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Operating instructions

 The unit complies with the corresponding EC guidelines.



Fig. 1: 13727-99, Multi Channel Analyzer – Extended Version

CONTENTS

- 1 SAFETY PRECAUTIONS
- 2 PURPOSE AND CHARACTERISTICS
- 3 FUNCTIONAL AND OPERATING ELEMENTS
- 4 DETAILS ON CONNECTORS AND OPERATING ELEMENTS
- 5 HANDLING
- 6 NOTES ON OPERATION
- 7 TECHNICAL SPECIFICATIONS
- 8 LIST OF ACCESSORY EQUIPMENT
- 9 NOTES ON THE GUARANTEE
- 10 WASTE DISPOSAL

1 SAFETY PRECAUTIONS



- Carefully read these operating instructions completely before operating this instrument. This is necessary to

avoid damage to it, as well as for user-safety.

- Only use the instrument for the purpose for which it is intended.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Before applying the mains voltage, ensure that the earth lead of the power supply is properly connected to the earth lead of the mains. Only plug the mains plug into a mains socket which has an earth lead. Do not cancel the protective effect by using an extension cable without an earth lead.
- Check that your mains supply voltage corresponds to that given on the type plate fixed to the instrument.
- Take care that no liquids or objects enter in through the ventilation slots.
- Do not connect any other equipment to the instrument than that intended for it.
- Switch the instrument off when cable connections are to be disconnected or newly made.
- The present-day state of software development makes it impossible to guarantee that a product is free of faults. PHYWE Systeme GmbH & Co. KG therefore does not take on any liability for damages that occur during the installation or the use of the instrument.

2 PURPOSE AND CHARACTERISTICS

The Multi Channel Analyzer (Fig. 1), named MCA for short in the following, is part of an instrument system for the generation of pulse height spectra that correspond, for example, to the energy spectra of ionizing radiation. This instrument system has been specifically developed for demonstration and practical work that fulfills needs in the teaching of Natural Science in schools and colleges.

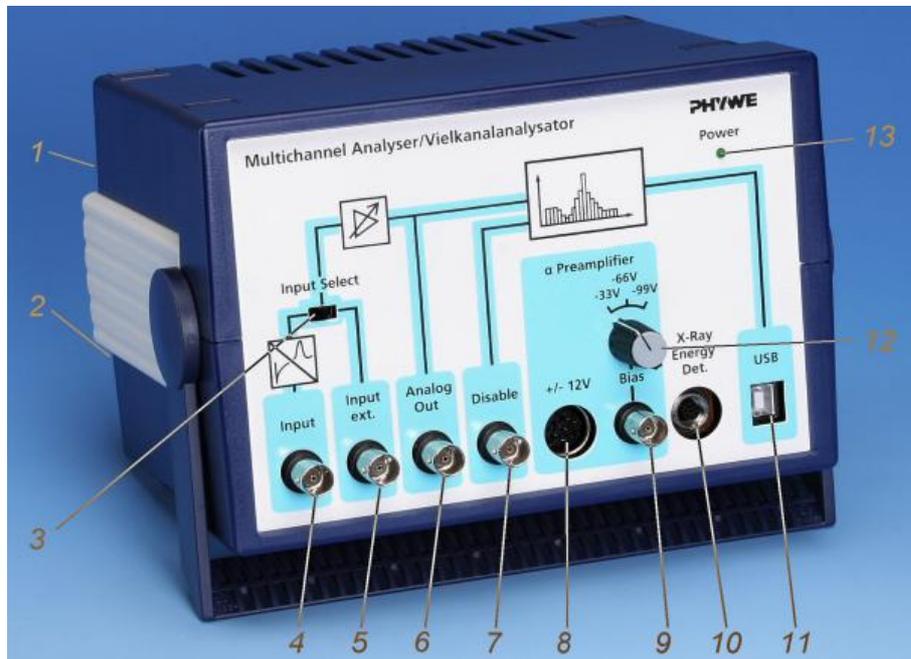


Fig. 2:
Functional and
operating ele-
ments of the MCA

The MCA classifies incoming voltage pulses according to their pulse height and assigns a value interval for the channel pulse height. The contents of a particular channel then correspond to the number of voltage signals registered, whose pulse heights are within the assigned value interval of that channel. The registration of each new voltage pulse which has a pulse height that is within the respective value interval increases the channel content by 1. The spectra result from the plotting of the channel contents against the channels.

When a detector for ionizing radiation is used, the pulse height of which is proportional to the energy of the registered event, then the pulse height spectrum corresponds to the energy spectrum of the radiation measured.

The counting rate can be up to 2,000 events per second.

Multi channel analysis with the MCA is controlled by a connected computer and a Phywe Systeme GmbH Software measure MCA Module (14452-61).

The pulse height analyzer itself has 4,000 channels, each of which has the same voltage interval width, and processes pulse heights within a voltage interval of 0 to 4 V. Pulses of other pulse heights which are received are discarded. Each channel so corresponds to a pulse height interval of 1 mV.

Each pulse that is imaged at this pulse interval by the preamplifier and main amplifier and the offset step is registered. The main amplifier extends the imaged input pulse height interval linearly, the offset step displaces it linearly to higher voltages.

Alongside the function as multi channel analyzer, the MCA also makes operating voltages and bias voltages available to a pre-connected preamplifier or the X-ray energy detector. These operating and bias voltages can be taken directly from, and be set at, the instrument.

3 FUNCTIONAL AND OPERATING ELEMENTS

- 1 *Main switch at the back*
- 2 *Socket for mains connection at the back*

The instrument is supplied with a connecting cable for the mains. The socket for mains connection is equipped with a fuse. This fuse is only to be replaced by a fuse of the type that is given on the type plate.

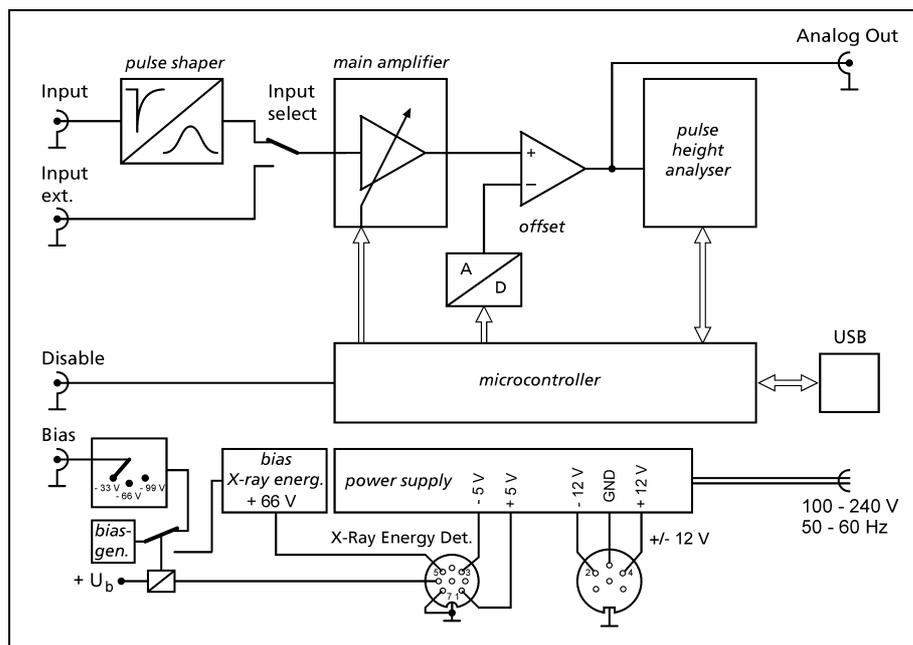


Fig. 3:
Functional dia-
gram of the MCA

3 Input Select

Selector switch for switching to input 4 or 5.

4 Input

BNC Socket for feed-in of measurement signals from a preamplifier or directly from a detector. Pulse shape and preamplifier input at which all pulses are converted to positive pulses, regardless of which polarity. The pulses are so shaped and amplified, that their height is defined and is proportional to the integral above the input pulse.

5 Input ext.

BNC Socket for feed-in directly to the main amplifier. This input can be used when the MCA is to pick up pulse height spectra via pulses from other instruments that supply pulses with a well-defined height, i.e. without sharp peaks, and with a positive polarity within the range from 0 V to 5 V.

6 Analog Out

BNC Socket at which the analog measurement signal can be tapped off after amplification by the main amplifier and reduction by the offset step, e.g. for presentation and examination using an oscilloscope.

7 Disable

BNC Socket for feed-in of TTL-signals. Without a connected instrument, this input is at +5 V, i.e. a logic "high". The data of a signal evaluated in the pulse height analyzer can be stored in the microcontroller when a high potential is applied here, and only then. When the input comes from a connected instrument or, for example, from a shorting plug at a logic "low", i.e. is almost brought to chassis earth, then pulse evaluation is blocked and no signals are registered.

8 Socket +/- 12 V

A 5-pin socket for the voltage supply of preamplifier 09100-10 or for an operating voltage of 12 V for an α -detector (positive or negative, can be selected); Preamplifier 09100-10 is supplied with an appropriate cable.

9 Bias

BNC Socket which puts out the detector bias voltage for a detector. The bias voltage can be switched between -33 V, -66 V and -99 V with switch 12. The bias voltage can be fed to the detector via preamplifier 09100-10.

10 X-Ray Energy Det.

An 8-pin socket provided for connection to x-ray energy detector 09058.30. Operating voltages of +5 V and -5 V and a detector bias voltage of +66 V are ready for pick up here. An appropriate cable is supplied with 09058-30. The MCA must be switched off when connection to the x-ray energy detector is to be made or broken.

11 USB

USB Interface for connection to a computer.

12 Switch

A rotary switch which enables the bias voltage (see 9) to be switched between -33 V, -66 V and -99 V.

13 Power

This green light emitting diode indicates the operating mode of the MCA (on/off).

4 DETAILS ON CONNECTORS AND OPERATING ELEMENTS

Gamma detector

Use a BNC cable to connect the signal output of γ -detector 09100-00 to input (4) of the MCA. The γ -detector is separately supplied with high voltage from operating unit 09101-93. The MCA input also accepts pulses from other gamma-detectors commonly used in Nuclear Physics.

Typical experimental set-up schemes with the multi channel analyzer:

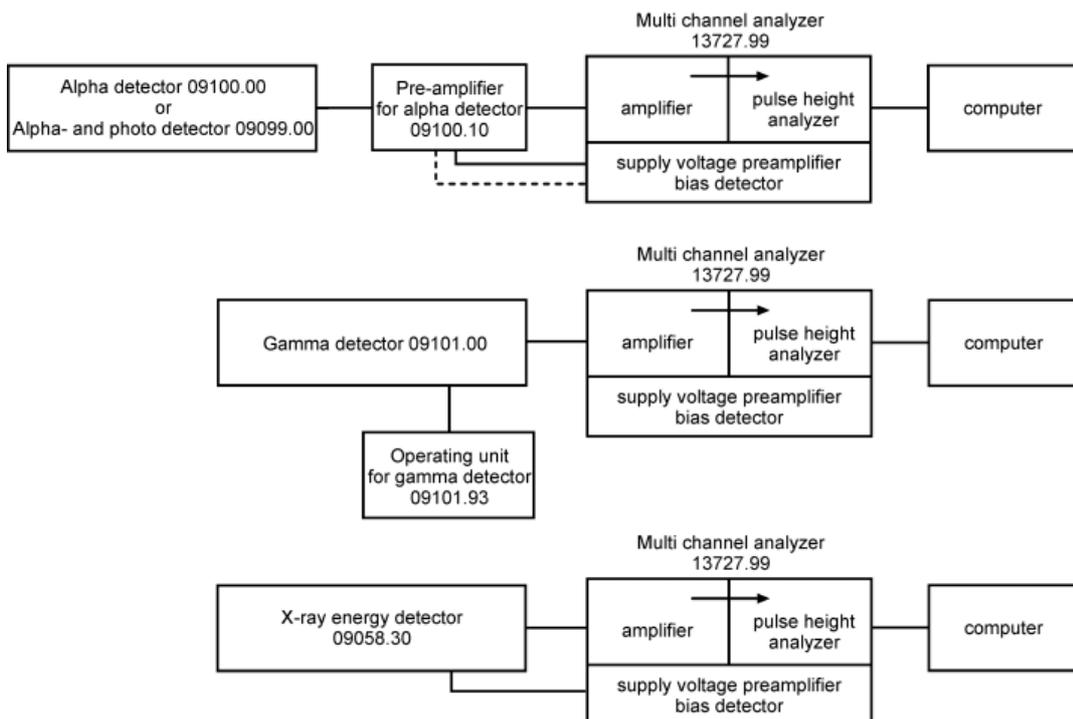


Fig. 4:
Typical uses of
the MCA

Alpha detector

Use a BNC cable to connect the output of α -preamplifier 09100-10 to input (4) of the MCA. The ± 12 V operating voltage for preamplifier 09100-10 can be picked up at 5-pin socket (8) using the connecting cable 06926-03 that is supplied with a preamplifier 09100.10; a smoothed 12 V biasing voltage is then fed to the α -detector from the preamplifier. Should the α -detector be operated at higher bias voltages (to fully utilize the resolving power), then a negative bias voltage that can be selected from -33 V, -66 V and -99 V can be picked up at BNC socket (9) and likewise be fed to the α -detector via the α -preamplifier using a further BNC cable. Rotary switch (12) allows switching between the selectable bias voltages. α -Detector 09100.00 can be so be operated with bias voltages of -12 V, -33 V, -66 V and -99 V; alpha and photodetector 09099-00 can be operated with bias voltages of -12 V, -33 V. Do not apply higher voltages.

Oscilloscope

Use a BNC cable to connect analog output (6) of the MCA to the input of the oscilloscope.

Oscilloscope settings:

- Triggering to rising edges
- Amplitude range from 0.1 to 10 volts
- Time-base deflection 10 to 100 $\mu\text{s}/\text{cm}$.

With the help of the oscilloscope, measuring signal voltage pulses can be analysed and, if appropriate, optimized after pulse shaping and amplification.

Coincidence conditions

The feed-in of TTL-signals to disable socket (7) enables signal processing to be made dependent on a further instrument, e.g. to set coincidence conditions. When the multi channel analysis is under coincidence conditions, only those voltage pulses of measuring signals are taken into consideration with which a "high" TTL-signal (momentary direct voltage of value between 2.3 and 5 V) simultaneously bears on the disable socket, e.g. because another detector has registered a further event. When the disable socket is open, then all measurement signal voltage pulses are classified by the multi channel analysis.

The digital processing requires a certain time. The enquiry on the condition of the disable input is therefore not made until about 50 μs after the input of the measurement signal and must then it be "high" for 1 μs for the measurement signal to be handed over.

Attention must be paid to the fact that the processing time might possibly be dependent on the height of the input pulse with other instruments that emit TTL-pulses when they register input pulses. With pulse height analyser 13725-93, the pulse height dependent delay until the TTL-signal is triggered at the output is 2.5 to 4.5 μs . The delay is hereby longer with lower pulses than at maximum level. The variation is less than 1 μs for input signals in the dynamic range that is practically relevant, however.

X-ray energy detector

A special cable is required for x-ray energy detector 09058-30 and is supplied with it. This cable has an angled plug at one end and a straight plug at the other end.

When x-ray energy detector 09058-99 is to be put to use, first fit the cable end with the straight plug in and out through the cable passage at the back of the x-ray energy detector.

Now plug the straight plug of the cable into 8-pin socket (10) of the switched-off MCA, but, before plugging it in, ensure that the catch-lug is correctly positioned. Finally screw the union nut tight. Now correspondingly connect the angled end to the detector. Only switch the MCA on after these connections have been properly made.

With proper connection, the control lamp at the back of the detector lights up and the required bias and operating voltages are applied to it.

Now use the BNC cable with the angled plug that is supplied with the x-ray energy detector to connect the signal output of the detector to MCA input (4), leading it through the cable passage of the x-ray unit if possible.

Computer

Use a BNC cable to connect the MCA to a computer via USB interface (11). For the MCA to function, installation of the corresponding FTDI-USB-driver on the computer is required. This driver is included on the "measure" installation CD in the following file (when the CD drive has been given the letter D): D:\Driver\USB-FTDI_Cobra_Driver.

The various Windows operating systems offer several ways to install device drivers. One of these is via the automatic recognition of the device after connection and switching on (message: „New hardware found“) and the subsequent manual input of the path under which the wanted driver is to be found. Do not select here an attempt to install the software automatically, a search for drivers in the net, connections with "Windows Update" or similar that are offered by the operating system. Instead of these, enter the path given above by the installation CD when the hardware installation assistant presents itself.

Note:

Electromagnetic disturbances, even those at other inputs of the computer, e.g. at the Ethernet input, can cause faults in USB data transmission.

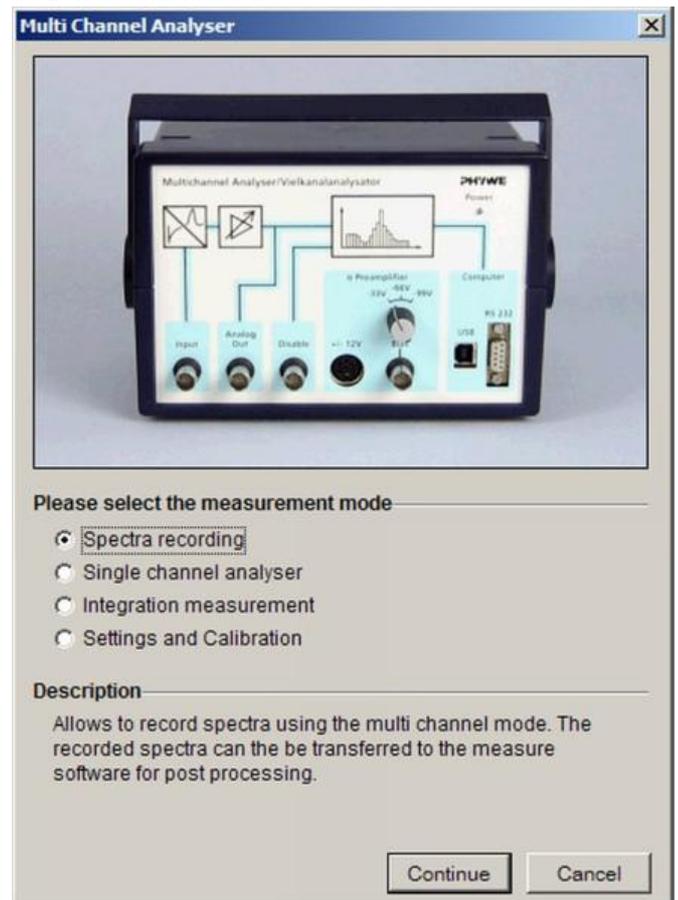


Fig. 5: Menu window of the MCA measuring instrument.

Should transmission faults occur in the USB connection during measurement, then the MCA is no longer recognized by the measurement module (e.g. spectra recording) – the counting rate drops to an apparent zero, the measurement data already collected can be adopted. The measurement

module must be switched off. The USB connection is again built up when the MCA is switched off and then back on. Otherwise the fault message says that no MCA can be recognized.

5 HANDLING

When all connections have been made, start the “measure” programme on the computer and select “Measuring instrument” > “Multi Channel Analyzer”. A menu window opens with four menu prompts (Fig. 5):

- Record spectra
- Single channel analyzer
- Integration measurement
- Setting and calibrating

5.1 Record spectra

Surfaces (Fig. 6) are available for the control of the MCA and for recording and presenting spectra. The following control functions for the MCA and/or for data capture are available:

Controls

- Start/Stop button: Starts and stops the recording of a spectrum. After stopping, the spectrum is still shown. When data capture is again started, the new measurement signals are added to the shown spectrum.
- Reset button: This is below the Start/Stop button. It deletes a spectrum and functions both during the recording of a spectrum and also after data recording has ended.

MCA – Settings

- Amplification factor button: For setting the amplification of the main amplifier in the MCA, steps of 1, 2 and 4 are possible.

The (physical) equisignal line lies at a higher amplification factor with higher channel numbers (further to the right) in the spectrum than with lower channel numbers.

In order to allow a suitable amplification factor to be set, this can be changed during the carrying out of a measurement. The spectrum recorded before the change in

the amplification factor is hereby further shown in gray as background spectrum. Only the part data of the spectrum subsequently shown in red is adopted data.

- Offset button: Serves to suppress noise. Noise can lead to events that do not originate from the specimen, but from the electronics at low channel numbers. The percentage given for the offset relates to a pulse height of 4 V after amplification, 100% so corresponds to 4 V. The measurement signals that enter the pulse height analyzer after pulse shaping and amplification are subjected to a subtraction of the given percentage of the offset from their voltages and the pulse height window is so displaced to higher voltages. Pulses which have a negative maximum value after subtraction of the offset are no longer taken into consideration and do not appear in the spectrum. In practice, each 1 percent of the offset displaces the spectrum 40 channels to the left.

The offset can also be used to view a certain section of a spectrum, as the signals are sorted into lower channels appropriate to their reduced voltage values. In interplay with the adjustable amplification, therefore, the relevant spectrum section can be optimally viewed by utilization of the 4,000 channels that are available.

The main amplifier overdrives starting from an input signal height of 5 V. Higher voltage input pulses are so all cut to the same 5 V height and are presented in a narrow channel range. This channel range can be made visible by setting the amplification factor to 1 and the offset to above 25%, or the amplification factor to 2 and the offset to above 75%. The resulting line in the pulse height spectrum then has no physical counterpart in the energy spectrum of the measured radiation.

The offset can be changed during an active measurement. The spectrum generated after the change in offset is shown in red. The spectrum generated prior to the change is shown gray-colored in the background.

Histogram

- x-Data record button: Switches between the presentation of the channel contents via the channel number or (in the case that an energy calibration has been carried out) via the energy.

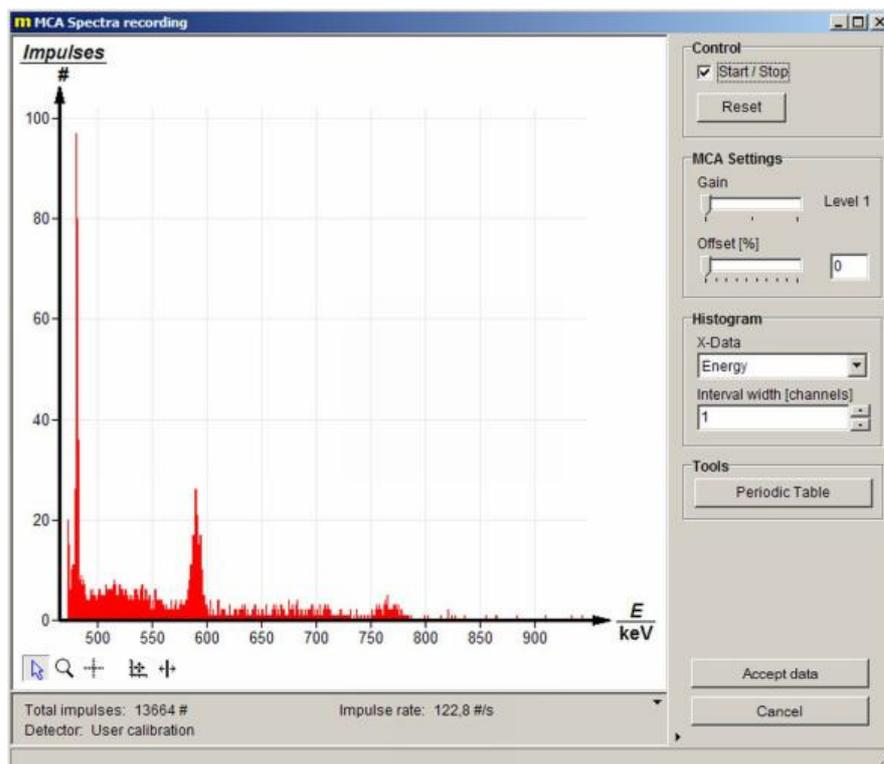


Fig. 6: Spectra recording window.

- Interval width button: Allows the summation of the contents of neighboring channels. The sum is then assigned to all channels whose content was summed up.

Adopt data

- Adopt data button: A measured spectrum is adopted by the MEASURE software from the multi channel analyzer module and can be processed with all the functions that are available there. The multi channel analyzer software module is then ended. The multi channel analyzer module starts with the same settings as last used when it is again called.

Abort

- Cancel button: Terminates the multi channel analyzer module without data transmission.

Other push buttons that are accessible during measurement

- Cursor mode  : Preset mode in which, for example, markings in the spectrum can be moved with the mouse (see below).
- Magnifier  : Enables spectrum sections to be magnified. Keeping the left mouse key pressed and dragging magnifies the marked section, doing this with the right mouse key reduces the section size by a factor of two.
- Reticle  : Can be shifted by the mouse to any position in the spectrum, whereby the channel number and channel content of that channel are shown.
 - Scaling  : Allows switching between automatic scaling (x, y), automatic scaling (only y) and manual scaling. With (x, y) automatic scaling, the whole of the spectrum is shown, whereas with (only y) automatic scaling, the y-axis of the spectrum is matched to the greatest channel content of the visible section of the spectrum, while maintaining the selected section of the x-axis. Selection of manual scaling opens a window in which the lower and upper limits of the wanted section can be entered on the x- and y-axes.
- Marking lines  : One or two marking lines can be shifted by the cursor to any position in the section of the spectrum that is shown. The channel number of their position is hereby given as well as, when two marking lines

are used, their distance from each other. The reset function brings the marking lines back to their original position after they have been shifted.

The following are shown below the spectrum: The total number of the events registered during the actual measurement the pulse rate per second and the calibration used.

5.2 Single channel analyzer

With the selection of the single channel analyzer menu prompt, the multi channel analyzer is limited in use to a single channel. In single channel analysis, the spectrum is determined stepwise. A particular energy interval is examined at each step. The interval or window is determined by the lower and upper limit, whereby the distance between the limits is the same for all intervals. During a step, the MCA counts the number of signal pulses whose energy, or height, is within the examined interval and which are registered within a certain period. The number obtained is the interval content. When a step has finished, then the lower and upper limits of the interval are each shifted to the right by the same step width, i.e. by a certain energy difference. This gives the interval for the next step. The start is made at zero with amplification factor 1 and offset 0% of the pulse height – the actual calibration must be previously carried out for this setting for the results to be useful.

The interval width can be greater or smaller than the step width. When it is greater, the intervals might overlap, i.e. the same pulse height might belong to different intervals. When it is smaller, then there are pulse heights that cannot be assigned to any interval and so are entered in the analysis.

Operating elements for the MCA under the Single channel analyzer menu prompt:

- Window width field: Establishes the interval width.
- Step width field: Establishes the step width.
- Gate time field: Establishes the period for the determination of the interval content.
- Start/Stop button: Starts single channel analysis or brings it to a stop.
- Adopt data / Abort button: As described under Record spectra.

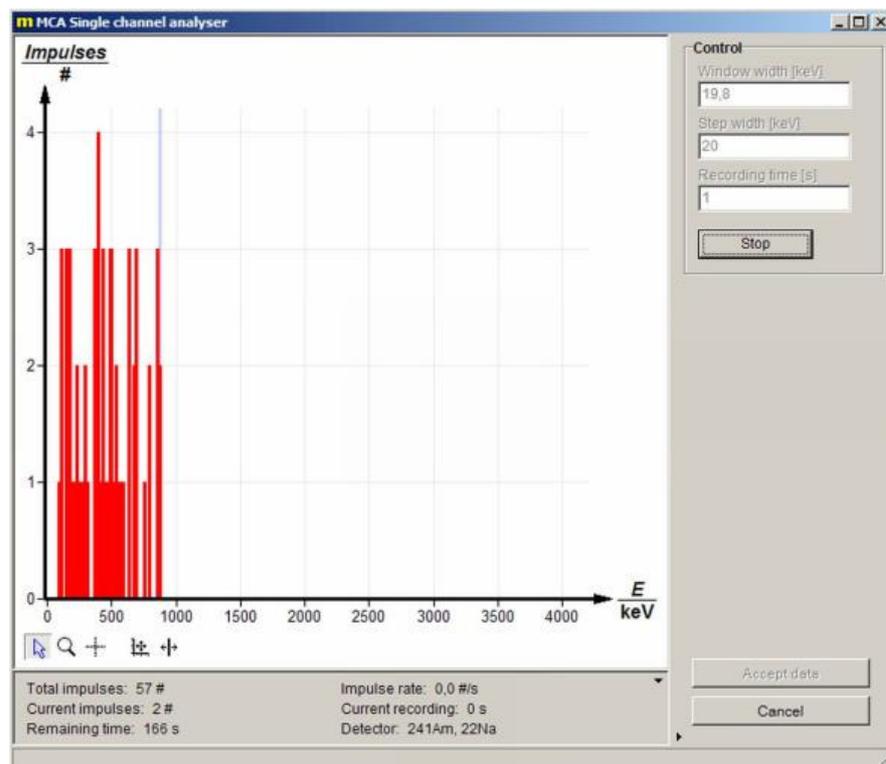


Fig. 7: Single channel analyzer window

- Button within the area for spectrum presentation: As described under Record spectra.

The following are given below the spectrum: The total number of pulses from the actual measurement, the number of pulses in the actual channel, the time remaining for the total measurement, the actual pulse rate per second, the actual gate time and the detector calibration.

5.3 Integration measurement

In integration measurements, the number of pulses whose energy or pulse height lies within a certain interval is determined. The interval or window is fixed by the entered upper and lower limits. The period for which registered pulses are to be counted must also be fixed. An integration measurement can be repeated for different parameterizations of the window and the measuring time. Parameterization and the carrying out of individual integration measurements must be manually performed.

The results of the various integration measurement are presented in a graph against the running number of the integration measurements. A Table of the data is also shown.

The following operating elements for the MCA are offered under the Integration measurement menu prompt.

Control

- Reduce window check box: The lower and upper limits of the interval and the measurement time are manually established. When the window is not reduced, then the MCA counts all pulses that are registered during the gate time.
- Lower limit / upper limit fields: Establish the lower and upper interval limits.
- Gate time field: For establishment of the measurement time.
- Make measurement button: (Abort measurement) serves to start or stop an integration measurement. The measurement can also be manually stopped before the gate time has expired. At the end of the gate time, the measurement stops automatically.
- Delete measured data button: The measurement data of the actual and of the previous integration measurement are deleted.

MCA Settings

- MCA Settings Field: As described above under Record spectra.

X-Data record

- x-Data record field: The individual integration measurements can be freely indexed.
- Identifier field: Determines the identifier for the integration measurement. The preset identifier is number. An identifier for a measured quantity can be set by an entry in the Measured quantity field. The running number for the integration measurement is preset. The unit for the measured quantity can be set in the Unit field.

Adopt data / Abort

- Adopt data and abort buttons: As described above under Record spectra.
- Buttons below the graphical presentation: As described under the menu prompt Record spectra.

The following are given under the graphical representation: The total count of registered pulses, the number of pulses for the actual integration measurement, the actual pulse rate per second, the time remaining for the actual integration measurement and the detector calibration.

5.4 Settings and calibration

The settings and calibration menu window allows the user to carry out either a two-point or a three-point calibration that determines the connection between the channel number and the energy of registered events. The equation for a straight line is fixed by the slope (keV per channel multiplied by the channel number) and x-axis section (keV of the zeroed channel). It is valid for a pair of values for offset and amplification. The program changes the energy displayed by changing the offset and the amplification factor. Whereas the calibration remains usable in the bounds of the linearity of the detector when the offset is changed, it is only very roughly correct when the amplification factor is changed. It is best to calibrate for each particular setting

On being called, Window settings is first opened.

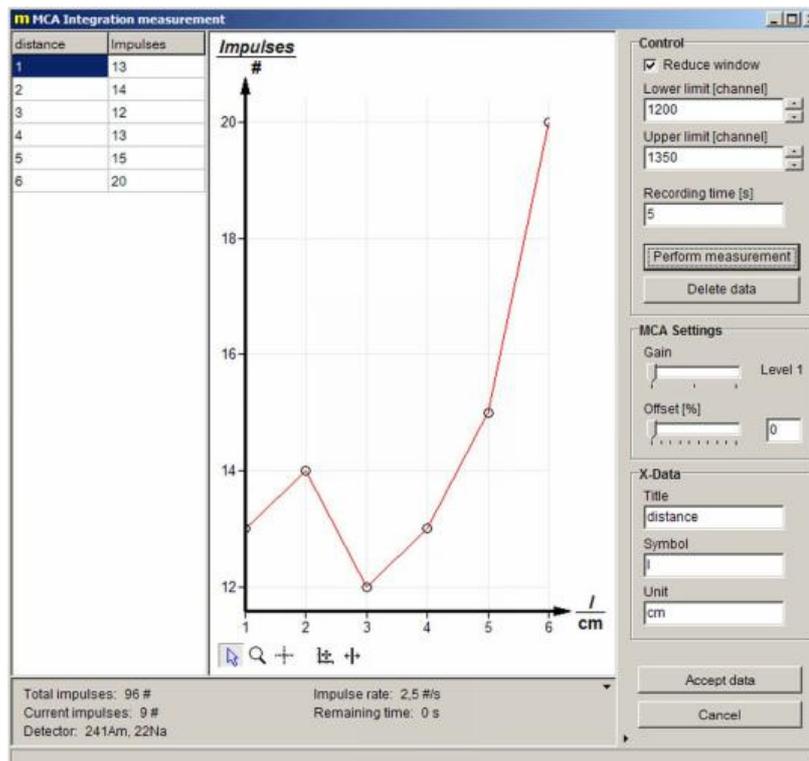


Fig. 8: Integration window

Window settings

The window is divided into two sections, Detector calibration and Device information.

Detector calibration section

- Detector/calibration selection box: A calibration that has already been filed can be selected. The parameterizing of the actual calibration is shown under the selection box. In the Remarks panel, information is given on the selected calibration, should such information have been saved with the calibration. The Mode panel shows if the chosen calibration was a two-point or a three point calibration. The Amplification panel displays the amplification step and the offset with which the selected calibration was carried out. The Equation panel shows the equation resulting from the calibration which connects the channel number with the energy of the event.
- Calibration button: Opens the calibration window (see below) for creation of a new calibration.
- Save button: For the filing of a newly created calibration and the parameters of it. Opens a window in which the user can enter a name the calibration and, if appropriate, remarks on it.
- Delete button: Deletes calibrations that have already been filed and is only active when there is a filed calibration in the Detector/calibration selection box.

Device information section

Serves for the matching of the MCA and is only to be used with the agreement of Phywe Systeme GmbH & Co. KG.

Close button

The Close button lies outside of the detector calibration and device information sections in the Settings window. A press on it causes the actual calibration to be accepted and brings the user back to the starting window of the Multi Channel Analyzer MEASURE module. When one of the three other menu prompts is called from this window, then the calibration is accepted for these menu prompts.

Calibration window

Pressing the Calibration selection box leads to this window. The face of the calibration settings window resembles the window of the Record spectra menu prompt.

MCA Settings section

Has the same function as the Record spectra menu prompt, so that the description of this section is to be found under the Record spectra menu prompt.

Calibration section

This serves for the parameterization of the calibration.

- Mode selection box: Select two-point or three-point calibration or manual calibration.
- Unit selection box: Select keV or MeV as energy unit.
- Input entry boxes: Two-column Table with two rows for two-point calibration and three rows for three-point calibration. Channel numbers are entered in the left-hand column and the corresponding energy values in the right-hand column. Manual entry of the channel numbers and corresponding energy values is possible, or the channel numbers can be entered with the help of the cursor. To do this, shift the marking lines with the cursor to lines of known energy in the spectrum. The numbers of channels selected with the marking lines are automatically entered in the Table. Each row in the Table corresponds to a marking line and different colors assist the assignment. In Manual calibration mode. Input boxes for the slope and axis section of calibration straight lines are displayed.
- Delete graph button: Deletes the spectrum that is on display.
- Adopt and abort button: Adopt closes the calibration window, adopts the parameters of the calibration that was carried out and returns to Window settings. Abort closes the calibration window without adoption of the parameters. The user is here again returned to Window settings.
- Buttons below the settings are the same as those described under the Record spectra menu prompt.

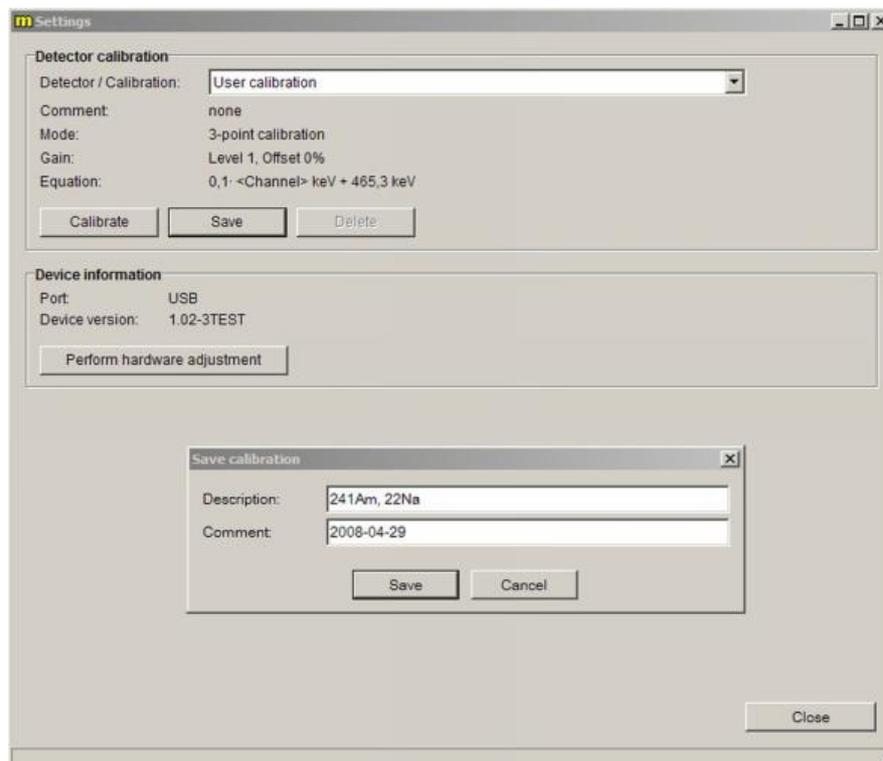


Fig. 9:
Settings window

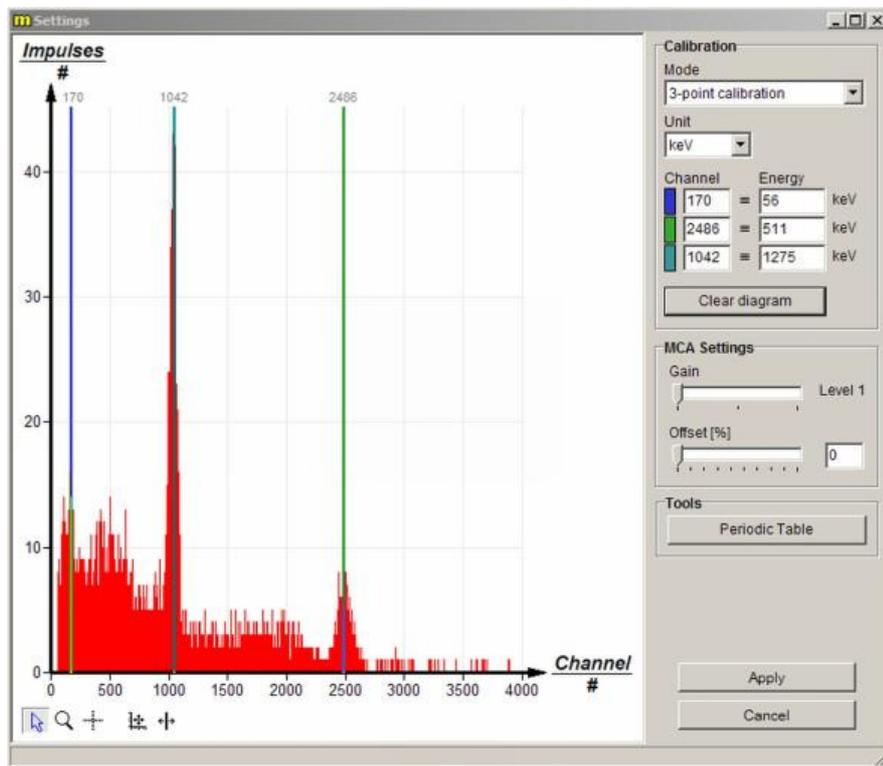


Fig. 10:
Calibration window

6 NOTES ON OPERATION

This high-quality instrument fulfils all of the technical requirements that are compiled in current EC guidelines. The characteristics of this product qualify it for the CE mark.

This instrument is only to be put into operation under specialist supervision in a controlled electromagnetic environment in research, educational and training facilities (schools, universities, institutes and laboratories).

This means that in such an environment, no mobile phones etc. are to be used in the immediate vicinity. The individual connecting leads are each not to be longer than 2 m.

The instrument can be so influenced by electrostatic charges and other electromagnetic phenomena that it no longer functions within the given technical specifications. The following measures reduce or do away with disturbances:

Avoid fitted carpets; ensure potential equalization; carry out experiments on a conductive, earthed surface, use screened cables, do not operate high-frequency emitters (radios, mobile phones) in the immediate vicinity. To carry out an instrument restart (reset), unplug the USB-cable, plug it back in again and then start measurement anew in the "measure" programme.

This instrument corresponds to Class A, Group 1 of the EN 55011 Standard and can only be operated without limitation outside of residential areas. Should electromagnetic disturbances occur in surrounding residential areas although operation is limited to the technical room of a school or other training facility, then it can be demanded of the operator that he carries out adequate measures (e.g. screening, greater distance, reduction in the operating time) at his own cost.

7 TECHNICAL SPECIFICATIONS

(Typical for 25 °C)

Operating temperature range 5... 40 °C
Relative humidity < 80 %

Mains supply

The instrument corresponds to protection class I. It is only to be connected to a socket with an earth lead connection.

Connecting voltage	110... 240 V
Mains frequency	50... 60 Hz
Power consumption	20 VA
Mains fuse (5 mm x 20 mm)	see type plate
Housing dimensions (mm)	205 x 155 x 135 (W, H, D)
Weight	approx. 1.37 kg

Signal input (for negative pulses)

Impedance: 3.3 kΩ || 150 pF
Pull zero internal

The input works integrally for a short time of 0.2 to 4 μs, and differentially for longer times. The preamplifier works totally pulse shaping and converts negative peak pulses to approximately Gaussian shaped positive pulses.

Amplification

Total amplification in three steps of approx. 6, 12 and 24 (can be digitally set)

Limitation of the pulse height at the A/D-converter of the pulse height analyser: 4.7 V
Length of the shaped pulse approx. 10 μs
Maximum pulse rate 2000 s⁻¹

Offset

Digital 12 bit resolution
Maximum offset 3.6 V

Analog output

Amplified positive pulse reduced by the offset
Pulse height 0 to 5 V
Pulse length approx. 15 μs

Pulse height analyser

Measured value resolution	12 bit
Number of channels	4000
Maximum pulse rate	2000 s ⁻¹

Disable input

Logic input (TTL) for coincidence measurements
Enable (default) $\log 1 > 2.5 \text{ V}$
Disable $\log 0 < 0.7 \text{ V}$

Voltage outputs

α -Detector provision	$\pm 12 \text{ V max. } 30 \text{ mA}$
Pin assignment clockwise (top view)	
2: -12 V; 3: GND; 4: +12 V	
X-ray energy detector provision	$\pm 5 \text{ V max. } 30 \text{ mA}$
Pin assignment clockwise (top view)	
1: +5 V; 3: -5 V; 5: +66 V; 6: +U _b ; 7: GND	
Bias voltage	BNC socket, high impedance
Bias voltage	-33 V, -66 V, -99 V switch-over

Computer

USB with USB-B socket

8 LIST OF ACCESSORY EQUIPMENT

Some of the instruments that can be used with the MCA are listed here, together with their order numbers:

Alpha detector	09100-00
Alpha and photodetector	09099-00
Preamplifier for alpha Detector	09100-10
Gamma detector	09101-00
Operating unit for gamma detector	09101-93
X-ray energy detector	09058-30
X-ray basic unit, 35 kV	09058-99
Goniometer for 35 kV x-ray unit	09058-10
Plug-in module with Cu x-ray tube	09058-50
Receiver for nuclear physics experiments	09103-00
Software Multi Channel Analyzer	14452-61

9 NOTES ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 24 months within the EU, or for 12 months outside of the EU. Excepted from the guarantee are damages that result from disregarding the Operating Instructions, from improper handling of the instrument or from natural wear.

The manufacturer can only be held responsible for the function and technical safety characteristics of the instrument, when maintenance, repairs and alterations to the instrument are only carried out by the manufacturer or by personnel who have been explicitly authorized by him to do so.

10 WASTE DISPOSAL

The packaging consists predominately of environmentally compatible materials that can be passed on for disposal by the local recycling service.



Should you no longer require this product, do not dispose of it with the household refuse. Please return it to the address below for proper waste disposal.

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