HAMEG Instruments

Spectrum Analyzer HM5014-2

Service Manual

Release: April, 2008

CE

Hersteller / Manufacturer / Fabricant: HAMEG Instruments GmbH, Industriestraße 6, D-63533 Mainhausen

KONFORMITÄTSERKLÄRUNG
DECLARATION OF CONFORMITY
DECLARATION DE CONFORMITE

HAMEG Instruments

Die HAMEG GmbH bescheinigt die Konformität für das Produkt
The HAMEG GmbH herewith declares conformity of the product
HAMEG GmbH déclare la conformité du produit

Bezeichnung / Product name / Désignation:
Spektrumanalysator
Spectrum Analyzer
Analyseur de spectre

Typ / Type / Type: **HM5014-2**

mit / with / avec: **–**

Optionen / Options / Options: **–**

mit den folgenden Bestimmungen / with applicable regulations / avec les directives suivantes

EMV Richtlinie 89/336/EWG ergänzt durch 91/263/EWG, 92/31/EWG
EMC Directive 89/336/EEC amended by 91/263/EWG, 92/31/EEC
Directive EMC 89/336/CEE amendée par 91/263/EWG, 92/31/CEE

Niederspannungsrichtlinie 73/23/EWG ergänzt durch 93/68/EWG
Low-Voltage Equipment Directive 73/23/EEC amended by 93/68/EEC
Directive des équipements basse tension 73/23/CEE amendée par 93/68/CEE

Angewendete harmonisierte Normen / Harmonized standards applied / Normes harmonisées utilisées

Sicherheit / Safety / Sécurité
EN 61010-1:2001 (IEC 61010-1:2001)

Messkategorie / Measuring category / Catégorie de mesure: I

Verschmutzungsgrad / Degree of pollution / Degré de pollution: 2

Elektromagnetische Verträglichkeit / Electromagnetic compatibility / Compatibilité électromagnétique

EN 61326-1/A1 Störaussendung / Radiation / Emission:
Tabelle / table / tableau 4; Klasse / Class / Classe B.

Störfestigkeit / Immunity / Imunitée: Tabelle / table / tableau A1.

EN 61000-3-2/A14 Oberschwingungsströme / Harmonic current emissions / Émissions de courant harmonique:
Klasse / Class / Classe D.

EN 61000-3-3 Spannungsschwankungen u. Flicker / Voltage fluctuations and flicker / Fluctuations de tension et du flicker.

Datum /Date /Date
15. 07. 2004

Unterschrift / Signature /Signature

Manuel Roth
Manager

General information concerning the CE marking

HAMEG instruments fulfill the regulations of the EMC directive. The conformity test made by HAMEG is based on the actual generic- and product standards. In cases where different limit values are applicable, HAMEG applies the severer standard. For emission the limits for residential, commercial and light industry are applied. Regarding the immunity (susceptibility) the limits for industrial environment have been used.

The measuring- and data lines of the instrument have much influence on emission and immunity and therefore on meeting the acceptance limits. For different applications the lines and/or cables used may be different. For measurement operation the following hints and conditions regarding emission and immunity should be observed:

1. Data cables

For the connection between instruments resp. their interfaces and external devices, (computer, printer etc.) sufficiently screened cables must be used. Without a special instruction in the manual for a reduced cable length, the maximum cable length of a dataline must be less than 3 meters and not be used outside buildings. If an interface has several connectors only one connector must have a connection to a cable.

Basically interconnections must have a double screening. For IEEE-bus purposes the double screened cable HZ72 from HAMEG is suitable.

2. Signal cables

Basically test leads for signal interconnection between test point and instrument should be as short as possible. Without instruction in the manual for a shorter length, signal lines must be less than 3 meters and not be used outside buildings.

Signal lines must screened (coaxial cable - RG58/U). A proper ground connection is required. In combination with signal generators double screened cables (RG223/U, RG214/U) must be used.

3. Influence on measuring instruments

Under the presence of strong high frequency electric or magnetic fields, even with careful setup of the measuring equipment an influence of such signals is unavoidable.

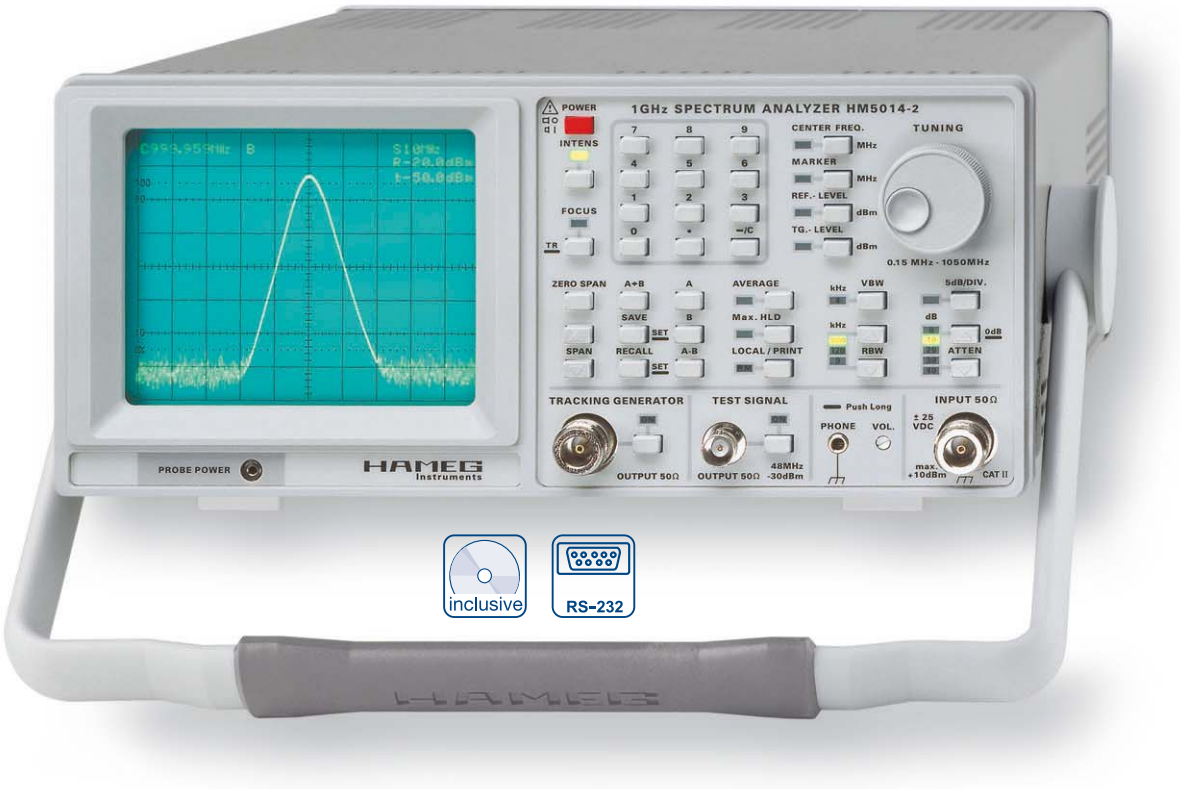
This will not cause damage or put the instrument out of operation. Small deviations of the measuring value (reading) exceeding the instruments specifications may result from such conditions in individual cases.

4. Noise immunity of spectrum analyzers

In the presence of strong electric or magnetic fields it is possible that they may become visible together with the signal to be measured. The methods of intrusion are many: via the mains, via the signal leads, via control or interface leads or by direct radiation. Although the spectrum analyzer has a metal housing there is the large CRT opening in the front panel where it is vulnerable. Parasitic signals may, however, also intrude into the measuring object itself and from there propagate into the spectrum analyzer.

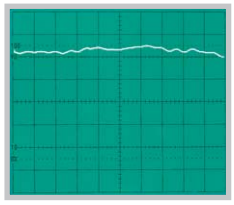
HAMEG Instruments GmbH

1 GHz Spectrum Analyzer
HM5014-2

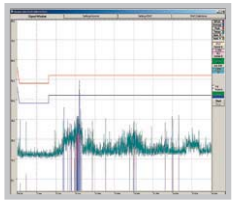


VSWR Test Unit HZ541

Amplifier frequency response measured using a tracking generator



Measurement of line-conducted interference



- Frequency range from 150 kHz to 1 GHz
- Amplitude measurement range from -100 dBm to +10 dBm
- Phase Synchronous, Direct Digital frequency Synthesis (DDS)
- Resolution bandwidths (RBW): 9 kHz, 120 kHz and 1 MHz
- included
- ance EMI measurements
- Software for documentation included
- Software for extended measurement functions for EMI measurements included
- Tracking Generator with output amplitude from -50 dBm to +1 dBm
- Serial interface for documentation and control

1 GHz Spectrum Analyzer HM5014-2

Valid at 23 °C after a 30 minute warm-up period

Frequency Characteristics

Frequency Range :	0.15 MHz to 1.050 GHz
Stability:	± 5 ppm
Ageing:	± 1 ppm/year
Frequency Resolution:	1 kHz (6 ½ digit in readout)
Center Frequency Range:	0 to 1.050 GHz
LO Frequency Generation:	TCXO with DDS (Digital Frequency Synthesis)
Span Setting Range:	Zero Span and 1 MHz –1000 MHz (1-2-5 Sequence)
Marker:	
Frequency Resolution:	1 kHz, 6 ½ digit,
Amplitude Resolution:	0.4 dB, 3 ½ digit
Resolution Bandwidths (RBW) @ 6dB:	1 MHz, 120 kHz and 9 kHz
Video Bandwidth (VBW):	4 kHz
Sweep Time (automatic selection):	40 ms, 320 ms, 1 s*)

Amplitude Characteristics (Marker Related) 150 kHz – 1 GHz

Measurement Range:	-100 dBm to +10 dBm
Scaling:	10 dB/div., 5 dB/div.
Display Range:	80 dB (10 dB/div.), 40 dB (5 dB/div.)
Amplitude Frequency Response (at 10 dB Attn., Zero Span and RBW 1 MHz, Signal – 20 dBm):	± 3 dB
Display (CRT):	8 x 10 division
Amplitude Scale:	logarithmic
Display units:	dBm
Input Attenuator Range:	0 – 40 dB (10 dB-increments)
Tolerance of input attenuator:	± 2 dB relative to 10 dB position
Max. Input Level (continuous)	
40 dB attenuation:	+20 dBm (0,1 W)
0 dB attenuation:	+10 dBm
Max. DC Voltage:	± 25 V
Max. Reference Level: +10 dBm	
Reference Level Accuracy rel. to 500 MHz, 10 dB Attn., Zero Span and RBW 1 MHz:	± 1 dB
Min. Average Noise Level:	ca. -100 dBm (RBW 9 kHz)
Intermodulation Ratio (3rd Order):	typical ›75 dBc (2 Signals: 200 MHz, 203 MHz, -3 dB below Reference Level)
Harmonic Distortion Ratio (2nd harm.):	typical › 75dBc (200MHz, Reference Level)
Bandwidth Dependent Amplitude Error rel. to RBW 1 MHz and Zero Span:	± 1 dB
Digitization Error:	±1 digit (0.4 dB) at 10 dB/div. scaling (Average, Zero Span)

Inputs/Outputs

Measuring Input:	N socket
Input Impedance:	50 Ω
VSWR: (Attn. ≥ 10 dB)	typ. 1.5:1
Tracking Generator Output:	N-socket
Output Impedance:	50 Ω
Test Signal Output:	BNC-Buchse
Frequency, Level:	48 MHz, -30 dBm (± 2 dB)
Supply Voltage for Probes (HZ 530):	6 V DC
Audio Output (phone):	3.5mm Ø jack
RS-232 Interface:	9pol./Sub-D

Functions

Keyboard Input:	Center Frequency, Reference Level, Tracking Generator Level
Rotary Encoder Input:	Center Frequency, Reference Level, Marker, Tracking Generator Level
Max. Hold Detection:	Peak Value Acquisition
Quasi-Peak Detection:*	Quasi-Peak Valuation
Average:	Mean Value Acquisition
Ref. Spectrum Memory:	2 k x 8 bit
SAVE / RECALL:	Save and Recall of 10 Instrument Settings
AM demodulation:	for audio
LOCAL:	RS-232 Remote Control OFF
Readout:	Display of various Measurement Parameters

Tracking Generator

Frequency Range:	0.15 MHz to 1.050 GHz
Output Level:	-50 dBm to +1 dBm
Frequency Response (0.15 MHz – 1 GHz)	
+1 dBm to -10 dBm:	± 3 dB
-10,2 dBm to -50 dBm:	± 4 dB
Digitization Error:	± 1 digit (0.4 dB)
Spurious Outputs	better than 20 dBc

General information

CRT:	D14-363GY, 8 x 10 cm with internal graticule
Acceleration Voltage:	approx. 2 kV
Trace Rotation:	adjustable on front panel
Ambient Temperature:	10° C to 40° C
Power Supply:	105-253 V, 50 / 60 Hz ± 10 %, CAT II
Power Consumption:	approx. 35 W at 230V/50 Hz
Safety Class	Safety Class I (EN61010-1)
Dimensions (W x H x D):	285 x 125 x 380 mm
Weight:	approx. 6.5 kg

*) in combination with software AS100E only

Accessories supplied: Line Cord, Operators Manual, HZ21 Adapter Plug (N-plug with BNC socket) and Software for Windows on CD-ROM

Optional accessories:

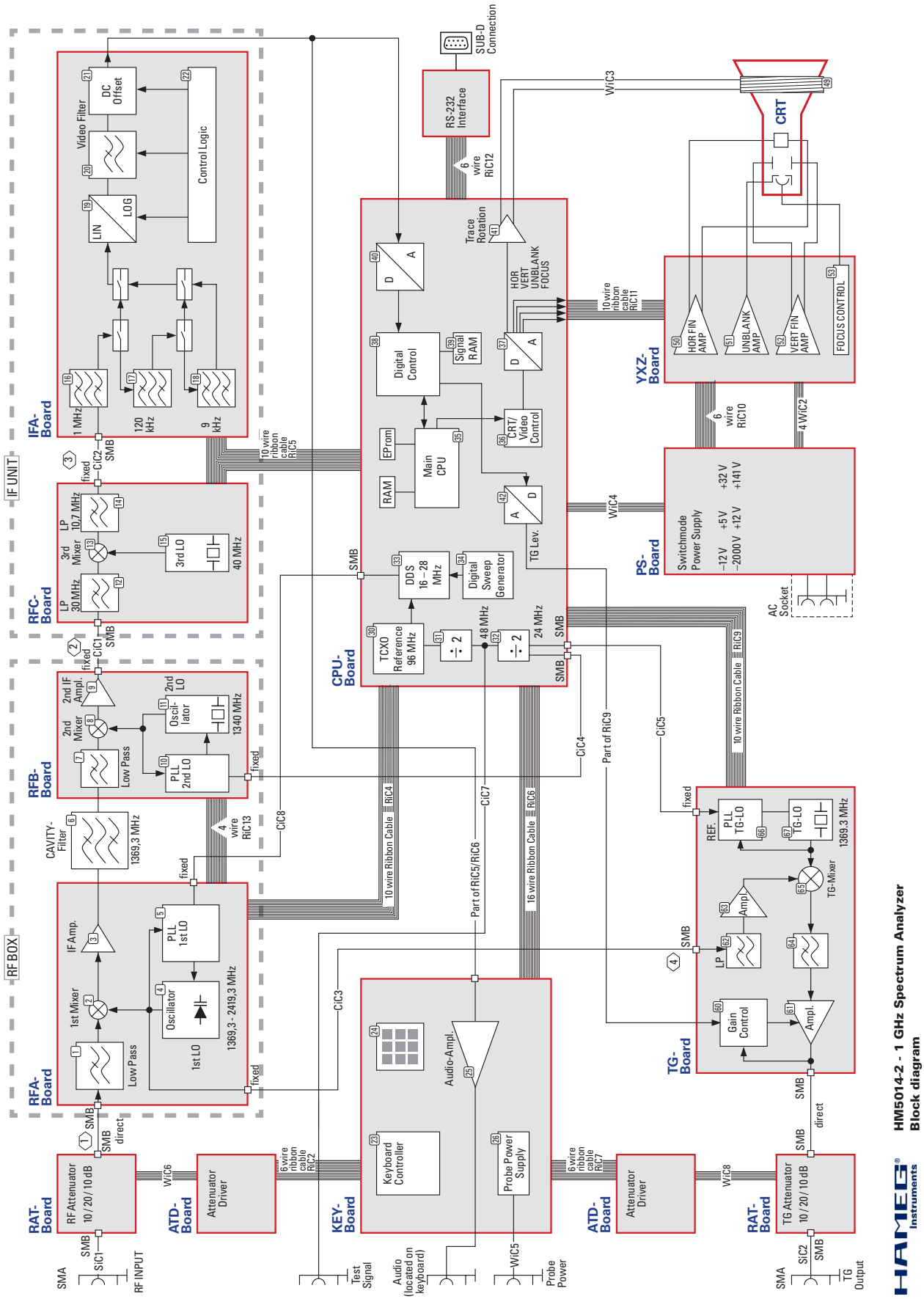
HZ70 Opto-Interface (with optical fiber cable)

HZ520 Antenna

HZ530 Near Field Probe Set for EMI Diagnosis

1. Basics

1.1 Block Diagram and Functional Description



The HM5014-2 spectrum analyzer consists of the following basic modules. The main RF process circuits are concentrated in the following units:

- **RF Box**
- **IF Unit**
- **RAT / ATD attenuator assembly (2 per unit)**
- **TG Unit**

The control modules are:

- **CPU Board**
- **XYZ Board**
- **KEY Board**

The auxiliary modules are:

- **PS Board**
- **CRT module**
- **Interface module**

The functional description will make frequent references to the block diagram. The encircled numbers in the text and the corresponding numbers in the block diagram assist orientation in the circuit.

RF Box

The RF Box is the main part of the receiver circuit of the spectrum analyzer. Three blocks together form one RF Box: the RFA and RFB PCBs and the cavity filter [6]. Both PCBs are fixed to the cavity filter. Due to both PCBs and the cavity filter forming a very complex unit it is not possible to change one part of the RF Box individually, the adjustment required would exceed the scope of this manual considerably.

The input signal exiting the attenuator via 2 directly connected SMB connectors is routed to the 1st mixer via a low pass filter [1] thus avoiding ambiguities due to subharmonic mixing. The 1st mixer [2] has been carefully adjusted for best LO suppression and bandwidth. It is fed by the 1st local oscillator (LO) [4]. The 1st LO is a wideband voltage controlled oscillator (VCO) that provides a mixing signal from 1369,3 to 2419,3 MHz, depending on the reference signal "DDSFRQ" input via CIC8 from the CPU Board. The frequency range of the "DDSFRQ" signal is from 16 to 28 MHz The RFA PLL [5] multiplies the "DDSFRQ" signal with a fixed factor to produce the desired 1st LO frequency. The signal of the 1st LO is also fed into CIC3 as tuning signal for the tracking generator (TG Unit).

Behind the mixer the 1st low noise IF amplifier [3] is located, then the 1st IF signal leaves the RFA PCB as it enters the cavity filter [6], which is preadjusted to a passband center frequency of 1369,3 MHz. After passing the cavity filter, the 1st IF signal enters the RFB PCB to be conducted via a low pass filter [7] to the 2nd mixer [8], converting the signal to 29,3 MHz. The 2nd local oscillator (LO) [11] is a 1340 MHz VCO based on a ceramic resonator controlled by a PLL [10] referenced to the "REFSIG" signal from CPU Board via CiC4. The frequency of this reference signal is 24 MHz.

The 2nd IF signal from the 2nd mixer is amplified in the 2nd IF amplifier and is fed to CIC 1, leading to the IF unit.

The ribbon cable to the RF Box reaches the box via CRA board fixed to the underside of the RFA casing, from CRA board RiC 13 connects the necessary supply voltages to CRB board, fixed to the underside of the RFB casing. These 2 PCBs are not acccessible when the RF box is mounted in the chassis, only the connector for RiC 4. They are not shown in the block diagram.

IF Unit

The IF Unit consists of the RFC board, the IFA board and the two mounting aluminium sheets, as well as the interconnections between the PCBs. The boards can only be changed as a unit, because they have been specially matched in the factory.

The IF signal enters the RFC board via CIC 1, after passing a low pass filter [12] and a band pass filter it reaches the 3rd mixer [13], where the signal is converted to the 3rd IF of 10,7 MHz, where again a low pass [14] filter is located.

The 3rd local oscillator (LO) signal is generated with a crystal oscillator [15] tuned to 40 MHz.

CIC 2 connects the 3rd IF output of the RFC board to the input of the IF board, which contains the resolution bandwidth (RBW) filters [16] - [18], the logarithmic detector [19] and amplifier and the video filter [20] as well as levelling circuitry for matching the 3 filter output amplitudes [21].

The signal passes the 1000 kHz RBW filter [16] and the control logic inserts either the 120 kHz filter [17] into the signal path or also the 9 kHz filter [18], depending on the control signals [22].

The logarithmic amplifier [19] demodulates the 10,7 MHz 3rd IF signal and gives a very precise logarithmic representation of the amplitude value as an output voltage. This voltage then passes the video filter [20] with either 50 kHz or 4 kHz video bandwidth (VBW). Finally the output level for the 3 filters is matched in the output amplifier [21] of the IF board. The video signal is routed via RiC 5 to the CPU board.

The ribbon cable Ric5 serves both the RFC Board and the IFA Board, using an extra connector crimped onto the cable.

RAT / ATD attenuator assembly

The 2 attenuators are located between the input / output connectors of the HM5014-2 and the RF Box and the TG Board. Both assemblies are identical, as well as the identical attenuator driver PCB, called ATD Board. These attenuators comprise circuitry to set attenuation in 10 dB steps from 0 dB to 40 dB. This is accomplished via relays and divider networks. The attenuator is controlled by logical signals and a demultiplexer to deliver the signals driving the relays.

TG Unit

The TG Unit is a generator for producing the exact signal the spectrum analyzer is receiving at this special moment of a sweep, thus providing easy twoport measurements. It consists of a PLL [66] using the 24 MHz reference signal from the TCXO [30] located on the CPU Board to provide a stable fixed local oscillator (LO) [67] signal of 1369.3 MHz. This signal is mixed with the signal momentarily produced by the 1st LO of the RFA Board (e. g. the receiver) to give the exact reproduction of the receiving frequency for each possible 1st LO frequency. The signal then is fed to a gain controlled amplifier [61] via a low pass filter [64]. Between output and the gain controlled amplifier the level detector [60] is located to obtain the gain control voltage from the output signal in combination with the level control voltage

from the CPU Board. The output signal is then fed directly via 2 SMB connectors to the TG attenuator.

CPU Board

The CPU Board contains most of the digital control circuitry, the TCXO reference [30], the complete digital signal processing circuits, the digital sweep generator [34] and the DDS reference generator for the 1st LO [33] as well as control circuitry for analog control signals to TG Board [42], XYZ Board [36] + [37] and the CRT [41]. The CPU Board also communicates with the KEY Board to obtain input from the user. In addition, the serial communication for the RS-232 interface is provided for flexible data transfer from and control of the HM5014-2. Also located on the CPU Board is the ASIC for the readout of the spectrum analyzer, also providing the display data given to the D/A converters [37] for X and Y signals to CRT.

The video signal from the IF Unit enters the CPU Board where ist is digitized and stored in the signal RAM [39]. Now the raw data is shifted to the correct position of the reference level setting and also the B-A representation is calculated using the data stored in the signal RAM. The main CPU [35] then processes the data, and provides it to the readout ASIC so it can be displayed on the CRT after D/A conversion [37] and the dot join circuit – an integrator for best interpolation of adjacent sample representations.

The CPU Board also contains the highly stable reference oscillator for the entire unit, a 96 MHz TCXO [30] used for several purposes throughout the unit. Its main use is the clocking of the DDS generator [33] on the CPU Board, which is the reference for the 1st LO [4] on RFA Board. Derived from these 96 MHz are also the 2 reference signals for the RFB and TG Boards as well as the 48 MHz test signal provided on the front panel (after a levelling stage) [31] + [32].

The digital sweep generator controls the sweep time according to the setting by the user for maintaining best signal and amplitude representation.

The main CPU [35] on the CPU Board is quite straightforward, using an EPROM for storing the firmware and a RAM for storing the necessary data, as well as providing control and communication for the entire spectrum analyzer and external devices via serial interface.

XYZ Board

The XYZ Board is fixed to the back end of the CRT via the CRT socket. It contains circuits for the X [50] and Y [52] signal deflection amplifiers. Also present is the unblanking circuit [51] controlling the intensity of the CRT and its focus [53].

CAUTION:
A part of the XYZ Board is operated at a voltage of 2000 Volts.

KEY Board

The KEY Board consists of a microcontroller (keyboard controller [23]) to control the reading of keys [24] and illumination of the LEDs on the KEY Board. Also present are the audio signal amplifier [25] which converts the video signal to an audio signal of the desired amplitude, and the probe power supply [26] for externally connected probes. The control outputs to both attenuators are also generated by the keyboard controller [23]. The input from the rotary encoder is processed by the keyboard controller.

The microcontroller is in constant communication with the main CPU [35] of the CPU Board.

PS Board

The PS Board comprises a switchmode power supply capable of accepting input voltages from 105 to 253 Volts AC providing all the voltages needed inside the instrument, some with a highly stable linear regulating circuit.

CRT Module

The CRT Module consists of the CRT enveloped in mu-metal for immunity to external magnetic fields. The mu-metal loses its capabilities when bent after treatment and should not be removed from the CRT.

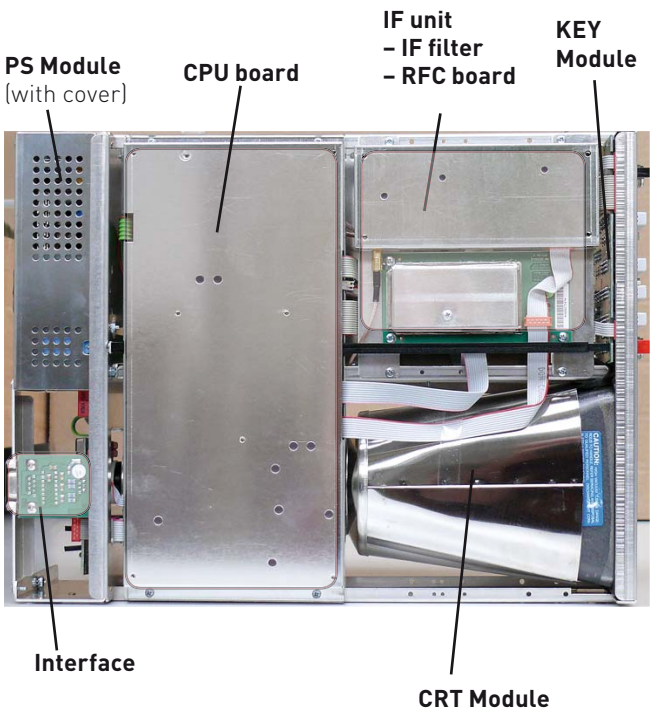
CAUTION:
The CRT contains a high vacuum inside and may implode if handled or treated improperly.

Interface module

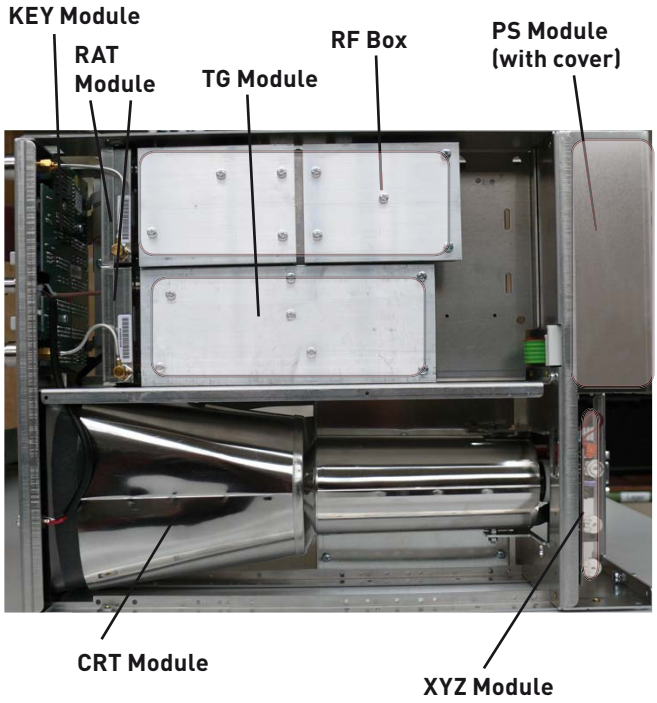
The interface module is a RS-232 converter module between the internal logic level and the logic levels demanded by the RS-232 standard. It is located on the upper rear side of the instrument.

1.2 Modules and Interconnections

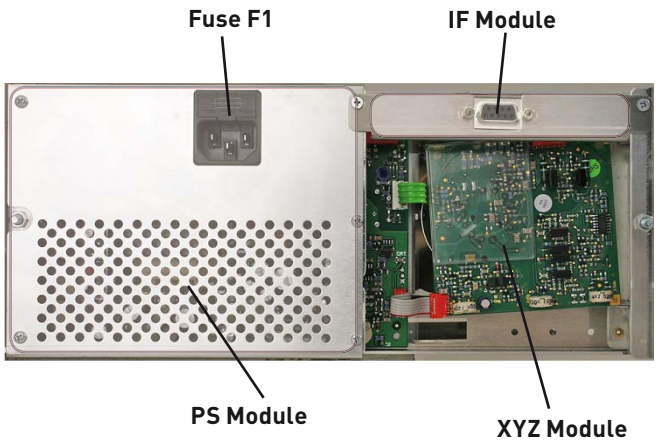
TOP VIEW



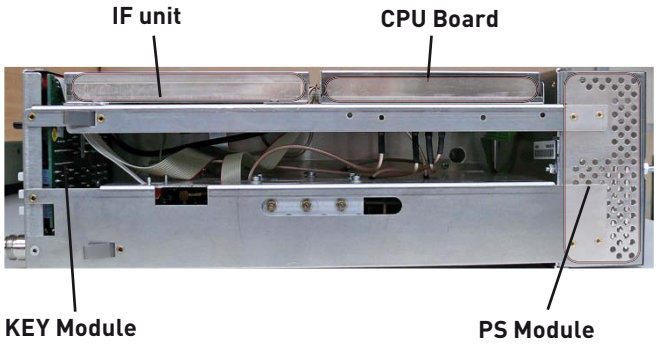
BOTTOM VIEW



REAR VIEW



SIDE VIEW



1.3 Measurement Equipment and Accessories

Item	Type of Equipment	Equipment minimum requirements	Recommended Equipment	Purpose
M1	RF Signal Generator	HM8134-3 with interface	HM8135 with interface	Used as signal source in multiple procedures
M2	Power Meter	Rohde&Schwarz NRVS	Rohde&Schwarz NRVS	Tracking Generator adjustment, Test Signal adjustment
M3	Insertion Unit (for M2)	100 kHz to 1.05 GHz	Rohde&Schwarz NRV-Z5 or Rohde&Schwarz NRV-Z4	Tracking Generator adjustment, Test Signal adjustment
M4	Frequency Counter	Frequency Measurement Accuracy: 0.001 ppm, External Reference	HAMEG HM8123	HM5014-2 TCXO and XO adjustment
M5	N Coaxial cable	50 Ohm, DC-8 GHz, N connectors (male/male) Length 1 – 1.5 m	Huber&Suhner No. 23023806	Signal interconnection
M6	SMB /BNC Coaxial Adaptor	50 Ohm, SMB male, BNC female	Schuricht 33-SMB-BNC-50-2 (Huber+Suhner)	Signal interconnection
M7	RS-232 cable	Connector 9-pin Sub-D (male/female), length 1-2.5 m	HAMEG HZ14	Interface connection, PC to HM5014-2
M8	Coaxial Cable BNC-BNC	BNC male Connector both ends, length 1-1.5 m	HAMEG HZ34	Signal interconnection
M9	Coaxial Cable N to SMA	50 Ohm, DC ... 6 GHz, N-connector (male), SMA connector (male), length 1 – 1.5 m	Huber&Suhner No. 23005050	Connection of TG output to frequency counter
M10	Digital Multimeter	3 1/2 digit resolution	HM8012	Measurement of probe voltage
M11	Adaptor N-BNC	50 Ohm N male, BNC female	HZ21	Signal interconnection

Table 1-1

Measurement setup 1

This setup is used whenever a signal has to be provided for the HM5014-2. It is used in multiple steps during checking and adjustment. The synthesizer [M1] has to be connected to an external reference with a minimum accuracy of 1E-9, if not otherwise specified.

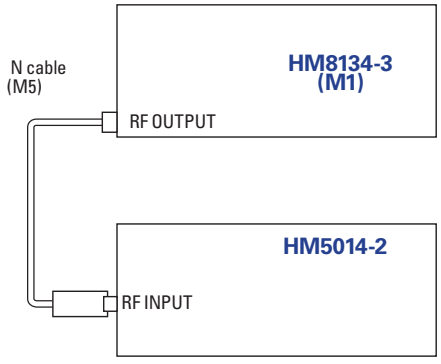


Figure 1.3.1: Measurement SETUP 1

Measurement setup 2

This setup is used whenever a frequency source inside the HM5014-2 is to measured to determine the exact frequency. The frequency counter [M4] has to be connected to an external reference with a minimum accuracy of 1E-9, if not otherwise specified.

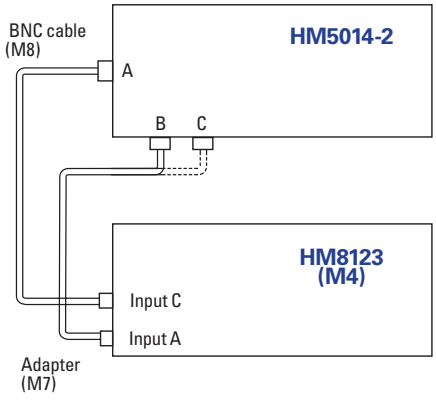


Figure 1.3.2: Measurement SETUP 2

Measurement setup 3

This measurement setup is used to determine the power of signals over the entire frequency range of the HM5014-2. The NRVS [M2] is always used with the insertion unit [M3].

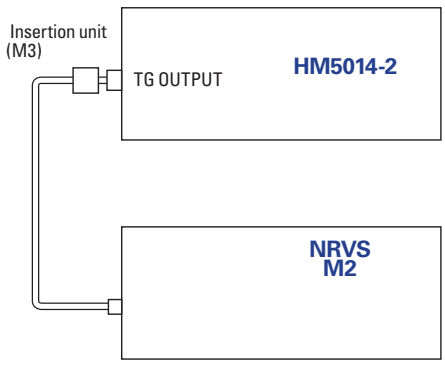


Figure 1.3.3: Measurement SETUP 3

Item	Type of Accessories, Requirements	Purpose
A1	"Screwdriver" with ceramic blade for adjustment (older version), Murata No. KMTZ16F	Adjustment of TCXO (older version)
A2	"Screwdriver" with ceramic blade for adjustment (newer version), Murata No. KMTZ11V	Adjustment of TCXO (newer version)
A3	Jaw wrench with wrench size 8 mm (max 3 mm thick)	Removing / mounting SMA nuts, semi-rigid cables
A4	Screwdriver for crosshead screw	Removing / mounting screws
A5	Screwdriver for adjustment purposes	Adjustment of various potentiometers
A6	Pair of long-nosed pliers	Removing or mounting connectors
A7	Serial Interface	IF unit is equipped with interface other than serial
A8	Probe power test cable	Measuring probe supply
A9	Jaw wrench with wrench size 5.5 mm	Removing / Mounting hex nuts

Table 1-2

2. Performance and Functional Tests

2.1 Test Instructions

Warning:
Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present. "Do not service alone"

Warning:
Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on. "Use care when servicing with power on"

Disconnect power before removing protective panels, soldering or replacing components.

The following procedures assume that the HM5014-2 is connected to mains/line via a safety class II transformer. Only qualified personnel who are aware of the danger of electricity should execute the following procedures. If cables or connectors have to be disconnected, the instrument must be switched off before the removal.

It is further assumed that the personnel executing the following procedures are acquainted with the operation of the instruments used and their use. The operation of the HM5014-2 is described in detail in the user manual downloadable at the HAMEG website, so it is not repeated here. Only special commands not included in the user manual are described as needed.

Note: The instrument must have a 30-minute warmup period before making any checks or adjustments. Performing the adjustment or the checking procedure while the temperature is drifting may cause erroneous adjustment setting and check results. During warm-up, the instrument is to be operated inside the casing. The ambient temperature must be 23°C ±2°.

To ensure proper conditions for the performance check and prevent settings errors, the instrument must be prepared as follows:

- Allow a minimum warm-up time of 30 minutes at ambient temperature (unit must be inside casing)
- Switch off the HM5014-2 and then switch it on again
- Set the HM5014-2 to the following:
- Center frequency 500 MHz
- Span 1000 MHz
- ATT 10 dB
- TG off
- RBW 1000 kHz
- VBW not activated
- Marker not active
- View A
- Test signal off
- Average not activated
- Max. HLD not activated
- Intens and Focus set to normal values (trace and readout visible)
- 5 dB/Div not active
- Ref.-Level –20 dBm
- Instrument in Local mode (LED RM not lit)

The following sections describe the checking procedures. The values are specified in the data sheet "Specifications". Additional introduction of errors caused by the measurement equipment must be taken into account when adjusting the rated values. All measurements will be performed with an external 10 MHz reference frequency with a minimum accuracy of 1E-9.

2.2 Basic Performance Tests

2.2.1 Check of supply voltages

The supply voltages must be in the intended range for the instrument to operate properly. A great variety of malfunctions may occur in case of incorrect supply voltages.

The 144V, 32V, 12V and –12V supplies can be measured on the pins of the unused 8 pin molex connector [Photo] as indicated in table x.x

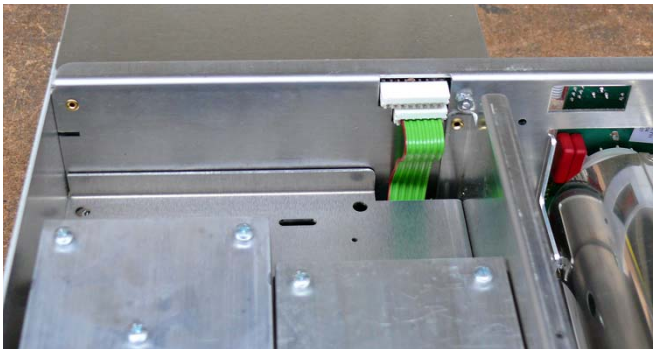


Figure 2-1: 8pin connector for supply measurement

Pin1 144V
Pin6 32V
Pin7 12V
Pin8 -12V
(In earlier units this connector may have a ribbon cable attached)

The 5 Volt supply voltage can be measured on the CPU-Board 5th pin of the supply voltage connector shown in Fig. 2-1.

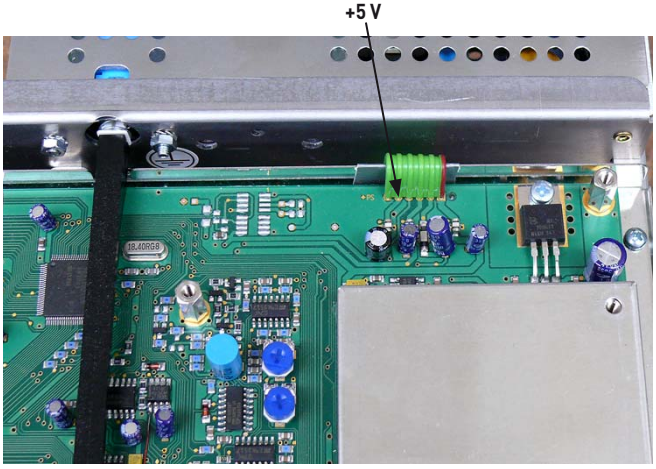


Figure 2-2: CPU board, showing the location for +5V measurement.

Enter the internal adjustment menu of the HM5014-2 by pressing the keys "Intens" and "Focus" while switching on the instrument. The time until the instrument emits a "beep" is about 10 seconds, then the 2 buttons can be released. Instead of the standard screen display the adjustment "**menu**" display will appear on the screen. The items

5dBADJ
TGL +1
TGL-10
OSCADJ
INTENS
FOCUS
TR-ROT
EEPNEW

appear on the screen, and to the left a cursor is shown. Items can be elected by pressing the Center button for moving the cursor upwards, and the Marker button for moving the cursor downwards. Items are selected by pressing the Ref.-Level button. The screen menu shown for each item is customized for each adjustment operation. To leave the adjustment menu, switch off the unit.

2.2.2 Check of CRT-XY Display adjustment

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT, forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large and has highlighted points at each end.

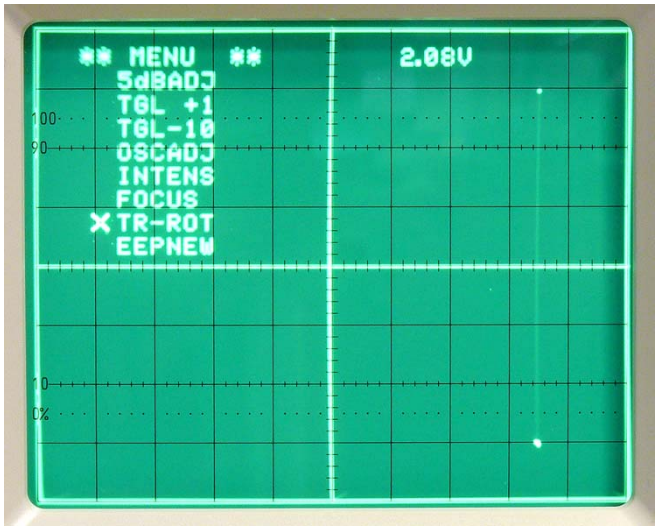


Figure 2-3: Adjustment menu on CRT

The outer 4 lines forming the rectangle must be aligned exactly along the outer perimeter of the CRT graticule, while the center cross must be aligned with the 2 main axis of the graticule. Deviations of up to 0.75 mm are permissible for the center cross and up to 1 mm for the rectangle.

2.2.3 Check of CRT-Z Display and Focus adjustment

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT, forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large and has highlighted points at each end.

This display must be without any extra points at any place in the CRT area. Also the width of the horizontal and vertical center lines should be equal to each other in the center area of the CRT (astigmatism check).
Select item „INTENS" in the internal adjustment menu as described in section 2.2.1. The same screen contents as above will appear. Observe the voltage reading shown on upper right part of CRT. Adjust this value to 1.50 volts using the rotary encoder. Then select item „FOCUS" in the internal adjustment menu as described in section 2.2.1. Again, the screen contents will be the same as described above. Adjust for best focus of the center cross on CRT. Using the reduced intensity just chosen, the focus will give a very precisely defined rendering of the 2 center cross lines.

Select item „INTENS" in the internal adjustment menu as described in section 2.2.1. Use the rotary encoder to adjust the intensity voltage value on the CRT to the maximum value of 5.10 volts. Check that the 2 center cross lines still have the same width and are not out of focus, equalling or being a fraction less in width compared to the width of the outer rectangle lines.

2.2.4 Check of Dot-Join adjustment

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT, forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large (see Fig. 2-3) and has highlighted points at each end.

The upper end point of the single vertical line is about half as bright as the lower end point. Check that both points occupy a small area only. The lower end point is in the form of a horizontal line of about 1 millimetre of length.
Swith off the unit to leave the adjustment menu.

2.2.5 Check of TCXO and 3rd LO adjustment

The checking of TCXO (temperature compensated crystal oscillator) frequency is extremely critical because it depends largely on the correct period of warmup with casing on the unit. Incorrect temperature during checking will lead to possibly incorrect values of TCXO frequency.
Set the HM5014-2 to the following:

RBW: 1 MHz
Center: 500 MHz
Span: Zero Span
Ref.-Level: -20dBm
ATT: 10 dB
(Max Hold, Average,Video filter, Marker and Tracking Generator not activated)

Connect a 500 MHz, -30 dBm signal (unmodulated) to the RF input of the HM5014-2, as shown in measurement setup 1. Unplug the SMB connector [CiC2] underneath the RFC board gently with a pair of pliers [A6]. Then connect it via an adaptor [M6] and a coaxial cable [M8] to the "A" input of the frequency counter, as shown in measurement setup 2 (using option "B" connection of the HM5014-2).

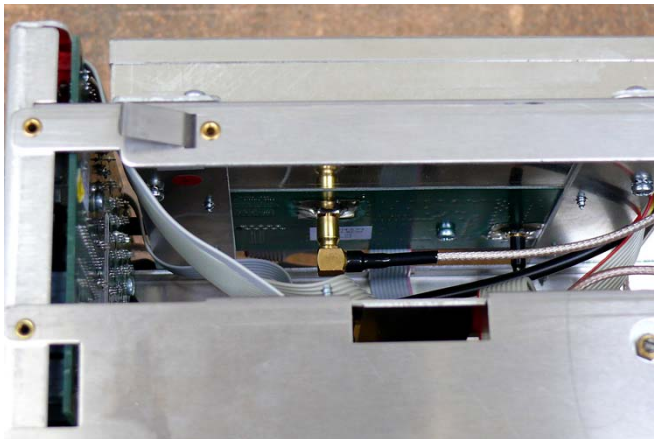


Figure 2-4: Illustration of CiC2 connector

The frequency indicated on the frequency counter should be 29.300000 MHz, a deviation of ±150 Hz is permissible. Choose a gate time of 2 seconds or greater for exact results. Note the frequency value on a sheet of paper, it is needed for the next step.

Now reconnect the SMB plug [CiC2] to the RFC board. Then unplug the SMB plug from the IFA-Board, and connect it via an adaptor[M6] and a coaxial cable [M8] to the "A" input of the frequency counter, as shown in measurement setup II (using option "C" connection of the HM5014-2).

The frequency indicated on the frequency counter should be 10.700000 MHz, a deviation of ±200 Hz is permissible. Choose a gate time of 2 seconds or greater for exact results.

Now take the reading obtained earlier and add the new frequency to the old value. The sum may not differ from 40.000000 MHz more than ±50 Hz.

2.2.6 Check of Amplitude adjustment

In order to check the amplitude adjustment, set the HM5014-2 to the following using measurement setup 1:

RB	1 MHz
Center	500 MHz
Span	Zero Span
Ref.-Level	-20 dBm
ATT	10 dB
Scale	10 dB/Div
Marker	active

(Max Hold, Average, Video filter and Tracking Generator not activated)

The synthesizer is set to the following:

Frequency	500 MHz
Amplitude	-20 dBm
Output	On
Modulation	Off
Sweep	Off

Now check that the level displayed is not more than 1 dB different than the level shown on the synthesizer when varying the level from –20 dBm to –60 dBm. Errors can occur in absolute position or in scaling.
While performing this measurement, do not vary the ATT setting.

2.2.7 Check of RBW filters

In order to check the bandwidth and form factor of the 3 resolution filters, use measurement setup 1 and set the HM5014-2 to the following:

RBW	1 MHz
Center	500 MHz
Span	5 MHz
Ref.-Level	-20 dBm
ATT	10 dB
Scale	5 dB/Div
Marker	active
Video filter	active

(Max Hold, Average and Tracking Generator not activated)

The Synthesizer is set to the following (applies to all 3 filter checks, except 9 kHz where the frequency is first set, then varied):

Frequency	500 MHz
Amplitude	-20 dBm
Output	On
Modulation	Off
Sweep	Off

Set the marker to the left and right side of the filter response shown, so that the marker level displayed is –26.0 dBm. Note the 2 frequencies at these 2 points and subtract them. The difference obtained may be in the range of 700 kHz and 1200 kHz. The HM5014-2 has the RBW values defined as the –6 dB points to follow standard EMC bandwidth definitions.
Then change the settings:

RBW	120 kHz
Span	1 MHz

Repeat the procedure described above with this filter also, note the 2 frequencies and subtract them. The result may be in the range 90 – 140 kHz.
The measurement of the 9 kHz filter is accomplished using measurement setup I, but a different approach is used to get the bandwidth value.
Set the HM5014-2 to the following:

RBW	9 kHz
Center	500 MHz
Span	Zero span
Ref.-Level	-20 dBm
ATT	10 dB
Scale	5 dB/Div
Marker	active
Video filter	active

(Max Hold, Average and Tracking Generator not activated)

To get the 2 corner frequencies at (–6 dB), use the HM8134-3 with the rotary encoder active for setting the frequency of the RF generator in steps of 100 Hz. Then vary the frequency until the reading of the marker is –26 dBm, and note the frequencies on both slopes of the 9 kHz filter at this point (the frequency is displayed on the RF generator). Subtract the 2 obtained values, the result may be in the range of 5.5 – 10 kHz.

2.2.8 Check of 5 dB/Div adjustment

In order to check the 5 dB/Div adjustment, use measurement setup I and set the HM 8134-3 to the following:

Frequency	500 MHz
Amplitude	-30 dBm
Output	On
Modulation	Off
Sweep	Off

Select item „5dBADJ" in the internal adjustment menu as described in section 2.2.1. The "OSCCAL"-text will change to "S10MHz". Now switch through the ATT settings from 0 dB to 40 dB and observe the location of the center of the trace on the CRT. No marker function is available for this test. The trace must change 2 graticule divisions for each attenuator step, and the value for the 10 dB attenuator step may be in the range of 1,6 to 2,4 graticule divisions from the top of the CRT graticule grid.
Switch off the unit to leave the adjustment menu.

2.2.9 Check of test signal level

To check the test signal level, it is very important that a correct warmup of the instrument has taken place and that the instrument is operated at the ambient temperature indicated in the specifications of the HM5014-2.
Set the HM5014-2 to the following:

Center	48 MHz
Span	Zero span
RBW	1 MHz
ATT	10 dB
Marker	active
Test signal	active

(Max Hold, Average, Video filter and Tracking Generator not activated)

Connect coaxial cable [M8 + adaptor M11] to the test signal output and to the RF input of the HM5014-2. The marker reading may be in the range of –27.0 dBm to –33.0 dBm.

2.2.10 Check of TG amplitude adjustment

To check the adjustment of TG amplitude, set the HM5014-2 to the following:

Center	500 MHz
RBW	1 MHz
Span	Zero Span
ATT	40 dB
Ref.-Level	+10 dBm
Marker	Active
TG	Active
TG Level	+1 dBm

(Max Hold, Average and Video filter not activated)

Observe the marker level displayed on the CRT, and compare the displayed level to the level shown on the readout. Vary the level from +1 dBm to –10 dBm and check the marker readout vs. the TG level readout.

Now set the ATT to, 30, 20, 10 and 0 dB while setting the TG level from –10, -20, -30 and –40 dBm to minimum, so that the reading of the marker value stays in the same major graticule division on the CRT for best precision of the marker values.

The difference between readout of TG level and readout of marker level may not exceed 3 dB in either direction.

2.2.11 Full Band Amplitude check

To check the amplitude flatness of the entire frequency range, set the HM5014-2 to the following:

Center	500 MHz
Span	1000 MHz
RBW	1000 kHz
ATT	10 dB
Ref.-Level	-20 dBm
Max Hold	Active
Marker	Active

(Tracking Generator, Average and Video filter not activated)

Then set the following on the RF Generator [M1] using measurement setup 1

Amplitude	-30 dBm
Modulation	Off
Freq. Step	1 MHz

and manually or automatically set all frequencies from 1 MHz to 1000 MHz.

The result on screen will be a line centered around the 2nd graticule line from the top.

Now repeat this test with a Center frequency setting of 550 MHz, and initialize the screen anew to use a "fresh" Max Hold screen. This will allow testing also to 1050 MHz.

Differences up to ±2 dB in the above measurements are permitted when measuring along the line using the marker.

For higher precision of the result, the generator should be measured first with a power meter connected to the end of the connection to the spectrum analyzer, thus establishing the values for a correction table for the generator. These values have to be taken into account when evaluating a precise pass/fail decision (see measurement setup 3).

2.2.12 Check of Audio Output

To check the audio output of the HM5014-2, connect a set of PC speakers to the audio output of the HM5014-2. Set the HM5014-2 to the following:

Center	500 MHz
Span	1000 MHz
RBW	1000 kHz
ATT	10 dB
Ref.-Level	-20 dBm

(Tracking Generator, Average, Max Hold and Video filter not activated)

and set the phones level so that a noise output signal can be obtained, broken by small pauses when the instrument prepares for the next sweep.

2.2.13 Check of Probe Power

To check the correct function of the probe power supply, connect special cable [A8] to the probe power output of the HM5014-2. Connect the other end to a digital multimeter [M10], red to positive input, black to negative. The voltage measured must range between 5.7 and 6.3 Volts

2.2.14 Check of Attenuator

To check the attenuator of the HM5014-2, use measurement setup I.

In order to get best test results, this test should be executed 3 times at frequencies of 10 MHz, 500 MHz and 1000 MHz. Set the HM5014-2 to the following:

Center	set to frequency chosen for test (see above)
Span	Zero span
RBW	1000 kHz
Ref. Level	depends on ATT
Marker	Active
Video filter	Activate where needed

Now set the Generator to the desired measurement frequency and set an output level of –30 dBm.

The marker readout will show this level independent of the location on the CRT, which will vary with the ATT setting chosen. The readout may not vary less than 8 dB and not more than 12 dB from setting to next setting over the entire frequency range (not more than 2 dB deviation from 10 dB nominal attenuation)

3. Adjustment

3.1 Preliminary Instructions

To ensure proper conditions for the adjustment and to prevent settings errors, the instrument must be prepared as follows:

- Allow a minimum warm-up time of 30 minutes at ambient temperature (unit must be inside casing)
- Switch off the HM5014-2 and then switch it on again
- Set the HM5014-2 to the following:
- Center frequency 500 MHz
- Span 1000 MHz
- ATT 10 dB
- TG off
- RBW 1000 kHz
- VBW not activated
- Marker not active
- View A
- Test signal off
- Average not activated
- Max. HLD not activated
- Intens and Focus set to normal values (trace and readout visible)
- 5 dB/Div not active
- Ref.-Level –20 dBm
- Instrument in Local mode (LED RM not lit)

The following sectins describe the adjustment procedures. The values are specified in the data sheet "Specifications". Additional introduction of errors caused by the measurement equipment must be taken into account when adjusting the rated values. All measurements will be performed with an external 10 MHz reference frequency with a minimum accuracy of 10-9.

3.2 Adjustments

3.2.1 Adjustment of supply voltages

The supply voltages must be in the intended range for the instrument to operate properly. A great variety of malfunctions may occur in case of incorrect supply voltages.
The 144V, 32V, 12V and –12V supplies can be measured on the pins of the unused 8 pin molex connector as indicated beow.

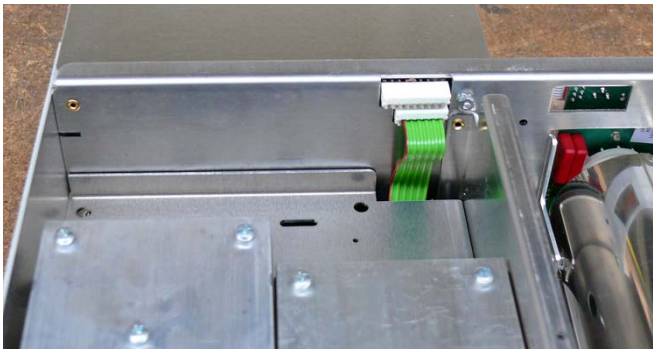


Figure 3-1: 8pin connector for supply measurement

Pin1	144V
Pin6	32V
Pin7	12V
Pin8	-12V

(In earlier units this connector may have a ribbon cable attached)

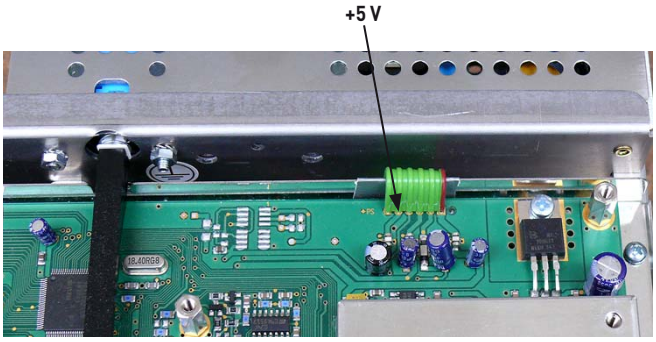


Figure 3-2: CPU board, showing the location for +5V measurement.

The 5 Volt supply voltage can be measured on the CPU-Board 5th pin of the supply voltage connector shown in Fig. 3-2.
Adjustment of the voltages is made at the factory, in the very unlikely event of having to readjust them, use RV1001 [indicated in Fig. 3-3 below] to adjust the +144 Volts, and then use RV1003 to adjust the +12 and –12 Volts supplies. No other adjustments are necessary at this point.

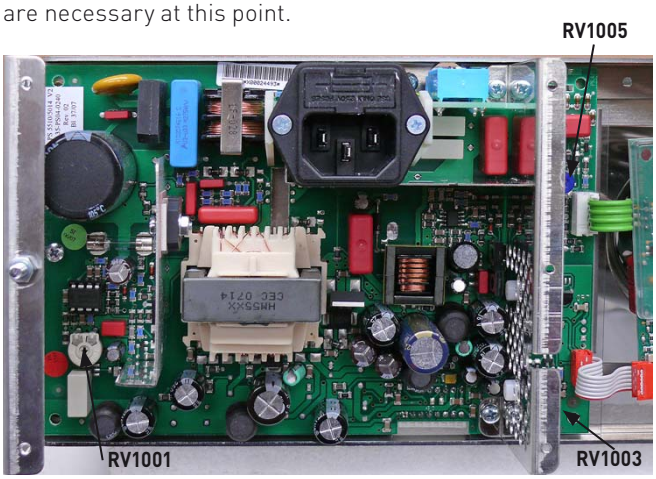


Figure 3-3: Location of RV1001

Enter the internal adjustment menu of the HM5014-2 by pressing the keys "Intens" and "Focus" while switching on the instrument. The time until the instrument emits a "beep" is about 10 seconds, then the 2 buttons can be released. Instead of the standard screen display the adjustment "**menu**" display will appear on the screen. The items

5dBADJ
TGL +1
TGL-10
OSCADJ
INTENS
FOCUS
TR-ROT
EEPNEW

appear on the screen, and to the left a cursor is shown. Items can be elected by pressing the Center button for moving the cursor upwards, and the Marker button for moving the cursor downwards. Items are selected by pressing the Ref.-Level button. The screen menu shown for each item is customized for each adjustment operation. To leave the adjustment menu, switch off the unit.

3.2.2 Check of CRT-XY Display adjustment

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT,

forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large and has highlighted points at each end.

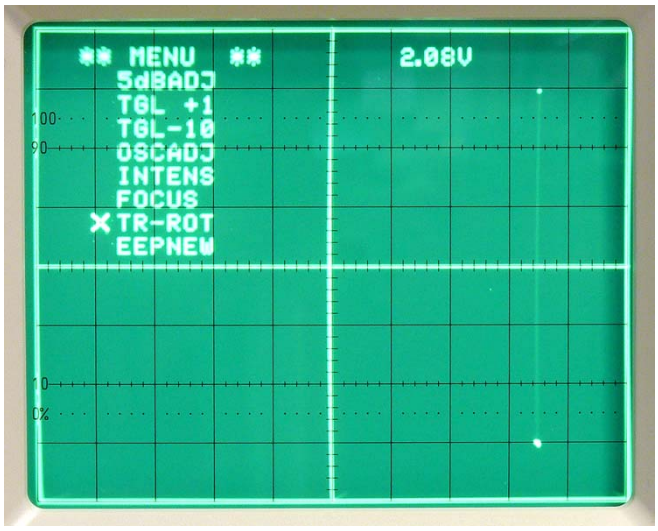


Figure 3-4: Adjustment menu on CRT

The outer 4 lines forming the rectangle must be aligned exactly along the outer perimeter of the CRT graticule, while the center cross must be aligned with the 2 main axis of the graticule. Deviations of up to 1 mm are permissible, the main axis permissible deviation is 0.75 mm.

To adjust the CRT display, use RV3 on XYZ board (see Fig. 3-5) to adjust X-amplitude, P2 (see Fig 3-5) to adjust X-position. Use P5 to adjust Y-position and P7 to adjust Y-amplitude. P2, P5 and P7 are located on CPU-Board (see Fig. 3-5).

3.2.3 Adjustment of CRT-Z Display and Focus

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT, forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large and has highlighted points at each end.

This display must be without any extra points showing at any place in the CRT area. Adjust the intensity setting with RV1 on XYZ-board so that the extra points are not visible, but the rest of the picture is. Also the width of the horizontal and vertical center lines should be equal to each other in the center area of the CRT (astigmatism check). Optimize the representation of the lines using RV2 on XYZ-board.

Select item „FOCUS" in the internal adjustment menu as described in section 3.2.1. Set the value displayed on screen to 2.50 V using the rotary encoder. Now very carefully using an isolated tool made entirely of plastic or ceramic adjust the Potentiometer RV1005 (see Fig. 3-3) on the PS-board right next to the XYZ-board for best focused traces on screen. If you prefer working with the unit not in operation, adjust the RV1005 to a new value when the unit is switched off, and switch it on to check, pressing only Focus button longer to get the normal

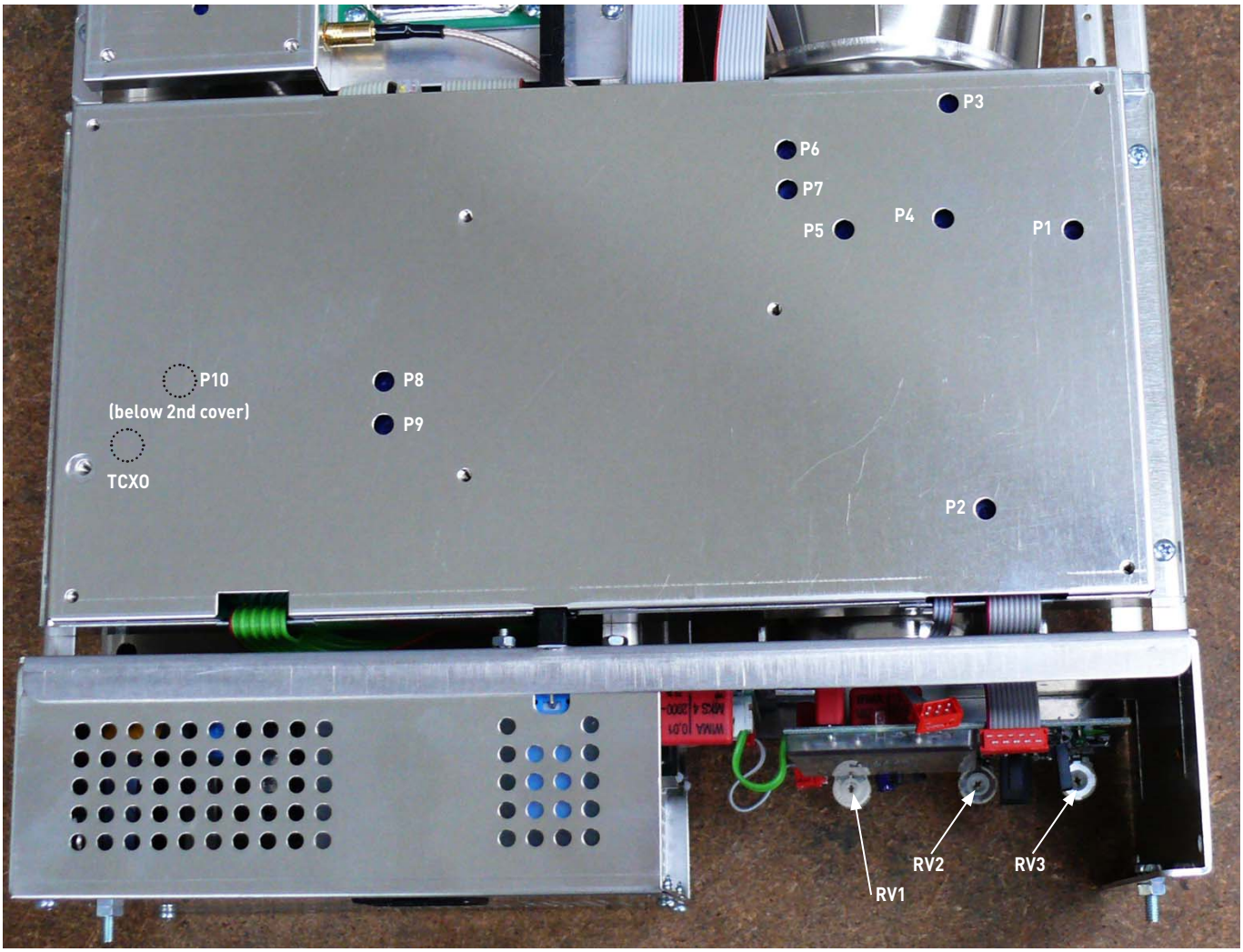


Figure 3-5: Illustration of adjustment locations

TR-ROT screen, and there compare which setting is best, and switch off again before next setting.

Select item „INTENS" in the internal adjustment menu as described in section 2.2.1. The same screen contents as above will appear. Observe the voltage reading shown on upper right part of CRT. Adjust this value to 1.50 volts using the rotary encoder. Then select item „FOCUS" in the internal adjustment menu as described in section 2.2.1. Again, the screen contents will be the same as described above. Adjust for best focus of the center cross on CRT. Using the reduced intensity just chosen, the focus will give a very precisely defined rendering of the 2 center cross lines.

Select item „INTENS" in the internal adjustment menu as described in section 2.2.1. Use the rotary encoder to adjust the intensity voltage value on the CRT to the maximun value of 5.10 volts. Check that the 2 center cross lines still have the same width and are not out of focus, equalling or being a fraction less in width compared to the width of the outer rectangle lines. Adjust P3 on CPU-board for best representation of focus at full intensity. P6 is preset at the factory and does not need to be touched.

3.2.4 Adjustment of Dot-Join

Select item „TR-ROT" in the internal adjustment menu as described in section 2.2.1. A set of 6 lines will appear on the CRT, forming a rectangle and a center cross. Also shown is a vertical line 1.5 cm from the right vertical side line, which is 6 cm large and has highlighted points at each end.

The upper end point of the single vertical line is about half as bright as the lower end point. Check that both points occupy a small area only. The lower end point is in the form of a horizontal line of about 1 millimetre of length.

Adjust this vertical line for best representation using P1 for X adjustment and P4 for Y adjustment. Both are located on CPU-board (see Fig. 3-5)

After adjustment, the representation of the CRT should look like the screen in Fig. 2-2. Swith off the unit to leave the adjustment menu.

3.2.5 Adjustment of TCXO and 3rd LO

The checking of TCXO (temperature compensated crystal oscillator) frequency is extremely critical because it depends largely on the correct period of warmup with casing on the unit. Incorrect temperature during checking will lead to possibly incorrect values of TCXO frequency.
Set the HM5014-2 to the following:

RBW	1 MHz
Center	500 MHz
Span	Zero Span
Ref.-Level	-20dBm
ATT	10 dB

(Max Hold, Average,Video filter, Marker and Tracking Generator not activated)

Connect a 500 MHz, -30 dBm signal (unmodulated) to the RF input of the HM5014-2, as shown in measurement setup 1.

Unplug the SMB connector [CiC2] underneath the RFC board gently with a pair of pliers[A6]. Then connect it via an adaptor[M6] and a coaxial cable [M8] to the "A" input of the frequency counter, as shown in measurement setup 2 (using option "B" connection of the HM5014-2) (see Fig. 3-4).

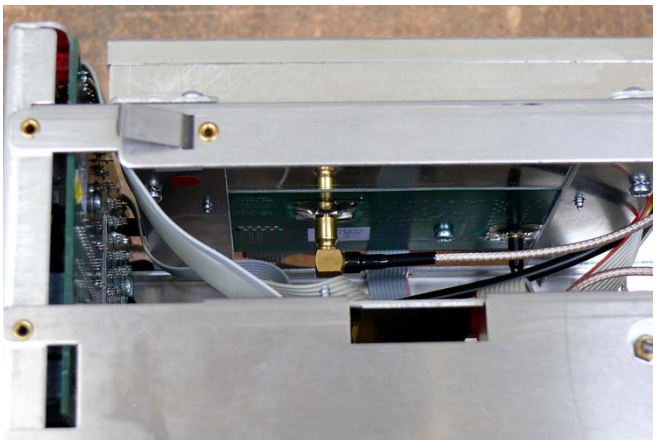


Figure 3-6: Illustration of CiC2 connector

The frequency indicated on the frequency counter should be 29.300000 MHz, a deviation of ±10 Hz is permissible. Choose a gate time of 2 seconds or greater for exact results. To adjust the frequency, open the cover of the CPU-board (see Fig. 3-5) by removing the 7 countersunk screws indicated, then remove the screw left over to open the cover on the right side of the CPU-board (as seen from the front), remove the protective label, and use a ceramic screwdriver [A1] or [A2] (depends on slot type) to adjust the frequency to 29.300000 MHz ±2Hz. Place a new label on the tuning hole of the TCXO. Close the cover of the TCXO part again, then replace the CPU-board cover. Fit all screws in place.

Now reconnect the SMB plug [CiC2] to the RFC board. Then unplug the SMB plug from the IFA-Board, and connect it via an adaptor[M6] and a coaxial cable [M8] to the "A" input of the frequency counter, as shown in measurement setup II (using option "C" connection of the HM5014-2).

The frequency indicated on the frequency counter should be 10.700000 MHz, a deviation of ±15 Hz is permissible. Choose a gate time of 2 seconds or greater for exact results. To adjust the frequency, open the cover of the RFC box (the smaller box in IF-unit) and use a ceramic screwdriver to adjust the frequency to 10.700000 Hz ±5 Hz (keeping in mind a possible deviation introduced by the TCXO). Close the cover of RFC box and fix it with the screw.

3.2.6 Check of Amplitude adjustment

In order to check the amplitude adjustment, set the HM5014-2 to the following using measurement setup 1:

RBW	1 MHz
Center	500 MHz
Span	Zero Span
Ref.-Level	-20 dBm
ATT	10 dB
Scale	10 dB/Div
Marker	active

(Max Hold, Average, Video filter and Tracking Generator not activated)

The synthesizer is set to the following:

Frequency	500 MHz
Amplitude	-20 dBm
Output	On
Modulation	Off
Sweep	Off

Now check that the level displayed is not more than 1 dB different than the level shown on the synthesizer when varying the

level from –20 dBm to –60 dBm. Errors can occur in absolute position or in scaling.

While performing this measurement, do not vary the ATT setting.

Adjustment is best done setting the HM 8134-3 to a step of 20 dB, and varying the amplitude fom –20 dBm to –40 and –60 dBm, observing the marker level displayed on the CRT. Use P8 (see Fig. 3-5) to set the steps to 20 dB each, and P9 to set the absolute position. When done, check in 10 dB-increments and repeat the adjustment procedure if necessary.

3.2.7 Adjustment of RBW filters

The RBW filters of the HM5014-2 are not to be adjusted by service personnel. This process is very complicated and delicate and the chances of positive outcome are very slim. If the filters have become defective, the only remedy is to change the IF Unit against a working unit. This is described in chapter 5.

3.2.8 Adjustment of 5 dB/Div

In order to check the 5 dB/Div adjustment, use measurement setup I and set the HM 8134-3 to the following:

Frequency	500 MHz
Amplitude	-30 dBm
Output	On
Modulation	Off
Sweep	Off

Select item „5dBADJ" in the internal adjustment menu as described in section 3.2.1. The "OSCCAL"-text will change to "S10MHz". Now switch through the ATT settings from 0 dB to 40 dB and observe the location of the center of the trace on the CRT. No marker function is available for this test. The trace must change 2 graticule divisions for each attenuator step, and the value for the 10 dB attenuator step may be in the range of 1,6 to 2,4 graticule divisions from the top of the CRT graticule grid.
For adjustment of the 5 dB/Div setting, set the distance on CRT exactly to 2 cm from the top of the graticule using the rotary encoder. Switch off the unit to leave the adjustment menu.

3.2.9 Adjustment of test signal level

To check the test signal level, it is very important that a correct warmup of the instrument has taken place and that the instrument is operated at the ambient temperature indicated in the specifications of the HM5014-2.
Set the HM5014-2 to the following:

Center	48 MHz
Span	Zero span
RBW	1 MHz
ATT	10 dB
Marker	active
Test signal	active

(Max Hold, Average, Video filter and Tracking Generator not activated)

Connect coaxial cable [M8] using [M11] to the test signal output and to the RF input of the HM5014-2. The marker reading may be in the range of –27.0 dBm to –33.0 dBm.

Adjustment of the test signal level is done by connecting the test signal to the RF input of the HM5014-2, adjusting the marker readout exactly to –30 dBm. The Potentiometer P10 under the shield of the DDS part of the CPU-board is used to set the test signal to the level of –30 dBm (see Fig. 3-5).

3.2.10 Adjustment of TG amplitude

To check the adjustment of TG amplitude, set the HM5014-2 to the following:

Center	500 MHz
RBW	1 MHz
Span	Zero Span
ATT	40 dB
Ref.-Level	+10 dBm
Marker	Active
TG	Active
TG Level	+1 dBm

(Max Hold, Average and Video filter not activated)

Observe the marker level displayed on the CRT, and compare the displayed level to the level shown on the readout. Vary the level from +1 dBm to –10 dBm and check the marker readout vs. the TG level readout.

Now set the ATT to, 30, 20, 10 and 0 dB while setting the TG level from –10, -20, -30 and –40 dBm to minimum, so that the reading of the marker value stays in the same major graticule division on the CRT for best precision of the marker values.

The difference between readout of TG level and readout of marker level may not exceed 3 dB in either direction.

Adjustment of the TG level is accomplished using the internal adjustment menu (see 2.2.1). Use a coaxial cable [M5] to connect the TG output to the RF input. Activate the item "TGL +1" and adjust the trace in centre of the screen to 1 mm above the second graticule line from the top, ATT of the receiver must be set to 40 dB (ref.-level of +10 dBm). Adjust the level using the rotary encoder. Then choose the menu item "TGL-10", set the ATT of the receiver to 30 dB, and place the trace in the centre of the screen exactly on top of the second graticule line from the top. Using the same position on the CRT assures no extra errors introduced by the signal processing path of the HM5014-2.

After completing the adjustment, leave the menu by switching off the HM5014-2. Then check the level adjustment as described in para. 2.2.10.

3.2.11 Full band amplitude check

There is no adjustment possible in case the full band amplitude check in 2.2.11 is not passed. Refer to chapter 4 for troubleshooting and chapter 5 for repair of the unit.

4. Troubleshooting of the HM5014-2

Caution: Security advice!
The following procedures assume that the HM5014-2 is connected to mains / line via a safety transformer. Only qualified personnel who are aware of the danger of electricity should execute the following procedures.

If cables or connectors have to be disconnected, the instrument must be switched off before removing. Before continuing, observe the remarks in chapter 2.1 "Test instructions".

See paragraph 5.1 "Opening the instrument" how to remove the rear cover and the casing of the instrument.

Item	Behaviour of the HM5014-2	Possible cause / What to do	Remark
1.1	No front panel LED light, no trace and no readout visible on the CRT (dark screen)	Blown fuse: Pull out fuse holder at the rear and check the fuse. If blown, replace with same rating only and switch the instrument on again. If the fuse is intact, continue with item 1.2	The instrument must be disconnected from mains / line before changing the fuse.
1.2	LEDs will flash one short time, nothing else happens	Power supply detects overload	Continue to isolate fault, execute 1.3 to 1.6
1.3	Pull KEY conn	Does the CRT light up (will display an error message) ?	Short on KEY Board – replace board and repeat test 1.2
1.4	Pull XYZ conn	Do the LEDs on the KEY Board light up (CRT is not active) ?	Short around XYZ-Board – replace board, and repeat test 1.2
1.5	Pull CPU conn	Measure the voltages on the cable.	Replace CPU Board and repeat test 1.2
1.6	Pull IF-Unit conn	Does CRT light up?	Replace IF-unit.
2.1	Check amplitude at "1", must be –31 dBm	Attenuator malfunction, replace ATT	1 thru 3 are the hex marks in the block diagram
2.2	Check amplitude at "2", must be –15 dBm (±3 dB), frequency 29,7 MHz for center peak	RF Box malfunction, replace RF Box	
2.3	Check amplitude at "3", must be –14 dBm (±3dB), frequency 10,7 MHz for center peak	IF Unit malfunction, replace IF unit	
3.1	Filters not equal in amplitude	IF Unit defective, replace IF unit	
3.2	No noise on baseline	Replace IF Unit as a test, if still no signal, replace CPU Board	Digitization working, but no signal voltage applied
	Interface not responding	Replace interface Board	
	No probe power	Replace KEY Board	Voltage regulator is located on KEY Board
4.1	RF ampl has dropped	Perform checks 2.2 to 2.4 to determine cause, follow instructions	Possible ATT, RF Box, IF Unit faulty
4.2	RF ampl not linear	Perform checks 2.2 to 2.3 to determine cause, follow instructions	Possible ATT, RF Box faulty
4.3	Full band ampl check fails	Perform checks 2.2 to 2.3 to determine cause, follow instructions	Possible ATT, RF Box faulty
5.1	No TG sig	Replace TG Board and test if error persists, check connection to CPU Board and RF Box, switch TG ATT in 10 dB steps and listen for sound of relays	Also check the connectors to TG Board. Is it powered?
6.1	No test sig	Replace CPU Board as test, check cable to jack	The signal is derived from the 96 MHz signal on CPU Board
7.1	No audio	Replace KEY Board	Is the jack damaged?

5. Module Replacement

Replacement of modules

Module changed	Readjustment/Check necessary, step:
ATT-R	3.2.6, 3.2.8, 2.2.11
ATT-T	3.2.6, 3.2.10
RF-Box	3.2.6, 3.2.8, 2.2.11
IF-Unit	3.2.6, 3.2.8, 3.2.7, 3.2.5
CPU-Board	3.2.2 – 3.2.6, 3.2.8, 3.2.9
XYZ-Board	3.2.2, 3.2.3
PS-Board	3.2.1 – 3.2.3
KEY-Board	3.2.2 – 3.2.4, 3.2.8, 3.2.10
Interface	None
CRT module	3.2.2 – 3.2.4
Jacks/Covers	None

Changing mechanical parts like front cover or input connectors will not affect adjustment of the HM5014-2

5.1 Opening the instrument

Always make sure that when working on the instrument the mains connection is removed. When working with voltages present, take extra care not to touch exposed connections and components.

5.1.1 Remove the handle

The handle can be removed by pulling it out in position "F" as shown in figure 5-1 and figure 5-2.

Figure 5-1: Removing Handle

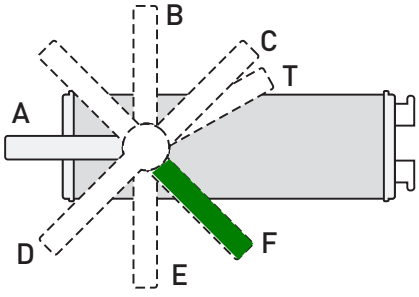


Figure 5-2: Removing Position

5.1.2 Remove the Rear Cover

Unscrew the two hexagon cap nuts as shown in figure 5-3. Use tool A7 (see paragraph 1.3, table 1-2). Remove the rear cover by pushing it backwards.

Figure 5-3: Back-Bottom View of HM5014-2 without handle

5.1.3 Remove the casing

Unscrew the crosshead screw as shown in figure 5-3 Use tool A4 (see paragraph 1.3, table 1-2). Remove the casing by pushing it backwards.

5.2 Replacement of XYZ-Board

Turn the HM5014-2 to the rear side. Make absolutely sure the unit is not connected to mains! See Fig. 5-4 showing the cable locations.

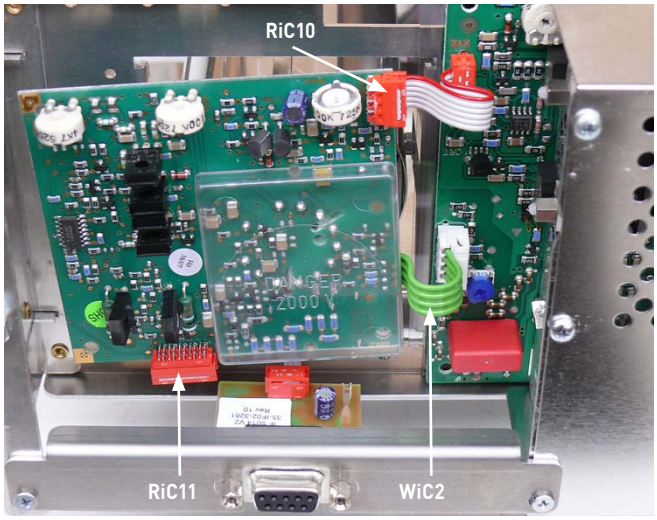


Figure 5-4: Location of XYZ module, cables

5.2.1 Removal of XYZ-Board

Remove the cables RiC10, WiC2 and RiC11 from the connectors on the XYZ-board. The cables are shown in Fig. 5-4. Then gently pull the XYZ-board away from the CRT socket, after about 6 mm it will come loose.

5.2.2 Installing of XYZ-Board

Set the new XYZ module on the CRT socket so that the nose on the CRT socket fits into the notch on the socket on XYZ-mo-

dule. Gently press the module into place. Connect the 3 wires RIC10, RIC11 and WIC2. Take the HM5014-2 into operation (ref. to paragraph. 5.18)

5.3 Replacement of interface module

Turn the instrument to the rear. See Fig. 5-2 for orientation, the interface module is the small PCB with the 9 pin SUB-D connector towards the back.

5.3.1 Removal of interface module

Remove the cable RiC12 from the connector and remove the 2 countersunk screws holding the interface in place. Remove the interface.

5.3.2 Installing of interface module

Put the new interface module in place and fix it with the 2 countersunk screws. Connect RiC12. Take the HM5014-2 into operation (ref. to paragraph. 5.18)

5.4 Replacement of IF-Unit

To exchange the IF-unit, it is not necessary to open any of the covers. See Fig. 5-5 for orientation. Rotate the instrument for convenient access.

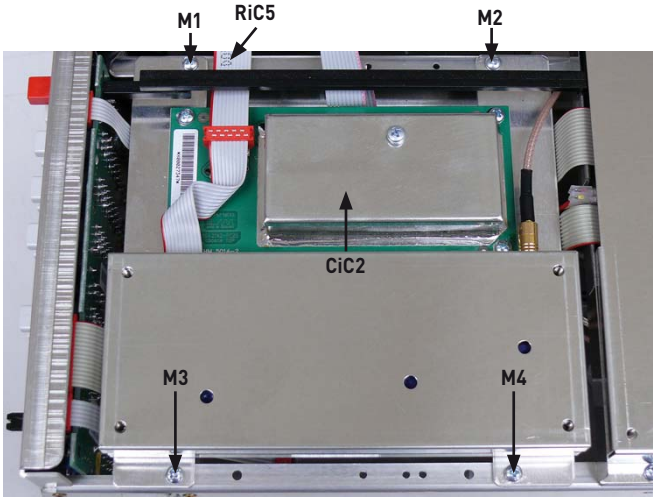


Figure 5-5: Location of screws of IF unit

5.4.1 Removal of IF-Unit

Remove the 4 holding screws (M1 – M4), one at each "corner" of the IF-unit (see Fig. 5-5). When loose, carefully disconnect all cables, RiC5 and CiC2. Remove the IF-unit, take care not to damage the power switch rod. The unit is changed as a whole. Do not loosen further screws.

5.4.2 Installing of IF-Unit

Take the new IF unit, and fix the cables RiC5 and CiC2 before putting it into place, take care not to damage the power switch rod. Then use the 4 fixing screws to hold it in place. Take the HM5014-2 into operation (ref. to paragraph. 5.18)

5.5 Replacement of CPU-Board

The replacement of the CPU-board has several steps. See Fig. 5-6 for orientation (First M1 – M7, then, after removing the cables, loosen M8 – M11).

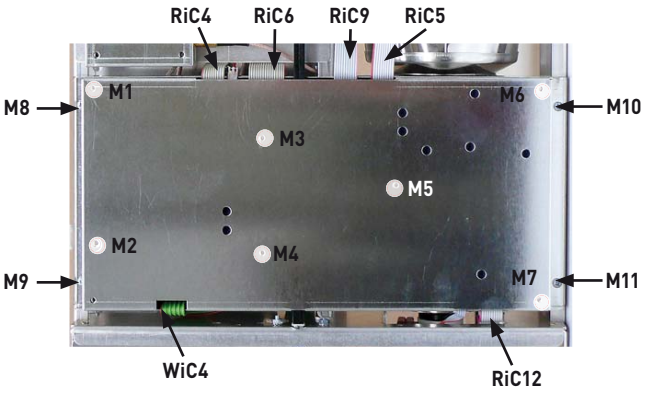


Figure 5-6: Location of screws and cables of CPU unit

5.5.1 Removal of CPU-Board

To remove the CPU-board, first loosen the 7 countersunk screws holding the cover. These are indicated in Fig. 5-6. Then remove the cover.
Now loosen all of the connecions to the CPU-board, RiC4, RiC6, RiC9, CiC7, CiC8, RiC12, RiC11, WiC4, WiC3, CiC4 and CiC5. Especially the 4 coaxial cables should be marked in order not to put them in a wrong place when assembling again. Now loosen the 4 screws holding the CPU-board in place and remove the board.

5.5.2 Installing of CPU-Board

Set the new CPU-board into place and fasten it with the 4 screws to the chassis. Replace RiC4, RiC6, RiC9, CiC7, CiC8, RiC12, RiC11, WiC4, WiC3, CiC4 and CiC 5. Put the cover on the CPU-board and fix it with the 7 countersunk screws. Take the HM5014-2 into operation (ref. to paragraph. 5.18).

5.6 Replacement of PS-Board

Turn the instrument to the rear. Before removing the cover of the PS module, make sure that no power is connected to the HM5014-2. See Fig. 5-7 for orientation. Note the countersunk screw holding one part of the interface module.

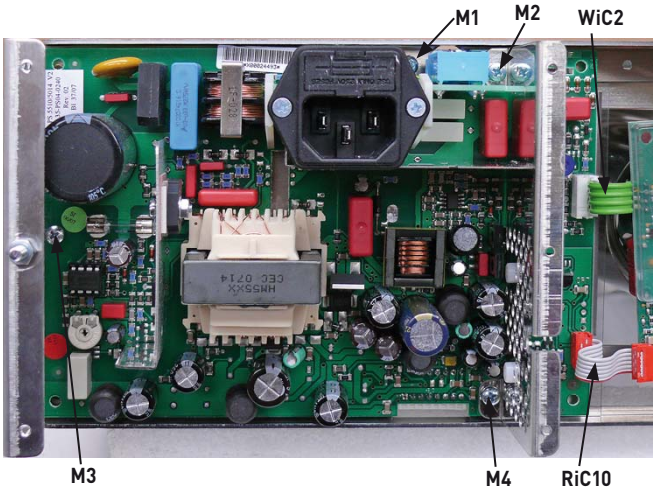


Figure 5-7: Location of screws of PS unit

5.6.1 Removal of PS-Board

To remove the PS module, loosen cables WiC2, WiC4 and RiC10. Then unsolder the Earth connection next to the power switch (see Fig. 5-7). Remove the power switch rod by gently

pulling it off the mains switch, and the removing it by moving it backwards and out of the instrument. Loosen the 3 nuts and washers inside the rear cover fixing the PS-module, and remove the PS module.

5.6.2 Installing of PS-Board

Insert the 3 screws of the PS module into the 3 holes of the rear chassis when putting it into place, and fix it with the 3 nuts and washers removed earlier. Solder the earth connector to the brass lug next to the mains switch, and check for connection. Now insert the power switch rod by first inserting the red part into the front chassis, and then moving it backwards until it fits onto the mains switch. Connect cables WiC2, WiC4 and RiC10. Place the cover on the PS module using the 4 crosshead screws and the countersunk screw holding part of the interface module. Take the HM5014-2 into operation (ref. to paragraph. 5.18).

5.7 Replacement of Tracking generator

The replacement of the Tracking generator requires the removal of the IF-unit prior to starting work. See paragraph 5.4 for reference.

5.7.1 Removal of the Tracking generator

Loosen the second coaxial cable CiC5 from the rear on the lower right side of the CPU-board. Then turn the unit so that the TG is located lower right hand side looking TG Jack to front. Then loosen the 4 crosshead screws holding the TG module (see Fig. 5-8), turn the HM5014-2 upside down, and pull the TG module gently backwards until the SMB connection to TG-ATT module comes loose. (see Fig. 5-9).

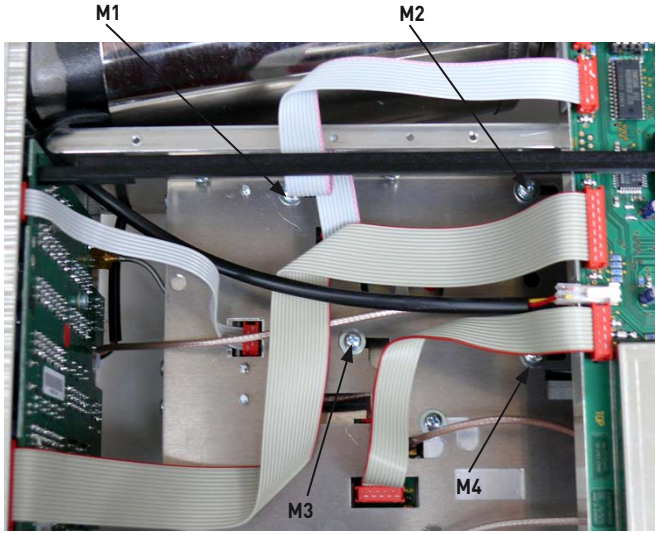


Figure 5-8: Location of screws for removal of TG

Now gently lift the TG module up, and loosen the remaining 2 connections, RiC 9 and CiC 3. Lift the TG module out of the HM5014-2.

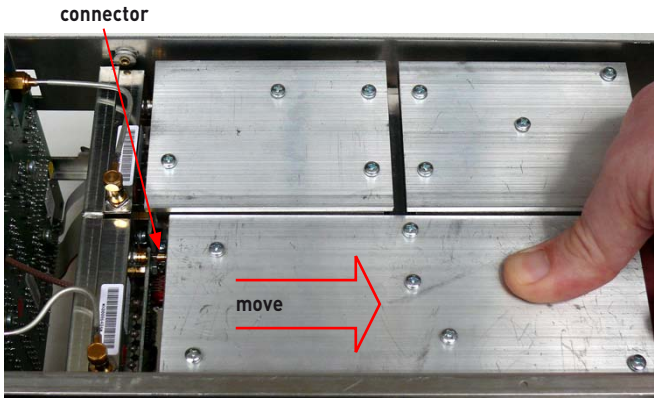


Figure 5-9: Removal of TG, likewise RF-Box

5.7.2 Installing of the Tracking generator

Put the TG module in the bay, fix the cables RiC9 and CiC3 to the TG, insert the TG into its position slipping it on the SMB jack of the ATT-TG module. Turn the HM5014-2 into its normal position and insert the 4 countersunk screws to hold the TG module. With pincers or pliers fix CiC5 to the SMB jack on CPU-board. Install the IF unit. Take the HM5014-2 into operation (ref. to paragraph. 5.18)

5.8 Replacement of ATT module (TG path)

Remove IF unit (see paragraph 5.4) and TG module (see paragraph 5.9) as preparation.

5.8.1 Removal of ATT module (TG path)

Turn the HM5014-2 upside down. Remove the SMB connector of SiC2 from the TG ATT module (next to CRT). Loosen the 2 crosshead screws holding the TG ATT module in place and gently remove the TG ATT module, disconnect WiC8 from TG ATT module.

5.8.2 Installing of ATT module (TG path)

Insert the new TG into its space and insert WiC8 connector. Put the TG ATT module in its place and fix it with the 2 crosshead screws. Place the SMB connector of SiC2 on the SMB jack. Insert TG module and IF unit (see 5.4 and 5.7). Take the HM5014-2 into operation (ref. to paragraph 5.18)

5.9 Replacement of RF-Box

Remove IF-unit (see Fig. 5.4) as preparation. Turn the HM5014-2 to its normal position.

5.9.1 Removal of RF-Box

First loosen the 4 crosshead screws (see Fig. 5-10) holding the RF-box in place and then very gently place the HM5014-2 with the CRT side down so the 4 coaxial cables to the CPU-board are visible, using a pair of pliers gently disconnect the first (CiC4) and second (CiC8) SMB plug (seen from front), and note that the frontmost one is also the frontmost one of the RF box.

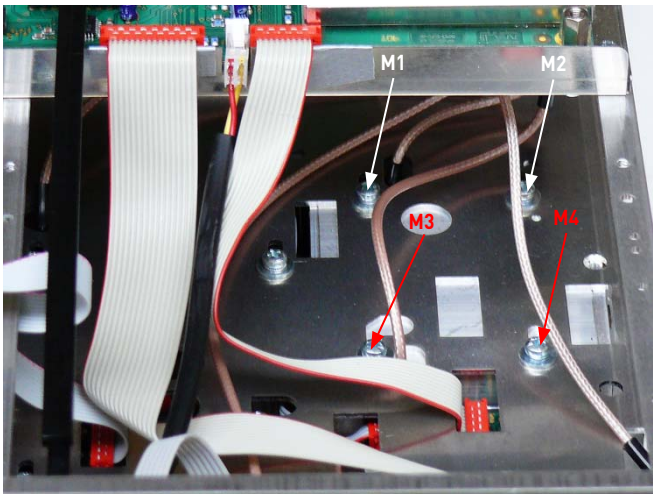


Figure 5-10: Location of the screws of the RF unit

Gently pull the RF box backward until the connector to the RF ATT is disconnected, then loosen the remaining cable RiC4 and the coaxial connection to the TG module (CiC3). Lift the RF box out of the HM5014-2 (See Fig. 5-9).

5.9.2 Installing of RF-Box
Put the new RF box so that RiC4 can be connected, feed the 2 coaxial cables through the appropriate holes in the chassis, and connect them to the 2 SMB jacks on CPU board, CiC 4 in front and CiC8 the second from the front. Gently insert into the mounting bay and fix cable RiC4 and the coaxial connection to the TG module (CiC3). Then insert the RF box into its position by sliding it on the SMB connector of the RF ATT box. Turn the HM5014-2 into its normal position. Fix the RF box in place using 4 countersunk screws and make sure it is pushed against the RF ATT while tightening the screws. Reinstall the IF unit (see paragraph 5.4). Take the HM5014-2 into operation (ref. to paragraph 5.18)

5.10 Replacement of RF ATT module

The replacement of the RF ATT module requires that IF unit (see 5.4) and RF box (see 5.9) are removed prior to the replacement of the RF ATT module.

5.10.1 Removal of RF ATT module
Turn the HM5014-2 upside down. Remove the SMB connector of SiC1 from the RF ATT module (outside). Loosen the 2 crosshead screws holding the RF ATT module in place and gently remove the RF ATT module, disconnect WiC6 from RF ATT module.

5.10.2 Installing of RF ATT module
Insert the new RF ATT into its space and insert WiC6 connector. Put the RF ATT module in its place and fix it with the 2 crosshead screws. Place the SMB connector of SiC1 on the SMB jack. Insert RF box and IF-unit (see paragraph 5.9 and 5.4). Take the HM5014-2 into operation (ref. to paragraph 5.18)

5.11 Replacement of KEY board

Prior to replacing the KEY board, the IF unit must be removed (see paragraph 5.4) as well as the front cover (see paragraph 5.12)

5.11.1 Removal of KEY board
Loosen the 4 countersunk screws that hold the KEY module from the front side, locations are indicated in the figure 5-11.

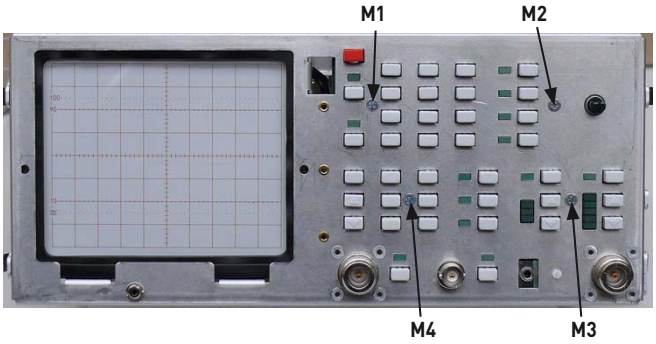


Figure 5-11: Location of the screws of the KEY board

When loose, remove the connectors of RiC6, RiC2, RiC7 and WiC5. Remove the KEY board out of the HM5014-2 by lifting it vertically out of the instrument. Be careful not to damage the probe power jack.

5.11.2 Installing of KEY board
Carefully insert the new KEY module into the unit from the top, be careful not to damage the probe power jack, the shaft of the rotary encoder and the caps of the buttons. Fix the connectors of RiC6, RiC2, RiC7 and WiC5 to the KEY board. Put the KEY board in place and fix it with the 4 countersunk screws shown in photo (see Fig. 5-11). Insert the IF unit (see Fig. 5-4). Take the HM5014-2 into operation (ref. to paragraph 5.18)

5.12 Replacing the front cover

5.12.1 Removal of the the Front Cover
Remove the knob of the rotary encoder, by pulling it forward. Remove the front panel by releasing the four snap-in noses at the right and left side of the panel and pulling the panel forward.

5.12.2 Installing the new Front Cover
Push the front cover onto the front chassis. **Caution with the buttons!** The four clips of the front cover must snap behind the flange of the front chassis. Press the knob of the rotary encoder on the axis of the encoder.

5.13 Replacement of the Rear Cover

5.13.1 Removal of the the Rear Cover
see paragraph 5.1.2

5.13.2 Installing the new Rear Cover
Push rear cover onto the rear chassis. Screw the two hex cap nuts as shown in figure 5-3.

5.14 Replacement of CRT module

5.14.1 Removal of the CRT Module
First remove the CPU board (see paragraph 5.5.1), then remove the XYZ module (see paragraph 5.2.1). Remove the hex nuts M1 and M2 from the CRT bracket as shown in Fig. 5-12. Use the jaw wrench size 5.5 mm, tool A9.

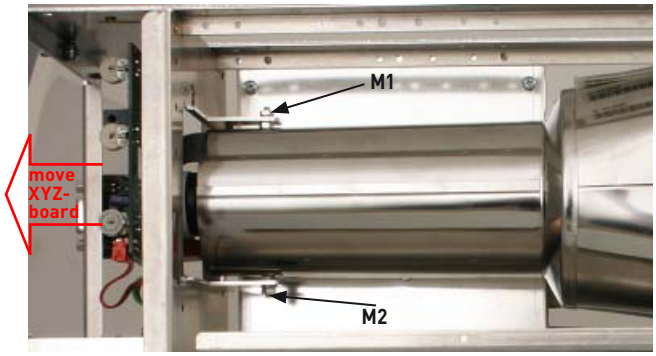


Figure 5-12: View of the CRT module

The CRT module can now be removed out of the chassis. Lift the CRT module at the position of the two mounting nuts M1 and M2 upwards and then push the module backwards, to lift it finally at the front chassis. Caution with the rubber part!

5.14.2 Installing the new CRT Module

- Place the rubber part into the front chassis and push the CRT module down with its screen side at the front chassis top flange.
- Push the CRT module into the rubber and then into the bracket at the back.
- Fix the hex nuts M1 and M2 as shown in Fig. 5-12. Use the jaw wrench size 5.5 mm, tool A9, install the CPU board (see parapgraph 5-5-2).
- Connect the ribbon cables and the wires to the CPU board.
- Install the XYZ module (see paragraph 5.2.2)
- Take the HM5014-2 into operation (see paragraph 5.18).

5.15 Replacement of the RF Input Connector / TG connector

5.15.1 Removal of the the RF Input Connector

Remove the front cover (see paragraph 5.12.1) Unscrew the SMA nut from the semi rigid cable SiC2 (see figure 5-9) . Unscrew the two mounting screws of the RF input connector / TG connector (see figure 5-11)

5.15.2 Installing the new RF Input Connector

Insert the two mounting screws of the RF input connector (see figure 5-9). Screw the SMA nut from the semi rigid cable SiC2 (see figure 5-9). Install the front cover (see paragraph 5.12.2).

5.16 Replacement of the Test Signal Connector

5.16.1 Removal of the the Test Signal Connector

Remove the front cover (see paragraph 5.12.1) Unsolder the coaxial cable at the rear of the BNC-connector. Unscrew the mounting nut of the test signal connector (see figure 5-11).

5.16.2 Installing the new Test Signal Connector

Screw the two mounting screws of the test signal connector (see figure 5-11). Fix the new BNC connector with the hex nut and solder the coaxial cable to the terminals. Install the front cover (see paragraph 5.12.2).

5.17 Replacement of the Power Probe Plug

The probe power plug is a part of the key board, see paragraph 5.11.

5.18 Putting the Instrument into Operation

Connect the open instrument to mains/line and switch it on. For a first check perform the adjustment and or test procedure as indicated in table 5-1 for the corresponding module which was replaced.

5.19 Completing the Instrument

Mount the housing by pushing it forwards to the front of the instrument. Take care that the holes for the handle are close to the front and the base is at the bottom. Screw the crosshead screw as shown in figure 5-3 and install the rear cover (see paragraph 5.13.2).

5.20 Final Performance Test

For the final performance test the instrument must be completed and, **VERY IMPORTANT**, allow a minimum warm up time of 30 minutes at ambient temperature. After that warm up time start with the required adjustments as indicated in table 5-1. For the proper instructions to perform adjustments see chapter 3. After successful adjustment all performance tests as described in chapter 2 have to be executed.

6. Spare Parts Handling

This chapter provides information on the ordering of spare parts and contains the spare parts list.

6.1 Shipping of Instrument or Modules

Please contact your HAMEG support center or the HAMEG spare parts express service if you need service or repair of your equipment or to order spare parts.

We require the following information in order to answer your inquiry fast and correctly and to decide whether the warranty still applies for your instrument:
- Instrument model
- Stock No.
- Serial Number
- Firmware version
- Detailed error description in case of repair
- Contact partner for checkbacks

When shipping the instrument, be careful to provide for sufficient mechanical and antistatic protection. Repack the instrument as it was originally packed when transporting or shipping. The two protective foam plastic parts prevent the control elements and connectors from being damaged.

6.2 Ordering Spare Parts

The stock numbers are necessary for ordering replacement parts and modules.

6.3 Spare Parts List

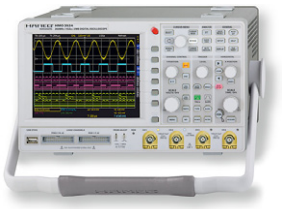
Spare Part	Stock Number
IFA Module	29-2000-0015
RFI Module	29-2000-0013
TG Module	29-2000-0017
RAT Module	29-2000-0005
XYZ Module	29-2000-0007
CPU Board	29-2000-0016
PS Module	29-2000-0002
KEY Module	29-2000-0012
CRT Module	29-2000-0029
Serial Interface (IF Module)	29-2000-0018
Front cover	29-2000-0019
Rear cover	29-1000-0010
Knob Set	29-2000-0020
Plug cable cpl.	29-2000-0044
Screen filter pane	29-1000-0012
Coaxial pipes	29-2000-0042
Flat cable Set	29-2000-0043
Casing	29-1000-0064
Handle	29-1000-0068

6.4 Hameg Tool Kit HM5014-2

For module replacement some special tools are needed. These tools are indicated in table 1-2, item A1, A2, A7 and A8. All these items belong to the Hameg tool kit HM5014-2 and can be ordered under the stock number 29-2000-0045.

HAMEG®
Instruments
A Rohde&Schwarz Company

Oscilloscopes



Spectrum Analyzer

Power Supplies

Modular System
Series 8000

Programmable Instruments
Series 8100

authorized dealer

www.hameg.com

Subject to change without notice
Release: · 30032011

A Rohde & Schwarz Company
DQS-Certification: DIN EN ISO 9001:2000
Reg.-Nr.: 071040 QM

HAMEG Instruments GmbH
Industriestraße 6
D-63533 Mainhausen
Tel +49 (0) 61 82 800-0
Fax +49 (0) 61 82 800-100
sales@hameg.com