



ROHDE & SCHWARZ

Measuring Instruments
and Systems Division

Service manual

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TESTER
CMT**

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VOLUME 1

The service manual consists of 2 volumes

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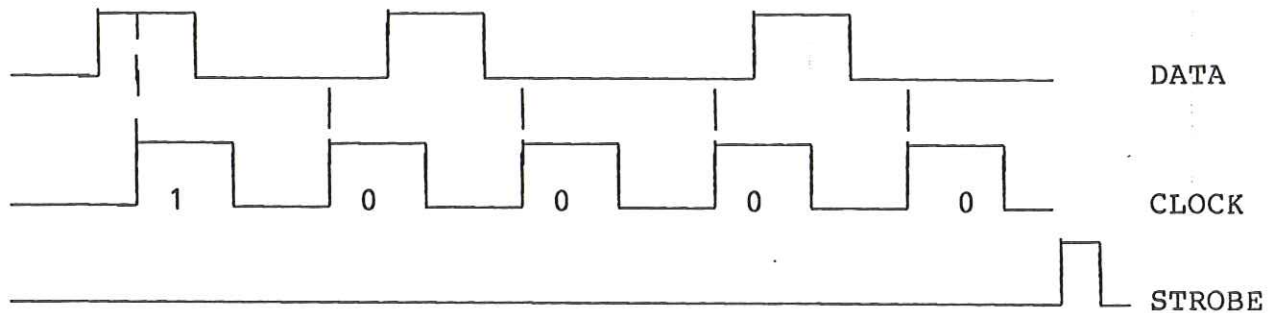
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General

Serial data transmission to the individual plug-in modules takes place on three lines: CLOCK, DATA and STROBE. The data must be read in using an external controller, e.g. PUC, in order to adjust or test the modules independent of the basic instrument.

The timing diagram for data transmission is shown below.



The data on the DATA line are transferred to the parallel/serial converter with each rising edge of the CLOCK pulses; a subsequent STROBE pulse enables the data at the converter outputs. The following BASIC program shows how the user port of the PUC can address the module:

```
10 POKE 59259,255      Set user port
20 DIM A(20)           Number of individual data bits,
                       20 in this case
30 A(1)=0:A(2)=1...    Define individual data

40 FOR I=1 TO 20
50 POKE 59471,A(I)      Read in data;
60 POKE 59471,A(I)+2    Line with significance  $2^0$  = DATA,
                       significance  $2^1$  = CLOCK
70 NEXT I

80 POKE 59471,4         Output of STROBE pulse on line
90 POKE 59471,0:END     with significance  $2^2$ 
```


4.1 Function Description

4.1.1 RF Synthesizer

The RF synthesizer with frequency modulation generates RF frequencies in the range from 500 to 1000 MHz which is covered by three selectable oscillators. Three linked phase locked loops (PLL) produce the resolution required for the frequency setting. The main reference is a 10-MHz crystal oscillator (temperature-stabilized as option) to which a 100-MHz crystal oscillator is linked. The 100-MHz frequency is divided per program and produces the reference frequency for a crystal oscillator which can be adjusted by ± 2 kHz and whose frequency, divided by a factor of 100, is the reference frequency for the coarse PLL of the RF oscillators.

If the Duplex Modulation Meter option CM-B9 is not fitted, the RF synthesizer is operated as a generator in the receiver test and as a mixing oscillator in the transmitter test. Information on voltages and on the locking of the PLLs is passed to the controller via the analog unit for test purposes and for troubleshooting.

4.1.2 Output Stage

The output stage divides the frequencies provided by the RF synthesizer such that a frequency range of 31.25 to 1000 MHz is covered. Appropriate filters are connected in series with the frequency dividers to ensure that the harmonics ratio required is attained. Frequencies < 31.25 MHz are generated by mixing the 100-MHz crystal frequency with a corresponding oscillator frequency.

A controlled amplifier increases the RF signal to the max. level of 13 dBm. Fine variation of the level is achieved by modifying the reference input for the control via D/A converters. Amplitude modulation is also active and the modulation signal is superimposed on the reference value of the D/A converter.

4.1.3 1st Modulation Generator

The AF synthesizer and the modulation controller are accommodated on the 1st modulation generator module. The AF synthesizer is basically a set of shift registers whose outputs are activated in succession by a clock generated by the controller.

The output levels are added by a resistor chain to give a sine curve. The stepped sinewave produced is freed from harmonics by suitable filters and output following an attenuation set consisting of D/A converters and selectable voltage attenuators.

The modulation controller divides the level provided by the modulation generator into AM and FM paths. D/A converters are used to achieve the setting accuracy required for modulation. ΦM is enabled by a corresponding filter in the FM branch.

The signal applied to connector MOD. EXT. is routed to the analog unit module for calibration where its level is measured and the connected amplifier is adjusted to the modulation controller according to the result.

4.1.4 Analog Unit

The analog unit consists of the following function units: RF amplifier, LO conditioning, demodulators, AF conditioning and DC amplifier.

The RF signals to be measured are regulated to a constant level in the RF amplifier according to the type of modulation and then routed to the RF frequency counter and the mixer.

The LO conditioning amplifies the signals from the output stage to the level required for the mixer. Frequencies below 31.25 MHz are divided to generate the IF of 455 kHz for signal frequencies up to approx. 1 MHz. A generator with amplitude modulation is integrated for self-testing.

The demodulators contain the IF amplifiers, the AM and FM/ ΦM demodulators and filters required to suppress the IF.

The AF conditioning weights the demodulated signal and the signal from the AF VOLTM input according to the measuring requirements; various filters (300-Hz HP, CCITT filter, 150-Hz HP) can be connected as required (rms or peak values). The signal to be measured is regulated to a constant rms value for distortion measurements and subsequently freed from the wanted signal in a notch filter.

The rectifiers (peak value and rms value rectifiers) are contained in the DC amplifier. A DC multiplexer connects the voltages supplied by the other modules to a selectable DC amplifier which passes the signal to the A/C converter incorporated in the digital unit.

4.1.5 Digital Unit

The digital unit consists of the following function units: RF counter, AF counter, A/D converter and controller.

The RF counter counts the frequency of the applied RF signal in the range from 1 to 1000 MHz. The setting of the RF synthesizer to generate the LO frequency required for demodulation is obtained from the counter result.

The AF counter counts the frequency of the demodulated signal as well as signals in the range from 10 Hz to 500 kHz applied to input AF VOLTM.

The controller controls the complete instrument. All data to the individual modules are applied via serial data lines (CLOCK, DATA, STROBE). Power fail logic with an additional battery voltage ensures that the data are not lost upon power failure or when the instrument is switched off.

4.1.6 Power Pack

The power pack supplies the instrument with the operating voltages of +5 V, +12 V, +15 V, -15 V and +24 V. The voltages are generated using a switched-mode power supply so that the instrument can also be operated using standard car batteries. When connected to the AC power supply, a transformer reduces the line voltage to the voltage required for the switched-mode power supply.

The instrument operates in STANDBY mode if the power pack is switched off from the front panel; all voltages are then switched off except the +12 V supply which is used for the 10-MHz crystal oven and the STANDBY logic.

Fuses are provided on the input side to protect the power pack. STANDBY mode is automatically switched on if one or more voltages on the secondary side are short-circuited with each other or to ground or if the power pack is operated without a secondary load.

4.1.7 Front Panel

All keys required to operate the instrument as well as the loudspeaker potentiometer and the spin wheel for fast adjustment of the parameters are located on the front panel.

The set parameters and the results are output on LCDs connected to the front panel via conductive rubber contacts. The loudspeaker amplifier is also mounted on the front panel with the loudspeaker control. A ribbon cable connects the front panel units to the motherboard and the digital unit.

4.1.8 Attenuation Set

The attenuation set contains the attenuator connected to relays for attenuating the RF synthesizer level as well as power attenuators in which the major part of the applied power is converted into heat. The connection between the power attenuators and the other attenuators is made via a 50- Ω star arrangement to which the power diode, the analog unit and the RF-30 dB output/input on the rear panel are connected.

Corresponding RF diodes are integrated to protect the attenuation set during mechanical switching and to detect power. A PCB screwed onto the attenuation set drives the attenuation set and evaluates the voltages from the diodes. The PCB is connected to the motherboard via a ribbon cable.

4.1.9 Oscilloscope

The oscilloscope enables visual display of the demodulated signals, the beat signal and externally applied signals.

The voltages required for the oscilloscope tube, the blanking amplifier and the deflection amplifier are generated by a switched-mode power pack with an operating voltage of 24 V. The deflection coefficients and the operating mode are read from the digital unit into RAMs, read out by D/A converters and written as Lissajous figures on the screen in the form of numbers, letters and arrows. The oscilloscope is powered via ribbon cables which are routed to the front panel.

4.1.10 Options

The function descriptions of the options are contained in the respective service manuals (Section 5).

4.2 Mechanical Design

Except for the front panel, power pack, attenuation set and oscilloscope, the CMT modules are designed as plug-in cards. Repairs can therefore be carried out rapidly or the faulty card can be completely replaced.

The electric connections are made via the common motherboard. Sensitive signals are routed via plug-in or screw-on coaxial connections. The connections from the power pack, front panel, attenuation set and oscilloscope to the other modules are made via plug-on ribbon cables.

A blower is provided at the rear to cool the modules. The air is sucked through the perforations at the side and blown out via the rear panel.

4.2.1 Opening the Instrument

Loosen the four Phillips screws at the rear used to secure the feet (marked A in Fig. 4-1); the captive screws remain in the feet. Remove the feet and slide out the top and bottom panels to the rear.

Caution: The power plug must be disconnected before removing the modules.

4.2.2 Removing Plug-in Modules

These modules are secured by two rails at the sides next to the motherboard. Loosen the Phillips screws marked A in Fig. 4-2 and press towards the rear using a suitable tool inserted into bracket B. Disconnect any coaxial and ribbon cables present and remove the modules from the instrument.

Note: If the IEC Bus/Control Interface option CM-B4 and the Autorun Control/Printer Interface option CM-B5 are present, these must be removed before removing the digital unit module (see Section 4.2.4).

4.2.3 Removing the Power Pack

Disconnect plugs X60, X61 and X70 from the motherboard. Loosen the five Phillips screws marked C and D in Fig. 4-1 and remove the power pack from the frame. Ensure that the cables leading from the power pack are not subjected to stress which could break the connected lead-through filters.

4.2.4 Removing the IEC Bus/Control Interface Option CM-B4 and the Autorun Control/Printer Interface Option CM-B5

Loosen the Phillips screws on the rear of the instrument (marked D and E in Fig. 4-1) and remove the option(s) towards the rear from the multiple connectors of the digital unit.

4.2.5 Removing the Attenuation Set

Unscrew the two SMA connectors from the cables with a solid jacket and pull off the two coaxial connectors.

The attenuation set with the heat sink is mounted to the chassis by four screws, two of which are fitted with nuts (marked C in Fig. 4-2). Loosen the screws and remove the attenuation set with the heat sink.

The drive board is fitted on the attenuation set using six screws. Before removing the board, desolder the two wires to the overtemperature sensor.

Note: The attenuation set must not be opened; the internal components consist of thin-film substrates which can only be replaced in the factory.

4.2.6 Removing the Oscilloscope

Loosen the hexagon socket screws of the rotary knobs on the front panel and remove the knobs. Loosen the six screws with which the inscription panel is secured (two screws in the centre between the displays). Loosen the screws marked A in Fig. 4-3. Disconnect the two ribbon cable plugs and the coaxial connector X605 from the analog unit module. The oscilloscope assembly can now be removed from the front.

4.2.7 Removing the Front Panel

Remove the inscription panel as described in Section 4.2.6 and loosen the screws marked B in Fig. 4-3. Disconnect the three ribbon cable connectors and remove the front panel.

Figs. 4-1 to 4-3 show the screws to be loosened to remove the modules.

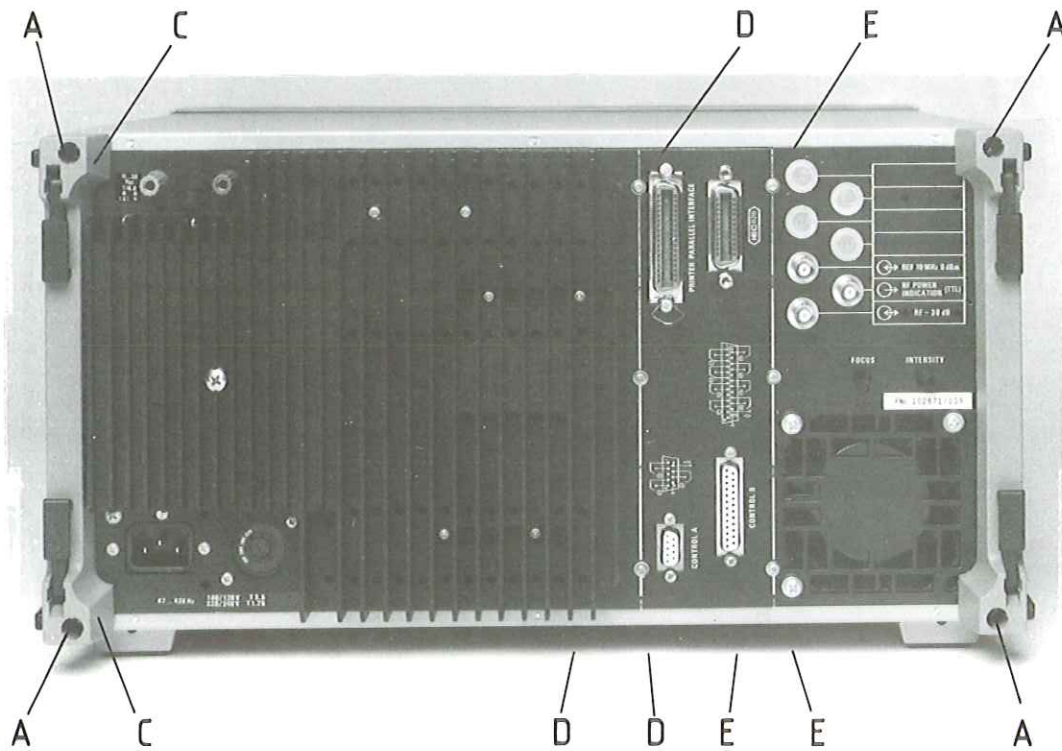


Fig. 4-1

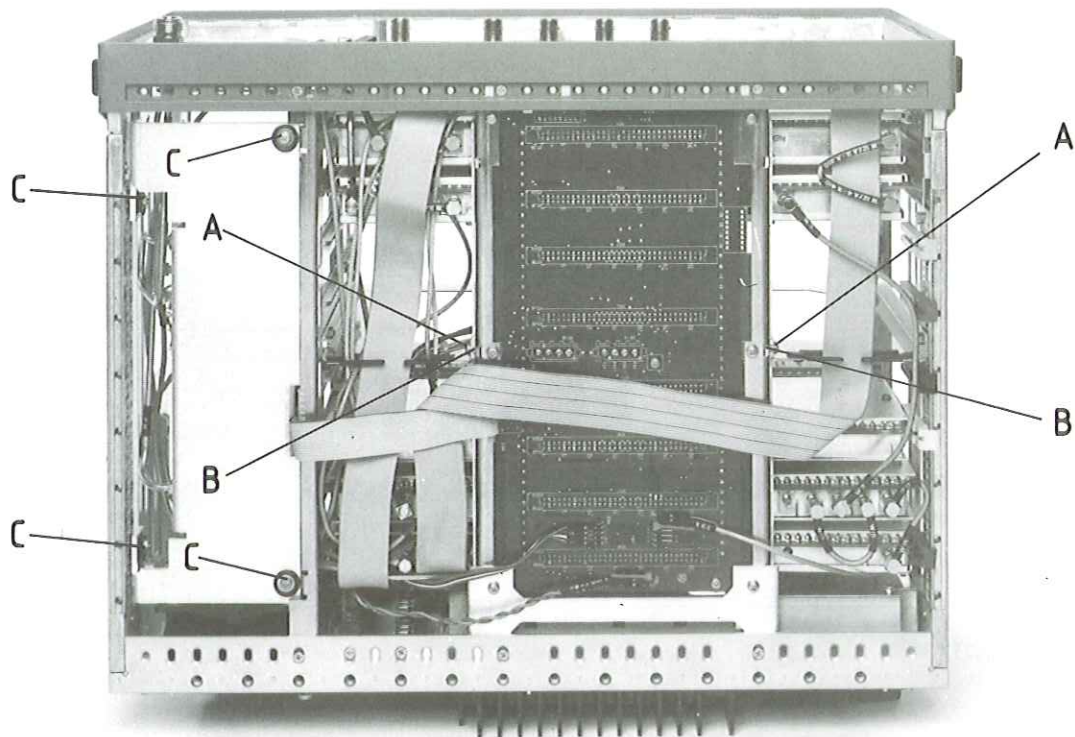


Fig. 4-2

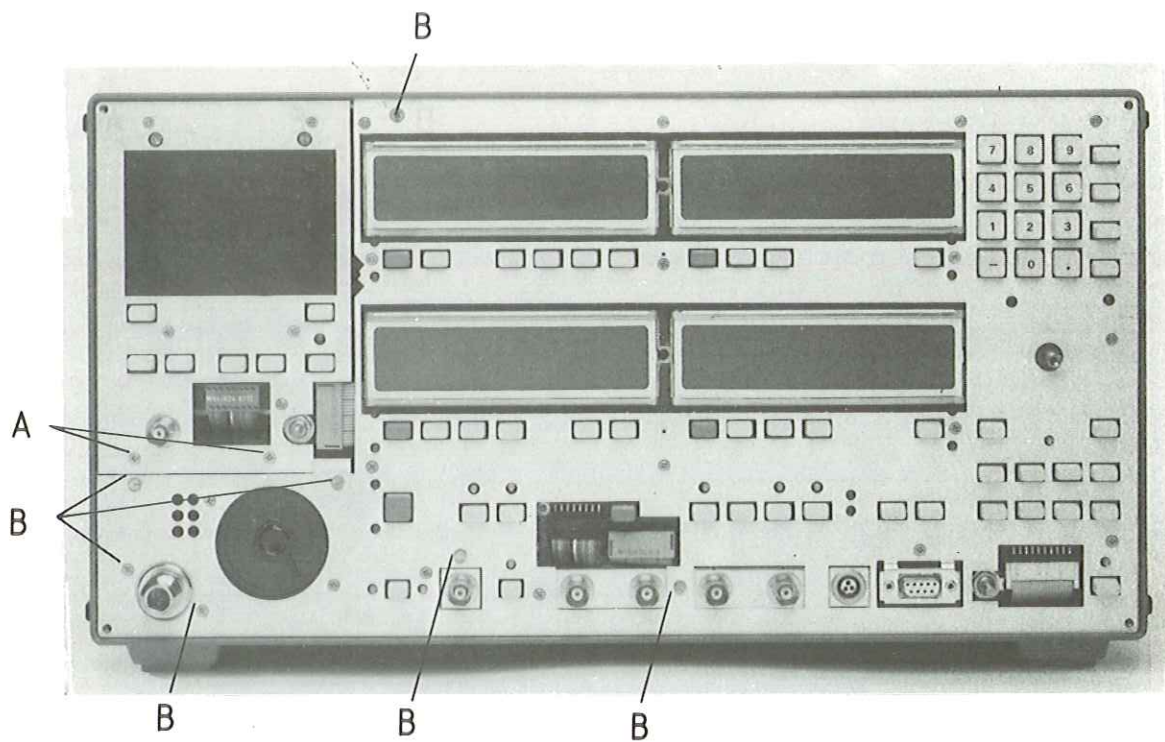


Fig. 4-3

4.3 Testing and Adjustment

Exact testing of the instrument specifications should be carried out according to Section 3.2 in the Operating Manual. Each test in the manual refers to a possible adjustment. Renewed testing is therefore necessary following adjustments.

Some adjustments on the CMT can be carried out without using the adapter cable; where required, this is clearly indicated.

Before carrying out any adjustments, ensure that the appropriate control element is about to be used; unintentional adjustment of set values can lead to large measurement errors.

All modules should be inserted or connected when an adjustment is carried out. If a module must be adjusted outside the instruments or if a fundamental unit is missing (e.g. digital unit), carry out the adjustment as described in Section 5.

The sequence of adjustments from module to module and also within modules ensures that the adjustments do not affect one another; if this is nevertheless possible, reference is made to the previously required setting.

4.3.1 Adjusting the Power Pack

4.3.1.1 +5 V Operating Voltage

Setting: + Switch on instrument

Adjustment point: + X61 on motherboard

Adjustment value: + Adjust to 5.3 V $\pm$ 10 mV using R12

4.3.1.2 +24 V Operating Voltage

Setting: + Switch on instrument

Adjustment point: + X61 on motherboard

Adjustment value: + Adjust to 24 V $\pm$ 100 mV/ $\pm$ 0 mV using R56

4.3.2 Adjusting the Digital Unit

Setting: → Switch on instrument
Adjustment point: → X58/A21 on motherboard
Adjustment value: → Adjust to 10 V $\pm$ 1 mV using R109

4.3.3 Adjusting the RF Oscillator

→ Pull out module and connect to the CMT using the adapter cable.
→ Open module.

4.3.3.1 Frequency Adjustment

Settings: → Receiver test
→ Frequencies as in following table:

Frequency	Trimmer
500.001 MHz	C21
655.001 MHz	C51
825.001 MHz	C81

Adjustment point: → X9/2
Adjustment value: → Adjust to 2.5 V DC $\pm$ 100 mV using C21, C51, C81

4.3.3.2 Level Adjustment

Settings: → Receiver test
→ Frequencies as in following table:

Frequency	Trimmer
575 MHz	R49
730 MHz	R79
900 MHz	R109

Adjustment point: → X310
Adjustment value: → Adjust to 0 dBm $\pm$ 3 dB using R49, R79, R109

4.3.4 Adjusting the Output Stage

Note: Check adjustment 4.3.3.2 before adjusting the output stage.

Remove the module from the CMT and connect using the adapter cable. The module need not be opened for the adjustment.

4.3.4.1 Level Adjustments

Settings:

- Receiver test
- Frequencies as in following table
- Set required level
- * Set level via hand wheel

Fre- quency	Level	Trim- mer	Adjustment value
100 MHz	+13 dBm	R514	13 dBm ± 0.05 dB
* 100 MHz	-16.9 dBm	R452	-6.9 dBm ± 0.05 dB
7.9 MHz	+13 dBm	R641	13 dBm ± 0.05 dB
* 7.9 MHz	-16.9 dBm	R663	-6.9 dBm ± 0.05 dB

Adjustment point: → X401 or RF IN/OUT on the front panel

Compare level of 13 dBm at 1 GHz and 330 MHz and take the average using R514.

4.3.4.2 Adjusting the Modulation Depth

Settings:

- Receiver test
- Frequency 100 MHz
- Level 0.1 dBm
- Modulation 80% AM
- AF = 1 kHz

Adjustment point: → X401 or RF IN/OUT on the front panel

Adjustment value: → Adjust to 80% AM $\pm 0.1\%$ AM using R503

4.3.5 Adjusting the Analog Unit

- Remove the module from the CMT and connect using the adapter cables.
- Open module.

4.3.5.1 Adjusting the LO Conditioning

- Settings:**
- Transmitter test
 - Fixed frequency 15 MHz
- Adjustment point:** → D100/3
- Adjustment value:**
- Adjust to TTL level using R102
 - Check at P30 whether TTL level is present at half frequency

4.3.5.2 Adjusting the RF Amplifier, FM

- Settings:**
- Transmitter test
 - Apply 500 MHz, 20 mV to INPUT2
 - Demodulation: FM
- Adjustment point:** → X610/50 Ω
- Adjustment value:** → Adjust to 150 mV $\pm$ 5 mV using R87

4.3.5.3 Adjusting the RF Amplifier, AM

Note: The adjustment 4.3.5.2 must be checked before this adjustment.

- Settings:**
- Transmitter test
 - Apply 500 MHz, 20 mV to INPUT2
 - Demodulation: AM
- Adjustment point:** → X610/50 Ω
- Adjustment value:** → Adjust to 75 mV $\pm$ 5 mV using R88

4.3.5.4 Adjusting the FM Demodulator

- Settings:**
- Transmitter test
 - Apply 100 MHz, 20 mV, 10 kHz deviation to INPUT2
 - Demodulation: FM, $\pm \frac{PK}{2}$
- Adjustment point:** → DEMODULATION display
- Adjustment value:**
- Adjust to 10 kHz $\pm$ 10 Hz using R304
 - Adjust to 0 V_{DC} $\pm$ 5 mV at DEMOD connector using R213

4.3.5.5 Adjusting the AM Demodulator

Note: Check adjustment 4.3.5.4 before this adjustment. The following three adjustments mutually affect one another; adjust in the specified sequence and check again at the end.

Settings:

- Transmitter test 100 MHz
- Apply 100 MHz, 10 mV, 80% AM, AF 1 kHz to INPUT2
- Demodulation: AM, $\pm \frac{PK}{2}$

Adjustment point 1: → D680/1

Adjustment value 1: → Adjust to 250 mV ± 2 mV using R197 (take settling time into account)

Adjustment point 2: → DEMOD connector

Adjustment value 2: → Adjust to minimum limitation of lower sine half-wave using R254

Adjustment point 3: → DEMODULATION display

Adjustment value 3: → Adjust to 80% $\pm 0.1\%$ using R275 (take settling time into account)

4.3.5.6 Adjusting the CCITT Filter

Settings:

- Receiver test
- Apply 1 V_{rms}, 800 Hz to AF VOLTM
- Press CCITT

Adjustment point: → AF VOLTMETER display

Adjustment value: → Adjust to 1 V ± 10 mV using R388

Check: → When pressing CCITT again (off), the display must not change.

Note: → The rms meter should be calibrated prior to this adjustment.

4.3.5.7 Adjusting the Distortion Control

Note: The following two adjustments mutually affect one another. Check the adjustments at the end and correct if necessary.

- Settings:**
- Receiver test
 - Apply 1 V_{rms} , 1 kHz to AF VOLTM
- Adjustment point 1:** → X23/1
- Adjustment value 1:** → Adjust to 1 V_{rms} ± 1 mV using R543
- Adjustment point 2:** → N450/1
- Adjustment value 2:** → Adjust to pure $\sin^2$ using R542

4.3.5.8 Adjusting the 1-kHz Notch Filter

- Settings:**
- Receiver test
 - Apply 1 kHz, 1 V_{rms} with low distortion ($\leq 0.01\%$) to AF VOLTM
 - Press DIST
- Adjustment point:** → AF VOLTMETER display
- Adjustment value:** → Alternately adjust to minimum distortion ($\leq 0.3\%$) using R557 and R556

4.3.5.9 Adjusting the 990-Hz Notch Filter

- Settings:**
- Receiver test
 - Apply 1 V_{rms} , 990 Hz with low distortion ($\leq 0.01\%$) to AF VOLTM
 - Press DIST
- Adjustment point:** → AF VOLTMETER display
- Adjustment value:** → Adjust to minimum distortion ($\leq 0.3\%$) using R566

4.3.5.10 Adjusting the 1010-Hz Notch Filter

- Settings:**
- Receiver test
 - Apply 1 V_{rms}, 1010 Hz with low distortion (<0.01%) to AF VOLTM
 - Press DIST
- Adjustment point:** → AF VOLTMETER display
- Adjustment value:** → Adjust to minimum distortion (<0.3%) using R571

4.3.5.11 Adjusting the Power Display

- Settings:**
- Transmitter test
 - Apply a defined power = 10 W to RF IN/OUT
- Adjustment point:** → RF POWER display
- Adjustment value:** → Adjust to 10.2 W using R672

4.3.6 Adjusting the Attenuation Set

- Settings:**
- Receiver test
 - Frequency 100 MHz
 - Level 13 dBm
- Adjustment point:** → RF LEVEL display
- Adjustment value:** → Rotate R34 until the attenuation set is heard to switch and -47 dBm is output on the display; subsequently rotate R34 approx. 1/6 revolution backwards
- Note:** Check the switchover threshold from receiver test to transmitter test following adjustment. The switchover threshold is at 0.35 W, approx. If the threshold is too low, rotate resistor R34 back further.

4.3.7 Adjusting the Oscilloscope

The oscilloscope must first be removed (see Section 4.2.6) and connected using the adapter cable; remove the mu-metal screening of the tube.

Note: When adjusting, ensure that no high-voltage parts are touched.

4.3.7.1 Adjusting the Horizontal Beam Deflection

Setting: + Switch on instrument

Adjustment point: + Graticule

Adjustment value: + After loosening the mounting screws of the tube, align the horizontal beam with the graticule

Note: Magnetic fields can lead to errors during the adjustment and the adjustment should therefore be checked after replacing the tube screen. Refer to the Service Manual, Section 5, for further adjustments.

4.3.8 Options

Adjustment of the options is described in Section 5.

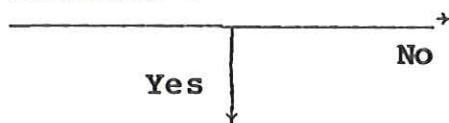
4.4 Troubleshooting

This section provides references to the modules possibly associated with faults.

Note: Modules must not be removed or inserted under power. It is absolutely essential to short X75 on the digital unit after removing the analog unit module and before switching on the power again, since the D/A converter N100 (AD 7520) on the digital unit would otherwise be destroyed.

Fault: The instrument immediately enters STANDBY following power-up.

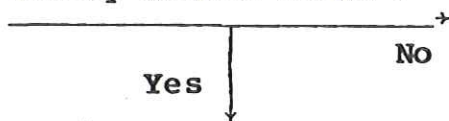
Plug-in jumper X75
(on digital unit)
inserted ?



Insert plug-in jumper X75

Remove modules,
except digital
unit, in sequence

Faulty module found ?

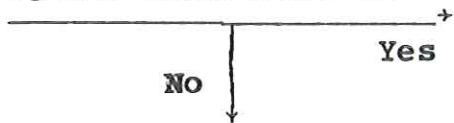


Power pack faulty,
operating voltage on digital
unit faulty

Short-circuit of
operating voltage(s)

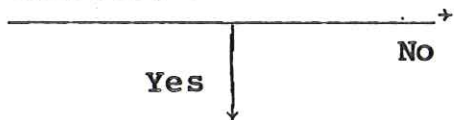
Fault: The instrument does not accept commands from the keyboard

Briefly isolate instrument from power supply and switch on again. Instrument OK ?



Reset logic,
digital unit

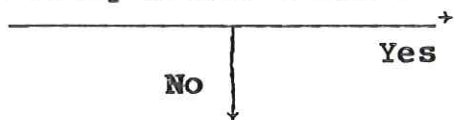
Plug-in jumper X75
(on digital unit)
inserted ?



Insert plug-in jumper

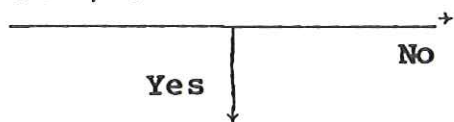
Remove modules, except
digital unit and RF
oscillator, in
sequence.

Faulty module found ?



Data transmission
blocked

10-MHz TTL level
at X701 (digital
unit) ?

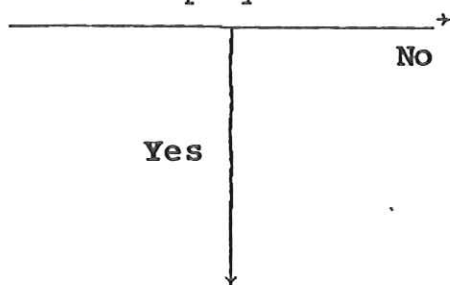


RF oscillator

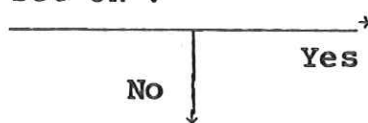
Digital unit, cable
from front panel to
digital unit,
front panel

Fault: No demodulation display in transmitter test

Power display OK ?



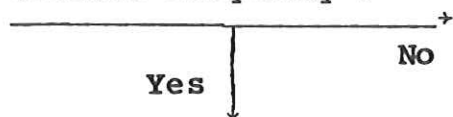
Attenuation set OK ?



A

Replace attenuation set

Does RF counter indicate correct frequency ?



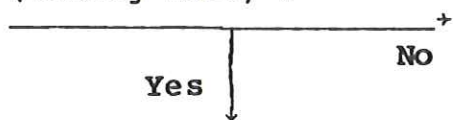
RF counter (digital unit)
RF amplifier (analog unit)

Faults only with frequencies <31.25 MHz ?



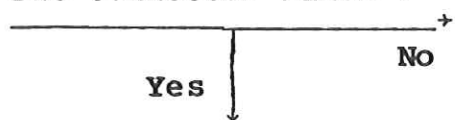
LO conditioning (analog unit)

Corresponding frequency to generate IF of 455 kHz (f >32 MHz) present at X608 (analog unit) ?



RF oscillator, output stage, duplex modulation meter

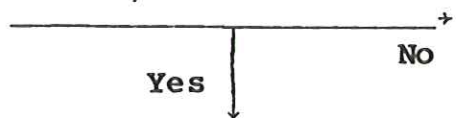
Demodulated signal at BNC connector DEMOD ?



Demodulators (analog unit)

A

No display of measured values: AF voltmeter, RF voltmeter, demodulation, distortion ?



Fault in analog unit (DC amplifier, AF conditioning)

A/D converter (digital unit)
DC amplifier (analog unit)

