ORTEC®

EASY-NIM™ 928 Suite

High Performance, Multi-Function Nuclear Multichannel Buffer/Counter/Timer/Rate Meter

Hardware Manual

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Manual Revision A

Advanced Measurement Technology, Inc.
a/k/a/ ORTEC®, a subsidiary of AMETEK®, Inc.

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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.

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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.

TABLE OF CONTENTS

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.

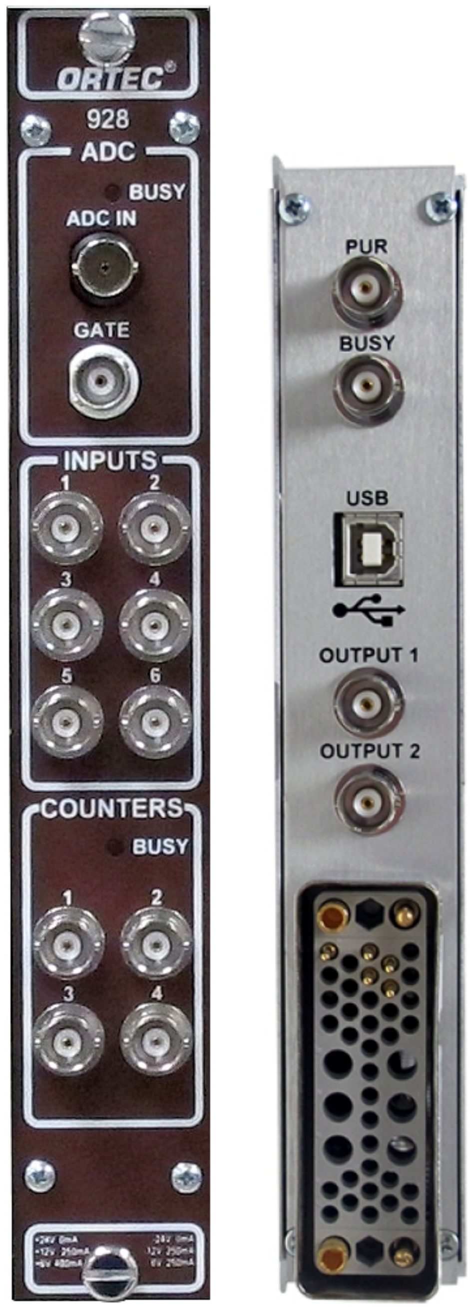
Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol might appear on the product:

ATTENTION – Refer to Manual

DANGER – High Voltage

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


ORTEC
928
ADC
BUSY
ADC IN
GATE
INPUTS
1
2
3
4
5
6
COUNTERS
BUSY
1
2
3
4
PUR
BUSY
USB
OUTPUT 1
OUTPUT 2

ORTEC® EASY-NIM™ 928 SUITE
High Performance, Multi-Function Nuclear Multichannel Buffer/ Counter/Timer/Rate Meter

1. INTRODUCTION

The ORTEC Model 928 EASY-NIM instrument family offers a new approach to nuclear pulse counting and pulse height analysis for a variety of applications in nuclear science. The four EASY-NIM modules are:

- **928** Combination multichannel buffer (MCB)/quad-counter/dual-timer
- **928-MCB** MCB only (no counter/timer)
- **928-COUNT2** Dual-counter/single-timer module (no MCB)
- **928-COUNT4** Quad-counter/dual-timer module (no MCB)

The EASY-NIM 928 operates in conjunction with both the accompanying Easy NIM front-panel emulation software and our MAESTRO® MCA Emulation Software (or our other spectroscopy applications). The 928-MCB uses only the spectroscopy software; and the two counter/timer-only models use only the Easy NIM front-panel emulator. The counter/timer modules each have six programmable inputs and two programmable outputs for connection to external devices, which can be assigned to a variety of sources.

1.1. FEATURES

- High performance, multi-function spectroscopy MCB combined with counter/timer/rate meters in a single-width NIM module.
- Group counters and timers for simultaneous start/stop/reset. This option makes it simple to synchronize multiple 928s.
- Fast (1.25 µs) 16k ADC.
- PUR, BUSY, and GATE inputs.
- Easy NIM front panel emulation software and programmer's toolkit support.
- Simple, flexible, internal interconnection of signals allows configuration without conventional external coaxial cabling.
- Timer with internal or external timebase capability, 200 MHz pulse counter, and rate meter with adjustable alarm threshold.
- Six configurable general-purpose inputs and two configurable outputs (rear panel).
- Dead time can be corrected using either the Gedcke-Hale extended live-time method[1] or our innovative Zero Dead Time — ZDT™ — loss-free dead-time correction method.[2]
- Connects to the host computer via high-speed USB.

The EASY-NIM 928 requires power from a NIM bin such as the ORTEC Model 4001A/4002D or the Model 4006.

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

[2] U.S. patent 6,327,549.

1.2. DEVELOPING CUSTOM SOFTWARE APPLICATIONS FOR THE 928

The EASY-NIM 928 suite of instruments are members of the ORTEC CONNECTIONS software architecture. CONNECTIONS is a unified scheme under which all instruments transmit and receive instrument commands and responses. It is the lowest-level software component used by ORTEC applications to communicate with hardware. CONNECTIONS locates and establishes communication with ORTEC instruments that are directly connected to the computer, connected to other computers in the network, or freestanding. It handles all of the details of network communication.

CONNECTIONS also handles the sending of commands to the hardware and the receipt of responses. The syntax of commands sent via CONNECTIONS conforms with the "traditional" NIM digital bus NIM/4881 per DOE/ER-0457T (formerly NIM-GPIB) protocol[3] used for several years in all ORTEC MCB and MCS products.

In the case of the EASY-NIM 928, the module itself uses these protocols. In certain other instruments, CONNECTIONS translates to and from these protocols via a loadable driver specific to that instrument. The syntax is simple, for example, following are the commands that start the counter and stop the timer, sent to the instrument from a user program.

START_COUNTER n1

n1 is the counter index from 1 to 4.

STOP_TIMER n1

n1 is the timer index from 1 to 2.

Our CONNECTIONS Programmer's Toolkit with Microsoft® ActiveX® Controls has two programming options. For programmers familiar with Dynamic Linked Libraries (DLLs), it provides DLLs and supplemental Windows applications programming interfaces that can be called from C, C++, or Visual Basic. For programmers using ActiveX controls, all the functionality can be accessed more conveniently through ActiveX methods, properties, and events. The ActiveX capability makes it easy to program ORTEC products from LabVIEW (Version 5.1 or later), Visual C++, and Visual Basic. Simple example programs are supplied with both programming options.

The ORTEC hardware configuration program, MCB Configuration, is included. MCB Configuration searches the local PC and network for supported MCBs (and multichannel scalers) and generates a master list of each instrument found, including the hardware type and the computer node to which it is connected. Also included is an MCB server (one background process for Windows 7 computers; two background processes for Windows XP) that handles requests from remote computers for MCB communication. Any data returned as a result of the request is sent through the network to the request's originator.

ORTEC and user-written software may be profitably combined. For example, the included MAESTRO® MCA Emulation Software or the Easy NIM front panel emulator can be used to configure the system and perform most of the interactive functions. The user application can then be used to handle the unique system functions.

1.3. ABOUT THIS MANUAL

To accommodate the MCB-only and counter/timer-only EASY-NIM modules, this manual discusses the MCB and counter/timer functions separately. In addition, it includes a section for the full Model 928 that discusses how the two hardware subcomponents are used together.

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[3] *Standard NIM Digital Bus (NIM/488)*, DOE/ER-0457T, U.S. NIM committee, May 1990; Standard NIM Instrumentation System, NTIS, U.S. Department of Commerce, Springfield, Virginia 22161.

2. INSTALLATION

NOTE	You must have Windows Administrator-level access to install ORTEC software applications.

The EASY-NIM 928 operates only under 32-bit and 64-bit Windows 7, and Windows XP SP3. Installation is straightforward. Do not connect the 928 to your computer until CONNECTIONS has been installed.

- Install the included CONNECTIONS Driver Update Kit (version 8.03 or higher).
- For modules with an MCB, install the accompanying version of MAESTRO.
- For modules with counter/timers, install the included Easy NIM front-panel emulation software.
- Install the 928 in the NIM bin, connect it to the host computer via USB cable, and power on the bin.
- Run the MCB Configuration program to establish communication between the hardware and computer.

2.1. INSTALL THE CONNECTIONS DRIVER UPDATE KIT

The first step is to install the accompanying CONNECTIONS Driver Update Kit (P/N 797230) according to its instruction sheet (P/N 932721). On the install wizard's Instrument Setup page, be sure to select the **USB-based instruments** family, otherwise the EASY-NIM module will not communicate properly with your ORTEC software.

Be sure to read the entire Driver Update Kit instruction sheet! It discusses MCB support in detail; and explains how to enable and disable the drivers for your ORTEC MCB(s) and share ORTEC MCBs across a network. It also points you to information on selecting the proper network protocol for legacy MCBs. At the end of installation, you will be directed to restart the PC.

2.2. INSTALL MAESTRO AND/OR THE EASY NIM FRONT-PANEL EMULATOR

As noted in the introduction, the 928 operates in conjunction with both the accompanying Easy NIM front-panel emulation software and MAESTRO (or our other spectroscopy applications). The 928-MCB uses only the spectroscopy software; and the two counter/timer-only models use only the Easy NIM front-panel emulator.

- Install MAESTRO according to its user manual.
- Insert the Easy NIM emulator CD. Open the **Computer** option, select the CD drive, then locate and open **Setup.exe**. One or more security dialogs will open. Choose the "**continue**" or "**install anyway**" option, then the installation wizard will start. Click **Next** and move through the wizard screens to completion.
- Check the Microsoft Windows Update website and install any .NET Framework updates.

2.3. RUN THE MCB CONFIGURATION PROGRAM

To start the software, enter **mcb** in the "**search programs and files**" box, then click the **MCB Configuration** search result; or open the Windows Start menu and click **Easy NIM**, then **MCB Configuration**.

The MCB Configuration program will locate all of the powered-on ORTEC Detectors on the local computer and the network, and display the list of instruments found (the *Master Instrument List*; Figure 1).

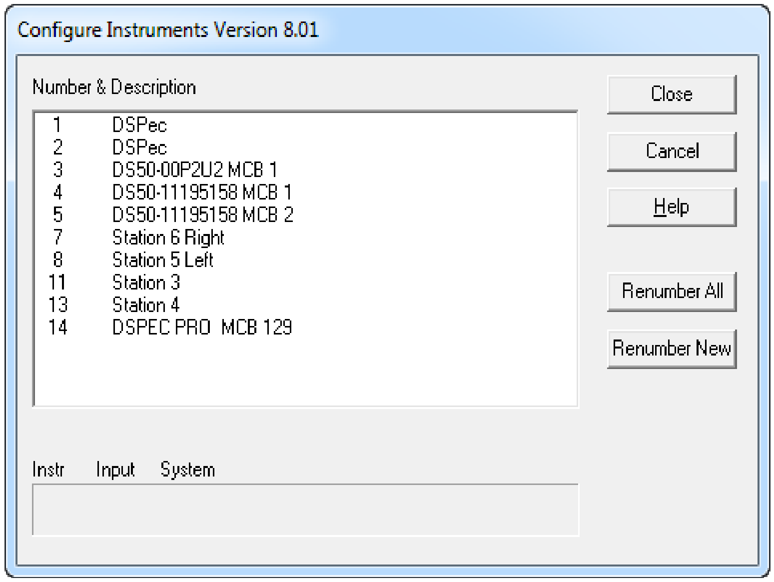

Figure 1. Detector Numbering and Descriptions.

If you wish, you may enter customized instrument ID numbers and descriptions as described in the CONNECTIONS Driver Update Kit guide. When you close the dialog, any changes you have made to an ID number or description will be written back to the corresponding MCB.

2.4. ATTACHING MORE THAN ONE 928 TO THE PC

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

REMINDER	Be sure to run MCB Configuration any time you add new EASY-NIM 928s (or other ORTEC MCBs) to your system, or when you move an instrument from one USB port to another.

2.5. CONNECTING TO AND DISCONNECTING FROM THE PC

The USB connection allows you to connect 928s to and disconnect them from a USB port without shutting down the computer or USB hub. Note that if MAESTRO is running when you disconnect the 928, you will see a “detector not responding” message on the status line at the bottom of the MAESTRO window. When you reconnect the 928 to its USB port — the same port to which it was attached when MCB Configuration was last run — you will have to reselect it from the **Detector** droplist on the MAESTRO Toolbar.

2.6. TROUBLESHOOTING

2.6.1. MAESTRO Does Not Connect with the 928

If properly installed and functioning MAESTRO and/or Easy NIM software (or other CONNECTIONS programs) cannot find and communicate with the 928, check for the following:

- NIM bin power.
- Proper connection between rear-panel and NIM bin
- Proper connection of the USB cable between the 928 and computer.
- Re-run the MCB Configuration program and ensure the 928 is added to the instrument list. If it is not listed, restart the computer then run MCB Configuration again.

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

3. THE EASY-NIM 928

3.1. FRONT AND REAR PANEL CONNECTORS

Figure 3 shows the front and rear panels of the full Model 928. The front and rear panels of the three subsidiary models are shown in Figure 2. Full specifications for all inputs and outputs are in Chapter 4.

3.1.1. MCB Inputs and Outputs — 928 and 928-MCB Only

ADC INPUT Front-panel BNC input accepts positive unipolar, positive gated integrator, or positive leading bipolar analog pulses in the dynamic range from 0 to +10 V; +12 V maximum.

ADC GATE Front-panel optional TTL input. Software selectable Coincidence mode, Anticoincidence mode, or Off.

PUR Rear-panel BNC pile-up rejection input accepts TTL signal; signal must occur prior to peak detect.

BUSY Rear-panel Busy input used by live-time correction circuits; accepts TTL signal.

3.1.2. Counter/Timer Inputs and Outputs — All Modules Except 928-MCB

COUNTER 1, 2, 3, 4 Fast analog signal input accepts analog or digital pulses up to ±5 V in amplitude on a front-panel BNC connector. Software selection of triggering on either positive or negative slope. Threshold is software adjustable from –1.6 V to +3 V in steps of 1.5 mV (minimum pulse 30 mV). Software selection of either 50 Ω or 1000 Ω input impedance, dc-coupled. Maximum count rate 200 MHz.

INPUT 1, 2, 3, 4, 5, 6 Front-panel BNC inputs accept any TTL input signal.

OUTPUT 1, 2 Rear-panel BNC outputs act as general purpose TTL outputs and can be configured under software control to one of the following functions:

- **Timer Interval Output** High when the counting interval is active.
- **Logic Level** Set high or low from software.

Figure 2. Models 928-MCB, 928-COUNT-4, and 928-COUNT-2.

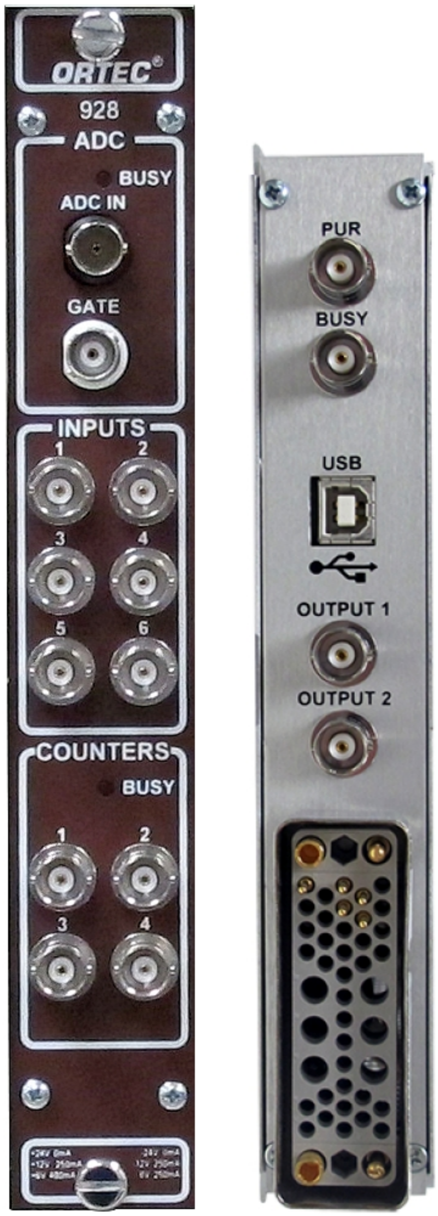

Figure 3. Model 928 (Full).

- **Counter Overflow n**
  - “Pulse” option: 1 µs wide pulse with rising edge synchronized to the rollover of a selected counter (n = 1, 2, 3 or 4).
  - “Level” option: On overflow, output remains high until manually reset.

- **Timer Overflow n**
  - "Pulse" option: 100 ns wide pulse with rising edge synchronized to the rollover of a selected timer (n = 1 or 2).
  - "Level" option: On overflow, output remains high until manually reset.
- **CRM Alarm n** Set high when count rate alarm is triggered (n = 1, 2, 3 or 4). Reflects the real-time count rate on the selected counter input.
- **Software Control** Hardware command **SET_OUTPUT n,x** where n is the output and x is 0 or 1.

3.2. CABLING FOR HPGE SPECTROSCOPY

Figure 4 shows the standard cabling of a 928 or 928-MCB in an HPGe detector system. If the detector has a TRP preamplifier ("-PLUS" model), all connections shown below should be made. For resistive-feedback preamplifiers, the INHIBIT output does not exist so the connection to INHIBIT is not made (i.e., is left open).

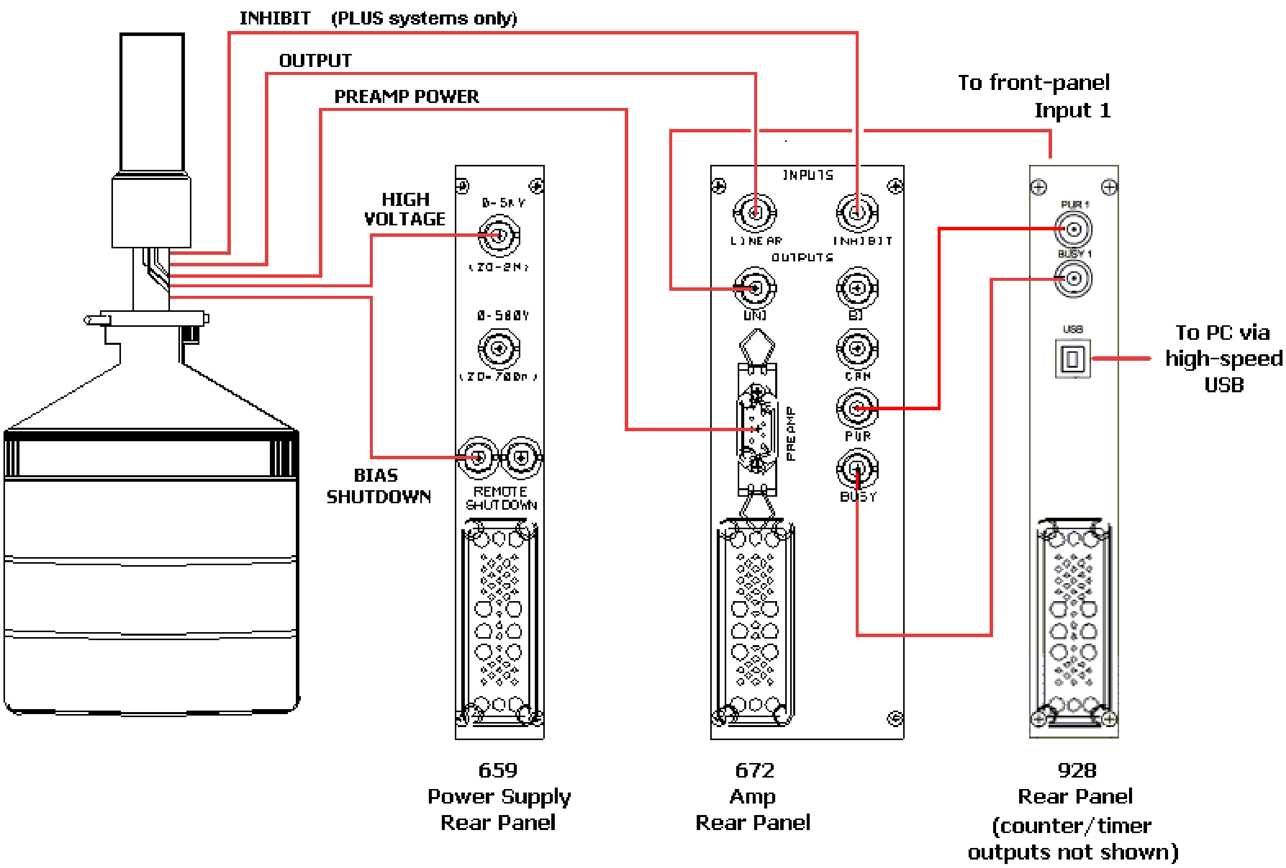

Figure 4. HPGe System Cabling (928-MCB rear panel [no outputs] pictured for clarity).

3.3. EASY-NIM 928 COUNTER/TIMER OPERATION

3.3.1. Starting the Easy NIM Front-Panel Emulation Software

NOTE	To avoid error messages, run the MCB Configuration program (Section 2.3) before first use of the Easy NIM software application.

Enter **eas** in the Windows "**search programs and files**" box, then click the **Easy NIM** search result; or open the Windows Start menu and click **Easy NIM**, then **Easy NIM** (Figure 5). Alternatively, start the application from the Windows desktop icon ( ). The Easy NIM main screen will open.

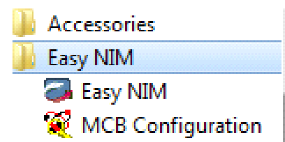

Figure 5.

3.3.2. The Main Screen

Figure 6 shows the Easy NIM main screen. Note that when you select a 928-COUNT-2 from the **MCB** list at the bottom of the screen, only 2 counters and 1 timer are displayed.

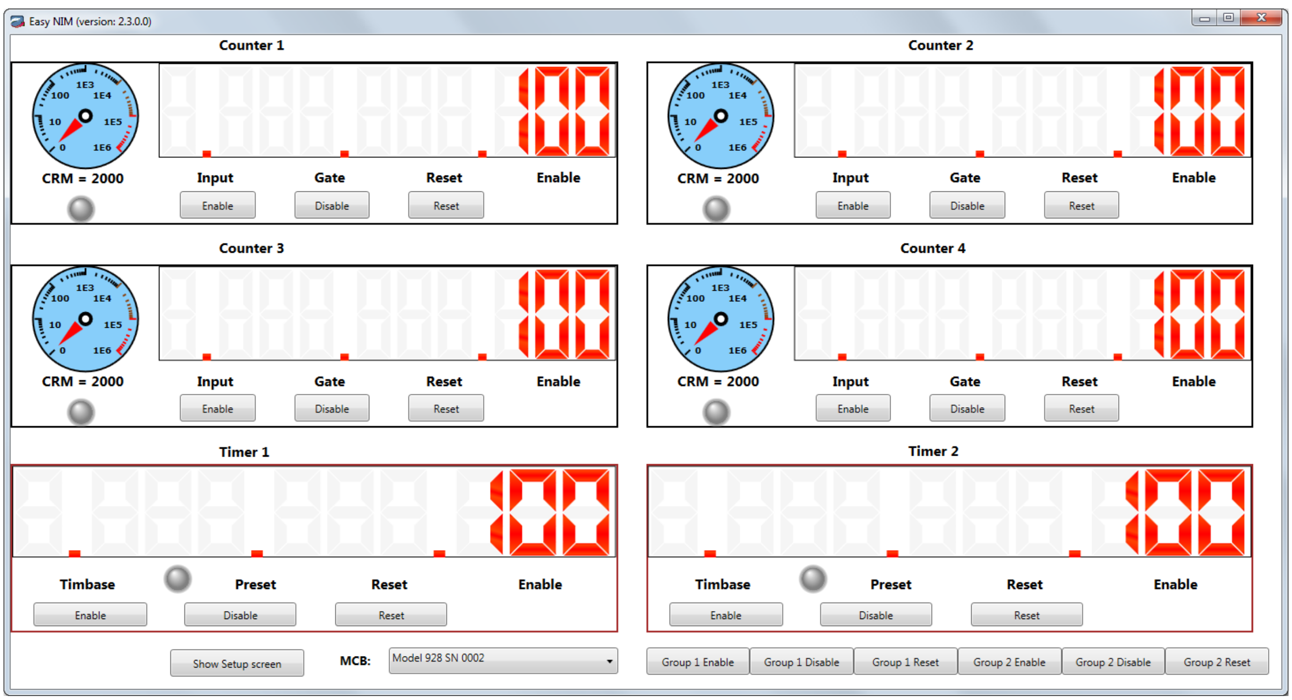

Figure 6. Easy NIM Application Main Screen.

Figure 7 illustrates the main features of the counter readouts.

1) User-defined counter **Friendly name**; can be changed on the setup screen (discussed in the next section).
2) Counter value digital display. Maximum value is 4294967295, readable with user-written software.

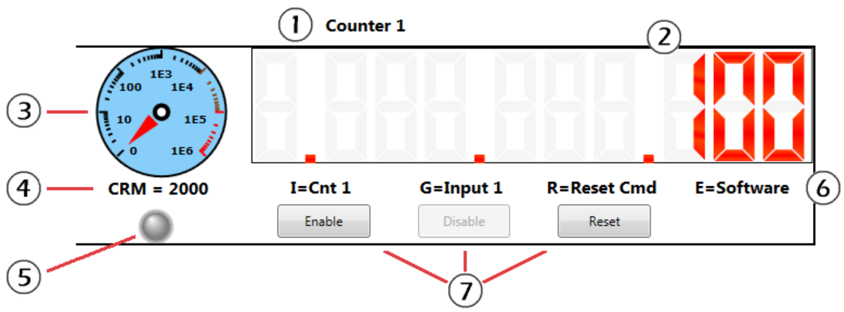

Figure 7. Counter Readout Features.

3) Alarming Counter/Rate Meter. The analog meter can be set as logarithmic or linear. The alarm threshold is variable and can be set to create a hardware alarm signal for external equipment (see the next section).

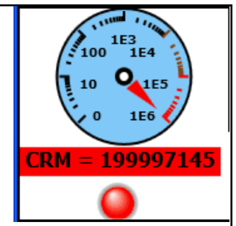

Figure 8.

4) Count rate meter (**CRM**), in counts per second (cps). If an alarm is triggered, based on the **Alarm threshold** entry discussed in Section 3.3.4.4, this field flashes red (Figure 8). In addition, if the **Play sound when alarm triggered** checkbox is marked on the setup screen, an audio alarm sounds. The count rate can be read from user-written software.

5) Data acquisition indicator. When counter is enabled, the "LED" blinks red (Figure 8).

6) Counter settings indicators display a mnemonic of the parameters selected on the Instrument Settings screen (discussed in the next section). **I** = Counter input, **G** = Gate input, **R** = Reset input, **E** = Enable input.

7) **Enable**, **Disable**, and **Reset** buttons. If the **Counter Enable** on the setup screen input is set to **Software Control**, the **Enable** and **Disable** buttons on this screen become active, allowing you to manually start and stop the counter. If the **Counter Reset** input is set to **Software Individual Reset**, the **Reset** button on this screen becomes active, allowing you to manually zero the counter. When a counter is enabled, it remains active until disabled. Data acquisition will suspend when all counters are full or an associated timer preset lapses, but clicking the corresponding **Reset** button immediately zeros the counter and restarts acquisition.

The main features of the timer readouts are shown in Figure 9.

1) User-defined timer **Friendly name**; can be changed on the setup screen (discussed in the next section).

2) Timer value digital display. Maximum value is 4294967295, readable with user-written software.

3) Timer settings indicators display a mnemonic of the parameters selected on the Instrument Settings screen (discussed in the next section). **TB** = Time base, **P** = Time preset, **R** = Reset input, **E** = Enable input.

4) **Enable**, **Disable**, and **Reset** buttons. If the timer **Enable input** is set to **Software Control**, the **Enable** and **Disable** buttons on this screen become active, allowing you to manually start and stop the timer from the application screen. If the timer **Reset input** is set to **Software Individual Reset**, the **Reset** button on this screen becomes active, allowing you to manually zero the timer value. When a timer is enabled, it remains active until disabled. Data acquisition will suspend when the timer preset lapses or when the associated

counter(s) are full, but clicking the corresponding **Reset** button immediately zeros the timer and restarts acquisition.

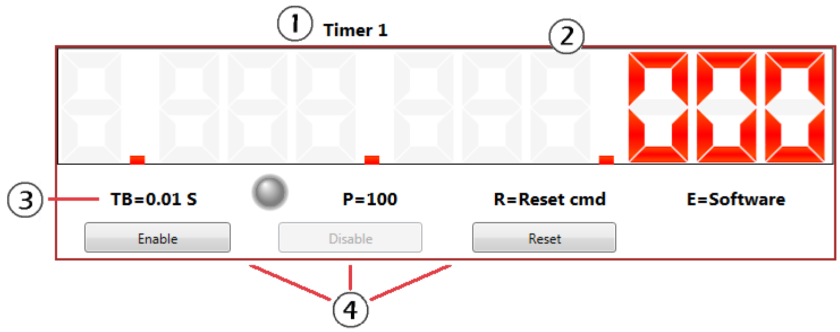

Figure 9. Timer Readout Features.

At the lower left of the screen is the **MCB** droplist, which lists all 928s found by the MCB Configuration program (no non-928 multichannel buffers are listed); and the **Show Setup Screen** button, which opens the Instrument Settings screen discussed in the next section.

3.3.3. Counter/Timer Group Controls

For all modules except the 928-MCB, the lower right section of the main screen displays the two sets of group control buttons shown in Figure 10.

Figure 10. Group Control Buttons.

These enable/disable/reset buttons work with the Group 1 and 2 enable and reset options on the Instrument Settings screen. They allow you to gang one or more counters and/or timers together, then enable, disable, and reset them simultaneously. You can add additional counters (for instance, one or more 928s) to a group by configuring the first 928's Output 1 and 2 settings and cabling the unit to the additional counters. See Sections 3.3.5 through 3.3.7 for group setup examples.

3.3.4. The Instrument Settings Screen

Click **Show Setup Screen** to display the screen shown in Figure 11.

3.3.4.1. Counter Setup (All Modules Except 928-MCB)

The available counter settings are shown in Figure 12.

Friendly name — Optionally assign alternative names to the counters.

Counter input — A counter input can be used simply as a pulse counter, or can count any of the internal signals on the list.

Gate input — The gate can be set as inactive (always on), connected to the interval signal from either of the timers, or controlled from any of the six front-panel inputs.

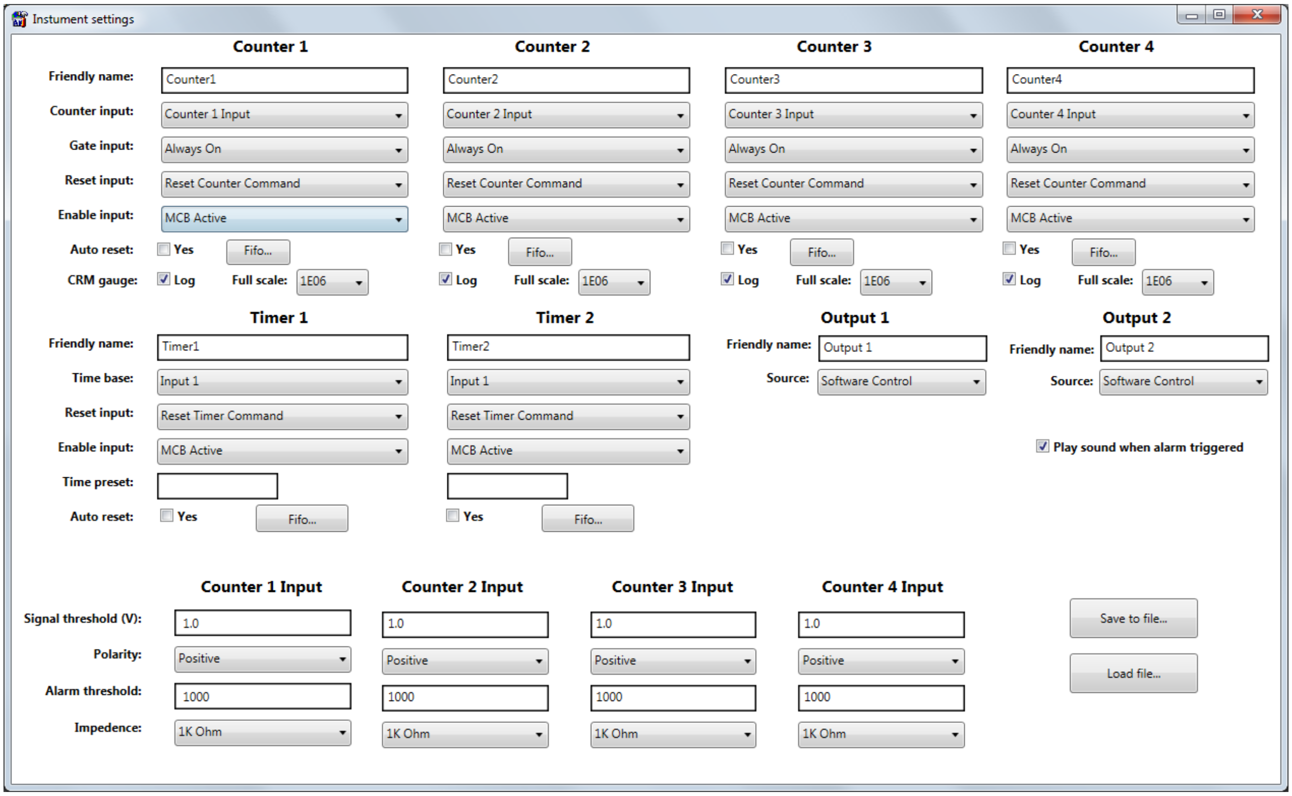

Figure 11. Easy NIM Application Setup Screen.

Reset input — Trigger a counter reset from (1) the Easy NIM main screen with the **Software Individual Reset** setting, (2) a "clear MCB spectrum memory" command from the MCB (Model 928 only) with the **MCB Clear Command** reset, or (3) a signal from any of the six front-panel inputs; or (4) simultaneously reset a group of counters or counters and timers with the Group 1 or 2 reset signal.

Enable input — The **Software Control** option lets you start and stop the counter from the Easy NIM application main screen (Figure 12). **MCB Active** starts the counter when the MCB begins data acquisition (Model 928 only). **Software Group n Enable** (n = 1 or 2) starts all counters for the specified group when the corresponding timer or output "group enable" signal is issued.

Auto reset — When this box is marked, the counter counts up to overflow (4294967295 counts) then automatically resets to zero and continues to count up.

Fifo — Click this button to display the values stored in the FIFO (first in first out buffer; see Figure 13) to a maximum of 256 entries. The FIFO is designed for the "Continuous Mode" scenario where a timer interval is selected as the **Gate input** and **Auto Reset** is selected for both the counter and the timer. The counter value is pushed to the FIFO whenever a manual reset or auto-reset signal sets the Gate input low. The FIFO can be read from a user-written program. In addition, you can click the **Fifo...** button to view the current FIFO contents at any time. *Note that if you wish to save the current FIFO contents as an ASCII text file* (Figure 14)*, you must do so before closing the Fifo Display dialog, otherwise the list will be deleted on close.* If you wish, you can leave the Fifo Display dialog open and periodically click the **Refresh** button to update the list. Again, if you do not save the current contents before closing the dialog, they will be lost.

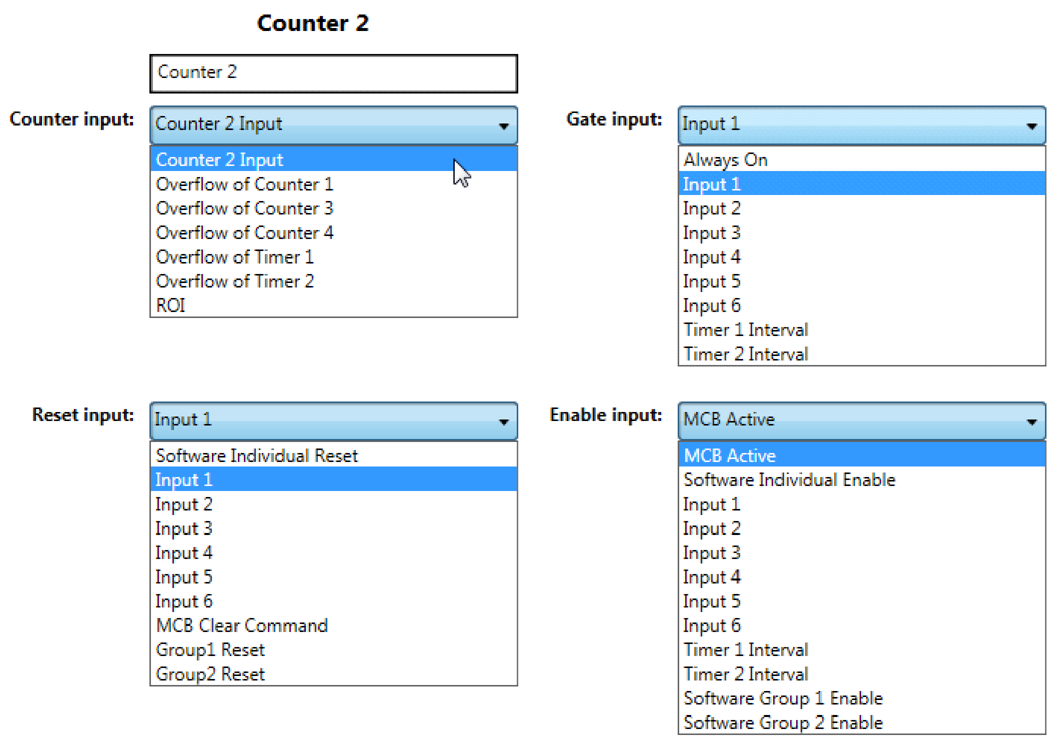

Figure 12. Counter Setting Lists.

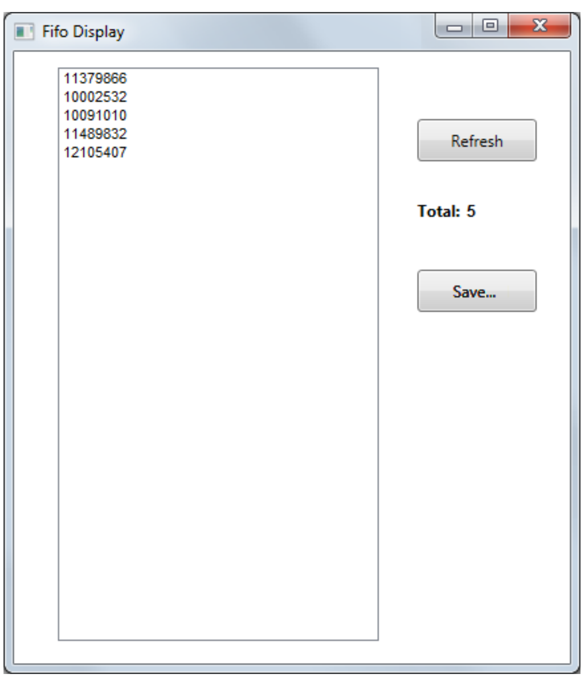

Figure 13. FIFO Contents.

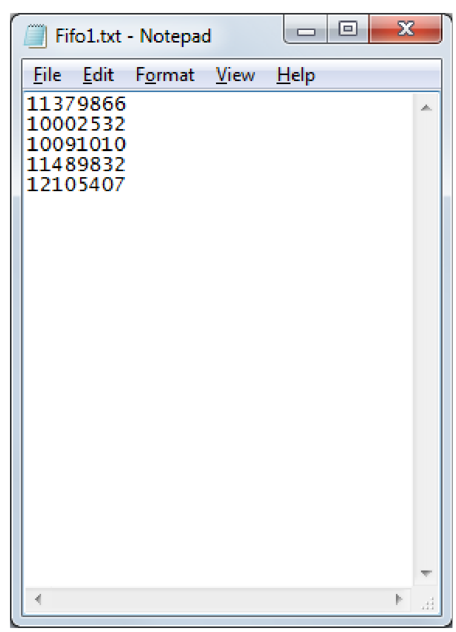

Figure 14. FIFO Contents Saved as Text File.

CRM gauge — Unmark the checkbox to switch the analog dial from logarithmic scale to linear scale.

Full scale — Select the maximum value to be displayed on the CRM gauge.

3.3.4.2. Timer Setup (All Modules Except 928-MCB)

Figure 15 shows the available timer settings.

Friendly name — Optionally assign alternative names to the timers.

Time base — The time base clock can be derived from any of the external inputs 1–6, or set internally from the selections on the list.

Reset input — Trigger a Timer reset from (1) the Easy NIM main screen with the **Software Individual Reset** setting, (2) a "clear MCB spectrum memory" command from the MCB (Model 928 only) with the **MCB Clear Command** reset, or (3) a signal from any of the six front-panel inputs; or (4) simultaneously reset a group of timers or counters and timers with the Group 1 or 2 reset signal.

Enable input — Use the **Software Individual Enable** to start the timer from the Easy NIM application main screen. **MCB Active** starts the timer when the MCB begins data acquisition (Model 928 only). **Software Group n Enable** (n = 1 or 2) starts all timers or counters and timers for the specified group from the main screen.

Time preset — Enter the duration of the event as a multiple of the currently selected **Time base** (i.e., if you select a time base of 0.1 s and a time preset of 100, the timer interval will be 10 s).

Auto reset — When this box is marked, the timer counts up to its **Time preset** then automatically resets to zero and continues to count up.

Fifo — Functions the same as the counter FIFO; see the discussion for Figure 13 and Figure 14.

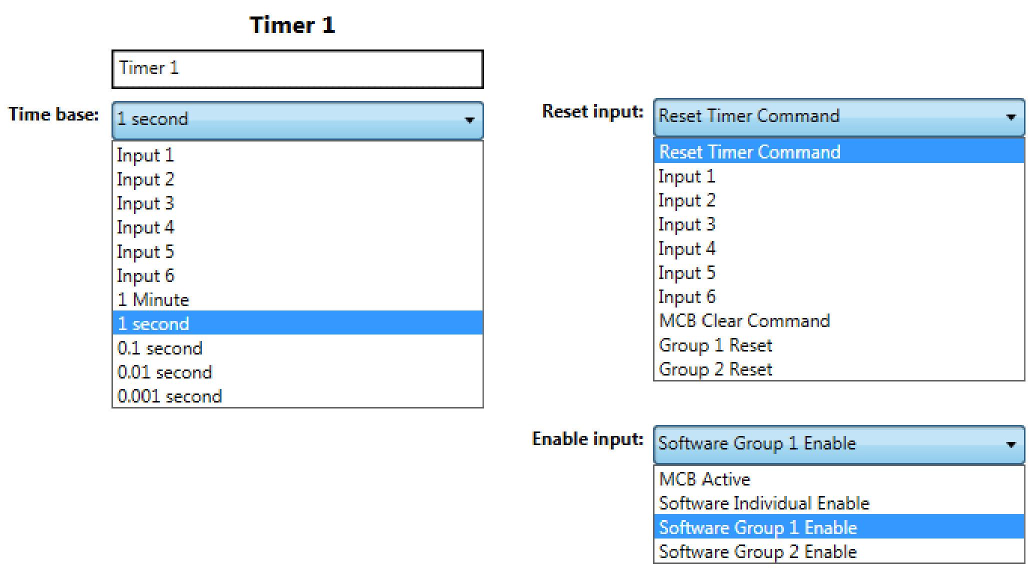

Figure 15. Timer Setting Lists.

3.3.4.3. OUTPUT SETUP

The output setup fields are illustrated in Figure 16. Optionally define a **Friendly name** and select an output **Source** from the list.

3.3.4.4. COUNTER INPUT SETUP

The counter input setup fields are shown in Figure 17.

Signal threshold (V) — Adjustable from -1.6 V to +3 V in steps of 1.5 mV.

Polarity — Select positive or negative signal polarity.

Impedance — Choose 50 Ω or 1 kΩ input impedance.

Alarm threshold — When count rate exceeds this value, the **CRM gauge** readout on the main screen flashes red. In addition, if the **Play sound when alarm triggered** checkbox is marked on the setup screen, an audio alarm sounds. If the output is configured to **CRM Alarm**, the output goes logic high.

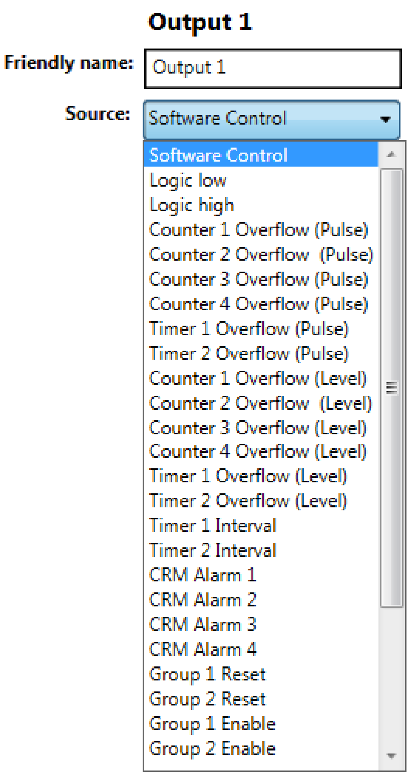

Figure 16. Output Setup.

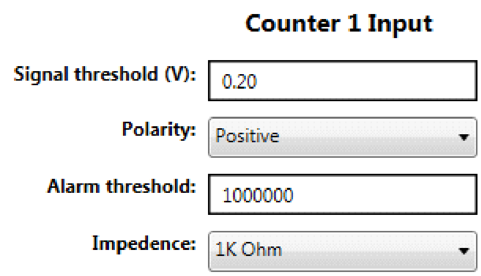

Figure 17. Counter Input Setup.

3.3.4.5. SAVING AND LOADING SETTINGS (.INI) FILES

The lower-right **Save to file** button allows you to create a. **.INI** file containing all current settings. The **Load settings** button allows you to recall the **.INI** file of your choice, and loads the settings into the currently selected 928.

Figure 18 shows the file-save dialog. Figure 19 shows an excerpt of a **.INI** file in Notepad.

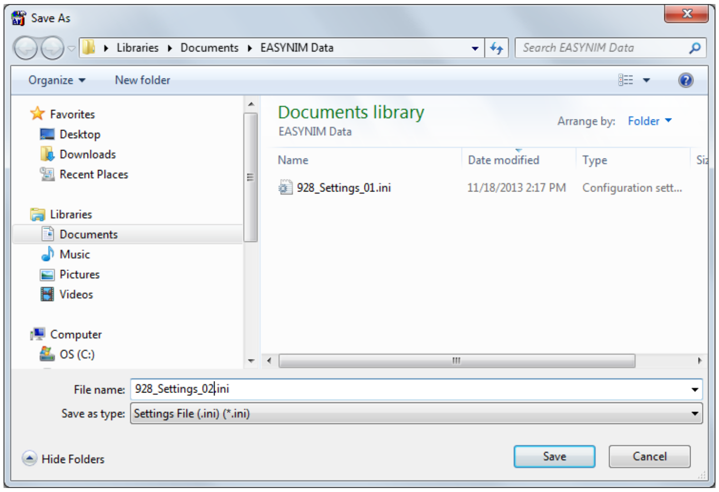

Figure 18. Save Counter/Timer Settings File.

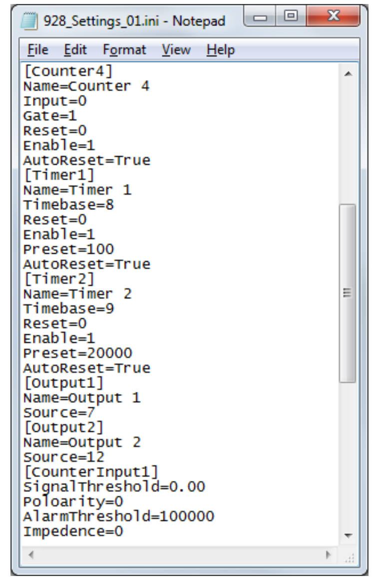

Figure 19. Settings .INI File.

3.3.5. Example 1: Controlling a Group of Two Counters and One Timer (All Modules Except 928-MCB)

This example explains how to gang two counters and one timer together as a *group*, configure the second counter to collect the overflow from the first, then set them up for simultaneous enable/disable/reset with the group control buttons on the lower right of the main screen. Each time the timer preset period elapses, counting stops and the data from the two counters are displayed on the main screen. In this example, data stops when the timer preset elapses and does not automatically reset. To continue collecting data, you would click the group's **Reset** button.

Figure 20 shows the Instrument Settings screen. (Note that the Counter 3 and 4, Timer 2, and Output fields in this illustration have been faded for clarity; they are not faded onscreen.)

- In the Counter section, Counter 1's **Counter input** is set to its counter input and Counter 2 is set to register the overflow from Counter 1. The **Gate input**s for both counters are set to **Timer 1 Interval**, both are designated to reset on the **Group 1 Reset**, and both are set to respond to the **Software Group 1 Enable**. In this example, **Auto reset** is *off* for both counters.
- In the Timer section, only Timer 1 is in use. A **Time base** and **Time preset** have been selected for a total acquisition time of 10 seconds. The timer is configured to reset on the **Group 1 Reset** and respond to the **Software Group 1 Enable** as the enable input. Again, **Auto reset** is *off*.
- The Counter 1 and 2 inputs are configured for the type of external signal on corresponding counter input BNC.

Figure 21 shows the main screen after a 10-second data acquisition period. (Analogous to the preceding illustration, the Counter 3 and 4 and Timer 2 fields here have been faded for clarity; they are not faded onscreen.)

The results in this figure show that 10 seconds elapsed, and that no counts registered in Counter 2 because Counter 1 did not overflow during the short acquisition period.

Note the correspondence between the settings in Figure 20 and the input/group/reset/enable codes below the counter readouts in Figure 21, as well as the time base/preset/reset/enable codes below the timer readout.

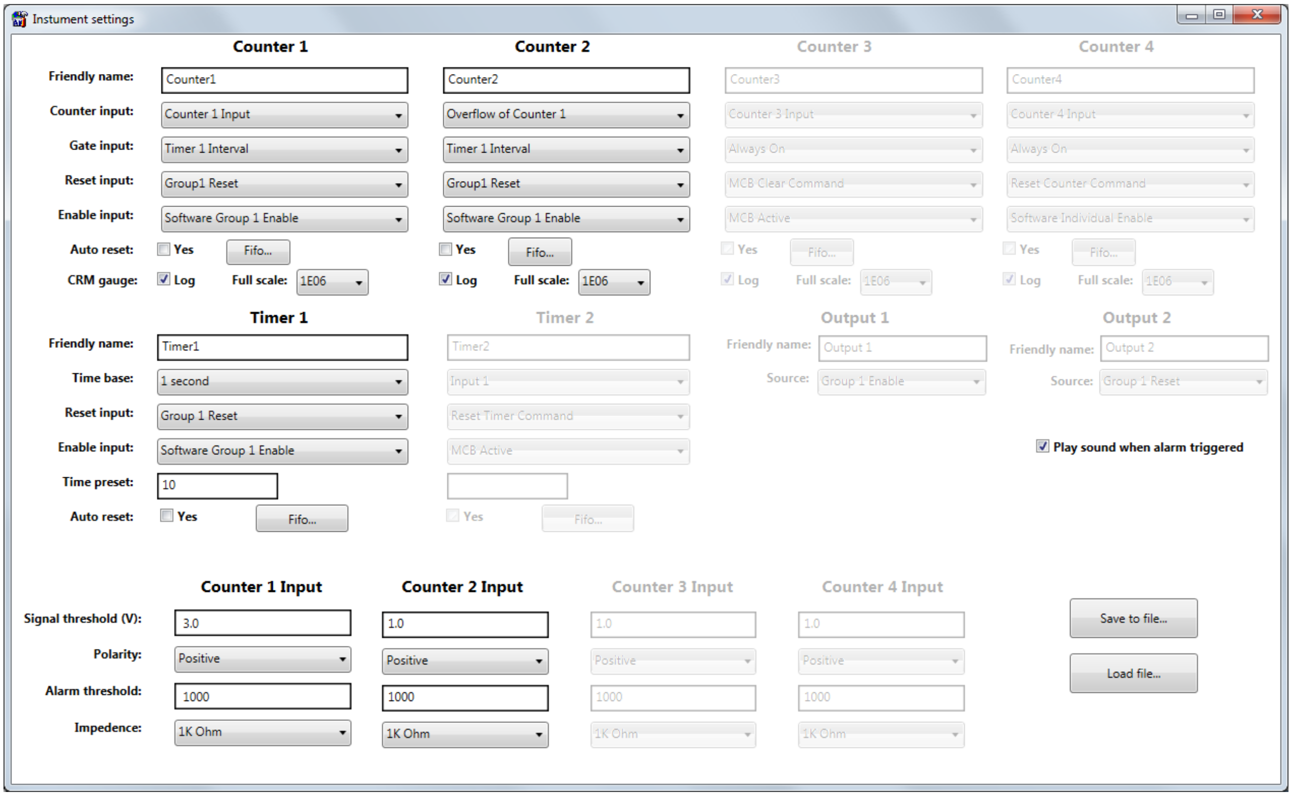

Figure 20. Creating a Counter/Timer Group.

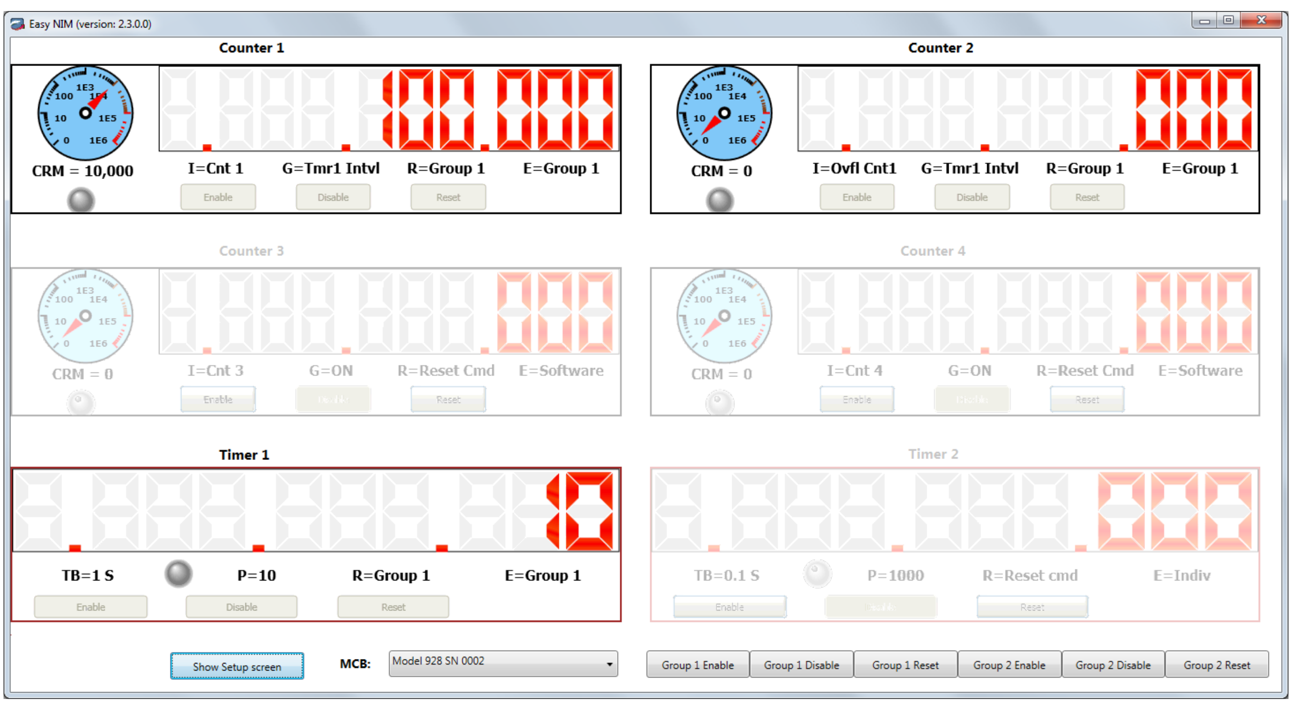

Figure 21. Results for Group 1 Data Acquisition.

3.3.6. Example 2: Eight Counters Controlled by One Timer (All Modules Except 928-MCB)

This example tells how to configure two 928s or 928-COUNT-4s to control eight counters with a timer from one of the 928s. In this setup, you trigger data collection by clicking the timer's **Enable** button on the Easy NIM main screen. Each time the timer preset period elapses, the data from each of the eight counters are pushed into their respective FIFO buffers, the counters reset, and data acquisition begins again automatically. In this continuous mode, data collection continues until you click the timer's **Disable** button on the main screen.

Figure 22 shows the physical connections between the two 928s, and from the eight counters (each of which can be different, if you wish).

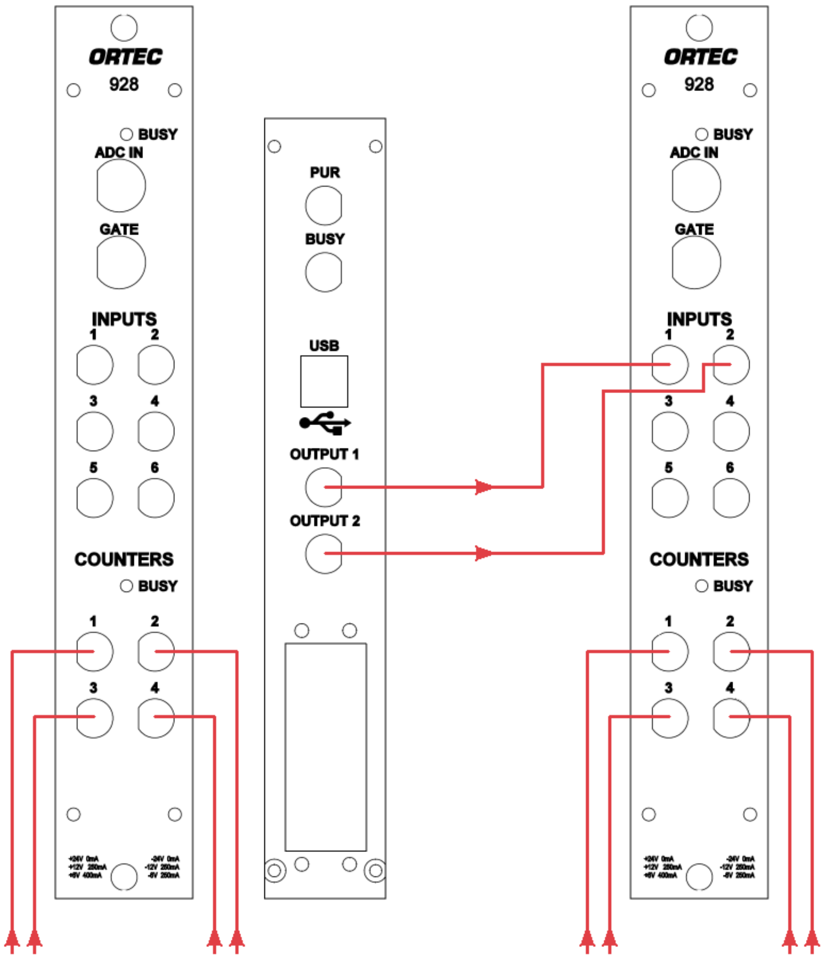

Figure 22. Cabling Eight Counters To Run From One Timer.

Figure 23 shows the settings for the first 928 (note that the Timer 2 field in this illustration has been faded for clarity; it is not faded onscreen).

- In the Counter section, each **Counter input** to its respective counter input, all **Gate input**s are set to **Timer 1 Interval**, all are designated to reset on the **Group 1 Reset** signal, all are set to respond to the **Software Group 1 Enable** as the enable input, and **Auto reset** is marked for all.

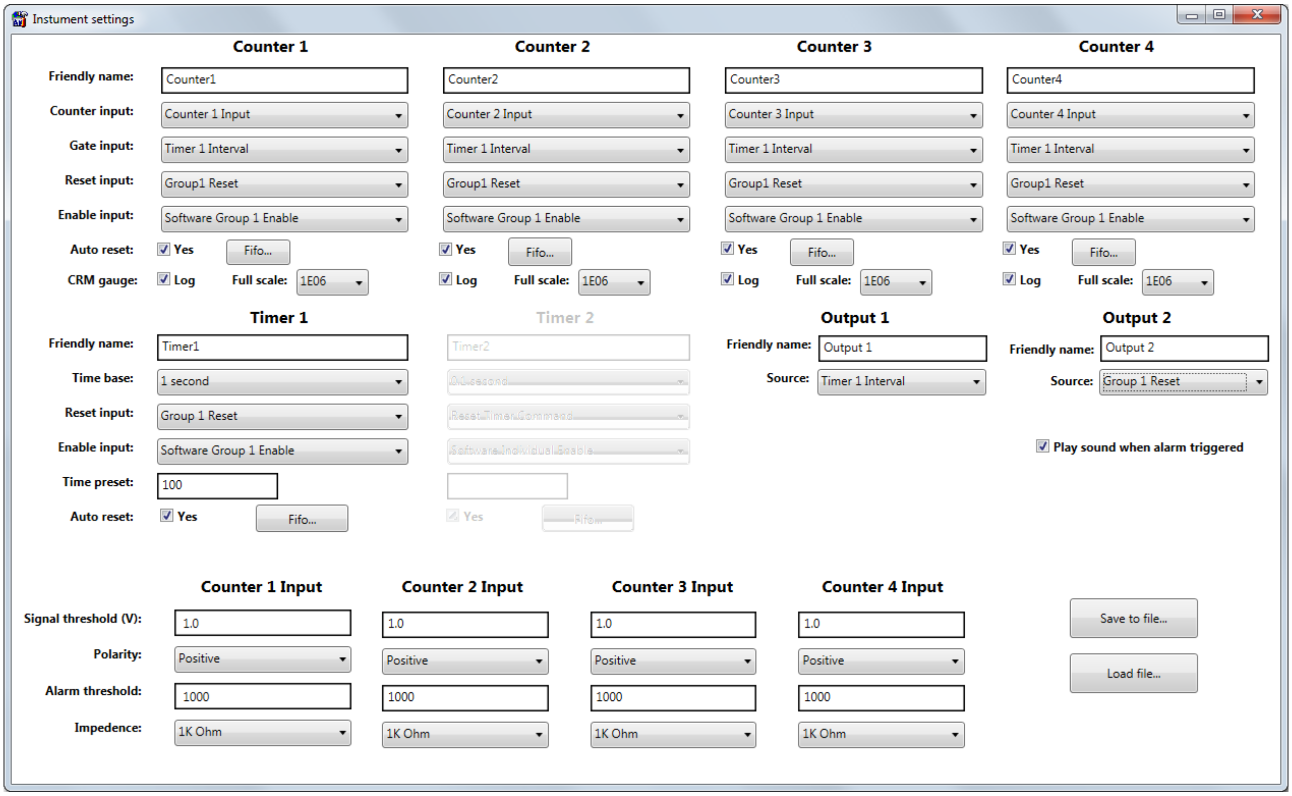

Figure 23. Setup for the First 928.

- In the Timer section, only Timer 1 is in use. A **Time base** and **Time preset** have been selected, the timer is configured to reset on the **Group 1 Reset** signal, all are set to respond to the **Software Group 1 Enable** as the enable input, and **Auto reset** is marked.
- In the Output section, the Output 1 **Source** is the **Timer 1 Interval** and Output 2 is set to respond to the **Group 1 Reset**. This sends the Timer 1 Interval signal to all counters on the second 928, and resets them when the Group 1 Reset signal is sent.
- Each of the four Counter Inputs is configured for the type of external signal on its respective BNC.

Figure 24 shows the upper part of the Instrument Settings screen for the second 928. Only the Counter fields are shown because (1) the timers cannot be controlled from another 928 and (2) the outputs are not being used to control a third 928.

- All **Gate input** and **Enable input** fields are set to **Input 1**, all **Reset input**s are set to **Input 2**, and all are in **Auto reset** mode.
- Each of the four Counter Inputs is configured for the type of external signal on its respective BNC.

To start, reset, and stop data acquisition, use the **Group 1 Enable/Reset/Disable** buttons on the first 928's main screen.

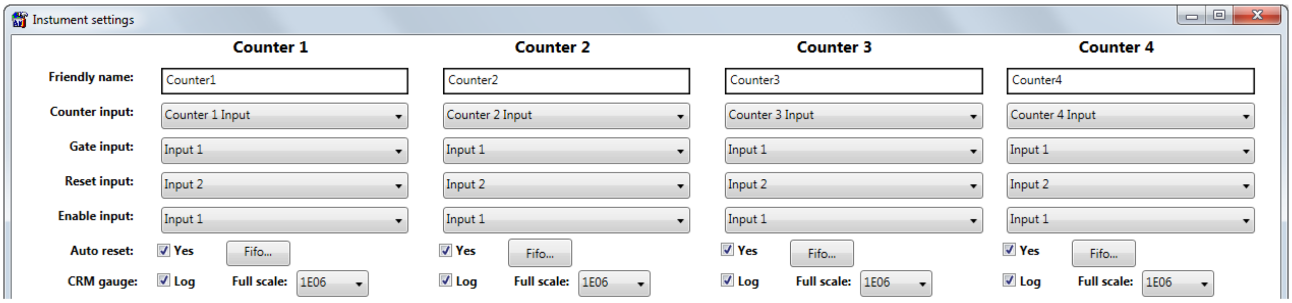

Figure 24. Setup for the Second 928.

3.3.7. Example 3: One 928, Four Tasks

This example highlights the EASY-NIM 928's versatility. Figure 25 shows one 928 configured for four separate tasks (which can be run concurrently if you wish):

1) A one-counter/one-timer group that also controls the counters on additional 928s.

2) A second group composed of one counter and one timer.

3) An individual (i.e., ungrouped) counter triggered by MCB start/stop/clear commands.

4) An individual counter triggered from the main Easy NIM screen.

3.3.7.1. Setup for Task 1

In this example, Counter 1 and Timer 1 of a 928 are ganged as Group 2, and the four counters from a second 928 are added to the group. All counters and the timer are controlled by the Group 2 enable/disable/reset buttons on the main screen for the *first 928*. At the end of each acquisition period, acquisition stops until manually restarted. In order to use the first 928 to control the counters on a second 928, the two MCBs must be cabled together as shown in Figure 26. For clarity, this illustration shows only the external connections for the Group 2 setup.[4]

For the first 928:

- The Counter 1 source is the **Counter 1 input** and the Counter 1 Input is configured for the type of external signal on the corresponding counter input BNC.
- The **Gate input** is set to **Timer 1 Interval**.
- Because this is Group 2, both **Reset Input**s are set to **Group 2 Reset**, and both **Enable input**s are set to **Software Group 2 Enable**. **Auto reset** is *not* marked.
- The Timer 1 **Time base** and **Time preset** have been selected for a total acquisition time of 10 seconds, and **Auto reset** is *not* marked.
- The final step is to set Output 1 to **Group 2 Reset** and Output 2 to **Group 2 Enable**.

[4] To configure the second 928 to control the counters on a third 928, adjust the third unit's settings to match those in Figure 27, and cable the inputs and outputs as shown in Figure 26. Repeat to add more 928s to the group.

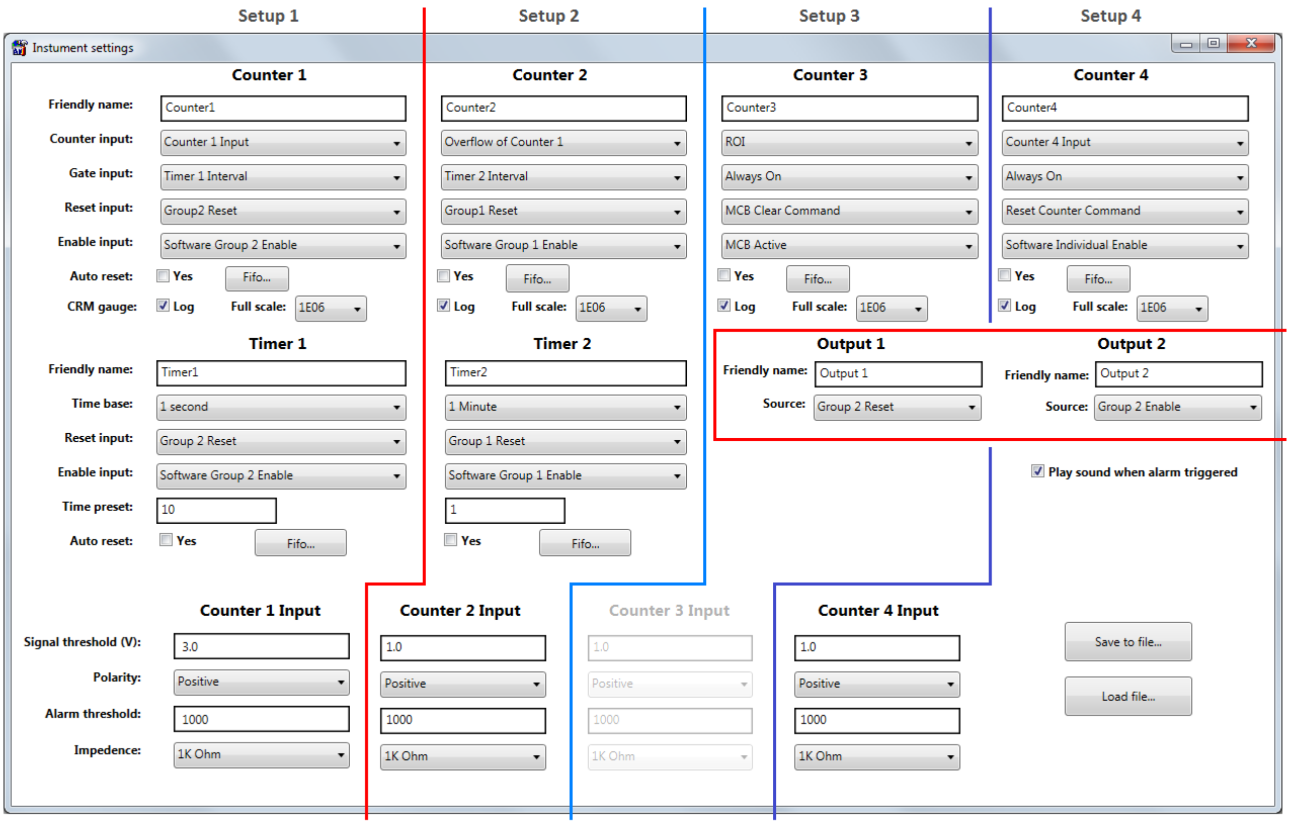

Figure 25. The First 928 Configured for Four Tasks.

We then select the *second* 928 from the **MCB** list on the main screen and click **Show Setup screen** (Figure 27). Note that the timers and outputs in this illustration are faded for clarity; they are not faded onscreen.

- The four Counters are set to their respective counter inputs, and each Counter Input is configured for the type of signal on its respective BNC.
- All counter **Reset input**s are set to **Input 1**.
- All **Enable input**s are set to **Input 2**.
- All **Gate input**s are set to **Always On** to disable the Gate Input.

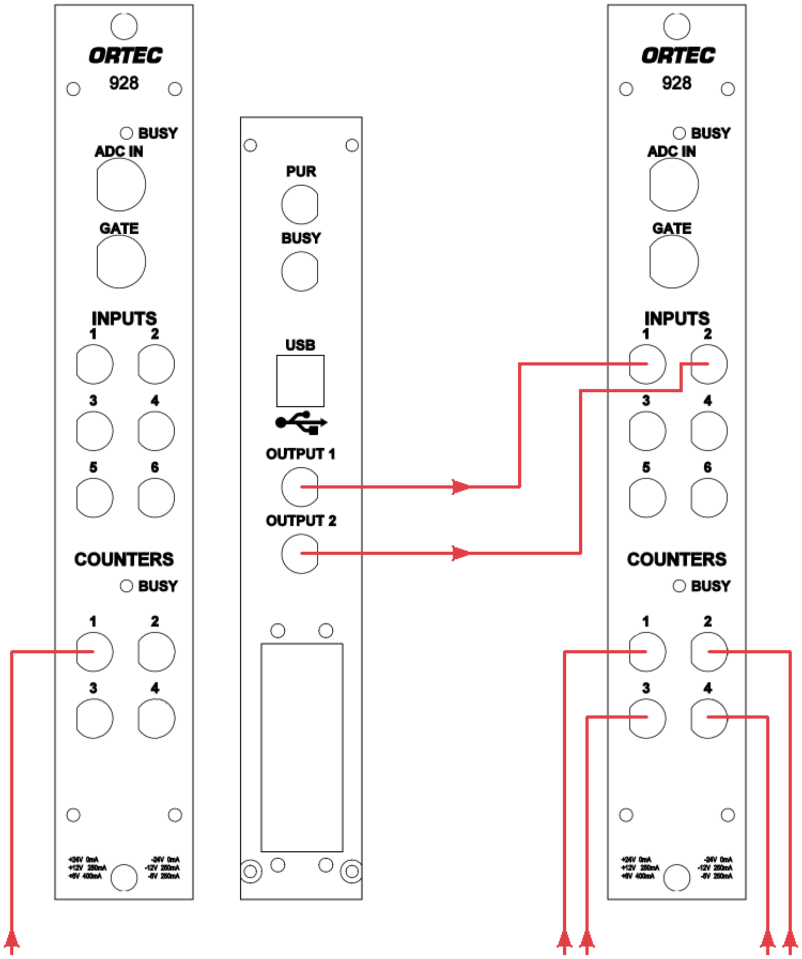

Figure 26. Task 1: Cabling Counter/Timer Group 2 To Control a Second 928.

3.3.7.2. SETUP FOR TASK 2

In Figure 25, Counter 2 and Timer 2 are ganged as Group 1, which is controlled by the Group 1 enable/disable/reset buttons on the main screen.

- The Counter 2 source is the **Counter 2 input**, and its Counter Input is configured for the type of signal on that BNC.
- The Counter 2 and Timer 2 **Gate input** fields are both set to **Timer 2 Interval**.
- Both **Reset Input**s are set to **Group 1 Reset**, both **Enable input**s are set to **Software Group 1 Enable**, and **Auto reset** is not marked.
- A **Time base** and **Time preset** have been selected for a total acquisition time of 1 minute.

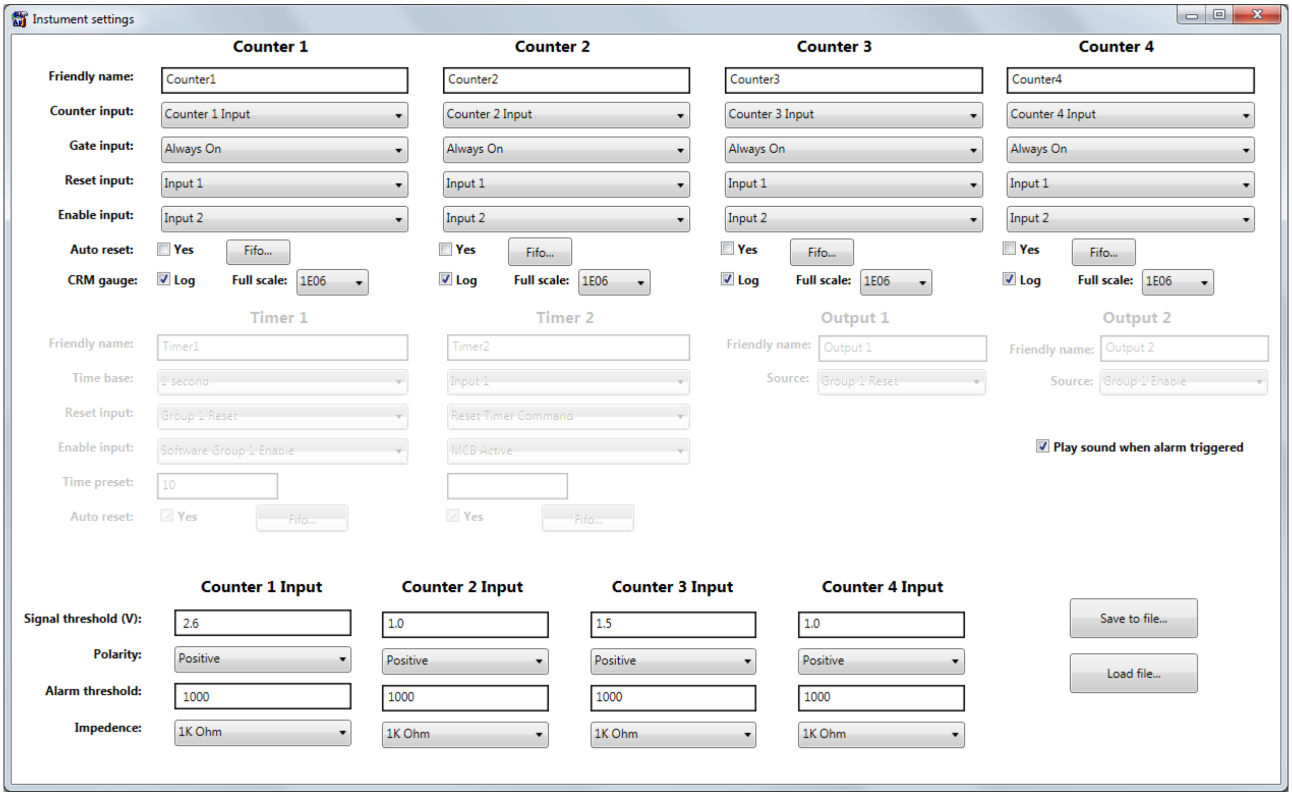

Figure 27. Task 1: The Second 928's Counters Configured for Group 2.

3.3.7.3. SETUP FOR TASK 3

In this setup, Counter 3 is controlled by the MCB and counts all pulses in all spectrum channels marked with the ROI bit. *ROIs in this 928 must be marked in MAESTRO before you begin data acquisition.* Starting and stopping data acquisition in the MCB enables and disables Counter 3, and clearing the spectrum resets the counter. All connections for this setup are internal, meaning that no input/output cabling or Output 1/2 assignments are necessary.

- The **Enable input** is set to **MCB Active**, the **Reset input** is set to **MCB Clear Command**, and we choose not to use **Auto reset**.
- The **Counter input** is set to **ROI**.
- This task does not use the two Output fields. In addition, it uses no **Gate input** so we select **Always On**.

3.3.7.4. SETUP FOR TASK 4

Here, Counter 4 is controlled manually with the Counter 4 enable/disable/reset buttons on the main screen.

- The **Reset input** is set to **Software Individual Reset**, the **Enable input** is set to **Software Individual Enable**, and we choose not to use **Auto reset**.
- The Counter 4 Input is configured for the type of external signal on the corresponding counter input BNC.
- This example does not use the two Output fields. In addition, it uses no **Gate input** so we select **Always On**.

3.4. MCB PROPERTIES IN MAESTRO (928 AND 928-MCB ONLY)

This section discusses the hardware setup dialog you will see in MAESTRO and other ORTEC CONNECTIONS software (i.e., GammaVision®, ISOTOPIC™, etc.) when you click **Acquire/MCB Properties...**. The MCB Properties dialog contains the controls for ADC setup and acquisition presets. Just move from tab to tab and set your hardware parameters, then click on **Close** — it's that easy.

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

3.4.1. ADC Tab

This tab (Figure 28) contains the **Gate**, **ZDT Mode**, **Conversion Gain**, **Lower Level Disc**riminator, and **Upper Level Disc**riminator controls. In addition, the current real time, live time, and count rate are monitored at the bottom of the dialog.

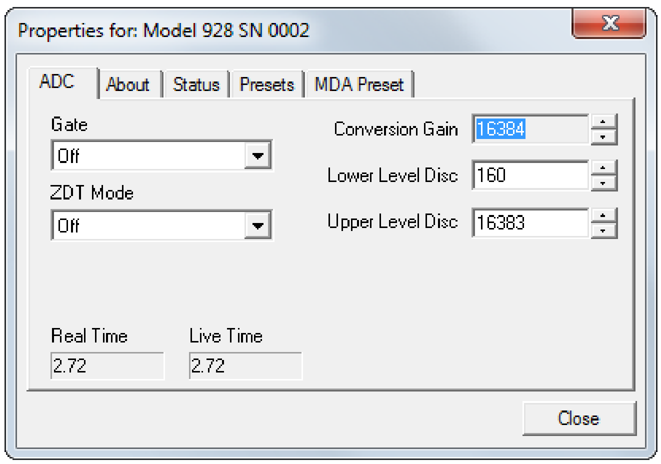

Figure 28. ADC Tab.

- **Gate** — This control allows you to select a a positive TTL logic gating function. With this function **Off**, no gating is performed (that is, all detector signals are processed). In **Coincidence** mode, a gating input signal *must be* present at the proper time for the conversion of the event; in **Anticoincidence**, the gating input signal *must not be* present for the conversion of the detector signal. The gating signal must occur prior to and extend 500 ns beyond peak detect (peak maximum).
- **ZDT Mode** — See Section 3.5 for a detailed discussion of this feature. Use this droplist to choose the **Off** (LTC spectrum only) or **CORR_ERR** (ERR and ZDT spectra) mode.[5] If a ZDT mode is selected, both spectra are stored in the same spectrum (**.SPC**) file. If you do not need the ZDT spectrum, you should select **Off**.

  In MAESTRO, the display can show either of the two spectra. Use **<F3>** or **Acquire/ZDT Display Select** to toggle the display between the two spectra. In the Compare mode, **<F3>** switches both spectra to the other type and **<Shift+F3>** switches only the compare spectrum. This allows you to make all types of comparisons.

[5] The NORM_CORR (LTC and ZDT) mode is typically not used; see Section 3.5.

- **Conversion Gain** — This sets the maximum channel number in the spectrum. If set to 16384, the energy scale will be divided into 16384 channels. The conversion gain is entered in powers of 2 (e.g., 8192, 4096, 2048). The up/down arrow buttons step through the valid settings.
- **Upper- and Lower-Level Discriminators** — The **Lower Level Disc**riminator sets the level of the lowest amplitude pulse that will be stored. This level establishes a lower-level cutoff by channel number for ADC conversions. The **Upper Level Disc**riminator sets the level of the highest amplitude pulse that will be stored. This level establishes an upper-level cutoff by channel number for storage.

3.4.2. About Tab

This tab (Figure 29) displays hardware and firmware information about the currently selected 928 as well as the data **Acquisition Start Time** and **Sample** description. In addition, the **Access** field shows whether the MCB is currently locked with a password (see the password discussion in the MAESTRO user manual); **Read/Write** indicates the instrument is unlocked; **Read Only** means it is locked.

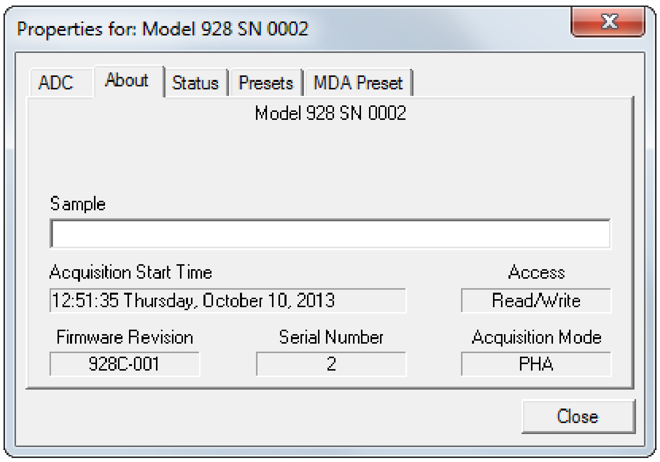

Figure 29. About Tab.

3.4.3. Status Tab

The Status tab (Figure 30) monitors the counters (four in the 928 and 928-COUNT-4, and two in the 928-COUNT-2). When you save a spectrum in the ORTEC **.SPC** file format, the counter values are saved in the file.

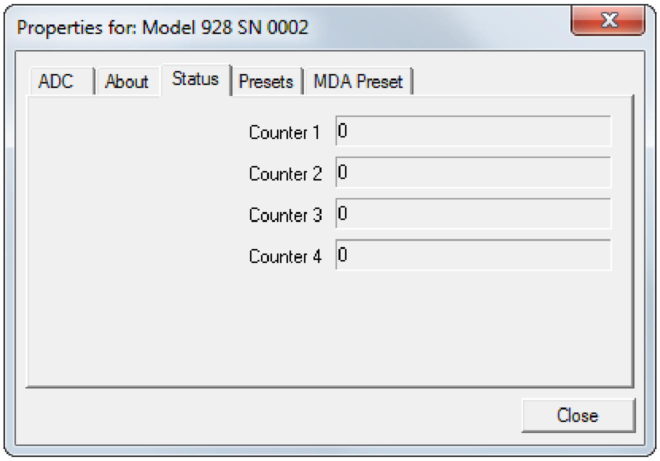

Figure 30. Status Tab.

3.4.4. Presets Tab

Figure 31 shows the Presets tab. MDA presets are shown on a separate tab.

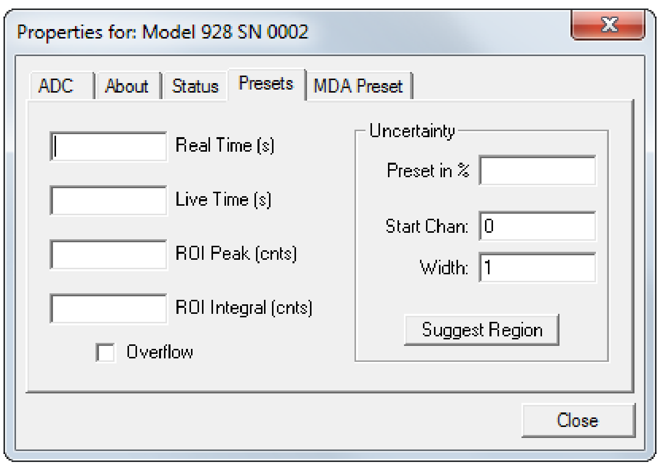

Figure 31. Presets Tab.

The presets can only be set when the 928 is not acquiring data. 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, the first condition met during the acquisition causes the MCB to stop. This can be useful when you are analyzing samples of widely varying activity and do not know the general activity before counting. For example, the **Live Time** preset can be set so that sufficient counts can be obtained for proper calculation of the activity in the sample with the least activity. But if the sample contains a large amount of this or another nuclide the dead time could be high, resulting in a long counting time for the sample. If you set the **ROI Peak** preset in addition to the **Live Time** preset, the low-level samples will be counted to the desired fixed live time while the very active samples will be counted for the region-of-interest (ROI) peak count. In this circumstance, the **ROI Peak** preset can be viewed as a “safety valve.”

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

- Enter the **Real Time** and **Live Time** presets in units of seconds and fractions of a second. These values are stored internally with a resolution of 20 milliseconds (ms) since the MCB clock increments by 20 ms. *Real time* means elapsed time or clock time. *Live time* refers to the amount of time that the MCB is available to accept another pulse (i.e., is not busy), and is equal to the real time minus the *dead time* (the time the MCB is not available).
- Enter the **ROI Peak** count preset value in counts. With this preset condition, the MCB stops counting when any ROI channel reaches this value unless there are no ROIs marked in the MCB, in which case that MCB continues counting until the count is manually stopped.
- Enter the **ROI Integral** preset value in counts. With this preset condition, the MCB stops counting when the sum of all counts in all channels for this MCB marked with an ROI reaches this value. This has no function if no ROIs are marked in the MCB.
- The **Uncertainty** preset stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the value you have entered. Enter the preset in % value as percent uncertainty at 1 sigma of the net peak area. The range is from 99% to 0.1% in 0.1% steps. You have complete control over the selected peak region. The region must be at least 7 channels wide with 3 channels of background on each side of the peak. Note that MAESTRO calculates this preset once per 40 seconds. Therefore, the software will continue data acquisition up to 40 seconds after the preset has been reached, and the uncertainty achieved for a high count-rate sample may be lower than the preset value.
- Use the **Start Channel** and **Width** fields to enter the channel limits directly, or click on **Suggest Region**. If the marker is positioned in an ROI around the peak of interest, **Suggest Region** reads the limits of the ROI with the marker and display those limits in the **Start Chan** and **Width** fields. The ROI can be cleared after the preset is entered without affecting the uncertainty calculation. If the marker is not positioned in an ROI, the start channel is 1.5 x FWHM below the marker channel and the width is 3 x FWHM.

  The net peak area and statistical uncertainty are calculated in the same manner as for the MAESTRO **Peak Info** command (see the MAESTRO user manual).
- Marking the **Overflow** checkbox terminates acquisition when data in any channel exceeds $2^{31}-1$ (over 2×10^9) counts.

3.4.5. MDA Preset Tab

The MDA preset (Figure 32) can monitor up to 20 nuclides at one time, and stops data collection when the values of the minimum detectable activity (MDA) for all of the user-specified MDA nuclides reach the needed value. Presets are expressed in Bq, and are evaluated every 40 seconds. *In all spectroscopy applications except MAESTRO, the detector must be calibrated for energy.*

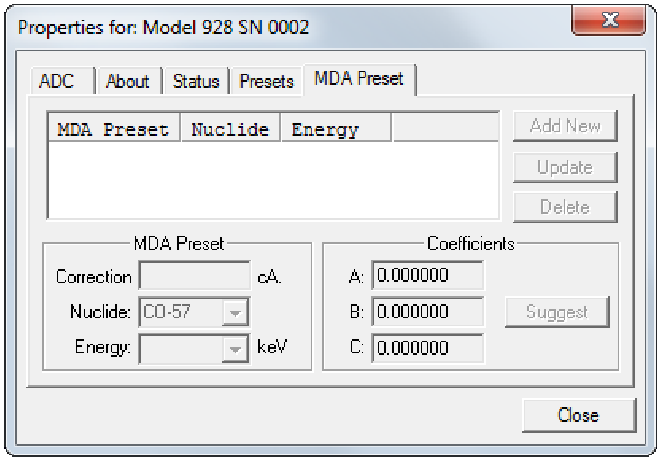

Figure 32. MDA Preset Tab.

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

$$\mathrm{MDA} = \frac{a + \sqrt{b + c * \mathrm{Counts}}}{\mathrm{Live\ Time} * \mathrm{Correction\ Factor}}$$

where:

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

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

Live Time is evaluated in 40 second intervals for the MDA presets.

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

NOTE MAESTRO does not support efficiency calibration. The efficiency component in the **Correction Factor** is set to 1.0; the preset field is labeled **Correction** instead of **MDA**; and the preset is based on counting activity (cA) instead of becquerels). You can enter the MDA preset either in counts; or corrected for factors such as sample volume, attenuation, or calculated efficiency. For example, if you manually calculate the efficiency for a peak, you can enter a corrected MDA target value by multiplying the desired MDA value times the calculated efficiency, and entering the product as the **Correction**.

- To add an MDA preset, enter the preset value in the **MDA** or **Correction** field; select the **Nuclide** and **Energy**; enter the desired values for coefficients **a**, **b**, and **c**; then click **Add New**.
- To edit an existing preset, click to highlight it in the table. This will load its **Nuclide**, **Energy**, and coefficients in the lower sections of the dialog. Change as needed, then click **Update**.
- To remove a preset, click to highlight it in the table, then click **Delete**.

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

3.5. Zero Dead-Time (ZDT) Mode

An *extended live-time clock* increases the collection time (real time) of the acquisition to correct for input pulse train losses incurred during acquisition due to system dead time. This corrected time value, known as the live time, is then used to determine the net peak count rates necessary to determine nuclide activities.

As an example, consider the case where the spectrometry amplifier and ADC are 60% dead during the acquisition. the elapsed real time will be:

$$\text{Real Time} = \left(\frac{\text{Live Time}}{1-0.60}\right)$$

$$= \left(\frac{\text{Live Time} \ * \ 100\%}{100\% \ - \ \%\,\text{Dead Time}}\right)$$

If the *N* counts in the gamma-ray peak in the spectrum are divided by the elapsed live time, the resulting counting rate, *N / Live Time*, is now corrected for dead-time losses. The standard deviation in that counting rate is *SQRT(N) / Live Time*.

Unfortunately, extending the counting time to make up for losses due to system-busy results in an incorrect result *if the gamma-ray flux is changing as a function of time*. If an isotope with a very short half-life is placed in front of the detector, the spectrometer might start out with a very high dead time, but the isotope will decay during the count and the dead time will be zero by the end of the count. If the spectrometer extends the counting time to make up for the lost counts, it will no longer be counting the same source as when the losses occurred. As a result, the number of counts in the peak will not be correct.

When a supported ORTEC MCB operates in ZDT mode, it adjusts for the dead-time losses by taking very short acquisitions and applying a correction in ***real time*** — that is, as the data are coming in — to the number of counts in the spectrum. This technique allows the gamma-ray flux to change while the acquisition is in progress, yet the total counts recorded in each of the peaks are correct. The resulting spectrum has no dead time at all — in ZDT mode, the *data* are corrected, not the acquisition time. Thus, the net counts in a peak are divided by the real time to determine the count rate.

ZDT mode has a unique feature in that it can store both the corrected spectrum and the uncorrected spectrum, or the corrected spectrum and the uncertainty spectrum. Therefore, supported MCBs allow you to choose between three **ZDT Mode** settings on the ADC tab under **MCB Properties...**: **Off**, **NORM_CORR**, and **CORR_ERR**.

The following table shows which spectra are collected in the three possible ZDT modes.

Mode	Uncorrected Spectrum	ZDT Corrected Spectrum	ZDT Error Spectrum
Off (ZDT Disabled)	Yes	No	No
NORM_CORR (ZDT–LTC Mode)	Yes	Yes	No
CORR_ERR (ZDT–ERR Mode)	No	Yes	Yes

3.5.1. Off — Uncorrected Spectrum Only

In this mode, only the uncorrected spectrum (live time and real time with dead-time losses) — also called the *live-time-corrected* or *LTC* spectrum — is collected and stored in the **.SPC** file. The LTC spectrum can be used to determine exactly how many pulses at any energy were processed by the spectrometer. The corrected spectrum gives the best estimate of the total counts that would have been in the peak if the system were free of dead-time effects. The uncertainty spectrum can be used to calculate the counting uncertainty, channel by channel, in the corrected spectrum.

NOTE When the spectrometer is in ZDT mode, the throughput of the instrument is reduced somewhat as extra processing must be done on the spectrum; therefore, if the gamma-ray flux is not changing as a function of time, but absolute highest throughput is desirable, you might wish to store only the LTC spectrum in the MCB memory.

3.5.2. NORM_CORR — ZDT and Uncorrected Spectra Stored

When the ZDT mode is set to **NORM_CORR**, the two spectra stored are the LTC spectrum and the ZDT spectrum (corrected for the dead-time losses; real time only). Unfortunately, in the analysis of the ZDT spectrum, the uncertainty of the measurement cannot be determined using either spectrum.

NOTE This mode is not useful for quantitative analysis if the counting rate varies significantly during the measurement time, particularly if the user desires an accurate counting rate and standard deviation calculation. *When you select the NORM_CORR mode, ISOTOPIC ignores the ZDT spectrum and analyzes the LTC spectrum as it would for the* ***Off*** *ZDT mode.*

3.5.3. CORR_ERR — ZDT and Error Spectra Stored

In the **CORR_ERR** mode, the estimation of the statistical uncertainty is stored in place of the LTC spectrum, and is referred to as the *error spectrum* (ERR). In this mode, the ZDT spectrum is used to measure the counts in a peak, and the error spectrum is used to determine the uncertainty of the measurement made in the corrected spectrum.

For example, if the area of a peak is measured in the corrected spectrum by summing channels 1000 to 1100, the variance of the measurement can be determined by summing the counts in channels 1000 to 1100 in the error spectrum. Or, shown another way, the counts in channel *i* can be expressed as *N(i)* ± *SQRT(V(i))* with a 1-sigma confidence limit, where *N* is the corrected spectral data and *V* is the variance (error) spectral data.

The live time is set to the real time within the analysis engine during the analysis of ZDT spectra.

A **CORR_ERR** spectrum is analyzed[6] as a regular spectrum most of the time, with a few exceptions as listed below.

- To calculate the peak area uncertainty, the error spectrum is used. If the peak limits are from *L* and *H* channels, then the background variance is calculated as:

$$B_{var} = \frac{(B_1/n_1/n_1 + B_2/n_2/n_2)}{4} * (H - L + 1)^2$$

  where:

  B_1 = sum of background counts for the channels adjacent to the peak start (low-energy) channel *L*
  B_2 = sum of background counts for the channels adjacent to the peak end (high-energy) channel *H*
  n_1 = the number of low background points (n_1 = 1, 3, or 5) used
  n_2 = the number of high background points (n_2 = 1, 3, or 5) used

  The peak area uncertainty is calculated from:

$$\sigma = \sqrt{G + B_{var}}$$

  where *G* is the sum of counts, from the error spectrum, from channels *L* to *H*.

$$\%\ \text{error} = \frac{\sigma\ (\text{from error spectrum})}{\text{Area}\ \ (\text{from ZDT spectrum})} * 100$$

- In our ISOTOPIC software's ISOWAN32 analysis engine, the peak fitting routine fits all the library peaks as singlets to calculate the peak centroid, peak start and end channels, and peak background. A linear background under the peak is assumed during the peak fitting process.
- The error spectrum is always used to calculate the uncertainties of counts whenever needed. For example, if peak deconvolution is needed, the error spectrum is used to find the best fit for the peak background.

3.5.4. Choosing a ZDT Mode

When the counting rate is essentially constant during the time required to acquire the spectrum, the standard mode — **ZDT Off** — is the preferred mode; only the uncorrected spectrum is collected and stored in the spectrum file. But, if the counting rate varies significantly during the measurement time, the standard mode will not yield the proper dead-time-corrected counting rate. This can be most easily understood by noting that the uncorrected mode compensates for dead-time losses by extending the real counting time. Hence a sample containing both a short-lived high-activity isotope and a long-lifetime lower-activity isotope will experience very high dead-time losses during the first few seconds of the measurement, as the short-lifetime isotope decays rapidly. This high dead time will cause the counting time to be extended after the short-lived isotope has decayed to zero activity, and the system will count the low-activity isotope for the extra time. Consequently, the average activity of the short-lived isotope will be underestimated.

If you anticipate significantly varying counting rates during the time taken to acquire the spectrum, the **CORR_ERR** ZDT mode should be used. The **CORR_ERR** mode corrects for dead-time losses over minuscule time intervals by adding counts to the ZDT spectrum in proportion to the instantaneous ratio of real time to live time. Thus, the dead-time correction can correctly track rapidly changing counting rates. The **CORR_ERR** mode should be used whenever the counting rate might change significantly during the measurement time. In addition to the rapidly-decaying isotope

[6] Using our gamma-ray spectrum analysis software such as GammaVision® or ISOTOPIC.

example above, the **CORR_ERR** mode should be used when monitoring cooling water flow from a nuclear reactor. The **CORR_ERR** mode accommodates brief bursts of high-activity in the water flowing past the gamma-ray detector. Both the corrected and error spectra are stored in the resulting spectrum file.

Note that the counts in the ZDT spectrum must be divided by the elapsed REAL time to compute the dead-time corrected counting rate. It is important to note that the standard deviation in the N_{ZDT} counts in a gamma-ray peak in the ZDT spectrum is not $SQRT(N_{ZDT})$. Instead the standard deviation is obtained from the N_{ERR} counts in the same peak ROI in the accompanying error spectrum. The standard deviation in this case is $SQRT(N_{ERR})$; and the standard deviation in the computed counting rate, $SQRT(N_{ZDT}) / Real\ Time$, is $SQRT(N_{ERR}) / Live\ Time$.

3.5.5. The NORM_CORR Diagnostic Mode

Why is there a **NORM_CORR** mode, and why should you avoid using it? This mode simultaneously collects the ZDT spectrum and the conventional uncorrected spectrum. It is useful for demonstrating that the counts in the uncorrected spectrum divided by the live time is the same counting rate as the counts in the ZDT spectrum divided by the real time, in the special case of constant counting rate. Because the error spectrum is not collected in **NORM_CORR** mode, the standard deviation in the ZDT counts cannot be calculated if the counting rate is varying. ISOTOPIC provides some protection for users if the **ZDT-LTC** mode is inadvertently selected. In this case, ISOTOPIC ignores the ZDT spectrum and presumes you intended to use the uncorrected spectrum in a constant-counting-rate application.

3.5.6. To Summarize

- Use the ZDT Off mode when the counting rate is expected to be constant during the time taken to acquire the spectrum.
- Use the ZDT CORR_ERR mode when the counting rate is expected to change or might change significantly during the time required to acquire the spectrum.
- Avoid using the NORM_CORR mode because ISOTOPIC v4 will default to analyzing the LTC spectrum and will ignore the ZDT spectrum.

3.5.7. More Information

Visit our website or contact your ORTEC representative for more detailed information:

- Application note AN56, "*Loss Free Counting with Uncertainty Analysis Using ORTEC's Innovative Zero Dead Time Technique,*" (http://www.ortec-online.com/pdf/an56.pdf)
- General gamma spectroscopy technical papers (http://www.ortec-online.com/papers/reprints.htm#General).

4. SPECIFICATIONS

Note that all specifications are subject to change without notice.

4.1. MULTICHANNEL BUFFER (928 AND 928-MCB)

ADC Successive-approximation type with sliding scale linearization.

Maximum Resolution 16,384 channels, software selectable as 16,384, 8,192, 4,096, 2,048, 1,024, and 512.

Dead Time Per Event 2 µs including memory transfer.

Integral Nonlinearity <+0.025% over the top 99% of the dynamic range.

Differential Nonlinearity <±1% over the top 99% of the dynamic range.

Gain Instability <+50 ppm/°C.

Dead-Time Correction Software selectable for extended Live-Time correction according to the Gedcke-Hale method or ZDT Live-Time corrections which monitors the counting rate and adjusts the dead-time for fluctuating counting rates.

Data Memory 512 kb.

Battery Backup PWB-mounted nominal 3 V lithium coin battery maintains data when power is turned off. Contact ORTEC for replacement. To replace battery, remove the left-side plate (viewed from the front panel), locate battery on the lower left corner of the PWB, and substitute new battery. It may be necessary to bend the battery holder down after removing the old battery to get good contact with the new battery.

4.1.1. Inputs and Outputs

ADC INPUT Accepts positive unipolar, positive gated integrator, or positive leading bipolar analog pulses in the dynamic range from 0 to +10 V; +12 V maximum; semi-Gaussian-shaped time constants from 0.25 to 30 µs, gated-integrator-shaped time constants from 3 to 30 µs, or delay-line-shaped with widths >0.25 µs. Z_{in} = 1 kΩ dc-coupled. No internal delay, BNC connector.

ADC GATE Optional TTL input. Computer selectable Coincidence mode, Anticoincidence mode, or Off. Signal must occur prior to and extend 0.5-µs beyond the peak of the pulse; BNC connector. Z_{in} = 1 kΩ.

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

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

4.1.2. Presets

Presets can be set to automatically stop MCB acquisitions. In addition, the counters and timers can be configured to start and stop in synchronization with the MCB.

Real Time/Live Time Multiples of 20 ms.

Region of Interest Peak count/Integral count.

Data Overflow Terminates data collection when any channel exceeds 2^{31}–1.

Peak Uncertainty Stops acquisition when the statistical or counting uncertainty of a user-selected net peak reaches the specified value.

Nuclide MDA Stops data collection when the value of the Minimum Detectable Activity (MDA) for a user-specified MDA reaches the specified value.

4.2. COUNTER/TIMER/RATE METER (ALL MODULES EXCEPT 928-MCB)

Maximum Counting Rate 200 MHz.

Number of Counters 4 (928 and 928-COUNT-4) or 2 (928-COUNT-2).

Number of Timers 2 (928 and 928-COUNT-4) or 1 (928-COUNT-2)

Count Capacity 32 bits.

Pulse Pair Resolution 7 ns.

4.2.1. Inputs and Outputs

Counter Input 1, 2, 3, 4 Fast analog signal input accepts analog or digital pulses up to ±5 V in amplitude on a front-panel BNC connector. Pulses are counted as they cross the discriminator threshold. Computer selection of triggering on either positive or negative slope. Threshold is computer adjustable from –1.6 V to +3 V in steps of 1.5 mV (minimum pulse 30 mV). Computer selection of either 50 Ω or 1000 Ω input impedance, dc-coupled. Minimum input pulse width is 3.5 ns at the discriminator threshold. Maximum counting rate is 200 MHz.

Input 1, 2, 3, 4, 5, 6 Front-panel BNC inputs accept any TTL input signal.

Output 1, 2 Rear-panel BNC outputs act as general purpose TTL outputs. Low is indicated by <0.4 V. High is indicated by >+2.4 V. The outputs can drive 50 Ω. The outputs can be configured under software control to one of the following functions:

- **Timer Interval Output** High when the counting interval is active.
- **Logic Level** Set high or low from software.
- **Counter Overflow n**
  - "Pulse" option: 1 µs wide pulse with rising edge synchronized to the rollover of a selected counter (n = 1, 2, 3 or 4).
  - "Level" option: On overflow, output remains high until manually reset.
- **Timer Overflow n**
  - "Pulse" option: 100 ns wide pulse with rising edge synchronized to the rollover of a selected timer (n = 1 or 2).
  - "Level" option: On overflow, output remains high until manually reset.
- **CRM Alarm n** Set high when count rate alarm is triggered (n = 1, 2, 3 or 4).
- **Software Control** Hardware command **SET_OUTPUT n,x** where n is the output and x is 0 or 1.

4.2.2. Counter/Timer Software Control

Each of the counters has the following inputs and outputs.

- **Counter Input** Can be used simply as a pulse counter, or can be configured to count one of the following:
  - Any one of the counter input signals listed for the corresponding front-panel input.
  - The overflow output of any other counter or timer.

  - All pulses in spectrum channels marked with the ROI bit (mark ROIs in MAESTRO, GammaVision, or other ORTEC CONNECTIONS spectroscopy applications).

- **Gate Input** Can be configured to be connected to any of the following:
  - Any number of the front-panel inputs. (All of the selected inputs must be active before the counter counts.)
  - Either Timer Interval signal.
  - Counter is always gated on; no connection.
- **Reset Input** Can be configured to be connected to any one or all of the following:
  - Any of the front-panel inputs.
  - The MCB Clear Command signal (allows counter to be synchronized to MCB acquisitions).
  - The Software Individual Reset from software control.
  - The Group 1 or 2 reset signal from software control.
- **Enable Input** Similar to Gate Input. Counter must be enabled to count. Enable can be configured to be controlled by any of the following:
  - Any number of the front-panel inputs. (All of the selected inputs must be active before the counter counts.)
  - The MCB Active signal.
  - Either Timer Interval signal.
  - The Software Individual Enable from software control.
  - The Group 1 or Group 2 enable from software control.
- **Overflow** Output provides a rising edge at the moment a counter overflows. The pulse can be routed to either of the two general outputs or any counter input.
- **FIFO Readout Control** Counter live values can be polled at any time from the computer. In addition, each counter or timer has a 128-word FIFO (first in first out) buffer that holds the previous final counter result at the moment the counter or timer was reset. Using the FIFO, counters can be configured to be reset when a timer reaches a preset value. The current counter value is stored in its FIFO so that the computer can read successive values without the fear of losing results because of sluggish computer operation. FIFO contents can be displayed during or after acquisition, and optionally saved in a text file.

Each of the two timers has the following controls:

- **Time Base Input** can be configured to any of the following:
  - Any of the front-panel inputs (external time base).
  - Internal Time Base (1 minute, 1 second, 0.1 second, 0.01 second, 0.001 second).
- **Reset Input** can be configured to be connected to any one or all of the following:
  - Any one of the front-panel TTL signals.
  - The **Software Individual Reset** from software control.

- ➢ The MCB Clear Command signal (allows timer to be synchronized to MCB acquisitions).
- ➢ Group n Reset (n = 1 or 2) resets all timers or counters and timers in the specified group.

- **Enable Input** Timer must be enabled to count. Enable can be configured to be controlled by the **MCB Active** signal, the **Software Control** signal, or the **Software Group n Enable** (for timer n, n = 1 or 2) signal, which starts all timers for the specified group.
- **Overflow** Output provides a rising edge at the moment a timer reaches the value supplied for Preset Input. The Timer will return to 0 at that moment and continue to count.
- **Time preset** Acquisition time specified by the number of repetitions of the currently selected **Time base**.
- **FIFO Readout Control** Timer FIFOs function the same as the counter FIFOs (see above).

4.3. ELECTRICAL AND MECHANICAL

High-Speed USB Standard connection via a supplied 3 m (10 ft) cable.

Indicators

- **ADC** Indicates activity for ADC-1.
- **Counter** Illuminated if any of the four counters is actively counting.

Power Required +6 V, 350 mA; -6 V, 225 mA; +12 V, 100 mA; –12 V, 100 mA.

Weight

- Net 0.9 kg (2 lb).
- Shipping 2.25 kg (5 lb).

Dimensions NIM-standard, single-wide 3.43 cm x 22.13 cm (1.35 in. x 8.714 in.) front panel per DOE/ER0457T.

4.4. MCB SOFTWARE CONTROLS IN CONNECTIONS APPLICATIONS

- **ADC LLD** Computer controlled from 0 to 100% full scale.
- **ADC ULD** Computer controlled from 0 to 100% full scale.
- **Live Time Correction** Gedcke-Hale, ZDT.
- **Gate** Coincidence, Anticoincidence, Off.
- **Operating Systems** 32-bit and 64-bit Microsoft Windows 7, Windows XP SP3.

4.5. FEATURE MASK BITS

The following table describes the feature bits from the SHOW_FEATURES command discussed on page 48. If the feature is supported in the Model 928, the bit is set to 1; if the feature is not supported, the bit is 0.

928	Bit	Meaning
1	0	Software-selectable conversion gain
0	1	Software-selectable coarse gain
0	2	Software-selectable fine gain
0	3	Gain stabilizer
0	4	Zero stabilizer
1	5	PHA mode functions available
0	6	MCS mode functions available
0	7	918-style list mode functions available
1	8	Sample mode functions available
0	9	Digital Offset (e.g., 920)
0	10	Software-selectable analog offset
0	11	HV power supply
0	12	Enhanced HV (SET_HV, SET/SHOW_HV_POL, SHOW_HV_ACT)
0	13	Software-selectable HV range (ENA_NAI, DIS_NAI)
0	14	Auto PZ (START_PZ_AUTO)
0	15	Software-selectable manual PZ (SET/SHOW_PZ)
0	16	Battery-backed, real-time clock (SHOW_DATE/TIME, SHOW_DATE/TIME_START)
0	17	Sample changer support (SET/SHOW_OUTPUT, SHOW_INPUT)
0	18	One-button acquisition (ENA/DIS/SHOW_TRIG_SPEC, MOVE)
0	19	Nomadic (likely to move between opens)
0	20	Local app data (SET_DATA_APP, SHOW_DATA_APP)
1	21	Software-retrievable serial number (SHOW_SNUM)
0	22	Power management commands
0	23	Battery status support (SHOW_STAT_BATT)
0	24	Software-selectable AMP polarity (SET/SHOW_GAIN_POLAR)

928	Bit	Meaning
0	25	Support for flattop optimization (ENA/DIS_OPTI)
0	26	Stoppable AutoPZ (STOP_PZ_AUTO)
0	27	Network support (e.g., DSPEC)
0	28	Multi-drop serial support (e.g., MicroNOMAD®)
0	29	Software-selectable DPM address (SET_DPM_ADDR)
0	30	Multiple devices (e.g., 919)
1	31	Software-selectable ADC gate mode (SET_GATE...)
Beginning of 2nd word		
0	32	Software-downloadable firmware
0	33	Time histogramming functions available (e.g., 9308)
1	34	Software-selectable lower level discriminator
1	35	Software-selectable upper level discriminator
0	36	MCS-mode SCA input available
0	37	MCS-mode positive TTL input available
0	38	MCS-mode fast-negative NIM input available
0	39	MCS-mode discriminator input available
0	40	Software-switchable MCS-mode discriminator edge
0	41	Software-programmable MCS-mode discriminator level
0	42	Software-programmable SCA upper and lower thresholds
0	43	Software-selectable MCS-mode input sources
1	44	Uncertainty/statistical preset (SET_UNCERT_PRES)
0	45	Features vary by input (SHOW_FEATURES depends on device/segment; multi-input MCBs only)
0	46	Software-selectable HV shutdown mode (SET/SHOW/VERI_SHUT)
0	47	Software-selectable shaping time constants (SET_SHAP)
0	48	Explorable shaping time constants (SHOW_CONFIG_SHAP)
0	49	Advanced shaping time (SET_SHAP_RISE, SET_SHAPE_FLAT, etc.)
0	50	Software-selectable BLR (ENA/DIS/SHO_BLR_AUTO SET/SHO/VERI_BLR)

928	Bit	Meaning
1	51	SHOW_STATUS command supported (returns $M record)
1	52	Overflow preset (ENA/DIS/SHO_OVER_PRES)
0	53	Software-enabled, MicroNOMAD-style audio clicker (ENA/DIS_CLICK)
0	54	Software-readable thermistor (SHOW_THERM)
0	55	Floating-point fine gain (SET/SHO/VERI/LIST_GAIN_FINE)
1	56	Software-enabled pileup rejector. (ENA/DIS/SHO_PUR, SET/VERI_WIDT_REJ)
0	57	Alpha-style HV power (SHOW_HV_CURRENT)
0	58	Software-readable vacuum (SHOW_VACUUM)
0	59	Acquisition alarms (ENA/DIS/SHO_ALARM)
1	60	Hardware acquisition trigger (ENA/DIS/SHO_TRIG)
0	61	Ordinal numbers for shaping times (SET_SHAP 0, SET_SHAP 1, ...)
0	62	Explorable gain ranges (LIST/VERI_GAIN_FINE, ..._COAR, ..._CONV)
0	63	Explorable gain ranges (LIST/VERI_GAIN_FINE, ..._COAR, ..._CONV)
Beginning of 3rd word		
0	64	External dwell support (ENA/DIS_DWELL_EXT)
0	65	Selectable SUM or REPLACE MCS modes (ENA/DIS_SUM)
0	66	External start of pass support (ENA/DIS/SHO_START_EXT)
0	67	Explorable with MCS list commands (LIST_SOURCE, LIST_LLSCA, LIST_ULSCA)
1	68	Device supports the MDA preset
0	69	Software-selectable ADC type (MatchMaker™)
0	70	Has ability to daisy-chain MCBs (DART)
1	71	Zero Dead Time functions available (DSPEC-series, ASPEC-927)
0	72	DSPEC Plus-style Insight triggering (LIST/SET_TRIG_SAMP)
0	73	Multiple inputs per connection (for example, OCTÊTE® Plus)
0	74	Hardware count-rate meter (SH_CRM)
1	75	Multiple ZDT modes (SET/SHOW/LIST_MODE_ZDT)
1	76	Multi-nuclide MDA preset
0	77	MCS Replace then Sum Mode (SET_RPLSUM)

928	Bit	Meaning
0	78	Programmable external dwell voltage capability
0	79	NO Peak Preset feature (M^3CA and OASIS)
0	80	Programmable pulser (OASIS)
0	81	Programmable Vacuum/HV interlock (OASIS)
0	82	Programmable Current/HV interlock (OASIS)
0	83	Explorable Stabilizer (LIST_GAIN_ADJU, LIST_ZERO_ADJU)
0	84	Programmable input impedance (MCS)
0	85	Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr 2.0, DSPEC Pro)
0	86	Selectable HV rise-time (SET/SHOW/LIST_HV_RISE) (SBS-60)
1	87	Explorable ADC GATE settings (LIST_GATE, SET_GATE n)
1	88	Monitor command support (SHOW_MONI_MAX/LABEL/VALUE)
0	89	SMART-1 Detector support (SHOW_SMART_DET, SHOW_SNUM_DET, SHOW_HV_RECO)
0	90	Nuclide report (SET/SHOW_NUCL_COEF, SET/SHOW_ROI_NUCL, ...)
0	91	Interactive Display Features Such as Nuclide Report
0	92	Advanced Stored Spectra (SH_SPEC_COUNT, SET/SHOW_SPEC_ID, MOVE)
1	93	SET/SHOW_VIEW in MCBs with Dual-Port Memory or printer port interfaces, LIST_VIEW in all MCBs
0	94	Connected to MCB via RS-232 (slow) port
0	95	No SET_HV_POSI, SET_HV_NEGA, ENA_NAI and DIS_N
Beginning of 4th word		
0	96	Low Frequency Rejecter (ENA/DIS/SHOW_LFR)
0	97	Resolution Enhancer (ENA/DIS/SH_RENHANCER, SET/SHOW_RETABLE idx,val)
0	98	SET_MODE_RELIST for Resolution Enhancer List Mode
0	99	Readable Sample mode time per channel (SH_TIME_SAMPLE)
0	100	Adjustable Sample mode time per channel (SET/LIST_TIME_SAMPLE)
0	101	List Mode data streamed and formatted as in digiBASE
0	102	Supports ETP mode (ENA/DIS/SHOW_ETP)
0	103	List Mode data streamed and formatted as in DSPEC Pro

928	Bit	Meaning
0	104	SET/SHOW/LIST_PZ using floating point microseconds
0	105	Rise time, flattop width and cusp not changeable from property page
0	106	HV not user changeable from property page (requires Bit 12)
0	107	Coarse and fine gain not user changeable from property page
0	108	PZ and flattop tilt not user changeable from property page
0	109	LFR not user changeable from property page (requires Bit 96)
0	110	Portal Monitor style List Mode Synch is available
0	111	DSPEC-Pro Auxiliary BNC input available
1	112	SET_DISPLAY is NOT used to select ZDT data view (requires Bit 93)
0	113	ID Reports (DO_ID, SHOW_REPORT, SHOW_REPO_LINES)
0	114	Has neutron detector (SHOW_CRM 2 returns valid number)
0	115	—
0	116	—
0	117	—
0	118	—
0	119	—
0	120	—
0	121	—
0	122	—
0	123	—
0	124	—
0	125	—
0	126	—
0	127	Extended feature mask available (SH_FEAT_EXT)

5. HARDWARE COMMANDS AND RESPONSES

Communication with a Model 928 consists of sending commands to and receiving commands from the MCB. Use the DLL interface call **MIOComm** or the ActiveX control UCONN's **Comm** method to send commands to instruments and receive responses.

5.1. 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 928. For example, the command **ENABLE_OVERFLOW_PRESET** can be abbreviated to **ENAB_OVER_PRES**.

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.

5.2. ERROR CODES

Upon 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

5.3. DOLLAR RESPONSE RECORDS

SHOW and STEP commands respond with a dollar response record. The valid dollar response records for each command are discussed in the command catalog. 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.

Response	**Description**
$Axxxccc<CR>	**xxx** is an 8-bit unsigned number
$Cxxxxxccc<CR>	**xxxxxx** is a 16-bit unsigned number
$Dxxxxxyyyyyccc<CR>	**xxxxx** and **yyyyy** are 16-bit unsigned numbers

$Exxxxxccc<CR>	**xxxxx** is a 16-bit alarm mask
$Fssss...<CR>	**ssss**... is a variable length ASCII character sequence (No checksum is sent with this record)
$Gxxxxxxxxxxccc<CR>	**xxxxxxxxxx** is a 32-bit 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_CONFIG command.
$Mxxxxxxxxxx...ccc<CR>	Response to SHOW_STATUS command.
$Nxxxyyyzzzccc<CR>	**xxx**,**yyy**, and **zzz** are 8-bit unsigned numbers.

5.4. MCB COMMANDS

This section lists each EASYNIM 928 command with a description of its operation. This list contains MCB part of the commands. For counters and timers specific commands, see section A.5. The descriptions include a list of any error codes that may result. As described in the two preceding sections, the usual 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 13 "," in the prototype line are literal text to be sent to the MCB exactly as it appears. Lowercase letters in the prototype line represent numeric values as described in the accompanying text and should not be sent literally to the MCB but should be replaced by an appropriate numeric value. In this section the term **<CR>** represents the ASCII carriage return character, decimal value 13, and the character "_" represents the ASCII underscore character, decimal value 95.

CLEAR

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

CLEAR_ALL

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

CLEAR_COUNTERS

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

CLEAR_DATA

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

CLEAR_MDA_PRESET

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

CLEAR_PRESETS

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

CLEAR_ROI

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

DISABLE_OVERFLOW_PRESET

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

DISABLE_TRIGGER

Disables the data acquisition trigger that was enabled by the ENABLE_TRIGGER command. Cancels an ENABLE_TRIGGER_REP if it is issued before the acquisition starts. See ENABLE_TRIGGER, TRIGGER, and SHOW_TRIGGER.

DISABLE_ZDT

Returns the EASYNIM 928 to normal operation if in zero-dead-time (ZDT) mode. See ENABLE_ZDT.

ENABLE_OVERFLOW_PRESET

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

ENABLE_ZDT

Sets the EASYNIM 928 to ZDT mode. See SET_MODE_ZDT for information on selecting the ZDT mode.

INITIALIZE

Returns the EASYNIM 928 (including flash) to the factory default settings.

LIST_DISPLAY

Not used by the EASYNIM 928; included for backward compatibility.

LIST_GAIN_CONV

Lists legal conversion gain settings.
Response:
GAIN_CONV 512 1024 2048 4096 8192 16384

LIST_MODE_ZDT

Reports the legal ZDT-mode settings. Each item in the list can be selected by sending the SET_MODE_ZDT command with a mode number. The mode number is implied by the location of the mode in the list. For example, the first item in the list had a mode number of 0. To select the first item, send SET_MODE_ZDT 0. The second item has a mode number of 1, and so on.
Response:

MODE_ZDT NORM_CORR CORR_ERR	Mode 0 stores the normal and corrected spectra. Mode 1 stores the corrected and the error spectra.

RESET

No function in the EASYNIM 928. This command has been included for backward compatibility.

SET_DATA start, chans,value

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

SET_DATA_APPLICATION "string1","string2"

This is used to store information in the EASYNIM 928 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_DEVICE

Not used; included for backward compatibility.

SET_GAIN_CONVERSION chans

Sets the conversion gain. The conversion gain defines the number of channels within the device that will 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:

SET_GAIN_CONVERSION 0	Conversion gain set to default (16384).
SET_GAIN_CONVERSION 512	Conversion gain set to 512 channels.
SET_GAIN_CONVERSION 1024	Conversion gain set to 1024 channels.
SET_GAIN_CONVERSION 2048	Conversion gain set to 2048 channels.
SET_GAIN_CONVERSION 4096	Conversion gain set to 4096 channels.
SET_GAIN_CONVERSION 8192	Conversion gain set to 8192 channels.
SET_GAIN_CONVERSION 16384	Conversion gain set to 16384 channels.

SET_GATE_ANTICOINCIDENT

Causes the EASYNIM 928 to use the ADC gate input signal in anticoincident mode. See also SET_GATE_OFF, SET_GATE_COINCIDENT, and SHOW_GATE.

SET_GATE_COINCIDENT

Causes the EASYNIM 928 to use the ADC gate input signal in coincident mode. See also SET_GATE_OFF, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_GATE_OFF

Causes the EASYNIM-928 to ignore the state of the ADC gate input signal. See also SET_GATE_COINCIDENT, SET_GATE_ANTICOINCIDENT, and SHOW_GATE.

SET_INTEGRAL_PRESET count

Sets the ROI integral preset to the specified count. During data acquisition when the sum of the counts contained in the channels that have the ROI flag set reaches the integral preset count, the preset is complete and the acquisition is stopped. The actual number of counts in the ROI integral may exceed the preset value by up to 512 counts due to the pipelined architecture of the EASYNIM-928. Setting an integral preset to 0 counts disables the preset. The integral preset can be set to from 0 (disabled) to 4294967295 counts. See also CLEAR_PRESETS and SHOW_INTEGRAL_PRESET.

SET_LIVE ticks

Sets the live-time counter to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks/s). Normally this value is set by the EASYNIM-928 during data acquisition. See also CLEAR_COUNTERS and SHOW_LIVE.

SET_LIVE_PRESET ticks

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

SET_LLD chan

Sets the lower level discriminator to chan, which must be between 0 and 16383. See also SHOW_LLD.

SET_MARK

Not used by the EASYNIM-928; included for backward compatibility.

SET_MDA_COEF a,b,c

Sets the coefficients in the MDA preset calculation to the specified values. A, b, and c are floating-point values. The MDA preset checks for the following condition to be met: The calculation is performed once every 30 seconds with *i* starting at 0 and advancing through each of up to 20 unique MDA presets. *i* only advances once the preset has been met. Note that a, b, and c are the same for each of the unique presets. Only the ROI range and the MDA preset change when *i* advances. Once *i* reaches 20 or $MDAPreset_i$ equals 0, the acquisition terminates.

SET_MDA_PRESET MDAPreset,[PeakNumber]

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

SET_MODE_PHA

Sets the mode to PHA.

SET_MODE_ZDT mode

Sets the ZDT mode. LIST_MODE_ZDT can be used to determine which modes are valid. Mode 0 (standard) indicates that a normal and corrected spectrum should be stored. Mode 1 (enhanced) indicates that an error and a corrected spectrum should be stored. ENABLE_ZDT must be issued to turn on ZDT mode.

SET_OUTPUT [port, value]

This sends value 0 or 1 (0 = low , 1 = high) to Output port 1 or 2.

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 EASYNIM-928. Setting a peak preset to 0 counts disables the preset. The peak preset can 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 flagswithout affecting previously set flags. ROI flags specify channels within a device that are considered for ROI integral and ROI peak presets.

SET_ROI_MDA start,numchans, [PeakNumber]

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

SET_ROI_UNCERTAINTY start, chans

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

SET_SEGMENT

Not used; included for backward compatibility.

SET_TRUE ticks

Sets the true-time counter to the specified number of ticks. The number represents true time in units of 20 ms (50 ticks/sec). Normally this value is set by the EASYNIM-928 during data acquisition. See also CLEAR_COUNTERS and SHOW_TRUE.

SET_TRUE_PRESET ticks

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

SET_ULD value

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

SET_UNCERTAINTY_PRESET percent

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

SET_WINDOW [start, length]

Sets the window of interest to the specified start channel and number of channels. The channels of spectral data in the window of interest are affected by EasyNIM/928 such as CLEAR, SET_DATA, and WRITE. If neither start nor length is provided, the window is set to the maximum size allowed by the conversion gain specified. The window of interest is always set to the maximum size after a SET_DEVICE command or a SET_SEGMENT command.

SHOW_ACTIVE

Returns a 1 if the EASYNIM-928 is active (i.e., acquiring spectral data) or 0 if it is not active.

Responses:

$C00000087<CR>	Not active.
$C00001088<CR>	Active.

SHOW_CONFIGURATION

Returns a record that indicates the hardware configuration of the MCB. The record contains information about the number of segments in an MCB device (always 1 for the EASYNIM-928), 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 in this chapter for more information about response 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_DATA_APPLICATION "string"

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

SHOW_DEVICE

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

Responses:

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

SHOW_FEATURES

Responds with four 32-bit masks indicating the features present in the MCB (see Section 4.5).

Example Response:

FEATURES 02150629409 00286330892 00562043024 00033619968

SHOW_GAIN_CONVERSION

This command returns the conversion gain.

Responses:

$C00512095<CR>	Conversion gain reported as 512 channels.
$C01024094<CR>	Conversion gain reported as 1024 channels.
$C02048101<CR>	Conversion gain reported as 2048 channels.
$C04096106<CR>	Conversion gain reported as 4096 channels.
$C08192107<CR>	Conversion gain reported as 8192 channels.
$C16384109<CR>	Conversion gain reported as 16384 channels.

SHOW_GATE

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

Responses:

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

SHOW_INTEGRAL [start_chan,number_of_chans]

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

Responses

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

SHOW_INTEGRAL_PRESET

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

Responses:

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

SHOW_LIVE

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

Responses:

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

SHOW_LIVE_PRESET

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

Responses:

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

SHOW_LLD

Shows the lower level discriminator setting. See also SET_LLD.

Responses:

$C00050092	The LLD is 50.

SHOW_MDA [PeakNumber]

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

Example response:

MDA 0000000000010.7

SHOW_MARK

Not used by the EASYNIM-928; included for backward compatibility.

SHOW_MDA_COEF

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

Example Responses:

MDA_COEF 000000000002.71 000000000000000 00000021.700001

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

SHOW_MDA_PRESET [PeakNumber]

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

Example Response:

MDA_PRES 0000000000025.7

SHOW_MODE

Reports the current mode of operation (PHA, 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_MODE_ZDT

Reports the current ZDT mode. See SET_MODE_ZDT.

Responses:

MODE_ZDT 00000	Mode 0 selected (normal and corrected).
MODE_ZDT 00001	Mode 1 selected (error and corrected).

SHOW_MONI_LABEL num

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

SHOW_MONI_MAX

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

SHOW_MONI_VALUE num

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

SHOW_NEXT

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

$Dsssssnnnnnccc<CR>

where sssss 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:

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

SHOW_OVERFLOW_PRESET

Reports the state of the overflow preset.

Responses:

$IT<CR>	Overflow preset enabled.
$IF<CR>	Overflow preset disabled.

SHOW_PEAK

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

Responses:

$G0000000000075<CR>	Maximum count in an ROI channel is zero or no ROI channels were found.
$G0000000001076<CR>	Maximum count in an ROI channel is 1.
…	**…**
$G2147483646120<CR>	Maximum count in an ROI channel is 2147483646.
$G2147483647121<CR>	Maximum count in an ROI channel is 2147483647.

SHOW_PEAK_CHANNEL

This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more that one channel contains the largest number of counts. Channel 16383 is the highest numbered channel in any device.

Responses:

$C00000087<CR>	Maximum count was found in channel 0 or no ROI channels were found.
$C00001088<CR>	Maximum count was found in channel 1.
…	**…**
$C16382107<CR>	Maximum count was found in channel 16382.
$C16383108<CR>	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:

$G0000000000075<CR>	Peak preset disabled.
$G0000000001076<CR>	Peak preset set to 1 count.
$G2147483646120<CR>	Peak preset set to 2147483646 counts.
$G2147483647121<CR>	Peak preset set to 2147483647 counts.

SHOW_RATE_ZDT

Not used; included for backward compatibility.

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:

$Dsssssnnnnnccc<CR>

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

Responses:

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

SHOW_ROI_MDA

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

Example Response:

$D0700000050ccc	Calculation is performed on channels 7000–7049.

SHOW_ROI_UNCERTAINTY

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

Response:

$D0700000050ccc	Calculation is performed on channels 7000–7049.

SHOW_SEGMENT

Returns the current segment number. Always 1 for the EASYNIM-928.

SHOW_SNUM

Responds with a $F record indicating the serial number of the EASYNIM-928

Response:

$F100	Serial number = 100.

SHOW_STATUS

Returns system status information in the following format:

$Mllllllllltttttttttaaaaahhhhhccc<CR>

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

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

SHOW_TRUE

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

Responses:

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

SHOW_TRUE_PRESET

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

Responses:

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

SHOW_ULD

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

SHOW_UNCERTAINTY

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

Responses:

UNCE 0000000000008.5	Uncertainty of the peak is 8.5%.

SHOW_UNCERTAINTY_PRESET

Returns the current uncertainty preset setting. See also SET_UNCERTAINTY_PRESET.

Responses:

UNCE_PRES 000000000000000	No preset.
UNCE_PRES 0000000000008.5	Preset set to 8.5%.

SHOW_VERSION

Reports the EASYNIM-928 firmware version number in the form:

Fmmmm-vvv<CR>

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

Example Responses:

$FDSPR–002<CR>	EASY-NIM-928 firmware Version 2 reported.

SHOW_WINDOW

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

$Dxxxxxyyyyyccc<CR>

where **xxxxx** is the start channel (0–16383) and **yyyyy** is the number of channels (1–16384). See SET_WINDOW for more information about the window of interest.

Example Responses:

$D0000016384094<CR>	Window of interest reported as starting at channel 0 and continuing for 16384 channels.
$D0000008192092<CR>	Window of interest reported as starting at channel 0 and continuing for 8192 channels.
$D0819208192112<CR>	Window of interest reported as starting at channel 8192 and continuing for 8192 channels.

SHOW_ZDT

Reports if ZDT mode is enabled.

Responses:

$IF	ZDT mode disabled.
$IT	ZDT mode enabled.

START [seg-mask]

Starts the acquisition of spectral data. The optional segment mask is provided for compatibility with other MCBs and can be any value from 0 to 65535 but is ignored by the EASYNIM-928.

STOP [seg-mask]

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

5.5. COUNTER AND TIMER COMMANDS (ALL MODULES EXCEPT 928-MCB)

These commands control the counter/timer functions in all but the 928-MCB. For the 928-COUNT2, counters n3 and n4 and timer n2 in the following discussion are always zero.

LOAD_CONFIG_FILE "file name"

Loads a counter/timer settings (**.INI**) file to the currently selected 928. "file name" is the full path to a settings file previously saved using the **Save to file** button. For example, use the following command syntax to load the file **928_Settings01.ini** located in folder **C:\Users\Your user name\Documents**:

LOAD_CONFIG_FILE "C:\\Users\\Your user name\\Documents\\928_Settings01.ini"

Note the double back-slashes (****)in the path name. These are necessary because the backslash is treated a special escape character.

RESET_GROUP n1

n1 is the group index from 1 to 2. Sets all group counters and/or timers to zero.

RESET_COUNTER n1

n1 is the counter index from 1 to 4. *Sets the counter to zero.*

RESET_TIMER n1

n1 is the timer index from 1 to 2. *Sets the timer to zero.*

SHOW_COUNTER_CRM

Returns the values for four counters, formatted as:

COUNTER_CRM n1 n2 n3 n4

where n1 to n4 are 10-digit numbers.

SHOW_FIFO_VAL n1

Returns the current value of the FIFO in a $G record where n1 is the index of the counter or timer, defined as follows:

1	Counter 1
2	Counter 2
3	Counter 3
4	Counter 4
5	Timer 1
6	Timer 2

SET_COUNTER_CONFIG n1,n2,value

Sets the counter index, n1, from 1 to 4 depending on the counter used; the counter configuration index, n2, from 1 to 11 as defined below; and the corresponding value code for n2.

1	**Gate input**	Value	
		0	Gate is always on
		1	Gate is connected to Input 1 BNC
		2	Gate is connected to Input 2 BNC
		3	Gate is connected to Input 3 BNC
		4	Gate is connected to Input 4 BNC
		5	Gate is connected to Input 5 BNC
		6	Gate is connected to Input 6 BNC
		7	Gate is connected to Timer Interval 1
		8	Gate is connected to Timer Interval 2
2	**Reset input**	Value	
		0	Software Individual Reset
		1	Reset is connected to Input 1 BNC
		2	Reset is connected to Input 2 BNC
		3	Reset is connected to Input 3 BNC
		4	Reset is connected to Input 4 BNC
		5	Reset is connected to Input 5 BNC
		6	Reset is connected to Input 6 BNC
		7	Reset is connected to MCB Clear Command (allows counter to be synchronized to MCB acquisitions)
		8	Group 1 Reset
		9	Group 2 Reset
3	**Enable input**	Value	
		0	MCB Active
		1	Software
		2	Input 1 BNC
		3	Input 2 BNC
		4	Input 3 BNC
		5	Input 4 BNC
		6	Input 5 BNC

		7	Input 6 BNC
		8	Timer Interval 1
		9	Timer Interval 2
		10	Software Group 1 Enable
		11	Software Group 2 Enable
4	**Counter input**	Value	
		0	Corresponding Counter BNC Input
		1	Connected to Overflow of Counter 2
		2	Connected to Overflow of Counter 3
		3	Connected to Overflow of Counter 4
		4	Overflow of Timer 1
		5	Overflow of Timer 2
		6	ROI (counts all channels for which Region-of-Interest bit is set)
5	**Signal threshold**		Range -1.6 V to 3.0 V
6	**Impedance**		0 = 1 kΩ, 1 = 50 kΩ
7	**Counter input signal edge**		0 = rising edge, 1 = falling edge
8	**Auto reset**		0 = off, 1 = On
9	**FIFO counts**		Number of words in FIFO (this value is read only. Can only be used in SHOW_COUNTER_CONFIG)
10	**Acquisition status mask**		(Read only. Can only be used in SHOW_COUNTER_CONFIG). Bit-mapped flags indicate whether counter or timer has started counting.
		Bit 0	Counter 1
		Bit 1	Counter 2
		Bit 2	Counter 3
		Bit 3	Counter 4
		Bit 4	Timer 1
		Bit 5	Timer 2
11	**Alarm threshold**	counts per second	

SET_OUTPUT_CONFIG n1, value

Set the output configuration where n1 is 1 and the corresponding output value is defined as follows:

0	Software Control
1	GND (0 V)
2	Logic high (5 V)
3	Counter 1 Overflow (Pulse)
4	Counter 2 Overflow (Pulse)
5	Counter 3 Overflow (Pulse)
6	Counter 4 Overflow (Pulse)
7	Timer 1 Overflow (Pulse)
8	Timer 2 Overflow (Pulse)
9	Counter 1 Overflow Level (must be Reset)
10	Counter 2 Overflow Level (must be Reset)
11	Counter 3 Overflow Level (must be Reset)
12	Counter 4 Overflow Level (must be Reset)
13	Timer 1 Overflow Level (must be Reset)
14	Timer 2 Overflow Level (must be Reset)
15	Timer 1 Interval
16	Timer 2 Interval
17	CRM Alarm 1
18	CRM Alarm 2

19	CRM Alarm 3
20	CRM Alarm 4
21	Group 1 Reset
22	Group 2 Reset
23	Group 1 Enable
24	Group 2 Enable

SET_TIMER_CONFIG n1, n2, value

Sets the timer configuration where n1 is the timer index (1 or 2) and n2 is the timer configuration index (1 to 6) followed by the corresponding value code.

1	**Reset**	Value	
		0	Software Individual Reset
		1	Reset is connected to Input 1 BNC
		2	Reset is connected to Input 2 BNC
		3	Reset is connected to Input 3 BNC
		4	Reset is connected to Input 4 BNC
		5	Reset is connected to Input 5 BNC
		6	Reset is connected to Input 6 BNC
		7	Reset is connected to MCB Clear Command (allows counter to be synchronized to MCB acquisitions)
		8	Group 1 Reset
		9	Group 2 Reset
2	**Enable**	Value	
		0	MCB Active
		1	Software Individual Enable
		2	Software Group 1 Enable
		3	Software Group 2 Enable
3	**Timebase**	Value	
		0	Time Base is connected to Input 1 BNC
		1	Time Base is connected to Input 2 BNC
		2	Time Base is connected to Input 3 BNC
		3	Time Base is connected to Input 4 BNC
		4	Time Base is connected to Input 5 BNC
		5	Time Base is connected to Input 6 BNC
		6	1 minute
		7	1 second
		8	0.1 second
		9	0.01 second
		10	0.001 second
4	**Preset**		Range 1 to 4294967295
5	**Auto-reset**		0 = disable, 1 = enable
6	**FIFO counts**		Number of words in FIFO

SHOW_COUNTER_CONFIG n1,n2

Returns a $G record except when n=2. n1 is the index of the counter, which has a value of 1 to 4. n2 is the configuration index (see SET_COUNTER_CONFIG for all possible values). If n=2, it returns a response such as "THRESHOLD 000000.19999998."

SHOW_COUNTER_STATUS

Returns a string with format:

COUNTER_STATUS n

where n is an 11-digit number, defined as follows.

Bit Number	Bit Mnemonic	Function
31–12		Unused
11	CRM Alarm Counter 4	If the CRM Alarm Threshold is exceeded, will be 1.
10	CRM Alarm Counter 3	If the CRM Alarm Threshold is exceeded, will be 1.
9	CRM Alarm Counter 2	If the CRM Alarm Threshold is exceeded, will be 1.
8	CRM Alarm Counter 1	If the CRM Alarm Threshold is exceeded, will be 1.
7	Input 6	State of Input 6
6	Input 5	State of Input 5
5	Input 4	State of Input 4
4	Input 3	State of Input 3
3	Input 2	State of Input 2
2	Input 1	State of Input 1
1	DACBusy	High when DAC state machine is busy transferring data to the hardware.
0	AcquisitionActive	High when acquisition is active.

SHOW_COUNTER_VALUE

Returns a string with format:

COUNTER_VAL n1 n2 n3 n4

where n1, n2, n3, and n4 are the respective values for counters 1 to 4, separated by one space.

SHOW_OUTPUT_CONFIG n1

Returns a $C record. n1 is the index of the output, which has a value of 1 or 2. See also SET_OUTPUT_CONFIG.

SHOW_TIMER_CONFIG n1, n2

Returns a $G record. n1 is the index of the timer, which has a value of 1 or 2. n2 is the configuration index (see SET_TIMER_CONFIG for all possible values).

SHOW_TIMER_VALUE

Returns a string with format:

TIMER_VAL n1 n2

where n1 and n2 are the respective values for timers 1 and 2, separated by one space.

START_COUNTER n1

n1 is the counter index from 1 to 4.

START_GROUP n1

n1 is the group index from 1 to 2.

START_TIMER n1

n1 is the timer index from 1 to 2.

STOP_COUNTER n1

n1 is the counter index from 1 to 4.

STOP_GROUP n1

n1 is the group index from 1 to 2.

STOP_TIMER n1

n1 is the timer index from 1 to 2.

INDEX