

ORTEC[®]

EASY-MCA-8K[™]

EASY-MCA-2K[™]

Digital Gamma-Ray Spectrometer

User's Manual

Advanced Measurement Technology, Inc.
(“AMT”)

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Safety Instructions and Symbols

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

- DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.
- WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.
- CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

In addition, the following symbols may appear on the product:



DANGER – Hazardous voltage



ATTENTION – Consult the manual in all cases where this symbol is marked in order to determine the nature of the potential hazards and any actions that must be taken to avoid them



Protective earth (ground) terminal

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

Cleaning Instructions

To clean the instrument exterior:

- Disconnect the instrument from the power source.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



1. INTRODUCTION

The ORTEC® EASY-MCA-8K™ and EASY-MCA-2K™ multichannel buffers (MCBs) include 512 KB of memory and 1.25 μ s conversion time. The 8K model's successive-approximation 8192-channel ADC has conversion gain settings of 256, 512, 1024, 2048, 4096, and 8192. The 2K model offers conversion gain settings of 256, 512, 1024, and 2048. Dead time can be corrected using the highly accurate Gedcke-Hale extended live-time method.¹

The EASY-MCA communicates via high-speed USB, and up to eight units can be controlled by a single computer.

Features

- Fast (1.25 μ s) ADC and memory.
- Onboard memory allows fast downloads to your computer.
- PUR, BUSY, and GATE inputs and an ADC-busy LED.
- Bundled with our MAESTRO® MCA Emulator Software.

1.1. Host Computer and Software Requirements

The EASY-MCA is completely computer controlled by ORTEC spectroscopy applications such as MAESTRO,² which runs under Microsoft® Windows® 8, 7, and XP Professional SP3, communicating with CONNECTIONS v6.11 or later.

1.2. About this Manual

This manual describes the EASY-MCA, tells how to connect it in a complete spectroscopy system, gives instructions on configuring the hardware settings (such as high voltage, presets, and gain), and supplies the firmware commands and responses for users who wish to write custom control software.

¹Ron Jenkins, R. W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp. 266–267.

²For the purposes of this manual, when we refer to MAESTRO, we mean the ORTEC MCA emulator/analysis application you are using (e.g., MAESTRO, GammaVision®, ScintiVision™).

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2. GETTING STARTED

2.1. The EASY-MCA

2.1.1. Front Panel

Figure 1 shows the EASY-MCA front panel.

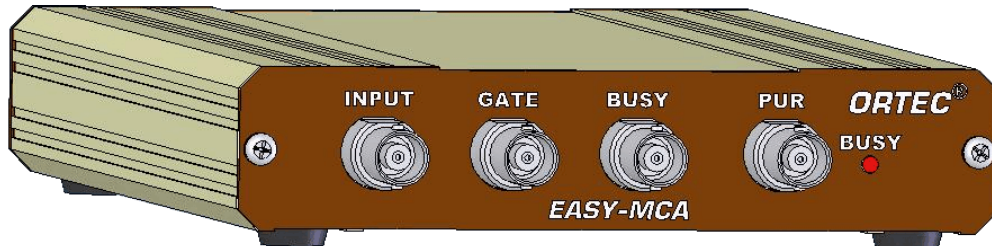


Figure 1. EASY-MCA Front Panel.

2.1.1.1. Inputs and Connectors

- **INPUT** Accepts positive unipolar, positive gated integrator, or positive-leading bipolar analog pulses in the dynamic range from 0 to +10 V; +12 V maximum; semi-Gaussian-shaped time constants from 0.25 μs to 30 μs , gated-integrator-shaped time constants from 3 μs to 30 μs , or delay-line-shaped with width $>0.25 \mu\text{s}$. $Z_{\text{in}} = 1 \text{ k}\Omega$, dc-coupled. No internal delay.
- **GATE** Optional positive TTL input. In MAESTRO, select the **Coincidence**, **Anticoincidence**, or **Off** gate mode from the ADC property page (see Section 2.3.1). The signal must occur prior to and extend 0.5 μs beyond the peak of the pulse. $Z_{\text{in}} = 1 \text{ k}\Omega$.
- **BUSY** Used by live-time correction circuits. Accepts a TTL signal, which must occur prior to peak detect. $Z_{\text{in}} = 1 \text{ k}\Omega$.
- **PUR** Pile-up rejection input. Accepts a TTL signal, which must occur prior to peak detect. $Z_{\text{in}} = 1 \text{ k}\Omega$.

2.1.2. Rear Panel

Figure 2 shows the rear panel.

- **+12V (POWER)** Connect the power adapter to the ac mains supply.
- **USB** High-speed port connects to the computer or hub via USB cable.

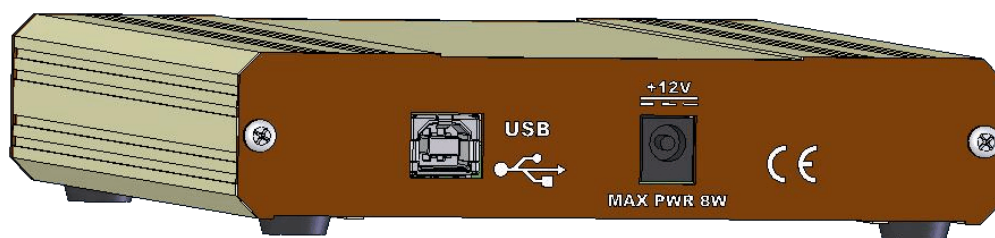


Figure 2. EASY-MCA Rear Panel.

2.1.3. Cabling for Spectroscopy

Figure 3 shows the standard cabling of an EASY-MCA in an HPGe detector system. If the detector has a TRP preamplifier (“-PLUS” model), all connections shown below should be made. Resistive-feedback preamplifiers do not have an INHIBIT output so the INHIBIT connection is left open.

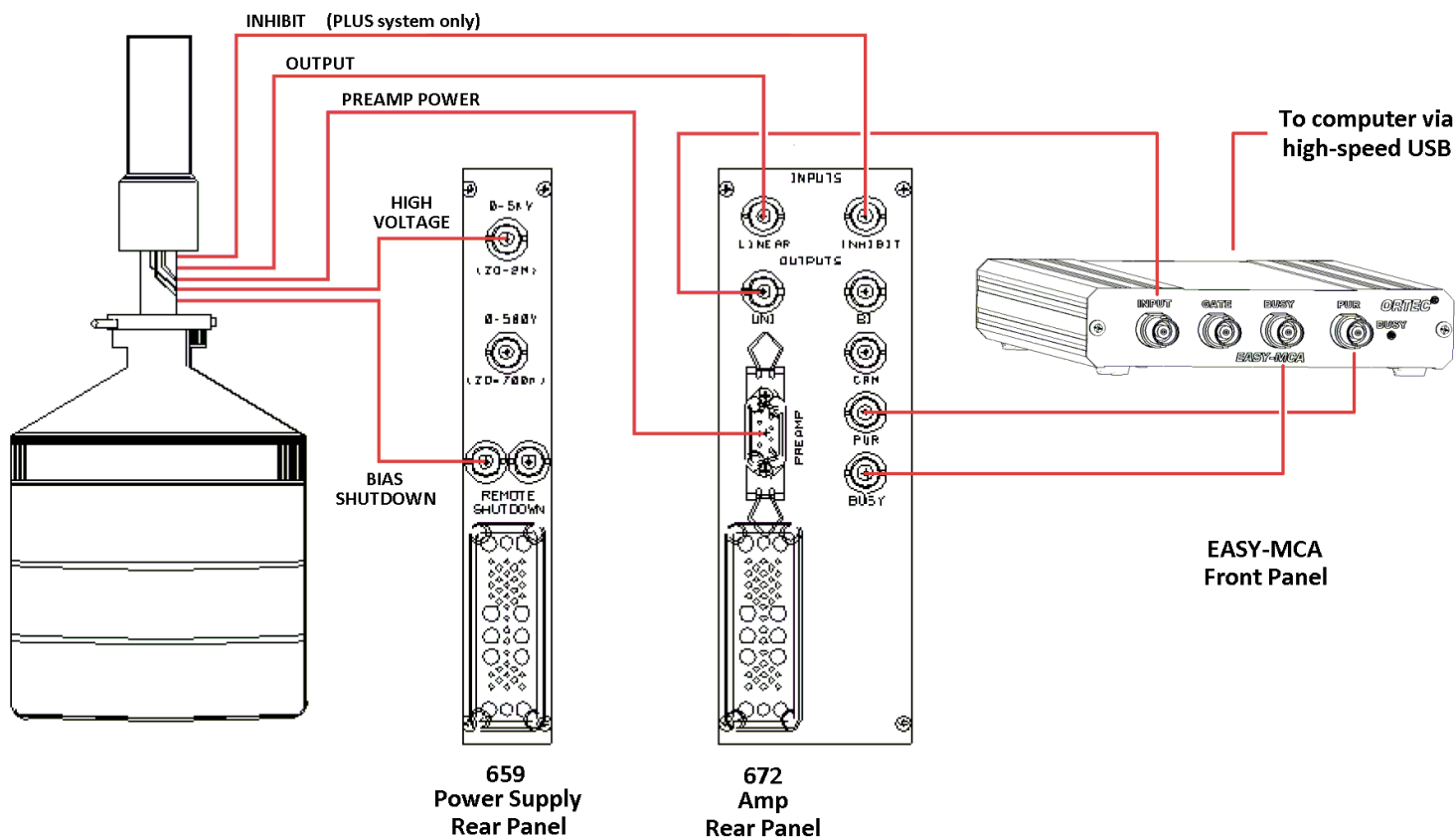


Figure 3. Cabling the EASY-MCA.

2.2. Software and Hardware Installation

Installing the EASY-MCA and the accompanying CONNECTIONS and MAESTRO software takes just four easy steps. Note that you must have Administrator-level access in Windows to install ORTEC software.

For easiest installation do not connect the EASY-MCA to your computer until MAESTRO has been installed.

- 1) Install the accompanying CONNECTIONS Driver Update Kit (P/N 797230), selecting the **USB-based instruments** family on the install wizard's Instrument Setup page.
- 2) Install the accompanying MAESTRO MCA Emulation Software (A65-BW).
- 3) Connect the EASY-MCA to the USB port on the computer.
- 4) Run the MCB Configuration program to build a list of available ORTEC MCBs.

2.2.1. Step 1: Install the CONNECTIONS Driver Update

The first step is to install the CONNECTIONS Driver Update Kit (P/N 797230) according to its instruction sheet. This software must be installed before MAESTRO can be installed. The update kit's instructions tell how to install CONNECTIONS, enable/disable the drivers for your ORTEC MCB(s), and share ORTEC instruments across a network. On the Instrument Families page, be sure to mark the **USB-based instruments** checkbox, as shown in Fig.4. ***Otherwise the EASY-MCA will not be able to communicate with the computer and MAESTRO software.*** At the end of installation, you will be directed to restart the computer.

If you also have other types of MCBs attached to this computer, refer to the installation instructions in the corresponding hardware manuals. Note that you can install device drivers for other types of instruments later, as described in the CONNECTIONS Driver Update Kit instructions.

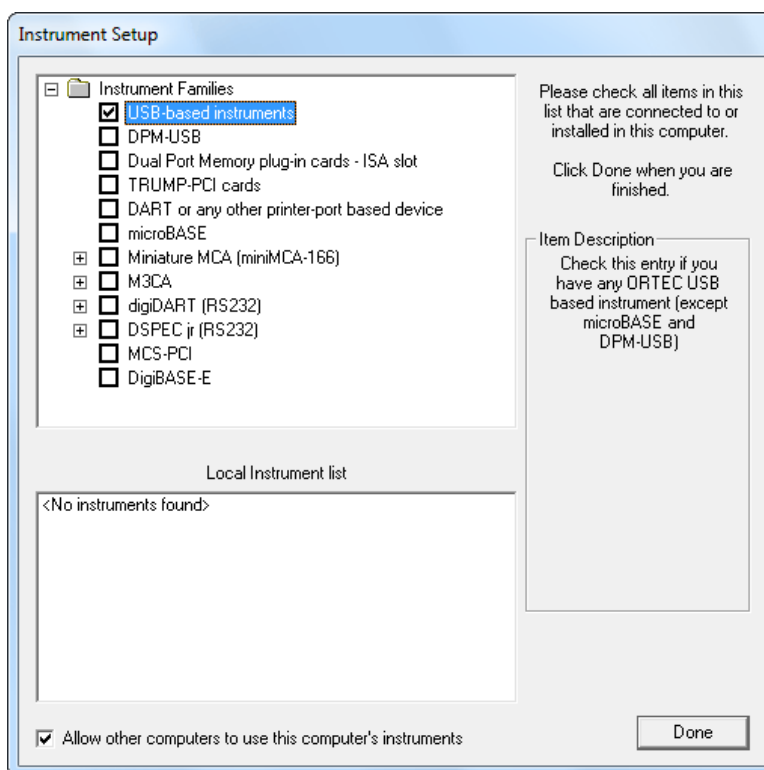


Figure 4. Choose 'USB-based instruments'.

2.2.2. Step 2: Install MAESTRO

Install MAESTRO according to the instructions in its *User Manual*.

2.2.3. Step 3: Connect the EASY-MCA to the Computer

- 1) With the computer powered on, connect the EASY-MCA to the computer's USB port.
- 2) Windows will indicate that the EASY-MCA has been detected. In Windows 8 and 7, the driver will install without a wizard. In XP, the new hardware installation wizard will open. Click **Next**, indicate you *do not* wish to connect to the internet or the Microsoft website to locate the driver, choose the "automatically locate driver" option, and follow the remaining prompts to completion. When this operation is complete, you are ready to run the MCB Configuration program so that MAESTRO and other CONNECTIONS software can recognize the EASY-MCA.

2.2.4. Step 4: Run MCB Configuration to Communicate With Your MCBs

IMPORTANT

This is an abbreviated discussion of the operation and use of the MCB Configuration program. We *strongly* recommend that you read the instructions for the CONNECTIONS Driver Update Kit for complete details on the command line arguments that change how the program searches for MCBs, customizing MCB ID Numbers and Descriptions, changing your Windows firewall settings to allow MCB access across a network, enabling additional device drivers, and troubleshooting.

- 1) Make sure the EASY-MCA is connected and powered on.
- 2) Connect and power on all other local and network ORTEC instruments to be used, as well as their associated computers. Otherwise, the MCB Configuration program will not detect them during installation. Any instruments not detected can be configured at a later time.
- 3) To start the software, type `mcb` in the “*Search programs and files*” box on the Windows Start menu, then click the **MCB Configuration** search result; or open the Windows Start menu and click **MAESTRO**, then **MCB Configuration**. The MCB Configuration program will locate all of the powered-on ORTEC MCBs on the local computer and the network, and display the list of instruments found (the *Master Instrument List*; Fig. 5). If you wish, you may enter customized instrument ID numbers and descriptions (Section 2.2.4.2). When you close the dialog, any changes you have made to an ID number or description will be written back to the corresponding MCB.

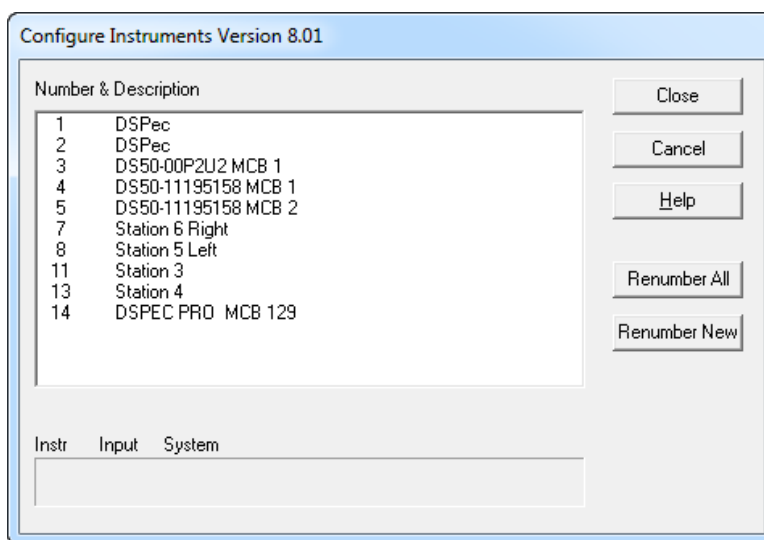


Figure 5. MCB Numbering and Descriptions.

2.2.4.1. Configuring a New Instrument

The first time a new instrument is detected, the dialog shown in Fig. 6 will remind you that all new instruments must be assigned a unique, *non-zero* ID number.³ Click **OK**. You can either manually change the ID Number and Description as described in the next subsection, or you can click the **Renumber New** button to renumber only the new instruments.



Figure 6. New Instruments Must Have a Non-Zero ID Number.

NOTE *We strongly recommend not using the Renumber All button.* In addition, we strongly recommend *not* renumbering MCBs that “belong” to other users, as this could affect the interaction between their MCBs and their ORTEC software, for instance, if they control their MCBs with .JOB files (e.g., the .JOB file command `SET_DETECTOR 5`), or use the GammaVision or ISOTOPIC spectroscopy applications. See also the NOTE FOR MULTIPLE USERS ON A NETWORK in the next section.

2.2.4.2. Customizing ID Numbers and Descriptions

If you wish, you can change the instrument ID Numbers and Descriptions by double-clicking an instrument entry in the Configure Instruments dialog. This will open the Change Description or ID dialog (Fig. 7). It shows the physical MCB location (read-only), and allows you to change the **ID Number** and **Description**.

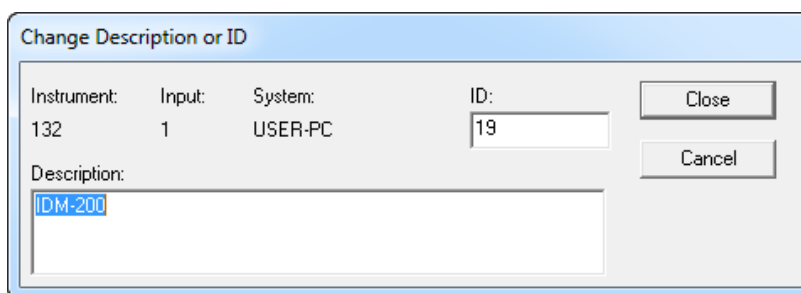


Figure 7. Change MCB Number or Description.

Make the desired changes and click **Close**. Any changes you have made to an ID number or description will then be written back to the corresponding MCB.

³If this is a first-time installation of ORTEC products, all your instruments will be “new.”

NOTE FOR MULTIPLE USERS ON A NETWORK

There are two ways to reduce the chance that other users will renumber your MCBs:

- Add the **-I** flag to their MCB Configuration command line, as described in the CONNECTIONS Driver Update Kit instructions. This will allow you to assign whatever ID Numbers you wish, regardless of the numbers assigned by other users on your network. (Ideally, everyone using ORTEC instruments on your network should make this change.)
- To prevent others from renumbering your MCBs (or performing any other actions except read-only viewing), password-lock your MCBs with the **MAESTRO Lock/Unlock Detector** command. If you lock a detector that will be controlled by a JOB stream, remember to include the proper password-unlock commands in your **.JOB** file (see the MAESTRO user manual).

If a modified description has already been applied to a particular instrument, you can restore the default description by deleting the entry in the **Description** field and re-running MCB Configuration. After MCB Configuration runs, the default description will be displayed.

2.2.5. Attaching More Than One EASY-MCA to the Computer

Once the drivers have been installed for one EASY-MCA, adding subsequent units is simple.

REMINDER Be sure to run MCB Configuration any time you add new EASY-MCAs (or other ORTEC MCBs) to your system, *or when you move an instrument from one USB port to another.*

2.2.6. Connecting to and Disconnecting from the Computer

The USB connection allows you to connect EASY-MCAs to and disconnect them from a USB port without shutting down the computer or USB hub. Note that if MAESTRO is running when you disconnect the EASY-MCA, you will see a “detector not responding” message on the status line at the bottom of the MAESTRO window. When you reconnect the EASY-MCA to the computer, you will have to reselect it from the detector droplist on the Toolbar.

2.3. EASY-MCA MCB Properties in MAESTRO

This section discusses the hardware setup dialog you will see within MAESTRO and all other ORTEC CONNECTIONS software (e.g., GammaVision, ISOTOPIC) when you click **Acquire/MCB Properties...** The EASY-MCA is completely software controlled; the MCB Properties dialog contains all of the instrument controls including ADC setup parameters and acquisition presets. Just move from tab to tab and set your hardware parameters, then click **Close**.

Note that as you enter characters in the data-entry fields, the characters will be underlined until you move to another field or until 5 seconds have lapsed since the last keyboard input. During the time the entry is underlined, no other program or computer on the network can modify this value.

2.3.1. ADC

This tab (Fig. 8) contains the **Gate**, **Conversion Gain**, **Lower Level Discriminator**, and **Upper Level Discriminator** controls. In addition, the current real time, live time, and count rate are monitored at the bottom of the dialog.

The **Gate** control allows you to select a positive TTL logic level gating function. With gating **Off**, no gating is performed (that is, all detector signals are processed); with gating in **Coincidence** mode, a gating input signal *must be* present at the proper time for the conversion of the event; in **Anticoincidence** mode, the gating input signal *must not be* present for the conversion of the detector signal. The gating signal must occur prior to and extend 500 ns beyond peak detect (peak maximum).

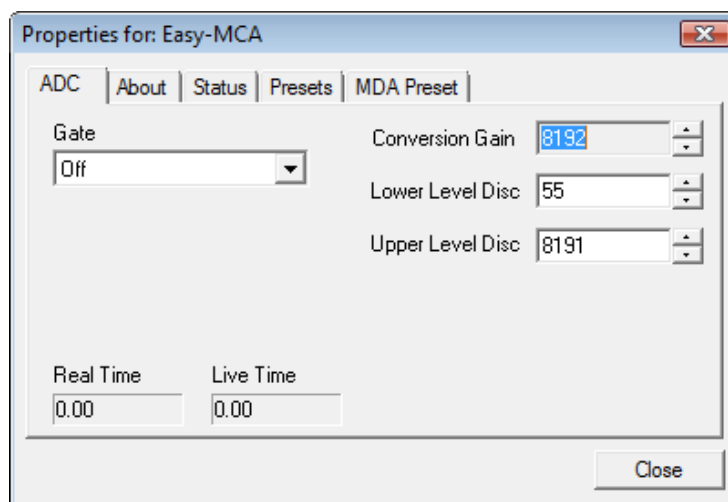


Figure 8. EASY-MCA ADC Tab.

The **Conversion Gain** sets the maximum channel number in the spectrum. If set to 8192, the energy scale will be divided into 8192 channels. The conversion gain is entered in powers of 2 (e.g., 8192, 4096, 2048, 1024, 512). The up/down arrow buttons step through the valid settings for the EASY-MCA.

The **Lower Level Discriminator** sets the level of the lowest amplitude pulse that will be stored. This level establishes a lower-level cutoff by channel number for ADC conversions. The minimum setting is 1.

The **Upper Level Discriminator** sets the level of the highest amplitude pulse that will be stored. This level establishes an upper-level cutoff by channel number for storage.

2.3.2. About

This tab (Fig. 9) displays hardware and firmware information about the currently selected EASY-MCA, as well as the data **Acquisition Start Time** and **Sample** description. In addition, the **Access** field shows whether the MCB is currently password locked (see the password discussion in the MAESTRO user manual). **Read/ Write** indicates the MCB is unlocked; **Read Only** means it is locked.

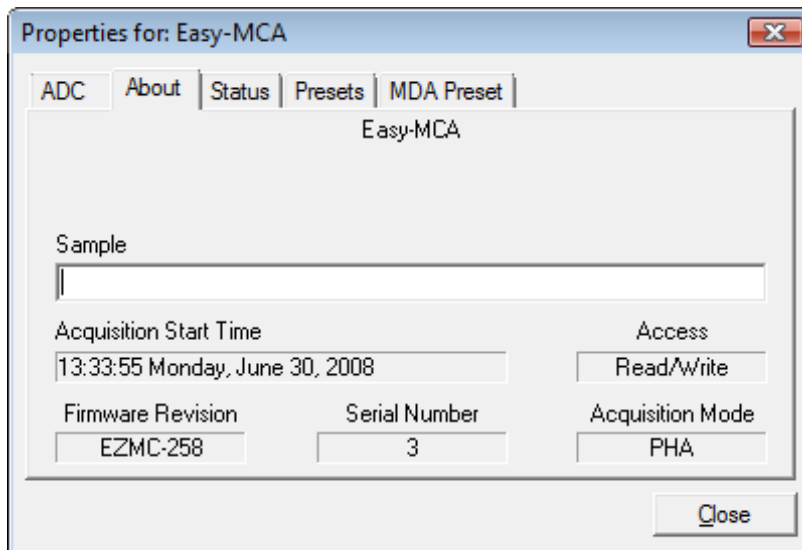


Figure 9. EASY-MCA About Tab.

2.3.3. Status

The Status tab is not used in the EASY-MCA.

2.3.4. Presets

Figure 10 shows the Presets tab. MDA presets are on a separate tab.

The presets can only be set on an MCB that is not acquiring data (during acquisition the preset fields are disabled). You may use any or all of the presets at one time. To disable a preset, enter a value of zero. If you disable all of the presets, data acquisition will continue until manually stopped.

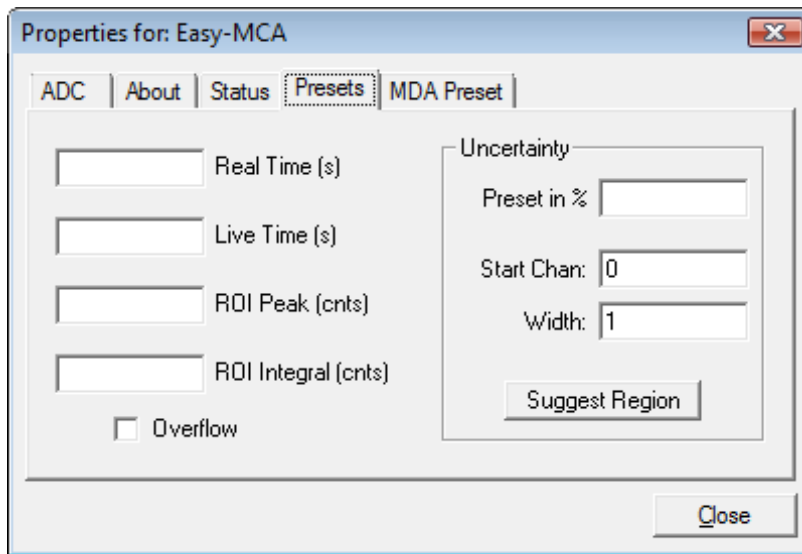


Figure 10. EASY-MCA Presets Tab.

The values of all presets for the currently selected MCB are shown on the Status Sidebar. These values do not change as new values are entered on the Presets tab; the changes take place only when you **Close** the Properties dialog.

When more than one preset is enabled (set to a non-zero value), the first condition met during the acquisition causes the MCB to stop. This can be useful when you are analyzing samples of

widely varying activity and do not know the general activity before counting. For example, the **Live Time** preset can be set so that sufficient counts can be obtained for proper calculation of the activity in the sample with the least activity. But if the sample contains a large amount of this or another nuclide, the dead time could be high, resulting in a long counting time for the sample. If you set the **ROI Peak** preset in addition to the **Live Time** preset, the low-level samples will be counted to the desired fixed live time while the very active samples will be counted for the ROI peak count. In this circumstance, the **ROI Peak** preset can be viewed as a “safety valve.”

Enter the **Real Time** and **Live Time** presets in units of seconds and fractions of a second. These values are stored internally with a resolution of 20 milliseconds (ms) since the MCB clock increments by 20 ms. *Real time* means elapsed time or clock time. *Live time* refers to the amount of time that the MCB is available to accept another pulse (i.e., is not busy), and is equal to the real time minus the *dead time* (the time the MCB is not available).

Enter the **ROI Peak** count preset value in counts. With this preset condition, the MCB stops counting when any ROI channel reaches this value unless there are no ROIs marked in the MCB, in which case that MCB continues counting until the count is manually stopped.

Enter the **ROI Integral** preset value in counts. With this preset condition, the MCB stops counting when the sum of all counts in all channels for this MCB marked with an ROI reaches this value. This has no function if no ROIs are marked in the MCB.

The **Uncertainty** preset stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the value you have entered. Enter the **Preset in %** value as percent uncertainty at 1 sigma of the net peak area. The range is from 99% to 0.1% in 0.1% steps. You have complete control over the selected peak region. The region must be at least 7 channels wide with 3 channels of background on each side of the peak. Note that MAESTRO calculates this preset once per 40 seconds. Therefore, the software will continue data acquisition up to 40 seconds after the preset has been reached, and the uncertainty achieved for a high count-rate sample may be lower than the preset value.

Use the **Start Channel** and **Width** fields to enter the channel limits directly, or click on **Suggest Region**. If the marker is positioned in an ROI around the peak of interest, **Suggest Region** reads the limits of the ROI with the marker and display those limits in the **Start Chan** and **Width** fields. The ROI can be cleared after the preset is entered without affecting the uncertainty calculation. If the marker is not positioned in an ROI, the start channel is 1.5 times the FWHM below the marker channel and the width is 3 times the FWHM.

The net peak area and statistical uncertainty are calculated in the same way as the MAESTRO **Peak Info** command.

Marking the **Overflow** checkbox terminates acquisition when data in any channel exceeds $2^{31} - 1$ ($>2 \times 10^9$) counts.

2.3.5. MDA Preset

The MDA preset (Fig. 11) can monitor up to 20 nuclides at one time, and stops data collection when the values of the *minimum detectable activity* (MDA) for *all* of the user-specified MDA nuclides reach the specified value. Presets are expressed in Bq, and are evaluated every 40 seconds. The detector must be calibrated for energy in all spectroscopy applications, and for efficiency in all applications but MAESTRO.

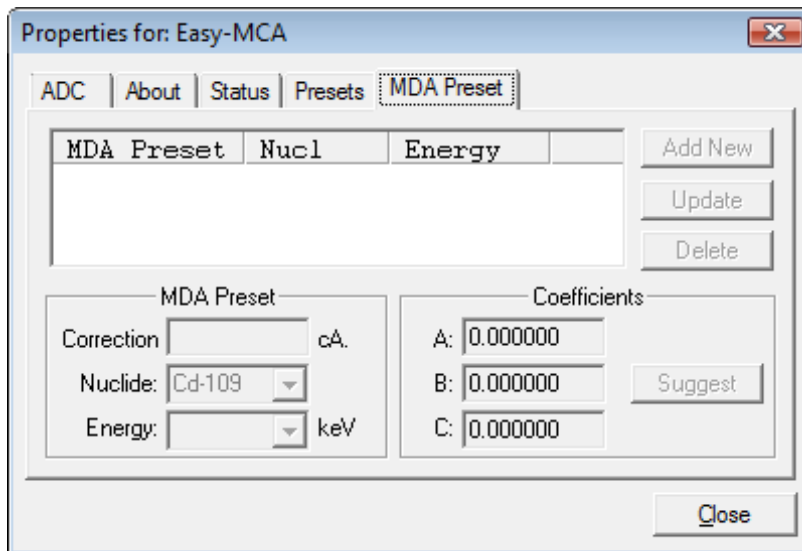


Figure 11. EASY-MCA MDA Preset Tab.

The MDA presets are implemented in the MCB (i.e., the entries you make on this screen are saved in the MCB memory), and have no direct link to MDA methods selected in the analysis options for applications such as GammaVision, ScintiVision, ISOTOPIC, etc. The MDA preset calculation uses the following formula:

$$MDA = \frac{a + \sqrt{b + c * Counts}}{Live\ time * (CorrectionFactor)}$$

where:

a , b , and c are determined by the MDA criteria you choose.

$Counts$ is the gross counts in an ROI that is $2.5 \times FWHM$ around the target peak energy.

$Live\ time$ is evaluated in 40 second intervals for the MDA presets.

$CorrectionFactor$ is the product of the calibration efficiency at the specified peak energy and the peak's branching ratio (yield) as listed in the working (active) library.

NOTE MAESTRO does not support efficiency calibration. The efficiency component in the $CorrectionFactor$ is set to 1.0; the preset field is labeled **Correction** instead of **MDA**; and the preset is based on counting activity (**cA**) instead of becquerels.

You can enter the MDA preset either in counts; or corrected for factors such as sample volume, attenuation, or calculated efficiency. For example, if you manually calculate the efficiency for a peak, you can enter a corrected MDA target value by multiplying the desired MDA value times the calculated efficiency, and entering the product as the **Correction**.

To add an MDA preset, enter the preset value in the **MDA** or **Correction** field; select the **Nuclide** and **Energy**; enter the desired values for coefficients *a*, *b*, and *c*; then click **Add New**.

To edit an existing preset, click to highlight it in the table. This will load its **Nuclide**, **Energy**, and coefficients in the lower sections of the dialog. Change as needed, then click **Update**.

To remove a preset, click to highlight it in the table, then click **Delete**.

IMPORTANT These MDA presets *are not dynamically calculated*. Each time you add an MDA preset to this table, its *CorrectionFactor* value is calculated and stored in the MCB's memory. If you then load a different library, change the efficiency calibration, or change the system geometry, the spectroscopy application *will not update* the existing *CorrectionFactors*, and your MDA presets may no longer be applicable.

When using spectrum analysis applications such as GammaVision and ScintiVision, you can create an analysis options file (.SDF or .SVD file) for each system geometry that you use; and include in it a set of MDA presets specific to that geometry, efficiency calibration, and nuclide library. You can then recall this tailored analysis options file as needed.

2.4. Troubleshooting

2.4.1. MAESTRO Does Not Connect with the EASY-MCA

If properly installed and functioning MAESTRO software (or other ORTEC spectroscopy applications) cannot find and communicate with the EASY-MCA, check for the following:

- The EASY-MCA does not have power.
- The USB cable is not properly connected.

- In MAESTRO, issue the **Services/Edit Detector List...** command to display the Master Instrument List. If the EASY-MCA is not on the list, cycle its power by disconnecting and reconnecting its power cable, then rerun the MCB Configuration program.

2.4.2. The MCB Configuration Program “Hangs” While Trying to Locate the EASY-MCA

If MCB Configuration “hangs” (i.e., fails to run to completion), click on **Cancel**, then cycle the power to the EASY-MCA by disconnecting and reconnecting its power cable. The MCB Configuration program will close. Re-run MCB Configuration.

2.4.3. The EASY-MCA Does Not Respond In MAESTRO

If MCB Configuration successfully locates the EASY-MCA but the unit does not respond within MAESTRO, cycle the power to the EASY-MCA by disconnecting and reconnecting its power cable.

For further assistance, contact your ORTEC representative or our Global Service Center.

[Intentionally blank]

3. SPECIFICATIONS

3.1. EASY-MCA

ADC Successive-approximation type with sliding-scale linearization.

Max Resolution

- **8K model** Software-selectable as 8192, 4096, 2048, 1024, 512, and 256.
- **2K model** Software-selectable as 2048, 1024, 512, and 256.

Dead Time per Event 2 μ s, including memory transfer.

Integral Nonlinearity $<\pm 0.025\%$ over the top 99% of the dynamic range.

Differential Nonlinearity $<\pm 1\%$ over the top 99% of the dynamic range.

Gain Instability $\leq \pm 50$ ppm/ $^{\circ}$ C.

Dead-Time Correction Software selectable Gedcke-Hale extended live-time correction method.

Data Memory 512 channels of battery-backed-up memory per MCB; $2^{31}-1$ counts per channel ($>2 \times 10^9$).

LLD Software-selectable from 1 to 100% full scale.

ULD Software-selectable from 0 to 100% full scale.

Presets

- **Real Time/Live Time:** Multiples of 20 ms.
- **Region-of-Interest:** Peak count/Integral count.
- **Data Overflow:** Terminates acquisition when any channel exceeds $2^{31}-1$.
- **Peak Uncertainty:** Stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the specified value.
- **Nuclide MDA** Stops data collection when the value of the minimum detectable activity (MDA) for up to 20 user-specified MDA nuclides reaches the needed value. The presets are implemented in hardware so the computer does not have to poll the EASY-MCA for the preset to operate. See Section 2.3.5 for details on the MDA preset calculation.

3.1.1. Inputs and Connectors

INPUT Accepts positive unipolar, positive gated integrator, or positive-leading bipolar analog pulses in the dynamic range from 0 to +10 V; +12 V maximum; semi-Gaussian-shaped time constants from 0.25 μ s to 30 μ s, gated-integrator-shaped time constants from 3 μ s to 30 μ s, or delay-line-shaped with width $>0.25 \mu$ s. $Z_{in} = 1 \text{ k}\Omega$, dc-coupled. No internal delay. BNC connector.

ADC GATE Optional positive TTL input. Computer-selectable **Coincidence**, **Anticoincidence**, or **Off** mode. Signal must occur prior to and extend 0.5 μ s beyond the peak of the pulse; BNC connector. $Z_{in} = 1 \text{ k}\Omega$.

PUR Pile-up rejection input; accepts TTL signal; signal must occur prior to peak detect. $Z_{in} = 1 \text{ k}\Omega$. BNC connector.

BUSY Busy input used by live-time correction circuits. Accepts TTL signal; signal must occur prior to peak detect. $Z_{in} = 1 \text{ k}\Omega$. BNC connector.

USB High-speed USB (480 Mbps) interface.

12 V DC External power input from wall-mounted dc power supply, +12 V dc, $<1.25 \text{ A}$, center contact positive.

3.1.2. Battery Backup

The memory in the EASY-MCA has battery backup to maintain data when power is turned off. Lithium battery, P/N 739480, 3 V nominal. Remove the enclosure and locate the battery on the lower left corner of the EASY-MCA board. After removing the old battery, you may have to bend the battery holder down to obtain good contact with the new battery.

3.1.3. Electrical and Mechanical

Dimensions 3.5 cm H \times 13.4 cm W \times 20.5 cm D (1.4 in. \times 5.3 in. \times 8.1 in.)

Weight 0.6 kg (1.3 lb).

3.2. Feature Mask Bits

The following table describes the feature bits from the SHOW_FEATURES command discussed on page 32. If the feature is supported in the EASY-MCA the bit is set to 1; if the feature is not supported, the bit is 0.

Bit	Meaning
0	Software-selectable conversion gain
1	Software-selectable coarse gain
2	Software-selectable fine gain
3	Gain stabilizer
4	Zero stabilizer
5	PHA mode functions available
6	MCS mode functions available
7	918-style list mode functions available
8	Sample mode functions available
9	Digital Offset (e.g., 920)
10	Software-selectable analog offset
11	HV power supply
12	Enhanced HV (SET_HV, SET/SHOW_HV_POL, SHOW_HV_ACT)
13	Software-selectable HV range (ENA_NAI, DIS_NAI)
14	Auto PZ (START_PZ_AUTO)
15	Software-selectable manual PZ (SET/SHOW_PZ)
16	Battery-backed, real-time clock (SHOW_DATE/TIME, SHOW_DATE/TIME_START)
17	Sample changer support (SET/SHOW_OUTPUT, SHOW_INPUT)
18	One-button acquisition (ENA/DIS/SHOW_TRIG_SPEC, MOVE)
19	Nomadic (likely to move between opens)
20	Local app data (SET_DATA_APP, SHOW_DATA_APP)
21	Software-retrievable serial number (SHOW_SNUM)
22	Power management commands
23	Battery status support (SHOW_STAT_BATT)
24	Software-selectable AMP polarity (SET/SHOW_GAIN_POLAR)
25	Support for flattop optimization (ENA/DIS_OPTI)
26	Stoppable AutoPZ (STOP_PZ_AUTO)
27	Network support (e.g., DSPEC)
28	Multi-drop serial support (e.g., MicroNOMAD®)
29	Software-selectable DPM address (SET_DPM_ADDR)
30	Multiple devices (e.g., 919)
31	Software-selectable ADC gate mode (SET_GATE...)
32	Software-downloadable firmware
33	Time histogramming functions available (e.g., 9308)
34	Software-selectable lower level discriminator
35	Software-selectable upper level discriminator

Bit	Meaning
36	MCS-mode SCA input available
37	MCS-mode positive TTL input available
38	MCS-mode fast-negative NIM input available
39	MCS-mode discriminator input available
40	Software-switchable MCS-mode discriminator edge
41	Software-programmable MCS-mode discriminator level
42	Software-programmable SCA upper and lower thresholds
43	Software-selectable MCS-mode input sources
44	Uncertainty/statistical preset (SET_UNCERT_PRESET)
45	Features vary by input (SHOW_FEATURES depends on device/segment; multi-input MCBs only)
46	Software-selectable HV shutdown mode (SET/SHOW/VERI_SHUT)
47	Software-selectable shaping time constants (SET_SHAP)
48	Explorable shaping time constants (SHOW_CONFIG_SHAP)
49	Advanced shaping time (SET_SHAP_RISE, SET_SHAPE_FLAT, etc.)
50	Software-selectable BLR (ENA/DIS/SHO_BLR_AUTO SET/SHO/VERI_BLR)
51	SHOW_STATUS command supported (returns \$M record)
52	Overflow preset (ENA/DIS/SHO_OVER_PRESET)
53	Software-enabled, MicroNOMAD-style audio clicker (ENA/DIS_CLICK)
54	Software-readable thermistor (SHOW_THERM)
55	Floating-point fine gain (SET/SHO/VERI/LIST_GAIN_FINE)
56	Software-enabled pileup rejector. (ENA/DIS/SHO_PUR, SET/VERI_WIDT_REJ)
57	Alpha-style HV power (SHOW_HV_CURRENT)
58	Software-readable vacuum (SHOW_VACUUM)
59	Acquisition alarms (ENA/DIS/SHO_ALARM)
60	Hardware acquisition trigger (ENA/DIS/SHO_TRIG)
61	Ordinal numbers for shaping times (SET_SHAP 0, SET_SHAP 1, ...)
62	Explorable gain ranges (LIST/VERI_GAIN_FINE, ..._COAR, ..._CONV)
63	Routable inputs (SET/SHOW_INPUT_ROUTE)
64	External dwell support (ENA/DIS_DWELL_EXT)
65	Selectable SUM or REPLACE MCS modes (ENA/DIS_SUM)
66	External start of pass support (ENA/DIS/SHO_START_EXT)
67	Explorable with MCS list commands (LIST_SOURCE, LIST_LLSCA, LIST_ULSCA)
68	Device supports the MDA preset
69	Software-selectable ADC type (MatchMaker™)
70	Has ability to daisy-chain MCBs (DART)
71	Zero Dead Time functions available (DSPEC-series, EASY-MCA)

Bit	Meaning
72	DSPEC Plus-style Insight triggering (LIST/SET_TRIG_SAMP)
73	Multiple inputs per connection (for example, OCTÊTE® Plus)
74	Hardware count-rate meter (SH_CRM)
75	Multiple ZDT modes (SET/SHOW/LIST_MODE_ZDT)
76	Multi-nuclide MDA preset
77	MCS Replace then Sum Mode (SET_RPLSUM)
78	Programmable external dwell voltage capability
79	NO Peak Preset feature (M ³ CA and OASIS)
80	Programmable pulser (OASIS)
81	Programmable Vacuum/HV interlock (OASIS)
82	Programmable Current/HV interlock (OASIS)
83	Explorable Stabilizer (LIST_GAIN_ADJU, LIST_ZERO_ADJU)
84	Programmable input impedance (MCS)
85	Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr 2.0, DSPEC Pro)
86	Selectable HV rise-time (SET/SHOW/LIST_HV_RISE) (SBS-60)
87	Explorable ADC GATE settings (LIST_GATE, SET_GATE n)
88	Monitor command support (SHOW_MONI_MAX/LABEL/VALUE)
89	SMART-1™ Detector support (SHOW_SMART_DET, SHOW_SNUM_DET, SHOW_HV_RECO)
90	Nuclide report (SET/SHOW_NUCL_COEF, SET/SHOW_ROI_NUCL, ...)
91	Interactive Display Features Such as Nuclide Report
92	Advanced Stored Spectra (SH_SPEC_COUNT, SET/SHOW_SPEC_ID, MOVE)
93	SET/SHOW_VIEW in MCBs with Dual-Port Memory or printer port interfaces, LIST_VIEW in all MCBs
94	Connected to MCB via RS-232 (slow) port
95	No SET_HV_POSI, SET_HV_NEGA, ENA_NAI and DIS_N
96	Low Frequency Rejecter (ENA/DIS/SHOW_LFR)
97	Resolution Enhancer (ENA/DIS/SH_RENHANCER, SET/SHOW_RETABLE idx,val)
98	SET_MODE_RELIST for Resolution Enhancer List Mode
99	Readable Sample mode time per channel (SH_TIME_SAMPLE)
100	Adjustable Sample mode time per channel (SET/LIST_TIME_SAMPLE)
101	List Mode data streamed and formatted as in digiBASE
102	Supports ETP mode (ENA/DIS/SHOW_ETP)
103	List Mode data streamed and formatted as in DSPEC Pro
104	SET/SHOW/LIST_PZ using floating point microseconds
105	Risetime, flattop width and cusp not changeable from property page
106	HV not user changeable from property page (requires Bit 12)

Bit	Meaning
107	Coarse and fine gain not user changeable from property page
108	PZ and flattop tilt not user changeable from property page
109	LFR not user changeable from property page (requires Bit 96)
110	Portal Monitor style List Mode Synch is available
111	DSPEC-Pro Auxilliary BNC input available
112	SET_DISPLAY is NOT used to select ZDT data view (requires Bit 93)
113	ID Reports (DO_ID, SHOW_REPORT, SHOW_REPO_LINES)
114	Has neutron detector (SHOW_CRM 2 returns valid number)
115	—
116	—
117	—
118	—
119	—
120	—
121	—
122	—
123	—
124	—
125	—
126	—
127	Extended feature mask available (SH_FEAT_EXT)

4. FIRMWARE COMMANDS AND RESPONSES

Software communication with the EASY-MCA will take place through the CONNECTIONS software layer. CONNECTIONS is used by all ORTEC software and can be accessed for other software development with our CONNECTIONS Programmer's Toolkit with Microsoft ActiveX® Controls (A11-BW). Use the DLL interface call `MIOComm` or the ActiveX control UCONN's `Comm` method to send commands to instruments and receive responses.

4.1. Command Format

The commands consist of a command header that may be followed by numeric parameter values. The header consists of a verb; a verb and noun; or a verb, noun, and modifier; each separated by underscores. The first four letters of a word in a command will always be enough to uniquely identify that word when composing commands for the instrument. For example, the command **ENABLE_GAIN_STABILIZATION** can be abbreviated to **ENAB_GAIN_STAB**.

Numeric parameters are unsigned integer numbers that follow the command header separated by one or more spaces. Specific commands require multiple parameters, separated by commas, that specify numeric quantities related to the operation of the MCB, such as live time or conversion gain. The command **SET_WINDOW 0,8192** has two parameters, 0 and 8192, which set the window of interest to start at channel 0 and continue for 8192 channels.

Some parameters are optional and are delimited by square brackets in the command prototype line to distinguish them from mandatory parameters (e.g., `SET_WINDOW [start,length]`). Commands with optional parameters can be sent to the MCB without the optional parameters, in which case the instrument behavior will be explained in the command description.

4.2. Error Codes

On each completion of the command, the MCB returns a macro error code and micro error code. The macro error code represents the general class of error with 0 meaning no error, and the micro error code represents the sub-class of error with 0 meaning no error. In case of error condition, you can use the `MIOGetLastError` (DLL interface) or `GetErrMajor`, `GetErrMinor` (ActiveX control interface).

Macro error codes:

0	Success
1	Power-up just occurred
2	Battery-backed data lost
129	Command syntax error

131	Command execution error
132	Invalid Command

For macro code 129 (syntax error) or 131 (execution error), the following apply:

1	Invalid Verb
2	Invalid Noun
4	Invalid Modifier
128	Invalid first parameter
129	Invalid second parameter
130	Invalid third parameter
131	Invalid fourth parameter
132	Invalid number of parameters
133	Invalid command
134	Response buffer too small
135	Not applicable while active
136	Invalid command in this mode
137	Hardware error
138	Requested data not found

Micro error codes:

0	Success
1	Input already started/stopped
2	Preset already exceeded
4	Input not started/stopped
64	Parameter was rounded (for decimal numbers)
128	No sample data available

4.2.1. Dollar Response Records

SHOW and STEP commands respond with a single dollar response record followed immediately by a percent response record. All valid dollar response records for each command are listed in the command dictionary.

The following list provides the general form of each dollar response record for the MCB API. In this list, lower case letters represent numeric values. The letters “ccc” always represent an 8-bit

unsigned checksum of all characters on the record up to but not including the checksum characters, and <CR> represents the ASCII carriage return character.

\$Axxxccc<CR>	xxx is a single 8-bit unsigned number.
\$Cxxxxccc<CR>	xxxx is a single 16-bit unsigned number.
\$Dxxxxxyyyyccc<CR>	xxxx and yyyy are 16-bit unsigned numbers.
\$Exxxxxccc<CR>	xxxx is a single 16-bit alarm mask.
\$Fsss...<CR>	sss... is a variable length ASCII character sequence (no checksum is sent with this record).
\$Gxxxxxxxxccc<CR>	xxxxxxx is a single 32-bit unsigned number.
\$IT<CR>	True response to a SHOW command (no checksum).
\$IF<CR>	False response to a SHOW command (no checksum).
\$Jxxxxxyyyy...ccc<CR>	Response to SHOW_CONFIGURATION command.
\$Mxxxxxxxx...ccc<CR>	Response to SHOW_STATUS command.
\$Nxyyyzzzccc<CR>	xxx, yyy, and zzz are 8-bit unsigned numbers.

4.2.2. MCB Commands

This section lists each command with a description of its operation. The descriptions include a list of any error codes that may result. As described in the two preceding sections, the usual response is a macro error code of 0 and a micro error code of 0 (no errors). Though syntax and communication error responses may result from any command, in practice, these error responses rarely occur on systems with reliable communication hardware running debugged software.

The commands are listed in alphabetical order, each starting with a command prototype line. Uppercase letters, numeric digits, blank space, and special symbols such as the underscore “_” and comma “,” in the prototype line are *literal text to be sent to the MCB exactly as they appear*. Lowercase letters in the prototype line represent numeric values as described in the accompanying text; they should not be sent literally to the MCB but should be replaced by an appropriate numeric value. In this section the term <CR> represents the ASCII carriage return character, decimal value 13; and the character “_” represents the ASCII underscore character, decimal value 95.

CLEAR

The channels of spectral data in the window of interest (see SET_WINDOW command) are set to zero. The live time and true time counters are also set to zero. This command is equivalent to the combination of CLEAR_COUNTERS and CLEAR_DATA commands.

CLEAR_ALL

This command is equivalent to the combination of CLEAR_COUNTERS, CLEAR_DATA, CLEAR_PRESETS, and CLEAR_ROI commands.

CLEAR_COUNTERS

The live time and true time counters are set to zero.

CLEAR_DATA

The channels of spectral data in the window of interest (see SET_WINDOW command) are set to zero. The ROI flags are not changed, nor are the presets changed.

CLEAR_MDA_PRESET

Clears all MCA preset values. This command is used to quickly clear the list of MDA preset values.

CLEAR_PRESETS

The live time, true time, ROI integral, ROI peak, and overflow presets are all set to zero (disabled).

CLEAR_ROI

The region-of-interest flags for the channels in the window of interest (see SET_WINDOW command) in the currently selected device (see SET_DEVICE command) are cleared.

DISABLE_OVERFLOW_PRESET

Disables the overflow preset. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will roll over to zero counts if the overflow preset is disabled. See also ENABLE_OVERFLOW_PRESET and SHOW_OVERFLOW_PRESET.

ENABLE_OVERFLOW_PRESET

Enables the overflow preset. Channels that receive a count when they contain 2147483647 counts, the maximum number of counts, will stop the acquisition if the overflow preset is enabled. The channel that caused the preset to complete will contain 2147483647 counts. See also DISABLE_OVERFLOW_PRESET and SHOW_OVERFLOW_PRESET commands.

INITIALIZE

Returns the EASY-MCA (including flash) to the factory default settings, including resetting the MCB Configuration instrument ID number to zero.

LIST_DISPLAY

Not used by the EASY-MCA; included for backward compatibility.

LIST_GAIN_CONV

Lists legal conversion gain settings.

Response:

GAIN_CONV	256	512	1024	2048	4096	8192	8K model.
GAIN_CONV	256	512	1024	2048			2K model.

RESET

No function in the EASY-MCA; included for backward compatibility.

SET_DATA [start, chans],value

If the optional start and chans parameters are included in this command, the range of channels specified by start and chans is loaded with value. If start and chans are not specified, sets all channels of spectral data in the window of interest (see SET_WINDOW command) to the specified value. ROI flags are not affected.

SET_DATA_APPLICATION "string1","string2"

This is used to store information in the EASY-MCA internal memory that can be used by other programs, such as sample descriptions and energy calibrations. CONNECTIONS uses this feature. String1 = the data identifier, 32 bytes maximum; string2 = the data, 128 bytes maximum.

SET_DEVICE

No function in the EASY-MCA; included for backward compatibility.

SET_GAIN_CONVERSION chans

Sets the conversion gain. The conversion gain defines the number of channels within the device that will be used for spectral data. This has the effect of altering the resolution of the ADC from 13 bits (conversion gain = 8192) to 9 bits (conversion gain = 512) for the device. See also SHOW_GAIN_CONVERSION.

Legal Commands:

SET_GAIN_CONVERSION 0<CR>	Conversion gain set to default (8192).
SET_GAIN_CONVERSION 512<CR>	Conversion gain set to 512 channels.
SET_GAIN_CONVERSION 1024<CR>	Conversion gain set to 1024 channels.
SET_GAIN_CONVERSION 2048<CR>	Conversion gain set to 2048 channels.
SET_GAIN_CONVERSION 4096<CR>	Conversion gain set to 4096 channels.
SET_GAIN_CONVERSION 8192<CR>	Conversion gain set to 8192 channels.

SET_GATE_ANTICOINCIDENT

Causes the EASY-MCA to use the ADC gate input signal in anticoincident mode. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SHOW_GATE.

SET_GATE_COINCIDENT

Causes the EASY-MCA to use the ADC gate input signal in coincident mode. See also SET_GATE_OFF, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_GATE_OFF

Causes the EASY-MCA to ignore the state of the ADC gate input signal. See also SET_GATE_COINCIDENT, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_INTEGRAL_PRESET count

Sets the ROI integral preset to the specified count. During data acquisition when the sum of the counts contained in the channels that have the ROI flag set reaches the integral preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI integral may exceed the preset value by up to 512 counts due to the pipelined architecture of the EASY-MCA. Setting an integral preset to 0 counts disables the preset. The integral preset may be set to from 0 (disabled) to 4294967295 counts. See also CLEAR_PRESETS and SHOW_INTEGRAL_PRESET.

SET_LIVE ticks

Sets the live-time counter to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks/s). Normally this value is set by the EASY-MCA during data acquisition. See also CLEAR_COUNTERS and SHOW_LIVE.

SET_LIVE_PRESET ticks

Sets the live-time preset to the specified number of ticks (20 ms/tick). During data acquisition when the live-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a live-time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_LIVE_PRESET.

SET_LLD chan

Sets the lower level discriminator to chan, which must be between 1 and 8191. See also SHOW_LLD.

SET_MARK

Not used by the EASY-MCA; included for backward compatibility.

SET_MDA_COEF a,b,c

Sets the coefficients in the MDA preset calculation to the specified values. A, b, and c are floating-point values. The MDA preset checks for the following condition to be met:

$$MDA\ Preset_i > \frac{a + \sqrt{b + c * Counts\ in\ ROI_i}}{Live\ Time}$$

The calculation is performed once every 30 seconds with *i* starting at 0 and advancing through each of up to 20 unique MDA presets. *i* only advances once the preset has been met. Note that a, b, and c are the same for each of the unique presets. Only the ROI range and the MDA preset change when *i* advances. Once *i* reaches 20 or *MDAPreset_i* equals 0, the acquisition terminates.

SET_MDA_PRESET MDAPreset,[PeakNumber]

Sets the MDAPreset PeakNumber value as shown in the equation in the SET_MDA_COEF description above. MDAPreset is usually the product of the desired MDA, the yield and the efficiency. PeakNumber is a parameter that specifies which of up to 20 (0–19) MDA presets to change. If PeakNumber is omitted in the set command, all MDA preset values will be set to 0 (disabled), and the supplied value will be applied to MDA Preset 0. This provides compatibility software that only supports the one-nuclide MDA method implemented in some MCBs.

SET_MODE_PHA

Sets the mode to PHA.

SET_OUTPUT [port, value]

This sends the value to the port. This command can be issued without entries for port and value because the EASY-MCA has only one port. If you wish to specify a port number, it must be zero for this unit. See also SHOW_OUTPUT. See also STEP_OUTPUT.

SET_PEAK_PRESET count

Sets the ROI peak preset to the specified count. During data acquisition when the contents of any channel of a device that has the ROI flag set reaches the peak preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI peak may exceed the preset value by a small number of counts due to the pipelined architecture of the EASY-MCA. Setting a peak preset to 0 counts disables the preset. The peak preset may be set to from 0 (disabled) to 2147483647 counts. See also CLEAR_PRESETS and SHOW_PEAK_PRESET.

SET_ROI start_chan,number_of_chans

Sets the ROI flags for the specified channels. This command can be used multiple times to set ROI flags without affecting previously set flags. ROI flags specify channels within a device that are considered for ROI integral and ROI peak presets.

SET_ROI_MDA start,numchans, [PeakNumber]

Sets the region to use to compute the gross counts in the MDA calculation. PeakNumber is an optional parameter (assumed 0 if not present) that specifies which of up to 20 (0–19) MDA Presets to change.

SET_ROI_UNCERTAINTY start, chans

Sets the region to be used for the uncertainty preset calculation. See also SHOW_ROI_UNCERTAINTY.

SET_SEGMENT

Not used in the EASY-MCA; included for backward compatibility.

SET_TRUE ticks

Sets the true-time counter to the specified number of ticks. The number represents true time in units of 20 ms (50 ticks/sec). Normally this value is set by the EASY-MCA during data acquisition. See also CLEAR_COUNTERS and SHOW_TRUE.

SET_TRUE_PRESET ticks

Sets the true-time preset to the specified number of ticks (20 ms/tick). During data acquisition when the true-time counter reaches the preset number of ticks, the preset is complete and the acquisition is stopped. Setting a true-time preset to 0 ticks disables the preset. See also CLEAR_PRESETS and SHOW_TRUE_PRESET.

SET_ULD value

This sets the upper level discriminator to value, in channels.

SET_UNCERTAINTY_PRESET percent

Sets the uncertainty preset to the specified value in percent. Percent is a floating point value from 0–99.9999. See also SHOW_UNCERTAINTY_PRESET.

SET_WINDOW [start, length]

Sets the window of interest to the specified start channel and number of channels. The channels of spectral data in the window of interest are affected by commands such as CLEAR, SET_DATA, and WRITE. If neither start nor length is provided, the window is set to the maximum size allowed by the conversion gain specified. The window of interest is always set to the maximum size after a SET_DEVICE command or a SET_SEGMENT command.

SHOW_ACTIVE

Returns a 1 if the EASY-MCA is active (i.e., acquiring spectral data) or 0 if it is not active.

Responses:

\$C00000087<CR> Not active.

\$C00001088<CR> Active.

SHOW_CONFIGURATION

Returns a record that indicates the hardware configuration of the MCB. The record contains information about the number of segments in an MCB (always 1 for the EASY-MCA), and the current conversion gain for each segment. The record is organized as follows:

\$J0819200001aaaaa00000[65 zeros here for total of 75 zeros]00000ccc

where **aaaaa** represents the conversion gain for the one and only segment in the currently selected device, and **ccc** represents the record checksum. See the section on response records in this chapter for more information about response records and checksums.

SHOW_CONFIGURATION_MASK

Returns two masks, the first of which can be “anded” with data from the MCB to clear the ROI bit from the data. When the second mask value is “anded” with data from the MCB, the data bits are removed and only the ROI bit remains.

Response:

CONF_MASK 02147483647 02147483648

SHOW_CONFIGURATION_UART

Reports the baud rate, parity option, number of data bits, and number of stop bits for the serial interface.

Responses:

\$F09600N81 9600 baud, no parity, 8 data bits, 1 stop bit.

\$F19200E82 19200 baud, even parity, 8 data bits, 2 stop bits.

\$F02400O71 2400 baud, odd parity, 7 data bits, 1 stop bits.

SHOW_DATA_APPLICATION “string”

If string matches “string1” in a previous SET_DATA_APPLICATION command, then string2 from that command is returned. The response is a \$F record.

SHOW_DEVICE

Reports which inputs are acquiring data. The 16-bit answer is transmitted as a \$C response record, which represents a binary mask of bits each representing one of the two inputs. A 1 bit in the mask indicates that the corresponding segment is counting.

Responses:

\$C00000087<CR>	Neither input is acquiring data.
\$C00001088<CR>	Only input 1 is acquiring data.
\$C00002089<CR>	Only input 2 is acquiring data.
\$C00003090<CR>	Both inputs 1 and 2 are acquiring data.

SHOW_FEATURES

Responds with four 32-bit masks indicating which features are present in the MCB. See Section 3.2 for a complete description of each bit in the mask.

Example Response:

FEATURES 02285062207 02014941185 0000000000 0000000000

SHOW_GAIN_CONVERSION

This command returns the conversion gain.

Responses:

\$C00512095<CR>	Conversion gain reported as 512 channels.
\$C01024094<CR>	Conversion gain reported as 1024 channels.
\$C02048101<CR>	Conversion gain reported as 2048 channels.
\$C04096106<CR>	Conversion gain reported as 4096 channels.
\$C08192107<CR>	Conversion gain reported as 8192 channels.

SHOW_GATE

Reports the current mode of operation of the ADC gate input. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SET_GATE_ANTICOINCIDENT.

Responses:

\$FOFF<CR>	Reports the ADC gate is off or ignored.
\$FCOI<CR>	Reports the ADC gate is in coincident mode.
\$FANT<CR>	Reports the ADC gate is in anticoincident mode..

SHOW_INTEGRAL [start_chan,number_of_chans]

Reports the sum of the specified group of spectral data channels. If start_chan and number_of_chans is not provided, SHOW_INTEGRAL reports the sum of all channels in the currently selected window that have their ROI flag set.

Responses:

\$G0000000000075<CR>	Integral reported as 0.
...	...
\$G4294967294131<CR>	Integral reported as 4294967294.
\$G4294967295132<CR>	Integral reported as greater than or equal to 4294967295 (maximum reportable value).

SHOW_INTEGRAL_PRESET

Reports the current ROI integral preset value. For more information about the ROI integral preset, see SET_INTEGRAL_PRESET. See also SHOW_INTEGRAL.

Responses:

```
$G0000000000075<CR>      Integral preset reported as 0.
...
$G4294967295132<CR>      Integral reported as 4294967295.
```

SHOW_LIVE

Reports the contents of the live-time counter in units of 20 ms (50 ticks/s). See also CLEAR_COUNTERS and SET_LIVE.

Responses:

```
$G0000000000075<CR>      Live time reported as 0 ticks.
$G0000000001076<CR>      Live time reported as 1 tick (20 ms).
...
$G4294967295132<CR>      Live time reported as 4294967295 ticks (over 23000
                             days).
```

SHOW_LIVE_PRESET

Reports the current live-time preset in units of 20 ms (50 ticks/s). See also CLEAR_PRESETS and SET_LIVE_PRESET.

Responses:

```
$G0000000000075<CR>      Live-time preset reported as disabled.
$G0000000001076<CR>      Live-time preset reported as 1 tick.
...
$G4294967295132<CR>      Live-time preset reported as 4294967295 ticks.
```

SHOW_LLD

Shows the lower level discriminator setting. See also SET_LLD.

Responses:

```
$C00050092                The LLD is 50.
```

SHOW_MDA [PeakNumber]

Reports current MDA for the MDA Preset selected by PeakNumber. PeakNumber is assumed to be 0 if not supplied.

Example response:

```
MDA 000000000010.7
```

SHOW_MARK

Not used by the EASY-MCA; included for backward compatibility.

SHOW_MDA_COEF

Reports the current settings for coefficients a, b, and c used for the MDA calculation. See SET_MDA_COEF.

Example Responses:

MDA_COEF 000000000002.71 00000000000000 00000021.700001

Coefficient a = 2.71, b = 0, and c = 21.7.

SHOW_MDA_PRESET [PeakNumber]

Reports MDA preset PeakNumber. If PeakNumber is omitted, 0 is assumed.

Example Response:

MDA_PRES 0000000000025.7

SHOW_MODE

Reports the current mode of operation (PHA mode only for the EASY-MCA). See also SET_MODE_PHA.

Responses:

\$FPHA<CR> PHA mode.

SHOW_MONI_LABEL num

Returns with an ASCII string label designation for the state-of-health parameter for num.

SHOW_MONI_MAX

Returns with the number of state-of-health values available for viewing.

SHOW_MONI_VALUE num

Returns with an ASCII representation of the value for the state-of-health parameter.

SHOW_NEXT

Used in conjunction with the SHOW_ROI command, SHOW_NEXT reports the next continuous group of channels that have the ROI flag set. The response is of the form

\$Dssssnnnnnccc<CR>

where ssss represents an integer number that is the number of the first channel of the “next” group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. If no more channels have their ROI bit set, SHOW_NEXT returns a first channel of 0 and a number of channels of 0. The SHOW_ROI command is used to report the “first” group of channels that all have their ROI bit set.

Example Responses:

\$D010000050078<CR>

Next ROI group starts at channel 1000 and is 50 channels long.

\$D0215000150086<CR> Next ROI group starts at channel 2150 and is 150 channels long.

\$D0000000000072<CR> No other ROI groups to report.

SHOW_OVERFLOW_PRESET

Reports the state of the overflow preset.

Responses:

\$IT<CR> Overflow preset enabled.

\$IF<CR> Overflow preset disabled.

SHOW_PEAK

This command returns the contents of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The maximum possible value is 2147483647, which is the maximum number of counts that can be stored in a 31-bit channel.

Responses:

\$G0000000000075<CR> Maximum count in an ROI channel is zero or no ROI channels were found.

\$G0000000001076<CR> Maximum count in an ROI channel is 1.

...

...

\$G2147483646120<CR> Maximum count in an ROI channel is 2147483646.

\$G2147483647121<CR> Maximum count in an ROI channel is 2147483647.

SHOW_PEAK_CHANNEL

This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more than one channel contains the largest number of counts. Channel 8191 is the highest numbered channel in any device.

Responses:

\$C00000087<CR> Maximum count was found in channel 0 or no ROI channels were found.

\$C00001088<CR> Maximum count was found in channel 1.

...

...

\$C08191107<CR> Maximum count was found in channel 8191.

SHOW_PEAK_PRESET

Reports the value of the ROI peak preset. See SET_PEAK_PRESET for information about the ROI peak preset.

Responses:

\$G0000000000075<CR> Peak preset disabled.

\$G0000000001076<CR> Peak preset set to 1 count.

\$G2147483646120<CR> Peak preset set to 2147483646 counts.
\$G2147483647121<CR> Peak preset set to 2147483647 counts.

SHOW_ROI

Used in conjunction with the SHOW_NEXT command, SHOW_ROI reports the first continuous group of channels that have the ROI flag set. The response is of the form

\$Dssssnnnnnccc<CR>

where ssss represents an integer number that is the number of the first channel of the “first” group of channels that all have their ROI bit set, and nnnnn represents an integer number that is the number of channels in the group. The SHOW_NEXT command is used to report the “next” group of channels that all have their ROI bit set.

Responses:

\$D0100000050078<CR> First ROI group starts at channel 1000 and is 50 channels long.
\$D0215000150086<CR> First ROI group starts at channel 2150 and is 150 channels long.
\$D0000000000072<CR> No ROI groups to report.

SHOW_ROI_MDA

Reports the start channel and number of channels used in the MDA preset calculation.

Example Response:

\$D0700000050ccc Calculation is performed on channels 7000–7049.

SHOW_ROI_UNCERTAINTY

Reports the start channel and number of channels used in the uncertainty preset calculation. See also SET_ROI_UNCERTAINTY.

Response:

\$D0700000050ccc Calculation is performed on channels 7000–7049.

SHOW_SEGMENT

Returns the current segment number. Always 1 for the EASY-MCA.

SHOW_SNUM

Responds with a \$F record indicating the serial number of the EASY-MCA

Response:

\$F100 Serial number = 100.

SHOW_STATUS

Returns system status information in the following format:

\$Miiiiiiiiitttttttttaaaaahhhhccc<CR>

where **llllllll** represents the live time as returned by the `SHOW_LIVE` command, **ttttttttt** represents the true time for the current device as returned by the `SHOW_TRUE` command, **aaaaa** represents the active device mask as returned by the `SHOW_ACTIVE_DEVICES` command, and **hhhhh** represents the hardware status, which is an ASCII representation of a 16 bit decimal number with the following bit definitions:

Bit 0 (LSB):	Bias supply polarity (0=positive, 1=negative)
Bit 1:	Bias supply overload (0=overload, 1=normal)
Bit 2:	High voltage enabled (0=disabled, 1=enabled)
Bit 3:	Unused
Bit 4:	Amplifier PZ'd since initialization (0=normal, 1=needs PZ'ing)
Bit 5:	Optimization since initialization (0=normal, 1=needed)
Bits 6–7:	Unused
Bit 8:	Amplifier automatic PZ (1=Auto PZ in progress, 0=normal)
Bit 9:	Optimization (0=normal, 1=in progress)
Bits 10–14:	Unused
Bit 15 (MSB):	Reserved

SHOW_TRUE

Reports the contents of the true-time counter in units of 20 ms (50 ticks/s). See also `CLEAR_COUNTERS` and `SET_TRUE`.

Responses:

\$G0000000000075<CR>	True time reported as 0 ticks.
\$G0000000001076<CR>	True time reported as 1 tick (20 ms).
...	...
\$G4294967295132<CR>	True time reported as 4294967295 ticks (over 23000 days).

SHOW_TRUE_PRESET

Reports the current true-time preset in units of 20 ms (50 ticks/s). See also `CLEAR_PRESETS` and `SET_TRUE_PRESET`.

Responses:

\$G0000000000075<CR>	True time preset reported as disabled.
\$G0000000001076<CR>	True time preset reported as 1 tick.
...	...
\$G4294967295132<CR>	True time preset reported as 4294967295 ticks.

SHOW_ULD

Returns the value of the ULD in channels, as a \$C record.

SHOW_UNCERTAINTY

Returns the current value of the uncertainty for the peak in the uncertainty preset. See also SET_UNCERTAINTY.

Responses:

UNCE 0000000000008.5 Uncertainty of the peak is 8.5%.

SHOW_UNCERTAINTY_PRESET

Returns the current uncertainty preset setting. See also SET_UNCERTAINTY_PRESET.

Responses:

UNCE_PRES 00000000000000 No preset.

UNCE_PRES 0000000000008.5 Preset set to 8.5%.

SHOW_VERSION

Reports the EASY-MCA firmware version number in the form

Fmmmm-vvv<CR>

where mmmm is a 4-character model designator and vvv is a 3-character version designator.

Example Responses:

\$FEZMC-002<CR> Model EASY-MCA firmware version 2 reported.

SHOW_WINDOW

Reports the start channel and number of channels in the window of interest, in the form

\$Dxxxxxyyyyccc<CR>

where xxxxx is the start channel (0–8192) and yyyyy is the number of channels (1–8192).

See SET_WINDOW for more information about the window of interest.

Example Responses:

\$D0000008192092<CR> Window of interest reported as starting at channel 0 and continuing for 8192 channels.

\$D0819208192112<CR> Window of interest reported as starting at channel 8192 and continuing for 8192 channels.

START [seg-mask]

Starts the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored by the EASY-MCA.

STOP [seg-mask]

Stops the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and may be any value from 0 to 65535 but is ignored.

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