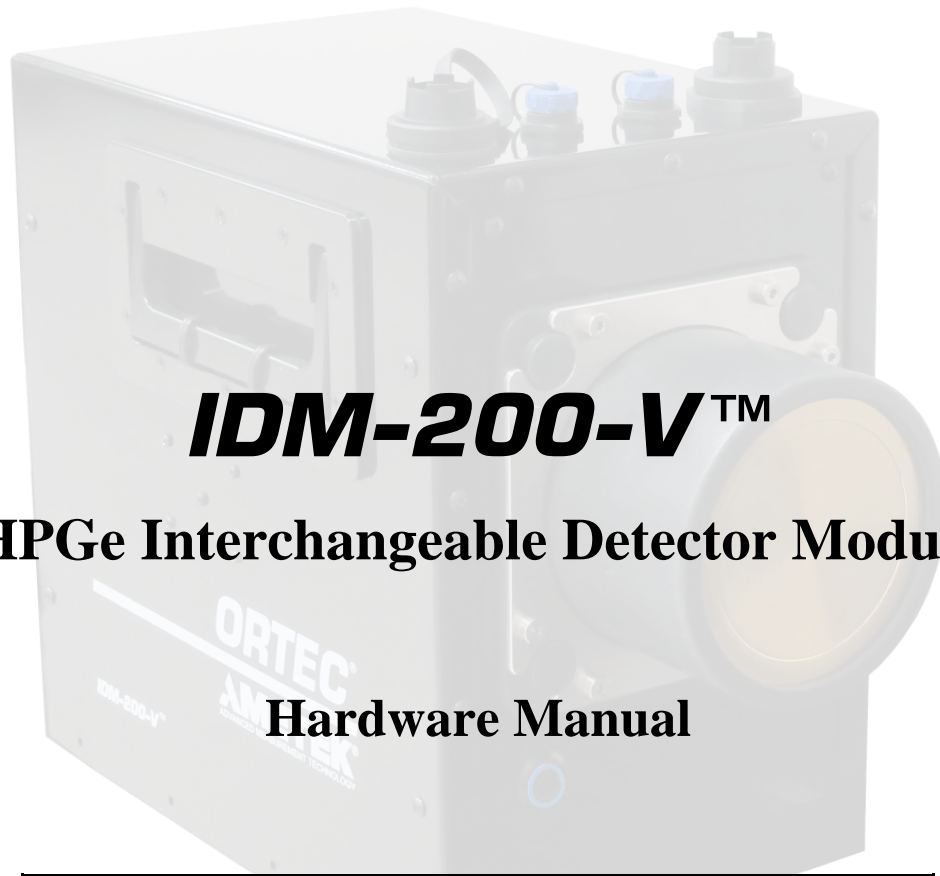


**ORTEC<sup>®</sup>**



***IDM-200-V<sup>™</sup>***

**HPGe Interchangeable Detector Module**

**Hardware Manual**

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# **Advanced Measurement Technology, Inc.**

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### **Quality Control**

Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

### **Repair Service**

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing, by telephone [(865) 482-4411] or by facsimile transmission [(865) 483-2133], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped PREPAID via Air Parcel Post or United Parcel Service to the designated ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation.

### **Damage in Transit**

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

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# ADDITIONAL WARRANTY STATEMENT

The IDM-200-V contains *no user-serviceable parts*. Except for the battery hatch on the left side panel, which can be opened when the battery requires replacement, breaking the seal on the case *voids your warranty*. The IDM-200-V should be opened only by ORTEC-authorized service personnel.

If you have any questions about the use or maintenance of this instrument, please contact your ORTEC representative or our Global Service Center first.

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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—High Voltage**



**ATTENTION—Refer to Manual**

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:

- 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® IDM-200-V™ Interchangeable Detector Module is a gamma-ray spectrometry “building block.” It is a completely self contained package comprising a single, large-area, mechanically cooled high-purity germanium (HPGe) detector of standardized crystal dimensions and all necessary spectrometry electronics in a rugged, low-power configuration.

The IDM-200-V includes everything needed for high-resolution spectrometry that either produces a spectrum in memory or delivers a digitized pulse stream in list mode form to an attached PC for further analysis.

The IDM-200-V is the perfect solution for a wide range of measurements and applications where spectroscopic performance, reliability and convenience of use are vital. It is ideally suited for OEM applications as a component of larger measuring systems in applications such as:

- Waste Assay
- Homeland Security
- Continuous Air Particulate Monitoring
- Bio-Assay
- Industrial Process Monitors
- Aerial Survey

IDM-200-Vs are designed for long, reliable service, and are interchangeable. An IDM-200-V can be swapped out for service quickly, resulting in high system availability with an absolute minimum of down time.

The IDM-200-V is light enough to be installed by one person. The instrument can be mounted and operated in any orientation. Customized mounting provisions can also be added to the IDM-200-V upon request. For overall dimensions, please refer to ORTEC drawing P/N 935241, which can be provided upon request.

ORTEC CONNECTIONS programmers’ toolkits are available to assist the system integrator. Contact your ORTEC representative or our Global Service Center for more information.

## 1.1. IDM-200-V Feature Summary

### HPGe Detector

- High low-energy efficiency — Large area 85 mm × 30 mm HPGe crystal: High sensitivity, up to 200% of the surface area of the system.
- Uniform detector size.

- Hardened cryostat designed for long operational life: Can be temperature cycled at any time, even from partial warm up without risk to detector performance.
- High-reliability Stirling-cycle cooler cools rapidly to operating temperature: NO servicing required.
- Integrated high-voltage supply.

**Dose Rate Monitor** <0.05  $\mu\text{Sv/h}$  to > 10000  $\mu\text{Sv/h}$

### Digital Multichannel Buffer (MCB)

- 16k channels.
- High-performance, high-stability digital signal processing.
- Low Frequency Rejector (LFR)<sup>1</sup> improves spectrum resolution in noisy environments.
- Pulse-Height Analysis (PHA) Mode produces high-resolution gamma-ray spectra.
- List Mode data stream for continuous data collection, no dead spots.

### High-Speed USB Connection

- Can acquire data without PC connection if required.
- “Hot swap” of IDM-200-V modules while in operational state: reduced downtime.

**External Inputs (2)** Optionally accept count data from other devices such as gross counters.

### Power

- AC/DC power operation.
- Internal battery and low power consumption keeps the IDM-200-V counting for up to 2 hours during mains power interruptions, longer with external battery option.

#### 1.1.1. Proven High-Performance Features

The IDM-200-V combines proven ORTEC technologies in a rugged, advanced, all-in-one HPGe gamma-ray spectrometer that can be deployed as a component in a variety of measuring systems:

- **Digital Signal Processing (DSP)** — DSP offers more options for optimizing the output signal of HPGe detectors. The built-in InSight™ Virtual Oscilloscope makes it simple to optimize detector performance for a given application from the PC, the automatic

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<sup>1</sup>Patent pending.

baseline restorer<sup>2</sup> and the highly accurate Gedcke-Hale extended live-time correction method.<sup>3</sup>

- **Low-Frequency Rejector (LFR) Filter** — Our Low-Frequency Rejector digital filter surpasses all signal processing methods for reducing the effects of microphonics, ground loops, and virtually all other sources of periodic noise for HPGe and NaI (TI) spectrometry.
- **List Mode** — In List Mode, the IDM-200-V records and stores the pulse value with a time-stamp for every pulse generated by the detector. With List Mode, you can write your own programs that can reconstruct histograms for any time segment without dead time between histograms, or make histograms for overlapping time slices. Data can be stored easily for reconstruction of any time frame needed. For more information, see Chapter 6.
- **Pulse Height Analysis (PHA) Mode** — The instrument's most familiar function is data acquisition in pulse height analysis (PHA) mode, in which a data histogram of events versus channel number (a spectrum) is gathered and stored in the onboard data memory. For each pulse digitized, the spectrum is incremented by one count in the channel corresponding to the energy of the gamma ray.

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<sup>2</sup>Patent number 5,912,825.

<sup>3</sup>Ron Jenkins, R. W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp. 266–267.

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# 2. GETTING STARTED

This chapter covers the steps required to prepare the IDM-200-V for use.

## 2.1. Major System Components

The specific components for your instrument will depend on the model and options you purchased, but typically they will include a USB cable, the appropriate documentation set, and an ac mains power adaptor. You must also have the appropriate CONNECTIONS Driver Update Kit (p/n 797230) CD, which will either be packaged with this instrument or otherwise supplied as part of a multi-component system.

**NOTE** Be sure to keep the shipping box and foam and use it for shipping the instrument.

Any options will be packaged separately, and will include instructions for that option.

## 2.2. The IDM-200-V

Figures 1 and 2 show the IDM-200-V's major features.

**CAUTION** The IDM-200-V is significantly *nose-heavy*. Keep this in mind when lifting and positioning the unit.

### 2.2.1. Front Panel

- **On/Off Button** Located below and left of the HPGe detector endcap. Press to turn on the IDM-200-V. If connected to external power or if the internal battery is sufficiently charged, the unit will power up and the cooler will start automatically. Note the outer edge of the On/Off button, which illuminates when the power is on. This indicator is *steady* when the IDM-200-V is *ready* for data acquisition, and *blinks* if unit is *not ready* (for instance, if the detector is warm).

The IDM-200-V also has a remote power on/off capability for integrating the unit into a larger system (see the **Remote Power On/Off** specification on page 27).

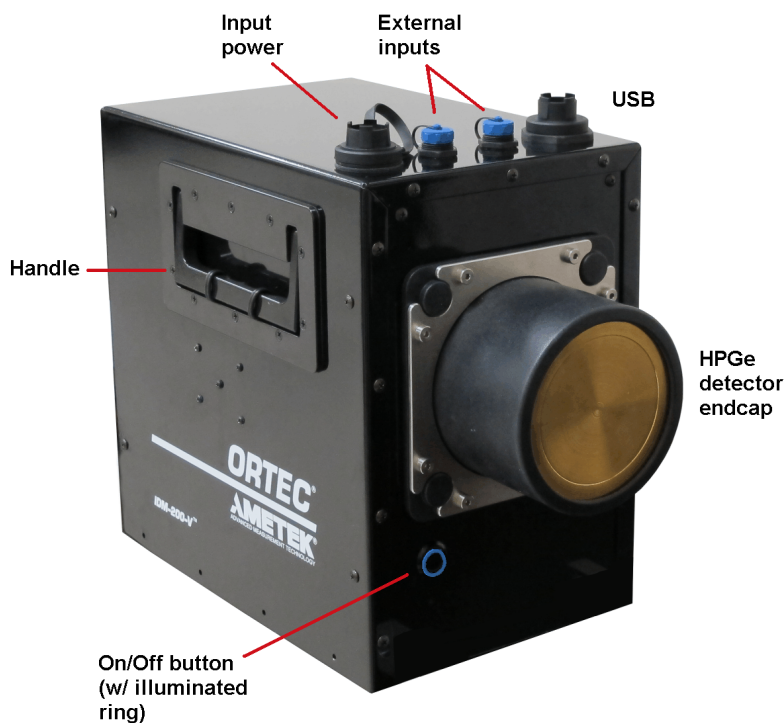


Figure 1. IDM-200-V Features.

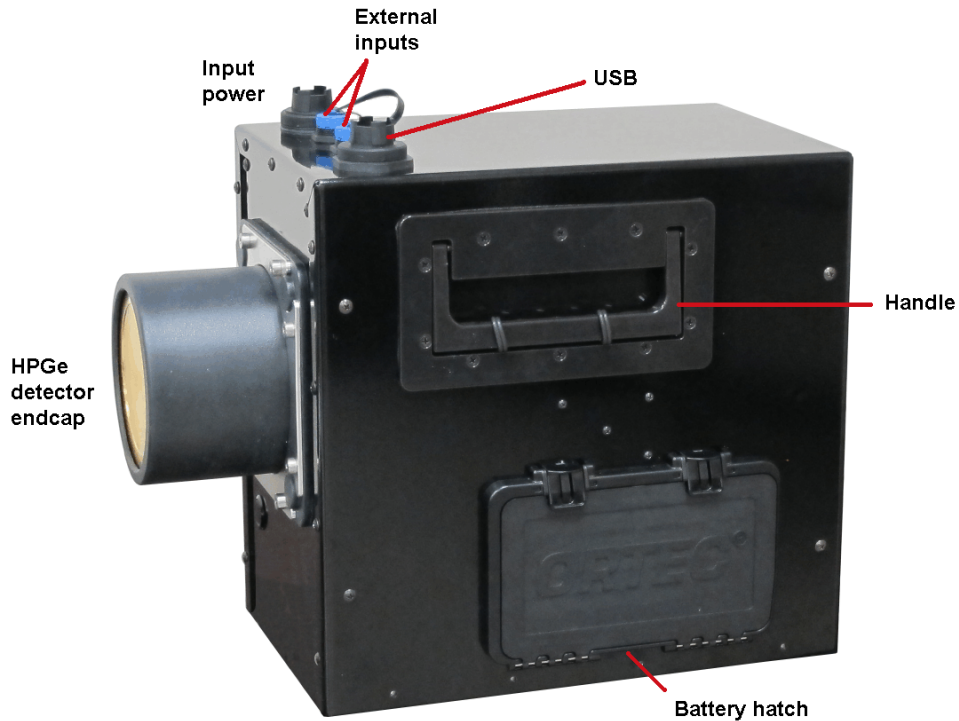



Figure 2. IDM-200-V Battery Hatch.

## 2.2.2. Top-Panel Connectors

- **INPUT POWER** — Supplies external power for operating the IDM-200-V and recharging the internal battery. Waterproof INPUT POWER connector is position-keyed and secured with a screw collet. When not connected to external power, seal the connector with its threaded, waterproof cap.
- **EXTERNAL 1 and 2** — Buccaneer PX0410/04S/4550 connector (Fig. 3). Connect to neutron detectors, occupancy sensors, other peripherals; 0 V to +5 V with adjustable threshold; input pulled up to +5 V via 5000  $\Omega$  resistor. Set and monitor thresholds with firmware commands SET\_THRESH\_AUX, SHOW\_THRESHOLD\_AUX, SHOW\_INPUT, ENAB\_COUNT\_LIST, and DISA\_COUNT\_LIST.<sup>4</sup> Waterproof threaded cap should be left in place when a port is not in use.
- **USB port** (  ) — Used to connect the IDM-200-V's microprocessor to the controlling PC. Waterproof threaded cap should be left in place when the port is not in use.

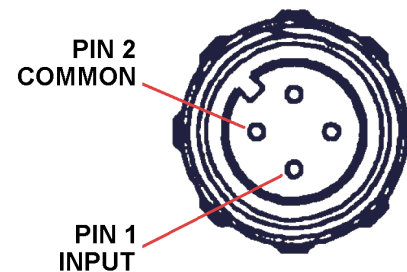


Figure 3. EXTERNAL IN.

**CAUTION** The factory-supplied USB cable for the IDM-200-V has a threaded cap. *Be sure the cable is oriented and inserted correctly in the USB port before tightening the threaded cap*, otherwise the port receptacle may be damaged and require factory repair!

## 2.2.3. The Internal Battery

The quick-access battery hatch makes it easy to exchange a fresh internal battery for an exhausted one. Figure 15, page 28, shows how to open the hatch. For a true “hot-swap” with no interruption in operation, connect the IDM-200-V to external power before changing batteries.

When the internal battery no longer holds a charge (typically, after 3–5 years), contact ORTEC for the appropriate battery replacement kit.

<sup>4</sup>Note that these thresholds cannot be set within ORTEC spectroscopy applications such as MAESTRO®.

## 2.3. Software Installation

### 2.3.1. Step 1: Install the CONNECTIONS Driver Update

The first step is to install the CONNECTIONS Driver Update Kit on the host PC according to the kit's instruction sheet. *This product must be installed before your spectroscopy application is installed.* On the Instrument Families page, be sure to mark the **USB-based** instruments checkbox. *Otherwise, the IDM-200-V will not be able to communicate with ORTEC applications.*

### 2.3.2. Step 2: Install the MAESTRO MCA Emulation Software

Install MAESTRO on the host PC according to the instructions in its *User's Manual*.

## 2.4. Startup and Cooldown

- Remove the IDM-200-V from its shipping carton.
- Connect the power input cable to an ac power source and to the IDM-200-V's top-panel INPUT POWER connector.<sup>5</sup>
- Press the On/Off button. Within a few seconds, the cooler will activate (it is very quiet, but you may be able to feel its vibration). The outer ring of the On/Off button will blink until the detector is cool and the detector high voltage turns on, at which point the blinking will change to steady illumination.
- If you wish to monitor the detector and hardware status during cooldown, start MAESTRO, select **MCB Properties...** from the **Acquire** menu, click on the Status tab, and view the various monitored parameters. Refer to the MAESTRO *User's Manual* for more information on this feature.
- The IDM-200-V typically requires <15 hours to fully cool. When the detector reaches operating temperature, the IDM-200-V bias voltage will automatically turn on, and the outer ring of the On/Off button will remain steady on.
- Note that the internal battery will not charge until the detector has reached operating temperature. After that, the battery will typically reaches full charge in 3–4 hours.

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<sup>5</sup>Alternatively, you can use a 12 V dc auto accessory adapter. If using a vehicle battery as a power source, note that cooling the detector to operating temperature can significantly discharge the vehicle battery.



**NOTE** Once the IDM-200-V is cooled, you can turn the instrument off for a brief period (e.g., 10 to 20 minutes) without significantly warming the detector. As soon as the unit is powered up again, it typically returns to ready status (outer ring of On/Off button illuminated steady on) within a few seconds. The IDM-200-V can be restarted at any time without harming the detector crystal, regardless of whether the detector is warm, partially cooled, or cooled to operating temperature.

The IDM-200-V also has a remote power on/off capability. See the **Remote On/Off** specification on page 27 in Chapter 5.

## 2.5. Connect the IDM-200-V to Your PC

Attach the IDM-200-V to a USB port on your PC. Windows will display a series of “new hardware” messages, followed by the Found New Hardware Wizard. Choose to *automatically* locate the driver, and *do not* search the internet for the driver. In the unlikely event Windows cannot locate the driver, it is in **C:\Program Files\Common Files\ORTEC Shared\UMCBI**. When all new-hardware processing is finished, you’re ready to run the MCB Configuration program (Section 2.6).

## 2.6. Run MCB Configuration to Establish Communication with the IDM-200-V

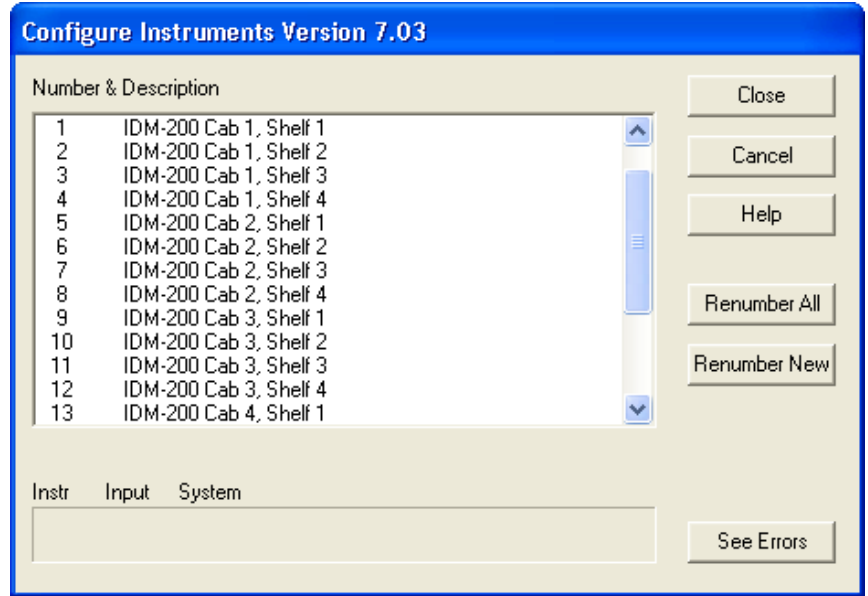
**NOTE** This is a very abbreviated discussion of the operation and use of the MCB Configuration program. We *strongly* recommend that you read the instructions for the CONNECTIONS Driver Update Kit for complete details on customizing MCB ID Numbers and Descriptions, changing your Windows firewall settings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

- 1) Make sure the IDM-200-V is connected and powered on. Otherwise, the MCB Configuration program will not detect it during installation. Any instruments not detected can be configured at a later time.
- 2) Enter **mcb con** in the “search programs and files” box, then click on the **MCB Configuration** search result; or open the Windows Start menu and select **MAESTRO 32, MCB Configuration**.

The MCB Configuration program will locate all of the powered-on ORTEC MCBs on the local PC and the network, display the *Master Instrument List* of instruments found (Fig. 4).

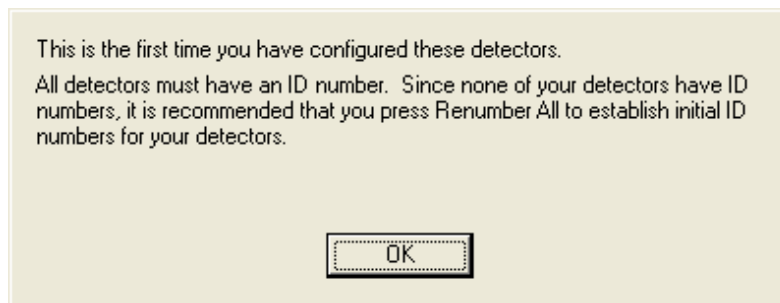
## 2.6.1. Configuring a New Instrument

The first time a new instrument is detected, the dialog shown in Fig. 5 will remind you that all new instruments must be assigned a unique, *non-zero* ID number.<sup>6</sup> Click on **OK**. See the CONNECTIONS Driver Update Kit for instructions on customizing ID Numbers and Descriptions, or simply click on the **Renumber New** button to renumber only the new instruments.



**Figure 4. MCB Numbering and Descriptions.**

**NOTE** We strongly recommend *not* using the **Renumber All** button.



**Figure 5. New Instruments Must Have a Non-Zero ID Number.**

<sup>6</sup>If this is a first-time installation of ORTEC products, all your instruments will be “new.”

## 2.7. Connecting to and Disconnecting from the PC

The IDM-200-V can be connected to and disconnected from the system without shutting down either. If this unit is a component of a larger system, the system's design will govern how connection and disconnection are handled. If you are using the instrument as a benchtop MCA with MAESTRO or other ORTEC spectroscopy applications, and disconnect from the PC during data acquisition (leaving the IDM-200-V under power so the high voltage stays on), the IDM-200-V will continue data collection. To redisplay the spectrum in your spectroscopy application, simply reconnect the IDM-200-V, then close and reopen the spectrum window for that input.

## 2.8. Notes on IDM-200-V Power Usage

The IDM-200-V uses internal and external power as follows:

- The internal battery provides >2 hours of operation. The internal battery can start the cooler, however, it cannot completely cool the detector from room temperature; *external power is required*. The transition from internal to external power is automatic and does not interfere with data collection. When recharging an exhausted internal battery, keep in mind that the battery does not begin charging until *after the detector is cooled down to operating temperature* (cooldown nominally takes <15 hours). At that point, fully recharging the battery takes 3–4 hours.
- The power adaptor provides external power to simultaneously start and operate the IDM-200-V, as well as charge the internal battery.
- Other external power (supplied by external battery belt or 12 V automobile battery) can start, cool, and operate the IDM-200-V, as well as charge the internal battery. When connected to an external battery, the IDM-200-V relies on external power until the external voltage drops below 9 V. It then switches to the internal battery. The instrument makes the transition smoothly, and there is no effect on the energy resolution. If you begin with both batteries fully charged, the sum of the two battery capacities will be achieved. If the external battery has its own charge indicator, this can be used to determine when the changeover will occur. The IDM-200-V battery monitor indicates the available capacity in the internal battery, and when the switchover occurs, this indicator runs down in the usual manner.

**NOTE** When all power is exhausted, the high voltage and cooler shut down and the detector begins to warm. The IDM-200-V cannot be used again until the unit has cooled

enough that the high voltage automatically switches on and the outer edge of the On/Off button illuminates steady on, indicating the unit is ready for data acquisition.

## 2.9. Operating Cautions and Notes

- Remember that there are no user-serviceable parts inside the IDM-200-V. Opening the IDM-200-V (except the battery hatch to replace the internal battery) voids the warranty.
- The cooler and detector are shock-sensitive, with a maximum tolerance of 20 g, so be careful not to drop the unit. A shock in excess of this value will void the warranty.
- The IDM-200-V must be protected from exposure to moisture and dust.
- Allow air to circulate freely around the unit to dissipate heat from the cooler.
- The power adaptor/charger should not be exposed to water, and should generally be protected from moisture and dirt. Make sure the recharging connector on both the IDM-200-V and power adaptor are clean and dry before attaching to an the input power supply.
- The IDM-200-V is designed for use at temperatures between  $-10^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ , maximum relative humidity 95%, non-condensing.
- The HPGe detector assembly is designed to be continuously cooled. If the instrument is turned off and allowed to warm between uses, it must be cooled and brought to operational status (outer edge of On/Off button steady on) for *at least 48 hours every month*. Failure to do this may result in degraded performance or cooling system failure. Read Section 5.6.
- To avoid damaging the cooler (and, where applicable, to comply with transportation regulations), be sure to turn the IDM-200-V *off* before packaging and shipping. The unit can be shipped as soon as the cooler is turned off; there is no need to wait until the detector warms up.
- If using a USB cable with a threaded cap (such as the cable supplied with the IDM-200-V), ***be sure the cable is oriented and inserted correctly in the USB port before tightening the threaded cap***, otherwise the port receptacle may be damaged and require factory repair.

# 3. MCB PROPERTIES IN MAESTRO

The IDM-200-V was designed as a detector subsystem for applications such as portal monitoring. However, when you connect it to a Windows 7 PC running an ORTEC spectroscopy application such MAESTRO, you can use it as a high-performance HPGe spectrometer/ digital MCA. This section discusses the hardware setup dialogs you will see within MAESTRO when you use the **MCB Properties...** command on the **Acquire** menu.<sup>7</sup> The MCB Properties dialog contains all of the instrument controls including acquisition presets, amplifier gain adjustments, pole-zero controls, high voltage monitor, hardware status indicators, and access to the InSight Virtual Oscilloscope. For more details on use, see the *MAESTRO User's Manual*.

**NOTE** The changes you make on most property tabs take place immediately. There is no cancel or undo option for this dialog.

## 3.1. Amplifier

Figure 6 shows the Amplifier tab, which displays the **Fine Gain**, **Baseline Restore**, and **Pole Zero** controls.

**Gain** — Set the amplifier coarse gain by selecting from the **Coarse** listbox, then adjust the **Fine** gain with the horizontal slider bar or the edit field, in the range of 0.45 to 1.00. The resulting effective gain is shown at the top of the **Gain** section. These controls used together cover the entire range of amplification from 0.45 to 32.

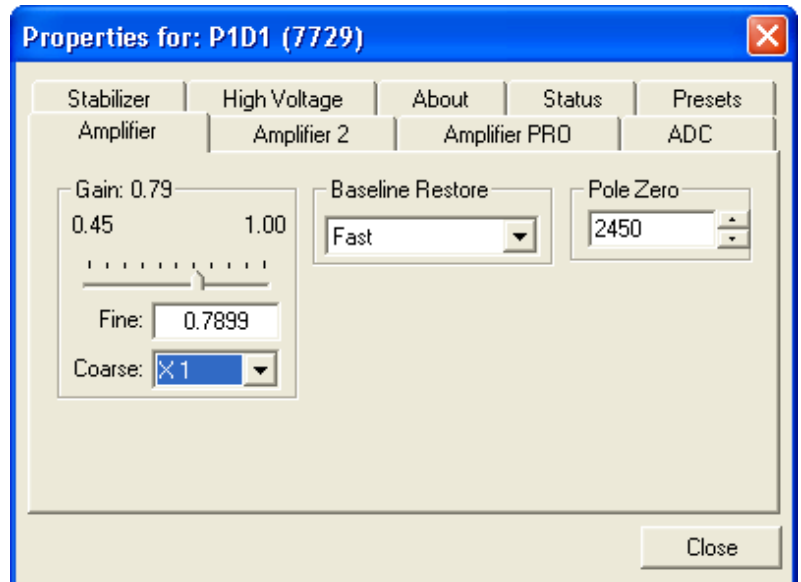


Figure 6. Amplifier Tab.

<sup>7</sup>In MAESTRO, GammaVision<sup>®</sup>, etc., the **Download Spectra** and **View ZDT Corrected** commands on the **Acquire** menu and the **Smooth** and **Strip** commands on the **Calculate** menu are disabled for the IDM-200-V.

**Baseline Restore** — Returns the baseline of the pulses to the true zero between incoming pulses. This improves the resolution by removing low frequency noise from dc shifts or mains power ac pickup. The baseline settings control the time constant of the circuit that returns the baseline to zero. There are three fixed choices (**Auto**,<sup>2</sup> **Fast**, and **Slow**); the default for the IDM-200-V is **Fast**. The fast setting is used for high count rates, the slow for low count rates. **Auto** adjusts the time constant as appropriate for the input count rate. The time constant can be manually set on the InSight display; for more information, see the discussion on Marks in the MAESTRO *User's Manual*.

**Pole Zero Adjustment** — To maintain optimum energy resolution and peak position stability to high counting rates, it is important to enter the correct value for the pole-zero cancellation. Use the default value as the starting point.

To make a fine adjustment of the **Pole Zero** setting:

- 1) On the Amplifier PRO tab, unmark (disable) **LFR** mode.
- 2) Use a radioactive source that produces a well-defined peak near the upper limits of the energy spectrum. At low counting rates, note the symmetry of the peak.
- 3) Move the source closer to the detector to achieve much higher counting rates. If the peak maintains the symmetry observed at low counting rates no further adjustment of the **Pole Zero** is needed. If high counting rates generate a tail on the high energy side of the peak, slightly decrease the pole-zero value until the tail disappears. If high counting rates generate a tail on the low-energy side of the peak, slightly increase the pole-zero value until the tail disappears.
- 4) Make a final adjustment to balance the symmetry of the peak as closely as possible to the symmetry observed at low counting rates. This will result in the optimum pole-zero adjustment.

## 3.2. Amplifier 2

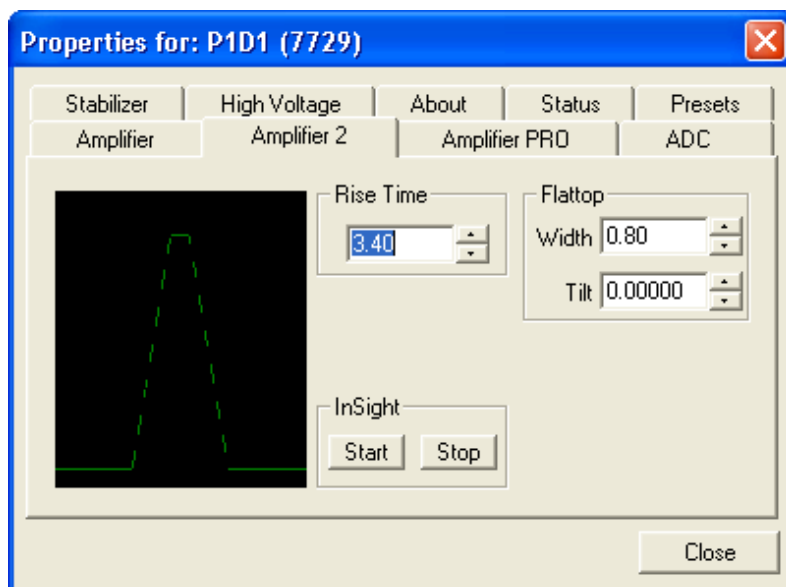
Figure 7 shows the Amplifier 2 tab, which accesses the advanced shaping controls including the InSight™ Virtual Oscilloscope mode.

The many choices of **Rise Time** let you precisely control the tradeoff between resolution and throughput. Starting with the default value, you should increase the rise time for better resolu-

tion for expected lower count rates; or, when you anticipate unusually high count rates, reduce the rise time for higher throughput with somewhat worse resolution.

Use the up/down arrows to adjust the **Rise Time** within the range of 0.8  $\mu$ s to 23.0  $\mu$ s.

For the more advanced user, the InSight mode allows you to directly view all the parameters and adjust them interactively while collecting live data. To access the InSight mode, go to the **InSight** section on the Amplifier 2 tab and click on **Start**. The InSight mode is discussed in detail in the *MAESTRO User's Manual*.



**Figure 7. Amplifier 2 Tab.**

The **Rise Time** value is for both the rise and fall times; thus, changing the rise time has the effect of spread-ing or narrowing the quasi-trapezoid symmetrically.

The **Flattop** controls adjust the top of the quasi-trapezoid. The **Width** adjusts the extent of the flattop (from 0.3 to 2.4  $\mu$ s). The **Tilt** adjustment varies the “flatness” of this section slightly. The **Tilt** can be positive or negative (range: -1.0 to +0.99219). Choosing a positive value results in a flattop that slopes downward; choosing a negative value gives an upward slope.

The dead time per pulse is approximately  $(3 \times \text{Rise Time}) + (2 \times \text{Flattop Width})$ .

When you are satisfied with the settings, **Close** the Properties dialog and prepare to acquire data.

Once data acquisition is underway, the advanced user might wish to return to the Amplifier 2 tab and click on the **InSight** section's **Start** button to adjust the shaping parameters interactively with a “live” waveform showing the actual pulse shape.

### 3.3. Amplifier PRO

Figure 8 shows the Amplifier PRO tab, which contains the **Low Frequency Rejector (LFR)** filter. Turning it off causes shifting and/or broadening of peaks in addition to the acquisition of noise in the lowest-energy channels. We strongly recommend the LFR be enabled during all data acquisitions. Note, however, that you must turn the LFR *off* to pole-zero the IDM-200-V. Subsequent measurements can then be taken with the LFR filter on.

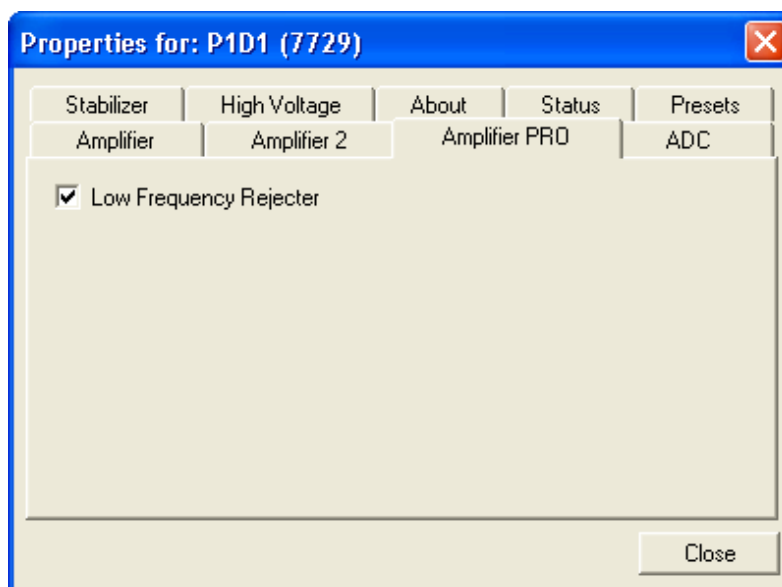


Figure 8. Amplifier PRO Tab.

### 3.4. ADC

This tab (Fig. 9) contains the **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 **Conversion Gain** sets the maximum channel number in the spectrum. If set to 16384, the energy scale is divided into 16384 channels. This parameter is entered in powers of 2 (e.g., 16384, 8192, 4096, 2048, 1024, 512). The up/down arrow buttons step through the valid settings.

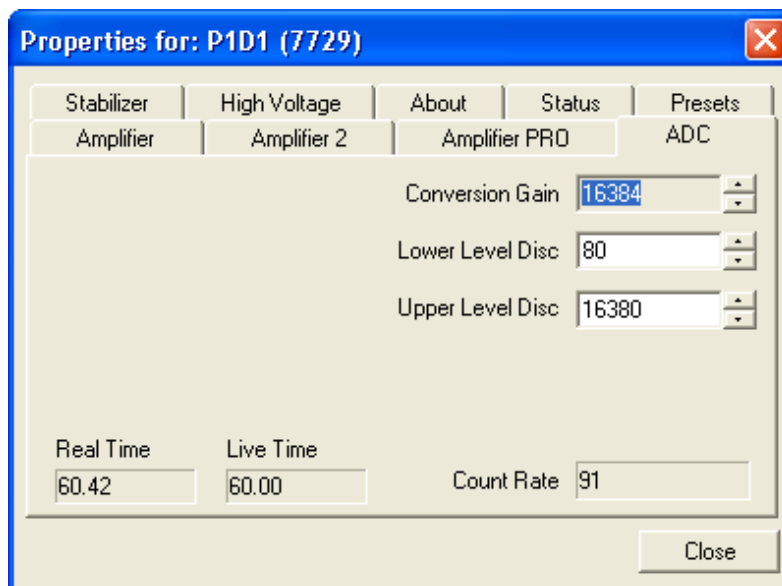


Figure 9. ADC Tab.



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. Because of the mechanical cooler, we recommend a minimum setting of 40 (in addition to leaving the LFR on at all times).

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.

### 3.5. Stabilizer

The IDM-200-V has both a gain stabilizer and a zero stabilizer. The Stabilizer tab (Fig. 10) shows the current values for the stabilizers. The value in each **Adjustment** section shows how much adjustment is currently applied. The **Initialize** buttons set the adjustment to 0. If the value approaches 90% or above, the amplifier gain should be adjusted so the stabilizer can continue to function — when the adjustment value reaches 100%, the stabilizer cannot make further corrections in that direction. The **Center Channel** and **Width** fields show the peak currently used for stabilization.

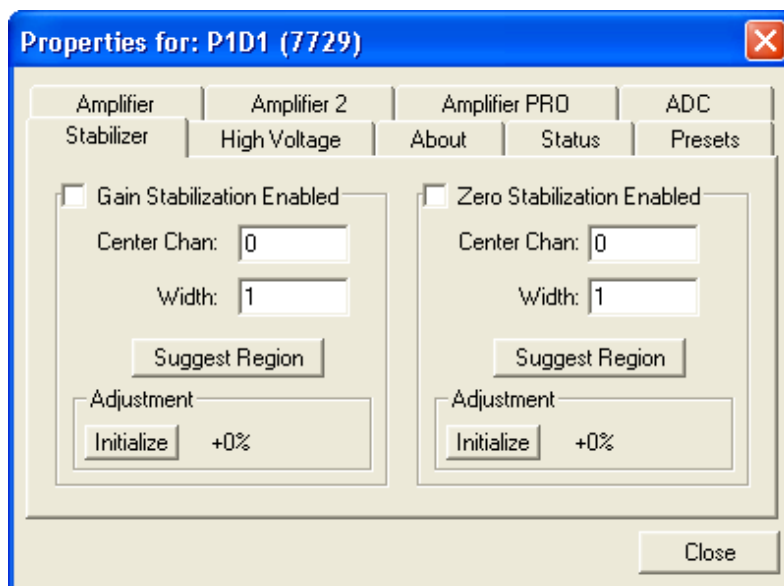


Figure 10. Stabilizer Tab.

To enable the stabilizer, enter the **Center Channel** and **Width** values manually or click on the **Suggest Region** button. **Suggest Region** reads the position of the marker and inserts values into the fields. If the marker is in an ROI, the limits of the ROI are used. If the marker is not in an ROI, the center channel is the marker channel and the width is 3 times the FWHM at this energy. Now click on the appropriate **Enabled** checkbox to turn the stabilizer on. Until changed in this dialog, the stabilizer will stay enabled even if the power is turned off. When the stabilizer is enabled, the **Center Channel** and **Width** cannot be changed. For more detailed information on gain and zero stabilization, see the *MAESTRO User's Manual*.

## 3.6. High Voltage

Figure 11 shows the High Voltage tab, which allows you to turn the bias voltage off and on, and monitor the **Actual** bias. You cannot adjust the bias voltage, nor can you change the **Shutdown** mode, which is fixed as **SMART**.<sup>8</sup>

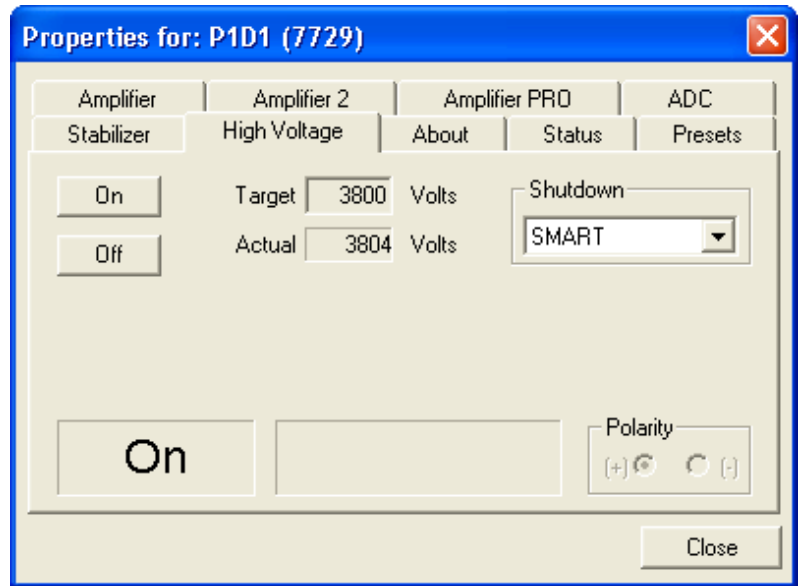


Figure 11. High Voltage Tab.

## 3.7. About

This tab (Fig. 12) displays hardware and firmware information about the IDM-200-V as well as the data **Acquisition Start Time**. In addition, the **Access** field shows whether the Detector is currently locked with a password by MAESTRO. **Read/Write** indicates the Detector is unlocked and **Read Only** means it is locked. See the MAESTRO *User's Manual*.

Use the **Firmware Revision** field to determine the instrument type and firmware version. This para-

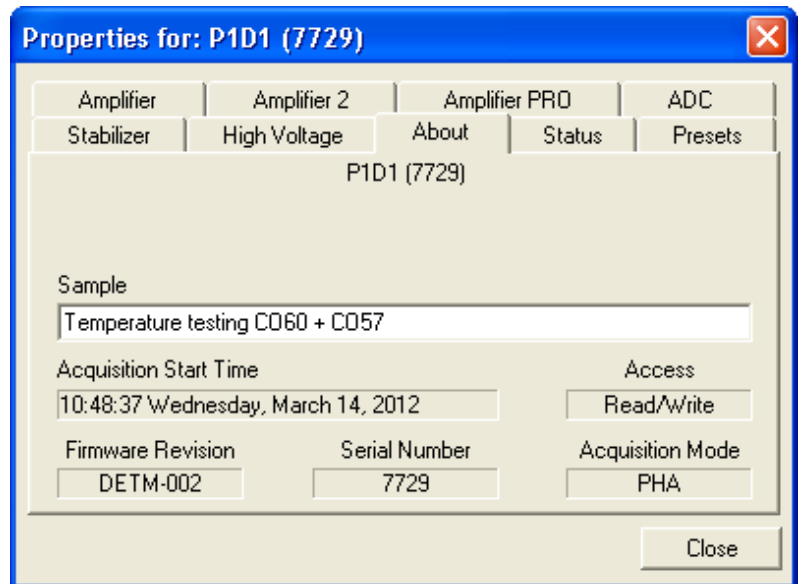


Figure 12. About Tab.

<sup>8</sup>This is a reference to the IDM-200-V's SMART-1<sup>®</sup> detector technology. For more information on SMART-1, see the ORTEC catalog or visit [www.ortec-online.com](http://www.ortec-online.com).

meter is formatted **DETM-*nnn***, where **DETM** is for the IDM-200-V and ***nnn*** is the firmware version. In the accompanying illustration, **DETM-002** indicates an IDM-200-V running firmware v2. You can also use the About tab to view this information for .SPC-format spectra downloaded from the IDM-200-V.

### 3.8. Status

Figure 13 shows the Status tab. All parameters are continuously monitored in real time. Satisfactory status is reported as **OK** or a numerical value. A failure is reported as **ERR** or a descriptive message. Use the list-boxes to select any six parameters to be displayed simultaneously on the Status tab. You can change the selected parameters at any time.

The monitored parameters are:

- **Detector State of Health** — Reported as **OK** or **ERR**.
- **Gamma Dose Rate** — Reported in  $\mu\text{Sv/h}$ , and indicating whether this reading was made with the detector (**Ge** for low dose rates) or the Geiger-Müller tube (**GM** for high dose rates). See **Gamma Dose-Rate Determination**, page 25, for further discussion of the two dose-rate meters.
- **Detector Temperature** — Reported as **OK** or **ERR**.
- **Battery Voltage** — Reported in volts.
- **Battery Time Remaining** — In minutes.
- **Cooler Body Temperature** — **OK** or **ERR**.
- **Cooler Drive Voltage** — **OK** or **ERR**.
- **Cold-Tip Temperature** — **OK** or **ERR**.

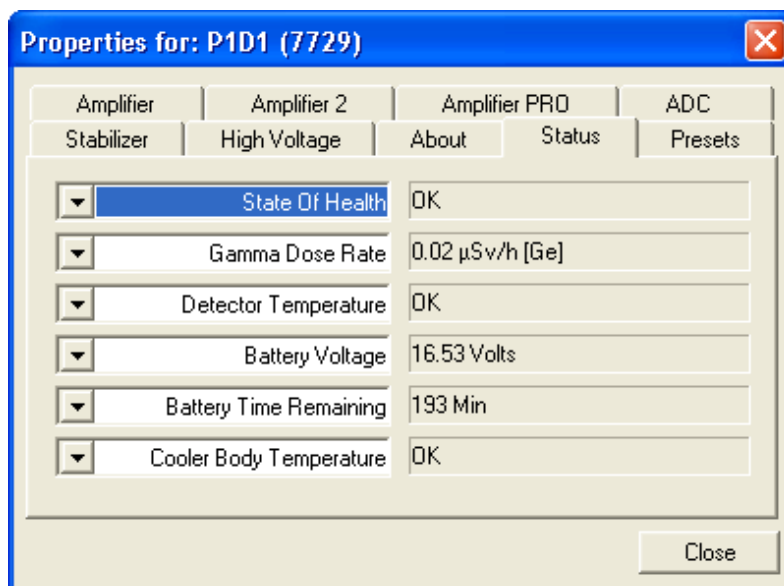


Figure 13. Status Tab.

- **HV Bias** — In volts.
- **External In 1** — The format is *N Cnts (input level)*, where *N* is the number of rising edges on this input since the current data acquisition started; and the input level is **1** (high) or **0** (low).
- **External In 2** — Same format as External In 1.
- **Ion Pump Diag. Code** — For maintenance purposes only.

To resolve status problems, refer to the troubleshooting chapter. For further assistance, contact your ORTEC representative or our Global Service Center.

### 3.9. Presets

Figure 14 shows the Presets tab. Presets can only be set when the IDM-200-V is not acquiring data (during acquisition the preset field backgrounds are gray, indicating they are inactive). You can 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.

When more than one preset is enabled (set to a non-zero value), the first condition met during the acquisition causes the Detector 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.”

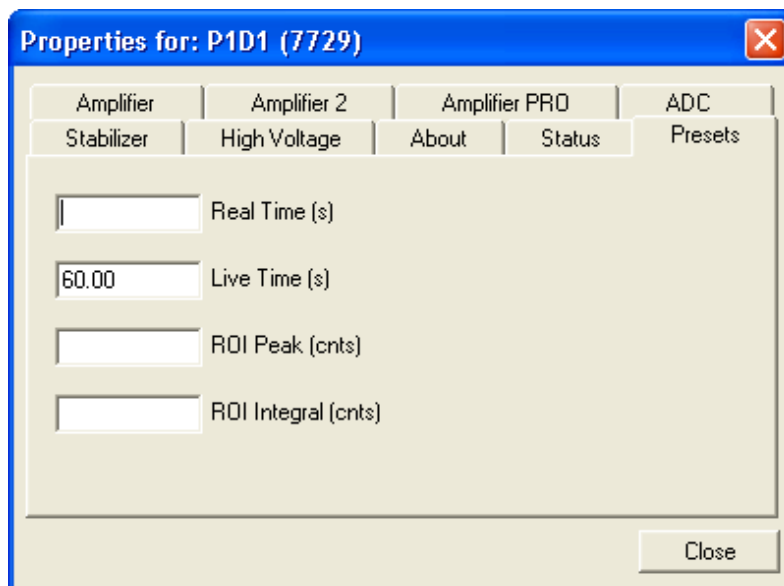


Figure 14. Presets Tab.

The values of all presets for the currently selected Detector 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.

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 Detector clock increments by 20 ms. *Real time* means elapsed time or clock time. *Live time* refers to the amount of time that the Detector 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 Detector is not available).

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

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

[Intentionally blank]

# 4. TROUBLESHOOTING

## 4.1. If the On/Off Button Does Not Stop Flashing

If the illuminated ring on the IDM-200-V's On/Off button begins flashing during normal operation, or if you start up a warm unit and the button does not stop flashing after 20 or more hours of cool-down:

- Connect the unit to the PC on which the accompanying CONNECTIONS Driver Update Kit and MAESTRO were installed, start MAESTRO, and select the IDM-200-V from the detector list. If you receive a “bad state of health” notification, click on **OK**.
- On the menu bar, select **Acquire/MCB Properties...**, then click on the Status tab and refer to Section 3.8. The state of health, detector temperature, cooler body temperature, cooler drive voltage, and cold-tip temperature readouts should be **OK**. On the High Voltage tab, the actual HV should be within a few percent of the factory-set target voltage. If any of the status monitors read **ERR** and/or the HV is off, allow the unit to cool for a few more hours. If it does not return to ready status, contact your ORTEC representative or our Global Service Center.

## 4.2. If You Drop the IDM-200-V

The IDM-200-V has been designed to be a rugged instrument, and should survive reasonable levels of mechanical abuse. It has been drop-tested to destruction in development and is known to have a high degree of survivability to “normal” shock and vibration.

If the instrument is dropped:

- Disconnect from any external power source, disconnect any USB connection, and cycle the power off/on. It should turn on and return to ready status (outer ring of On/Off button illuminated steady on) immediately.
- Inspect the exterior for evidence of mechanical damage or distortion.
- *Listen* to the cooler: If you hear any unusual noises (rattling or pinging) emanating from the cooler, contact your ORTEC representative or our Global Service Center.
- Monitor the unit for the next few hours to ensure that it remains ready (outer ring of On/Off button illuminated steady on) and performs as expected with test sources.

If the unit fails in one or more of these respects or if one or more hardware diagnostic settings (Section 3.8) indicate a hardware failure, contact your ORTEC representative or our Global Service Center for further assistance. *Remember that there are no user-serviceable parts inside the IDM-200-V, and opening the case will void the warranty.*

### 4.3. If the IDM-200-V Will Not Turn On

- Connect the IDM-200-V to an external power source; it should automatically boot up, turn the cooler on, and start the IDM-200-V software application. The unit can start the cooler using internal battery power, but *must* be connected to an external power source to fully cool a warm detector.
- If the internal batteries have become exhausted but can still hold a charge, see the next section.
- If the battery does not hold a charge, ensure that it is properly installed. If properly installed, the battery must be replaced.

## 4.4. Troubleshooting MAESTRO-Related Problems

### 4.4.1. MAESTRO Does Not Connect with the IDM-200-V

If properly installed and functioning MAESTRO software (or other CONNECTIONS programs) cannot find and communicate with the IDM-200-V when it is connected via the USB port and being used as an MCA:

- Make sure the USB cable is competent and properly connected to both the IDM-200-V and PC.
- Make sure USB hubs are correctly connected and functioning.
- Make sure the IDM-200-V is turned on and ready for data acquisition (On/Off button light steady on).
- Check the Master Instrument List on the PC to ensure that the IDM-200-V is on the list. If it is not listed, manually run the MCB Configuration program from the Windows Start menu. See the MAESTRO *User's Manual* for detailed instructions on this operation.



# 5. SPECIFICATIONS<sup>9</sup>

## 5.1. HPGe Detector

**Dimensions** 85 mm diameter × 30 mm length nominal; coaxial construction; P-type, high-purity germanium; long-life cryostat with all-metal seals; no molecular sieve.

**Relative Efficiency** >50% typical (ANSI/IEEE 325-1996).

**Resolution** ≤1400 eV @ 122 keV and ≤2.3 keV @ 1332 keV (FWHM warranted at optimum settings).

**Peak Shape** 1.9 typical (FWTM/FWHM).

**Internal Compensated Geiger-Müller Tube** LND 7149 Geiger Müller tube. GM tube specifications are available on request.

**Gamma Dose-Rate Determination** The IDM-200-V uses two detectors to determine the gamma dose rate over a wide range from <0.05 μSv/h to >10000 μSv/h, a dose-rate range of around six decades. For low dose rates (below ~20 μSv/h) the dose rate is determined from the Ge detector spectrum. For dose rates above this value, the internal compensated GM tube is used. The IDM-200-V switches between the two automatically.<sup>10</sup>

**NOTE** The dose rate function in the IDM-200-V should not be considered as adequate for accurate dosimetry purposes. Its primary purpose is to protect the IDM-200-V user from high radiation fields.

**Cooler** High-reliability, low-power Stirling cooler. Power usage when cold <2 A. Initial cooldown time depends on ambient temperature, but at 25°C is typically <15 hours.

**System Gain Settings** 0.45 to 32.

**System Conversion Gain** Software selectable from 512 to 16384 channels.

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<sup>9</sup>Subject to change without notice.

<sup>10</sup>For radiation fields from extended sources (e.g., from a container full of NORM) or far-field point sources (>1 ft [0.3 m] from the instrument), the precise location of the detector in use is not important. When point sources are close to the instrument, the detector readings might not be in agreement because they are in different places within the instrument and the dose rate is varying rapidly with position.

## Shaping-Time Constants

- Rise time: Default Mode: 3.4  $\mu$ s, fixed. MCA Mode: 0.8  $\mu$ s to 23  $\mu$ s.
- Flattop: Default Mode: 0.8  $\mu$ s width, fixed. MCA Mode: 0.3  $\mu$ s to 2.4  $\mu$ s width.

**Dead-Time Correction** Extended live-time correction according to Gedcke-Hale method.<sup>11</sup>  
Accuracy: area of reference peak changes  $<\pm 3\%$  from 0 to 50000 cps.

## Linearity

- Integral Nonlinearity:  $<\pm 0.025\%$  over top 99.5% of spectrum, measured with a mixed source (<sup>55</sup>Fe at 5.9 keV to <sup>88</sup>Y at 1836 keV).
- Differential Nonlinearity:  $<\pm 1\%$  (measured with a BNC pulser and ramp generator) over top 99% of range.

**Overload Recovery** At maximum gain, recovers to within 2% of rated output from  $\times 1000$  overload in 2.5 non-overloaded pulse widths (measured using our InSight™ Virtual Oscilloscope).

**Pulse Pileup Rejector** Automatically set threshold. Pulse-pair resolution typically 500 ns.

**Low Frequency Rejector (LFR) Filter**<sup>12</sup> When set to ON, removes low-frequency ( $< 3$  kHz) input noise from spectrum. Designed to reduce microphonic and low-frequency periodic noise from surrounding electronics and equipment or ground loops.

**Presets** Multiple presets can be set within MAESTRO for any or all of the following:

- **Real Time** Stops data collection when the real time reaches this value (in increments of 1 s).
- **Live Time** Stops data collection when the live time reaches this value (in increments of 1 s).
- **ROI Integral** Integral count stops data collection when the sum of all ROI channels reaches this value.

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<sup>11</sup>Ron Jenkins, R. W. Gould, and Dale Gedcke, *Quantitative X-Ray Spectrometry* (New York: Marcel Dekker, Inc.), 1981, pp. 266–267.

<sup>12</sup>Patent pending.

- **ROI Peak** Peak count stops data acquisition when any ROI channel reaches this value (maximum value of  $2^{32}-1$  counts [ $4 \times 10^9$ ]).

## 5.2. Electrical and Mechanical

**Dimensions** Maximum overall dimensions including handle, Ge detector endcap, neutron detector and shock absorbers: 41.3 cm L  $\times$  34.0 cm W  $\times$  21.2 cm H (16.3 in.  $\times$  13.4 in.  $\times$  8.3 in.)

**Weight** 17.7 kg (39 lb) without tungsten back-shield option.

**Input Power** 10 to 17 V dc from battery or dc power supply (universal mains supply included). Battery charger circuit is inside instrument.

**Power Usage** <100 W during cooldown, 72 W nominal during battery recharge, <28.8 W cold with fully charged battery.

**Remote Power On/Off** Opto-isolated input on pins 5 and 6 of the power connector turns off the IDM-200-V if the input voltage exceeds 2 V. Power is turned on if the voltage between the two pins is less than 0.25 V. Power is on if pins are left disconnected. The voltage on the pins should not exceed 24 V. Input is not polarized. Only the absolute voltage between the two pins is significant. Input impedance 2000  $\Omega$ .

**Maximum Shock Tolerance** 20 g. An accelerometer inside the instrument tracks the maximum shock to which the unit has been subjected, and a shock in excess of 20 g will void the warranty.

**Ambient Operating Environment**  $-10^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  at relative humidity 95%, non-condensing.

**Internal Battery** Rechargeable, nominal 14.4 V lithium-ion battery pack. Battery lifetime 3–5 years; replacement kit available from ORTEC. The compartment is semi-sealed and protects against penetration of dirt and moisture. An exhausted battery is easily exchanged with a fresh one. Open the quick-access battery door by sliding the clips up (parallel to the enclosure; Fig. 15), remove obvious contamination from door gasket before closing. To exchange without power interruption, connect the instrument to external power before changing the battery.

**Battery Life** When HPGe detector is cold, >2 hours at  $25^{\circ}\text{C}$ , <4 hour charge time. Battery life can be extended indefinitely by the use of optional external battery belt. The unit is expected to be kept running once cold.


Note that the internal battery charge can start the mechanical cooler but cannot fully cool a warm detector; external power is required. In addition, an exhausted internal battery should be charged for 2 hours before the identifier is cooled using external power. If the internal battery is completely exhausted but can still hold a charge, see troubleshooting Section 4.3. Note that using an automobile battery to cool the detector could significantly discharge the auto battery.

**CE** Conforms to CE standards for radiated and conducted emissions, susceptibility, and low-voltage power directives.



Figure 15. Slide Battery Door Clips Up To Open.

### 5.3. Connectors

**USB** (  ) Top-panel high-speed USB port connects the IDM-200-V's microprocessor to the controlling PC. Waterproof threaded cap should be left in place when the port is not in use.

**INPUT POWER** Top-panel external power input, with dust cover, 12–17 V dc, <90 W, or from battery or ac mains.

**EXTERNAL 1 and 2** — Buccaneer PX0410/04S/4550 connector; connect to neutron detectors, occupancy sensors, other peripherals; 0 V to +5 V with adjustable threshold; input pulled up to +5 V via 5000  $\Omega$  resistor. Set and monitor thresholds with firmware commands SET\_THRESH\_AUX, SHOW\_THRESHOLD\_AUX, SHOW\_INPUT, ENAB\_COUNT\_LIST, and DISA\_COUNT\_LIST.<sup>13</sup> Waterproof threaded cap should be left in place when a port is not in use.

## 5.4. PC Prerequisites

The IDM-200-V operates together with ORTEC CONNECTIONS software such as MAESTRO on PCs running 32- or 64-bit Microsoft Windows 7 or XP Professional SP3.

## 5.5. Shipping the IDM-200-V

To avoid damaging the cooler and, where applicable, to comply with transportation regulations, be certain to turn the IDM-200-V *off* before packaging and shipping. The unit can be shipped as soon as the cooler is turned off. There is no need to wait until the detector warms up.

## 5.6. Long-Term Shutdown/Storage

### CAUTION

This instrument should be cooled and brought to operational status (illuminated outer ring of On/Off button steady on) for at least 48 hours every month. Failure to do this may result in degraded performance or cooling system failure.

This instrument uses a Stirling cycle refrigerator and all-metal-sealed cryostat designed for long operational life. The vacuum integrity inside the cryostat is maintained by “getters,” which scavenge traces of residual material when cold; and by an ion pump that operates when the instrument is powered up. These two techniques maintain the system vacuum in peak condition during normal use. A good vacuum yields rapid cooldown and ensures operation at the high end of the instrument’s operating temperature range.

Over time, in any cryostat system, residual contaminants can be released from the materials inside the evacuated cryostat by a process called *outgassing*.<sup>14</sup> It has become apparent that, in extended storage, the vacuum in our mechanically cooled identifiers may degrade to the point

<sup>13</sup>Note that these thresholds cannot be set within ORTEC spectroscopy applications such as MAESTRO®.

<sup>14</sup>This is not to be confused with a vacuum leak, although both result in a degradation of the vacuum.

that, on trying to restart, the gas load inside the cryostat is too high and the unit fails to cool. The remedy is straightforward, if inconvenient: a “pump and bake” of the instrument is required at an ORTEC service center.

Fortunately, you can easily avoid this problem: *We strongly recommend that instruments used only occasionally be turned on once a month, fully cooled to ready status, and allowed to run for at least 48 hours. Doing this starts the ion pump and activates the internal getters, ensuring that the vacuum is maintained in good condition.*

As well as maintaining the vacuum, this procedure keeps the system battery “topped up” and also provides peace of mind that the system will cool when required.

# 6. LIST MODE

The IDM-200-V is equipped with a *List Mode* that is useful in real-time monitoring applications. Because of the widely varying requirements for a real-time monitoring application, no standard software is provided for collecting and analyzing List Mode data. To enter List Mode, issue the SET\_MODE\_LIST command; use SET\_MODE\_PHA to exit List Mode.

This chapter provides details about the List Mode that will enable experienced programmers, using the ORTEC CONNECTIONS Programmer's Toolkit with Microsoft® ActiveX® Controls (A11-B32), to write a custom software application program that can collect List Mode data and write it to a disk file.

## 6.1. Spectrometer Data Format

List Mode data is retrieved from the IDM-200-V spectrometer by calls to the CONNECTIONS MIOGetData() DLL function or the CONNECTIONS control GetRawData() method. A minimum of 4 and a maximum of 16384 32-bit words of data can be requested at a time. Each request for data returns a block of 32-bit list mode words that begin with a 32-bit integer number of valid bytes followed by a 3-word CONNECTIONS time stamp, thus the minimum of 4 words in a request. The first word is the number of bytes returned, not including the first 4 bytes. The minimum value returned here is 12, indicating 3 CONNECTIONS time stamp words only, and the maximum is 65532, indicating 3 CONNECTIONS time stamp words plus 16383 data words.

The CONNECTIONS time stamp represents the 64-bit Windows file time that corresponds to the exact time that the request for data is sent to the spectrometer. At the exact time the CONNECTIONS requests data from the spectrometer, the spectrometer creates a hardware time word in the list mode data stream that indicates the corresponding time within the spectrometer. The 16-bit real time number on the hardware time word is from the same time source as the 16-bit real time stamps on each of the ADC words. Using the CONNECTIONS time stamp and the hardware time word you can determine the 64-bit Windows time associated with each ADC word in the buffer. Refer to the Win-32 function GetSystemTimeAsFileTime() for more information about the 64-bit time format contained in these words.

In the case where the data acquisition program does not get all of the data from the spectrometer, the data block will not contain a hardware time word. In this case the data acquisition program must immediately request another block of data from the spectrometer in order to find the corresponding hardware time stamp. Note that the second block will begin with another CONNECTIONS time stamp, which will correspond to another hardware time word. The data acquisition program must associate the first CONNECTIONS time stamp to the first hardware time word and the second CONNECTIONS time stamp to the second hardware time word even though the first hardware time word appears after the second CONNECTIONS time stamp. For example, if you

request 16384 words and the first returned word is 65532 indicating that 16380 data words plus 4 overhead words were returned, you should immediately request another block of data.

The IDM-200-V has buffer storage for up to 96k 32-bit words. Therefore, six requests may be needed to drain the buffer and find all of the hardware time words. In practice, a program buffer of 96k words would always hold enough data to drain an instrument buffer assuming that all six requests were made in less than 1 second.

The following tables describe the format for the list-mode data as returned by CONNECTIONS from the IDM-200-V spectrometer:

**Table 1. Spectrometer List Mode Data Format.**

	31	30	29	16	15	0
<b>ADC Word</b>	1	1	14-bit ADC value		16-bit real time in 200nS ticks	
<b>RT Word</b>	1	0	30-bit real time in 10 ms ticks			
<b>LT Word</b>	0	1	30-bit live time in 10 ms ticks			

**Table 2. Spectrometer List Mode Data Format.**

	31	24	23	16	15	8	7	0
<b>Hdw Time</b>	00000000		00000000		16-bit real time in 200nS ticks			
<b>CONNECTIONS Time</b>	00000001		Byte 2		Byte 1		Byte 0	
<b>CONNECTIONS Time</b>	00000010		Byte 5		Byte 4		Byte 3	
<b>CONNECTIONS Time</b>	00000011		00000000		Byte 7		Byte 6	
<b>ADC CRM</b>	00000100		00000000		Counts per 10 ms period			
<b>Ext Counter 1</b>	00000101		00000000		Counts per 10 ms period			
<b>Ext Counter 2</b>	00000110		00000000		Counts per 10 ms period			
<b>GM Counter (IDM-200 Only)</b>	00000111		00000000		Counts per 10 ms period			

The ADC Word contains a 14-bit ADC value and a 16-bit real time stamp. The Hardware Time Word contains the same 16-bit real time stamp. In both cases this value represents the time that the word was created as represented by an internal clock that increments every 200 ns. The 200 ns clock rolls over from 49999 to 0, which gives it a period of 10 ms. Every time the 200 ns clock rolls over a RT Word and LT Word are created. The 30-bit real time stamp on the RT word



corresponds to the number of times the 200 ns clock rolls over. The 10 ms real time clock and the 10 ms live time clocks are cleared when the CLEAR command is sent to the spectrometer. Otherwise they increment every 10 ms while data is collecting. Using the RT Word as a time standard and the 200 ns time stamps from the ADC Word you can determine the time that any ADC event occurred,  $\pm 200$  ns, relative to the beginning of the acquisition.

LT Words are created by the spectrometer at the same time as are RT Words. The 30-bit live time stamp represents the ADC live seconds since the beginning of the acquisition (or since the last CLEAR command). By calculating the relative change in live time between any two LT Words in a list mode stream you can calculate the live time for a given block of data,  $\pm 10$  ms.

The ADC CRM Word is generated at the same time as the RT Word, and always appears just after the LT Word in the list data. This word reports the number of gamma rays detected in the preceding 10 ms. The count is incremented each time the ADC fast channel detects a pulse. Since many pulses may be rejected before one is converted into a valid ADC event, this number is not the simple sum of the ADC events over the past 10 ms; instead it represents the true input count-rate during the 10 ms interval.

The Ext Counter Words are generated at the same time as the RT Word. They represent the number of rising edges that arrived on the External inputs in the preceding 10 ms. Note that an external input must remain high for at least 40 ns for the pulse to be counted.

Optionally, the external counters can be configured to be a simple level sensitive input (see the ENAB\_COUNT\_LIST command on page 39). In this case the counter value is 0 or 1, depending on the level of the input at the time the counter word is generated.

The GM Counter Word is generated at the same time as the RT Word. It reports the number of counts registered in the Geiger-Müller tube in the preceding 10 ms (the GM tube specification is on page 25).

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# 7. FIRMWARE COMMANDS AND RESPONSES

Most software communication with the IDM-200-V will be 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-B32). Use the DLL interface call **MIOComm** or the ActiveX control UCONN's **Comm** method to send commands to instruments and receive responses.

## 7.1. 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.

## 7.2. 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

### 7.2.1. 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.

\$Axxxxccc<CR>	xxx is a single 8-bit unsigned number.
\$Cxxxxxccc<CR>	xxxxx is a single 16-bit unsigned number.
\$Dxxxxxyyyyyccc<CR>	xxxxx and yyyy are 16-bit unsigned numbers.
\$Exxxxxccc<CR>	xxxxx is a single 16-bit alarm mask.
\$Fssss...<CR>	ssss... is a variable length ASCII character sequence (no checksum is sent with this record).
\$Gxxxxxxxxxxxxccc<CR>	xxxxxxxxxxx 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).
\$Jxxxxxyyyyy...ccc<CR>	Response to SHOW_CONFIGURATION command.
\$Mxxxxxxxxxxx...ccc<CR>	Response to SHOW_STATUS command.
\$Nxxxxyyzzzccc<CR>	xxx, yyy, and zzz are 8-bit unsigned numbers.

### 7.2.2. 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\_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\_BLRE\_AUTOMATIC**

Disables the automatic determination of baseline restorer time constant. See also ENABLE\_BLRE\_AUTOMATIC, SET\_BLRE, and SHOW\_BLRE.

**DISABLE\_COOLER**

Powers off the cooler. Typically used only for troubleshooting.

**DISA\_COUNT\_LIST x**

In the List Mode data stream, data from the external inputs can either be returned as a counter, or a level. This command sets the specified input to be used as a “Level” (0 = EXTERNAL 1, 1 = EXTERNAL 2). See also ENAB\_COUNT\_LIST.

**DISABLE\_GAIN\_STABILIZATION**

Stops stabilization of the gain peak while data is being acquired. The gain stabilization adjustment is held at its current value until either gain stabilization is reenabled with the ENABLE\_GAIN\_STABILIZATION command or reinitialized with the INITIALIZE\_GAIN\_STABILIZATION, SET\_GAIN\_PEAK or SET\_GAIN\_WIDTH command. See also SHOW\_GAIN\_STABILIZATION.

**DISABLE\_HV**

Turns off the high-voltage. See also ENABLE\_HV and SHOW\_HV.

**DISABLE\_ZERO\_STABILIZATION**

Stops stabilization of the zero peak while data is being acquired. The zero stabilization adjustment is held at its current value until either zero stabilization is reenabled with the ENABLE\_ZERO\_STABILIZATION command or reinitialized with the INITIALIZE\_ZERO\_STABILIZATION, SET\_ZERO\_CHANNEL or SET\_ZERO\_WIDTH commands. See also SHOW\_ZERO\_STABILIZATION.

**ENABLE\_BLRE\_AUTOMATIC**

Enables the automatic determination of baseline restorer time constant. See also `DISABLE_BLRE_AUTO`, `SHOW_BLRE`, and `SET_BLRE`.

**ENABLE\_COOLER**

Powers on the cooler. Typically used only for troubleshooting.

**ENAB\_COUNT\_LIST x**

In the List Mode data stream, data from the external inputs can either be returned as a counter, or a level. This command sets the specified input to be used as a “Counter” (0 = EXTERNAL 1, 1 = EXTERNAL 2). See also `DISA_COUNT_LIST`.

**ENABLE\_GAIN\_STABILIZATION**

Enables the stabilization of the gain peak by the previously selected method, either Gauss mode or point mode (see `SET_MODE_GAUSS` and `SET_MODE_POINT`). See also `DISABLE_GAIN_STABILIZATION`, `SHOW_GAIN_STABILIZATION`, and `INITIALIZE_GAIN_STABILIZATION`.

**ENABLE\_HV**

Turns on the high-voltage. See also `DISABLE_HV` and `SHOW_HV`.

Execution Errors:

**%131137085<CR>**

The high voltage could not be enabled due to a high voltage shutdown condition.

**ENABLE\_ZERO\_STABILIZATION**

Enables the stabilization of the zero peak by the previously selected method, either Gauss mode or point mode (see `SET_MODE_GAUSS` and `SET_MODE_POINT`). See also `DISABLE_ZERO_STABILIZATION`, `SHOW_ZERO_STABILIZATION`, and `INITIALIZE_ZERO_STABILIZATION`.

**INITIALIZE**

Returns the IDM-200-V to the factory default settings.

**INITIALIZE\_GAIN\_STABILIZATION**

Resets the gain peak stabilization adjustment to unity (no adjustment). This value is reported as 2048 by the `SHOW_GAIN_ADJUSTMENT` command. See also `SET_GAIN_ADJUSTMENT`, `ENABLE_GAIN_STABILIZATION`, and `DISABLE_GAIN_STABILIZATION`.

**INITIALIZE\_ZERO\_STABILIZATION**

Resets the zero peak stabilization adjustment to unity (no adjustment). This value is reported as 2048 by the SHOW\_ZERO\_ADJUSTMENT command. See also SET\_ZERO\_ADJUSTMENT, ENABLE\_ZERO\_STABILIZATION, and DISABLE\_ZERO\_STABILIZATION.

**LIST\_BLRE**

Lists the valid settings of the baseline restore function.

**LIST\_CORR\_FLAT**

Lists the valid settings of the flattop width.

**LIST\_GAIN\_COARSE**

Lists the valid coarse-gain settings.

Response:

**GAIN\_COAR 1 2 4 8 16 32**

**LIST\_GAIN\_CONV**

Lists legal conversion gain settings.

Response:

**GAIN\_CONV 512 1024 2048 4096 8192 16384**

**LIST\_GAIN\_FINE**

Lists the valid fine-gain settings.

**LIST\_HV**

Lists the valid high-voltage settings.

**LIST\_ROI\_SAMPLE**

Lists the valid ROI sample settings.

**LIST\_SHAP\_FLAT**

Lists the valid flattop width settings.

**LIST\_SHAPE\_RISE**

Lists the valid rise-time settings.

**LIST\_SHUT**

Lists the valid shutdown settings.



**LIST\_TRIG\_SAMPLE**

Lists the valid sample trigger settings.

**RESTORE\_CAL**

Initializes spectrum stabilizers, returns fine gain to factory calibration, and returns energy calibration to factory calibration.

**RESTORE\_CAL\_ENERGY**

Returns energy calibration to factory calibration.

**RESTORE\_GAIN\_FINE**

Returns fine gain to factory calibration.

**SAMPLE**

Sending this command causes another waveform to be captured in InSight mode. This command is invalid when not in InSight mode.

**SET\_BLRE** baseline

This sets the baseline restorer time constant to the value baseline. Baseline is in microseconds with a range from 10 to 100. The specified value is only used if automatic baseline restorer mode is disabled. See also **ENABLE\_BLRE**, **DISABLE\_BLRE**, and **SHOW\_BLRE**.

**SET\_CAL\_ADJUST** fff.ff

Adjusts fine gain by the ratio:

$$\text{New fine gain} = \text{Current fine gain} * (1 + \text{fff.ff})$$

where fff.ff can be positive or negative.

**SET\_CORRECTION\_FLAT** value

This sets the flattop correction to value. See also **SHOW\_CORRECTION\_FLAT**.

**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 IDM-200-V internal memory that can be used by other programs, such as sample descriptions and energy calibrations. CONNECTIONS makes use of this feature. String1 = the data identifier, 32 bytes maximum; string2 = the data, 128 bytes maximum.

**SET\_DATE** day,month,year

Sets the date stored in the battery backed-up system clock to the specified values. Day can be any value from 1–31; month any value from 1–12; and year any value from 0–99. The current date and time are stored for a device when an acquisition is started. See also SHOW\_DATE, SET\_TIME, and SHOW\_TIME.

**SET\_DATE\_START** day,month,year

Sets the start date to the specified values. Normally the start date and time are set automatically whenever a device is started with the START command. See also SHOW\_DATE\_START, SET\_TIME\_START, and SHOW\_TIME\_START.

**SET\_DELAY\_SAMPLE** num

Delays the waveform collected in InSight mode by num points. Num must be between 0 and 65535. See also SHOW\_DELAY\_SAMPLE.

**SET\_GAIN\_ADJUSTMENT** value

Sets the gain stabilization adjustment to an arbitrary value from –65535 to 65535. This adjustment is usually made only by the gain stabilizer, and reset to 0 with the INITIALIZE\_GAIN\_STABILIZATION command. See also SHOW\_GAIN\_ADJUSTMENT.

**SET\_GAIN\_CHANNEL** chan

Sets the center channel for the stabilizer gain peak. If a gain channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel as determined by the conversion gain, the gain peak width is reduced until the peak fits the device boundaries. A gain channel and width must be set before gain stabilization can be enabled.

**SET\_GAIN\_COARSE** num

Sets the coarse gain to num, which must be 1, 2, 4, 8, 16, or 32. See also SHOW\_GAIN\_COARSE.

**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 14 bits (conversion gain = 16384) to 9 bits (conversion gain = 512) for the device. See also SHOW\_GAIN\_CONVERSION.

Legal Commands:

<b>SET_GAIN_CONVERSION 0&lt;CR&gt;</b>	Conversion gain set to default (16384).
<b>SET_GAIN_CONVERSION 512&lt;CR&gt;</b>	Conversion gain set to 512 channels.
<b>SET_GAIN_CONVERSION 1024&lt;CR&gt;</b>	Conversion gain set to 1024 channels.
<b>SET_GAIN_CONVERSION 2048&lt;CR&gt;</b>	Conversion gain set to 2048 channels.
<b>SET_GAIN_CONVERSION 4096&lt;CR&gt;</b>	Conversion gain set to 4096 channels.
<b>SET_GAIN_CONVERSION 8192&lt;CR&gt;</b>	Conversion gain set to 8192 channels.
<b>SET_GAIN_CONVERSION 16384&lt;CR&gt;</b>	Conversion gain set to 16384 channels.

**SET\_GAIN\_FINE** value

This sets the fine gain to value. Value is a floating point value from 0.45 to 1.0. See also SHOW\_GAIN\_FINE.

**SET\_GAIN\_WIDTH** chans

Sets the width in channels for the stabilizer gain peak. The gain width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The gain channel and width must be set before gain stabilization can be enabled. The absolute minimum width for the gain peak is 3 channels, and the absolute maximum width for the gain peak is 256 channels in Gauss mode. In point mode there is no maximum peak width, though the chosen width must allow the peak to fit within the device's channel limits as stated above. See also SHOW\_GAIN\_WIDTH, SET\_GAIN\_CHANNEL and SHOW\_GAIN\_CHANNEL.

**SET\_HV** value

The HV in this unit is fixed.

**SET\_ID** “<id string>”

Sets the sample id string. This string can be up to 16 characters long and can be set to any arbitrary value. The id string is intended to uniquely identify the sample being analyzed. The id string is also set by the BARCODE command and is stored with each spectrum acquired in field mode. See also SHOW\_ID.

Examples:

**SET\_ID “Site 123”**

**SET\_ID “Sample 123456789”**

**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 IDM-200-V. 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\_LENGTH\_SAMPLE** length

Sets the number of points in the Insight mode display to the specified value. Normally this setting would remain at 1000.

**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 IDM-200-V 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. The preset should always be set to a multiple of 1 second. 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 0 and 16383. See also **SHOW\_LLD**.

**SET\_MODE\_LIST**

Sets the IDM-200-V to list mode. See also **SHOW\_MODE**.

**SET\_MODE\_PHA**

The mode is set to PHA.

**SET\_MODE\_SAMPLE**

Starts InSight Virtual Oscilloscope mode.

**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 IDM-200-V. 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\_SAMPLE** num

Selects which controls signals are displayed as an ROI on the captured waveform. Only a single bit can be turned on at a time. The following signals can be selected with the associated bit.

- Bit 0:** Pileup reject.
- Bit 1:** Negative baseline threshold.
- Bit 2:** Baseline restorer gate.
- Bit 3:** Positive baseline threshold.
- Bit 4:** Busy.
- Bit 5:** Gate.
- Bit 6:** Reserved.
- Bit 7:** Peak detect.
- Bit 8:** Reserved.

**SET\_SHAP\_FLAT** value

Sets the width of the flattop to value. Value is in microseconds, ranging from 0.3 to 2.4 in steps of 0.1. See also **SHOW\_SHAP\_FLAT**.

**SET\_SHAP\_RISE** value

Sets the rise time to value. Value is in microseconds, ranging from 0.8 to 23 in steps of 0.2. See also **SHOW\_SHAP\_RISE**.

**SET\_THRESH\_AUX** value,n

Sets the threshold, in volts, for the top-panel EXTERNAL 1 and EXTERNAL 2 inputs; value ranges from 0 to 4.98 V; n is 0 for EXTERNAL 1 and 1 for EXTERNAL 2. For example, SET\_THRESH\_AUX .3,0 sets the threshold for EXTERNAL 1 to 0.3 V.

**SET\_TIME** hour,min,sec

Sets the time stored in the battery backed-up system clock to the specified values. hour can be any value from 0–23; min and sec can be any value from 0–59. The current date and time are stored for a device when an acquisition is started. See also SHOW\_TIME, SET\_DATE, SHOW\_DATE, SET\_TIME\_START, and SHOW\_TIME\_START.

**SET\_TRIG\_SAMPLE** setting

Selects the triggering source in Insight Mode. See LIST\_TRIG\_SAMP for legal trigger sources.

**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 IDM-200-V 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. The preset should always be set to a multiple of one second. See also CLEAR\_PRESETS and SHOW\_TRUE\_PRESET.

Execution Errors:

**%131135083<CR>**

The command was attempted while spectrum acquisition was in progress. No action was taken.

**SET\_ULD** value

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

**SET\_ZERO\_ADJUSTMENT** value

Sets the zero stabilization adjustment to an arbitrary value from –65535 to 65535. The total range of the adjustment value represents  $\pm 256$  channels. This adjustment is usually only made by the gain stabilizer, and reset to 0 with the INITIALIZE\_ZERO\_STABILIZATION command. See also SHOW\_ZERO\_ADJUSTMENT.

**SET\_ZERO\_CHANNEL** chan

Sets the center channel for the stabilizer zero peak. If a zero channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel, as determined by the conversion gain, the zero peak width is reduced until the peak fits the device boundaries. A zero channel and width must be set before zero stabilization can be enabled. See also **ENABLE\_ZERO\_STABILIZATION**.

**SET\_ZERO\_WIDTH** chans

Sets the width in channels for the stabilizer zero peak. The zero width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The zero channel and width must be set before zero stabilization can be enabled. The absolute minimum width for the zero peak is 3 channels, and the absolute maximum width for the zero peak is 256 channels in Gauss mode. In point mode there is no maximum peak width, though the chosen width must allow the peak to fit within the device's channel limits as stated above.

**SHOW\_ACTIVE**

Returns a 1 if the IDM-200-V is active (i.e., acquiring spectral data) or 0 if it is not active.

Responses:

**\$C00000087<CR>** Not active.

**\$C00001088<CR>** Active.

**SHOW\_BATT\_LIFE**

Shows the remaining battery life in minutes.

**SHOW\_BLRE**

Shows the baseline restorer time constant in microseconds. See also **SET\_BLRE**.

Responses:

**BLUE 000000000000091** Time constant is 91  $\mu$ s.

**SHOW\_BLRE\_AUTOMATIC**

Shows whether automatic selection of the baseline restorer constant is off or on.

Responses:

**\$IT<CR>** Automatic baseline is enabled.

**\$IF<CR>** Automatic baseline is disabled.

**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 device (always 1 for the IDM-200-V), and the current conversion gain for each segment. The record is organized as follows:

**\$J1638400001aaaaa00000[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\_COOLER

Shows whether the cooler is on or off.

Responses:

**\$IT<CR>** Cooler is on/enabled.

**\$IF<CR>** Cooler is off/disabled.

### SHOW\_CORRECTION\_FLAT

Shows the flattop correction value. See also SET\_CORR\_FLAT.

Responses:

**CORR\_FLAT 0000000000000000**

### SHOW\_CRM

Returns the current reading of the count-rate meter.

Response:

**\$G0000050781096** Current input count rate is 50781 counts/s.

### 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.

Execution Errors:

**%%131138085<CR>** The specified string could not be matched.

### SHOW\_DATE

Returns the day, month, and year of the current date as maintained in the battery-backed-up real time clock, in the form dddmmmyyy. The day is returned as a 3-digit integer number from 001–031, month as a 3-digit integer number from 001–012, and year as a 3-digit integer number from 000–099. See also SET\_DATE\_START.



Responses:

\$N001001088052<CR>      Date reported as Jan 1, 1988.  
 ...      ...  
 \$N031012099059<CR>      Date reported as Dec 31, 1999.  
 \$N001001000036<CR>      Date reported as Jan 1, 2000.  
 ...      ...  
 \$N031012087056<CR>      Date reported as Dec 31, 2087.

**SHOW\_DATE\_START**

Returns the day, month and year of the acquisition start date in the form dddmmmyyy. The day is returned as a 3-digit integer number from 001–031, month as a 3-digit integer number from 001–012, and year as a 3-digit integer number from 000–099. See also SET\_DATE\_START.

Responses:

\$N001001088052<CR>      Date reported as Jan 1, 1988.  
 ...      ...  
 \$N031012099059<CR>      Date reported as Dec 31, 1999.  
 \$N001001000036<CR>      Date reported as Jan 1, 2000.  
 ...      ...  
 \$N031012087056<CR>      Date reported as Dec 31, 2087.

**SHOW\_DELAY\_SAMPLE**

Shows the Delay Sample setting. See also SET\_DELAY\_SAMPLE.

Responses:

\$C00003090      The sample number is 00003, and 090 is the checksum.

**SHOW\_DET\_TEMP**

Shows detector temperature relative to factory setpoint, in kelvins (K).

**SHOW\_DOSE**

Returns dose in microSieverts ( $\mu$ Sv).

**SHOW\_FEATURES**

Responds with four 32-bit masks indicating which features are present in the MCB.

Example Response:

**FEATURES 00003774783 01083064332 00195036416 00000050313**

**SHOW\_GAIN\_ADJUST**

Returns the gain stabilizer amplifier setting.

**SHOW\_GAIN\_CHANNEL**

Reports the current center channel for the stabilizer gain peak. See also SET\_GAIN\_CHANNEL.

Responses:

<b>\$C00000087&lt;CR&gt;</b>	Gain channel has not been set.
<b>\$C00002089&lt;CR&gt;</b>	Gain channel is channel 2 (lowest possible channel).
...	...
<b>\$C16382107&lt;CR&gt;</b>	Gain channel is channel 16382 (highest possible channel).

**SHOW\_GAIN\_COARSE**

Returns the coarse gain for the IDM-200-V internal amplifier. In operation, the resulting signal gain is the product of the coarse gain, the fine gain, and the super-fine gain (used by stabilizer).

Responses:

<b>\$C00001088&lt;CR&gt;</b>	Coarse gain reported as 1.
<b>\$C00002089&lt;CR&gt;</b>	Coarse gain reported as 2.
<b>\$C00004091&lt;CR&gt;</b>	Coarse gain reported as 4.
<b>\$C00008095&lt;CR&gt;</b>	Coarse gain reported as 8.
<b>\$C00016094&lt;CR&gt;</b>	Coarse gain reported as 16.
<b>\$C00032092&lt;CR&gt;</b>	Coarse gain reported as 32.

**SHOW\_GAIN\_CONVERSION**

This command returns the conversion gain.

Responses:

<b>\$C00512095&lt;CR&gt;</b>	Conversion gain reported as 512 channels.
<b>\$C01024094&lt;CR&gt;</b>	Conversion gain reported as 1024 channels.
<b>\$C02048101&lt;CR&gt;</b>	Conversion gain reported as 2048 channels.
<b>\$C04096106&lt;CR&gt;</b>	Conversion gain reported as 4096 channels.
<b>\$C08192107&lt;CR&gt;</b>	Conversion gain reported as 8192 channels.
<b>\$C16384109&lt;CR&gt;</b>	Conversion gain reported as 16384 channels.

**SHOW\_GAIN\_FINE**

Returns the current fine gain setting. See SET\_GAIN\_FINE.

Sample Response:

<b>GAIN_FINE 000000000000.5</b>	Gain is 0.5.
---------------------------------	--------------

**SHOW\_GAIN\_POLARITY**

Returns the polarity of the amplifier input as \$F records.

Responses:**\$INEG<CR>**

The amplifier input is set to negative.

**\$IPOS<CR>**

The amplifier input is set to positive.

**SHOW\_GAIN\_STABILIZATION**

Reports the state of gain peak stabilization. See also **ENABLE\_GAIN\_STABILIZATION** and **DISABLE\_GAIN\_STABILIZATION**.

Responses:**\$IT<CR>**

Gain stabilization is currently enabled.

**\$IF<CR>**

Gain stabilization is currently disabled.

**SHOW\_GAIN\_WIDTH**

Reports the current width for the stabilizer gain peak. See also **SET\_GAIN\_WIDTH**, **SET\_GAIN\_CHANNEL**, and **SHOW\_GAIN\_CHANNEL**.

Responses:**\$C00001088<CR>**

Gain width has not been set.

**\$C00003089<CR>**

Gain width is 3 channels (lowest possible width).

**\$C00256100<CR>**

Gain width is 256 channels (highest possible width in Gauss mode).

...

**\$C16383108<CR>**

Gain width is 16383 channels (highest possible width in point mode with gain channel set to 8192).

**SHOW\_HV**

Reports the current high voltage and the status of the high voltage power supply in the form

**\$Dvvvvvsssssccc<CR>**

where vvvvv represents the current output voltage if the high voltage is enabled, or the rear-panel high voltage setting if the high voltage is disabled. sssss represents the status of the high voltage bias supply as 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).

Example Responses:**\$D0200000003077<CR>**

2000 V, negative, not overloaded, disabled.

**\$D0200000002076<CR>**

2000 V, positive, not overloaded, disabled.

**\$D0200000007082<CR>**

2000 V, negative, not overloaded, enabled.

**SHOW\_HV\_ACTUAL**

Returns the value of HV actually on the detector.

**SHOW\_HV\_HEALTH**

Returns the status of the state of health for the detector as reported by the DIM or SMART-1.

**SHOW\_HV\_POLARITY**

Always returns a positive record for the IDM-200-V.

**\$FPOS<CR>** The HV is set to positive.

**SHOW\_HV\_TARGET**

Under normal operation, the HV will go to this value when the HV is enabled. Reports the current HV setting (see SET\_HV) and the status of the HV power supply in the form:

**\$Dvvvvvsssssccc<CR>**

where **vvvvv** represents the HV setting, and **sssss** represents the status of the HV bias supply as 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:** HV enabled (0=disabled, 1=enabled).

Example Responses:

**\$D0200000003077<CR>** 2000 V, negative, not overloaded, disabled.

**\$D0200000002076<CR>** 2000 V, positive, not overloaded, disabled.

**\$D0200000007082<CR>** 2000 V, negative, not overloaded, enabled.

**SHOW\_HV\_POLARITY**

Always returns positive polarity for the IDM-200-V.

Responses:

**\$IPOS<CR>** The HV is set to positive.

**SHOW\_INPUT**

Returns the state of the two external inputs

Responses:

**\$C00000087<CR>** Both external inputs are low (less than the auxiliary threshold setting).

**\$C00001088<CR>** EXTERNAL 1 is greater than its auxiliary threshold setting and EXTERNAL 2 is less than its threshold setting.

**\$C00002089<CR>** EXTERNAL 2 is greater than its auxiliary threshold setting and EXTERNAL 1 is less than its threshold setting.

**\$C00003090<CR>** Both external inputs are high (greater than the auxiliary threshold setting).

### **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 segment 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\_INTEGRAL\_REMAINING**

Reports the current ROI integral remaining value. For more information about the ROI integral remaining, see SET\_INTEGRAL\_REMAINING. See also SHOW\_INTEGRAL.

Responses:

**\$G0000000000075<CR>** Integral remaining reported as 0.

...

**\$G4294967295132<CR>** Integral reported as 4294967295.

### **SHOW\_LENGTH\_SAMPLE**

Reports the number of points in the Insight Mode Waveform.

Response:

**\$C010000088** 1000 points in the waveform.

**SHOW\_LFR**

Tells whether LFR mode is enabled.

Responses:

**\$IF** LFR mode disabled.

**\$IT** LFR mode enabled.

**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\_LIVE\_REMAINING**

Reports the current live-time remaining in units of 20 ms (50 ticks/s). See also SET\_LIVE\_REMAINING.

Responses:

**\$G0000000000075<CR>** Live-time remaining reported as disabled.

**\$G0000000001076<CR>** Live-time remaining reported as 1 tick.

...

...

**\$G4294967295132<CR>** Live-time remaining reported as 4294967295 ticks.

**SHOW\_LLD**

Shows the lower level discriminator setting. See also SET\_LLD.

Responses:

**\$C00050092** The LLD is 50.

**SHOW\_MODE**

Reports the current mode of operation (PHA, List, or Sample [InSight Virtual Oscilloscope]). See also SET\_MODE\_PHA and SET\_MODE\_SAMPLE.

Responses:

**\$FPHA<CR>** PHA mode.  
**\$FLIS<CR>** List mode.  
**\$FSAM<CR>** Sample mode (InSight).

**SHOW\_MONI\_LABEL num**

Returns with an ASCII string label designation for the monitor num.

**SHOW\_MONI\_LIVE num**

Returns with an ASCII representation of the real-time value for the monitor.

**SHOW\_MONI\_MAX**

Returns with the number of monitors available for viewing.

**SHOW\_MONI\_VALUE num**

Returns with an ASCII representation of the value for the monitor at the end of the last acquisition.

**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

**\$Dssssnnnnccc<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\_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:

<b>\$G0000000000075&lt;CR&gt;</b>	Maximum count in an ROI channel is zero or no ROI channels were found.
<b>\$G0000000001076&lt;CR&gt;</b>	Maximum count in an ROI channel is 1.
...	...
<b>\$G2147483646120&lt;CR&gt;</b>	Maximum count in an ROI channel is 2147483646.
<b>\$G2147483647121&lt;CR&gt;</b>	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 32767 is the highest numbered channel in any device.

Responses:

<b>\$C00000087&lt;CR&gt;</b>	Maximum count was found in channel 0 or no ROI channels were found (see errors below).
<b>\$C00001088&lt;CR&gt;</b>	Maximum count was found in channel 1.
...	...
<b>\$C16383108&lt;CR&gt;</b>	Maximum count was found in channel 16383.

**SHOW\_PEAK\_PRESET**

Reports the value of the ROI peak preset. See SET\_PEAK\_PRESET for information about the ROI peak preset.

Responses:

<b>\$G0000000000075&lt;CR&gt;</b>	Peak preset disabled.
<b>\$G0000000001076&lt;CR&gt;</b>	Peak preset set to 1 count.
...	...
<b>\$G2147483646120&lt;CR&gt;</b>	Peak preset set to 2147483646 counts.
<b>\$G2147483647121&lt;CR&gt;</b>	Peak preset set to 2147483647 counts.

**SHOW\_PZ**

Displays the PZ setting. See also SET\_PZ.

Responses:

<b>PZ_ENA 002200</b>	Pole zero enabled and set to 2200.
<b>PZ_DIS 001000</b>	Pole zero disabled and set to 1000.



**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:

**\$Dssssnnnnccc<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 nnnn 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:

**\$D010000050078<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.  
**\$D000000000072<CR>** No ROI groups to report.

**SHOW\_ROI\_SAMPLE**

Displays the ROI Sample setting. See also SET\_ROI\_SAMPLE.

Responses:

**\$C00001088**

**SHOW\_SHAP\_FLAT**

Reports the width of the flattop in  $\mu$ s. See also SET\_SHAP\_FLAT.

Responses:

**SHAP\_FLAT 000000000001.2**

**SHOW\_SHAP\_RISE**

Displays the rise-time setting in  $\mu$ s. See also SET\_SHAP\_RISE.

Responses:

**SHAP\_RISE 000000000003.2**

**SHOW\_SHUTDOWN**

Shows the type of HV shutdown selected. Always SMART-1 for this unit.

Responses:

**\$FSM1** SMART-1 mode selected

**SHOW\_SHUT\_ACTUAL**

Returns the current status of the bias remote shutdown input signal. This command is valid whether the bias supply is turned on or off.

Responses:

**\$IT** Shutdown is active (supply is shut down or can't be turned on).  
**\$IF** Shutdown is inactive (supply is on or can be turned on).

**SHOW\_SNUM**

Responds with a \$F record indicating the serial number of the IDM-200-V.

Response:

**\$F100** Serial number is 100.

**SHOW\_STATUS**

Returns system status information in the following format:

**\$MMMMMMMMTTTTTTTTAAAAHHHHCCC<CR>**

where **MMMMMM** represents the live time as returned by the SHOW\_LIVE command, **TTTTTTTT** represents the true time for the current device as returned by the SHOW\_TRUE command, **AAAA** represents the active device mask as returned by the SHOW\_ACTIVE\_DEVICES command, and **HHHH** 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\_THRESHOLD\_AUX n**

Returns the threshold setting for EXTERNAL 1 (n = 0) and EXTERNAL 2 (n = 1) inputs.

**SHOW\_TIME**

Reports the time from the battery backed-up system clock in the form:

**\$Nhhmmssccc<CR>**

where hhh represents a 3-digit integer hour (0–23), mmm represents a 3-digit integer minute (0–59), and sss represents a 3-digit integer second (0–59). See also SET\_TIME, SET\_DATE, and SHOW\_DATE.

Example Responses:

**\$N010054017052<CR>** Time returned 10:54:17 (10 h, 54 min, 17 s).  
**\$N020013037050<CR>** Time returned 20:13:37 (20 h, 13 min, 37 s).

### SHOW\_TIME\_START

Reports the time of the last START command in the form

**\$Nhhmmssccc<CR>**

where hhh represents a 3-digit integer hour (0 through 23), mmm represents a 3-digit integer minute (0 through 59) and sss represents a 3-digit integer second (0 through 59). See also SET\_TIME\_START, SET\_DATE\_START, and SHOW\_DATE\_START.

Example Responses:

**\$N010054017052<CR>** Time returned 10:54:17 (10 h, 54 min, 17 s).  
**\$N020013037050<CR>** Time returned 20:13:37 (20 h, 13 min, 37 s).

### SHOW\_TRIG\_SAMPLE

Reports the trigger source in Insight Mode.

Responses:

**\$F0LLD** LLD is source.  
**\$F1PKD** Peak-detect is source.  
**\$F2RANDOM** Trigger happens randomly.  
**\$F3Gate** Gate Input triggers the waveform.

### SHOW\_TRIGGER\_SPECIAL

Not used; included for backward compatibility.

### 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\_TRUE\_REMAINING**

Reports the current true time remaining in units of 20 milliseconds (50 ticks per second). See also SET\_TRUE\_REMAINING.

Responses:

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

**SHOW\_ULD**

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

**SHOW\_VERSION**

Reports the IDM-200 series firmware version number in the form:

**FDETx-vvv<CR>**

where the DETx string designates the model and vvv designates the firmware version. In the model string, x is **M** for the IDM-200.

Example Response:

**\$FDETM-002<CR>** Model IDM-200 firmware version 2 reported.

**SHOW\_VMON 3**

Returns the major detector and HV state-of-health parameters as a \$F response in a comma delimited string as follows:

**aaaa,bbb.bb,c.cc,dddd,eeee,ffff,g,hh,iii,-jjj,kkk.kk,lll.ll,mm.m,nnnn,oooo,pppp,q,r**  
 where:

aaaa = the battery time remaining, in minutes  
 bbb.bb = the gamma dose, in microSieverts ( $\mu$ Sv)  
 c.cc = the cooler drive, in volts  
 dddd = the actual HV, in volts  
 eeee = the target HV, in volts  
 ffff = the HV Status word (see SHOW\_HV)  
 g = cooler on/off state; 1 = on, 0 = off  
 hh = the 3.3V voltage, in units of 0.1V

- iii = the +12V voltage, in units of 0.1V
- jjj = the -12V voltage, in units of 0.1V
- kkk.kk = the detector temperature, in kelvins
- lll.ll = the detector cold tip temperature, in kelvins
- mm.m = the detector body temperature, in degrees Celsius
- nnnn = the ion pump voltage
- oooo = the ion pump current
- pppp = the stabilizer percentage, in units of 0.1%
- q = the battery state (0 = charging, 1 = external power (not charging), 2 = internal battery)
- r = gain stabilizer state; 1 = on, 0 = off

### SHOW\_ZERO\_ADJ

Returns the value of the zero offset for the zero stabilizer.

### SHOW\_ZERO\_CHANNEL

Reports the center channel for the stabilizer zero peak. See also SET\_ZERO\_CHANNEL, SET\_ZERO\_WIDTH, and SHOW\_ZERO\_WIDTH.

Responses:

\$C00000087<CR>	Zero channel has not been set.
\$C00002089<CR>	Zero channel is channel 2 (lowest possible channel).
...	...
\$C16382107<CR>	Zero channel is channel 16382 (highest possible channel).

### SHOW\_ZERO\_STABILIZATION

Reports the state of zero peak stabilization. See also ENABLE\_ZERO\_STABILIZATION and DISABLE\_ZERO\_STABILIZATION.

Responses:

\$IT<CR>	Zero stabilization is currently enabled.
\$IF<CR>	Zero stabilization is currently disabled.

### SHOW\_ZERO\_WIDTH

Reports the current width for the stabilizer zero peak. See also SET\_ZERO\_WIDTH, SET\_ZERO\_CHANNEL, and SHOW\_ZERO\_CHANNEL.

Responses:

\$C00001088<CR>	Zero width has not been set.
\$C00003089<CR>	Zero width is 3 channels (lowest possible width).
\$C00256100<CR>	Zero width is 256 channels (highest possible width in Gauss mode).

**\$C16383108<CR>**

Zero width is 16383 channels (highest possible width in point mode with zero channel set to 8192).

**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 IDM-200-V.

**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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