV REF-LEV` and `mV REF-LEV`, the reference levels are always converted into the other unit and indicated on the screen above the REF-LEV label. The demodulated signal can be output in the units %, Hz, kHz or rad.

- **Amplitude scale**

Selecting the amplitude scale

The amplitude scale is always displayed on the top right of the screen. This scale can be changed by actuating SOFTKEY CHANGE ***100*** and then the softkeys***103***, ***104*** or ***105***. The normal menu is restored by actuating SOFTKEY CHANGE ***100*** again.

Note: (referring to BEAT signal)

The reference level is not labelled, since an absolute level measurement is not possible.

- **Start and stop frequency (or center and span)**

Start, center and stop frequency are in the range 0 Hz to 20 kHz with a resolution of 1 Hz. The frequency span may cover 0 Hz to 20 kHz with a resolution of 16 Hz. These four values can be entered. The start and the stop frequencies are always indicated on the screen.

Selecting the start frequency

Input:

(e.g. 500 Hz) 5 0 0 Hz START ***101***

The stop frequency is adjusted and displayed so that the span is an even-numbered multiple of 16 Hz. If the selected start frequency is greater than the stop frequency, the stop frequency is set equal to the start frequency.

Selecting the stop frequency

Input:

(e.g. 15 kHz) 1 5 kHz STOP ***105***

The start frequency is adjusted and displayed so that the span is an even-numbered multiple of 16 Hz. If the selected stop frequency is smaller than the start frequency, the start frequency is set equal to the stop frequency.

Selecting the center frequency

Input:

(e.g. 9.5 kHz) 9 . 5 kHz CENT ***102***

Start and stop frequency are selected so that the required center frequency of 1 Hz is exactly adhered to. The span (even-numbered multiple of 16 Hz) is limited to the maximum value when the range is exceeded (0 Hz or 20 kHz).

Selecting the frequency span

Input:

(e.g. 800 Hz) 8 0 0 Hz SPAN ***104***

The center frequency is not varied. The span (even-numbered multiple of 16 Hz) is set to the maximum value when the range is exceeded.

Variation:

- The variation keys ***108*** and ***109*** can be used to vary the frequency value marked by the variation bar above the labelling.

Note: (referring to BEAT signal)

If a frequency which is 10 kHz higher or lower than a spectral line to be measured is entered using SET f key ***6***, the AF spectrum analyzer can be used as a narrowband (20 kHz) RF analyzer. Image frequencies will however occur symmetrically about the 0-Hz AF frequency (corresponds to the selected mixer frequency).

2.3.9.6.3 SSB Analyzer

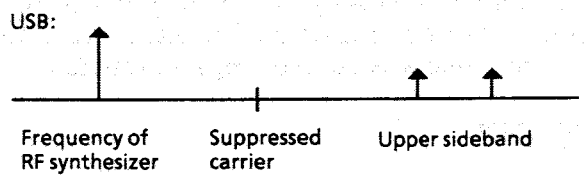
Receiver test (menus 3.2.9 to 3.2.12)

At the RF socket ***84***, the CMTA provides an SSB signal with single or two-tone modulation for the transceiver.

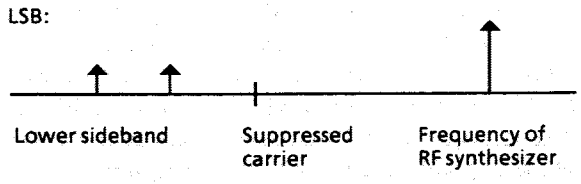
The signal demodulated by the transceiver can be fed into CMTA via the AF VOLTM socket ***91*** and spectrally displayed (frequency range 0 Hz to 20 kHz, see also section 2.3.9.6.2).

As soon as the softkeys LSB ***104*** (lower sideband) and USB ***105*** (upper sideband) are actuated at the first menu level of the spectrum branch, the CMTA provides a pseudo SSB signal at the RF socket RF ***84***.

The suppressed carrier is entered via the f key ***5***. The modulation frequencies are selected using the keys AF INT 1 ***10*** and AF INT 2 ***11***.



The frequency of the amplitude-modulated RF synthesizer is 10 kHz below the desired suppressed carrier. The AF generator signals are increased by 10 kHz.



The frequency of the amplitude-modulated RF synthesizer is 10 kHz above the desired suppressed carrier. The AF generator signals are increased by 10 kHz.

Transmitter test

The suppressed carrier frequency is set using the SET f key ***6***. The spectrum analyzer allows narrowband display of the signal applied to sockets RF ***84*** or INPUT 2 ***86*** (switchover by means of INPUT SELECT ***85***). The frequency of 0 Hz corresponds to the position of the suppressed carrier. Positive frequencies up to 8 kHz represent the upper sideband, negative frequencies down to -8 kHz the lower sideband. As soon as the SSB key ***104*** is actuated at the first menu level of the spectrum branch, switchover to menu 3.2.21 or 3.2.22 is made, where the input attenuator is selected.

After one of the softkeys 0 dB, 10 dB, 20 dB or 30 dB (***102*** to ***105***) has been actuated, the SSB signal spectrum (menu 3.3.1) is displayed on the screen. If the input signal power is unknown, a 30-dB input attenuator should be selected in order to avoid damage to the input mixer. If the dynamic range is too small, it is possible to return to the menu 3.2.21 or 3.2.22 using MENU UP ***107*** and to select a smaller attenuation. If the signal is applied to the RF socket ***84*** and the power meter switched on, the CMTA is able to automatically select the input attenuator (AUTO softkey ***101***).

Note:

When the input is switched over (INPUT SELECT 85), one of the menus 3.2.21 or 3.2.22 is always displayed.

If the device status changes from transmitter test to receiver test, switchover is automatically made from the second or third menu level to the first level.

The following settings can be made in the menus 3.3.1 and 3.3.2 (third level):

The start and stop frequency (range -8 kHz to + 8 kHz with 1 Hz resolution) is selected using the softkeys START ***101*** and STOP ***105***. If one of these frequencies has been selected, the other one is adjusted so that the difference of stop minus start frequency is an even-numbered multiple of 16 Hz.

Examples:

Start frequency - 4 kHz

Input:

`- 4 kHz  START` ***101***

Stop frequency 800 Hz

Input:

`8 0 0 Hz  STOP` ***105***

The variation keys ***108*** and ***109*** can be used if a bar is displayed above the respective labelling.

The reference level can be entered in dBm, dBµV or mV using the REF-LEV softkey ***103***.

Examples:

Reference level -20 dBm

Input:

`- 2 0 dBm  REF-LEV` ***103***

Reference level 50 mV

Input:

5 0 mV REF-LEV ***103***

Reference level 30 dBµV

Input:

3 0 dBµV REF-LEV ***103***

Varying the reference level:

- Actuate REF-LEV softkey ***103*** (a bar is displayed above REF-LEV)
- Use the two variation keys ***108*** and ***109*** to vary the reference level (in steps of 1 dB)

When entering a unit (dBm, dBµV, mV) and REF-LEV ***103***, the reference level is converted into the unit selected and displayed above the REF-LEV labelling.

The amplitude scale is always superimposed on the top right of the screen. This scale can be changed by actuating SOFTKEY CHANGE ***100*** and then the softkeys ***103***, ***104*** or ***105***. The normal menu is restored by actuating SOFTKEY CHANGE 100 again.

Note:

If the SSB analyzer is switched on a frequency of 12 kHz is entered. The LO is below the suppressed carrier (default), which is advantageous for signals in the upper side band. The LO should be above the suppressed carrier for signals in the lower side band, which can be selected using the special function 221 SPEC.

The SSB spectrum analyzer mode allows for accurate measurements of low RF levels and their exact fequencies. Narrowband modulation spectra can be displayed at high frequency selectivity.

2.3.9.6.4 RF Spectrum Monitor

If the CMTA is in transmitter test mode and the RF softkey ***105*** is actuated at the first menu level of the spectrum branch, the RF spectrum analyzer is switched on (menu 3.2.23 or 3.2.24 is displayed).

The RF signal applied to RF socket ***84*** or INPUT 2 86 (switchover by means of INPUT SELECT 85) can be displayed.

The input attenuator is selected at the second menu level using the softkeys ***102*** to ***105***. After one of the softkeys 0 dB, 10 dB, 20 dB or 30 dB (***102*** to ***105***) has been actuated, the spectrum analysis is started (menu 3.3.3, third menu level). If the input voltage is unknown, the 30-dB attenuator should be selected in order to avoid damage to the input mixer.

If the dynamic range is too small, menu 3.2.23 or 3.2.24 can be restored using MENU UP ***107*** and a smaller attenuation selected. If the signal at RF socket ***84*** is to be analyzed and the power meter switched on, the CMTA is able to automatically select the input attenuator (AUTO softkey ***101***).

Note:

When the input is switched over (INPUT SELECT 85), one of the menus 3.2.23 or 3.2.24 is always displayed.

If the device status changes from transmitter test to receiver test, switchover is automatically made from the second or third menu level to the first level.

In the spectrum mode, a few settings and measurements (e.g. demodulation, ACP, deviation measurements) are no longer possible on the basic unit.

The following settings can be made in the menus 3.3.3 and 3.3.4 (third level):

The center frequency (range 0.4 MHz to 1000 MHz, resolution 1 kHz) is selected using the CENTER softkey ***103***.

The desired frequency span (30 kHz to 10 MHz) is entered using the SPAN softkey ***105***.

Examples:

Center frequency 999.999 MHz

Input:

`9 9 9 . 9 9 9 MHz CENTER` ***103***

Frequency span 100 kHz

Input:

`1 0 0 kHz SPAN` ***105***

When actuating the softkeys CENTER ***103*** or SPAN ***105***, a bar is displayed above the labelling. The center frequency or frequency span can then be varied using the variation keys ***108*** or ***109***.

Four resolution filters are available which are automatically selected depending on the set frequency span. The four frequency ranges are overlapping:

30	kHz	to	300	kHz
100	kHz	to	1	MHz
300	kHz	to	3	MHz
1	MHz	to	10	MHz

The reference level is set by means of the REF-LEV softkey ***101*** and can be entered in dBm, dBµV or mV. When entering a unit and REF-LEV ***101***, the reference level is converted into the selected unit and indicated above the REF-LEV labelling.

Examples:

Reference level -20 dBm

Input:

`- 2 0 dBm REF-LEV` ***101***

Reference level 50 mV

Input:

`5 0 mV REF-LEV` ***101***

Reference level 30 dBµV

Input:

`3 0 dBµV REF-LEV` ***101***

Varying the reference level:

- Actuate the REF-LEV softkey ***101*** (a bar is displayed above REF-LEV)
- Use the two variation keys ***108*** and ***109*** to vary the reference level (in steps of 1 dB)

The amplitude scale is always displayed on the top right of the screen. This scale can be changed by actuating SOFTKEY CHANGE ***100*** and the softkeys ***103***, ***104*** or ***105***. Frequency and level entry is restored by actuating SOFTKEY CHANGE ***100*** again.

2.3.9.6.5 Marker Mode

At all spectrum menus (AF, DEMOD, BEAT, LSB, USB, SSB and RF) a new measuring cycle is automatically started when the preceding one ends.

The MARKER softkey ***101*** allows for interrupting the measurement after the measuring cycle, thus enabling a detailed analysis of the amplitude and frequency of the signal spectrum recorded. Further measurements can be performed by pressing the CONT ***105*** key.

How to switch on the marker mode:

First press the SOFTKEY-CHANGE key ***100***, then press the MARKER softkey ***101***. The frequency may be entered simultaneously.

Example:

NF spectrum analyzer : Start 0 kHz, Stop 4 kHz, marker point at 1 kHz

Input:

0 kHz START ***101***
4 kHz STOP ***105***
SOFTKEY-CHANGE ***100***
1 kHz MARKER ***101***

After the measurement has been carried out the frequency and the amplitude are displayed on the screen (except: BEAT-Signal). The marker position may now be changed at will.

Variation:

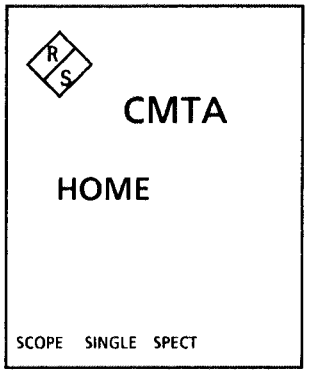
- change the position of the marker using the two variation keys ***108*** and ***109*** (in smallest possible steps).

Note:

Three dashes are displayed in case of amplitude overshoot or undershoot.

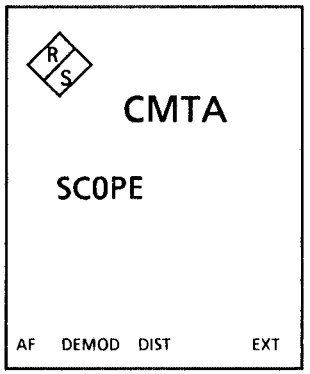
HOME menu

0.0.0

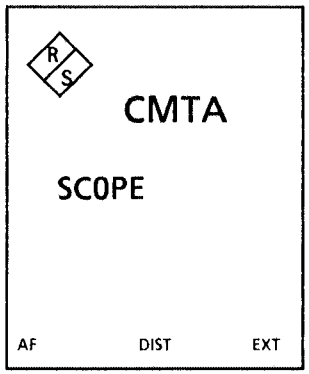


SCOPE menu (level 1)

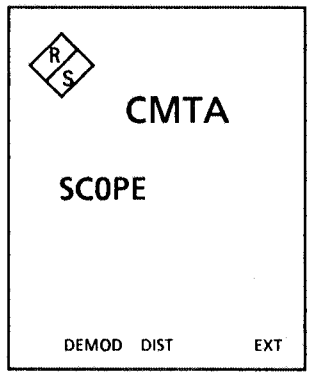
1.1.1



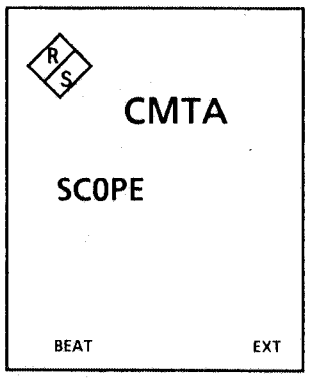
1.1.2



1.1.3

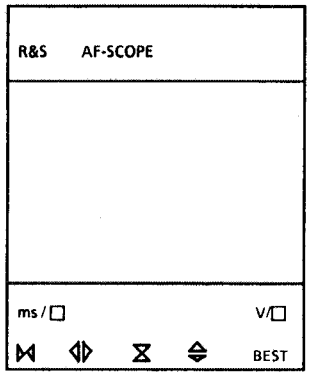


1.1.4

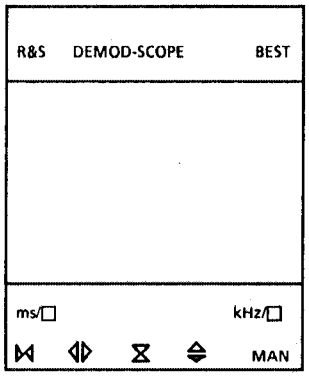


SCOPE menu (level 2)

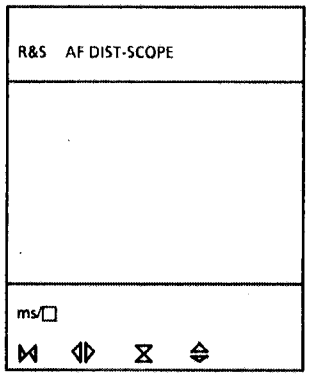
1.2.1



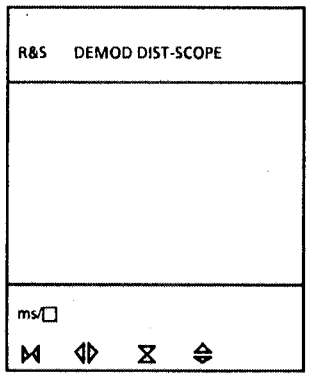
1.2.3



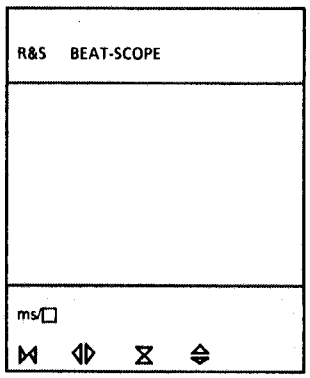
1.2.5



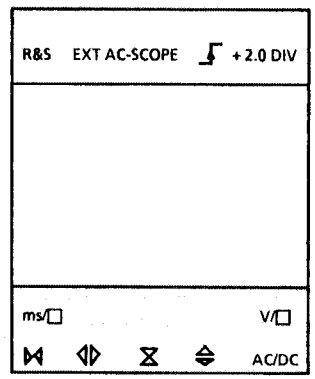
1.2.6



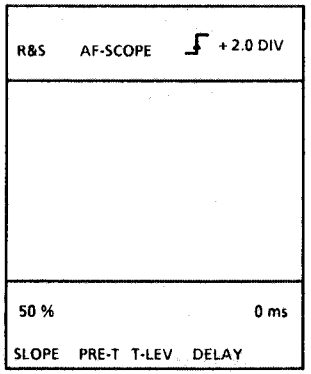
1.2.7



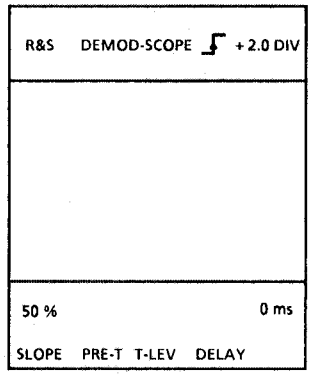
1.2.8



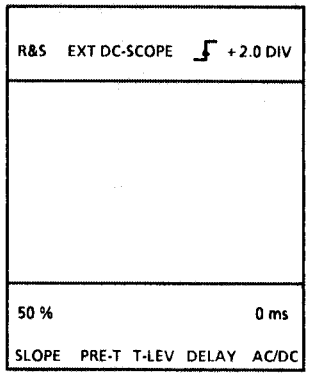
1.2.2



1.2.4

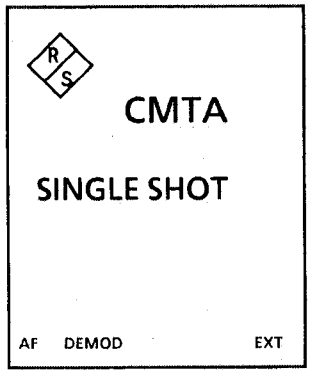


1.2.9

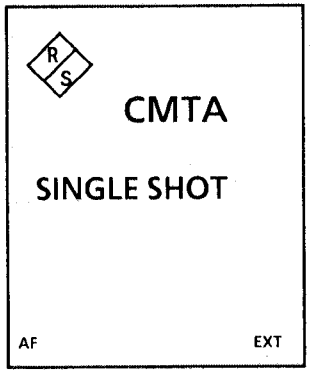


SINGLE SHOT menu (level 1)

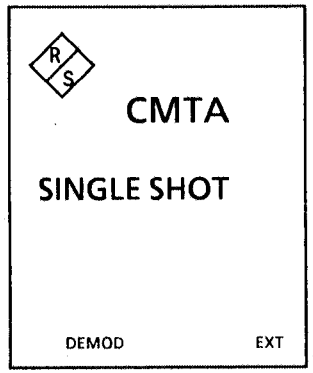
2.1.1



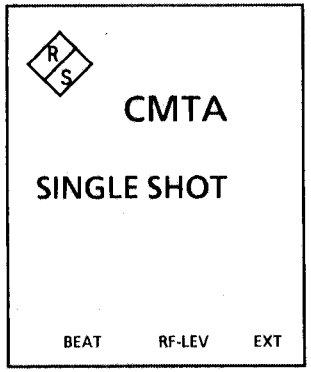
2.1.2



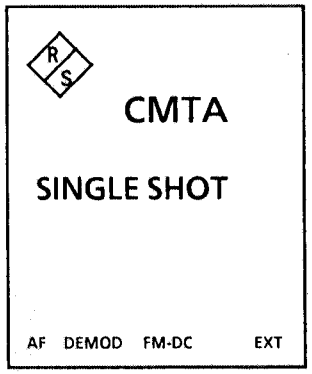
2.1.3



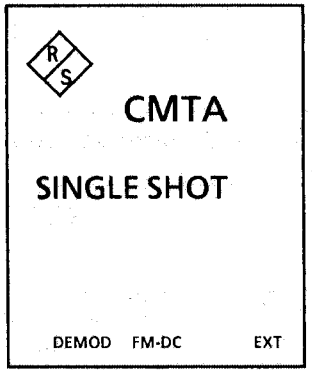
2.1.4



2.1.5

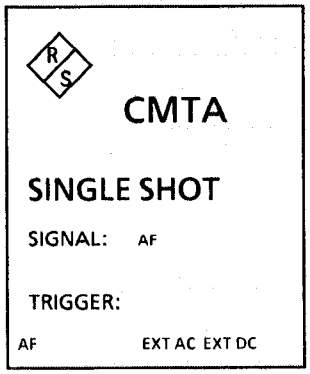


2.1.6

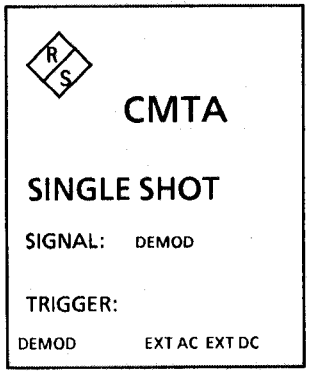


SINGLE SHOT menu (level 2)

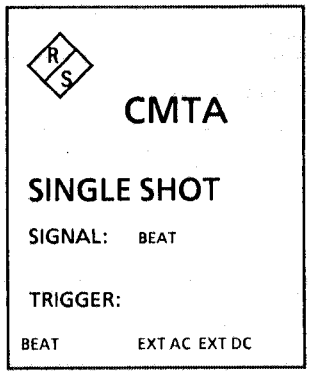
2.2.1



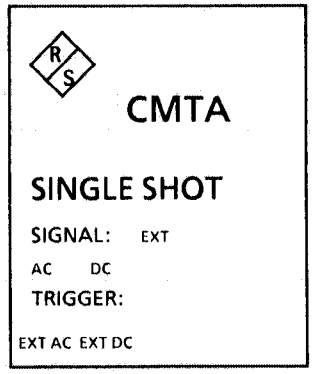
2.2.2



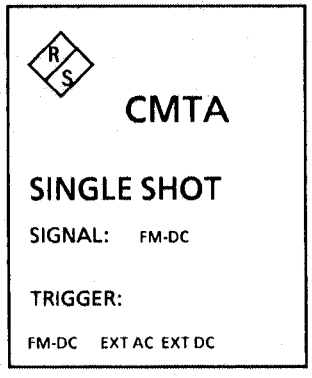
2.2.3



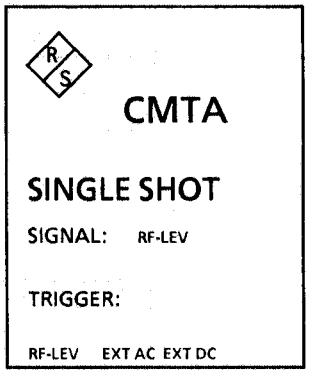
2.2.4



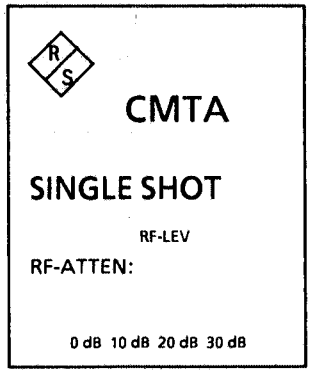
2.2.5



2.2.6

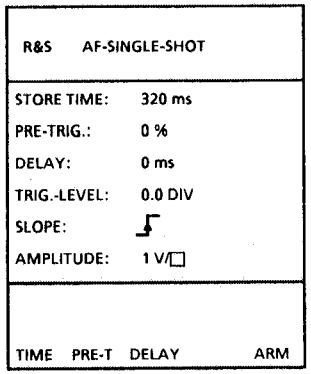


2.2.7

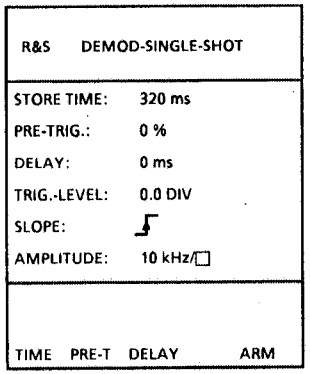


SINGLE SHOT menu (level 3)

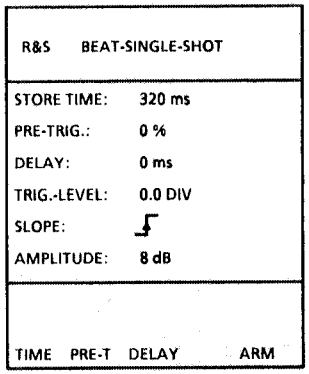
2.3.1



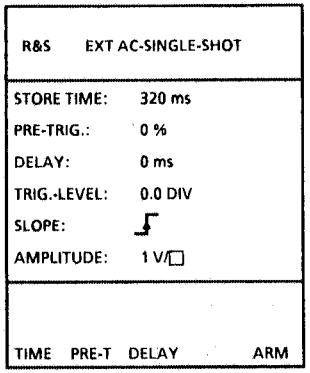
2.3.3



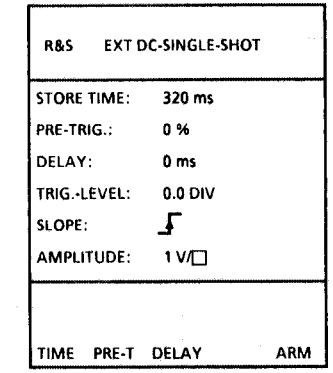
2.3.5



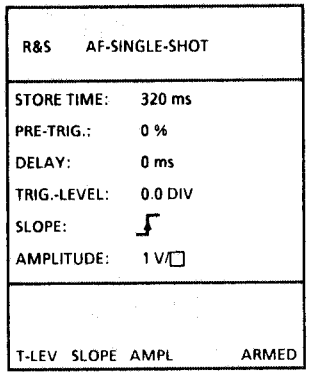
2.3.7



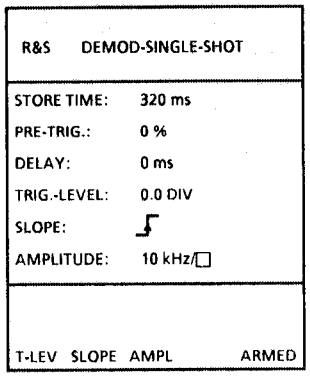
2.3.9



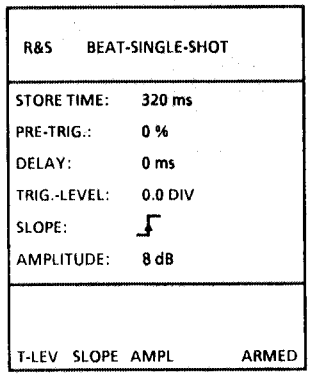
2.3.2



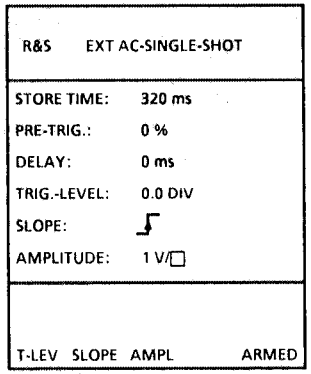
2.3.4



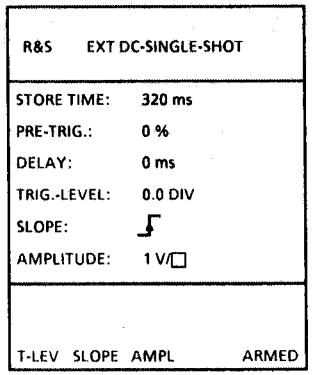
2.3.6



2.3.8

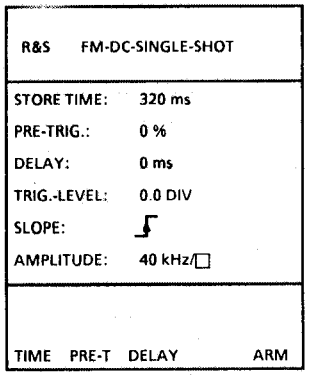


2.3.10

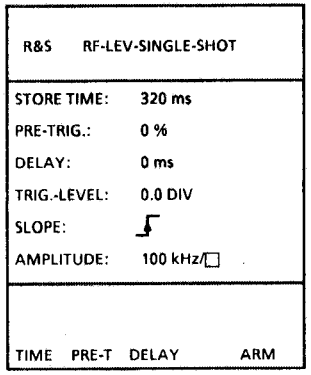


SINGLE SHOT menu (level 3)

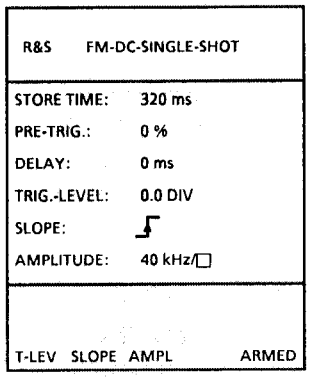
2.3.11



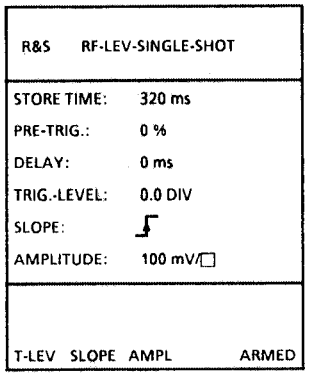
2.3.13



2.3.12

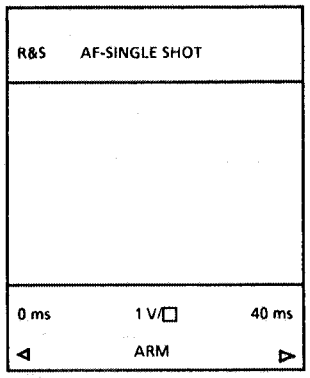


2.3.14

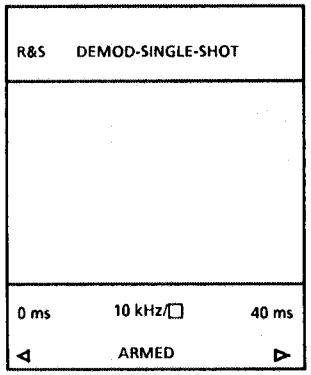


SINGLE SHOT menu (level 4)

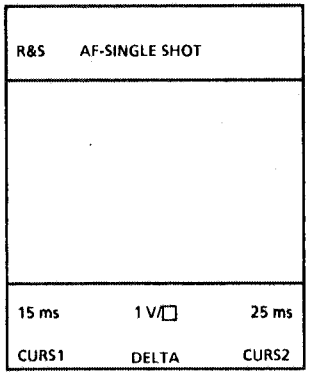
2.4.1



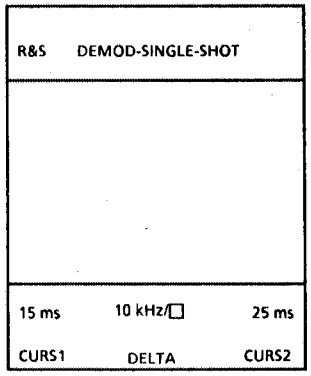
2.4.3



2.4.2

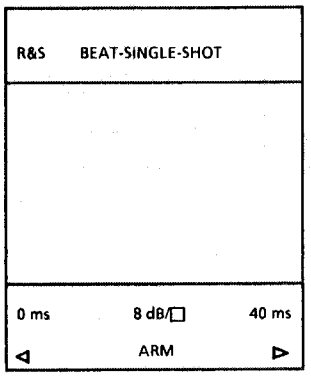


2.4.4

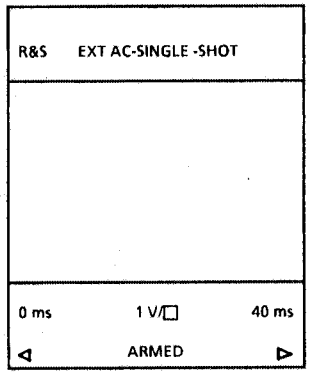


SINGLE SHOT menu (level 4)

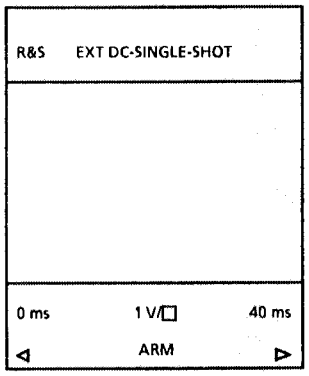
2.4.5



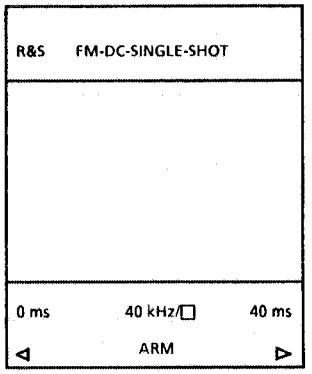
2.4.7



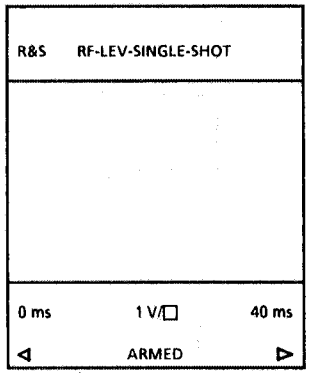
2.4.9



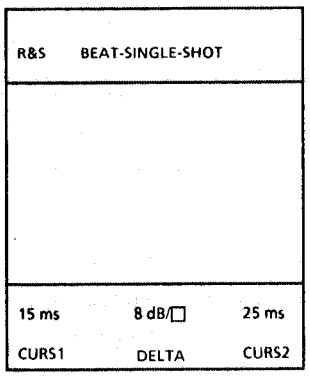
2.4.11



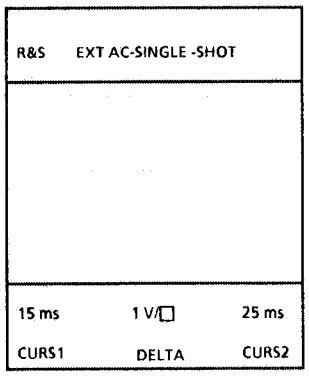
2.4.13



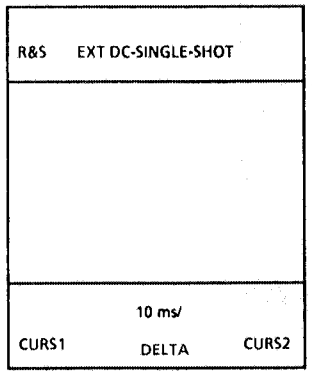
2.4.6



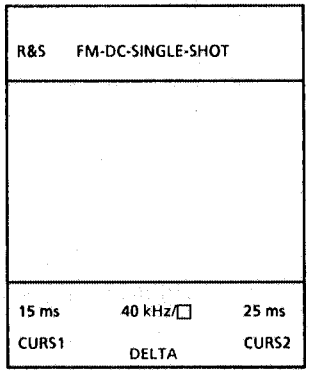
2.4.8



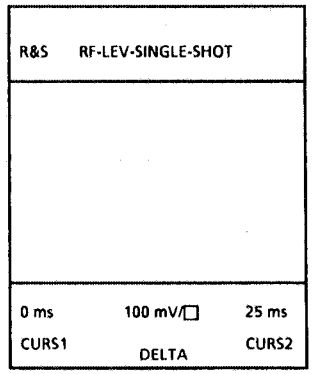
2.4.10



2.4.12

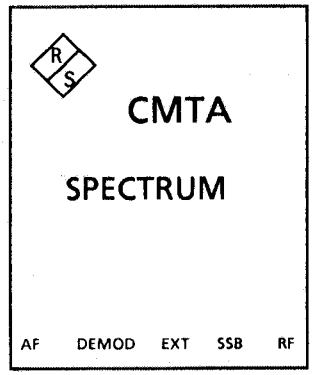


2.4.14

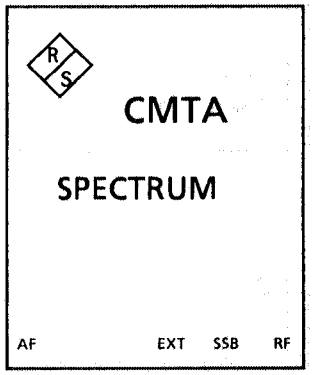


SPECTRUM menu (level 1)

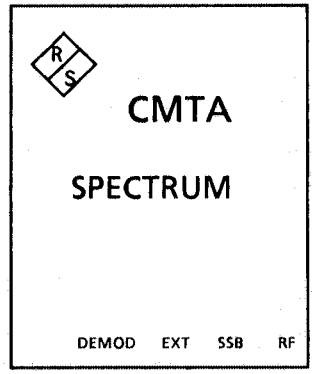
3.1.1



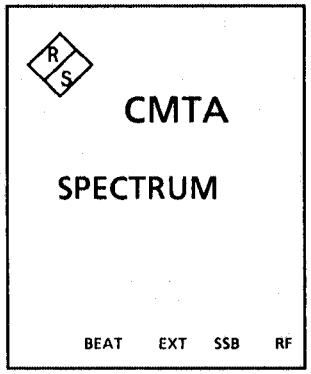
3.1.2



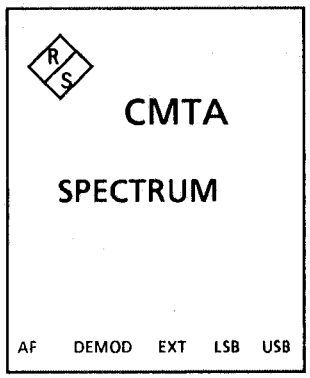
3.1.3



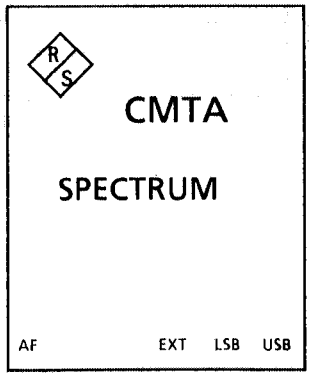
3.1.4



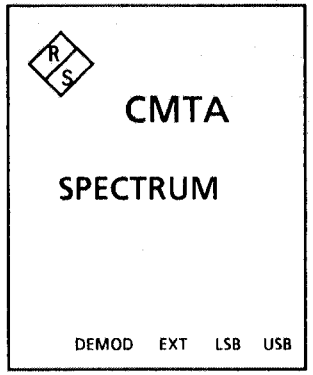
3.1.5



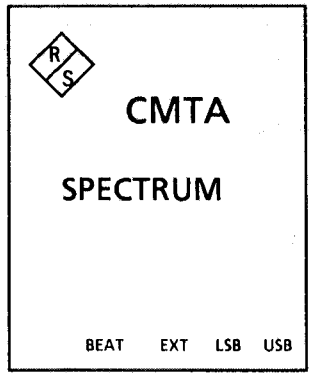
3.1.6



3.1.7

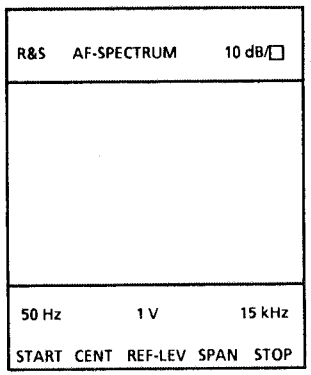


3.1.8

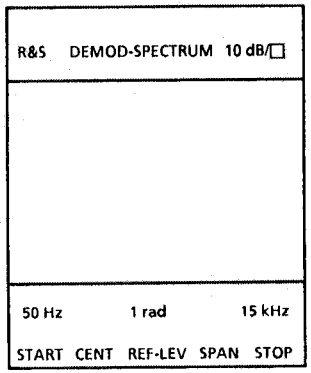


SPECTRUM menu (level 2)

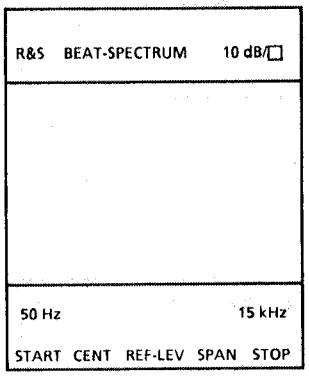
3.2.1



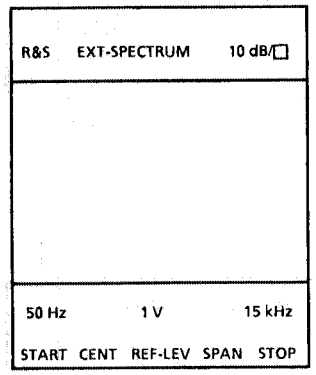
3.2.3



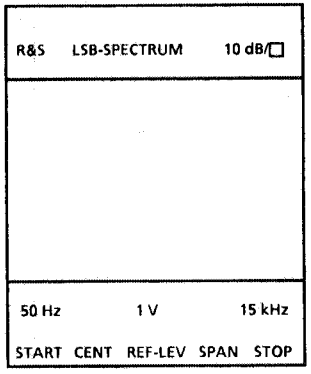
3.2.5



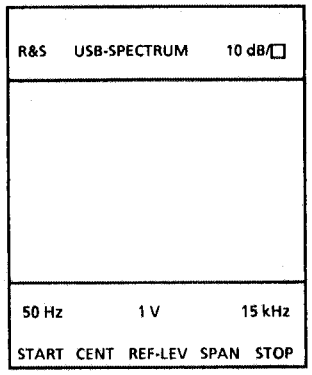
3.2.7



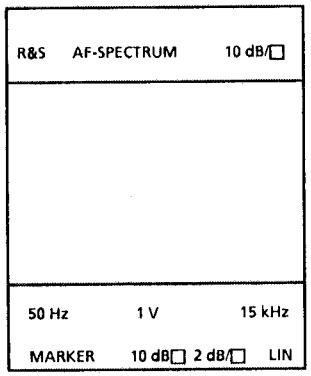
3.2.9



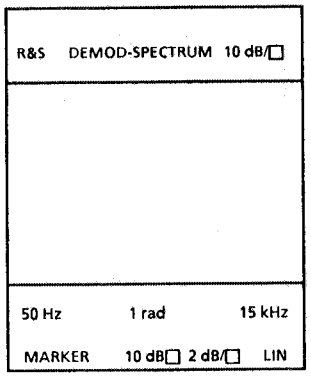
3.2.11



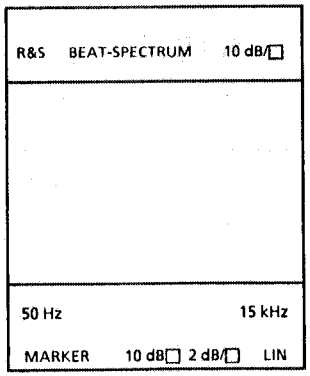
3.2.2



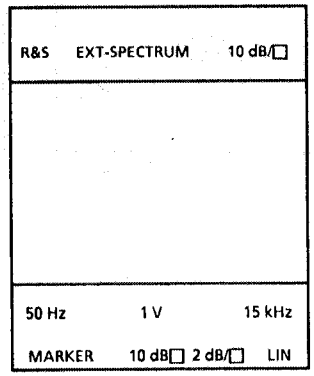
3.2.4



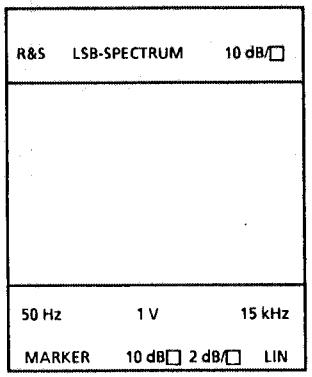
3.2.6



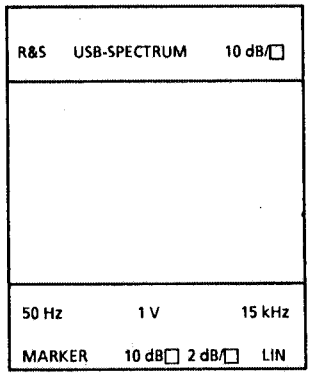
3.2.8



3.2.10

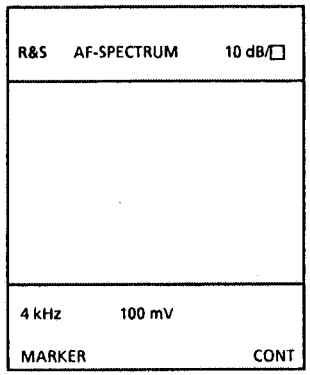


3.2.12

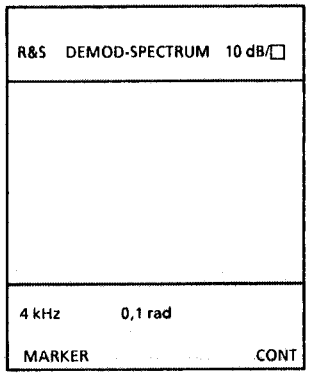


SPECTRUM menu (level 2)

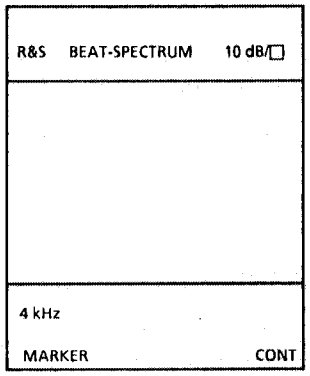
3.2.13



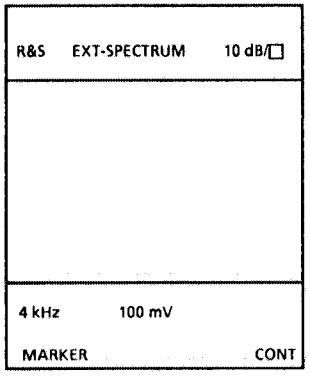
3.2.14



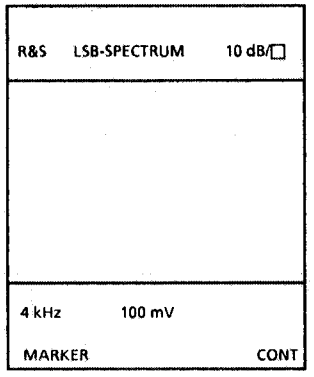
3.2.15



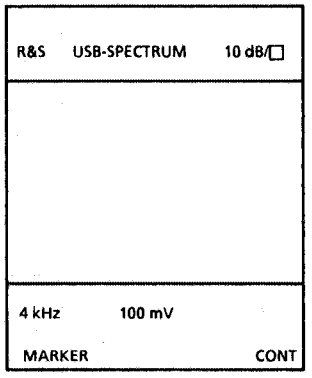
3.2.16



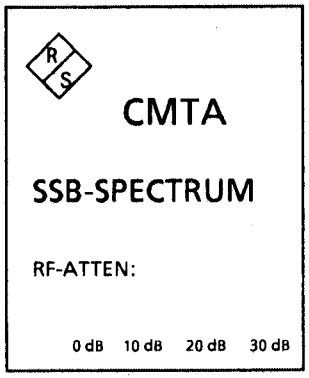
3.2.17



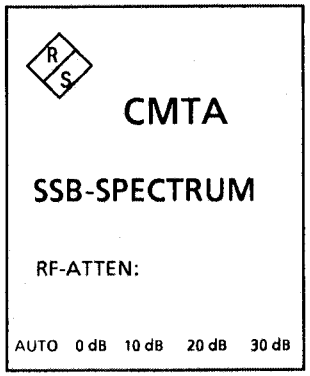
3.2.18



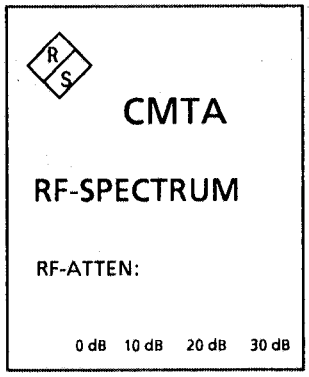
3.2.21



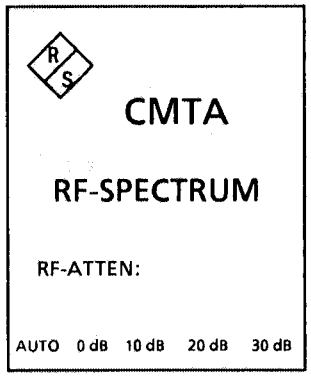
3.2.22



3.2.23

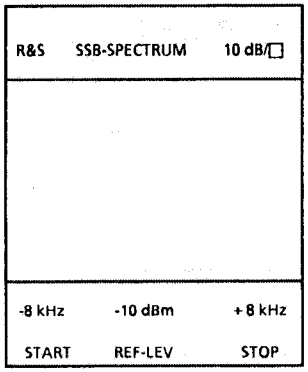


3.2.24

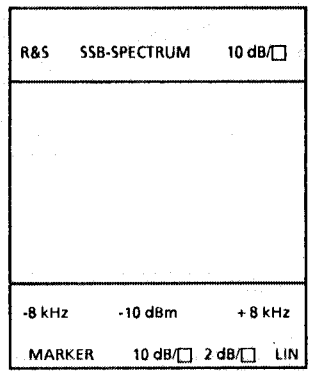


SPECTRUM menu (level 3)

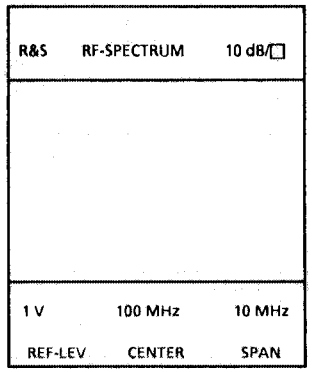
3.3.1



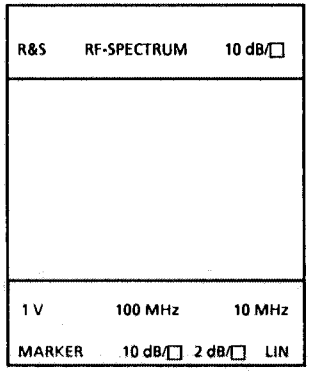
3.3.2



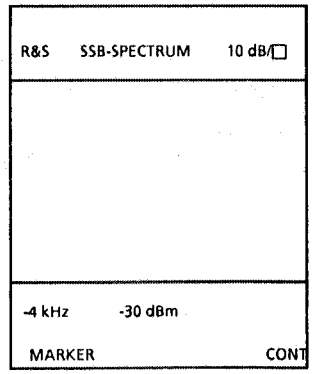
3.3.3



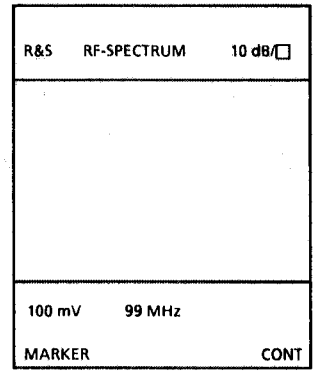
3.3.4



3.3.5



3.3.6

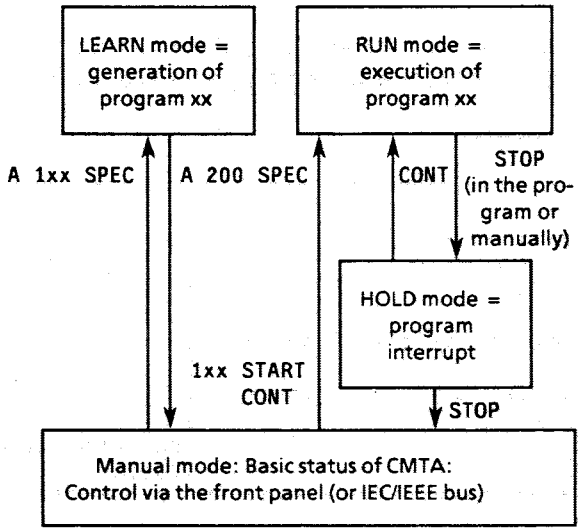


2.3.10 Autorun Control

If the option CMTA-B5 is fitted, the CMTA allows up to 100 different test programs defined via the front-panel keys to be stored (in LEARN MODE) and repeated as often as required (in RUN mode) without the need for an external controller.

2.3.10.1 Control Modes of CMTA with Autorun Control

xx ≙ program number 00 to 99



Manual mode

After switching on, the CMTA automatically enters this status; control is exclusively via the front-panel keys.

LEARN mode

The instrument works as in manual mode (except for the spinwheel ***46*** which is used for selection of program lines). In addition, each pressing of a key is temporarily stored in a buffer. When a command is entered completely, it can be stored in the program by pressing the STORE key ***56***.

RUN mode (START LED lights)

After starting a program, the CMTA executes all commands successively.

HOLD mode (START and STOP LED light)

When the STOP key ***72*** is pressed or the STOP function occurs in the running program, the RUN MODE is interrupted (HOLD mode).

The program is continued by pressing the CONT key ***70*** and aborted by pressing the STOP key ***72***.

2.3.10.2 Memory Allocation and Configuration of a Control Program

Up to 100 different programs identified by the program numbers (00 to 99) can be stored. The maximum available storage space is divided up among the individual programs according to their length. If the available storage space is occupied by several programs with excessive length, generation of further programs is no longer possible (error message: NO MORE MEMORY).

000 PROGRAM 00	to	000 PROGRAM 45	to	000 PROGRAM 99
001 command 1		001 command 1		001 command 1
002 command 2		002 command 2		002 command 2
003 command 3		003 command 3		003 command 3
004 command 4		004 command 4		004 command 4
005 command 5		005 command 5		005 command 5
006 command 6		006 command 6		
007 command 7		007 command 7		
		008 command 8		
to		009 command 9		
999 command 999				

The program configuration is based on lines, i.e. each stored command corresponds to a program line with an associated line number. The storage space required by the individual commands is 6, 12, 18 or 24 bytes, depending on the number of keys pressed.

During the program run, command 1 is executed first (line 0 always contains the heading with program number), followed by commands 2, 3, etc. and finally by the command stored last. For this purpose, autonumbering of lines is provided while writing the program and retained even when lines are inserted or deleted subsequently.

To enable fast location of a particular program, a directory is provided where the content of each line 001 is stored. By entering `A 605 SPEC` , line 1 of the program loaded first and the associated program number are output in the α display ***2***. By varying the spinwheel ***46***, the heading of all programs which are not empty can be displayed.

Switching off is possible via A 606 SPEC .

Example:

A 605 SPEC

Output in the α display *2*: 15 RADIO $23

15 is the program number of the first program loaded, "RADIO $23" is contained in line 1 in program 15.

2.3.10.3 Control Program Generation

2.3.10.3.1 Program Call/ Program Termination

By entering the command A 1xx SPEC in manual mode, a program is selected (00 < xx < 99 = program number) and prepared for insertion of new commands.

This causes the following message to be output in the α display *2*:

000 PROGRAM xx

Line number Program number

From then on, the CMTA is in LEARN mode, i.e. all complete commands can be stored in sequence or inserted into an existing program from the indicated line number onwards by pressing the STORE key *56*.

The input A 200 SPEC permits to quit the LEARN mode after completion of the program and to return to manual mode. This command is acknowledged in the α display *2* by the message ">PROG READY<".

Example:

A 123 SPEC

Output in the α display *2*: 000 PROGRAM 23
Enter commands

A 200 SPEC

Return to manual mode
Output in the α display *2*: PROG READY

2.3.10.3.2 Storing the Commands

The commands are stored completely, i.e. after entering the terminating key, the command can be stored once by pressing the STORE key *56*. If the command is not stored, the buffer will be cleared again when the next command is entered. Thus, it is possible to carry out any instrument setting required (e.g. to produce a particular operating status) without incorporating it into the program.

Input errors, such as overflow, underflow, wrong unit, syntax errors, as well as command abort (CLEAR or illegal key) cause the command to be completely deleted so that it can no longer be stored by STORE.

After storing a command, the α display *2* presents the corresponding output in plain text.

Example:

Input	α display
2 kHz AF INT 1 STORE	(AF INT 1 2.000 kHz) 001 AF INT 1 > 001 >kHz 2
500 mV V0 MOD GEN (too much) Correction 5 mV V0 MOD GEN (correct) Store STORE	 002 AF OUTPUT > 002 >mV 5

2.3.10.3.3 Selection of Program Lines/ Checking the Commands

In LEARN mode, the spinwheel *46* abandons its normal function (variation of the individual setting parameters) and is used for selection of the individual program lines (turning it clockwise increases the line number). Furthermore, direct selection of a particular program line is also possible using the SPEC function A 1xxx SPEC (000<xxx<999 = line number). The current position can be seen from the command line indicated in the α display 2 (including line number).

Easy selection by means of the spinwheel *46* and output of each selected command in the α display *2* permit the program to be checked easily and quickly.

Example:

A 1034 SPEC

Select line 34
Output in the α display: 034 Befehl 34...

2.3.10.3.4 Insertion of Commands

When a particular position in the program has been selected using the spinwheel ***46*** or `A 1xxx SPEC` , each newly stored command is inserted in the following line number; the line numbers of the subsequent commands are incremented accordingly.

Example:

`A 1034 SPEC`

or selection using the spinwheel:
select command 34

034 command 34	→ new command	034 command 34
035 command 35		→ 035 new command
036 command 36		036 command 35
037 command 37		037 command 36
...		038 command 37
		...

2.3.10.3.5 Deletion of Commands and Command Blocks

For deleting commands, the first line to be deleted must be selected. By entering the command `A 2xxx SPEC` (with 000<xxx<999) , a program block with the length xxx is deleted from this position. The input `A 2000 SPEC` (or `A 2001 SPEC`) only deletes the current line.

Example:

`A 1034 SPEC`

Select line 34

→ 034 command 34
035 command 35
036 command 36
037 command 37
038 command 38
039 command 39

`A 2000 SPEC`

Line 34 is deleted, the following line numbers are decremented.

→ 034 command 35
035 command 36
036 command 37
037 command 38
038 command 39

`A 2003 SPEC`

Lines 34, 35, 36 are deleted.

→ 034 command 38
035 command 39

2.3.10.3.6 Representation of Commands in the α Display

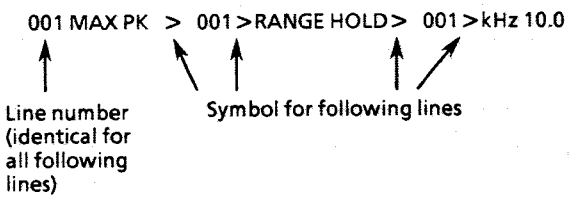
Commands requiring more than 9 characters for representation use several lines with the same number, which can be output in the α display ***2*** using the spinwheel ***46***.

Example:

Representation of the command:

`MAX PK RANGE HOLD 10.0 kHz`

Display:



A complete list of the possible commands and their representation in the α display ***2*** can be obtained from section 2.3.10.7.

2.3.10.3.7 Program Example

Input		α display
A 123 SPEC	**Start of program**	000 PROGRAM 23
TXRX		
STORE		001 XMITTER
2 kHz AF INT 1		(AF INT 1 2.000 kHz)
STORE		002 AF INT 1 > 002>kHz 2
500 mV V0 MOD GEN	(too much)	
Correction		
5 mV V0 MOD GEN	(correct)	
Store		
STORE		003 AF OUTPUT > 003>mV 5
COUNT f		
STORE		004 RF COUNT
POWER		
STORE		005 POWER
MAX PK		
STORE		006 MAX PK
1000 STOP		
STORE		007 STOP > 007>1000
TXRX		
STORE		008 RECEIVER
145 MHz SET f RX		
STORE		009 SET RF RX > 009>MHz 145
10 µV V_0 SYNTH		
STORE		010 RF OUTPUT > 010>µV 10
MOD OFF		
STORE		011 MOD OFF
2.8 kHz INT 2		(STORE is omitted: Command is executed on the instrument but not stored in the program.)
0 INT 2		(Command is cancelled)
2.8 kHz INT 1		
STORE		012 MOD INT 1 > 012>kHz 2.8
LEVEL		
STORE		013 AF LEVEL
2000 STOP		
STORE		014 STOP > 014>2000
A 200 SPEC	**End of program**	

2.3.10.4 Special Functions in Conjunction with Autorun Control

2.3.10.4.1 Measurement Tolerances

Each time a measurement is called up in LEARN mode, a lower or upper limit or a tolerance window consisting of both limit values can be specified for evaluating the result. If, during the following program run, the measured value lies within the limits thus defined, the green TOL IN LED lights, and the program is executed without interruptions. If the value falls outside the tolerance, the red TOL OUT LED lights and the program run is interrupted (HOLD mode). The measurement producing the out-of-tolerance result is continuously repeated, enabling the user to make an adjustment.

Example:

Input	α display
POWER STORE	015 POWER
5.5 W UPPER STORE	016 UPPER TOL> 016>W 5.5
4.5 W LOWER STORE	017 LOWER TOL> 017>W 4.5

Total evaluation

If tolerance limits have been entered into a test program, a tolerance evaluation is automatically accomplished at the end of the program.

Possible cases:

- All tolerances lie within the tolerance window

  At the end of the program, the message "TOTAL TOL IN" is output in the α display **2**, the green TOL IN LED lights and, with the printer in on-line operation, the following line appears in the printout (see test log a)).

- One or more tolerances lie outside the tolerance window

  At the end of the program, the message "TOTEL TOL OUT" is output in the α display **2**, the red TOL OUT LED lights up and, with the printer in on-line operation, the following line appears in the printout (see test log b)).

Autorun control with tolerance evaluation

If specail function `A 510 SPEC` has been used to switch to tolerance stop (interruption of RUN mode if tolerance is exceeded), the autorun control switches to HOLD mode (STOP LED lights) to display the evaluation result. The result can now be read off and the program run finished by pressing STOP or CONTINUE.

In the event that `A 511 SPEC` has been used to switch to tolerance continue, the instrument does not switch to HOLD mode. The tolerance evaluation messages are only displayed according to the time between the autorun control commands. In this case, the printout is of crucial importance.

```
+------+--------------..-------------------------------------+
! LINE !     COMMAND   ..    !  PARAMETER  !  RESULT  !  TOL  !
+------+--------------..-------------------------------------+
!  ..  !               ..    !     ..      !    ..    !  ..  !
! ***  !  TOTAL TOLERANCE    !             !          !  OK  !
+------+--------------..-------------------------------------+
```

Test log a)

```
+------+--------------..-------------------------------------+
! LINE !     COMMAND   ..    !  PARAMETER  !  RESULT  !  TOL  !
+------+--------------..-------------------------------------+
!  ..  !               ..    !     ..      !    ..    !  ..  !
! ***  !  TOTAL TOLERANCE    !             !          ! FAULT !
+------+--------------..-------------------------------------+
```

Test log b)

2.3.10.4.2 STOP Function

If the STOP command is stored in the program in LEARN mode, the CMTA enters the HOLD mode at this position in the program run. In this mode, any settings can be carried out on the CMTA or the device under test and the program run continued by entering CONT.

Input of the command <Numerical value> STOP (with 10 < numerical value < 10000) causes the CMTA to stop the program run at this position for a period of time (in ms) corresponding to the numerical value.

If the last command prior to STOP calls up a measurement, this measurement is continued during the complete wait time to enable the user to carry out adjustments.

Example:

Input	α display
STOP STORE	 005 STOP

The program run is interrupted here; the CMTA can be set as required in HOLD mode. When CONT is entered, the program run is continued with command 006.

Input	α display
COUNT f STORE 2000 STOP STORE	 006 RF COUNT 007 STOP > 007> 2000

After execution of the command 006, the program is stopped for 2000 ms. After this period, the program is automatically continued in line 008.

Input	α display
POWER STORE	 008 POWER

2.3.10.4.3 Conditional Program Continuation

Incorporation of the command <No> CONT (0<No<5) into the program causes the CMTA to stop the program run and wait for a particular event.

No.	Event
0	RF power at RF connector ***84*** drops
1	RF power >0.5 W is applied to RF connector ***84***
2	reserved
3	reserved
4	reserved

2.3.10.4.4 Programming of Messages

If the CMTA is to output messages in the alphanumeric display ***2*** during the program run in order to request particular entries or to specify e.g. type of transceiver and date/number of test report in the hardcopy printout, the front panel keys can be converted to alphanumeric keys by entering A 500 SPEC (in LEARN mode). Each key is assigned a letter from the alphabet (see Table 2-1), the normal key functions are suppressed.

Only the following 3 keys have a control function:

CLEAR	Clears the input character by character. String input is further possible.
STORE	Stores the message. Switches off string input.
SPEC	Switches off string input.

A message can contain up to 33 characters, all further inputs are ignored.

In the hardcopy printout, the complete message is output, whereas the output in the alphanumeric display ***2*** is confined to 14 characters (can be checked in the following lines in LEARN mode).

The character $ is used as an identification for the display and the program listing.

Note:

If, in a program line, commands are sent to the CMTA which cause the output on the alphanumeric display to be changed (e.g. search routines), it is possible that an immediately following message does not appear in the alphanumeric display 2. This problem can be solved by inserting a waiting time prior to output on the alphanumeric display 2.

Example:

010 SINAD 20 dB
011 STOP 50
012 $ NEXT STEP

Example:

The following messages are to be incorporated into the program:

Message 1 RECEIVER TEST - RADIO-SET $12345
Message 2 TX-FREQUENCY*

Input	α display
A 101 SPEC STORE A 500 SPEC	000 PROGRAM 01

Input of message 1 on the front panel according to Table 2-1

RECEIVER TEST - RADIO-SET $ 12345 STORE TXRX STORE A 500 SPEC	001 RECEIVER > 001 >TEST - RA> 001 >DIO-SET $ > 001 >12345 002 RECEIVER

Input of message 2 on the front panel according to Table 2-1

TX-FRF (error, delete) CLEAR TX-FREQUENCY* STORE STOP STORE MAX PK STORE A 500 SPEC TRY (abort superfluous input of message) SPEC HP TX STORE	 003 TX-FREQUE > 003 >NCY* 004 STOP 005 MAX PK 006 HP TX

Associated output in the α display in RUN mode:

Message 1 RECEIVER TEST
Message 2 TX-FREQUENCY*

Associated line in hardcopy printout:

Message 1 RECEIVER TEST - RADIO-SET $12345
Message 2 TX-FREQUENCY*

Table 2-1 Alphanumeric assignment of CMTA keys

Key	Ref.No. (front-panel view)	Alphanum. characters
0	39	0
1	39	1
2	39	2
3	39	3
4	39	4
5	39	5
6	39	6
7	39	7
8	39	8
9	39	9
A	42	A
B	43	B
C	44	C
D	45	D
COUNT f	5	E
SET f TX	6	F
DECODE	8	G
DEMOD · BEAT	9	H
AF INT 1	10	I
AF INT 2	11	J
POWER	14	K
ACP	15	L
V_0 SYNTH OFF	16	M
PROBE	19	N
MAX PK	22	O
POLARITY SELECT	23	P
PK HOLD	24	Q
DIST TX	25	R
LP TX	27	S
CCITT TX	28	T
V_0 MOD GEN	32	U
V_0 MOD GEN+20 dB	33	V
S/N	34	W
V_0 MOD GEN OFF	35	X
CCITT RX	38	Y
TXRX	60	Z
DUPL	64	SPACE
ACK TEST	66	$
DISPLAY CHANGE	67	+
START	69	*
CONT	70	II
STOP	72	<
PRINT	74	>
TOL UPPER	76	?
TOL LOWER	77	/
.	41	.
-	40	-

2.3.10.4.5 Repetition of Program Blocks

If one or more operations are to be performed repeatedly, they can be combined in a repetition block. The start of this command sequence and the number of repetitions are set as follows (in LEARN mode).

- Select the last line before the repetition block.
- Enter A 505 SPEC xxx SPEC
  (xxx is the desired number of repetitions)

  Output in the α display: 023 REP START>
  023>xxx

The end of the repetition block is identified after the last line by entering A 506 SPEC .
Identification in the program: "REP STOP"

Example:

Input	α display
TXRX	
STORE	001 RECEIVER
A 505 SPEC 12 SPEC	
STORE	002 REP START>
	002>12
SET f RX	
STORE	003 SET RF RX
STOP	
STORE	004 STOP
SINAD · DIST	
STORE	005 SINAD
A 506 SPEC	
STORE	006 REP STOP

When this program section is executed, the output frequency of the signal generator is requested 12 times (SET f RX before STOP) and the SINAD value measured subsequently. It is thus possible to measure e.g. the receiver sensitivity on all channels of a 12-channel transceiver.

2.3.10.5 Control Program Execution

2.3.10.5.1 Program Start

Each stored program (at least one command line entered) can be called up in manual mode (not via IEC/IEEE bus) using the command 1xx START (00<xx<99). If the same program is to be run again, it will be sufficient to press the CONT key ***70*** instead of repeating the above entry. If this key is pressed immediately after switching on the CMTA, the program 00 is started (corresponds to 100 START . All current measurements of the CMTA are immediately aborted and the front-panel keys switched off (except for STOP ***72*** and PRINT ***74***).

As the initial status of the CMTA (TX/RX mode) at the program start does not necessarily correspond to LEARN mode, it is recommended to define this status clearly in the first command lines. Starting with line 1, all commands are executed in sequence according to their line number as fast as possible. To enable observing the program run on the slower LCDs for testing, a pause can be inserted after each command (see section 2.3.10.4.2).

2.3.10.5.2 Program Interrupt

A program interrupt can be caused by

- pressing the STOP key ***72*** during the program run
- a STOP function in the program (STOP or 100 STOP = 100 ms pause)
- a measured value which exceeds or falls below the programmed tolerance values.

The instrument then enters the HOLD mode which permits operation as in manual mode. In addition, the automatic test can be completely switched off by pressing the STOP key ***72*** once again or the program be continued with the next command via CONT ***70***.

2.3.10.5.3 Program End

After execution of the last command of the called program, the automatic test switches off automatically. It is also possible to return to HOLD mode at any point in the program by pressing the STOP key ***72***. By pressing this key again, the automatic test is switched off completely.

2.3.10.5.4 Special Features During Program Run

Contrary to manual mode, each measurement is made only once during the program run and the result stored in the displays. However, in HOLD mode and if the measured value is outside the tolerance, the last command (provided it is a measurement call) is continuously repeated until the program is continued.

When a STOP function occurs in the program and if the last but one command was a setting where no parameter was specified, this measurement parameter is requested in the α display ***2***.

Example:

032 RF COUNT
033 STOP

As long as the CMTA is in HOLD mode, the last measurement call is repeated, in the above example the frequency count RF COUNT.

034 SET RF TX
035 STOP

When this STOP function occurs, the entry of the operating frequency for the transmitter test is requested by the message "*SET RF TX*" in the α display.

036 ...

As the instrument status may be different for each program run (TX/RX mode, filter on/off, etc.), all important parameters should be set at the start of the program.

Example:

Switch on transmitter test

in receiver test	in transmitter test
TXRX STORE	TXRX TXRX STORE

Program line: 001 XMITTER

Switch on receiver test

in receiver test	in transmitter test
TXRX TXRX STORE	TXRX STORE

Program line: 001 RECEIVER

In LEARN mode, each change in the instrument status should therefore be stored in the program.

2.3.10.6 Deletion of Programs/ Initialization of Autorun Control

Deletion of Programs:

A 3xx SPEC STORE (with 00<xx<99).

Deletion of complete programs is only possible in manual mode.

When this function is called up, the message "REALLY DELETE?" appears in the α display ***2*** of the CMTA. When STORE ***56*** is entered to acknowledge this function, the selected program is deleted. All other entries abort the selected function.

Example:

A 356 SPEC STORE Program 56 is deleted.

Initialization of Autorun Control:

A 800 SPEC STORE

This procedure needs only be performed on the option CMTA-B5 after switching the instrument on for the first time or replacing the battery, all programs, possibly available test reports and control variables being deleted.

2.3.10.7 Autorun Control Commands

Command codes (1st line)

Command (acc. to definition)	Representation in α display
RF FREQUENCY	
COUNT f	RF COUNT
SET f RX	SET RF RX
SET f TX	SET RF TX
Δf	CH.SP.
AF FREQUENCY	
DECODE	DECODE
CODE	CODE
DEMOD	DEMOD CNT
BEAT	BEAT CNT
AF EXT	AFEXT CNT
AF INT 1	AF INT1
AF INT 2	AF INT2
RF POWER	
POWER	POWER
ACP	ACP
RF LEVEL	
V_0 SYNTH.	RF OUTPUT
V_0 SYNTH. + 6 dB	RFOUT + 6dB
	RFOUT-6dB
RF POWER / RF LEVEL	
V_0 OFF	RFOUT ON
	RFOUT OFF
PROBE	PROBE
VDC	VDC
IDC	IDC

Command (acc. to definition)		Representation in α display
DEMODULATION		
MAX PK		MAX PK
POLARITY SELECT		+ PK
		- PK
		+-/2 PK
PK HOLD		PKHLD ON
		PKHLD OFF
DIST		TX DIST
HP TX		HP TX
LP TX		LP TX
CCITT TX		CCITT TX
		CCITT OUT
MODULATION		
INT 1		MOD INT 1
INT 2		MOD INT 2
EXT		MOD EXT
MOD OFF		MOD OFF
FMDC		FMDC ON
		FMDC OFF
$1\ V_{RMS}$		EXT 1 VRMS
EXT CAL		EXT CAL
MODULATION GENERATOR		
V_0 MOD GEN		AF OUTPUT
V_0 MOD + 20 dB		AFOUT + 20
		AFOUT-20
V_0 OFF		AFOUT ON
		AFOUT OFF
AF VOLTMETER		
AF-LEVEL		AF LEVEL
SINAD		SINAD
DIST		RX DIST
S/N		S / N
HP RX		HP RX
		HP OUT
LP RX		LP RX
		LP OUT
CCITT RX		CCITT RX
		CCITT OUT
DEVICE STATUS		
TXRX		XMITTER
		RECEIVER
LOCK		LOCK ON
		LOCK OFF
DUPL		DUPL ON
		DUPL OFF
ACK TEST		ACK ON
		ACK OFF
DISPLAY CHANGE	DISPL1 TX	frequency field
	DISPL1 RX	
	DISPL2 TX	RF level field
	DISPL2 RX	
	DISPL3 TX	modulation field
	DISPL3 RX	
	DISPL4 TX	AF level field
	DISPL4 RX	
INPUT SELECT		INPUT 2
		RF IN/OUT
NARROW		NARROW.IN
		NARROW.OUT

Command (acc. to definition)	Representation in α display
SPECIAL FUNCTIONS	
SPEC	SPEC
STORE	STORE
RECALL	RECALL
AUTORUN CONTROL	
STOP	STOP
CONT	CONTINUE
PRINT	PRINT
TOL LIMITS UPPER	UPPER TOL
TOL LIMITS LOWER	LOWER TOL
GRAPHICS UNIT	
SOFTKEY1	SOFTKEY1
SOFTKEY2	SOFTKEY2
SOFTKEY3	SOFTKEY3
SOFTKEY4	SOFTKEY4
SOFTKEY5	SOFTKEY5
MENU UP	MENU-UP
MENU HOME	MENU-HOME
SOFTKEY CHANGE	SOFTKEY-C
VARIATION UP	VARI-UP
VARIATION DOWN	VARI-DOWN

1st following line

Numerical values or special functions

Key labelling	Representation in α display
CLEAR	CLEAR
RANGE HOLD	RANGEHOLD
ANALOG SELECT	ANAL.SEL.
α-DISPL SELECT	ALPHA SEL
ΔVAR	DELTA VAR
REF	REF

2nd and 3rd following line

Numerical values or special functions
(CLEAR in the 1st following line)

Key labelling	Representation in α display
RANGE HOLD	RANGEHOLD
ANALOG SELECT	ANAL.SEL.
ΔVAR	DELTA VAR
REF	REF

2.3.10.7.1 Operation of Graphics Unit via Autorun Control

The graphics unit is operated via the autorun control in the same way as in manual mode (see section 2.3.9). Programming is easy, since operation of the graphics unit is menu-driven. The menu structure can be seen from the menus appended to section 2.3.9.

It should be noted that the softkey commands (SOFTKEY1 to SOFTKEY5) have different functions at the individual menu levels of the graphics unit and that these functions also depend on the device status.

The softkey functions in the menus can be changed with the aid of the SOFTKEY-C (softkey change) command.

The menu levels can be changed with the aid of the MENU-UP and MENU-HOME commands. The MENU-UP command switches to the next higher menu level and the MENU-HOME command branches into the home menu.

The VARI-UP and VARI-DOWN commands are used to vary the setting parameters if no direct entry is provided for a parameter.

After completion of the autorun control program the instrument always switches from an active beat measurement to demod measurement. This affects all graphic modes, where a beat measurement is taken. In order to make sure, that the graphics are not deleted after completion of the program, the program has to be finished using the STOP command.

2.3.10.8 Printing of Test Logs / Program Listings

2.3.10.8.1 Facilities and Control of Printer Function

If a printer with parallel interface (Centronics), such as PUD2/PUD3, is available, program listings and test logs can be output using the PRINT key ***74***. Depending on the operating mode of the CMTA, this key has different functions.

Manual mode

```
100  PRINT  to  199  PRINT:
```

Print listing of control program 100 to 199. Printing starts when the PRINT key ***74*** is pressed, the PRINT LED lights up.

```
PRINT
```

As long as the PRINT LED is lighting, indicating that a program listing is being printed, this command causes printing to be aborted and the PRINT LED goes out. However, the content of the CMTA output buffer or the printer input buffer is still output.

If the PRINT LED is off, generation of a test log can be switched on or off for the subsequent program run by pressing the PRINT key ***74*** (several times, if required). This is acknowledged by output of the messages **"PRINTER ON"** or **"PRINTER OFF"** in the α display ***2***.

Logical Connection of the Printer when Switching on the CMTA

- Upon switching on the CMTA, the printer is connected and switched to on-line operation. CMTA declares the printer to be present (logically available).
- Upon switch-on, the printer is not connected or in off-line operation. CMTA declares the printer to be not present (logically not available).

LEARN mode

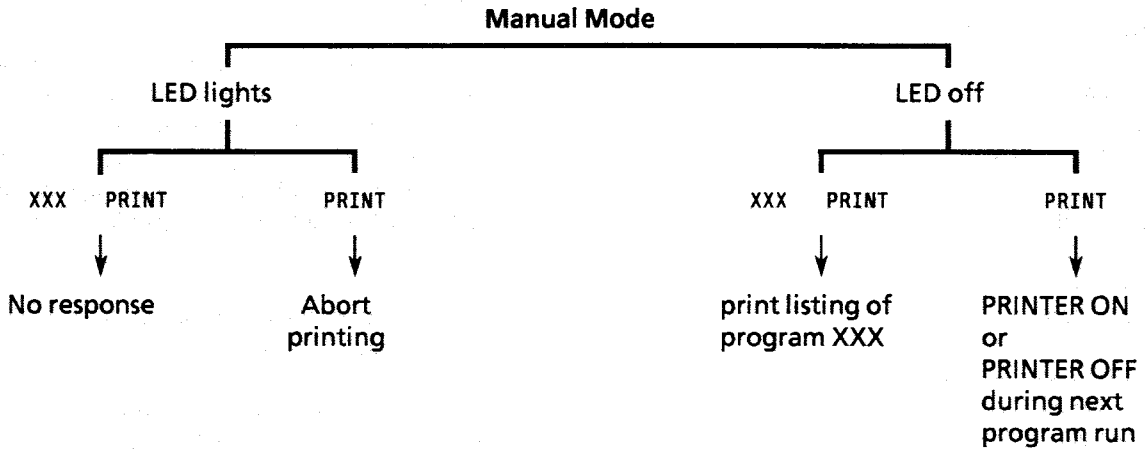
```
PRINT  STORE
```

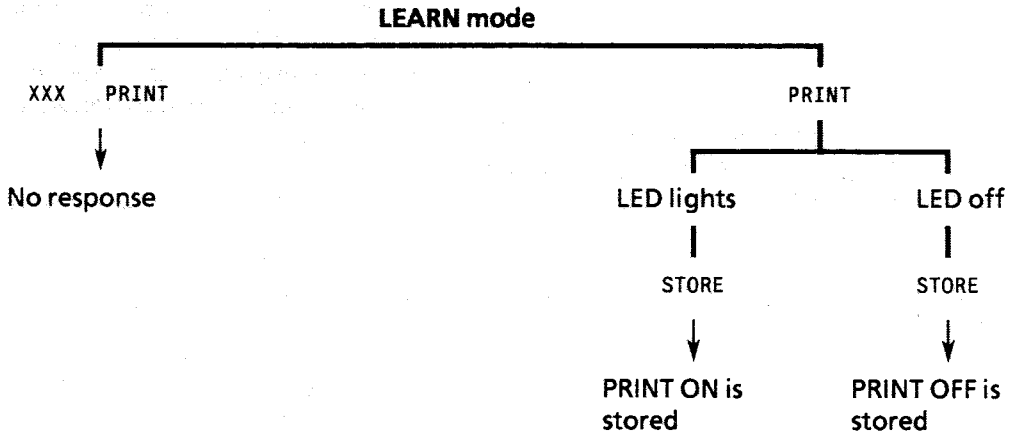
Pressing the PRINT key ***74*** in LEARN mode does not lead to an immediate start of printing, but allows a PRINT ON or PRINT OFF command to be stored in the program. It is thus possible to suppress printing in each program for individual program blocks, e.g. for time-critical program parts. With the printer switched off (PRINTER OFF), these commands have no effect.

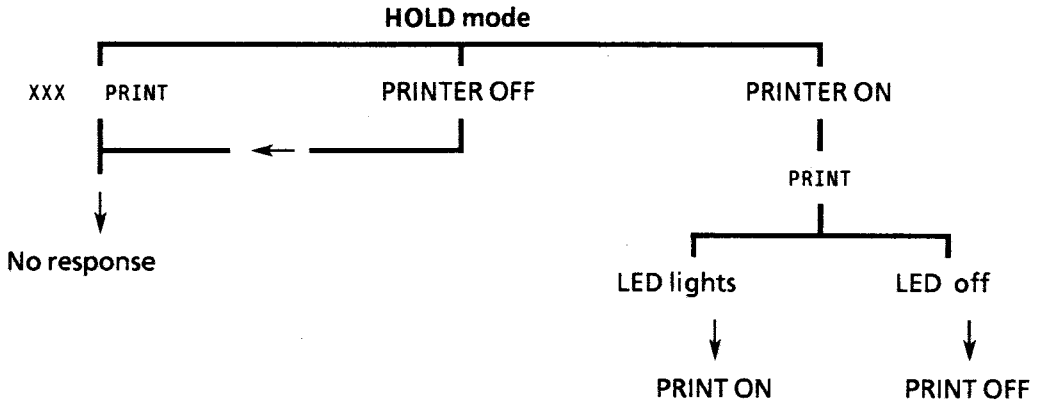
If the PRINT LED lights after pressing the PRINT key ***74***, PRINT ON is stored using STORE ; if it is off, this corresponds to PRINT OFF (toggle function).

HOLD mode

In HOLD mode, the PRINT key ***74*** has a similar function as in LEARN mode, i.e. by pressing this key, it is possible to decide whether a test log is to be generated in the subsequent program part (PRINT LED lights up) or not (PRINT LED goes out). If the printer has been switched off in manual mode (PRINTER OFF), the PRINT key ***74*** is without function in HOLD mode.







2.3.10.8.2 Program Listings

Program listings can only be printed out in manual mode. During printing (PRINT LED lights), it is therefore not possible to start a program, switch over to learn mode or have a look at the directory (A 605 SPEC). Contrary to the readout in the α display ***2***, each program line corresponds to a print line; after 65 lines and at the end of the program, a page-feed (= OCH) is automatically produced.

Example: (corresponding to 2.3.10.3.7)

```
000 PROGRAM 23
001 XMITTER
002 AF INT1 2 kHz
003 AF OUTPUT 5 mV
004 RF COUNT
005 POWER
006 MAX PK
007 STOP 1000
008 RECEIVER
009 SET RF RX 145 MHz
010 RF OUTPUT 10 µV
011 MOD OFF
012 MOD INT 1 kHz
013 AF LEVEL
014 STOP 2000
```

After aborting a program, the printer head should again be set to the beginning of the next page by means of the following program:

```
000 PROGRAM 99
001 CONTROL 0C    (Entry: A 527 SPEC 0C STORE)
002 PRINT OFF
```

2.3.10.8.3 Test Logs

For logging a program run, the printer must be switched on before starting the program (PRINT or PRINT PRINT in manual mode → PRINTER ON in α display ***2***).

Generation of Control Characters for Printer

To configure the CMTA for different types of printer, a hexadecimal control character set can be generated.

A 525 SPEC enables this string to be edited. It may have a length of up to 14 characters. In this case, the CMTA interprets the numbers 0 to 9 and A to F as hexadecimal input. Subsequent pressing of the STORE key ***56*** causes the string to be stored. The CMTA ignores all other key entries.

Transfer of the control character string to the printer is triggered by entering A 526 SPEC .

If the autorun control is to transfer control characters to the printer during RUN mode, a control character string can be generated in LEARN mode as described above using A 527 SPEC. This entry is stored by pressing the STORE key ***56***, "001 CONTROL <hexadecimal control characters>" is displayed as command. These control characters are then transferred to the printer in RUN mode.

After the program start, printing always begins with line 000 so that the program number and, if necessary, a heading (in line 001) can be placed at the top of the test log.

Printing of the test log can then be suppressed at any point by means of PRINT OFF commands in the program or by pressing the PRINT key ***74*** in HOLD mode.

a) Structure of the test log

Test log heading

```
+------+-------------------------------------------------------------------------+
! LINE !         COMMAND          !    PARAMETER     !      RESULT       ! TOL  !
+------+-------------------------------------------------------------------------+
! 000  ! PROGRAM                  ! 00               !                   !      !
! 001  ! ********************** TRANSMITTER TEST ***************************   !
```

Each line (except for messages) is divided into five columns.

Line

The content of this column corresponds to the line number of the program, enabling the test log to be compared with the corresponding program listing.

Command

In this column, measurement calls and setting instructions to the CMTA are printed in plain text corresponding to the command code (section 2.3.10.7).

```
+------+-------------------------------------------------------------------------+
! LINE !         COMMAND          !    PARAMETER     !      RESULT       ! TOL  !
+------+-------------------------------------------------------------------------+
! 000  ! PROGRAM                  ! 00               !                   !      !
!  :   !                          !                  !                   !      !
! 005  ! SINAD                    !                  ! 49.9 dB           !      !
! 006  ! SET RF RX                ! 120.00000 MHz    !                   !      !
```

Parameter

This field contains additionally entered parameters for measurement calls (e.g. search routines), settings and control instructions as well as the second parameter for SPEC functions (only numerical values)

```
+------+-------------------------------------------------------------------------+
! LINE !         COMMAND          !    PARAMETER     !      RESULT       ! TOL  !
+------+-------------------------------------------------------------------------+
! 000  ! PROGRAM                  ! 00               !                   !      !
!  :   !                          !                  !                   !      !
! 005  ! SINAD                    ! 20 dB            ! 49.9 dB           !      !
!  →   ! RF LEVEL                 !                  ! 0.032 uV          !      !
! 006  ! SET RF RX                ! 145.00000 MHz    !                   !      !
! 007  ! SPEC A600                ! 1000             !                   !      !
```

Result

This field contains the result obtained as reply to the command in the command column.
If a measurement call returns two results, e.g. the start of search routines, the setting value coupled with the measurement result (output level of signal generator in this case) or the second result is printed in the following line.

```
+------+-------------------------------------------------------------------------+
! LINE !         COMMAND          !    PARAMETER     !      RESULT       ! TOL  !
+------+-------------------------------------------------------------------------+
! 000  ! PROGRAM                  ! 00               !                   !      !
!  :   !                          !                  !                   !      !
! 005  ! SINAD                    ! 20 dB            ! 49.9 dB           !      !
!  →   ! RF LEVEL                 !                  ! 0.032 uV          !      !
! 006  ! SET RF RX                ! 145.00000 MHz    !                   !      !
```

Tol

If a measurement is evaluated with tolerances, the GO/NOGO information appears in the tolerance field which corresponds to the TOL IN/OUT LEDs on the front panel.

OK: green (TOL IN) LED lights
FAULT: red (TOL OUT) LED lights

Messages

Messages entered into the program may have a length of up to 33 characters. They are located in the center of the Command, Parameter, Result and Tol columns and printed with a row of asterisks on each side so that they can be easily recognized.

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	00		
001	**********	TRANSMITTER TEST	**********	
:				
010	AF LEVEL		20.7 mV	OK
011	UPPER TOL AF LEVEL	30 mV		
012	LOWER TOL AF LEVEL	20 mV		
016	PRINT ON			
017	AF LEVEL		20.7 mV	FAULT
018	UPPER TOL AF LEVEL	55.5 mV		
019	LOWER TOL AF LEVEL	23.6 mV		

Repetition blocks

With each run, the content of a repetition block is again printed with the current parameters and measurement results but with unchanged line numbers. For identification of the individual runs, the Result field is used.

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	01		
017	REP START	5	1	
017	REP START	5	2	
017	REP START	5	3	
017	REP START	5	4	
017	REP START	5	5	
023	REP STOP			

In the case of relative changes in parameters via ΔVAR, the change value is contained in the Parameter field (increment or decrement) and the actually set value in the Result field.

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	02		
:				
018	MOD INT1 DELTA VAR	0.1 kHz	3.00 kHz	

b) Types of test logs

Depending on the intended use of the test log, it is not always necessary to print each command line (e.g. simple GO/NOGO test). For this reason, SPEC functions are provided to select one of three possible log sizes:

A	513	SPEC:	Minimum log size (small)
A	514	SPEC:	Restricted log size (medium)
A	515	SPEC:	Complete log size (large)

Complete test log (large)

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	01		
001	**********	RECEIVER TEST	**********	
002	RECEIVER			
003	RF OUTPUT	0.500 uV		
004	SET RF RX	145.80000 MHz		
005	AF INT1	1.000 kHz		
006	MOD INT1	2.80 kHz		
007	REP START	4	1	
008	AF LEVEL		14.4 mV	
009	SINAD		OVERFLOW	
010	MOD INT1 DELTA VAR	0.1 kHz	2.90 kHz	
007	REP START	4	2	
008	AF LEVEL		2.1 mV	
009	SINAD		54.4 dB	
010	MOD INT1 DELTA VAR	0.1 kHz	3.00 kHz	
007	REP START	4	3	
008	AF LEVEL		14.6 mV	
009	SINAD		53.6 dB	
010	MOD INT1 DELTA VAR	0.1 kHz	3.10 kHz	
007	REP START	4	4	
008	AF LEVEL		14.5 mV	
009	SINAD		53.6 dB	
010	MOD INT1 DELTA VAR	0.1 kHz	3.20 kHz	
011	REP STOP			
012	**********	TRANSMITTER TEST	**********	
013	XMITTER			
014	AF INT1	1.000 kHz		
015	AF OUTPUT	10.0 mV		
016	RF COUNT		145.200180 MHz	
017	POWER		0.017 W	
018	MAX PK		-2.66 kHz	OK
019	UPPER TOL MAX PK	3.0 kHz		
020	LOWER TOL MAX PK	2.5 kHz		
021	TX DIST		0.30 %	FAULT
022	UPPER TOL TX DIST	0.1 %		

Restricted test log (medium)

In this operating mode, printing of the following program lines is suppressed:

- Control instructions to the CMTA (e.g. RECEIVER, SPEC functions)
- Settings with the associated parameters in the program (e.g. RF OUTPUT 0.5 µV)
- Control instructions to the autorun control (e.g. STOP, CONTINUE)
- Settings whose parameters are requested by the user during autorun mode are not suppressed

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	01		
001	**********	RECEIVER TEST	**********	
008	AF LEVEL		9.8 mV	
009	SINAD		14.2 dB	
008	AF LEVEL		12.1 mV	
009	SINAD		54.0 dB	
008	AF LEVEL		9.9 mV	
009	SINAD		55.4 dB	
008	AF LEVEL		9.8 mV	
009	SINAD		55.9 dB	
012	**********	TRANSMITTER TEST	**********	
016	RF COUNT		145.200080 MHz	
017	POWER		0.017 W	
018	MAX PK		-2.67 kHz	OK
019	UPPER TOL MAX PK	3.0 kHz		
020	LOWER TOL MAX PK	2.5 kHz		
021	TX DIST		0.31 %	FAULT
022	UPPER TOL TX DIST	0.1 %		

Minimum test log (small)

This log contains all messages in the program and the measurements (tolerance specifications inclusive) whose result lies outside the tolerance.

LINE	COMMAND	PARAMETER	RESULT	TOL
000	PROGRAM	01		
001	**********	RECEIVER TEST	**********	
012	**********	TRANSMITTER TEST	**********	
021	TX DIST		0.32 %	FAULT
022	UPPER TOL TX DIST	0.1 %		

c) Additional inputs in the program run

If additional information is to be entered into the printout during the program run, e.g. serial number of the transceiver or the date, this can be prepared when writing the program by the input of `A 520 SPEC <message input> STORE` . This message input in LEARN mode corresponds to the use of `A 500 SPEC`.

During the program run, this message is output in the α display ***2*** and the user can now enter e.g. the current date. This entry is terminated by pressing the STORE key ***56***. By pressing SPEC ***55***, the input mode is left. CLEAR ***49*** deletes character by character. The stored prompt string is identified by "?" in the display and the program listing. The maximum length of the test to be entered depends on the length of the prompt. A maximum of 67 and minimum of 37 characters is possible. The maximum length of the prompt is 33 characters (however, only 14 can be output in the α display ***2***).

Example:

LEARN mode

Input	α display
A 520 SPEC D A T E (via alphanumeric keyboard) STORE	MESSAGE INPUT 007 DATE

RUN mode

Input	α display
 18.04.88 STORE	DATE DATE 18.04.88

The program is continued by subsequently pressing CONTINUE.

Printout

```
+------+-------------------------------------------------------------------------+
! LINE ! COMMAND          !   PARAMETER    !      RESULT       ! TOL  !
+------+-------------------------------------------------------------------------+
! 000  ! PROGRAM          ! 01             !                   !      !
:      :                  :                :                   :      :
! 007  ! DATE : 18.04.88  !                !                   !      !
```

The colon separating the request for input and the input is automatically generated by the CMTA.

2.3.10.8.4 Error Handling

If the printer is not available at the start of printing, the following response of the CMTA is to be expected:

Program listings

First, the output buffer of the CMTA is loaded (capacity: approx. $^1/_2$ page). If the complete program can be loaded into the output buffer, the PRINT LED is immediately extinguished and all functions of the autorun control can be used without restriction. In the case of buffer overflow (PRINT LED lights continuously), the CMTA waits up to one minute for the ready message from the printer to arrive. Use of the autorun control (LEARN, RUN) is not possible in this state, however, all other instrument functions are available without restriction.

After expiration of this waiting time, the CMTA outputs "PRINTER ERROR" in the α display ***2*** and automatically aborts printing; the PRINT LED is extinguished.

Test logs

After the program start, the output buffer of the CMTA is loaded (capacity: approx. $^1/_2$ page), the program runs at normal speed. If this output buffer is not read out (printer switched off or not connected), the CMTA waits up to one minute for the ready message from the printer to arrive, the program run is halted.

After expiration of this waiting time, the CMTA outputs "PRINTER ERROR" in the α display ***2*** and automatically aborts printing, the PRINT LED is extinguished. The autorun control continues program execution without a test log being printed (PRINTER OFF).

2.3.10.8.5 Printer Interface

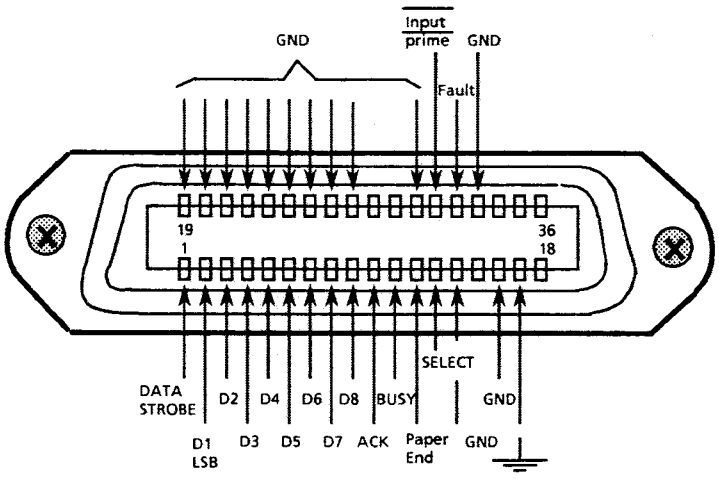


Fig. 2-14 PRINTER PARALLEL INTERFACE ***111***

From the signal lines available at the interface, the CMTA only evaluates the BUSY signal.

2.3.10.9 Operation of Transfer Memory

The transfer memory CM-Z1 can be compared to a floppy disk for electronic data processing applications. It permits to file 100 programs of the CMTA.The transfer memory must first be initialized before being used. Then any test programs can be copied from the CMTA into the transfer memory and vice versa. When copying from the transfer memory into the CMTA, it is possible to append the copy to already existing programs. The DELETE function allows programs to be deleted from the transfer memory, e.g.in order to provide memory space for other programs. The display directory function permits to display the first line of a program contained in the transfer memory using the spinwheel.

2.3.10.9.1 Size of Transfer Memory Space

The transfer memory has a memory capacity of 7784 bytes. This memory space can be loaded with test programs. In accordance with the specified length of the vacant memory blocks of the CMTA, approx. 1946 blocks are to be expected here.

2.3.10.9.2 Initialization of Transfer Memory

Initialization of the transfer memory is necessary before using it for the first time or after replacing the battery.

For this purpose, plug the transfer memory into the CMTA and use A 540 SPEC to start initialization. In order to avoid inadvertent deletion, the message "REALLY RESET?" appears in the display. The function is only activated when STORE ***56*** is entered. During initialization, the LED of the transfer memory lights. After execution of the command, the message ">>> DONE <<<" is output in the α display **2**.

During initialization, indicated by lighting of the LED of the transfer memory, the transfer memory should not be disconnected since otherwise the function cannot be terminated.

Initialization of a transfer memory which has already been loaded with programs causes destruction of the programs.

Note:

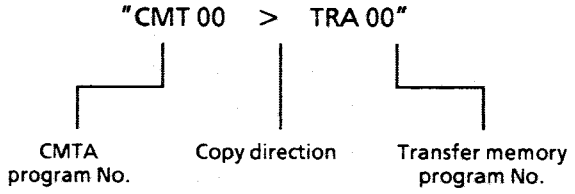
In order to prevent inadvertent overwriting of the data contained in the transfer memory, the CMTA should not be switched off or on as long as the transfer memory is connected.

Possible criteria for aborting initialization:

- Transfer memory is disconnected
  → Message "FORMAT ERROR", initialization of transfer memory cannot be terminated.
- CMTA is switched off
  → Initialization of transfer memory cannot be terminated.
- Transfer memory has not been connected to the instrument
  → Message "FORMAT ERROR"

2.3.10.9.3 Program Copying from CMTA to Transfer Memory

The corresponding function menu is called up using A 530 SPEC . The following message is displayed:



CMTA program No.:
Number of CMTA program to be copied.

Transfer memory Program No.:
Number of program in the transfer memory where to copy.

The arrow specifies the copy direction, indicating that the program selected is to be copied from the CMTA to the transfer memory. When the menu line appears in the display, the parameters can be entered. If more than four numbers are entered, the entry is started again. Subsequent STORE starts the copy procedure, SPEC aborts this function.

During the copy procedure, indicated by lighting of the LED of the transfer memory, the transfer memory should not be disconnected, since otherwise its contents and the initialization will be lost.

Successful termination of this function is indicated in the α display **2** by the message ">>> DONE <<<".

Possible criteria for aborting the copy procedure:

- Memory space in the transfer memory is not sufficient
  → Message "NO MORE MEMORY"

- Transfer memory is disconnected although copying is not yet terminated
  → Message "TRANSFER ERROR",
  initialization of transfer memory is lost; programs available before are no longer accessible.

- CMTA is switched off
  → Initialization of transfer memory is lost; programs available before are no longer accessible.

- Transfer memory has not been initialized
  → Message "TRANSFER ERROR",
  program is not copied.

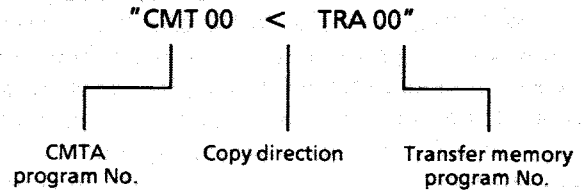
- Transfer memory has not been connected to the instrument
  → Message "TRANSFER ERROR"

- Program already exists in the transfer memory
  → Message "PGM EXISTS",
  the existing program must first be deleted (prevents inadvertent deletion of a program).

- The program to be copied does not exist
  → Message "NO SUCH PGM"

2.3.10.9.4 Program copying from Transfer Memory to CMTA

The corresponding function menu is called up using A 531 SPEC . The following message is displayed:



CMTA program No.:
Number of CMTA program where to copy

Transfer memory program No.:
Number of program in transfer memory from which to copy.

The arrow specifies the copy direction, indicating that the program selected is to be copied from the transfer memory to the CMTA. When the menu line appears in the display, the parameters can be entered. If more than 4 numbers are entered, the entry starts again. Subsequent STORE starts the copy procedure, SPEC aborts this function.

During the copy procedure, indicated by lighting of the LED of the transfer memory, the transfer memory should not be disconnected, since otherwise the program cannot be properly transferred.

Successful termination of this function is indicated in the α display **2** by the message ">>> DONE <<<".

Possible criteria for aborting the copy procedure:

- Memory space in the CMTA is not sufficient
  → Message "NO MORE MEMORY"

- Transfer memory is disconnected although copy procedure is not yet terminated
  → Message "TRANSFER ERROR",
  programs in the transfer memory and the CMTA are retained.

- CMTA is switched off
  → The programs of the CMTA may be lost, some information of the copied program may be changed.

- Transfer memory has not been initialized
  → Message "TRANSFER ERROR",
  the program is not copied.

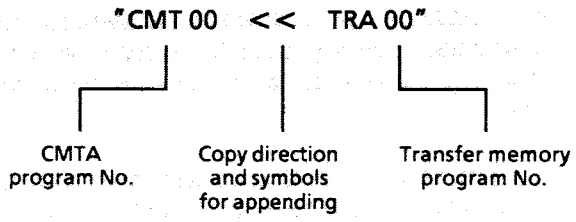
- Transfer memory has not been connected to the instrument
  → Message "TRANSFER ERROR"

- The program already exists in the transfer memory
  → Message "PGM EXISTS",
  the existing program must first be deleted (prevents inadvertent deletion of a program).

- The program to be copied does not exist
  → Message "NO SUCH PGM"

2.3.10.9.5 Appending a Transfer Memory Program to a CMTA Program

The corresponding function menu is called up using A 532 SPEC .The following message is displayed:



CMTA program No.
Number of CMTA program to which to append

Transfer memory program No.
Number of program in transfer memory from which to copy

The double arrow specifies the copy direction, indicating that the program selected is to be appended to an existing program in the CMTA. When the menu line is displayed, the parameters can be entered. If more than 4 numbers are entered, the entry starts again. Subsequent STORE starts the copy procedure, SPEC aborts this function.

During the copy procedure, indicated by lighting of the LED of the transfer memory, the transfer memory should not be disconnected, since otherwise the program cannot be properly transferred.

Successful termination of this function is indicated in the α display ***2*** by the message ">>>DONE<<<".

Possible criteria for aborting the copy procedure, see section 2.3.10.9.4.

2.3.10.9.6 Deletion of a Transfer Memory Program

The corresponding function menu is called up using A 533 SPEC .

The following message is displayed:
"DELETE TRA 00".

The number of the program to be deleted from the transfer memory must be entered as parameter. The parameter can be deleted by further entry.

During deletion, indicated by lighting of the LED of the transfer memory, the transfer memory should not be disconnected, since otherwise its contents and the initialization will be lost.

Successful termination of this function is indicated in the α display *2* by the message ">>>DONE<<<".

Possible criteria for aborting deletion:

- Transfer memory is disconnected although deletion is not yet terminated
  → Message "TRANSFER ERROR", initialization of transfer memory cannot be terminated

- CMTA is switched off
  → Initialization of transfer memory cannot be terminated.

- Transfer memory has not been connected to the instrument
  → Message "TRANSFER ERROR"

2.3.10.9.7 Display Directory of Transfer Memory

This function is called up using A 607 SPEC . The first line of the program selected using the spinwheel is output in the α display *2*. Programs which are not occupied are identified by "PGM EMPTY". When entering this function, the first line of program 00 is displayed (basic setting). This function can be left using A 606 SPEC .

2.3.10.10 Control Instructions (Brief Summary)

Input	Effect
A 800 SPEC STORE	Initialization of autorun control. Required after each battery replacement and new fitting of option (only in manual mode).
A 100 SPEC to A 199 SPEC	Start of programming = switchover to LEARN mode. 100 to 199 = program 00 to 99 (only in manual mode).
A 200 SPEC	End of programming = switchover to manual mode (only in LEARN mode).
A 300 SPEC STORE to A 399 SPEC STORE	Deletion of a program 300 to 399 = program 00 to 99 (only in manual mode).
A 500 SPEC	Start of message entry (only in LEARN mode).
A 505 SPEC 1 SPEC to A 505 SPEC 1000 SPEC	Start of a repetition block to be executed 1 to 1000 times (only in LEARN mode).
A 506 SPEC	End of a repetition block (only in LEARN mode).
A 510 SPEC	If the tolerance is exceeded during the program run (red LED lights), the program is interrupted (Default).
A 511 SPEC	Exceeding of the tolerance is only stored in the protocol, the program run is continued without interruption.
A 512 SPEC	After calling up this special function, the memory capacity still available is indicated (in blocks). Each command line consists of at least one block.
A 513 SPEC	Small format of test reports.
A 514 SPEC	Medium format of test reports.
A 515 SPEC	Large format of test reports.
A 520 SPEC	Starting message input with input requested in RUN mode (only in LEARN mode).
A 525 SPEC	Editing the printer configuration string.
A 526 SPEC	Output of printer configuration string to the printer (string is generated before by A 525 SPEC .)
A 527 SPEC	Entering a control character sequence for the autotest. In RUN mode, the programmed string is output to the printer.
A 530 SPEC	Copying CMTA program to transfer memory.
A 531 SPEC	Copying transfer memory program to CMTA.
A 532 SPEC	Appending transfer memory program to CMTA program.
A 533 SPEC	Deleting transfer memory program.
A 540 SPEC	Initializing transfer memory.
A 600 SPEC 0 SPEC to A 600 SPEC 10000 SPEC	Setting of minimum time between execution of the individual commands. 0 to 10000 = 0 to 10000 ms (only in manual mode and HOLD mode).

Input	Effect
A 605 SPEC	Display of directory of programs in the α display (only in manual mode).
A 606 SPEC	Directory switched off.
A 607 SPEC	Entering the function display directory of transfer memory.
A 610 SPEC	Output of the Autorun Control Directory on a printer
A 611 SPEC	Output of the Transfer Memory Directory on a printer
A 1000 SPEC to A 1999 SPEC	Selection of a particular line. 1000 to 1999 = line 000 to 999 (only in LEARN mode).
A 2000 SPEC to A 2999 SPEC	Deletion of a program block. 2000 to 2999 = deletion of lines 000 to 999 from the set position (only in LEARN mode).
100 START to 199 START	Start of program run. 100 to 199 = program 00 to 99 (only in manual mode).
STOP	Program interrupt (in RUN mode). Program run switched off (in HOLD mode).
CONT	Continuation of an interrupted program run (in HOLD mode).

2.4 Remote Control

2.4.1 Introduction

The IEC 625-1 interface allows remote control of the CMTA with the aid of a process controller. If the CMTA is remotely controlled via this interface, manual operation via the front panel is switched off.

The IEC/IEEE-bus address is indicated on the α display **2** on power-up. The address (default = 0) can be changed using the special function B 100 SPEC <address (0 to 30)> SPEC . The newly entered address will be retained even after the instrument has been switched off.

If the CMTA is controlled by a controller via the IEC bus, it can operate either as listener or as talker.

- **CMTA as listener**

In this mode, the CMTA receives device-specific data sent by the controller via the IEC bus. Several devices may operate as listeners. For this purpose, they must have been addressed by the controller before.

- **CMTA as talker**

In this mode, the CMTA sends device-specific data to the controller or other devices connected to the IEC bus. However, the CMTA must have been addressed as talker before. As opposed to listener mode, only one device may operate as talker in this case.

Using the LOCAL key ***47***, the CMTA can be switched to normal mode, provided that no IEC/IEEE-bus command is being processed.

2.4.2 Command Entry

2.4.2.1 General Command Entry

The IEC/IEEE-bus command entry has the following syntax:
10 IECOUT0 "<header><SP><parameter>"<NL>

The command entry always starts with a header. Header is to be understood as a device-specific instruction. This instruction may be a complete command or part of a command. The entry of headers is described in detail in section 2.4.2.2.

For many IEC/IEEE-bus commands it is necessary or possible to enter parameters, just like in the manual mode of the CMTA. The entry of numerical values and/or units must be separated from the headers by a space (space, 20H). The entry of numbers and units is described in section 2.4.2.3.

A complete command line may consist of up to 80 characters. A new line (NL) as termination of the IEC/IEEE-bus command makes the command available for execution.

The entry of commands or parameters shown in Fig. 2-15 is a representation of the possible entries.

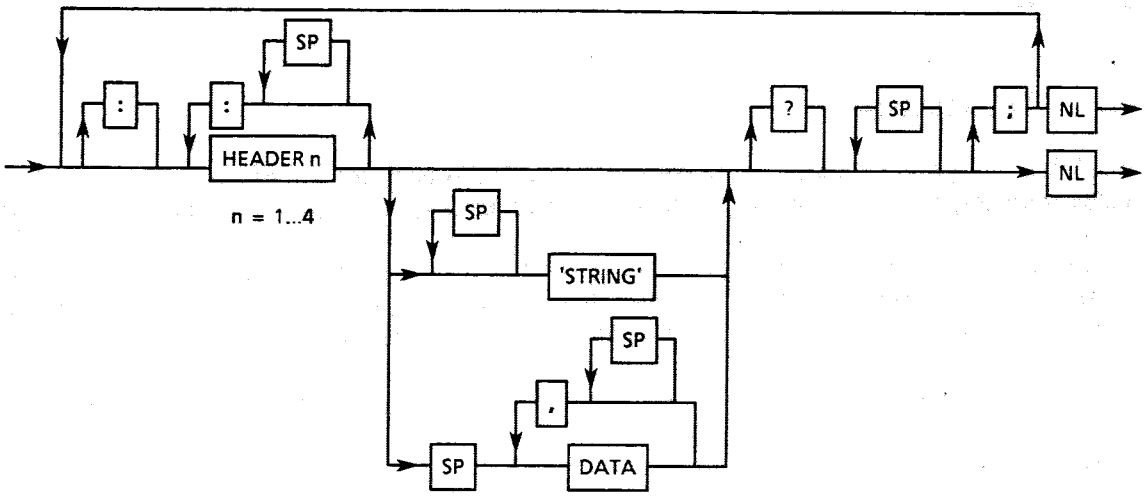


Fig. 2-15 Command entry

Meaning of the individual terms in Fig. 2-15 and in the following syntax structures:

NL	New line (ASCII 0DH, 0AH)
SP	Space (ASCII 20H)
:	Delimiter for header
;	Delimiter for commands
.	Decimal point
+/-	Sign
E	Exponent for numerical entries
EH	Units
#EH	Desired unit for measured/setting values
STRING	Numerical entry in inverted commas
DATA	Numbers and/or units
?	Measured/setting value request
→ counterclockwise	Repeated entry of a command or character is possible
→ clockwise	Single entry of a command or character

2.4.2.2 Entry of Headers

Up to four headers, which have to be separated from each other by a colon, are allowed per command line. For the commands, please refer to section 2.4.3.1. The headers may also be abbreviated (see also section 2.4.3). Fig. 2-16 shows the syntax and entry of headers.

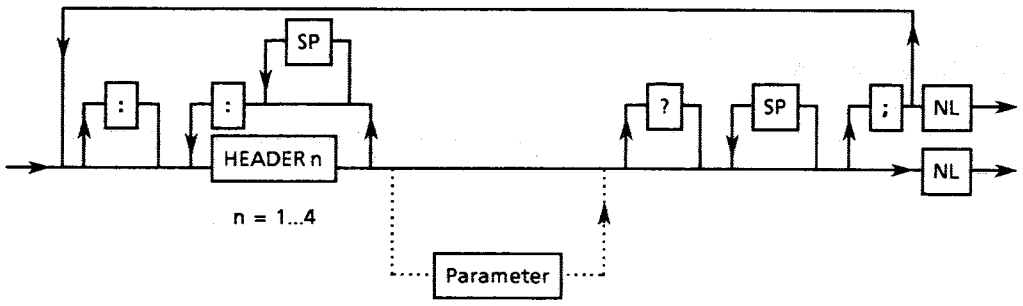


Fig. 2-16 Entry of headers

Examples:

Switchover from transmitter test to receiver test is effected by actuating the TX RX key ***60***. The IEC/IEEE-bus command consists of two headers:

10 IECOUT0,"MODE:RX_TEST"

The CCITT filter of the CMTA is switched into the demodulation circuit by a command consisting of four headers:

20 IECOUT0,"FILTER:CCITT:DEMODULATION:ON"

The same command may also be entered in abbreviated form:

20 IECOUT0,"FI:CC:DEMODU:ON"

It is possible, although not necessary, to put a colon before a command line and enter one or several spaces after each header.

Example:

The following command line, which is used for switching on the modulation generator, can be varied as shown:

10 IECOUT0,"LEVEL:AF:ON"
10 IECOUT0,":LEVEL:AF:ON"
10 IECOUT0,"LEVEL :AF :ON "
10 IECOUT0,":LEVEL :AF :ON "

Terminating a header line by a question mark (?) causes a talker request, which can be used to read the measurement results or setting values into the controller (see also section 2.4.2.4).

If a header or a header sequence is terminated by a semicolon with subsequent NEWLINE (NL) and a new command with the same first headers is to be entered, it is sufficient to enter the last header only.

Example:

10 IECOUT0,"FILTER :IF :NARROW ;";

For switching the filter to the WIDE mode, it is now no longer necessary to enter the complete command, but only:

20 IECOUT0,"WIDE " (NL)

2.4.2.3 Entry of Parameters

Parameters, e.g. for setting a frequency, must be entered according to the syntax shown in Fig. 2.17.

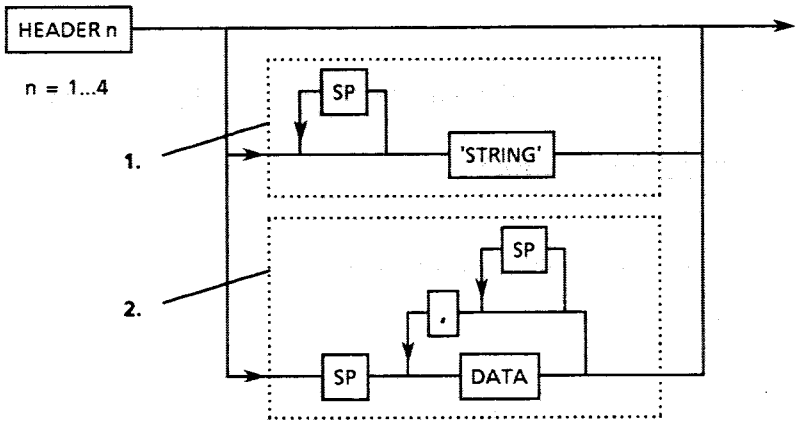


Fig. 2-17 Parameter entry

As shown from the above syntax structure, two different entries are possible:

- Entry of a string in inverted commas - as e.g. required in the CODE command for sending a data telegram.
- Entry of numerical values and units. If multiple entry is possible in a command, the parameters must be separated from each other by a comma or, optionally, by a space.

The following character set is available for the entry of numbers, units and strings:

Numerical entry			Unit entry			String entry		
0	1	2	%	rad		0	1	2
3	4	5	µV	mV	V	3	4	5
6	7	8	µA	mA	A	6	7	8
9	0		Hz	kHz	MHz	9	A	B
			nW	µW	mW	C	D	E
			W			F		
			dB	dBµV	dBm			

When entering parameters, it should be noted that a space must always be entered before numbers and units; no space is required for strings, but one or several spaces may be entered.

Fig. 2-18 below shows the syntax to be used for entering numbers and units. This structure corresponds to the DATA branch in Figs. 2-15 and 2-17.

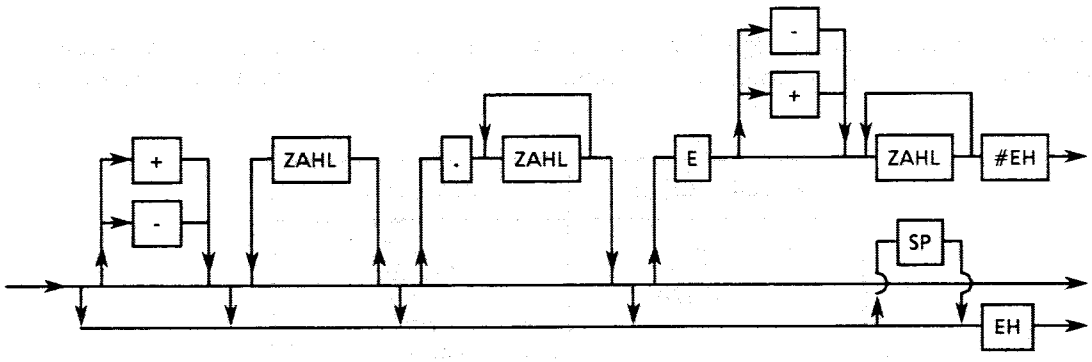


Fig. 2-18 Numerical/unit entry

- **Numbers without units**

Up to 24 digits can be entered per number. Numbers outside the numerical range of the CMTA will be ignored, i.e. before entering numbers, the user should check whether the entry is valid.

- Number without sign: 1234
- Number with sign: ± 1234
- Number with decimal point: ± 1234.56

- **Numbers with units**

Units can be entered with or without space after the numerical entries.

- Number without sign: 1234 EH, 1234EH
- Number with sign: ± 1234 EH, ± 1234EH
- Number with decimal point: ± 1234.56 EH, ± 1234.56EH

- **Numbers with unit request (#EH)**

The entry of numbers with unit request is described in section 2.4.2.4; the following combinations are possible:

- Exponent: ± E ± 3#EH
- Number with exponent: ± 1234E ± 3#EH
- Number with decimal point and exponent: ± 1234.56E ± 3#EH

2.4.2.4 Reading in Measured/Setting Values

If the CMTA is requested to perform a measurement and deliver the result to the controller, a question mark (?) must be put after the last header. This applies also when calling up device settings, such as frequency, output level or modulation depth.

The measurement result returned or the setting value is output in the following form:

<value> <exponent> <unit>

The measurement results and setting values are indicated in SI basic units. The numerical value either consists of a number and an exponent or a number only. If an exponent is output, it is a multiple of three.

Numerical output	Unit output	
e.g.: 120 2.31E6 -1.23E-3	Hz	Frequency
	V	Voltage
	A	Current
	W	Power
	%	Ratio
	dB	Ratio
	dBm	Ratio
	rad	Phase deviation
	s/div	Graphic scale
	V/div	Graphic scale
	%/div	Graphic scale
	rad/div	Graphic scale
	Hz/div	Graphic scale
	Div	Graphic scale

Examples:

RF frequency measurement is called and the result sent to the controller using the following commands:

```
10 IECOUT0,"COUNT:RF?"
20 IECIN0,A$ :PRINTA$
```

Screen output: 250E6 HZ (measured value)

The set deviation of the 1st modulation generator can be requested by means of the following commands:

```
10 IECOUT0,"MODULATION:INT1?"
20 IECIN0,A$:PRINTA$
```

Screen output: 4.0E3 HZ (setting value)

If two values are output, as e.g. in bandwidth measurement, the second value begins at the 20th digit in the display.

```
<VALUE1><EXP1><EH1> ... <VALUE2><EXP2><EH2>
↑                       ↑
1st digit               20th digit
```

If a measurement does not yield a result, a message is output on the CMTA as it would also appear in the α display **2** in normal mode.

The completion of a measurement is noted by the socalled SRQ byte (service request). By interrogating this byte, the controller is able to determine the end of measurement and to read in the measured value. For examples please refer to section 2.4.4.

If IEC/IEEE-bus commands causing device status settings (commands without value entry) are terminated by a question mark (?), the command will be executed, but after a read command of the controller, the message "*NOT TALKABLE*" will be read in.

Example:

The following IEC/IEEE-bus command switches the CMTA to transmitter test mode. The question mark (?) appended to the command causes the following message after the read command of the controller:

```
10 IECOUT0,"MODE:TX_TEST?"
20 IECIN0,B$:PRINTB$
```

Screen output: * NOT TALKABLE *

If for a talker request "#unit" is entered, the result will be returned in the desired unit. No setting is made on the instrument.

Example:

```
10 IECOUT0,"FREQUENCY:RF:TX_TEST 10MHZ?"
20 IECIN0,A$:PRINTA$
```

Screen output: 10.0E6 HZ

The set frequency of the RF synthezier is read in and displayed in MHz using the following commands:

```
10 IECOUT0,"FREQUENCY:RF:TX_TEST #MHZ?"
20 IECIN0,A$:PRINTA$
```

Screen output: 10.0 MHZ

If a number is entered before the character (#), this value will first be set in the currently selected unit and the result then be output in the unit specified after the "#".

Example:

```
10 IECOUT0,"FREQUENCY:RF:TX_TEST HZ"
20 IECOUT0,"FREQUENCY:RF:TX_TEST 215E3#MHZ"
30 IECIN0,A$:PRINTA$
```

Screen output: 215.0E-3 MHZ

The following command is illegal:

```
10 IECOUT0,"FREQUENCY:RF:TX_TEST 20 MHZ #KHZ"
```

Readout of a result from the CMTA to the controller is terminated by CR/LF. If the controller expects the additional information EOI, this can be set by means of:

```
B   102   SPEC
```

It is switched off by:

```
B   101   SPEC
```

(default after switching on)

The following special functions return a result to the controller:

```
10 IECOUT0,"SPECIALFUNCTION:D 20?"
20 IECOUT0,"SPECIALFUNCTION:D 21?"
30 IECOUT0,"SPECIALFUNCTION:D 22?"
```

Battery voltage measurement

```
40 IECOUT0,"SPECIALFUNCTION:DATA 80?"
50 IECOUT0,"SPECIALFUNCTION:DATA 84?"
```

Squelch measurement
Bandwidth measurement

2.4.3 Device-specific IEC/IEEE-bus Commands

All device-specific IEC/IEEE-bus commands of the CMTA are listed in the following tables.

XYZ stands for numerical values/units that have to be entered in the commands; entries in brackets [XYZ] may but need not be entered (see front-panel operation). Numerical values which are outside the numerical range of the CMTA or invalid units will be ignored, ie the user should check first whether the numerical values and/or units to be entered are valid.

The ASCII 95 character (_) in the IEC/IEEE-bus commands corresponds to <Shift> <Del> with Process Controller PCA 5 and to (<-) with Process Controller PUC.

2.4.3.1 Universal IEC/IEEE-bus Commands of CMTA

Device settings are made and measurements triggered via the universal IEC/IEEE-bus commands. In particular those commands or command lines calling up measurements must be terminated by a question mark (?). After completion of the measurement, the CMTA is switched to the talker mode by the question mark and sends the result to the controller (see also section 2.4.2.4).

Instrument setting	Response
MODE:TX_TEST MODE:TX_T	Switchover to transmitter test
MODE:TX_LOCK MODE:TX_L	Switchover to transmitter test and LOCK
MODE:RX_TEST MODE:RX_T	Switchover to receiver test
MODE:RX_LOCK MODE:RX_L	Switchover to receiver test and LOCK
MODE:LOCK_OFF MODE:LO	Switching off LOCK
MODE:DUPL:ON MODE:DU:ON	Duplex operation on
MODE:DUPL:OFF MODE:DU:OF	Duplex operation off
MODE:FREQUENCY_FIELD:TX_TEST MODE:FR:TX_T	Switchover of the individual displays to transmitter or receiver test
MODE:FREQUENCY_FIELD:RX_TEST MODE:FR:RX_T	Switchover of the individual displays to transmitter or receiver test
MODE:RF_LEVEL_FIELD:TX_TEST MODE:RF_:TX_T	Switchover of the individual displays to transmitter or receiver test
MODE:RF_LEVEL_FIELD:RX_TEST MODE:RF_:RX_T	Switchover of the individual displays to transmitter or receiver test
MODE:MODULATION_FIELD:TX_TEST MODE:MODU:TX_T	Switchover of the individual displays to transmitter or receiver test
MODE:MODULATION_FIELD:RX_TEST MODE:MODU:RX_T	Switchover of the individual displays to transmitter or receiver test
MODE:AF_LEVEL_FIELD:TX_TEST MODE:AF_:TX_T	Switchover of the individual displays to transmitter or receiver test
MODE:AF_LEVEL_FIELD:RX_TEST MODE:AF_:RX_T	Switchover of the individual displays to transmitter or receiver test

Instrument setting	Response
MODE:ACKTEST:ON MODE:AC:ON	Acknowledgement call test on
MODE:ACKTEST:OFF MODE:AC:OF	Acknowledgement call test off
MODE:INPUT:SELECT_RF MODE:INP:SELECT_R	RF input connector
MODE:INPUT:SELECT_2 MODE:INP:SELECT_2	Input connector INPUT 2
FREQUENCY:AF:INT1 [XYZ] FR:AF:INT1 [XYZ]	Setting the modulation generator frequency 1
FREQUENCY:AF:INT2 [XYZ] FR:AF:INT2 [XYZ]	Setting the modulation generator frequency 2
FREQUENCY:RF:RX_TEST [XYZ] FR:RF:RX_T [XYZ]	Setting the output frequency of the RF test generator
FREQUENCY:RF:TX_TEST [XYZ] FR:RF:TX_T [XYZ]	Setting the operating frequency for the transmitter test
MODULATION:INT1 [XYZ] MODU:INT1 [XYZ]	Setting the type and depth of modulation
MODULATION:INT2 [XYZ] MODU:INT2 [XYZ]	Setting the type and depth of modulation
MODULATION:EXT [XYZ] MODU:EXT [XYZ]	Setting the type and depth of modulation
MODULATION:FMDC:ON MODU:FM:ON	DC-coupled FM modulation on
MODULATION:FMDC:OFF MODU:FM:OFF	DC-coupled FM modulation off
MODULATION:EXT_CALIBRATION MODU:EXT_C	Calibration of AF voltage at input MOD EXT
MODULATION:EXT_1VRMS MODU:EXT_1	Nominal level 1 V_{RMS} at input MOD EXT
MODULATION:OFF MODU:OF	Switching off modulation of test generator
LEVEL:AF:ON L:AF:ON	Switching on modulation generator
LEVEL:AF:OFF L:AF:OF	Switching off modulation generator
LEVEL:AF:BOOST:ON L:AF:BO:ON	Level increased by 20 dB at MOD GEN output
LEVEL:AF:BOOST:OFF L:AF:BO:OF	Switching off level increase
LEVEL:AF:VOLTAGE [XYZ] L:AF:V [XYZ]	Setting the output level at MOD GEN output
LEVEL:RF:ON L:RF:ON	Switching on RF output level
LEVEL:RF:OFF L:RF:OF	Switching off RF output level
LEVEL:RF:BOOST:ON L:RF:BO:ON	Output level of RF signal generator increased by 6 dB
LEVEL:RF:BOOST:OFF L:RF:BO:OF	Switching off level increase
LEVEL:RF:VOLTAGE [XYZ] L:RF:V [XYZ]	Setting the RF output level
LEVEL:RF:FINE [XYZ] L:RF:FI [XYZ]	RF level fine variation

Instrument setting	Response
FILTER:IF:NARROW FI:IF:N	IF filter on
FILTER:IF:WIDE FI:IF:W	IF filter off
FILTER:HP:DEMODULATION:FREQUENCY [XYZ] FI:H:DEMODU:F [XYZ]	Highpass filter in demodulation path on
FILTER:HP:DEMODULATION:OFF FI:H:DEMODU:OF	Highpass filter in demodulation path off
FILTER:LP:DEMODULATION:FREQUENCY [XYZ] FI:LP:DEMODU:F [XYZ]	Lowpass filter in demodulation path on
FILTER:LP:DEMODULATION:OFF FI:LP:DEMODU:OF	Lowpass filter in demodulation path off
FILTER:CCITT:DEMODULATION:ON FI:CC:DEMODU:ON	CCITT filter in demodulation path on
FILTER:CCITT:DEMODULATION:OFF FI:CC:DEMODU:OF	CCITT filter in demodulation path off
FILTER:HP:AF_INPUT:FREQUENCY [XYZ] FI:H:AF_:F [XYZ]	Highpass filter in AF voltmeter path on
FILTER:HP:AF_INPUT:OFF FI:H:AF_:OF	Highpass filter in AF voltmeter path off
FILTER:LP:AF_INPUT:FREQUENCY [XYZ] FI:LP:AF_:F [XYZ]	Lowpass filter in AF voltmeter path on
FILTER:TP:AF_INPUT:OFF FI:LP:AF_:OF	Lowpass filter in AF voltmeter path off
FILTER:CCITT:AF_INPUT:ON FI:CC:AF_:ON	CCITT filter AF voltmeter on
FILTER:CCITT:AF_INPUT:OFF FI:CC:AF_:OF	CCITT filter AF voltmeter off
CODE ['XYZ'] COD ['XYZ']	Transmission of data telegram
DELTA_F [XYZ] DEL [XYZ]	Setting the channel spacing
STORE XY STO XY	Storage of complete instrument settings
RECALL XY REC XY	Call of complete instrument settings
SPECIALFUNCTION:DATA XYZ SPECIALF:DA XYZ	Entry of special function, e.g. 72 SPEC
SPECIALFUNCTION:A XYZ SPECIALF:A XYZ	Entry of special function, e.g. A200 SPEC
SPECIALFUNCTION:B XYZ SPECIALF:B XYZ	Entry of special function, e.g. B 00 SPEC
SPECIALFUNCTION:C XYZ SPECIALF:C XYZ	Entry of special function, e.g. C 151 SPEC
SPECIALFUNCTION:D XYZ SPECIALF:D XYZ	Entry of special function, e.g. D 13 SPEC
SPECIALINPUT:DATA XX,YY SPECIALI:DATA XX,YY	Entry of special function, e.g. XX SPEC <YY< SPEC
SPECIALINPUT:A XX,YY SPECIALI:A XX,YY	Entry of special function, e.g. A 505 SPEC 1 SPEC
SPECIALINPUT:B XX,YY SPECIALI:B XX,YY	Entry of special function, e.g. B 100 SPEC 0 SPEC
SPECIALINPUT:C XX,YY SPECIALI:C XX,YY	Entry of special function, e.g. C 111 SPEC 15 SPEC

Measurement	Response
DEMODULATION:MAX_PK DEM:MA	Call of modulation measurement
DEMODULATION:POS_PK DEM:POS_	Call of modulation measurement
DEMODULATION:MED_PK DEM:MED	Call of modulation measurement
DEMODULATION:NEG_PK DEM:NEG	Call of modulation measurement
DEMODULATION:PK_HOLD:ON DEM:PK_:ON	Switching on PK-HOLD measurement
DEMODULATION:PK_HOLD:OFF DEM:PK_:OFEM:NEG_	Switching off PK-HOLD measurement
DEMODULATION:DISTORTION:FREQUENCY [XYZ] DEM:DI:FR [XYZ] 1)	Measurement of transmitter modulation distortion and selection of notch filter frequency
AF_INPUT:LEVEL AF:LE	AF level measurement
AF_INPUT:DISTORTION:FREQUENCY [XYZ] AF:DI:FR [XYZ] 1)	Distortion measurement at frequency XYZ
AF_INPUT:DISTORTION:SEARCH_VALUE [XYZ] AF:DI:SEA [XYZ] 2)	Start of search routine for distortion value XYZ
AF_INPUT:SINAD:FREQUENCY [XYZ] AF:SI:FR [XYZ] 3)	SINAD measurement at frequency XYZ
AF_INPUT:SINAD:SEARCH_VALUE [XYZ] AF:SI:SEA [XYZ] 4)	Start of search routine for SINAD value XYZ
AF_INPUT:S/N [XYZ] AF:S/ [XYZ] 5)	S/N measurement; start of search routine for S/N value XYZ when entering a numerical value
COUNT:RF COU:RF	Switching on RF counter
COUNT:AF:DEMOD COU:AF:DEMOD	Frequency measurement of demodulated signal
COUNT:AF:BEAT COU:AF:BE	Frequency measurement of demodulated signal
COUNT:AF:EXTERN COU:AF:E	Measurement of frequency at AF VOLTM input
RF_INPUT:POWER RF:POW	RF power measurement
RF_INPUT:PROBE RF:PR	RF level measurement with RF millivoltmeter
DECODE DEC	Decoding a tone sequence
ACP [XYZ]	Adjacent-channel power measurement ACP1 or ACP -1 ACP2 or ACP -2
VDC:	DC voltage measurement via V_{DC} connectors on
IDC:	DC current measurement via I_{DC} connectors on

1) to 5) These commands provide two results in talker mode:

1)	1st value: distortion [%]	2nd value:	test frequency [Hz]
2)	1st value: distortion [%]	2nd value:	RF output level [V]
3)	1st value: SINAD [dB]	2nd value:	test frequency [Hz]
4)	1st value: SINAD [dB]	2nd value:	RF output level [V]
5)	1st value: S/N [dB]	2nd value:	RF output level [V]

2.4.3.2 IEC/IEEE-bus Commands for Reference Function

In manual mode, the CMTA is able to display new measured/setting values relative to a reference value. This is also possible in IEC/IEEE-bus mode by means of the following commands:

Switch on	Switch off	Response
REF:POWER REF:POW	REF_CLEAR:POWER REF_:POW	RF power measurement
REF:RF:VOLTAGE REF:RF:V	REF_CLEAR:RF:VOLTAGE REV_:RF:V	RF level
REF:PROBE REF:PR	REV_CLEAR:PROBE REF_:PR	RF millivoltmeter
REF:MAX_PK REF:MA	REF_CLEAR:MAX_PK REF_:MA	Modulation measurement (MAX PK)
REF:POS_PK REF:POS_	REF_CLEAR:POS_PK REF_:POS_	Modulation measurement (+ PK)
REF:MED_PK REF:MED_	REF_CLEAR:MED_PK REF_:ME	Modulation measurement (+/- PK)
REF:NEG_PK REF:NEG_	REF_CLEAR:NEG_PK REF_:NEG_	Modulation measurement (- PK)
REF:INT1 REF:INT1	REF_CLEAR:INT1 REF_:INT1	Modulation setting (INT 1)
REF:INT2 REF:INT2	REF_CLEAR:INT2 REF_:INT2	Modulation setting (INT 2)
REF:EXT REF:EXT	REF_CLEAR:EXT REF_:EXT	Modulation setting (EXT)
REF:LEVEL REF:LE	REF_CLEAR:LEVEL REF_:LE	AF voltmeter
REF:VDC REF:V	REF_CLEAR:VDC REF_:V	DC voltage measurement
REF:IDC REF:I	REF_CLEAR:IDC REF_:I	DC current measurement

Without additional indication of a reference value, the "REF" commands only produce an effect on the front-panel display (like in manual mode), i.e. the command IECOUT0,"REF:LEVEL" switches the output of the measured value to 0.0 dB, and the currently displayed measured value is defined as reference value.

Using IECOUT0,"REF_CLEAR:LEVEL", the absolute measured value (e.g. 1.00 V) is displayed again.

If a measured/setting value is requested (e.g. IECOUT0,"REF:LEVEL?"), two results are always obtained, namely relative and absolute value. If the reference value is indicated in the REF command, the result is referred to this value and can be requested by the controller via the bus.

Example:

The following commands are used to set the output level of the RF synthesizer and to read the set value into the controller:

```
10 IECOUT0,"LEVEL:RF:V 1µV?"
20 IECIN0,A$:PRINT A$
```

Result displayed on the screen: 1E-6 V

The following commands are used to define the previously set level as reference value and to read in the value (two results: relative and absolute):

```
30 IECOUT0,"REF:RF:V?"
40 IECIN0,A$:PRINT A$
```

Result displayed on the screen: 0 DB 1E-6 V

The entry of a value in the REF command followed by a CMTA talker request (?) also returns two results:

```
50 IECOUT0,"REF:RF:V 10IJV ?"
60 IECIN0,A$:PRINT A$
```

Result displayed on the screen: -20 DB 1E-6 V

2.4.3.3 IEC/IEEE-bus Commands for the Graphics Unit of CMTA

Manual operation of the graphics unit of the CMTA (scope, single-shot and spectrum mode) is simulated by the following IEC/IEEE-bus commands:

Instrument setting	Response
GRAPHIK:SOFTKEY_1 [XYZ] G:SOFTKEY_1 [XYZ]	Softkey 1 (key ***101***)
GRAPHIK:SOFTKEY_2 [XYZ] G:SOFTKEY_2 [XYZ]	Softkey 2 (key ***102***)
GRAPHIK:SOFTKEY_3 [XYZ] G:SOFTKEY_3 [XYZ]	Softkey 3 (key ***103***)
GRAPHIK:SOFTKEY_4 [XYZ] G:SOFTKEY_4 [XYZ]	Softkey 4 (key ***104***)
GRAPHIK:SOFTKEY_5 [XYZ] G:SOFTKEY_5 [XYZ]	Softkey 5 (key ***105***)
GRAPHIK:MENU_HOME G:MENU_H	Return to home menu
GRAPHIK:MENU_UP G:MENU_U	Selects the next higher menu
GRAPHIK:SOFTKEY_CHANGE G:SOFTKEY_C	Changing the softkey functions

The commands GRAPHIK:SOFTKEY_1 to GRAPHIK:SOFTKEY_5 have a different function at the individual menu levels and these functions also depend on the device status.

The command GRAPHIK:SOFTKEY_CHANGE can be used to change the functions of the five softkey commands. When jumping to a new menu, the softkey commands always have their first function (that of the highest menu level).

The IEC/IEEE-bus commands GRAPHIK:MENU_HOME and GRAPHIK:MENU_UP are used for selecting the menu level and are independent of the current menu level and device status. Using the command GRAPHIK:MENU_HOME at any menu level provides access to the home menu, from where the individual graphics modes (scope, single-shot or spectrum) can be selected. The command GRAPHIK:MENU_UP switches the graphics menu to the next higher level.

The menu overview of the graphics unit (see section 2.3.9) provides information on the softkey functions at the individual menu levels with different device states.

2.4.3.3.1 Entry/Variation of Values in Graphics Mode

Operation of the CMTA via the IEC/IEEE bus in graphics mode is partly different from the manual operation. The following settings can be made by the direct entry of the required value, however varying some parameters as in manual mode is not possible.

Numerical entries exceeding the range of values are set to the upper or lower limit value. On entering intermediate values, the closest value will be automatically set. The value entry via the IEC/IEEE bus in graphics mode has the following syntax:

10 IECOUT0,"GRAPHIK:SOFTKEY_n <value><unit>"

(n = 1 to 5)

1. Scope mode

In the scope mode, all values are entered without units. The default units must be observed. If, for instance, an amplitude deflection of 2 V/div is desired, the following value must be entered for the default unit mV/div:

10 IECOUT0,"GRAPHIK:SOFTKEY_3 2000"

- **Time base**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_1 <value>" or
10 IECOUT0,"GRAPHIK:SOFTKEY_2 <value>"

Range of values: 0.05 ms/div to 50 ms/div
Resolution: 1/2/5 steps
Default unit: ms/div

- **Amplitude**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value>" or
10 IECOUT0,"GRAPHIK:SOFTKEY_4 <value>"

EXT AC/DC

Range of values: 2 mV/div to 5 V/div
Resolution: 1/2/5 steps
Default unit: mV/div

AF

Range of values: 1 mV/div to 20 V/div
Resolution: [1)] 1/2/5 steps
Default unit: mV/div

1) It is not always possible to select all ranges due to built-in switchable amplifiers and attenuators

DEMOD

- AM

Range of values: 0.1 %/div to 40 %/div
Resolution: 1/2/5 steps
Default unit: %/div

- ϕM

Range of values: 0.01 rad/div to 10 rad/div
Resolution: 1/2/5 steps
Default unit: rad/div

- FM

Range of values: 20 Hz/div to 40 kHz/div
Resolution: 1/2/5 steps
Default unit: kHz/div

BEAT, AF-DIST, DEMOD-DIST

Range of values: -10 dB to 56 dB
Resolution: 6 dB
Default unit: dB (no absolute amplitude, but relative setting)

- **Display [BEST/MAN]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_5"
Default value: MAN

- **Coupling [AC/DC]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_5 <value>"
Range of values: 0 to 1 (0 = DC coupling, 1 = AC coupling)

- **Trigger slope [SLOPE]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
20 IECOUT0,"GRAPHIK:SOFTKEY_1 <value>"
Range of values: 0 to 1 (0 = pos. slope, 1 = neg. slope)

- **Pre-trigger [PRE]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
20 IECOUT0,"GRAPHIK:SOFTKEY_2 <value>"

Range of values: 0 % to 100 %
Resolution: 12.5 %
Default unit: %

- **Trigger level [LEV]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE" 20 IECOUT0,"GRAPHIK:SOFTKEY_3 <value>"
Range of values:	-8.0 div to 8.0 div
Resolution:	0.1 div
Default unit:	div

- **Delay time [DELAY]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE" 20 IECOUT0,"GRAPHIK:SOFTKEY_4 <value>"
Range of values:	0 ms to 800 ms
Resolution:	0.1 ms
Default unit:	ms

2. Single-shot mode

In the single-shot mode, all values must also be entered without units, observing the respective default values of the units. If, for instance, a storage time of 3.2 s is desired, the following value must be entered for the default unit ms:

10 IECOUT0,"GRAPHIK:SOFTKEY_1 3200"

- **Storage time[TIME]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_1 <value>"
Range of values:	3.2 ms to 3200 ms
Resolution:	1/2/5 steps
Default unit:	ms

- **Pre-trigger [PRE]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_2 <value>"
Range of values:	0 % to 100 %
Resolution:	12.5 %
Default unit:	%

- **Delay time [DELAY]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value>"
Range of values:	0 ms to 800 ms
Resolution:	0.1 ms
Default unit:	ms

- **Trigger level [LEVEL]**

IEC-bus command:
10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
20 IECOUT0,"GRAPHIK:SOFTKEY_1 <value>"

Range of values: -8.0 div to 8.0 div
Resolution: 0.1 div
Default unit: div

- **Trigger slope [SLOPE]**

IEC-bus command:
10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
20 IECOUT0,"GRAPHIK:SOFTKEY_2 <value>"

Range of values: 0 to 1 (0 = pos. slope, 1 = neg. slope)

- **Amplitude [AMPL]**

IEC-bus command:
10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value>"

EXT AC/DC

Range of values: 2 mV/div to 5 V/div
Resolution: 1/2/5 steps
Default unit: mV/div

AF

Range of values: 1 mV/div to 20 V/div
Resolution: [1] 1/2/5 steps
Default unit: mV/div

DEMOD

- AM

Range of values: 0.1 %/div to 40 %/div
Resolution: 1/2/5 steps
Default unit: %/div

- ϕM

Range of values: 0.01 rad/div to 10 rad/div
Resolution: 1/2/5 steps
Default unit: rad/div

- FM

Range of values: 20 Hz/div to 40 kHz/div
Resolution: 1/2/5 steps
Default unit: kHz/div

BEAT

Range of values: -10 dB to 56 dB
Resolution: 6 dB
Default unit: dB (no absolute amplitude, but relative setting)

1) It is not always possible to select all ranges due to built-in switchable amplifiers and attenuators

- **Measurement start [ARM]:**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE" or
20 IECOUT0,"GRAPHIK:SOFTKEY_5 "

Special feature: The command only enables the measurement, start is, however, made by a trigger event.

3. Spectrum mode

In the spectrum mode, the unit is entered in addition to the value. In the SSB and RF mode, some device functions/measurements are inhibited. When calling these functions, "execution error" and the message "not possible" is returned.

a) AF analyzer

- **Start frequency [START]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_1 <value><unit>"
Range of values: 0 Hz to 20 kHz
Resolution: 1 Hz
Units: Hz or kHz

- **Center frequency [CENT]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_2 <value><unit>"
Range of values: 0 Hz to 20 kHz
Resolution: 1 Hz
Units: Hz or kHz

- **Reference level [LEV]**

IEC-bus command: 10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value><unit>"

EXT

Range of values: -46 dBV to 23 dBV, or 5 mV to 14.1 V
Resolution: 1 dB
Units: dBV or mV

AF, LSB, USB

Range of values: -56 dBV to 31 dBV, or 1.58 mV to 35.5 V
Resolution: [1] 1 dB
Units: dBV or mV

DEMOD

- AM

Range of values: 0.1 % to 100 %
Resolution: 1 dB
Unit: %

[1] It is not always possible to select all ranges due to built-in switchable amplifiers and attenuators

- φM

Range of values:	0.06 rad to 25 rad
Resolution:	1 dB
Unit:	rad

- FM

Range of values:	44.7 Hz to 100 kHz
Resolution:	1 dB
Units:	Hz or kHz

BEAT

Range of values:	-10 dB to 61 dB
Resolution:	1 dB
Unit:	dB

- **Span [SPAN]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_4 <value><unit>"
Range of values:	0 Hz to 20 kHz
Resolution:	16 Hz
Units:	Hz or kHz

- **Stop frequency [STOP]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_5 <value><unit>"
Range of values:	0 Hz to 20 kHz
Resolution:	1 Hz
Units:	Hz or kHz

b) SSB analyzer

- **Start frequency [START]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_1 <value><unit>"
Range of values:	-8 kHz to 8 kHz
Resolution:	1 Hz
Units:	Hz or kHz

- **Reference level [LEV]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value><unit>"
Range of values: [2]	43 dBµV to 154 dBµV - 64 dBm to + 47 dBm 0.14 mV to 50.1 V
Resolution:	1 dB
Units:	dBµV, dBm or mV

[2] The range of values is partly restricted by the selection of the input (1st/2nd input) and the attenuators (0 dB to 30 dB)

- **Stop frequency [STOP]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_5 <value><unit>"
Range of values:	-8 kHz to 8 kHz
Resolution:	1 Hz
Units:	Hz or kHz

c) RF analyzer

- **Reference level [LEV]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_1 <value><unit>"
Range of values: [2]	43 dBµV to 154 dBµV -64 dBm to + 47 dBm 0.14 mV to 50.1 V
Resolution:	1 dB
Units:	dBµV, dBm or mV

- **Center frequency [CENT]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_3 <value><unit>"
Range of values:	400 kHz to 1000 MHz
Resolution:	1 kHz
Units:	kHz or MHz

- **Span [SPAN]**

IEC-bus command:	10 IECOUT0,"GRAPHIK:SOFTKEY_5 <value><unit>"
Range of values:	30 kHz to 10 MHz
Units:	kHz or MHz

[2] The range of values is partly restricted by the selection of the input (1st/2nd input) and the attenuators (0 dB to 30 dB)

2.4.4 Examples for IEC/IEEE-bus Operation

When the CMTA is switched on, the IEC/IEEE-bus address is shown on the α display ***2***. During operation, the IEC-bus address can be changed using the special function `B 100 SPEC <address (0 to 30)> SPEC` . By actuating the LOCAL key ***47***, the CMTA can be reset to normal mode.

The IEC/IEEE-bus command of the controller (PUC, SCUD, PCA) to the CMTA has the following syntax:
<line number> IECOUT<address>,"<IEC-bus command>"

Example:

If the IEC-bus address is e.g. 0, a simple IEC-bus command can be used for setting the RF synthesizer frequency to 10 MHz in TX test:

```
10 IECOUT0,"FREQUENCY:RF:TX_TEST 10MHZ"
```

The following command enables the controller (PUC, SCUD, PCA) to read results or setting values from the CMTA:
<line number> IECIN<address>,<variable>

Example:

```
10 IECOUT0,"COUNT:RF?"
20 IECIN0,A$:PRINTA$
```

When the command line is terminated with the question mark (?), the CMTA is switched to the talker mode after the RF frequency measurement has been carried out. The measurement result, which is contained in the variable A$, is then read in by the controller with command IECIN0 and displayed on the screen (PRINTA$).

The status byte can be read in by the controller with the aid of the following IEC-bus command:
<> IECSPL<address>,<variable>

Example:

See programming example: "IEC/IEEE-bus control of CMTA using SRQ" (section 2.4.4.1).

Each time the LOCAL key ***47*** is actuated, the command IECDCL should initiate IEC/IEEE-bus operation. A complete BASIC program reads as follows:

Example:

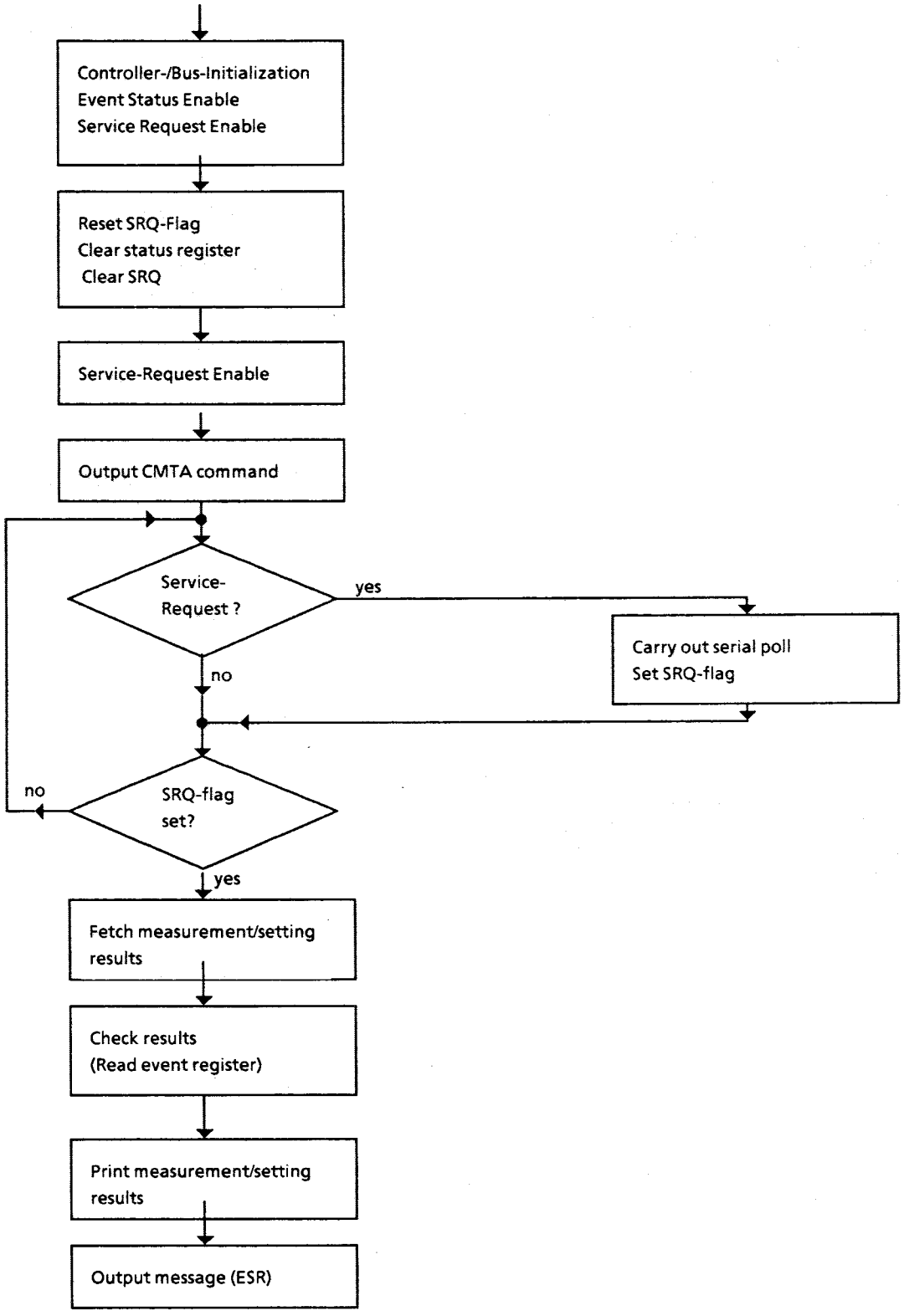
```
10 IECDCL
20 IECTIME10                                  Initialization
30 IECTERM10
40 IECOUT0,"MODE:TX_TEST "
50 IECOUT0,"FREQUENCY:AF:INT1 20 kHz "
60 IECGTL
```

This program switches the CMTA to the transmitter test mode and sets the frequency of the first modulation generator to 20 kHz. The command IECGTL terminates the IEC/IEEE-bus operation and resets the instrument to normal mode.

For a detailed description of the IEC/IEE-bus commands of the controller used, please refer to the relevant operating instructions since there are differences in the handling of some commands by the various controllers.

2.4.4.1 Programming Example for CMTA Operation

- **IEC/IEEE-bus control of CMTA using SRQ**



The following program was written on a PUC controller (PUC/SCUD syntax)

```
100 IECDCL:IECOFFSRQ                                    Initialization
110 IECTIME10:IECTERM10
120 IECOUT0,"*ESE 255"                                  Event mask
130 IECOUT0,"*SRE 32"                                   SRQ mask
140 :
150 :
160 IECOUT0,"RECALL 1"                                  User program
170 O$ = "SPECIALF:DATA 80?"
180 GOSUB1200:REM CALL MEASUREMENT
190 PRINT"SQUELCH-TEST:":PRINTI$
200 PRINTES$
210 :
220 END
999 :
1200 REM SRQ-HANDLING ***************
1210 SQ = 0:IECOUT0,"*CLS"                              Clear status register
1220 IECSPL0,SP%:REM CLEAR SRQ
1230 IECSRQGOTO1300                                     Activate SRQ
1240 IECOUT0,O$                                         Call measurement
1250 DUMMY = 0:IFSQ = 0THEN1250:REM WAIT FOR SRQ
1260 IECOFFSRQ                                          Disable SRQ
1270 GOSUB1400:REM FETCH RESULT
1280 GOSUB1500:REM CHECK EVENTS
1290 RETURN
1300 :
1300 REM #### SERIAL POLL                               Serial poll following SRQ
1310 IECSPL0,SPL%
1320 SQ = 1
1330 IECRETSRQ
1340 :
1400 REM #### FETCH RESULT                              Fetch results
1410 IECIN0,I$
1420 RETURN
1430 :
1500 REM #### EVENT STATUS                              Read event register
1510 IECOUT0,"*ESR?"
1520 IECIN0,B$:B = VAL(B$)
1530 IFBAND32THENES$ = "COMMAND ERROR"
1540 IFBAND16THENES$ = "EXECUTION ERROR"
1550 IFBAND1THENES$ = "CMTA READY"
1560 IFB = 0THENES$ = "NO EVENT OCCURED"
1570 RETURN
READY.
```

The following program was written on a PCA 5 controller: (PCA 5 syntax)

```
10 REM Sample Program with SRQ for CMTA
20 REM = = = = = = = = = = = = = = = = = = = =
30 REM
40 REM ------------------ INITIALIZATION -----------------
50 HOLD 1000
60 IEC DCL
70 ON SRQ1 RETURN
80 IEC TIME 20000
90 IEC TERM 10
100 IEC OUT 0,"*ESE 255"
110 IEC OUT 0,"*SRE 32"
120 REM
130 REM ---------------- ROUTINE ----------------
140 BEFEHL$ = "SPECIALFUNCTION:D 20?"
150 GOSUB 200: REM CALL OF MEASUREMENT
160 PRINT "BATTERY VOLTAGE = "
170 PRINT I$
180 PRINT ES$
190 END
200 REM ------ ---------- SRQ-INITIALIZATION --------------
210 SQFLAG = 0: REM CLEAR SRQ-FLAG
220 IEC OUT 0,"*CLS": REM CLEAR STATUS
230 IEC SPL 0,SP%: REM CLEAR SRQ
240 REM
250 REM ---------- ENABLE SRQ ----------
260 ON SRQ1 GOSUB 380: REM SERIAL POLL
270 REM
280 REM ---------- OUTPUT DEVICE COMMAND ---------
290 IEC OUT 0,COMMAND$
300 REM
310 REM ---------- SERIAL POLL SRQ FLAG --------------
320 DUMMY = 0: IF SQFLAG = 0 THEN 320
330 REM
340 REM ---------- FETCH RESULTS ---------------
350 GOSUB 420: REM FETCH RESULT
360 GOSUB 450: REM CHECK EVENTS
370 RETURN
380 REM ---------- SERIAL POLL ----------
390 IEC SPL 0,SP%
400 SQFLAG = 1
410 RETURN
420 REM ---------- FETCH RESULTS- ----------
430 IEC IN 0,I$
440 RETURN
450 REM ---------- READ EVENT REGISTER ----------
460 IEC OUT 0,"*ESR?"
470 IEC IN 0,B$: B = VAL(B$)
480 IF B AND 32 THEN ES$ = "COMMAND ERROR"
490 IF B AND 16 THEN ES$ = "EXECUTION ERROR"
500 IF B AND 1 THEN ES$ = "CMTA READY"
510 IF B = 0 THEN ES$ = "NO EVENT OCCURED"
520 RETURN
```

- **Bandwidth measurement**

```
10 REM
20 REM                              Bandwidth measurement
30 REM
40 IECDCL
50 IECSPE
60 IECOUT0,"*ESE 255"
70 IECOUT0,"*SRE 32"
80 ON SRQ GOTO 200
90 IECOUT0,"SPECIALF: DATA 84?"
.
.
.
200 IECSPL0,A%
210 IF A% = 96 THEN GOTO 290
220 GOTO 1000
.
.
.290 IECIN0,X$
300 IECOUT0,"*ESR?"
310 IECIN0,B$ : B = VAL(B$)
320 IF B = 32 THEN ...              Command Error
330 IF B = 16 THEN ...              Execution Error
340 IF B = 1 THEN ...               Operation complete
.
.
.
1000 END
```

2.4.4.2 Programming Examples for Operating the CMTA in Graphics Mode

- **Scope mode**

In the following program, the output signal of the internal modulation generator is displayed in repetitive mode on the screen (2 to 3 new pictures per second). First, connect MOD GEN ***90*** and AF VOLTM ***91*** via a BNC cable.

```
10 IECDCL
20 REM
30 REM ********** Set modulation generator*********
40 REM
50 IECOUT0,"LEVEL:AF:ON"                          Mod. gen. on
60 IECOUT0,"LEVEL:AF:VOLTAGE 1.0V"                Amplitude: 1V
70 IECOUT0,"FREQUENCY:AF:INT1 1KHZ"               Frequency: 1kHz
80 REM
90 REM ********* Call graphics, scope mode**********
100 REM
110 IECOUT0,"GRAPHIK:MENU_HOME"                   → Home menu
120 IECOUT0,"GRAPHIK:SOFTKEY_1"                   → Scope menu
130 IECOUT0,"GRAPHIK:SOFTKEY_1"                   → AF (scope) menu
140 REM
150 REM *************** Set graphics*************
160 REM
170 IECOUT0,"GRAPHIK:SOFTKEY_1 0.5"               Time base: 0.5 ms/div
180 IECOUT0,"GRAPHIK:SOFTKEY_3 500"               Amplitude: 0.5 V/div
190 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
200 IECOUT0,"GRAPHIK:SOFTKEY_1 0"                 Trigger slope: pos.
210 IECOUT0,"GRAPHIK:SOFTKEY_2 0"                 Pre-trigger: 0 %
220 IECOUT0,"GRAPHIK:SOFTKEY_3 0"                 Trigger level: 0 div
230 IECOUT0,"GRAPHIK:SOFTKEY_4 0"                 Delay time: 0 s
```

- **Single-shot mode:**

In this program, the output signal of the internal modulation generator is displayed in single-shot mode on the screen. First, connect MOD GEN ***90*** and AF VOLTM ***91*** via a BNC cable.

```
10 IECDCL
20 REM
30 REM ********* Set modulation generator********
40 REM
50 IECOUT0,"LEVEL:AF:ON"                          Mod. gen. on
60 IECOUT0,"LEVEL:AF:VOLTAGE 1.0V"                Amplitude: 1V
70 IECOUT0,"FREQUENCY:AF:INT1 1KHZ"               Frequency: 1kHz
80 REM
90 REM ****** Call graphics, single-shot mode*******
100 REM
110 IECOUT0,"GRAPHIK:MENU_HOME"                   →Home menu
120 IECOUT0,"GRAPHIK:SOFTKEY_2"                   → Single menu
130 IECOUT0,"GRAPHIK:SOFTKEY_1"                   → AF (single) menu
140 REM
.
.
.
```

```
150 REM  *************** Set graphics****************
160 REM
170 IECOUT0,"GRAPHIK:SOFTKEY_1"                    Trigger source: AF
180 IECOUT0,"GRAPHIK:SOFTKEY_1 32"                 Storage time: 32 ms
190 IECOUT0,"GRAPHIK:SOFTKEY_2 0"                  Pre-trigger: 0 %
200 IECOUT0,"GRAPHIK:SOFTKEY_3 0"                  Delay time: 0 s
210 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
220 IECOUT0,"GRAPHIK:SOFTKEY_1 0"                  Trigger level: 0 div
230 IECOUT0,"GRAPHIK:SOFTKEY_2 0"                  Trigger slope: pos.
240 IECOUT0,"GRAPHIK:SOFTKEY_3 500"                Amplitude: 0.5 V/div
250 REM
260 REM  ************ Enable measurement***********
270 REM
280 IECOUT0,"GRAPHIK:SOFTKEY_5"                    ARM → ARMED
```

Note:

In this example, the signal is recorded almost immediately after the last graphics command, since the signal of the modulation generator itself (which has a periodic characteristic) has been selected as the trigger source.

- **Spectrum mode**

In the following program, the AF spectrum of the modulation generator output voltage is displayed on the screen. First, connect MOD GEN ***90*** and AF VOLTM ***91*** via a BNC cable.

```
10 IECDCL
20 REM
30 REM  ********* Set modulation generator********
40 REM
50 IECOUT0,"LEVEL:AF:ON"                           Mod. gen. on
60 IECOUT0,"LEVEL:AF:VOLTAGE 1.0V"                 Amplitude: 1V
70 IECOUT0,"FREQUENCY:AF:INT1 1KHZ"                Frequency: 1kHz
80 REM
90 REM  ******* Call graphics, spectrum mode********
100 REM
110 IECOUT0,"GRAPHIK:MENU_HOME"                    → Home menu
120 IECOUT0,"GRAPHIK:SOFTKEY_3"                    → Spectrum menu
130 IECOUT0,"GRAPHIK:SOFTKEY_1"                    → AF (spectrum) menu
140 REM
150 REM  ************** Set graphics*************
160 REM
170 IECOUT0,"GRAPHIK:SOFTKEY_1 0KHZ"               Start frequency: 0 kHz
180 IECOUT0,"GRAPHIK:SOFTKEY_3 6DBV"               Reference level: 6 dBV
190 IECOUT0,"GRAPHIK:SOFTKEY_5 4KHZ"               Stop frequency: 4 kHz
200 IECOUT0,"GRAPHIK:SOFTKEY_CHANGE"
210 IECOUT0,"GRAPHIK:SOFTKEY_1"                    Display: 10 dB/div
```

Reading in the marker position via the IEC bus

In the spectrum mode the marker position is read in using the following command:

IECOUT 0,"GRAPHIK:SOFTKEY_1 <Position> ?"

The "position" parameter provides a frequency, at which the marker is positioned. If no parameter is provided, the marker is located at the stored x-position like in manual mode.

This command provides two values, if the CMTA is in the marker mode (frozen values).
The x-position of the marker is always output in Hz.
The y-position, i.e. the measured value of the marker, however, is output in the same unit as the selected reference level (see table below).

Mode	Y-position of the marker
AF-, Beat-, Ext-, LSB-, USB-Spectrum	V, dBV
Demod-Spectrum (FM) (φM) (AM)	Hz rad %
SSB-, RF-Spectrum	V, dBμV, dBm

e.g.

IECOUT0,"GRAPHIK:SOFTKEY_1 4KHZ?"
▪
▪
▪
IECIN0,A$: PRINT A$

⇒ 4.0E3 Hz -6.0 DBV

2.4.4.2.1 Graphics Display of the Data Read in via B200/B300 SPEC

It is possible via two SPEC functions to read out the data (X-/Y-positions) of a graphic display in spectrum-marker mode or of eight single-shot graphic displays from the memory to have them processed by the controller.

- **Marker mode:** 32-value memory output for IEC bus

The 256-byte memory of the marker display is read via a double SPEC function:

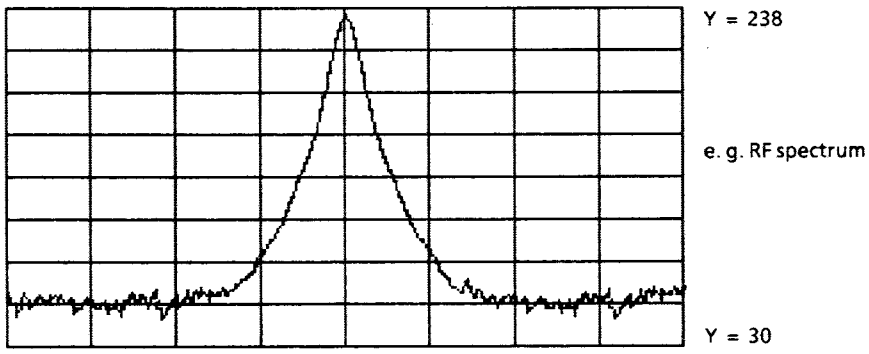
B 200 SPEC<0 . . . 255> SPEC

32 measured values (Y-positions within a value range of 30 to 238, starting from the transmitted X-position) are transferred in ASCII. The following IEC / IEEE-bus commands deliver 65 characters in the string variable "A$" (32 x 2-byte measured values and a delimiter).

IECOUTO, "SPECIALINPUT:B 200, <Position>?"
IECIN, A$

The CMTA graphics marker display consists of 256 values. To read out the whole display the SPEC function is called eight times:

Position	X-values
0 →	0 ... 31
32 →	32 ... 63
64 →	64 ... 95
96 →	96 ... 127
128 →	128 ... 159
160 →	160 ... 191
192 →	192 ... 223
224 →	224 ... 255



- **Single-Shot: 32-value memory output for IEC bus**

The 2-kByte memory of the single-shot oscilloscope is read via a double SPEC function:

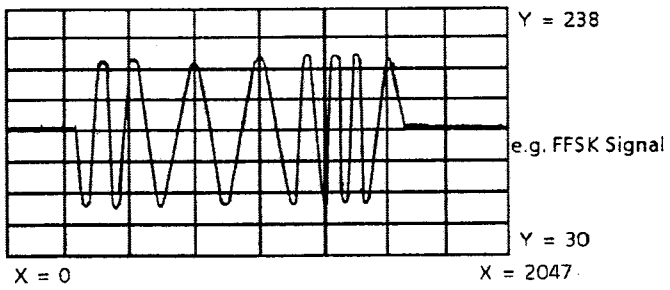
B 300 SPEC <0 ... 2047> SPEC

32 measured values (Y-positions within a value range of 30 to 238, starting from the transmitted X-position) are transferred in ASCII. The following IEC / IEEE-bus commands deliver 65 characters in the string variable"A$"(32 x 2-byte measured values and a delimiter).

IECOUT0,"SPECIALINPUT:B 300, <Position> ?"
IECIN0,A$

The CMTA graphics display consists of 256 values. Since the memory capacity is 2 Kbyte the graphics has thus stored 8 displays. This means that the SPEC function must be called eight times to read the whole display. The value ranges are classified in the tables below :

Position	X-Values	Position	X-Values		Position	X-Values
0 →	0 ... 31	256 →	256 ... 287		1792 →	1792 ... 1823
32 →	32 ... 63	288 →	288 ... 319		1824 →	1824 ... 1855
64 →	64 ... 95	320 →	320 ... 351		1856 →	1856 ... 1887
96 →	96 ... 127	352 →	352 ... 383	• • •	1888 →	1888 ... 1919
128 →	128 ... 159	384 →	384 ... 415		1920 →	1920 ... 1951
160 →	160 ... 191	416 →	416 ... 447		1952 →	1952 ... 1983
192 →	192 ... 223	448 →	448 ... 479		1984 →	1984 ... 2015
224 →	224 ... 255	480 →	480 ... 511		2016 →	2016 ... 2047
Values of the 1st picture		Values of the 2nd picture			Values of the 8th picture	



If graphics are to be displayed on a scale in single-shot mode the window labelling can be read in at the fourth menu level of this mode.

Sample program for reading in one or more single-shot graphic displays of the CMTA

PCA5-Syntax

```
60 IECDCL
70 IECTIME 20000
80 HOLD 100
90 COMMAND$ = "SPECIALINPUT:B 300,"
100 XOFFSET = 40
110 YOFFSET = 30
120 HEADLINE$ = "R&S    AF-SINGLE SHOT"
130 REM
140 IECOUT0,"GRAPHICS:MENU_HOME"
150 IECOUT0,"GRAPHICS:SOFTKEY_2": REM Single
160 IECOUT0,"GRAPHICS:SOFTKEY_1": REM AF-Single
170 IECOUT0,"GRAPHICS:SOFTKEY_1": REM Trigg AF
180 IECOUT0,"GRAPHICS:SOFTKEY_1 ?": REM Storage Time ?
190 IECIN0,TIM$
200 IECOUT0,"GRAPHICS:SOFTKEY_2 ?": REM Pre-Trig ?
210 IECIN0,PRE$
220 IECOUT0,"GRAPHICS:SOFTKEY_3 ?": REM Delay
230 IECIN0,DEL$
240 IECOUT0,"GRAPHICS:SOFTKEY_CHANGE"
250 IECOUT0,"GRAPHICS:SOFTKEY_3 ?": REM Ampl ?
260 IECIN0,AMPL$
270 IECOUT0,"GRAPHICS:SOFTKEY_5": REM ARM
280 HOLD 1000
290 IECOUT0,GRAPHICS:SOFTKEY_1 ?": REM Left t ?
300 IECIN0,LEF$
310 PRINT "Select Display Sector"
320 INPUT "(1,2,4,8) DISPLAYS : ",D
330 REM
340 XI = (1/D)*2
350 IF D = 1 OR D = 2 OR D = 4 OR D = 8 THEN D = (D*256)-1 ELSE GOTO 310
360 REM
370 REM DISPLAY SETUP
380 REM ------------------
390 REM ! Grid
400 DOT XOFFSET,(YOFFSET + 30)
410 FOR M = XOFFSET TO (512 + XOFFSET) STEP 64
420 DRAW M,(238 + YOFFSET)
430 DOT M + 64,(YOFFSET + 30)
440 NEXT M
450 REM
460 REM - Grid
470 DOT XOFFSET,(YOFFSET + 30)
480 FOR N = (YOFFSET + 30) TO (238 + YOFFSET) STEP 26
490 DRAW (512 + XOFFSET),N
500 DOT XOFFSET,N + 26
510 NEXT N
520 REM
530 MOVE XOFFSET,265 + YOFFSET
540 LABEL HEADLINE$,1
550 MOVE XOFFSET, YOFFSET + 20
560 LABEL LEF$
570 MOVE XOFFSET,YOFFSET + 10
580 LABEL "                    Ampl: " + AMPL$ + "  Time: " + TIM$,0
590 MOVE XOFFSET,YOFFSET-5
600 LABEL "                    Pre-Trig: " + PRE$ + "  Delay: " + DEL$,0
610 REM
```

```
620 MOVE XOFFSET,(YOFFSET + 30)
630 REM
640 REM OUTPUT MEASURED VALUES
650 REM ------------------------------
660 X = 0
670 FOR J = 0 TO D STEP 32
680 J$ = STR$(J)
690 IECOUT0,COMMAND$ + J$ + "?": REM Read 32 y-positions
700 IECIN0,A$
710 FOR I = 1 TO 63 STEP 2
720 Y$ = MID$(A$,I,2)
730 Y = HEX(Y$)
740 X = X + XI
750 DRAW (X + XOFFSET),(Y + YOFFSET)
760 NEXT I
770 NEXT J
780 IECOUT0,"*ESR?" : REM Read and evaluate event state register
790 IECIN0,B$: B = VAL(B$)
800 IF B = 32 THEN PRINT "Command Error"
810 IF B = 16 THEN PRINT "Execution Error"
820 IF B = 1 THEN PRINT "Operation Complete"
830 IECGTL
```

- **Spectrum: 32-value memory output for IEC / IEEE-bus**

In the spectrum mode the values of the graphics display are read in via a double-SPEC function :

B 200 SPEC <0 ... 255> SPEC

32 measured values (Y-positions within a value range of 30 ... 238) are transferred in ASCII. The number of output values is limited for transfer parameters >223.

The following IEC / IEEE-bus commands deliver 65 characters in the string variable "A$"(32 x 2-byte measured values and delimiter).

```
IECOUT 0, "SPECIALINPUT:B 200, <0 ... 255> ?"
IECIN0,A$
```

The CMTA graphics display consists of 256 values. The value ranges are classified in the table below:

Position	X-Values
0 →	0 ... 31
32 →	32 ... 63
64 →	64 ... 95
96 →	96 ... 127
128 →	128 ... 159
160 →	160 ... 191
192 →	192 ... 223
224 →	224 ... 255

Values of the spectrum display

Sample Program for Reading in a complete RF-Spectrum Graphics Display of the CMTA

PCA5-Syntax

```
60 IECDCL
70 IECTIME 20000
80 HOLD 100
90 COMMAND$ = "SPECIALINPUT:B  200,"
100 XOFFSET = 40
110 YOFFSET = 30
120 HEADLINE$ = "R&S              RF-SPECTRUM 10 dB/[]"
130 BOTTOM LINE$ = "                 REF-LEV: 0 dB   CENTER: 120 MHz   SPAN: 400 kHz"
140 REM
150 IECOUT0,"GRAPHICS:MENU_HOME"
160 IECOUT0,"GRAPHICS:SOFTKEY_3": REM Spectrum
170 IECOUT0,"GRAPHICS:SOFTKEY_5": REM RF-Spectrum
180 IECOUT0,"GRAPHICS:SOFTKEY_4": REM 20 DB
190 IECOUT0,"GRAPHICS:SOFTKEY_1 0 DBM": REM Ref-Lev
200 IECOUT0,"GRAPHICS:SOFTKEY_3 120 MHZ": REM Center-f
210 IECOUT0,"GRAPHICS:SOFTKEY_5 400 KHZ": REM Span-f
220 IECOUT0,"GRAPHICS:SOFTKEY_CHANGE"
230 IECOUT0,"GRAPHICS:SOFTKEY_1": REM Marker
240 REM
250 REM DISPLAY SETUP
260 REM ------------------
270 REM ! Grid
280 DOT XOFFSET, (YOFFSET + 30)
290 FOR M = XOFFSET TO (512 + XOFFSET) STEP 64
300 DRAW M,(238 + YOFFSET)
310 DOT M + 64,(YOFFSET + 30)
320 NEXT M
330 REM
340 REM - Grid
350 DOT XOFFSET,(YOFFSET + 30)
360 FOR N = YOFFSET + 30) TO (238 + YOFFSET) STEP 26
370 DRAW (512 + XOFFSET),N
380 DOT XOFFSET,N + 26
390 NEXT N
400 REM
410 DOT XOFFSET,265 + YOFFSET
420 LABEL HEADLINE$,1
430 DOT XOFFSET,YOFFSET + 10
440 LABEL BOTTOM LINE$,0
450 REM
460 DOT XOFFSET,(YOFFSET + 30)
470 REM
480 REM OUTPUT MEASURED VALUE
490 REM ------------------------------
500 X = 0
510 FOR J = 0 TO 224 STEP 32
520 J$ = STR$(J)
530 IECOUT0,COMMAND$ + J$"?": REM 32 Read Y-position
540 IECIN0,A$
550 FOR I = 1 TO 63 STEP 2
560 Y$ = MID$(A$,I,2)
570 Y = HEX(Y$)
580 X = X + 2
590 IF X<>512 THEN DRAW (X + XOFFSET),(Y + YOFFSET)
600 NEXT I
610 NEXT J
620 IECOUT0,"*ESR?": REM Read and evaluate event state register
630 IECIN0,B$: B = VAL(B$)
640 IF B = 32 THEN PRINT "Command Error"
650 IF B = 16 THEN PRINT "Execution Error"
660 IF B = 1 THEN PRINT "Operation Complete"
670 IECGTL
```

2.4.5 Device-independent Commands

Device-independent commands refer to

- reset commands
- service request function
- device identification

Headers consist of an asterisk (*) followed by three letters.

Table 2-2 Device-independent commands

Header	Meaning
*CLS	**Clear Status** Sets status registers (ESR and STB) to zero.
*ESE 0 to 255 *ESE?	**Event Status Enable** Sets the mask register to 0 to 255 or reads out the register.
*IDN?	**Identification Query** Identification of the device with the reply ROHDE & SCHWARZ CMTA.
*ESR?	**Event Status Register Query** Output of the event status register.
*STB?	**Status Byte Query** Reads out the register.
OPT?	Options Display of options fitted The output has the following meaning: 0001 0110 0111 1101 2nd AF Synthesizer 1) Autorun Control (CMTA-B5) IEC Bus 1) Duplex Modulation Meter (CMTA-B9) Model 52 Model 54 RF Millivoltmeter (CM-B8) Adjacent-channel Power Meter (CMT-B6) CR Simulator (CMTA-B13) 1) Fitted as standard

2.4.5.1 Service Request and Status Registers

Fig. 2-19 shows the status registers and the links between them. In line with the standard, the status byte (STB) and its associated mask register (SRE), which are also available in older instruments, have been supplemented by the event status register (ESR) and its event status enable (ESE) mask register.

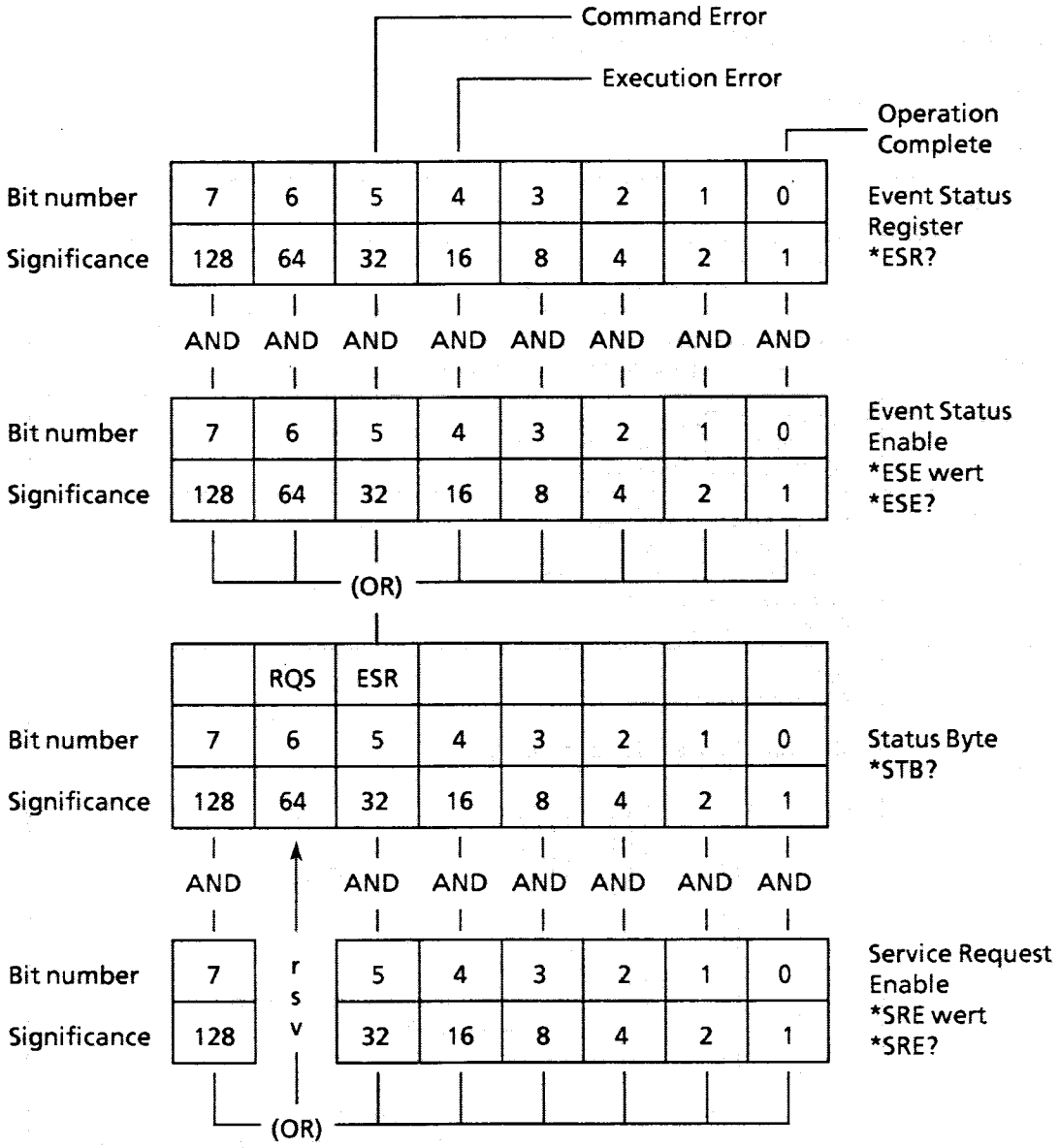


Fig. 2-19 Status register

Table 2-3 Significance of event status register

Bit 5	**Command Error** is set if the following errors are detected during analysis of the received commands: → syntax error → illegal header → illegal unit
Bit 4	**Execution Error** is set if one of the following messages appears: → ADD OPTION... → CHECK MOD. → CHECK INST. → TIMEOUT ERROR → >NOT DEFINED< → >ERROR< → *NO CALL* → >PROTECTED< → NOT TALKABLE → ** CH. SP. ** → * SET RF FIRST * → 0V RF / CH.SP. These messages can then be read in via the IECIN command.
Bit 0	**Operation Complete** is set if all previous commands have been executed.

Using the service request enable mask register (SRE), the user can determine whether the RQS bit of the status byte is also to be set with the ESR bit set and if a service request is to be sent to the controller by activating the SRQ line. The following possibilities exist since each bit in the service request enable mask register is assigned to the corresponding bit in the status byte:

Contents of the SRE (decimal)	Set bit No. in the SRE	Effect
0	-	No service request
32	5	Service request with ESR bit set (at least 1 bit set in the event status register and not masked)

The service request enable mask register (SRE) is written with the command "*SRE wert" ("wert" is the contents in decimal) and can be read again using the command *SRE?. It is not changed by other commands or interface messages (DCL, SDC).

Several devices can trigger a service request simultaneously, the open collector drivers cause an OR function on the SRQ line. The controller must read the status bytes of the devices to identify the device which has triggered the service request. A set RQS bit (bit 6/DIO 7) indicates that the device is transmitting a service request.

The status byte of the CMTA can be read in the following manner:

- Using the command "*STB?"
  The contents are output in decimal form. The status byte is not modified by reading and the service request is not cleared.

- Using a serial poll
  (With R&S controllers: IECSPL adr, status)
  The contents are transferred in binary form as only byte. The RQS bit is subsequently set to zero and the service request becomes inactive, the other bits of the status byte are not changed.

In the event status register (ESR), a bit is set to 1 (see Table 2-3) if certain events occur (e.g. error, ready message).

These bits remain set until they are cleared by reading the event status register (using the command *ESR? or *CLS).

Using the event status enable mask register (ESE), the user can select the bits in the event status register which also set the sum bit ESR (bit 5 in the status byte). The sum bit is only set if at least one bit in the ESR and the corresponding bit in the ESE are set to 1. The sum bit is automatically cleared again if the above condition is no longer satisfied, e.g. if the bits in the ESR are cleared by reading the ESR or if the ESE is changed.

The event status enable mask register is written with the command "*ESE wert" ("wert" is the contents in decimal) and can be read out again using the command *ESE?.

It is not changed by other commands or interface messages (DCL, SDC).

Only the following bits are used in the status byte (STB):

Bit No.	Bus line	Desi-gnation	Meaning
5	DIO 6	ESR	Sum bit of event status register
6	DIO 7	RQS	Request Service

2.4.6 Special Features of CMTA in Remote Control Mode

(IEC/IEEE bus and autorun control)

2.4.6.1 Readout of Decoded Selective Call via IEC Bus / Autorun Control

The IEC-bus command IECOUT0,"DECODE?" starts decoding and delivers as a result the contents of the data telegram received.

In an acknowledgement test (ACK TEST), it must be possible to read out the contents of the data telegram received without having to restart decoding. For this purpose,

IECOUT0, "SPECIALFUNCTION:C 186?"
is used.

This command can also be used directly in manual mode (useful only in LEARN mode of autorun control) and in the autorun control program:

```
C   186   SPEC
```

The IEC-bus command IECOUT0,"DECODE?" is synchronized, i.e. it must first be terminated before a further command can be sent to the CMTA.

In order to be able to send further commands to the CMTA after decoding has been started (e.g. control of the relays on IEC bus and autorun control), this synchronization must be suppressed.

For this purpose, the following command sequence is used:

IECOUT0, "SPECIALFUNCTION:C 185"
(decode unsynchronized)

IECOUT0, "SPECIALFUNCTION:A 31"
(switch relay)

:

Wait for the result or read out the result until the buffer is no longer empty!

:

IECOUT0, "SPECIALFUNCTION:C186?"
(fetch result)

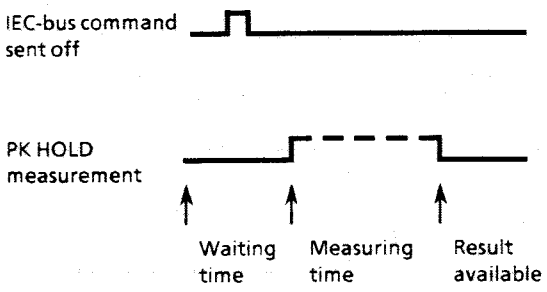
This function can also be used with the autorun control!

2.4.6.2 PK HOLD Function via IEC Bus and Autorun Control

If the PK HOLD function is switched on in manual mode, the greatest measured modulation value is displayed as a result until the function is switched off.

In addition, particular time conditions are useful in IEC-bus mode:

- Waiting time between incoming IEC-bus command and start of PK HOLD measurement.
- Measuring time (time between start and end of PK HOLD)



These times can be set between 0.1 and 3 s via the two functions

```
181  SPEC  <measuring time (s)>  SPEC
```

(resolution 0.1 s)
(IECOUT0, "SPECIALINPUT: DATA 181, waiting time")

and

```
182  SPEC  <waiting time (s)>  SPEC
```

(resolution 0.1 s)
(IECOUT0, "SPECIALINPUT: DATA 182, measuring time")
The IEC-bus command

IECOUT0, "DEMODULATION:PK_HOLD:ON"

starts the +PK or -PK measurement with the PK HOLD function activated.

MAX PK	⌉
+ PK	activated → PK HOLD with + PK
MED PK	⌋
- PK	activated → PK HOLD with -PK

This command is not synchronized, ie further commands (e.g. switching built-in relays) can be sent to the CMTA even before the measurement is terminated.

The measurement result is read out using the command

IECOUT0, "SPECIALFUNCTION:DATA 180?"

and provides the +PK or -PK result (after expiration of the measuring time).

Operation via the autorun control is performed accordingly.

Note:

With the ACK TEST activated (ACK TEST LED lights) and in manual mode, times entered via **181 / 182 SPEC** ***are ignored.***

The function **180 SPEC** ***can be used in the ACK TEST for reading out the determined deviation in IEC-bus and autorun mode.***

2.4.6.3 Automatic Background Calibration of CMTA

Approximately every 10 minutes, the CMTA performs a calibration of the A/D converter (incl. preamplifier), the rms meter and the peak-value meter. During calibration, the measuring mode is interrupted for approx. two seconds which may lead to difficulties in time-critical measurements (above all via IEC bus and autorun control).

The automatic calibration can therefore be switched off via D 5 SPEC .
It can be switched on again via D 0 SPEC.

2.4.6.4 Waiting Times and Transients of CMTA in IEC-bus Programs

All internal transients of the CMTA with respect to switching of amplifiers, attenuators and source selection are taken into account in the individual measurement calls.

In some cases, however, it is not useful to take into account all possible errors in the firmware of the CMTA (reduction of measuring rate):

- **Distortion meter (SINAD/DIST, DIST TX)**

If the input voltage varies heavily, the internal CMTA control requires up to 6 s until the display of the measured SINAD value is steady and correct. Since the point in time at which such level jumps occur is always known in a fully automatic test program, it is better to wait for the steady-state condition in the control program than reduce the measuring rate in the firmware.

Level jumps at the AF VOLTM input *91*

20 IECOUT0, "AF_INPUT:SINAD"
(1st measurement call in order to activate SINAD measurement)

30 HOLD 3000
(Waiting time until signal applied is stable)

40 IECOUT0, "AF_INPUT:SINAD?"
(Perform measurement)

- **Switchover of type of modulation**

When selecting the MAX PK measurement, the type of modulation can be switched over at the same time via the unit. In order to suppress settling of the demodulators, it is recommended to evaluate the result of a second measurement:

AM modulation is switched on

50 IECOUT0, "DEMODULATION:MAX_PK KHZ"
60 IECOUT0, "DEMODULATION:MAX_PK?"

- **Changing from BEAT/ACP measurement to demodulation**

Demodulation is not possible while a BEAT/ACP measurement is running, since the local oscillator must be converted for this purpose.

Therefore, this operating mode should be switched off before measuring the demodulated signal.

BEAT measurement active

```
50 IECOUT0, "DEMODULATION:MAX_PK"
(BEAT is switched off)
60 IECOUT0, "DEMODULATION:MAX_PK?"
```

or

```
60 IECOUT0, "DEMODULATION:DISTORTION"
70 HOLD 3000
80 IECOUT0, "DEMODULATION:DISTORTION?"
```

ACP measurement active

```
50 IECOUT0, "RF_INPUT:POWER"
(ACP is switched off)
60 IECOUT0, "DEMODULATION:MAX_PK?"
or
60 IECOUT0,"DEMODULATION:DISTORTION"
70 HOLD 3000
80 IECOUT0, "DEMODULATION:DISTORTION?"
```

2.4.7 IEC/IEEE Bus Interface (IEC 625-1/IEEE 488)

The instrument is controlled via 16 signal lines which should not be longer than 20 m.

The signal lines have the following functions:

- Eight lines form the data bus for sending data, addresses and control commands.
- Three lines handle handshaking.
- The remaining five lines form the management bus. It controls the data bus and transmits some special messages.

Fig. 2-20 shows the pin assignment of the IEC-bus connector ***112***. The functions of the individual lines are listed in Table 2-4.

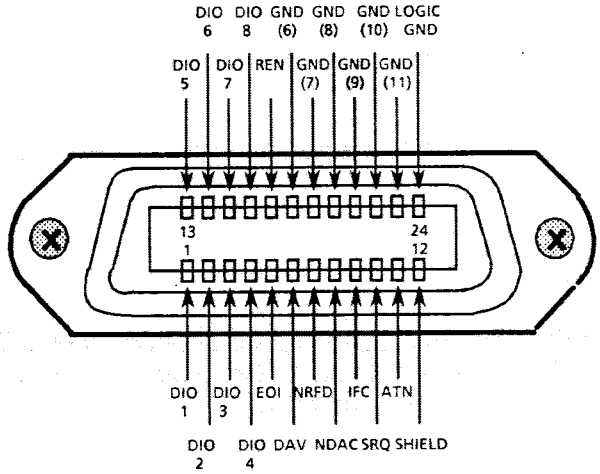


Fig. 2-20 Pin assignment of IEC-bus connector ***112***

Table 2-4 IEC/IEEE-bus lines

DIO1 to DIO8	Transmission lines for data, addresses and commands. DIO1 = LSB; DIO8 = MSB	Data bus
NRFD	**Not ready for data** Listener signals with NRFD = Low that it cannot accept data at present.	Hand-shake bus
NDAC	**Not data accepted** Listener signals with NDAC = Low that it has not accepted data.	
DAV	**Data valid** Talker signals with DAV = Low that the data applied to DIO1 to DIO8 are valid.	
ATN	**Attention** For differentiating between device messages (ATN = Low) and interface messages (ATN = High)	Manage-ment bus
EOI	**End or identify** Signal with two functions depending on ATN:	

EOI	ATN	Meaning on DIO
0	0	(data byte)
1	0	**END:** last data byte of a block
0	1	(address or command)
1	1	**IDENTIFY:** request for identification after service request

IFC	**Interface clear** Controller resets the 100-µs device remote control circuit (the interface) with IFC = Low.	Manage-ment bus
REN	**Remote enable** Controller switches the devices connected to the bus from manual to remote control with REN = Low. Manual control is inhibited.	
SRQ	**Service request** Each device connected and fitted with this function can request service from the controller via this line by setting SRQ = Low.	

2.5 Installation of Options

For installing most of the options, the instrument must be opened and plug-in PCBs be withdrawn. The necessary information is provided in the service manual (section 4).

2.5.1 Autorun Control (CMTA-B5)

For fitting this option, the instrument need not be opened. Unscrew and withdraw the IEC-bus interface fixed to the rear panel by means of six Phillips screws, break off the corresponding connector cutouts and fasten the option using the screws supplied. Carefully slide the cover plate with the interface and the option into the instrument and tighten the screws.

After the option has been fitted, first enter A 800 SPEC (initialization) when switching on for the first time.

2.5.2 Adjacent-channel Power Meter (CMT-B6)

Open the instrument. Insert the option into slot X52 on the "reference" module. Establish the following cable connections:

Test signal:

Cable W20 between analog section (X606) and CMT-B6 (X918).

100-MHz signal without CMTA-B9 option (Duplex Modulation Meter):

Cable W21 between reference (X951) and CMT-B6 (X911).

100-MHz signal with CMTA-B9 option:

Cable W21 between reference (X951) and CMTA-B9 (X931). Cable W22 between CMTA-B9 (X932) and CMT-B6 (X911).

RF signal without 2nd attenuator:

Remove cable W16 between analog section (X609) and analog section (X607). Cable W23 between analog section (X609) and CMT-B6 (X917). Cable W24 between CMT-B6 (X916) and analog section (X607).

RF signal with 2nd attenuator:

Remove cable W24 between 2nd attenuator (X907) and analog section (X607). Cable W23 between 2nd attenuator (X907) and CMT-B6 (X917). Cable W24 between CMT-B6 (X916) and analog section (X607).

2.5.3 RF Millivoltmeter (CM-B8)

Disconnect cable W4 and W5 from the 1st modulation generator module (slot X53, grey colour coding) and remove the module including the 2nd AF synthesizer. Insert the option into the 2nd AF synthesizer and use the protruding cover as a support. Insert the modules. Reconnect cables W4 and W5. Connect the X511 connector of cable W26 to the RF millivoltmeter.

2.5.4 Duplex Modulation Meter (CMTA-B9)

Open the instrument and insert the option into slot X51 (yellow colour coding). Establish the following cable connections:

Remove cable W21 between reference (X951) and CMT-B6 (X911), if connected.

Cable W21 between reference (X951) and CMTA-B9 (X931). Cable W22 between CMTA-B9 (X932) and CMT-B6 (X911). Cable W3B between CMTA-B9 (X939) and reference.

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Bilder

Figures

Figures