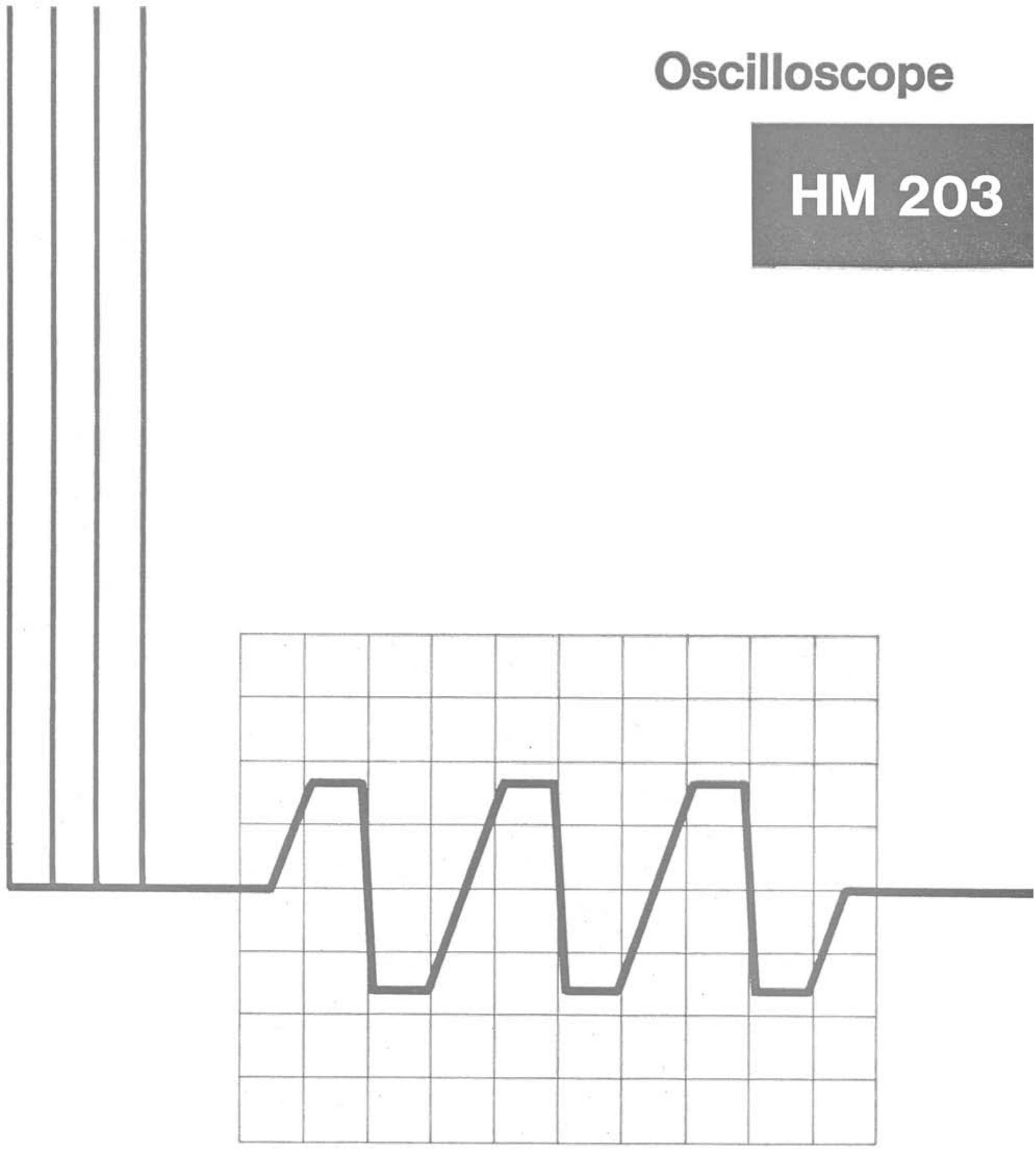
MANUAL

Oscilloscope

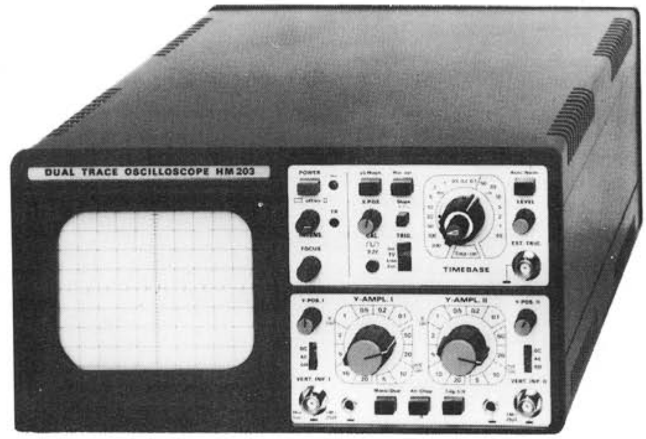
HM 203



HAMEG MESSTECHNIK

OSCILLOSCOPE HM 203

HAMEG



- **Bandwidth DC-20MHz**
- **Dual Trace Oscilloscope**
- **8cm x 10cm Display**
- **Triggering up to 30MHz**

The **new HM203** is a **20MHz** bandwidth general-purpose Dual Trace Oscilloscope. The **stable sweep triggering** (to 30MHz) and the relatively **high measuring accuracy** (±3%) are particularly impressive. The useful display area is approximately 8x10cm. With the aid of the **electronic stabilization** of all operating voltages and the thermically favorable arrangement of the drift-sensitive components, an **outstanding display stability** is obtained. The brightness and display definition of the cathode-ray tube are excellent.

Following the trend of the times, this oscilloscope is the first **compact instrument** with a **flat shape** from the new HAMEG series. This conception is very advantageous especially for stacking on test assemblies as well as being **portable for the field service**. The logical subdivision of the front-panel controls into two sections — **separated for X and Y** — facilitates the handling of the HM203. After a short time, operating the instrument poses no problems, even for the newcomer.

Accessories optional
Attenuator Probes x1, x10, x100; Demodulating Probe; various Test Cables; Component Tester; Four-channel Unit; Viewing Hood; Carrying Case; ect.

Specification

Vertical Deflection (Y)

Bandwidth of both channels
DC-20MHz (-3dB), DC-28MHz (-6dB).
Risetime: 17.5ns (approx.).
Overshoot: 1% (maximum).
Deflection coefficients: 12 calibr. steps, 5mV/cm-20V/cm (1-2-5 sequence), accuracy better than ±3%.
Input impedance: 1MΩ II 25pF.
Input coupling: DC-AC-GND.
Input voltage: max. 500V (DC + peak AC).
Operating modes
Channel I, Channel II, Channel I and II, alternate or chopped (approx. 120kHz).
X-Y operation: sensitivity ratio 1:1.

Timebase

Time coefficients: 18 calibrated steps, 0.5µs/cm-0.2s/cm (1-2-5 sequence), with variable control uncalibr. to 200ns/cm, with magnifier x5 uncalibr. to 40ns/cm, accuracy better than ±3% (in cal. position).
Ramp output: 5V (approx.).

Trigger System

Modes: automatic or variable trigger level.
Sources: Channel I, Ch. II, line, external.
Slope: positive or negative.
Coupling: AC or TV-low-pass-filter.
Sensitivity: int. 3mm, ext. 0.7V (approx.).
Bandwidth: 30Hz (auto), 5Hz (level) up to at least 30MHz.

Horizontal Deflection (X)

Bandwidth: DC-2MHz (-3dB).
Input: via Channel I, for other data see Y deflection spec.
X-Y phase difference: <3° up to 100kHz.

Miscellaneous

Cathode-ray tube: 130BXB31, 13cm Ø.
Accelerating potential: 2000V.
Calibrator: square-wave generator 1kHz, 0.2V ±1%, for probe compensation.
Trace rotation: adjustable at front panel.
Regulated DC power supplies: all operating voltages including the EHT.
Line voltages: 110, 125, 220, 240V AC.
Line fluctuation: ±10% (maximum).
Line frequency range: 50-60Hz.
Power consumption: 36 Watts (approx.).
Weight: 6kg (approximately).
Dimensions (mm): **H** 145, **W** 285, **D** 380.
Finish: dark grey.
With handle and tilt stand.

Subject to change.

General

The **high performance** and competitive price of the HM203 has been achieved by the optimum use of both discrete semiconductor and **integrated circuit** technology. Quality and long term reliability are assured, as only **high quality components** are selected for the instrument. A well-arranged mounting style combined with **stable construction** ensureseasy servicing. The subdivision of the complete circuitry into two large printed circuit boards enables each component to be easily reached, without dismounting any other part.
Particular attention has been paid to the front panel design with the function of each control being clearly identified.
Each instrument is supplied with a **comprehensive manual** which includes operating and servicing instructions, circuit diagrams, and PCB layouts. It contains also **test instructions** for checking the most important functions by relatively simple means.

Modes of Operation

The HM203 can be used for **single or dual trace** operation. Two signals differing in time and amplitude can be displayed either consecutively (alternate mode) or by the multiple switching of the channels within one sweep period (chop mode). When **X-Y operation** is selected, the X input is via channel I. Input impedance and sensitivity are then the same for both X and Y deflection. A particular feature of the HM203 is its simplicity to use, as generally only one pushbutton needs to be operated to obtain the desired operating mode. In doing so, the button for Channel II is attached in such a manner that with simultaneous pressing of the adjoining button, triggering is switched over, too.

Vertical Deflection

The HM203 has two preamplifiers with **diode-protected FET inputs**. These are electronically switched either individually or alternately to the final Y amplifier. The switching circuit operates with bistable-controlled diode gates. Control for the alternate mode is effected by the unblanking pulse from the sweep generator and for the chopped mode by a 120kHz signal. The chop generator and the bistable multivibrator are both combined in a single integrated circuit. The preamplifier input stages utilize **monolithic integrated circuits to minimize drift**. Exact measurement of the displayed waveform is achieved by the 12-step frequency compensated input attenuator calibrated in V/cm. In order to obtain reliable triggering, particularly at higher frequencies, the bandwidths of the preamplifiers are approximately **40MHz**. The total bandwidth of the Y amplifier is dependent on the output stage. The value stated refers to -3dB (70% of 60mm).

Timebase

The timebase of the HM203 operates with a **new type of trigger technique** developed by HAMEG. Here, the entire trigger preparation is through a **monolithic integrated voltage comparator** whose TTL output is connected directly to the control logic of the sweep generator. This dispenses with any kind of stability adjustment. The fast operation of this circuit means that very small signal amplitudes can be reliably triggered, and **perfect triggering** is also achieved **up to 40MHz**. The trigger input can be selected from channel I or II as well as from the line or externally. A choice can also be made between positive or negative trigger edges. With the trigger switch in the **Auto** position, a time axis is always displayed even in the abscence of a signal. The sweep generator then oscillates independently in accordance with the sweep rate selected. The HM203 allows the triggering of **TV signals** (line or frame frequency). The unblanking of the CRT is effected by means of a **voltage-proof opto-coupler.**

Miscellaneous

All internal supply voltages, including the EHT, are **electronically stabilized**, so that line fluctuations of ±10% will not affect the display or accuracy of the HM203. A **square-wave generator** for calibrating the vertical amplifiers and probe compensation is incorporated. By means of the **Trace Rotation**, the alignment of the trace with the horizontal graticule lines is possible from the front panel.

This frequency compensated attenuator probe should be used when the circuit under test is a high impedance source or the signal voltage exceeds 100 Vpp. It should be noted that the probe reduces the input voltage by a factor of 10. The probe can be connected to the test circuit by a removable sprung hook, and an integral ground lead with an insulated crocodile clip.

Specification

Attenuation x10. Bandwidth DC-100 MHz. Risetime 3.5 ns. Max. input voltage 600 V (DC + peak AC). Input impedance 10 Megohm. Input capacitance 10.3-13.6 pF. Compensation range 10-60 pF. Cable length 1.5 m.
Accessories supplied: Sprung Hook, Trimming Tool.

HZ 30 Oscilloscope Probe x 10

The HZ 35 is a straight through probe without attenuation and therefore allows the full sensitivity of the oscilloscope to be used. Due to the probe capacity it is only recommended for use with relatively low impedance and low frequency sources. This probe is connected to the test circuit by a sprung hook and integral ground lead with an insulated crocodile clip.

Specification

Bandwidth DC-10 MHz. Max. input voltage 600 V (DC + peak AC). Input resistance equal to the oscilloscope resistance. Input capacitance 47 pF + oscilloscope input capacitance. Cable length 1.5 m.
Accessories supplied: Sprung Hook, BNC Adapter.

HZ 35 Oscilloscope Probe x 1

The HZ 36 is a switchable probe offering both x10 and x1 operation. In the x10 mode the characteristics are the same as the HZ 30. In the x1 position the cable capacity will act as a load on a high impedance source, however the maximum sensitivity of the oscilloscope can be fully utilized. The reference position enables a ground reference level to be set. In this mode the oscilloscope input is grounded.

Specification

Attenuation x10 same as HZ 30 spec. x1 operation: Bandwidth DC-10 MHz. Max. input voltage 600 V (DC + peak AC). Input resistance equal to the oscilloscope resistance. Input capacitance is 40 pF + oscilloscope input capacitance. Reference position: probe tip grounded via 9 Megohm, oscilloscope input grounded. Cable length 1.5 m.
Accessories supplied: Sprung Hook, Trimming Tool, BNC Adapter, Insulating Tip, IC Tip.

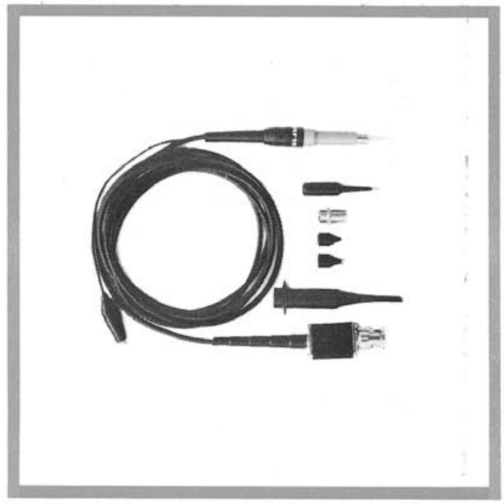
HZ 36 Switchable Probe x 10/x 1

For the measurement of voltages between 500 V and 1500 V it is essential to use the HZ 37 x 100 attenuator probe. It should be noted that if voltages greater than 600 V are applied to the HZ 30, HZ 36 and HZ 38 probes then serious damage to the probes and the oscilloscope input will occur. When using the HZ 37 the input voltage to the oscilloscope is reduced by a factor of 100.

Specification

Attenuation x 100. Bandwidth DC-50 MHz. Risetime 7 ns. Max. input voltage 1500 V (DC + peak AC). Input resistance 9.1 Megohm. Input capacitance approx. 4.6 pF. Compensation range 12 - 48 pF. Cable length 1.5 m.

Accessories supplied: Sprung Hook, Trimming Tool, BNC Adapter, Insulating Tip, IC Tip.



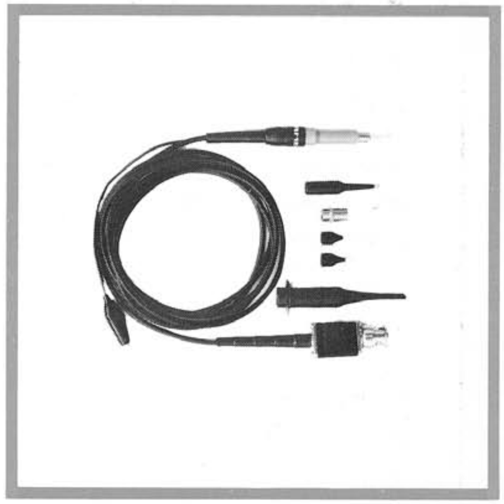
HZ 37 Oscilloscope Probe x 100

The HZ 38 is a x 10 attenuator probe which has been specially designed for the investigation of relatively high frequency signals. As the risetime of the probe is added geometrically to that of the oscilloscope it should not be greater than 20% of the oscilloscope risetime. The HZ 38 is recommended for use with instruments quoting a bandwidth of 40 MHz or more, as the effective bandwidth of the oscilloscope will not suffer reduction by the probe.

Specification

Attenuation x 10. Bandwidth DC-200 MHz. Risetime 1.7 ns. Max. input voltage 500 V (DC + peak AC). Input resistance 10 Megohm. Input capacitance approx. 13 pF. Compensation range 12 - 48 pF. Cable length 1.5 m.

Accessories supplied: Sprunk Hook, BNC Adapter, 2 Ground Leads.



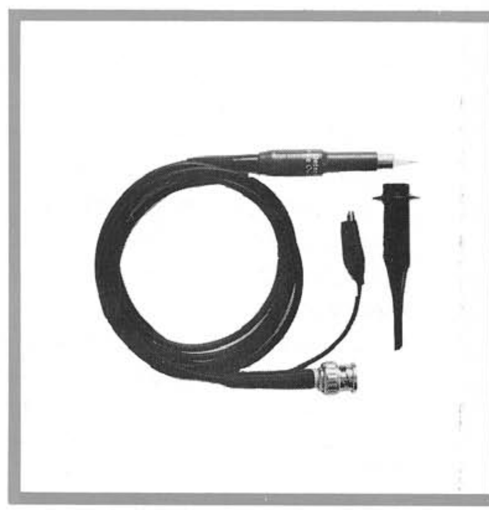
HZ 38 Oscilloscope Probe x 10

The HZ 39 Demodulator Probe is particularly suitable for the display of the AM content of RF signals, and as a detector for swept-frequency voltages. The main circuit component is a peak to peak rectifier with a capacitor input. For RF suppression the output signal is derived via a low-pass filter. For correct operation the probe must be terminated by 1 Megohm (oscilloscope input resistance with DC coupling). If AC coupling has to be used then a separate 1 Megohm resistor will be required to achieve the neccessary DC bias voltage for the diodes.

Specification

Bandwidth approx. 35 kHz to 250 MHz. RF input voltage range 0.25 Vrms to 40 Vrms. Max. input voltage 200 V (DC + peak AC). Output polarity positive. Cable length 1.5 m.

Accessories supplied: Sprung Hook, BNC Adapter.

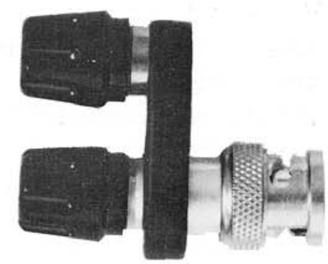


HZ 39 Demodulator Probe

This adapter is designed to meet applications where it is neccessary to connect 4 mm plugs to an instrument with a BNC input socket. The HZ 20 is solidly constructed and versatile incorporating a BNC male plug to dual 4 mm binding post. The binding post mounting can be rotated so that the adapter can be positioned to avoid obstructing front panel controls.

Specification

Dimensions (mm) length 42, width 35, depth 18. Standard BNC male plug. Two 4 mm binding posts 19 mm between centres. Maximum input voltage 500 V (DC + peak AC).



HZ 20 Adapter Binding Posts to BNC

The HZ 22 is a 50 ohm through termination with a BNC female socket to receive the test cable and a BNC male plug for connection to the oscilloscope. This termination should be used to terminate signal generators and koax-cables which have a 50 ohm characteristic impedance. For correct operation the termination must be connected directly to the oscilloscope input, otherwise the test signals, irrespective of its fundamental shape, will be deformed. The termination should also be used for the accurate measurement of high frequency sine wave signals (to avoid standing waves). The HZ 22 should not be employed when a compensated attenuator probe is used.

Specification

Dimensions (mm): 14 x 20 x 62. Max. load 2 W. Max. voltage 10 Vrms.

HZ 22 50 ohm Through-Termination

When setting the frequency compensation of an oscilloscope input attenuator with a 1 Megohm input resistance a screened x2 input attenuator must be used. The HZ 23 is a compact attenuator with a BNC male plug for connection to the oscilloscope vertical input, and a BNC female socket for connection to the coaxial cable from the oscilloscope calibrator. In series with the centre connections of the plug and socket is a 1 Megohm resistor paralled by a ceramic trimmer capacitor. The trimmer can be adjusted to equal the input capacitance of the oscilloscope, then the impedance of the HZ 23 is equal to the specified input impedance of the oscilloscope under test.

Specification

Dimensions (mm) 62 x 21 x 15. Fixed resistor 1 Megohm. Capacitance compensating range 12 - 48 pF. Max. voltage 250 V (DC + peak AC).

HZ 23 Input Attenuator x 2

The HZ 32 coaxial test cable is designed to facilitate connection between an oscilloscope and instruments with 4 mm sockets. However, this combination of BNC- 4 mm can be used for many other applications. For example when investigating AF signals from a high impedance source the possibility of hum pick-up and crosstalk is greatly reduced as the signal input 4 mm plug is completely screened. Both the BNC and 4 mm signal plug have anti-kink mouldings while the 4 mm earth lead is fine stranded wire, to minimize the risk of the cable breaking.

Specification

Cable length 1.15 m. Cable capacitance 120 pF. Characteristic impedance 50 ohm. Max. voltage 500 V (DC + peak AC).

HZ 32 Test Cable BNC- 4 mm

The HZ 34 is a coaxial test cable terminated with BNC male plugs at each end. Today the BNC connection system is the most widely used type in the commercial electronics field, and the HZ 34 gives the user a test cable with specified characteristics. To minimize the possibility of cable breakage both BNC plugs are protected by anti-kink mouldings.

Specification

Cable length 1.2 m. Cable capacitance 126 pF. Characteristic impedance 50 ohm. Max. voltage 500 V (DC + peak AC).

HZ 34 Test Cable BNC - BNC

HAMEG

When the oscilloscope is used for field service applications the HZ 43 carrying case will prove to be invaluable, as it has been designed to protect the instrument and provide storage for accessories and tools. The carrying case is manufactured from hard wearing material, the base of the case has a thick shock absorbing lining which protects the instrument against rough handling. One side of the case has a compartment which can be used to carry accessories, tools and spares. Dimensions for the carrying case are 260 x 210 x 460 mm, while the compartments measurements are 260 x 210 x 50 mm. The instrument handle is used for carrying minimizing the stresses applied to the carrying case.

Suitable for HM 312, HM 412 and HM 512 oscilloscopes. Special model for HM 812 oscilloscope on request.

HZ 43 Carrying Case

The HZ 44 Carrying Case has been specially designed for the smaller instruments in the HAMEG range, though of course it may be used for other instruments of a similar size. It also contains a compartment which can be used for accessories and tools. The case is manufactured from a hard wearing material. A leather shoulder strap, with a protective pad, is fixed to the case, this is particularly advantageous if other equipment has to be carried. Ventilation holes are provided in the case so that instruments with a maximum consumption of 30 Watts can be operated in the case. Overall dimensions are approx. 300 x 125 x 300 mm, accessory compartment approx. 120 x 40 x 280 mm.

Suitable for HM 307, HZ 62 and HZ 64 instruments.

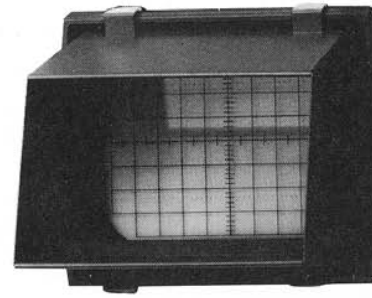
HZ 44 Carrying Case

This laboratory type instrument trolley is suitable for all HAMEG oscilloscopes and ancillary instruments. Both instrument trays can be tilted to a maximum of 10° from the horizontal, allowing precise setting of a convenient viewing angle. Each tray is covered with a grooved PVC mat which prevents the instrument from sliding. The lower tray can be used for ancillary instruments or for storing accessories. The HZ 48 is ruggedly constructed and in spite of its low weight (10 kg) it is very stable. Mounted on four wheels, both front wheels have brakes, the trolley is fully mobile, and is recommended for use in locations where HAMEG oscilloscopes have to be shared between several work stations. Tray dimensions (mm): Upper 250 x 300, Lower 250 x 250.

Suitable for oscilloscopes HM 307, HM 312, HM 412, HM 512, HM 812 and ancillary intruments HZ 62 and HZ 64.

HZ 48 Instrument Trolley

Under high ambient light conditions it may be found that the contrast of the display is diminished, also problems can sometimes be caused by unwanted reflections on the graticule. In most cases the HZ 47 Viewing Hood will overcome these problems as it shields the display area, substantially increasing the contrast, and decreasing the possibility of reflections. The HZ 47 has four sprung clips which easily locate into slots on the oscilloscope bezel.



HZ 47 Viewing Hood

Suitable for HM 312, HM 412, HM 512 and HM 812 oscilloscopes.

General Information

The new HM203 is as easy to use as its predecessors. Technologically it represents the latest state of engineering in this price range. This is particularly illustrated by the increased use of monolithic integrated circuits. The logical arrangement of the controls and connectors on the front panel ensures that the user will quickly become familiar with the operation of the instrument. However, even experienced operators are advised to read the following instructions thoroughly, as they include important information relating to the use of the HM203.

This instrument is designed and tested according to international safety standards (e. g. ***VDE 0411 part 1 and 1a: Safety requirements for electronic measuring apparatus)***. The instrument has left the factory in perfect safety condition. To preserve this state and to ensure operation without danger, the user must observe all advice and warning remarks in these Operating, Test, and Service Instructions. ***The case, chassis, and all measuring terminals are connected to the Safety Earth conductor.*** The instrument corresponds to the specification for the ***Safety Classification I*** (three-conductor AC power cable). The grounded accessible metal parts (case, sockets, jacks) and the power line circuit of the HM203 are tested against one another with 1500V 50Hz. Under certain conditions, 50Hz or 60Hz hum voltages can occur in the measuring circuit due to interconnection with other line powered instruments or devices. This can be avoided by using a protective isolating transformer between the line outlet and power plug of the HM203. Without an isolating transformer, the instrument's power cable must be plugged into an approved three-contact electrical outlet, which meets International Electrotechnical Commission (IEC) safety standards. The disconnection of the Safety Earth conductor is not allowed.

As with most electron tubes, the cathode-ray tube develops X-rays. With the HM203 ***the dose equivalent rate falls far below the maximum permissible value of 36pA/kg*** (0.5mR/h).

If a protective isolating transformer is used for the display of signals with high zero potential, it should be noted that these voltages are also connected to the oscilloscope's case and other accessible metal parts. Voltages up to 42V are not dangerous. Higher voltages, however, involve a shock hazard. In this case, special safety measures must be taken and must be supervised by qualified personnel.

To obtain the maximum life from the cathode-ray tube, the minimum intensity setting necessary for the measurement in hand and the ambient light conditions should be used. ***Particular care is required when a single spot is displayed***, as a very high intensity setting may cause damage to the fluorescent screen of the CRT. In addition, switching the oscilloscope off and on at short intervals stresses the cathode of the CRT and should therefore be avoided.

In spite of Mumetal-screening of the CRT, effects of the earth's magnetic field on the horizontal trace position cannot be completely avoided. This is dependent upon the orientation of the oscilloscope on the place of work. Sometimes, however, the CRT itself may be rotated slightly, due to hard shocks during shipment. In both cases, a centred trace will not align exactly with the horizontal center line of the graticule. A few degrees of misalignment can be corrected by a potentiometer accessible through an opening on the front panel marked **TR**. ***If repositioning of the CRT is required, the procedure described in the Service Instructions should be followed.***

As with all HAMEG oscilloscopes, the front panel is subdivided into two sections according to the main functions. Located on the upper right, next to the CRT, are the **POWER** pushbutton and indicating lamp; the **INTENS.**, **FOCUS**, and **TR** (Trace Rotation) controls are arranged below them. The controls for the X (horizontal) deflection system are located to the right in this section: **TIMEBASE** range switch with its fine control (double knob); **X-POS.** and **LEVEL** control; **TRIG.** selector slide switch; pushbuttons for **x5 Magn.**, **Slope +/−**, **Hor. ext.**; BNC connector for **EXT. TRIG.**; **CAL.** (calibrator) output. The lower section contains the controls for the Y (vertical) deflection system. Right and left in this section are located: **Y-AMPL.** attenuator switch; **VERT. INP.** connector; **DC-AC-GD** input coupling slide switch; **Y-POS.** control; ground jack. All these operating controls exist in duplicate: for Channel I and Channel II. This section contains also three pushbuttons for the selection of the operating mode: **Mono/Dual, Alt/Chop, Trig. I/II**.

The instrument is designed so that even incorrect operation will not cause serious damage. The pushbuttons control only minor functions, and it is recommended that before the commencement of operation that all pushbuttons are in the "out" position. After this the pushbuttons can be operated depending upon the mode of operation required. For a better understanding of these Operating Instructions the front panel picture at the end of these instructions can be unfolded for reference alongside the text.

The HM203 accepts all signals from DC (direct voltage) up to a frequency of at least 20MHz (-3dB). For sine-wave voltages the upper frequency limit will be 30-35MHz. However, in this higher frequency range the vertical display height on the screen is limited to approx. 3-4cm. In addition, problems of time resolution also arise, i.e. with 25MHz and the fastest adjustable sweep rate (40ns/cm), one cycle will be displayed every 1cm. The tolerance on indicated values amounts to ±3% in both deflection directions. All values to be measured can therefore be determined relatively accurately. However, it should be remembered that from approximately 6MHz upwards the measuring error will increase as a result of loss of gain. At 12MHz this reduction is about 10%. Thus, approximately 11% should be added to the measured voltage at this frequency. As the bandwidth of the amplifiers differ (normally between 20 and 25MHz), the measured values in the upper limit range cannot be defined exactly. For frequencies above 20MHz the dynamic range of the display height steadily decreases. The vertical amplifiers are designed so that the transmission performance is not affected by its own overshoot.

Warranty

Before being shipped each instrument must pass a 24 hour quality control test. By burning-in the oscilloscope over the 24 hour period, early failure of components is kept to a minimum. The off-on cycling during the test provides a realistic environmental stress, that the instrument would see in the field. This means an enhancing of the oscilloscope's reliability.

All HAMEG instruments are under warranty for a period of one year, provided that no modifications have been made to the instrument. HAMEG will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. HAMEG is not liable for consequential damages. It is recommended that the instrument be repackaged in the original manner for maximum protection. We regret that transportation damage due to poor packaging is not covered by this warranty.

In case of any complaint, attach a tag to the instrument with a description of the fault observed. Please supply name and department, address and telephone number to ensure rapid service.

Operating Conditions

Admissible ambient temperature range during operation: +10°C... +40°C. Admissible ambient temperature range for storage or transportation: −40°C ... +70°C. If condensed water exists in the instrument it should not be turned on before acclimatization is achieved. In some cases (an extremely cold oscilloscope) about two hours should be allowed before putting the instrument into operation. The instrument should be placed in a clean and dry room and may not be put into operation in explosive, corrosive, dusty, or moist environments. The instrument is capable of operating in any position. But due to the convection cooling, the oscilloscope should be in the horizontal position or on its tilt stand for continuous operation.

The instrument must be disconnected and secured against unintentional operation if there is any presumption that safe operation is not possible. This supposition is qualified

— if the instrument has visible damage,
— if the instrument has loose parts,
— if the instrument does not function,
— after a long storage under unfavourable circumstances (e. g. out of doors or in moist

environments),
- after excessive transportation stress (e. g. in a poor packaging).

First Time Operation

On delivery, the instrument is set to AC 125V ±10% (50-60Hz) line voltage. The power plug-in unit at the rear contains the three-pin power connector. For this a three wire power cord with triple-contact connector and three-pole power plug is required. The unit also contains the power fuse, which is interchangeable for the different line voltages. The fuse holder with its square top plate can be pulled out, and ***changing of the line voltage*** is possible by turning this plate 90 degrees for each of the four voltages marked on the plate (see triangle above the fuse holder). The fuse holder should then be plugged in again in the desired position, which should be the ***closest value of the measured line voltage in your area***. The power fuse must correspond to the voltage selected and when necessary should be replaced. The type and rated current are given on the rear panel and in the Service Instructions.

***To obtain a display the following procedure should be adopted. All pushbuttons should be in the* out *position, with the exception of the* POWER *button. The variable control knobs with arrow should be in the fully counterclockwise position (arrows pointing horizontally to the left:* TIMEBASE *fine control to* C, LEVEL *control to* AT*). The marker lines on the grey knob caps should point vertically. These controls are then in the center of their setting range. The* TRIG. *selector switch should be set to its uppermost position* Int.**

The instrument is switched on by depressing the **POWER** pushbutton located above on the right of the CRT; an LED indicates that the instrument is on. If the trace is not visible, after a warm-up period of one minute, it is possible that the **INTENS.** control needs to be increased (rotate clockwise), or the sweep generator is not triggered. Also, the **POS.** controls might be incorrectly set. All knobs and switches should again be checked to ensure that the correct positions have been selected. Particular attention should be paid to the **LEVEL** control. In the absence of an input signal the baseline will only be displayed if this control is in the fully counterclockwise and locked **AT** position (Automatic Triggering). If only a dot appears (Caution! CRT phosphor could be damaged under this condition), probably the **Hor. ext.** pushbutton is depressed. If this is so, it should be released. Now, the baseline should appear and the **INTENS.** control should be adjusted for average brightness, while optimum sharpness is obtained by adjusting the **FOCUS** control. At the same time both input coupling switches **DC-AC-GD** should be in the **GD** position. Thus, the inputs to the Y-amplifiers are shorted preventing the introduction of unwanted signals. In the **GD** position, any signal applied to the vertical inputs is not shorted, therefore preventing damage to the circuit under investigation.

All measurements should be done utilizing proper techniques for minimizing effects due to parallax error.

Type of Signal

All types of signals whose frequency spectrum is below 20MHz can be displayed on the HM203. The display of simple electrical processes such as sinusoidal RF and AF signals or ripple voltage poses no problems. However, when square or pulse-shaped signals are displayed it must be remembered that their ***harmonic content*** must also be transmitted. In this case, the bandwidth on the vertical amplifier must be considerably higher than the repetition frequency of the signal. In view of this, accurate evaluation of such signals with the HM203 is only possible up to a maximum repetition rate of 2MHz. Operating problems can sometimes occur when composite signals are to be displayed, especially if they do not contain any suitable level components and repetition frequency which can be used for triggering. This occurs, for example, with burst signals. To obtain a stably triggered display in these cases, it may be necessary to use the timebase variable control. ***Television video signals are relatively easy to trigger***. However, when investigating signals at frame rate, the **TRIG.** selector slide switch has to be set in **TV** position (low-pass filter). In this mode, the more rapid line pulses are attenuated so that, with appropriate level adjustment, triggering can easily be carried out on the leading or trailing edge of the frame synchronizing pulse.

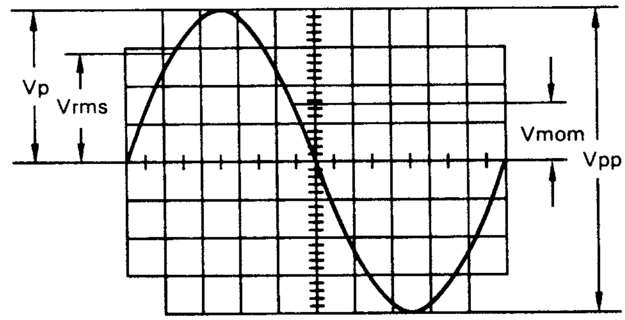
For optional operation as a DC or AC voltage amplifier, each channel is provided with a **DC-AC** coupling switch. The **DC** position should only be used with an attenuator probe or at very low frequencies or if the acquisition of the DC voltage content of the signal is absolutely necessary.

When investigating very low-frequency pulses, disturbing ramp-offs may occur with **AC** coupling. In this case, **DC** operation is to be preferred if the signal voltage is not superimposed on a high DC voltage level. Otherwise, a capacitor of adequate capacitance must be connected before the input of the vertical amplifier (with **DC** coupling). It should be remembered that this capacitor must have a sufficiently high breakdown voltage. **DC** operation is also recommended for the display of logic and pulse signals, particularly if their pulse duty factor changes permanently during operation. Otherwise, the display will move up and down with any change. DC voltages can only be measured in the **DC** position.

Amplitude Measurements

In general electrical engineering, alternating voltage data normally refers to effective values (rms = root-mean-square value). However, for signal magnitudes and voltage designations in oscilloscope measurements, the peak-to-peak voltage (Vpp) value is applied. The latter corresponds to the real potential difference between the most positive and most negative points of a signal waveform.

If a sinusoidal waveform, displayed on the oscilloscope screen, is to be converted into an effective (rms) value, the resulting peak-to-peak value must be divided by $2 \times \sqrt{2} = 2.83$. A sinusoidal voltage, given in Veff (Vrms), has 2.83 times the potential difference in Vpp. The relationship between the different voltage magnitudes can be seen from the following figure.



Voltage values of a sine curve
Vrms = effective value; Vp = simple peak or crest value; Vpp = peak-to-peak value; Vmom = momentary value.

The minimum signal voltage required at the vertical amplifier input for a display of 1 cm is approximately ***5mVpp***. This is achieved with the attenuator control set at **5mV/cm**. However, smaller signals than this may also be displayed. The ***deflection coefficients*** on the input attenuators, designated by **Y-AMPL.** are indicated in **mV/cm** or **V/cm** (peak-to-peak value). ***The magnitude of the applied voltage is ascertained by multiplying the selected deflection coefficient by the vertical display amplitude in cm.***

If an attenuator probe X10 is used, multiplication by a factor of 10 is required to ascertain the correct voltage value.

To determine the ***polarity*** of the voltage to be measured, set the input coupling switch to **GD** and vertically position the baseline to the center of the graticule. Set the input coupling switch to **DC**. If the waveform moves to above the center of the graticule, the voltage is positive. If the waveform moves to below the center, the voltage is negative.

Using the **Y-POS.** control in the **GD** position of the input couping switch, the baseline can be set to each horizontal graticule line as a convenient reference line with respect to ground potential. For example, if the voltage to be measured is positive, then position the baseline to the bottom graticule line. Switch the input coupling switch to **DC**. Measure the vertical distance in cm between the reference line and the desired point on the waveform. Multiply the measured cm's by the V/cm setting. Include the attenuation factor of the probe in use.

With direct connection to the vertical input, signals up to 160Vpp may be displayed. If the applied signal is superimposed on a DC (direct voltage) level the total value (DC + peak value of the alternating voltage) of the signal on the input must not exceed **±500V**. This same limit applies to normal attenuator probes X10, the attenuation ratio of which allows signal voltages up to approximately 1,000Vpp to be evaluated. Voltages of up to approximately 3,000Vpp may be measured by using the HZ37 high voltage probe which has an attenuation ratio of 100:1. It should be noted that its Vrms value is derated at higher frequencies (see page M6: Connection of Test Signal). If a normal X10 probe is used to measure high voltages there is the risk that the compensation trimmer bridging the attenuator series resistor will break down causing damage to the input of the oscilloscope. However, if for example only the residual ripple of a high voltage is to be displayed on the oscilloscope, a normal X10 probe is sufficient. In this case, an appropriate high voltage capacitor (approx. 22-68nF) must be connected in series with the input tip of the probe.

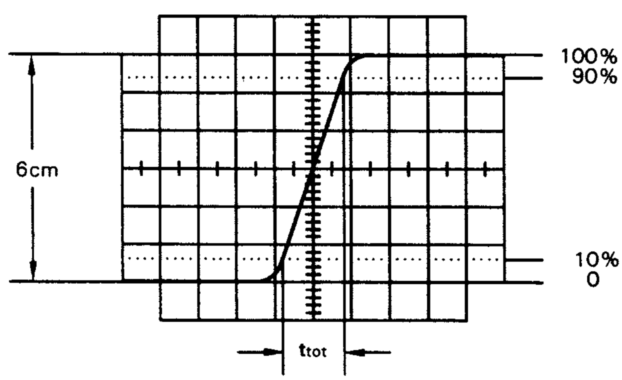
It is very important that the oscilloscope input coupling is set to **DC**, if an attenuator probe is used for voltages higher than 500V (see page M6: Connection of Test Signal).

Time Measurements

As a rule, all signals to be displayed are periodically repeating processes and can also be designated as periods. The number of periods per second is the recurring frequency or repetition rate. One or more signal periods or even part of a period may be shown as a function of the adjustment of the **TIMEBASE** switch. The time coefficients on the **TIMEBASE** switch are indicated in **ms/cm** and **µs/cm**. Accordingly, the dial is subdivided into two sectors. ***The duration of a signal period or a portion of the waveform is ascertained by multiplying the relevant time (horizontal distance in cm) by the time coefficient selected on the* TIMEBASE *switch. The time variable control (small knob on the* TIMEBASE *switch) must be in its calibrated detent (C) for accurate measurement*** (arrow horizontal and pointing to the left).

If the time is relatively short as compared with the complete signal period, an expanded time scale should be applied (**x5 Magn.** button depressed). In this case, the ascertained time values have to be divided by ***5***. When investigating pulse or square waveforms, the critical feature is the risetime of the voltage step. To ensure that transients, ramp-offs, and bandwidth limits do not unduly influence the measuring accuracy, the risetime is generally measured between ***10%*** and ***90%*** of the vertical pulse height. Both these values are marked on the CRT graticule by horizontal dotted lines along with the 0 and 100% values for signal peak-to-peak amplitudes of ***6cm*** height and are symmetrical about the horizontal center line. Adjust the **Y-AMPL.** and/or the test circuit controls together with the **Y-POS.** control so that the pulse is precisely aligned with the 0 and 100% graticule lines. The 10% and 90% points of the signal will now coincide with the dotted lines. ***The risetime is given by the product of the horizontal distance in cm between these two points and the time coefficient setting.*** If magnification is used, this product must be divided by 5. The fall time of a pulse can also be measured by using this method.

The following figure shows correct positioning of the oscilloscope trace for accurate risetime measurement.



When very fast risetimes are being measured, the risetime of the oscilloscope amplifier has to be deducted from the measured time value. The risetime of the signal can be calculated using the following formula.

$$t_r = \sqrt{t_{tot}^2 - t_{osc}^2}$$

In this t_{tot} is the total measured risetime, and t_{osc} is the risetime of the oscilloscope amplifier (approx. 17.5ns with HM203). If t_{tot} is greater than 100ns, then this can be taken as the risetime of the pulse, and calculation is unnecessary.

Connection of Test Signal

The signal to be displayed should be fed to the vertical input of the oscilloscope by means of a shielded test cable, e.g. the HZ32 or HZ34, or by a X10 or X100 attenuator probe. The use of these shielded cables with high impedance circuits is only recommended for relatively low frequencies (up to approx. 50kHz). For higher frequencies, and when the signal source is of low impedance, a cable of matched characteristic impedance (usually 50Ω) is recommended. When investigating square or pulse waveforms, a resistor equivalent to the characteristic impedance of the cable must also be connected to the cable at the input of the oscilloscope. When using a 50Ω cable, such as the HZ34, a 50Ω through termination type HZ22 is available from HAMEG. When investigating square or pulse waveforms with fast risetimes, transient phenomena on both the edge and top of the signal (e.g. ringing) may become visible if the correct termination is not used. The HZ22 50Ω through termination will only dissipate a maximum of 2 watts. This power consumption is reached with 10Vrms or with 28Vpp sine signal. If a X10 attenuator probe (e.g. HZ30) is used, no termination is necessary. In this case, the connecting cable is matched directly to the high impedance input of the oscilloscope. When using attenuator probes even high internal impedance sources are only slightly loaded (by approximately 10MΩ‖11pF). Therefore, when the voltage loss due to the attenuation of the probe can be compensated by a higher sensitivity setting on the HM203, the probe should always be used. The series impedance of the probe provides a certain amount of protection for the input of the oscilloscope amplifier. It should be noted that all attenuator probes must be compensated in conjunction with the oscilloscope (see: Probe Adjustment, page M7).

If a X10 or X100 attenuator probe is used, the* DC *input coupling must always be set. With **AC** coupling, the attenuation is frequency-dependent, the pulses displayed can exhibit ramp-off, DC-voltage contents are suppressed — but loads the respective input coupling capacitor of the oscilloscope. The dielectric strength of which is maximum 500V (DC + peak AC). For the suppression of unwanted DC voltages, a ***capacitor*** of adequate capacitance and dielectric strength ***may be connected before the input tip of the probe*** (e. g. for ripple measurements).

With the HZ37 X100 probe the permissible AC input voltage is frequency-dependent limited:
below 20kHz (TV line frequency!) up to

max. 1.500Vp ≙ 3.000Vpp ≙ 1.061Vrms;

above 20kHz (with f in MHz) up to

$$\text{max. } \frac{212}{\sqrt{f}}\text{Vp} \triangleq \frac{424}{\sqrt{f}}\text{Vpp} \triangleq \frac{150}{\sqrt{f}}\text{Vrms.}$$

When low voltage signals are being investigated the position of the ground point on the test circuit can be critical. This ground point should always be located as close as possible to the measuring point. If this is not done, serious signal deformation may result from any spurious currents through the ground leads or test chassis parts. This comment also applies to the ground leads on attenuator probes which ideally should be as short and as thick as possible.

Hum or interference voltage appearing in the measuring circuit (especially with a small deflection coefficient) is possibly caused by multiple grounding, because through it equalizing currents can flow in the shielding of the measuring cables (voltage drops between the non-fused grounded conductors of other line powered devices, which are connected to the oscilloscope or test object, e. g. signal generators).

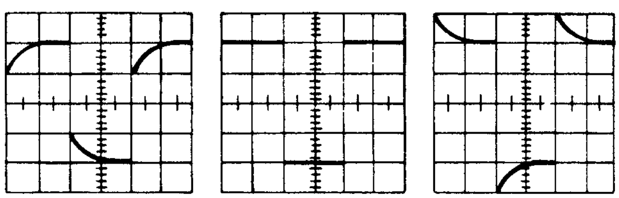
Caution: When connecting unknown signals to the oscilloscope input, always set the **DC-AC** input coupling switch to **AC** and the **Y-AMPL.** switch should initially be set to **20V/cm**.

Sometimes the trace will disappear after an input signal has been applied. Then the **Y-AMPL.** switch must be turned back to the left, until the vertical signal height is only 3-7cm. With a signal amplitude greater than 160Vpp, an attenuator probe must be inserted before the oscilloscope's vertical input. If after applying the signal, the trace is blanked, the period of the signal is probably substantially longer than the set value on the **TIMEBASE** switch. It should be turned to the left on an adequately greater time coefficient.

Probe Adjustment

To achieve the undistorted display of signals when using an X10 or X100 attenuator probe, the probe must be compensated to match the input impedance of the vertical amplifier. This can be easily achieved as the HM203 has a built-in square-wave generator with a repetition frequency of approx. 1 kHz and an ***output voltage of 0.2 Vpp ±1%***.

The method employed is as follows. The probe tip with its sprung hook is connected to the output eyelet designated by a square-wave on the front panel of the instrument. The probe trimmer is then adjusted by using the trimming tool supplied. The correct display is shown in the following figure.



incorrect   correct   incorrect

The **TIMEBASE** switch should be in the **0.2 ms/cm** position. The input coupling is set to **DC**. If the attenuator sensitivity is set to **5 mV/cm**, the display will have a height of ***4cm*** when an X10 probe is being compensated. Check the waveform presentation for overshoot or rolloff, and if necessary, readjust probe compensation for flat tops on the waveform. As an attenuator probe is constantly subjected to considerable stresses the compensation should be frequently checked.

The calibrator signal is intended only for probe compensation and amplitude calibration. It should not be used to verify timebase calibration. Due to the fast rise and fall time the leading and trailing edge will be difficult to view. This is not a flaw, but actually the precondition for a simple and exact probe compensation (or a deflection coefficient check) like horizontal pulse tops, calibrated pulse amplitude, and zero potential on the negative pulse top.

Operating Modes

The required operating modes are selected on three pushbuttons located in the lower Y-section. For ***Mono*** operation with ***Channel I***, all pushbuttons should be in the ***out*** position. For ***Mono*** operation with ***Channel II***, the central pushbutton marked with **II** (under the button) has to be pressed. Generally the **Trig. I/II** pushbutton, located directly beside it, should be pressed also. The internal trigger signal is then derived from Channel II. When the **Mono/Dual** button is pressed, the HM203 is in ***Dual Channel Operation***. The method of channel switching is dependent upon the position of the **Alt/Chop** pushbutton. If it is in out position, the channels are displayed consecutively (***alternate mode***). This mode should be preferred for signals higher than 1 kHz repetition frequency. However, this mode is not suitable for the display of low frequency signals, as the trace will appear to flicker or jump. This can be overcome by pressing the **Alt/Chop** button; both channels then share the trace during each sweep period (***chopped mode***). Therefore the display of low frequency signals is free of flicker. For displays with a higher repetition rate, the type of channel switching is less important, but the alternate mode would normally be recommended.

For ***X-Y operation*** the pushbutton marked **Hor. ext.** in the upper X-section must be pressed. The X signal is then derived from ***Channel I. The calibration of the X signal during X-Y operation is determined by the setting of the Channel I input attenuator.*** This means that the sensitivity range and input impedance are identical for both the X and Y axes. However, the **Y-POS. I** control is disconnected in this mode. Its function is taken over by the **X-POS.** control. The **x5 Magn.** pushbutton, normally used for expanding the sweep, should not be operated in the X-Y mode. The bandwidth of the X amplifier is approximately 2 MHz (-3dB), and therefore an increase in phase difference between both axes is noticeable from 50kHz upwards.

Trigger and Timebase

In order to obtain a satisfactory stable display, the timebase must be triggered synchronously with the test signal. The trigger signal can be derived from the test signal itself, when internal triggering is selected, or from a frequency related signal applied to the external trigger input. If the **LEVEL** control is in position **AT** (***Automatic Triggering***), the sweep generator will be triggered automatically. The baseline (time axis) is then visible with or without applying a signal voltage. In this position, virtually all uncomplicated, periodically recurring signals above 30Hz repetition frequency will be displayed in a stably locked condition. Adjusting a convenient time setting is then sufficient for operation of the timebase. This is valid for internal and external triggering.

With **LEVEL** adjustment (***Normal Triggering***), triggering of the sweep is possible at any point of a signal edge, also with very complex signal shapes. With internal Normal Triggering, the trigger range, which is determined by the **LEVEL** control, is directly dependent on the display height. If it is smaller than 1cm, the **LEVEL** adjustment needs to be operated with a sensitive touch. With external Normal Triggering, the same is valid relating to the external trigger voltage amplitude.

Triggering can be selected on either the leading or trailing edge of the trigger signal depending on whether the **Slope** +/— pushbutton is in the out or pressed position. In the out position, triggering from the positive-going edge is selected.

With ***internal triggering*** in the ***Mono channel mode*** of the Y amplifier, the trigger signal must be derived from the respective channel in use. For this the **Trig. I/II** pushbutton in the Y-section has to be released or pressed. In the ***Dual channel mode***, the internal trigger signal may be selected from either ***Channel I*** or ***Channel II*** using the **Trig. I/II** button; in out position, the trigger signal is derived from Channel I. However, it is preferable to trigger from the less complicated signal.

For ***external triggering*** the **TRIG.** selector switch in the X-section must be set to **Ext.** The sync. signal (0.7-7Vpp) must then be fed to the **EXT. TRIG.** input socket. However, an alternative method may be used for external triggering: on Mono channel operation with Channel I, "external" triggering is possible via the input of the unemployed Channel II (**Trig. I/II** button pressed; **TRIG.** selector switch to **Int.** or **TV**). This method is particularly advisable, if the amplitude of the trigger signal does not lie between 0.7-7Vpp, or if it is of unknown value. In this case, the trigger amplitude can be adjusted by means of the **Y-AMPL. II** attenuator switch in a range from 5mVpp up to approximately 150Vpp, matching the trigger input requirements in an optimum manner. First the external trigger signal is displayed and adjusted to a height of 2-6cm. For this, the **II** button (also marked **Alt/Chop**) has to be pressed. Afterwards, the **II** button must be released to Channel I display. The **TRIG.** selector switch remains in the **Int.** or **TV** position and the **Trig. I/II** button in the pressed position. This "external" trigger mode has an additional advantage: this method allows the use of a X10 or X100 frequency-compensated attenuator probe and the **TV** low-pass filter coupling for the sync. signal. This means that not only a high input impedance is achieved, but also the possibility for external TV signal triggering on frame frequency is obtained (also with high trigger voltage level). These advantages are not available on external triggering via the **EXT. TRIG.** input socket. This method can apply on operation with a mutual exchange of Channel I for Channel II. However, it can only be used in the Mono channel display mode.

The trigger signal is always AC coupled, whether selected internally or externally. When in external trigger mode, utilizing the **LEVEL** adjustment triggering down to 5Hz can be obtained.

If the ***video signal*** of a television is to be displayed ***at frame frequency***, synchronization is generally difficult due to the presence of the higher line frequency pulses contained in the signal. The line pulses can be attenuated by switching the **TRIG.** selector switch to **TV**. In this position, a low-pass filter is switched into the trigger circuit. The trigger **LEVEL** control can be adjusted to trigger from either the positive or negative edge of the frame pulse. This setting is also advantageous when triggering from other signals that have a recurrence frequency of 800Hz or less, as high frequency harmonics or noise in the signal are suppressed by the presence of the low-pass filter. However, ***TV triggering at line frequency*** needs **Int.** or **Ext.** setting of the **TRIG.** selector slide switch. In both cases, ***Normal Triggering*** with **LEVEL** adjustment should be used.

As already mentioned, simple signals may be triggered automatically in the automatic trigger mode (**LEVEL** control in **AT** position). The repetition rate may also vary in such cases. However, if the pulse duty factor on square-wave or pulse signals changes drastically or deforms to a needle pulse, then the ***Normal Triggering*** mode with **LEVEL** adjustment may well become necessary. With composite signals, the trigger facility is dependent on the occurence of certain periodically recurring levels. The **LEVEL** adjustment of these signals will require some care.

If a trigger point cannot be located on complex signals even after repeated and careful adjustment of the **LEVEL** control in the ***Normal Triggering*** mode, it may be possible to obtain one by adjusting the ***variable time fine control*** on the **TIMEBASE** switch. On occasions it may be advantageous to set the **LEVEL** control in the **AT** position and to use only the time variable control. Especially with burst signals and pulse trains (with constant amplitude), the start of the sweep can then be adjusted with optimum timing.

For ***triggering with line frequency*** (50-60Hz), the **TRIG.** selector switch must be set in the **Line** position. This trigger mode is recommended for all input signals, which are time-related (multiple or submultiple) to the power-line frequency or when it is desirable to provide a stable display of a line-frequency component in a complex waveform. The triggering is then independent of the signal amplitude or display height and allows a display under the trigger threshold.

The time coefficient settings on the **TIMEBASE** switch are calibrated when the variable time fine control (small knob on the **TIMEBASE** switch) is set in the **C** position. When this control is set fully clockwise, then the sweep speed is increased by a factor of at least 2.5. This factor is not precisely calibrated. When the X5 expansion of the sweep (**x5 Magn.** button pressed) is also operated in conjunction with the time fine control, a maximum sweep speed of approximately 40ns/cm is obtained (**TIMEBASE** to **0.5µs/cm**). The choice of the optimum time coefficient depends on the repetition rate of the signal being measured. The number of cycles displayed will increase with the time coefficient (by turning the **TIMEBASE** switch counterclockwise).

Miscellaneous

The ***ramp output*** of the sweep generator provides a positive-going sawtooth voltage of approximately 5Vpp coincident with the display's sweep time and can be derived from two banana jacks (one for ground) mounted on the rear panel of the HM203. At a later stage, a BNC-socket is to be built into the rear panel in place of these jacks. The load resistance should not be less than 10kΩ. If the DC potential of the ramp output is not required, a capacitor should be connected in series with the output. The ramp output can be used for different measuring tasks in combination with the HM203 and other instruments, e. g. 4-Channel-Amplifier HZ64, triggering of signal sources, swept-frequency signal generators, and so forth.

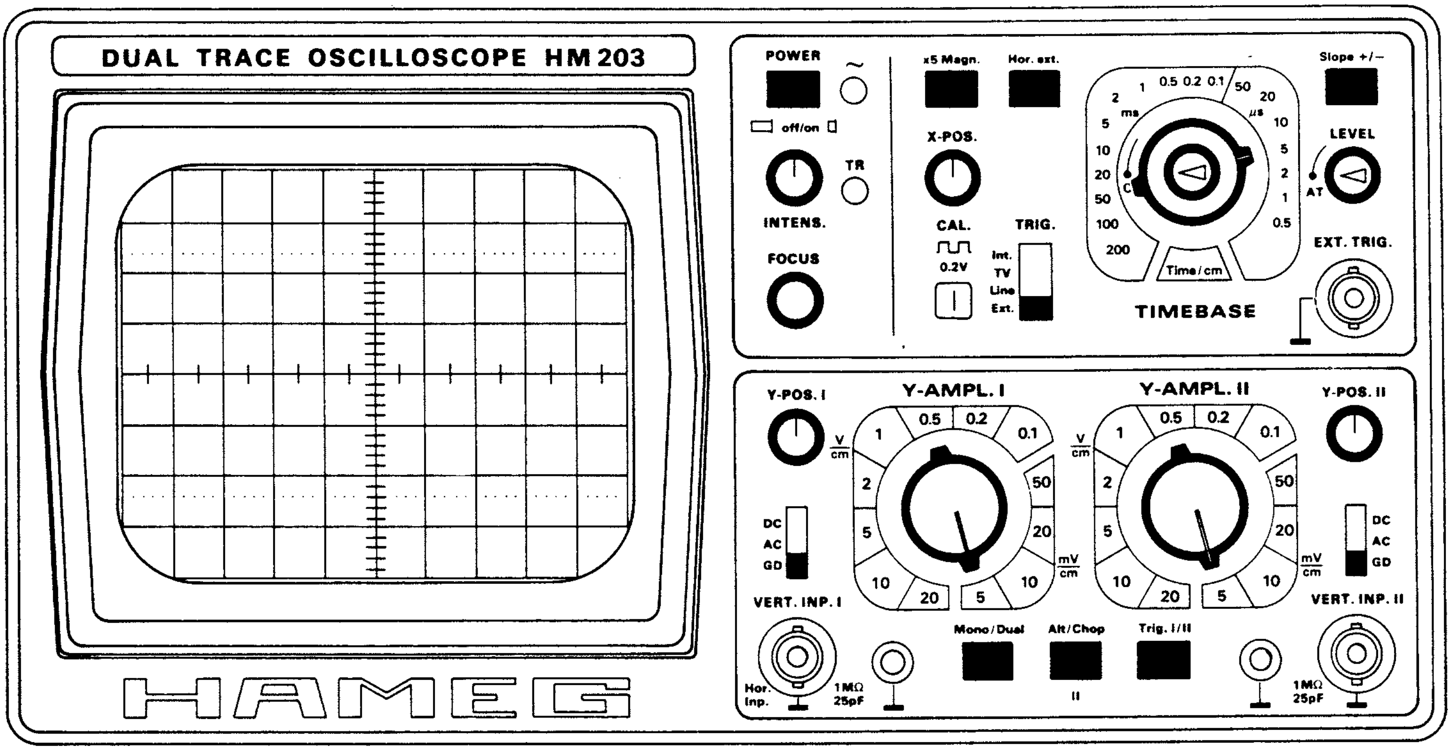
Maintenance

Within the context of maintenance, it is recommended that the important characteristics of the HM203 be periodically checked. The following Test Instructions indicate only those tests, which can be performed without the use of expensive ancillary instruments. For more exacting tests the HAMEG Oscilloscope Calibrator HZ62 is recommended. The HZ62 may be used to calibrate oscilloscopes manufactured by other companies.

Standard Accessories included

Each HAMEG oscilloscope HM203 is supplied with an Instruction Manual and 2 Switchable Probes X10/X1. A wide range of accessories, which include test cables and probes, are also available and should be ordered according to the particular application (see HAMEG Accessory Prospectus and HAMEG Pricelist).

FRONT VIEW



DUAL TRACE OSCILLOSCOPE HM 203
POWER
off/on
INTENS.
TR
FOCUS
x5 Magn.
Hor. ext.
X-POS.
CAL.
0.2V
TRIG.
Int.
TV
Line
Ext.
TIMEBASE
Time/cm
Slope +/−
LEVEL
AT
EXT. TRIG.
Y-POS. I
Y-AMPL. I
Y-AMPL. II
Y-POS. II
DC
AC
GD
VERT. INP. I
VERT. INP. II
Hor. Inp.
1MΩ 25pF
Mono/Dual
Alt/Chop
Trig. I/II
HAMEG

SHORT INSTRUCTION FOR HM 203

First Time Operation

Connect the instrument to power outlet. Switch on **POWER** pushbutton.
LED indicates operating condition. Case, chassis, and all measuring terminals are connected to the Safety Earth conductor (Safety Classification I).
No other pushbutton is pressed; **LEVEL** control is set to **AT** (Automatic Triggering).
Adjust **INTENS.** control for average brightness.
Center trace on CRT using **X-POS.** and **Y-POS. I** controls.
Then focus trace using **FOCUS** control.

Operating Modes of Vertical System

Channel I : All pushbuttons in out position.
Channel II: **II** (= **Alt/Chop**) button pressed.
Channel I ***and*** Channel II: **Mono/Dual** button pressed.
Alternate channel switching: **Alt/Chop** button in out position.
Chopped channel switching: **Alt/Chop** button pressed.
Signals <1 kHz recurrence frequency with **Chop**.

Trigger Modes

Automatic Triggering: **LEVEL** control in **AT** position. Trace always visible.
Normal Triggering: Select amplitude point on trigger signal using **LEVEL** control.
In absence of an adequate trigger signal, there is no trace.
Internal triggering from Channel I: **Trig. I/II** button in out position.
Internal triggering from Channel II: **Trig. I/II** button pressed.
These both int. trig. modes are valid also for Dual channel operation.
Triggering from positive-going signal edge: **Slope +/−** button in out position.
Triggering from negative-going signal edge: **Slope +/−** button pressed.
This is important when only a portion of a cycle is being displayed.
Positions of the **TRIG.** selector switch (always AC coupling):
Int. : internal triggering.
TV : internal triggering with low-pass filter trigger coupling.
Line : line/mains frequency triggering (signal must be time-related to power freq.).
Ext. : external triggering from **EXT. TRIG.** connector in the 0.7-7Vpp range.
External trigger signal must be time-related to the displayed signal.
Video signal mixtures with line freq. triggering: **TRIG.** selector to **Int.** or **Ext.**
Video signal mixtures with frame freq. triggering: **TRIG.** selector to **TV** (only internal).
For external triggering use an unemployed channel input.

Measuring

Connect test signal to **VERT INP.** connector Channel I and/or Channel II.
Compensate attenuator probe with built-in square-wave generator.
Select **AC** or **DC** input coupling.
Position **GD**: vertical amplifier is disconnected from input connector and grounded.
Adjust required display height of signal with **Y-AMPL.** attenuator switch.
Select sweep speed with **TIMEBASE** switch and time fine control.
Calibrated time measurement with time fine control fully counterclockwise (**C**).
Increased sweep rate with **x5 Magn.** button pressed.
Ext. horizontal deflection (X-Y operation) with **Hor. ext.** button pressed.
X-signal input via **VERT. INP. I** connector. Adjust X-position with **X-POS.** control.

General

These Test Instructions are intended as an aid for checking the most important characteristics of the HM203 at regular intervals without the need for expensive test equipment. For more exacting tests the HAMEG Oscilloscope Calibrator HZ62 is recommended. The HZ62 may be used to check and calibrate oscilloscopes manufactured by other companies. It is also suitable for checking large numbers of oscilloscopes on a regular routine basis. Resulting corrections and readjustments inside the instrument, detected by the following tests, are described in the Service Instructions. They should only be undertaken by qualified personnel.

As with the First Time Operation instructions, care should be taken that all knobs with arrows are set to the calibrated positions (**LEVEL** control to **AT**). None of the pushbuttons should be pressed. It is recommended to switch on the instrument for about 15 minutes prior to the commencement of any check.

Cathode-Ray Tube: Brightness and Focus, Linearity, Raster Distortions

Normally, the CRT of the HM203 has very good brightness. Any reduction of this brightness can only be judged visually. However, decreased brightness may be the result of reduced high voltage. This is easily recognized by the greatly increased sensitivity of the vertical amplifier. The control range for maximum and minimum brightness (intensity) must be such that the beam just disappears before reaching the left hand stop of the **INTENS.** control, while with the control at the right hand stop the focus is just acceptable. The timebase fly-back must on no account be visible. It should be noted that with wide variations in brightness, refocusing is always necessary. Moreover, with maximum brightness, no "pumping" of the display must occur. If pumping does occur, it is normally due to a fault in the regulation circuitry for the high voltage supply. The presetting pots for the high voltage circuit, minimum and maximum intensity, are only accessible inside the instrument (see Adjusting Plan and Service Instructions).

A certain out-of-focus condition in the edge zone of the screen must be accepted. It is limited by standards of the CRT manufacturer. The same is valid for the non-linearity and raster distortion in the edge zone of the CRT in accordance with international standards (see CRT data book). These limit values are strictly supervised by HAMEG. The selection of a cathode-ray tube without any tolerances is practically impossible (too many parameters).

Astigmatism Check

Check whether the horizontal and vertical sharpness of the display are equal. This is best seen by displaying a square-wave signal with the repetition rate of approximately 1MHz. Focus the horizontal tops of the square-wave signal at normal intensity, then check the sharpness of the vertical edges. If it is possible to improve this vertical sharpness by turning the **Focus** control, then an adjustment of the astigmatism control is necessary. An alternative method is to check the shape of the spot with both vertical inputs switched to the **GD** position (and the **Hor. ext.** pushbutton depressed); the **FOCUS** control is then repeatedly varied around the optimum focusing point. The shape of the spot, whether round or oval or rectangular, must stay the same to the right and left of the optimum focusing point. A potentiometer of 50kΩ (see Adjusting Plan) is provided inside the instrument for the correction of astigmatism (see Service Instructions). A certain loss of marginal sharpness of the CRT is unavoidable; this is due to the manufacturing process of the CRT.

Symmetry and Drift of the Vertical Amplifier

A check of the vertical amplifier symmetry is possible by testing the control range of the **Y-POS.** controls. A sine-wave signal of 10-100kHz is applied to the amplifier input. When the **Y-POS.** control is then turned fully in both directions from stop to stop with a display height of approximately 8cm, the upper and lower portions of the trace that are visible should be approximately of the same height. Differences of up to 1cm are permissible (input coupling should be set to **AC**). Checking the drift is relatively simple. **Ten**

minutes after switching on the instrument, set the trace exactly on the horizontal center line of the graticule. The beam position must not change by more than ***5mm*** during the following hour. Larger deviations generally result from different characteristics of the two FET's in the input to the Y amplifier. To some extent, fluctuations in drift are caused by offset current on the gate. The drift is too high, if the vertical trace position drifts by more than ***0.5mm*** on turning the appropriate **Y-AMPL.** switch through all 12 steps. Sometimes such effects occur after long periods of operation. For further details see Service Instructions.

Calibration of the Vertical Amplifier

A square-wave voltage of ***200mVpp*** is present at the output eyelet marked with a square-wave. This has a tolerance of ±***1%***. If a direct connection is made between this eyelet and the input of the vertical amplifier, the displayed signal in the **50mV/cm** position should be ***4cm*** high (**DC** input coupling). Maximum deviations of 1.2mm (3%) are permissible. If a ***X10 probe*** is connected between the output eyelet and Y input, the same display height should result in the **5mV/cm** position. With higher tolerances it should first be investigated whether the cause lies within the amplifier or in the amplitude of the square-wave signal. On occasions it is possible that the probe is faulty or incorrectly compensated. If necessary, the measuring amplifier can be calibrated with an accurately known DC voltage (**DC** input coupling). The trace position should then vary in accordance with the deflection coefficient set. Adjustment of the vertical amplification or the calibrator voltage is only possible from within the instrument (see Adjusting Plan and Service Instructions). According to experience, this is rarely necessary.

Transmission Performance of the Vertical Amplifier

The transient response and the phase compensation can only be checked with the aid of a square-wave generator with a fast risetime (***max. 5ns***). The signal coaxial cable (e. g. HZ34) must be terminated at the vertical input of the oscilloscope with a resistor equal to the characteristic impedance of the cable (e. g. with HZ22). Checks should be made at 50Hz, 500Hz, 5kHz, 50kHz and 500kHz, the deflection coefficient should be set at **5mV/cm** with **DC** input coupling. In so doing, the square pulses must have a flat top without ramp-off, spikes and glitches; no overshoot is permitted, especially at 500kHz and a display height of ***4-5cm***. At the same time, the top corner of the pulse must not be rounded. In general, no great changes occur after the instrument has left the factory, and it is left to the operator's descretion whether this test is undertaken or not.

Certainly the quality of the transmission performance is not only dependent on the measuring amplifier. ***The input attenuators***, located in the front of the amplifier, ***are frequency-compensated in each position***. Even small capacitive changes can reduce the transmission performance. Faults of this kind are as a rule most easily detected with a square-wave signal with a low repetition rate (e. g. 1kHz). If a suitable generator with max. output of 40Vpp is available, it is advisable to check at regular intervals the deflection coefficients on all positions of the input attenuators and readjust them as necessary. A compensated ***2:1 series attenuator*** is also necessary, and this must be matched to the input impedance of the oscilloscope. This attenuator can be made up locally or ordered from HAMEG under the type designation HZ23. It is important that this attenuator is screened. For local manufacture, the electrical components required are a 1MΩ ±1% resistor and, in parallel with it, a trimmer 3-15pF in parallel with approx. 20pF. One side of this parallel circuit is connected directly to the input connector of the vertical amplifier and the other side is connected to the generator, if possible via a low-capacitance coaxial cable. The series attenuator must be matched to the input impedance of the oscilloscope in the **5mV/cm** position (**DC** input coupling; square tops exactly horizontal; no ramp-off is permitted). This is achieved by adjusting the trimmer located in the 2:1 attenuator. ***The shape of the square-wave should then be the same in each input attenuator position.***

Operating Modes: Mono/Dual, Alt/Chop, X-Y Operation

On depressing the **Mono/Dual** pushbutton, two traces must appear immediately. On actuation of the **Y-POS.** control, the trace positions should have no affect on each other. Nevertheless, this cannot be entirely avoided, even in fully serviceable instruments. When one trace is shifted vertically across the entire screen, the position of the other trace must not vary by more than 0.5mm. A criterion in chopped operation is trace widening and shadowing around and within the two traces in the upper or lower region of the screen. Set **TIMEBASE** switch to **20µs/cm**, press the **Mono/Dual** and **Alt/Chop** pushbuttons, set input coupling of both channels to **GD** and advance the **INTENS.** control fully clockwise. Adjust **FOCUS** for a sharp display. With the **Y-POS.** controls shift one of the traces to a +2cm, the other to a −2cm vertical position from the horizontal center line of the graticule. Do not try to synchronize the chop frequency (120kHz) by means of the time variable control! Then alternately release and press the **Alt/Chop** pushbutton. Check for a negligible trace widening and periodic shadowing in the chopped mode.

In X-Y Operation (**Hor. ext.** pushbutton depressed), the sensitivity in both deflection directions will be the same. When the signal from the built-in square-wave generator is applied to the input of Channel I, then, as with Channel II in the vertical direction, there must be a horizontal deflection of ***4cm*** when the deflection coefficient is set to **50mV/cm** position (**x5 Magn.** button in out position).

The check of the Mono channel display with the **II** (or **Alt/Chop**) button is unnecessary; it is contained indirectly in the tests above stated.

Triggering Checks

The internal triggering threshold is important as it determines the display height from which a signal will be stably displayed. It should be approx. 3-5mm (frequency-dependent) for the HM203. An increased trigger sensitivity creates the risk of response to the noise level in the trigger circuit. This can produce double-triggering with two out-of-phase traces. Alteration of the trigger threshold is only possible internally. Checks can be made with any sine-wave voltage between 50Hz and 1MHz in both trigger modes: Automatic (**AT**) and Normal Triggering. In the Normal mode, a **LEVEL** adjustment is necessary. The checks should show the same trigger sensitivity with the same frequency. On depressing the **Slope +/−** button, the trigger polarity changes from the positive-going to the negative-going edge of the trigger signal. The HM203 should trigger internally on sinusoidal signals up to 30MHz perfectly at a display height of approx. 5mm.
For external triggering (**TRIG.** selector switch to **Ext.**), the **EXT. TRIG.** input connector requires a signal voltage of at least 0.2-1Vpp, which is in synchronism with the Y input signal. The voltage value is somewhat dependent on the trigger frequency.

Checking of the ***internal*** TV triggering is possible with a video signal of any given polarity. In the **TV** position only, reliable triggering on ***frame*** frequency is possible. However, triggering on ***line*** (horizontal-scanning) frequency requires **Int.** (possibly **Ext.**) trigger coupling. If no video signal is available, the function of the **TV** position (low-pass filter) can be checked using line/mains frequency or the built-in calibrator signal. With a line/mains frequency signal (50-60Hz), switching from **Int.** to **TV** trigger coupling should have no effect. In contrast, the minimum signal voltage required for reliable triggering should be at least double, when the 1kHz calibration signal is applied.

If both vertical inputs are **AC** coupled to the same signal and both traces are brought to coincide exactly on the screen, when working in the ***alternate Dual-channel mode***, then no change in display should be noticeable, when the **Trig. I/II** button is alternately released or pressed.

Timebase

Before checking the timebase it should be ascertained that the ***trace length is exactly 10cm***. If not, it can be corrected with the potentiometer for sweep amplitude (see Adjusting Plan). This adjustment should be made with the **TIMEBASE** switch in a middle position (i.e. **50µs/cm**). Prior to the commencement of any check set the time variable control to **C** and the **x5 Magn.** button in out position (if not otherwise stated).

Check that the ***sweep runs from the left to the right side of the screen*** (**TIMEBASE** switch to **200ms/cm**; **X-POS.** control in mid-range).

If a precise marker signal is not available for checking the **Timebase** time coefficients, then an accurate sine-wave generator may be used. Its frequency tolerance should not be greater than ±1%. The timebase accuracy of the HM203 is given as ±3%, but as a rule it is considerably better than this. For the simultaneous checking of timebase linearity and accuracy at least 10 oscillations, i. e. ***1 cycle every cm***, should always be displayed. For precise determination, set the peak of the first marker or cycle peak exactly behind the first vertical graticule line using the **X-POS.** control. Deviation tendencies can be noted after some of the marker or cycle peaks.

The following table shows which frequencies are required for the particular ranges.

200ms/cm —	5Hz	0.2ms/cm —	5kHz
100ms/cm —	10Hz	0.1ms/cm —	10kHz
50ms/cm —	20Hz	50µs/cm —	20kHz
20ms/cm —	50Hz	20µs/cm —	50kHz
10ms/cm —	100Hz	10µs/cm —	100kHz
5ms/cm —	200Hz	5µs/cm —	200kHz
2ms/cm —	500Hz	2µs/cm —	500kHz
1ms/cm —	1kHz	1µs/cm —	1MHz
0.5ms/cm —	2kHz	0.5µs/cm —	2MHz

The 20 and 10ms/cm ranges can be checked very precisely with line frequency (***50Hz*** only). On the 20ms/cm range a cycle will be displayed every cm, while on the 10ms/cm range it will be every 2cm.

The time variable control range can also be checked. The sweep speed becomes faster by turning this variable control clockwise to its right stop. One cycle at least every 2.5cm should be displayed (with **x5 Magn.** button in out position; measurement in the **50µs/cm** range).

When the **x5 Magn.** button is pushed, a marker or cycle peak will be displayed every 5cm (with time variable control in **C** position; measurement in the **50µs/cm** range).

The use of an Oscilloscope Calibrator (HAMEG Type HZ62) is recommended, if the timebase is to be checked on a number of oscilloscopes on a regular routine basis. This instrument employs a quartz marker, providing peak pulses at 1cm intervals for each time range. To trigger such pulses the **LEVEL** control must be used (Normal Triggering).

Check the ramp output voltage on rear panel with a control oscilloscope. It should show a positive-going linear saw-tooth with an amplitude of ***approx. 5V***.

Trace Alignment

The angular deviation between the X deflection plane D1-D2 and the horizontal center line of the graticule, due to the influence of the earth's magnetic field, is dependent on the instrument's North orientation. This deviation can be corrected by means of the **TR** potentiometer. In general, the trace rotation range is somewhat asymmetric. It should be checked, whether the baseline can be adjusted somewhat sloping ***to both sides*** round about the center line of the graticule. With the HM203 in its closed case, an angle of rotation ±0.57° (1mm difference in elevation per 10cm graticule length) is sufficient for the compensation of the earth's magnetic field.

Greater deviations, e. g. due to excessive transportion shocks, can be corrected by rotating the CRT (see Service Instructions: "Correction of the Trace Alignment", page S2).

Miscellaneous

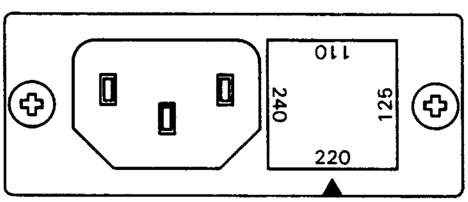
If a variable line transformer is available, the characteristics of the HM203 on power voltage fluctuations of ±10% should be checked. Under these conditions no variations should be detected on the display in either the vertical or horizontal axis.

General

The following instructions are intended as an aid for the electronic technician, who is carrying out re-adjustments on the HM203, if the nominal values do not meet the specifications. These instructions primarily refer to those faults, which were found after using the Test Instructions. However, this work should only be carried out by properly qualified personnel. For any further technical information call or write to HAMEG. Addresses are provided at the back of the manual. It is recommended to use only the original packing material, should the instrument be shipped to HAMEG for service or repair (see also Warranty, page M2).

Line Voltage Change

The instrument has a power plug-in unit at the rear. This unit contains the power fuse, which is interchangeable for the different line voltages. The fuse holder with its square top plate can be pulled out by means of a small screwdriver (after disconnection of the power cord from the plug-in unit), and changing of the power voltage is possible by turning this plate 90 degrees for each of the four power voltages marked on the plate (see triangle above the fuse holder). The fuse holder should then be plugged in again in the position closest to the measured line voltage in your area.



Required power fuse-link:
5x20mm, time lag (slow-blow), **250V~, C,** to IEC 127/III; DIN 41662.

Line voltage	Rated current
110V~ ±10%	**T 0.5A**
125V~ ±10%	**T 0.5A**
220V~ ±10%	**T 0.25A**
240V~ ±10%	**T 0.25A**

The power fuse has to match the set line voltage and must be changed if necessary. Only fuses of the specified type and current are to be used. The use of patched fuses or short circuit of the fuse holder or incorrect rating is inadmissible and will void the warranty.

Instrument Case Removal

The rear cover can be taken off after two cross recessed pan head (Phillips type) screws (M4x30mm) with two washers on it have been removed and after unpluging of the power cord's triple-contact connector. While the instrument case is firmly held, the entire chassis with its front panel can be withdrawn forward. When the chassis is inserted into the case later on, the case has to fit under the flange of the front panel. The same applies for the rear of the case, on which the rear cover is put.

Caution
During opening or closing of the case, the instrument must be disconnected from all power sources for maintenance work or a change of parts or components. If a measurement, troubleshooting, or an adjustment on the opened instrument is unavoidable, this work must be done by a specialist, who is familiar with the risk involved.

When the instrument is set into operation after the case has been removed, attention must be paid to the accelerating voltage for the CRT, which is 2000V. These high voltage potentials are on the CRT socket as well as on both the upper and the lower horizontal PCB's. They are highly dangerous and therefore precautions must be taken. Shorts occuring on different points of the CRT high voltage and unblanking circuitry will definitely damage some semiconductors and the optocoupler. For the same reason it is very risky to connect capacitors to these points while the instrument is on.

Capacitors in the instrument may still be charged, even when the instrument is disconnected from all voltage sources. Normally, the capacitors are discharged 6 seconds after switching off. However, with a defective instrument, an interruption of the load is not impossible. Therefore, after

switching off, it is recommended to connect one after the other all 10 terminals of the check strip, located next to the neck of the CRT on the upper X-PCB, across 1 kΩ to ground (chassis) for a period of 1 second.

Handling of the CRT needs utmost caution. It is not allowed — under no circumstances — to come into contact with the glass bulb by hardened tools. The local superheating (e. g. by soldering iron) or local undercooling (e. g. by cryogenic-spray) of the glass bulb is also not permitted. We recommend the wearing of safety goggles (implosion danger).

Correction of the Trace Alignment

If it is found that the trace on the screen is not exactly parallel with the horizontal center line of the graticule, the cause of this may be mainly due to the influence of the earth's magnetic field. Such small misalignments depending on the oscilloscope's position in the workroom can be easily corrected by the adjustment of the variable resistor for trace rotation. This is performed by a screwdriver which should be inserted into the opening of the front panel marked **TR** (Trace Rotation). Greater misalignments can only be corrected by rotation of the CRT when the instrument is open and the **TR**-pot is set in midrange. The clamp on the shielding around the CRT neck has to be loosened. Because the area around the screen's rim is relatively small, a tenacious adhesive tape will be a good help for tube rotation. The middle of the tape should be pressed onto the top of the exposed CRT area which is accessible between the graticule plate and the front cover. Now, either the left or the right end of the adhesive tape can be drawn effecting the CRT rotation in both directions. After this alignment is performed, both screws on the clamp must be tightened, otherwise the CRT might be misaligned again. Check the trace alignment range of the **TR** control before closing the case (see: "Trace Alignment" on page T4).

Operating Voltages

Besides the two AC voltages for the CRT heating and line triggering there are seven electronically regulated DC operating voltages generated (+24V, +5V, −12V, +140V, +260V, −1900V, and 33V for the unblanking circuit). These different operating voltages are fixed voltages, except the +140V (vertical final stage) and the high voltage, which can be adjusted. The variation of the fixed voltages greater than ±5% from the nominal value indicates a fault. Both adjustable voltages have to be set exactly for +140V respectively −1900V by the adjustments of two variable resistors 5kΩ. These voltages are measured on the Check Socket with reference to ground (see Adjusting Plan). Measurements of the high voltage may only be accomplished by the use of a sufficient highly resistive voltmeter (≥10MΩ). You must make absolutely sure that the electric strength of the voltmeter is sufficiently high. It is recommended to check the ripple and also the interaction from other possible sources. Excessive values might be very often the reason for incomprehensible faults. The maximum ratings are specified on the circuit diagrams. For the measurement of the high voltage ripple you need a probe capable to withstand 2000V. But also a normal probe X10 is sufficient with a capacitor (10... 22nF 2000V) connected in series to the probe tip.

Maximum and Minimum Brightness

Two variable resistors of 500kΩ each, located on the upper X-PCB, are used for these adjustments (see Adjusting Plan). They may only be touched by a properly insulating screwdriver (Caution! High voltage!). The adjustments must possibly be repeated, because the functions of both variable resistors are dependent on each other. Correct adjustment is achieved, when the trace can be blanked while **Hor. ext.** pushbutton is pressed and, in addition, the requirements described in the Test Instructions are met.

Astigmatism Correction

The ratio of vertical and horizontal sharpness can be adjusted by the variable resistor of 50kΩ, located on the lower Y-PCB (see Adjusting Plan). As a precaution however, the voltage for the vertical deflecting plates (approx. +90V) should firstly be checked, because this voltage will affect the astigmatism cor-

Pay ATTENTION to change information on page K2.

rection. While the adjustment is accomplished (with pressed **Hor. ext.** button and medium brightness), the **FOCUS** control knob has to be repeatedly turned to and fro until the shape of the luminous spot, whether round or oval or rectangular, stays the same to the right and left of the optimum focusing. The interaction of focus adjustment and astigmatism correction should be noted. After this adjustment, a square-wave signal should be displayed and be verified once more in accordance with the Test Instructions. The final adjustment has always to be the **FOCUS** control.

Trouble-Shooting the Instrument

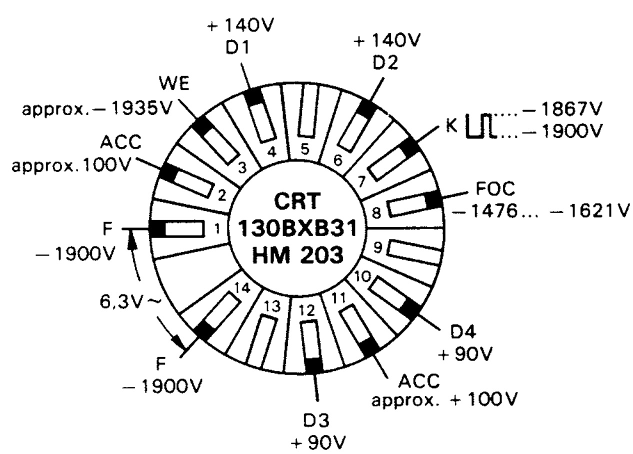
For this job, there will be needed at least an isolating variable line transformer (protection classification II), a signal generator, an adequate precise multimeter, and, if possible, an oscilloscope. This last item is required for complex faults, which can be traced by the display of signal or ripple voltages. As noted before, the regulated high voltage and the supply voltage for the final stages (approx. 300V) are highly dangerous. Therefore it is recommended to use **totally insulated extended probe tips**, when troubleshooting the instrument. Accidental touches with dangerous voltage potentials are then unlikely. Of course, these instructions cannot thoroughly cover all kinds of faults. Some common-sense will certainly be required, when a complex fault has to be investigated.

If trouble is suspected, visually inspect the instrument thoroughly after removal of the case. Look for loose or badly contacted or discolored components (caused by overheating). Check to see that all circuit board connections are making good contact and are not shorting to an adjacent circuit. Especially inspect the connections between the PCB's, to the power transformer, to front chassis parts (**DC-AC-GD** slide switches, LED, **CAL.** output eyelet), to CRT socket, to trace rotation coil (inside of the CRT's shielding), to ramp output (rear chassis), and to the control potentiometers and switches over and under both PCB's. In addition, check the 4 ground connections between the main angle pieces of the attenuators and the adjacent Y-PCB and also both ground connections between chassis and **DC-AC-GD** slide switches (near the **VERT. INP.** connectors). Furthermore, the soldering connections of the 9 transistors and Fixed Three-Terminal Regulators resp. on the rear chassis. This visual inspection can lead to success much quicker than a systematic fault location using measuring instruments. Prior to any extensive troubleshooting, also check the external power source.

If the instrument fails completely, the first and most important step — ***after checking the line voltage and power fuse*** — will be to measure the deflecting plate voltages of the CRT. In almost any case, the faulty section can be located. The sections represent:

1. Vertical deflection.
2. Horizontal deflection.
3. CRT circuit.
4. Power supply.

While the measurement takes place, the position controls of both deflection devices must be in mid-position. When the deflection devices are operating properly, the separate voltages of each plate pair are almost equal then (Y = 85-95V and X = 133-147V). If the separate voltages of a plate pair are very different, the associated circuit must be faulty. An absent trace in spite of correct plate voltages means a fault in the CRT circuit. Missing deflecting plate voltages is probably caused by a defect in the power supply.



Voltages at the CRT socket

Replacement of Components and Parts

For the replacement of parts and components use only parts of the same or equivalent type. Resistors without specific data in the diagrams have a power dissipation of 1/3 Watt and a tolerance of 2%. Resistors in the high voltage circuit must have sufficient electric strength. Capacitors without a voltage value must be rated for an operating voltage of 63V. The capacitance tolerance should not exceed 20%. Many semiconductors are matched pairs, quartets, or octets, especially the gate-diodes 1N4154, and all amplifier transistors, which are contained in push-pull circuits (including the FET's). If a matched semiconductor is defective, all gate-diodes or both push-pull transistors of a stage should be replaced by matched components, because otherwise there are possibly deviations of the specified data or functions. The HAMEG Service Department can give you advice for troubleshooting and replaceable parts. Replacement parts can be ordered by letter or telephone from the nearest HAMEG Service Office. Please supply the following information: Instrument type and serial number, description of the part (including function and location in the instrument), quantity desired.

Adjustments

Indeed, as advised in the Operating, Test and Service Instructions, small corrections and adjustments are easily carried out with the aid of the Circuit Diagrams and ***Adjusting Plan***. However, a complete recalibration of the oscilloscope should not be attempted by an inexperienced operator, but only someone with sufficient expertise. Several precision measuring instruments with cables and adapters are required, and only then should the pot's and trimmers be readjusted provided that the result of each adjustment can be exactly determined. Thus for each operating mode and switch position, a signal with the appropriate sine or square waveform, frequency, amplitude, risetime and duty cycle is required.

Pay ATTENTION to change information on page K2.

HAMEG
West Germany **G.m.b.H.**
Kelsterbacher Str. 15-19 — 6 FRANKFURT/M. 71
Tel. (0611) 676017-19 — Telex 0413866

HAMEG
France **S.A.R.L.**
5-9, Avenue de la République - 94800 VILLEJUIF
(Region Paris) - Tél. 678.09.98 - Télex 270705

HAMEG
España **IBERICA S.A.**
Villaroel 172-174 - Tel. 230.15.97 - BARCELONA-36

HAMEG
United Kingdom **LTD.**
74-78 Collingdon Street — LU1 1RX LUTON
Tel. (0582) 413174 — Telex 825484

HAMEG
USA **INC.**
Office: 191 Main Street — Tel. 516-883-3837
Factory: 88-90 Harbor Road — Tel. 516-883-6428
TWX 510 223-0889 — PORT WASHINGTON
N. Y. 11050