ORTEC®

digiBase®

PMT Base with Integrated Bias Supply, Preamplifier, and Digital Multichannel Analyzer for NaI Spectrometry and Counting

Hardware User's Manual

AMETEK®

Part No. 931003
Manual Revision F

072022
Printed in USA

Advanced Measurement Technology, Inc. ("AMT")

WARRANTY

AMT warrants that the items will be delivered free from defects in material or workmanship. AMT makes no other warranties, express or implied, and specifically NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

AMT's exclusive liability is limited to repairing or replacing at AMT's option, items found by AMT to be defective in workmanship or materials within one year from the date of delivery. AMT's liability on any claim of any kind, including negligence, loss, or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event AMT fails to manufacture or deliver items called for in this agreement or purchase order, AMT's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall AMT be liable for special or consequential damages.

Quality Control

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

Repair Service

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, AMT 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 AMT 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 AMT 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 AMT 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 to establish claims. After such notification to the carrier, please notify AMT of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

TABLE OF CONTENTS

FIGURES

TABLES

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 they are understood fully before attempting to use this product.

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

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

DANGER – Hazardous voltage

Protective earth (ground) terminal

Please read all safety instructions carefully and make sure they are understood fully before attempting to use this product.

CLEANING INSTRUCTIONS

To clean the instrument exterior:

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

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

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

THIS PAGE INTENTIONALLY BLANK.

1. INTRODUCTION

The ORTEC® digiBASE® is a 14-pin photomultiplier tube base for gamma-ray spectroscopy applications with NaI(Tl) scintillation detectors and accommodates virtually all 14-pin tube bases used with NaI detectors. The digiBASE combines a miniaturized preamplifier and detector high voltage (0 V to +1200 V bias) with a powerful digital multichannel analyzer and special features for fine time-resolution measurements, all incorporated into a lightweight (10.1 oz), compact (63 mm diameter × 87 mm length) tube base with a USB connection. Everything needed to connect to the NaI(Tl) detector is included in the tube base – no interface card to install, no external NIM-based components.

NaI(Tl) detectors have a gain that is sensitive to changes in ambient temperature and magnetic fields. The digiBASE incorporates a gain stabilizer to significantly diminish this sensitivity. It works by monitoring the centroid of a designated peak in the energy spectrum; the fine gain is automatically and continuously adjusted to maintain the centroid of the peak at its desired position.

The digiBASE is supplied with the MAESTRO® MCA Emulation Software. For those wishing to integrate the digiBASE into their own software systems, ORTEC offers the CONNECTIONS Programmer's Toolkit (A11-BW). The Toolkit offers Microsoft® ActiveX® controls to simplify programming with National Instruments LabVIEW®, and Microsoft Visual C++ and Visual Basic.

Installing the digiBASE is a snap with its USB connection. Just install the accompanying CONNECTIONS Driver Update Kit and MAESTRO software, connect the digiBASE to the USB port of the computer, start MAESTRO, and begin making measurements - it's that easy. MAESTRO contains all the controls needed to adjust the acquisition parameters, acquire the data, and save the spectra. As a member of the CONNECTIONS family of ORTEC products, it also provides full networking with other ORTEC MCBs and supporting computers.

If users need the ultimate in fine time resolution – especially important for Homeland Security applications – the digiBASE features *List Mode* operation, in which each valid input signal is converted to a digital value, which is transmitted to the computer along with the time the event occurred. Time is measured to the nearest microsecond. Each event causes a 32-bit word to be transmitted to the computer. (See Appendix A for a detailed discussion of this feature and how to capture the data stream generated in this mode.)

If users wish to use more than one digiBASE, ORTEC offers four- and seven-port, powered USB hubs (ORTEC Models C-USB-HUB-4B and C-USB-HUB-7B, respectively) rated for both high- and low-speed USB operations. Daisy-chain multiple hubs to control as many as 255 units from a single computer (their use is, however, subject to some limitations, as discussed in Section A.2). In addition, ORTEC offers a 5-m USB Active Extension Cable (Part No. USBEXT). A maximum of five cables can be daisy-chained per instrument, allowing users to connect a digiBASE to a computer 25 m away.

1.1 HOST COMPUTER AND SOFTWARE REQUIREMENTS

The digiBASE is completely computer-controlled and can be operated with any suitable version of ORTEC spectroscopy software, including MAESTRO, which is supplied with the instrument. The digiBASE connects via a USB port.

1.2 ABOUT THIS MANUAL

This manual describes the digiBASE, tells how to connect it in a complete spectroscopy system, gives instructions on configuring the hardware settings (such as high voltage, presets, and gain), and supplies the hardware commands and responses. Complete details on using the control software are in the MAESTRO *Software User's Manual*.

2. GETTING STARTED

2.1 THE DIGIBASE

Figure 1 shows the digiBASE connectors on both the top and bottom panels, including the pin assignments for the TRW 3B14 socket base, which accepts JEDEC B14-38 PMT pin bases. The digiBASE is powered by the USB bus so there is no separate power supply or cord. For more information on the ENABLE INPUT and USB connector, see Section 3.

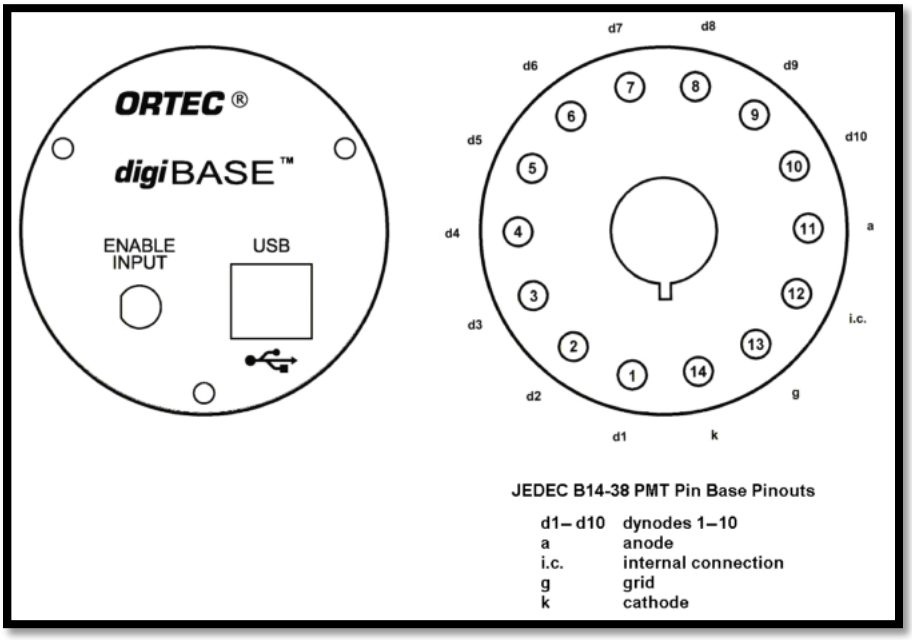

Figure 1. The digiBASE Connectors

2.2 SETTING THE COARSE GAIN JUMPER

The digiBASE has 3 coarse gain settings, 1, 3, and 9, determined by setting a jumper within the unit. The factory setting is 1×. (Fine gain is software-controlled within MAESTRO; see Section 2.4.3.) To change the coarse gain:

- Disconnect the digiBASE from USB cable and wait 1 minute for the internal circuits to completely discharge.

DANGER	***HIGH VOLTAGES are present on the tube socket and inside the unit.*** Never operate the digiBASE with the shroud removed or without a detector installed on the socket.

- With a 5/16-in. wrench, remove the nut on the ENABLE INPUT connector.
- With a 0.050-in. Allen wrench, remove the 4 set screws that hold the shroud in place.

- Slide the shroud off of the socket to expose the internal circuit boards.

> **CAUTION** *Do not touch any components on the circular board*. Oils from fingers can contaminate the components and result in poor operation of the bias supply.

- Locate the 3-pin jumper on the rectangular board that does not have the USB connector mounted on it.

- Orient the digiBASE such that the tube socket is to the right. In this orientation, when the jumper is on the left-most and center pins, this coarse gain is 1. When the jumper is on the right-most and center pins, the coarse gain is 3. The gain is 9 when the jumper is removed. These settings are illustrated in Figure 2. To avoid losing the jumper in this high-gain setting, place it on just one of the pins at a 90° angle to the connector.

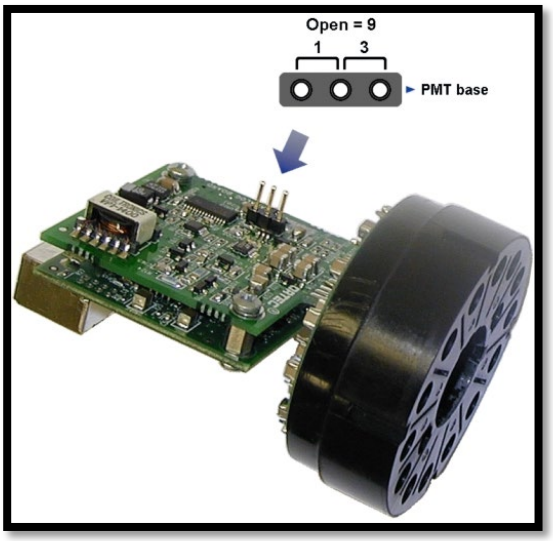

Figure 2. Setting the Coarse Gain Jumper

- After putting the jumper in the desired location, slide the shroud back over the unit, carefully guiding the USB and ENABLE INPUT connectors through the holes in the panel.

- Replace the set screws.

- Replace the washer and nut on the ENABLE INPUT connector.

2.3 SOFTWARE AND HARDWARE INSTALLATION

Installing the digiBASE and the MAESTRO MCA Emulation Software takes just four easy steps:

1) Install the accompanying version of the CONNECTIONS Driver Update Kit (p/n 797230), being sure to select **USB-based instruments** on the Instrument Families screen.
2) Install the accompanying version of MAESTRO (A65-BW).
3) Connect the digiBASE to the USB port on the computer.
4) Run the MCB Configuration program to establish communication with the MCBs.

2.3.1 Step 1: Install the Connections Drive Update Kit

The first step is to install the accompanying version of the CONNECTIONS Driver Update Kit. This product must be installed before MAESTRO can be installed. On the Instrument Families

page, be sure to mark the **USB-based instruments** checkbox, as shown in Figure 3. Otherwise, the digiBASE will not be able to communicate with the computer and MAESTRO.

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

2.3.2 Step 2: Install MAESTRO

Install the accompanying copy of MAESTRO according to the instructions in its User's Manual.

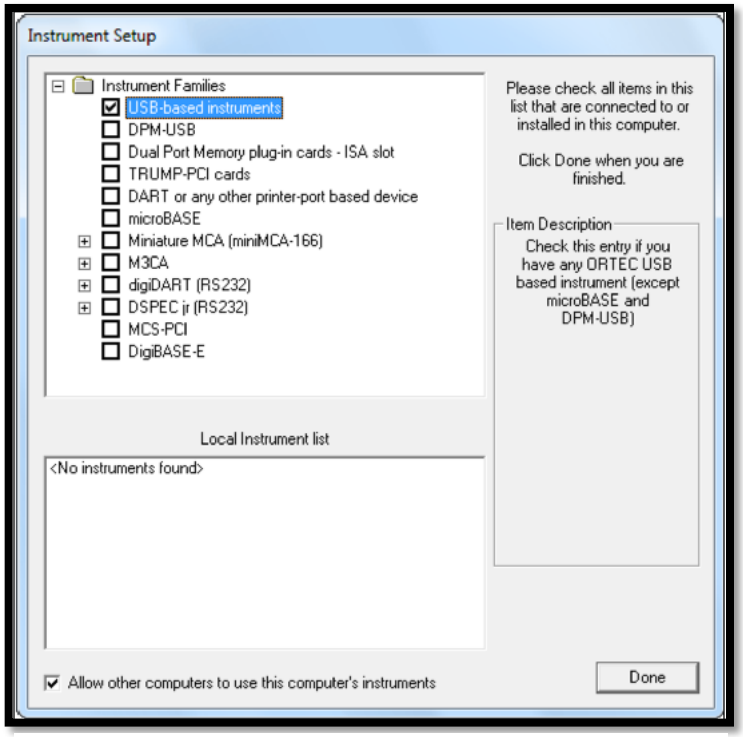

Figure 3. Choose "USB-Based Instruments"

2.3.3 Step 3: Connect the digiBASE to the Computer

1) Attach the PMT and detector to the digiBASE. Before doing so, make sure the PMT matches the pin assignments shown in Figure 1 above. Align the PMT pins so that they key correctly, and firmly seat the PMT in the digiBASE socket.

2) With the computer powered on, connect the digiBASE to the USB port on the computer.

3) Windows will indicate that new hardware has been detected. In Windows 8 and 7, the driver will install without a wizard. In XP, the new hardware installation wizard will open. Click **Next**, indicate it is not desired to connect to the internet or the Microsoft website to locate the driver, choose the "automatically locate driver" option, and follow the remaining prompts to completion. When this operation is complete, the system is now ready to run the MCB Configuration program so that MAESTRO and other CONNECTIONS software can recognize the digiBASE.

2.3.4 Step 4: Run the MCB Configuration Program to Establish Communication with the MCBs

IMPORTANT

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

1) Make sure the digiBASE is connected and powered on.

2) Connect and power on all other local and network ORTEC instruments that are desired to use, as well as their associated computers. Otherwise, the MCB Configuration program will not detect them during installation. Any instruments not detected can be configured at a later time.

3) To start the software, type mcb in the "*Search programs and files*" box on the Windows Start menu, then click the **MCB Configuration** search result; or open the Windows Start menu and click **MAESTRO**, then **MCB Configuration**. The MCB Configuration program will locate all of the powered-on ORTEC MCBs on the local computer and the network and display the list of instruments found (the *Master Instrument List*; Figure 4). If desired, users may enter customized instrument ID numbers and descriptions (Section 2.3.4.2). When the dialog box is closed, any changes made to an ID number or description will be written back to the corresponding MCB.

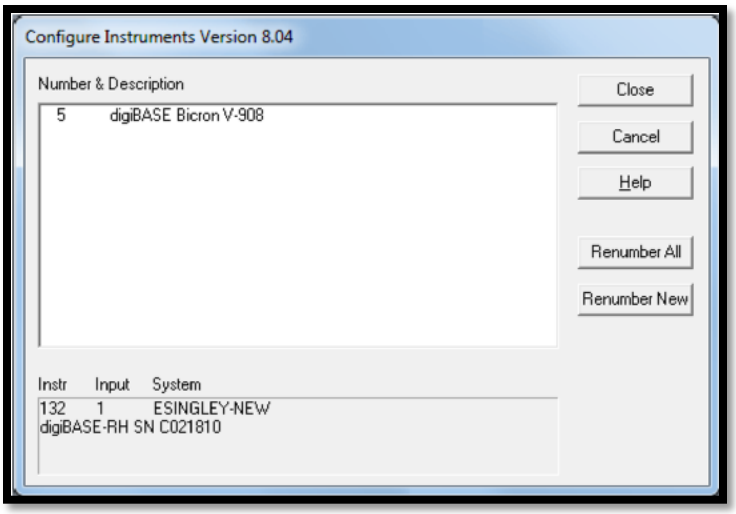

Figure 4. MCB Numbering and Descriptions

2.3.4.1 Configuring a New Instrument

The first time a new instrument is detected, the dialog shown in **Error! Reference source not found.** will remind users that all new instruments must be assigned a unique, *non-zero* ID number.[1] Click **OK**. Users can either manually change the ID Number and Description as described in the next subsection or can click the **Renumber New** button to renumber only the new instruments.

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

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

2.3.4.2 Customizing ID Numbers and Descriptions

If it is desired, users can change the instrument ID Numbers and Descriptions by double-clicking an instrument entry in the Configure Instruments dialog. This will open the Change Description or ID dialog (Figure 6). It shows the physical MCB location (read-only) and allows users to change the **ID** Number and **Description**.

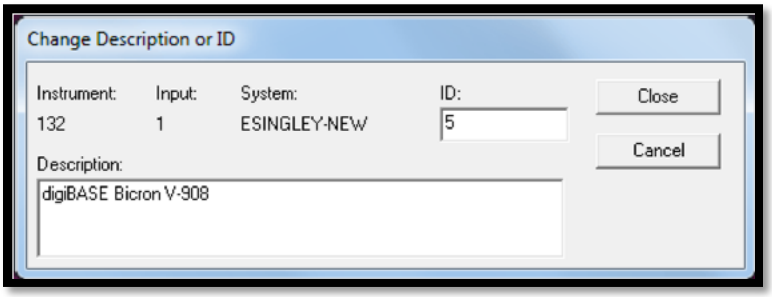

Figure 6. Change MCB Number or Description

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

[1] If this is a first-time installation of ORTEC products, all the instruments will be "new."

NOTE FOR MULTIPLE USERS ON A NETWORK

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

- Add the -I flag to their MCB Configuration command line, as described in the CONNECTIONS Driver Update Kit instructions. This will allow users to assign whatever ID Numbers desired, regardless of the numbers assigned by other users on the network. (Ideally, everyone using ORTEC instruments on the network should make this change.)

- To prevent others from renumbering MCBs (or performing any other actions except read-only viewing), password-lock the MCBs with the MAESTRO **Lock/Unlock Detector** command. If users lock a detector that will be controlled by a JOB stream, remember to include the proper password-unlock commands in the .JOB file (see the MAESTRO user manual).

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

2.3.5 Attaching More Than One digiBASE to the Computer

Once the drivers have been installed for one digiBASE, adding subsequent units is simple. Users can attach as many digiBASE units to a computer as the computer has USB ports and add-on USB hubs, to a limit of 255 (as discussed in Section A.2, their use is subject to some limitations).

REMINDER Be sure to run MCB Configuration any time users add new digiBASEs (or other ORTEC MCBs) to the system, *or when an instrument is moved from one USB port to another*.

2.3.6 Connecting to and Disconnecting from the Computer

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

2.4 DIGIBASE MCB PROPERTIES IN MAESTRO

This section discusses the hardware setup dialog that can be seen within MAESTRO and other CONNECTIONS programs when selecting the **MCB Properties...** command under the **Acquire** menu. The digiBASE is completely software controlled; the MCB Properties dialog contains all of the instrument controls including ADC setup parameters, acquisition presets, high voltage, the gain and zero stabilizers, and amplifier gain adjustments. Just move from tab to tab and set the hardware parameters, then click **Close**.

As characters are entered in the data-entry fields, the characters will be underlined until users move to another field or until 5 seconds have elapsed without data entry. During the time the entry is underlined, no other program or computer on the network can modify this value.

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

2.4.1 Amplifier

Figure 7 shows the Amplifier tab. This tab contains the controls for **Gain** and **Shaping Time.**

Set the amplifier coarse gain by setting the gain jumper described in Section 2.2 to 1x, 3x, or 9x (be sure to note the setting; it is not reflected in this dialog). Then adjust the **Fine** gain with the horizontal slider bar or the edit box, in the range of 0.4 to 1.2. The two controls used together cover the entire range of amplification from 0.4 to 10.8.

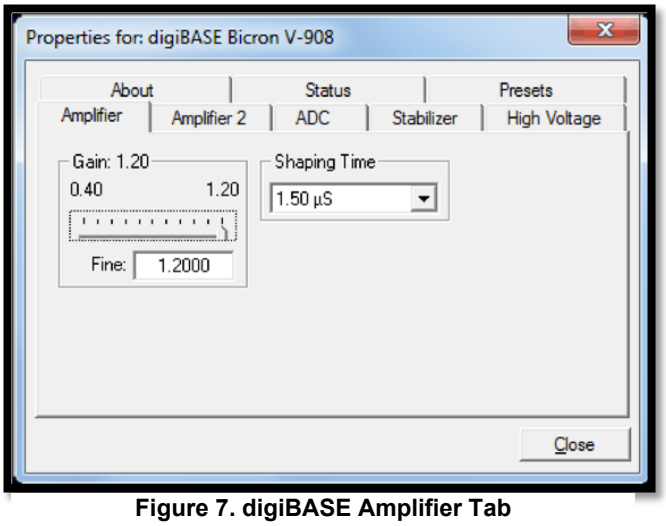

Figure 7. digiBASE Amplifier Tab

In almost all cases, the default **Shaping Time**, 0.75 µs, is the preferred setting. However, the digiBASE supports shaping times from 0.75 µs to 2 µs in steps of 0.25 µs.

2.4.2 Amplifier 2

Figure 8 shows the Amplifier 2 tab, which accesses the InSight™ Virtual Oscilloscope mode. For the more advanced user, the InSight mode allows users to direct the digiBase's advanced shaping parameters and adjust them interactively while collecting live data. To access the InSight mode, click **Start**, then refer to the discussion in Section 2.4.2.1.

When the user is satisfied with the settings, **Close** the Properties dialog and prepare to acquire data. Once data acquisition is underway, the advanced user might wish to return to this tab and switch to the InSight mode to monitor or adjust the shaping parameters interactively with a "live" waveform showing the actual pulse shape.

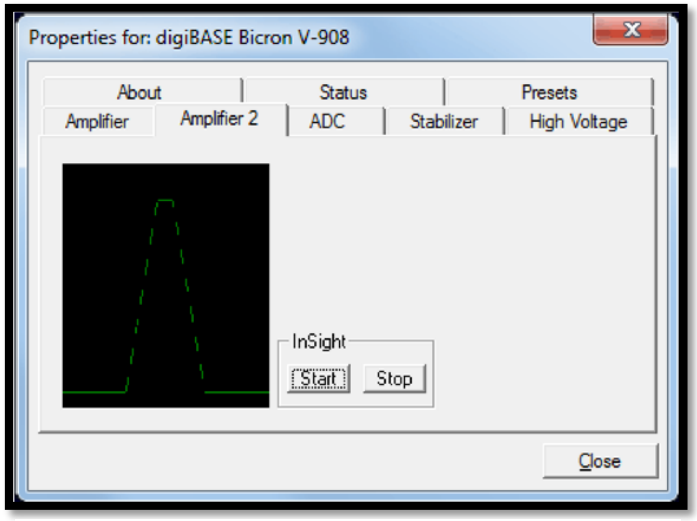

Figure 8. digiBASE Amplifier 2 Tab

2.4.2.1 InSight Mode

The **InSight** display (Figure 9) shows the actual sampled waveform in the digital processing units on a reference graticule. The Properties dialog remains active and can be used to change MCB settings while the user is viewing the pulses.

As none of the traditional analog signals are available in the digiBASE, this mode is the only way to display the equivalent amplifier output pulse. Note that at the bottom of the window the marker channel is displayed in units of time.

Exiting InSight Mode

To exit the InSight mode and return to the PHA display, press **<Esc>** or go to the **Insight** section on the Amplifier 2 tab and click **Stop**. The PHA mode is set to STOP when entering the InSight mode.

InSight Controls

The Status Sidebar changes from the PHA mode controls to the InSight controls for adjusting the peak display. On the left is a vertical scrollbar for adjusting the vertical offset of the waveform. The value of the offset is shown on the display. Double-clicking the mouse in the scrollbar will set the vertical offset to the vertical value of the channel at the marker position. This lets users conveniently zoom in on a particular part of the waveform.

In the **Auto** trigger mode, the display is updated every time a new pulse exceeds the trigger level. To keep a single pulse displayed, select **Single**. Click **Reset** to refresh the display to see the next pulse. There will usually be one or two pulses in the “pipeline” that will be displayed before any change entered will be seen. If the trigger is turned off, the display will be redrawn periodically, even if no pulse is there.

Just as for the PHA mode display, the vertical scale can be adjusted with the vertical adjustments. The display can be set to **Log** mode, but the peak shapes do not have a familiar shape in this display. The **Auto** mode will adjust the vertical scale for each pulse. The pulse is shown before the amplifier gain has been applied, so the relation between channel number and pulse height is not fixed.

The horizontal scale extends from 16 to 256 channels. The display is expanded around the marker position which means that in some cases the peak will disappear from the display when it is expanded.

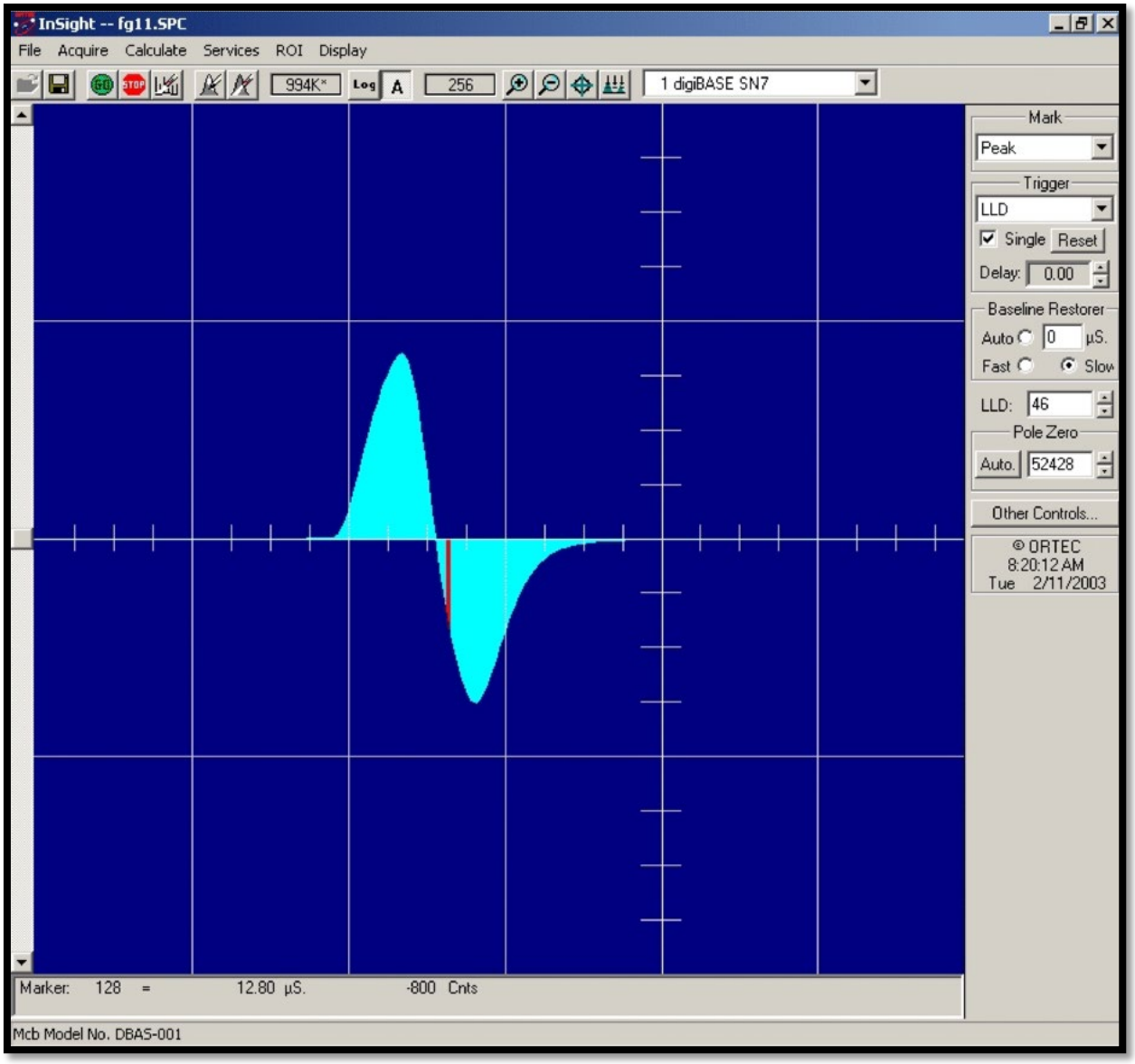

Figure 9. digiBASE InSight Mode

The display can be switched from the digiBASE to another MCB or the buffer. In this case the other MCB will be shown in the mode selected for it. The buffer will always be shown in PHA mode. The display will return to the InSight mode when users return to the first digiBASE. If the program is exited with the digiBASE in InSight mode, it will be in InSight mode on the next startup.

The display can include a **Mark** to indicate one of the other signals shown in Figure 10. The Mark is a solid-color region displayed similarly to that of an ROI in the spectrum. The digiBASE supports only **PosBLDisc** and **Peak**.

Figure 10. Mark Display Section

Mark Types

For the **Mark,** go to the **Display/Preferences** submenu and select either **Points** or **Fill All**. This choice does not change the histogram appearance in PHA mode.

None No channels are marked in the display.

PosBLDisc This shows when the positive baseline discriminator has been triggered. The signal is used internally in the live-time correction circuit.

Peak This is the peak detect pulse. It indicates when the peak detect circuit has detected a valid pulse. The Mark occurs about 0.5 µs after the pulse maximum on the display.

On the lower right of the InSight display are the shaping parameter controls. Except for the **LLD** control, accessed by clicking on the **other controls...** toggle, these are not functional for the digiBASE.

2.4.3 ADC

This tab (Figure 11) contains the **Gate**, **Lower Level Discriminator**, and **Upper Level Discriminator** controls. In addition, the current real time and live time are monitored at the bottom of the dialog.

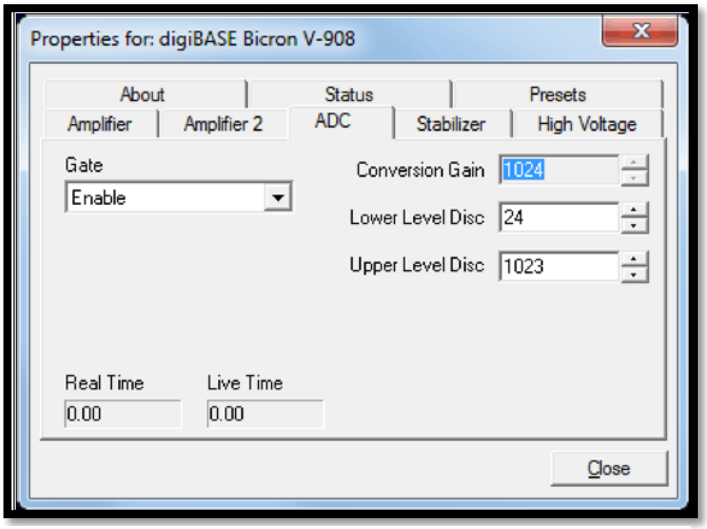

Figure 11. digiBASE ADC Tab

The **Gate** control allows users to select a logic gating function. With this function **Off**, no gating is performed (that is, all detector signals are processed).

When the **Gate** is set to **Enable**, if the ENABLE INPUT is low (<0.8V), real time, live time, and data acquisition are stopped. When the ENABLE INPUT is left open or forced high (>2.0V), real time, live time, and data acquisition are enabled.

If set to **Coincidence**, when the ENABLE INPUT is low, real time and live time operate normally, but no counts are stored in memory. If the ENABLE INPUT is high, normal acquisition occurs.

If set to **Event**, rising edges are counted by a 32-bit event counter. The contents of this counter can be monitored in the **Enable Counter** field on the Status tab (Section 2.4.7). The input impedance is 5 kΩ to +3.3V, protected to ±10 V.

The digiBASE operates at a **Conversion Gain** of 1024 only.

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.

2.4.4 Stabilizer

The digiBASE has both a gain stabilizer and a zero stabilizer; their operation is discussed in more detail in the MAESTRO *User's Manual*.

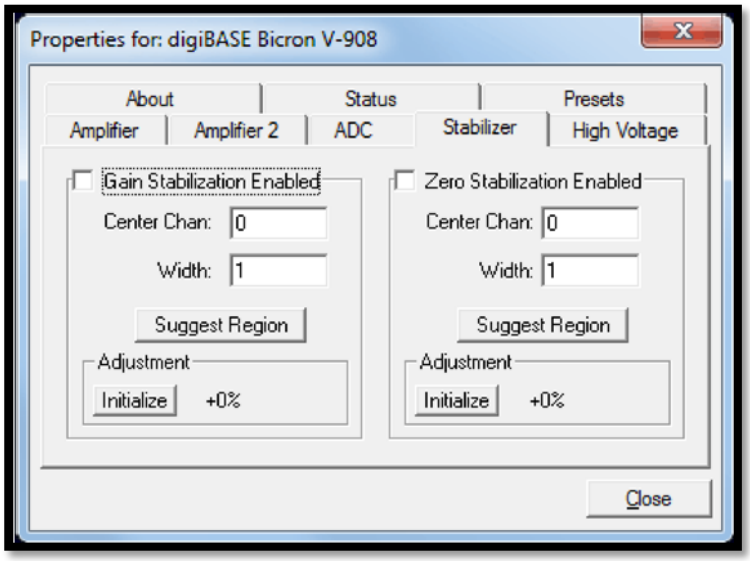

Figure 12. digiBASE Stabilizer Tab

The stabilizer tab (Figure 12) shows the current values for the stabilizers. The value in each **Adjustment** section shows how much adjustment is currently applied. The **Initialize** buttons set the adjustment to 0. If the value approaches 90% or above, the amplifier gain should be adjusted so the stabilizer can continue to function – when the adjustment value reaches 100%, the stabilizer cannot make further corrections in that direction. The **Center Chan**nel and **Width** fields show the peak currently used for stabilization.

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

2.4.5 High Voltage

Figure 13 shows the High Voltage tab, which allows users to turn the high voltage on or off; and set and monitor the voltage.

Enter the detector high voltage in the **Target** field, click **On**, and monitor the voltage in the **Actual** field. Click the **Off** button to turn off the high voltage.

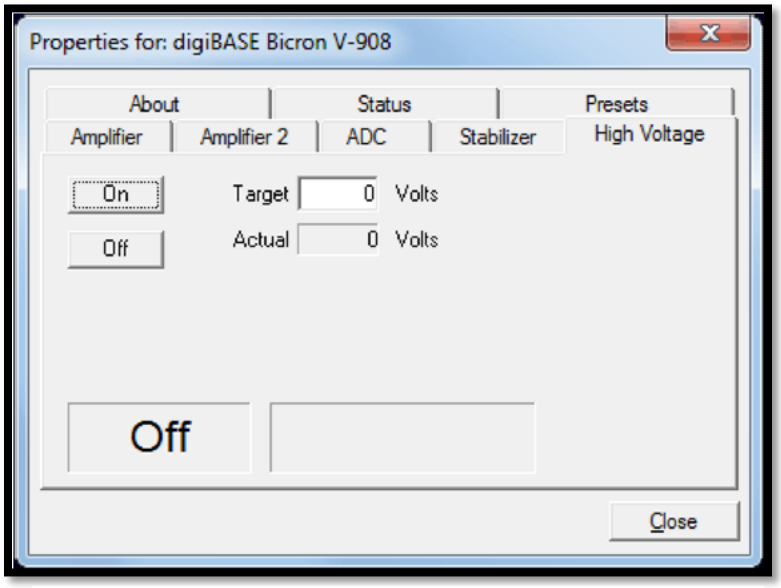

Figure 13. digiBASE High Voltage Tab

2.4.6 About

This tab (Figure 14) displays hardware and firmware information about the currently selected digiBASE 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's manual). **Read/Write** indicates that the MCB is unlocked; **Read** Only means it is locked.

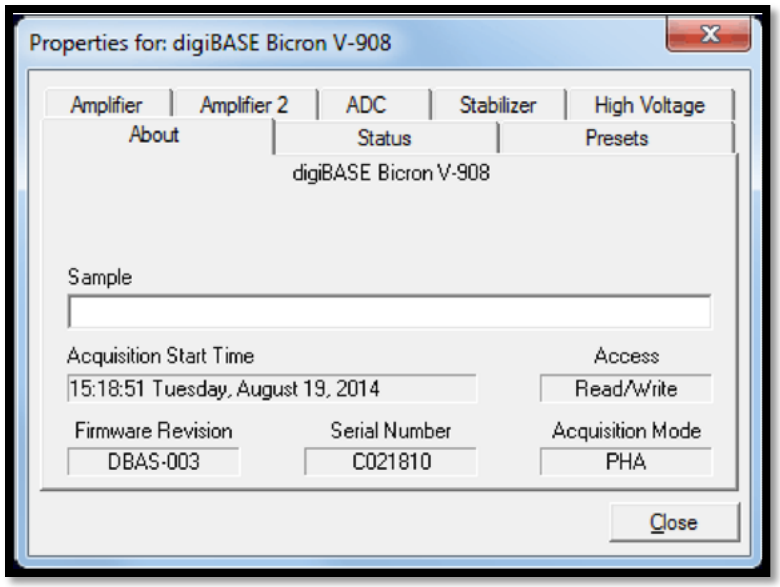

Figure 14. digiBASE About Tab

2.4.7 Status

Figure 15 shows the Status tab. The **Enable Counter** functions when the **Gate** function on the ADC tab is set to **Event** and the digiBASE is actively acquiring data in a spectrum. Under these conditions, the **Enable Counter** accrues the number of events at the ENABLE INPUT since the **Start** command was issued. To clear this counter, click on the **Clear Spectrum** button on the MAESTRO toolbar or issue **Acquire/Clear.**[2]

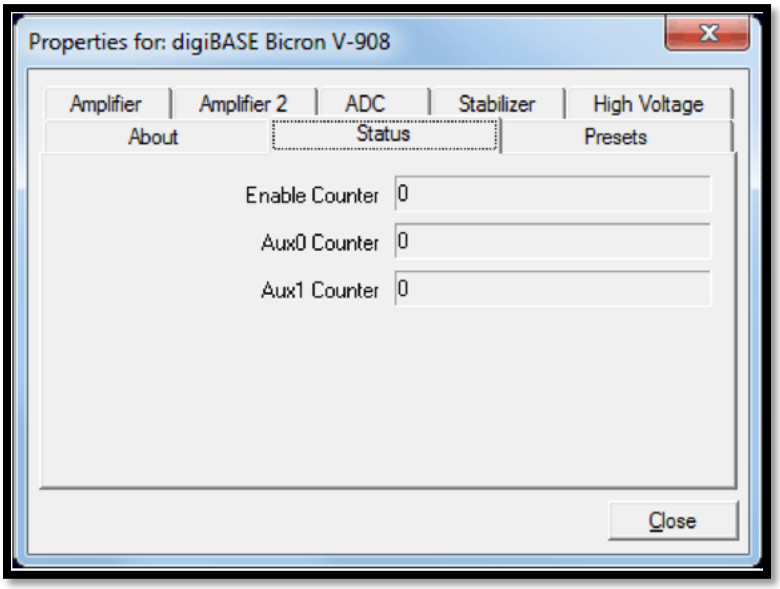

Figure 15. digiBASE Status Tab

2.4.8 Presets

Figure 16 shows the Presets tab. The presets can only be set on an MCB that is not acquiring data (during acquisition the preset field backgrounds are gray indicating that they are inactive). Uses can use either or both presets at one time. To disable a preset, enter a value of zero. If both presets are disabled, data acquisition will continue until manually stopped.

When more than one preset is enabled (set to a non-zero value), the first condition met during the acquisition causes the MCB to stop. This can be useful when users are analyzing samples of widely varying activity and do not know the general activity before counting.

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 users **Close** the Properties dialog.

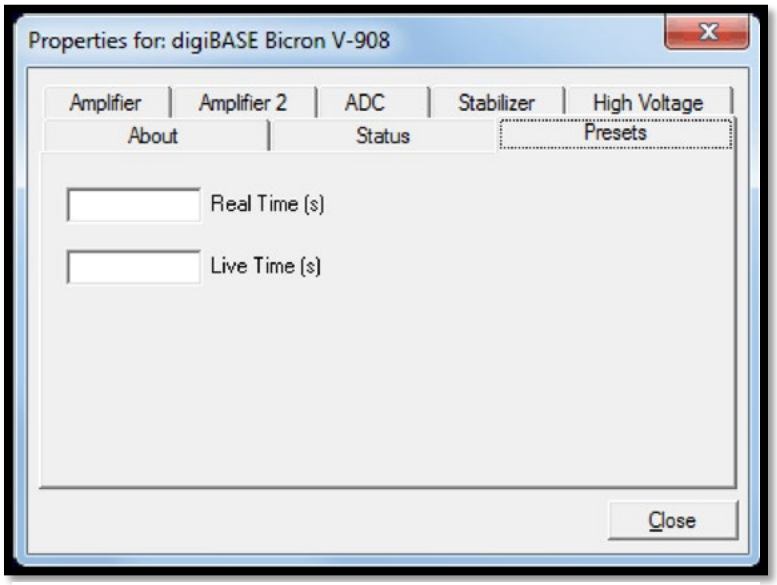

Figure 16. digiBASE Presets Tab

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).

[2] The **Aux0** and **Aux1** counters are reserved for future use.

2.5 TROUBLESHOOTING

If properly installed and functioning MAESTRO software cannot find and communicate with the digiBASE, check the following:

- Make sure the USB cable is properly connected to the computer.
- Make sure USB hubs are correctly connected and functioning.
- Check the Master Instrument List on the computer to ensure that the digiBASE is on the list. If it is not listed, shutdown and restart the computer, then run the MCB Configuration program from the Windows Start menu, as described in Section **Error! Reference source not found.**.

3. SPECIFICATIONS

3.1 PERFORMANCE

Conversion Gain 1024 channels.

Coarse Gain Gain settings of 1, 3, and 9, controlled by jumper setting as described in Section 2.2. Factory setting is 1×.

Fine Gain 0.4–1.2.

Integral Nonlinearity ≤±0.05% over the top 99% of the range.

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

Dead-Time Accuracy <5% error up to 50k cps input count rate. Dead time is measured with a Gedcke-Hale live-time clock.[3]

Detector Voltage 0 to +1200 V dc in steps of 1.25 V under computer control. Read-back of high voltage is available.

Offset Drift <50 ppm of full-scale range per °C.

Gain Drift <150 ppm per °C.

Shaping Time Bipolar shaping adjustable under computer control from 0.75 µs to 2 µs in steps of 0.25 µs.

Presets

- **Live Time** up to 8.5×10^7 seconds in steps of 20 ms
- **Real Time** up to 8.5×10^7 seconds in steps of 20 ms

Spectrum Stabilizer The digiBASE features built-in gain and offset stabilization circuitry. Stabilization is performed by providing a reference peak in the spectrum, which the MCA can monitor, should drift be detected, the gain and offset of the system are adjusted automatically to correct for the drift. The stabilizer can correct for 10% of FSR error in offset and uses the full-range of the fine gain to correct for gain errors.

3.1.1 Inputs

ENABLE INPUT The SMA connector accepts a TTL signal, the function of which depends on the **Gate** setting on the ADC tab under **Acquire/MCB Properties...** in MAESTRO.

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

- When set to **Enable**, if the ENABLE INPUT is low (<0.8V), real time, live time, and data acquisition are stopped. When the ENABLE INPUT is left open or forced high (>2.0V), real time, live time, and data acquisition is enabled.

- If set to **Coincidence**, when the ENABLE INPUT is low, real time and live time operate normally, but no counts are stored in memory. If the ENABLE INPUT is high, normal acquisition occurs.

- If set to **Event**, rising edges are counted by a 32-bit event counter. The contents of the counter can be monitored on the Status tab under **Acquire/MCB Properties...** in MAESTRO. Input impedance is 5 kΩ to +3.3V, protected to ±10 V.

USB Full-speed (12M bps), bus-powered USB 1.1 interface.

3.1.2 Special Performance Features

List Mode Acquisition If users need the ultimate in fine time resolution – especially important for Homeland Security applications – the digiBASE features ***List Mode*** operation, in which each valid input signal is converted to a digital value, which is transmitted to the computer along with the time the event occurred. Time is measured to the nearest microsecond. Each event causes a 32-bit word to be transmitted to the computer. The bits of the word are decoded as follows:

Bit	Description
31 (msb)	TimeStampFlag (0 = Normal Data, 1 = Time Stamp)
30–21	Amplitude of the event
20–0	Time event arrived in units of microseconds

In addition, every second a " time stamp" word is transmitted. This time-stamp word is used to track rollovers in the 21-bit time stamp in the normal data word.

Bit	Description
31 (msb)	TimeStampFlag (0 = Normal Data, 1 = Time Stamp)
30–0	Current time in microseconds

Number of List Mode Units per Computer When multiple units are used in a list mode application, the limited bandwidth of the USB bus sets a practical limit on the number of units that can send data to a single computer. The total data rate of all units should be kept less than 200 kcps. The following chart gives typical maximum pulse rates for various numbers of units. This is discussed in detail in Section .

Number of digiBASEs	Maximum Pulse Rate (typ)
4	50 kcps
5	40 kcps
6	33 kcps
8	25 kcps

Histogram Mode Acquisition Data is histogrammed inside the digiBASE. Data channels are 31 bits. Most significant bit is ROI bit.

3.2 COMPUTER CONTROLS AND INDICATORS

All controls and readouts are implemented in the MAESTRO MCA Emulation Software included with the digiBASE. For more complex applications, the digiBASE is completely compatible with our GammaVision spectroscopy application software.

3.3 ELECTRICAL, MECHANICAL, AND ENVIRONMENTAL

Dimensions 2.48 in. D × 3.43 in. L (63 mm × 87 mm)

Weight 10.1 oz (287 g)

Power Requirement <500 mA from USB connection.

Ambient Operating Environment −10 to +50°C at 0-80%; non-condensing humidity.

> **NOTE** The digiBASE will operate at -10°C, however, at power-on it should be at least 0°C for proper startup.

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

3.4 FEATURE MASK BITS

The following table describes the feature bits from the SHOW_FEATURES command discussed in Section 4.2.2 . If the feature is supported in the digiBASE, the bit is set to 1; if the feature is not supported, the bit is 0.

Table 1. Feature Mask Bits

digiBASE	Bit	Meaning
1	0	Software-selectable conversion gain
0	1	Software-selectable coarse gain
1	2	Software-selectable fine gain
1	3	Gain stabilizer
1	4	Zero stabilizer
1	5	PHA mode function available
0	6	MCS mode functions available
0	7	List mode functions available
1	8	Sample mode functions available
0	9	Digital Offset (e.g., 920)
0	10	Software-selectable analog offset
1	11	HV power supply
1	12	Enhanced HV (SET_HV, SET/SHOW_HV_POL, SHOW_HV_ACT)

digiBASE	Bit	Meaning
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
0	22	Power management commands
0	23	Battery status support (SHOW_STAT_BATT)
0	24	Software-selectable AMP polarity (SET/SHOW_GAIN_POLAR)
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…)
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
0	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)
1	47	Software-selectable shaping time constants (SET_SHAP)

digiBASE	Bit	Meaning
1	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)
1	51	SHOW_STATUS command supported (returns $M record)
0	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)
1	55	Floating-point fine gain (SET/SHO/VERI/LIST_GAIN_FINE)
0	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)
0	60	Hardware acquisition trigger (ENA/DIS/SHO_TRIG)
1	61	Ordinal numbers for shaping times (SET_SHAP 0, SET_SHAP 1)
1	62	Query gain ranges (LIST/VERI_GAIN_FINE, …_COAR, …_CONV)
0	63	Routable inputs (SET/SHOW_INPUT_ROUTE)
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)
0	68	Device supports the MDA preset
0	69	Software-selectable ADC type (Matchmaker™)
0	70	Has ability to daisy-chain MCBs (DART)
0	71	ZDT functions available (DSPEC Plus)
1	72	DSPEC Plus-style Insight triggering (LIST/SET_TRIG_SAMP)
0	73	Multiple inputs per connection (for example, OCTETE® Plus)
0	74	Hardware count-rate meter (SH_CRM)
0	75	Has multiple ZDT modes (SET/SHOW/LIST_MODE_ZDT)
0	76	Has multi-nuclide MDA preset
0	77	Has MCS Replace then Sum mode (SET_RPLSUM)
0	78	Has programmable external dwell voltage capability
0	79	No Peak Preset feature (M^3CA and OASIS)
0	80	Programmable pulser (OASIS)

digiBASE	Bit	Meaning
0	81	Programmable Vacuum/HV interlock (OASIS)
0	82	Programmable Current/HV interlock (OASIS) 0
1	83	Explorable Stabilizer (LIST_GAIN_ADJU, LIST_ZERO_ADJU)
0	84	Has programmable input impedance (MCS)
1	85	Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr)
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_MONI_MAX/LABEL/VALUE)
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)
0	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
1	95	No SET_HV_POSI, SET_HV_NEGA, ENA_NAI and DIS_NAI

4. FIRMWARE COMMANDS AND RESPONSES

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

4.1 COMMAND FORMAT

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

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

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

4.2 ERROR CODES

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

Table 2. 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

Table 3. Macro Code 129 (Syntax Error) or 131 (Execution Error)

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

Table 4. Micro Error Codes

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

4.2.1 Dollar Response Records

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

The following list provides the general form of each dollar response record for the MCB API. In this list, lower case letters represent numeric values. The letters "**ccc**" always represent an 8-bit unsigned checksum of all characters on the record up to but not including the checksum characters, and **<CR>** represents the ASCII carriage return character.

$Axxxccc<CR> xxx is a single 8-bit unsigned number.
$Cxxxxxccc<CR> xxxxx is a single 16-bit unsigned number.
$Dxxxxxyyyyyccc<CR> xxxxx and yyyyy are 16-bit unsigned numbers.
$Exxxxxccc<CR> xxxxx is a single 16-bit alarm mask.
$Fssss...<CR> ssss... is a variable length ASCII character sequence (no checksum is sent with this record).
$Gxxxxxxxxxccc<CR> xxxxxxxxxx is a single 32-bit unsigned number.
$IT<CR> True response to a SHOW command (no checksum).
$IF<CR> False response to a SHOW command (no checksum).
$Jxxxxxyyyyy...ccc<CR> Response to SHOW_CONFIGURATION command.
$Mxxxxxxxxxx...ccc<CR> Response to SHOW_STATUS command.
$Nxxxyyyzzzccc<CR> xxx, yyy, and zzz are 8-bit unsigned numbers.

4.2.2 MCB Commands

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

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

CLEAR
Sets the channels of spectral data to zero. The live time and true time counters are also set to zero. This command is equivalent to the combination of CLEAR_COUNTER and CLEAR_DATA commands.

CLEAR_ALL
This command clears all spectrum channels, presets, and ROIs. It is equivalent to the combination of CLEAR_COUNTER, CLEAR_DATA, CLEAR_PRESETS, and CLEAR_ROI commands.

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

CLEAR_DATA
Sets the channels of spectral data to zero. The ROI flags and presets are not changed.

CLEAR_PRESETS
The live time and true time presets are all set to zero (disabled).

CLEAR_ROI [start], [length]
If start and length are not specified, the region-of-interest flags for the channels in the window of interest (see SET_WINDOW) are cleared. If start and length are specified, region-of-interest flags for the channels specified by start and length are cleared.

DISABLE_GAIN_STAB
Stops stabilization of the gain peak while data is being acquired and sets the center channel to zero. The gain stabilization adjustment is held at its current value until either gain stabilization is reenabled with the ENABLE_GAIN_STABILIZATION command or reinitialized with the INITIALIZE_GAIN_ STABILIZATION or SET_GAIN_PEAK. See also SHOW_GAIN_STABILIZATION.

DISABLE_HV
Turns off the high voltage enable signal. See also ENABLE_HV and SHOW_HV.

DISABLE_ZERO_STABILIZATION
Stops stabilization of the zero peak. The zero-stabilization adjustment is held at its current value until either zero stabilization is reenabled with the ENABLE_ZERO_STABILIZATION command or reinitialized with the INITIALIZE_ZERO_STABILIZATION or SET_ZERO_PEAK. See also SHOW_ZERO_STABILIZATION.

ENABLE_GAIN_STABILIZATION
Enables the stabilization of the gain peak. See also DISABLE_GAIN_ STABILIZATION, SHOW_GAIN_STABILIZATION, and INITIALIZE_GAIN_STABILIZATION.

ENABLE_HV
Turns on the high voltage enable output of the digiBASE and sets the HV to the target HV value. See also DISABLE_HV and SHOW_HV.

ENABLE_ZERO_STABILIZATION
Enables the stabilization of the zero peak. See also DISABLE_ZERO_STABILIZATION, SHOW_ZERO_STABILIZATION, and INITIALIZE_ZERO_STABILIZATION.

INITIALIZE
Resets the digiBASE to factory defaults.

INITIALIZE_GAIN_STABILIZATION
Resets the gain peak stabilization adjustment to 1.0 (no adjustment). This value is reported as 0 by the SHOW_GAIN_ADJUSTMENT command. See also SET_GAIN_ADJUSTMENT, ENABLE_GAIN_ STABILIZATION, and DISABLE_GAIN_STABILIZATION.

INITIALIZE_ZERO_STABILIZATION
Resets the zero peak stabilization adjustment to 0 (no adjustment). This value is reported as 0 by the SHOW_ZERO_ADJUSTMENT command. See also SET_ZERO_ADJUSTMENT, ENABLE_ZERO_STABILIZATION, and DISABLE_ZERO_STABILIZATION.

LIST_GAIN_ADJUST
Displays the range of gain-stabilizer adjustment that can be returned with the SHOW_GAIN_ADJUST command. A value of -100 corresponds to the internal value of -100 and +100 corresponds to 100.
Response:
GAIN_ADJU -100 100-100 100

LIST_GAIN_CONVERSION
digiBASE operates at a conversion gain of 1024 only.
Response:
CONV_GAIN 1024

LIST_GAIN_FINE
Lists the valid fine-gain settings. digiBASE has a fine gain range between 0.4 and 1.2.
Response:
GAIN_FINE 0.41.2 13107 39322

LIST_GATE
Lists the various ways the GATE (ENABLE on the digiBASE) can be used.
Response:
GATE OFF Coincidence Enable Event

LIST_HV
Lists the valid high-voltage settings. digiBASE accepts HV values between 0 and +1200V in 960 steps (1.25 V/step)

LIST_ROI_SAMPLE
Lists the various status bits that can be displayed in InSight mode.
Response:
ROI_SAMP RESV RESV RESV LLD BUSY ULD RESV PKDET

LIST_SHAP
Displays the valid shaping times in units of 10ns.
Response:
SHAPING 75 100 125 150 175 200

LIST_TRIG_SAMPLE
Lists the valid trigger sources in InSight mode.
Response:
TRIG_SAMP Enable PeakDet LLD Random

LIST_ZERO_ADJUST
Displays the range of zero-stabilizer adjustment that can be returned with the SHOW_ZERO_ADJUST command. A value of -100 corresponds to the internal value of -100 and +100 corresponds to +100
Response:
ZERO_ADJU -100 100 -100 100

SAMPLE
Causes a waveform to be capture in InSight mode.
Response:
%000128080 No waveform was available
%000000069 New waveform was successfully captured

SET_DEVICE
Included for backward compatibility. This command executes SET_WINDOW, resetting the window of interest to the maximum number of channels.

SET_GAIN_CHANNEL chan
Sets the center channel for the stabilizer gain peak. If a gain channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel as determined by the conversion gain, the gain peak width is reduced until the peak fits the device boundaries.

SET_GAIN_CONV value
Sets the conversion gain to the specified value. Use LIST_GAIN_CONV to determine legal values.

SET_GAIN_FINE value
Sets the fine gain to value. Value is a floating-point value from 0.4 to 1.2. See also SHOW_GAIN_FINE.

SET_GAIN_WIDTH chans
Sets the width in channels for the stabilizer gain peak. The gain width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The gain channel and width must be set before gain stabilization can be enabled. The absolute minimum width for the gain peak is 3 channels. See also SHOW_GAIN_WIDTH, SET_GAIN_CHANNEL, and SHOW_GAIN_CHANNEL.

SET_GATE value
Sets the function of the ENABLE INPUT. Value is used as an index into the list returned by LIST_GATE. For example, SET_GATE 0 turns the ENABLE INPUT off, SET_GATE 1 sets the ENABLE INPUT to be a coincidence gate, etc.

SET_HV value
This sets the HV bias to value, in volts, and stores value as the target HV.

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 [conversion gain - 1]. See also SHOW_LLD.

SET_MODE_LIST
Puts the unit in List mode as opposed to InSight or PHA Mode. In List mode, individual peak values along with the time the pulse arrived are stored and transferred to memory. See SET_MODE_PHA and SET_MODE_SAMPLE.

SET_MODE_PHA
This command sets the MCB to pulse height analysis mode for collection of histogram data.

SET_MODE_SAMPLE
Starts the InSight Virtual Oscilloscope mode.

SET_ROI start_chan,number_of_chans
Sets the ROI flags for the specified channels. This command can be used multiple times to set ROI flags without affecting previously set flags.

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

Bit 0: Reserved
Bit 1: Reserved
Bit 2: Reserved
Bit 3: LLD
Bit 4: Busy
Bit 5: Gate
Bit 6: Reserved
Bit 7: Peak detect
Bit 8: Reserved

SET_SEGMENT
Not used; included for backward compatibility. This command executes SET_WINDOW, resetting the window of interest to the maximum number of channels.

SET_SHAP value
Sets the shaping time to the setting indexed by "value". The LIST_SHAP command gives a list of shaping times. The SET_SHAP command indexes into that list to set the shaping time. For example, if the result of the LIST_SHAP is:

SHAPING 75 100 125 150 175 200

then the following SET_SHAP commands are valid:

SET_SHAP 0 Sets the shaping time to 0.75 µs (75 x 10 ns)
SET_SHAP 1 Sets the shaping time to 1 µs
SET_SHAP 2 Sets the shaping time to 1.25 µs
SET_SHAP 3 Sets the shaping time to 1.5 µs
SET_SHAP 4 Sets the shaping time to 1.75 µs
SET_SHAP 5 Sets the shaping time to 2 µs

SET_TRIG_SAMPLE setting
Selects the triggering source in Insight Mode. See LIST_TRIG_SAMP for legal trigger sources.

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

SET_ULD chans
Sets the upper-level discriminator to chans, which must be between 0 and [conversion gain - 1]. See also SHOW_ULD.

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

SET_ZERO_ADJUSTMENT value
Sets the zero-stabilization adjustment to an arbitrary value from −65535 to 65535. The total range of the adjustment value represents ±256 channels. This adjustment is usually only made by the gain stabilizer and reset to 0 with the INITIALIZE_ZERO_ STABILIZATION command. See also SHOW_ZERO_ADJUSTMENT.

SET_ZERO_CHANNEL chan
Sets the center channel for the stabilizer zero peak. If a zero channel is chosen such that the beginning channel or ending channel would be below channel 0 or above the maximum channel, as determined by the conversion gain, the zero peak width is reduced until the peak fits the device boundaries.

SET_ZERO_WIDTH chans
Sets the width in channels for the stabilizer zero peak. The width must be chosen such that the beginning channel is no lower than channel 0 and the ending channel is no higher than the maximum channel as determined by the conversion gain. The zero channel and width must be set before gain stabilization can be enabled. The absolute minimum width for the zero peak is 3 channels. See also SHOW_ZERO_WIDTH, SET_ZERO_CHANNEL and SHOW_ZERO_CHANNEL

SHOW_ACTIVE
Returns a 1 if the digiBASE 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 digiBASE), and the current conversion gain for each segment. The record is organized as follows:

$J0102400001aaaaa00000[65 zeros here for total of 75 zeros]00000ccc

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

SHOW_CONFIGURATION_MASK
Returns two masks, the first of which can be “anded” with data from the MCB to clear the ROI bit from the data. When the second mask value is “anded” with data from the MCB, the data bits are removed and only the ROI bit remains.
Response:
CONF_MASK 02147483647 02147483648

SHOW_DEVICE
Shows the currently selected device. Always 1 for digiBASE.

SHOW_FEATURES
Responds with four 32-bit masks indicating which features are present in the MCB. See Appendix A.3.4 for a complete description of each bit in the mask.
Example Responses:
Standard Models
FEATURES 02149587261 01619623948 02175271168 0000000000

SHOW_GAIN_ADJUST
Returns the percentage adjustment that has been applied by the stabilizer.

SHOW_GAIN_CHANNEL
Reports the current center channel for the stabilizer gain peak or zero if the gain channel has not been set. See also SET_GAIN_CHANNEL.
Responses:
$C00000087<CR> Gain channel has not been set.
$C00002089<CR> Gain channel is channel 2 (lowest possible channel).
$C00250094<CR> Gain channel is channel 250.

SHOW_GAIN_CONVERSION
This command returns the conversion gain (1024 channels).
Responses:
$C01024094<CR> Conversion gain reported as 1024 channels.

SHOW_GAIN_FINE
Returns the current fine gain setting. See SET_GAIN_FINE.
Sample Response:
GAIN_FINE 000000.8 Fine gain is set to 0.8.

SHOW_GAIN_POLARITY
Returns the polarity of the amplifier input as $F records.
Responses:
$IPOS<CR> Always positive in digiBASE.

SHOW_GAIN_STABILIZATION
Reports the state of gain peak stabilization. See also ENABLE_GAIN_STABILIZATION and DISABLE_GAIN_STABILIZATION.
Responses:
$IT<CR> Gain stabilization is currently enabled.
$IF<CR> Gain stabilization is currently disabled.

SHOW_GAIN_WIDTH
Reports the current width for the stabilizer gain peak. See also SET_GAIN_WIDTH, SET_GAIN_CHANNEL, and SHOW_GAIN_CHANNEL.
Responses:
$C00001088<CR> Gain width has not been set.
$C00003089<CR> Gain width is 3 channels (lowest possible width).
... ...
$C00256100<CR> Gain width is 256 channels (highest possible width in Gauss mode).

SHOW_GATE

Reports the current setting for the GATE (Enable) Input.

Responses:

$F0OFF<CR> Gate disabled.
$F1COIN<CR> Gate set to coincidence mode. Low during peak detect rejects conversions.
$F2ENABLE<CR> Gate functions as ENABLE. Stops clocks and conversions when low.
$F3EVENT<CR> Gate functions as event counter.

SHOW_HV

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

$Dvvvvvssssccc

Where vvvvv represents the current output voltage if the high voltage is enabled, or the rear-panel high voltage setting if the high voltage is disabled. sssss represents the status of the high voltage bias supply as a 16-bit decimal number with the following bit definitions:

Bit 0 (LSB): Bias supply polarity (0 = positive, 1 = negative).
Bit 1: Bias supply overload (0 = overload, 1 = normal).
Bit 2: High voltage enabled (0 = disabled, 1 = enabled).

Example Responses:

$D0100000003077<CR> 1000 V, negative, not overloaded, disabled.
$D0100000002076<CR> 1000 V, positive, not overloaded, disabled.
$D0100000007082<CR> 1000 V, negative, not overloaded, enabled.

SHOW_HV_ACTUAL

Returns the value of HV actually on the detector.

SHOW_HV_POLARITY

This returns the HV polarity settings as a $F record (always positive for the digiBASE).

Responses:

$IPOS<CR> The HV is positive.

SHOW_HV_TARGET

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

$Dvvvvvssssccc<CR>

where **vvvvv** represents the HV setting, and **sssss** represents the status of the HV bias supply as a 16-bit decimal number with the following bit definitions:

Bit 0 (LSB): Bias supply polarity (0 = positive, 1 = negative).
Bit 1: Bias supply overload (0 = overload, 1 = normal).
Bit 2: HV enabled (0 = disabled, 1 = enabled).

Example Responses:

$D0100000003077<CR> 1000 V, negative, not overloaded, disabled.
$D0100000002076<CR> 1000 V, positive, not overloaded, disabled.
$D0100000007082<CR> 1000 V, negative, not overloaded, enabled.

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_LENGTH_SAMPLE
Reports the number of points in the Insight mode waveform.
Response:

$C00256100	256 points in the waveform.

SHOW_LIVE
Reports the contents of the live-time counter in units of 20 ms (50 ticks/s). See also CLEAR_COUNTER 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_PRES
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_MODE
Reports mode of operation (PHA, List, or Sample [InSight]).
Responses:

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

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

SHOW_MONI_MAX
Returns with the number of monitors available for viewing.

SHOW_MONI_VALUE num
Returns with an ASCII representation of the value for the monitor.

SHOW_NAI
Indicates whether MCB is in NaI mode. Responses are true and false.
Responses:
$IT<CR> digiBASE is always in NaI mode.

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_PEAK
This command returns the contents of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The maximum possible value is 2147483647, which is the maximum number of counts that can be stored in a 31-bit channel.
Responses:
$G0000000000075<CR> Maximum count in an ROI channel is zero or no ROI channels were found.
$G0000000001076<CR> Maximum count in an ROI channel is 1.
... **...**
$G2147483646120<CR> Maximum count in an ROI channel is 2147483646.
$G2147483647121<CR> Maximum count in an ROI channel is 2147483647.

SHOW_PEAK_CHANNEL
This command returns the number of the ROI channel with the largest number of counts. An ROI channel is a channel that has the ROI flag set. The lowest number ROI channel with the largest count is reported if more than one channel contains the largest number of counts.
Responses:
$C00000087<CR> Maximum count was found in channel 0 or no ROI channels were found (see errors below).
$C00001088<CR> Maximum count was found in channel 1.
... **...**
$C01023093<CR> Maximum count was found in channel 1023.

SHOW_RADIX
This command is for compatibility with other ORTEC MCBs. It always reports that the number base radix for the WRITE command is binary.
Responses:
$FBIN<CR> Number base set to binary radix.

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

SHOW_ROI_SAMPLE
Displays the ROI Sample setting. See also SET_ROI_SAMPLE.
Responses:
$C00001088

SHOW_SEG
Returns the current segment number. Always 1 for the digiBASE.

SHOW_SHAP
Displays the shaping time as an index into the list returned by LIST_SHAP.
Responses:
$C00000087 First shaping time selected (0.75 µs)
$C00001088 Second shaping time selected (1 µs)
$C00002089 Third shaping time selected (1.25 µs)
$C00003090 Fourth shaping time selected (1.5 µs)
$C00004091 Fifth shaping time selected (1.75 µs)
$C00005092 Sixth shaping time selected (2 µs)

SHOW_SNUM
Responds with a $F record indicating the serial number of the digiBASE.
Response:
$F100 Serial number 100.

SHOW_STATUS

Returns system status information in the following format:

$MIIIIIIIIIIttttttttttaaaaahhhhhccc<CR>

where **IIIIIIIIII** 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). Always 1 in digiBASE.
Bit 1: Bias supply overload (0=overload, 1=normal). Always 1 in digiBASE.
Bit 2: High voltage enabled (if actual HV>10V; 0=disabled, 1=enabled)
Bit 3: Unused
Bit 4: Unused
Bit 5 Unused
Bits 6–7: Unused
Bit 8: Unused
Bit 9: Unused
Bits 10–14: Unused
Bit 15 (MSB): Reserved

SHOW_TIME_SAMP

Reports the number of microseconds per channel in InSight mode (see SET_MODE_SAMP).

SHOW_TRUE

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

Reports the trigger source in InSight mode.

Responses:

$F0ENABLE ENABLE INPUT is source.
$F1PKD Peak-detect is source.
$F2LLD Lower-level discriminator is source.
$F3RANDOM Triggers randomly.

SHOW_TRUE

Reports the current true-time in units of 20 milliseconds (50 ticks per second).

Responses:

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

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.

Responses:

$C01023093	The ULD is 1023 (the maximum setting for the digiBASE).

SHOW_VERSION

Reports the digiBASE 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:

$FDBAS–001<CR>	digiBASE firmware version 1 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 to [conversion gain-1]) and yyyyy is the number of channels (1 to [conversion gain]). See SET_WINDOW for more information about the window of interest.

Example Responses:

$D0000001024079<CR>	Window of interest reported as starting at channel 0 and continuing for 1024 channels.
$D0000001512080<CR>	Window of interest reported as starting at channel 0 and continuing for 512 channels (first ½).
$D0051200512088<CR>	Window of interest reported as starting at channel 1024 and continuing for 512 channels (last ½).

SHOW_ZERO_ADJ

Returns the percentage adjustment that has been applied by the stabilizer.

SHOW_ZERO_CHANNEL

Reports the current center channel for the stabilizer zero peak or zero if the zero channel has not been set. See also SET_ZERO_CHANNEL.

Responses:

$C00000087<CR>	Zero channel has not been set.
$C00002089<CR>	Zero channel is channel 2 (lowest possible channel).
$C00250094<CR>	Zero channel is channel 250.

SHOW_ZERO_STABILIZATION

Reports the state of zero peak stabilization. See also ENABLE_ZERO_STABILIZATION and DISABLE_ZERO_STABILIZATION.

Responses:

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

SHOW_ZERO_WIDTH

Reports the current width for the stabilizer zero peak. See also SET_ZERO_WIDTH, SET_ZERO_CHANNEL, and SHOW_ZERO_CHANNEL.

Responses:

$C00001088<CR>	Zero width has not been set.
$C00003089<CR>	Zero width is 3 channels (lowest possible width).
...	**...**
$C00256100<CR>	Zero width is 256 channels.

START [seg-mask]

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

STOP [seg-mask]

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

APPENDIX A. LIST MODE

The digiBASE is equipped with *List Mode*, which streams spectroscopy data directly to the computer, event-by-event, without the data "dead periods" associated with the acquire-store-clear-restart cycle of standard spectrum acquisition.

MAESTRO v7 supports our List Mode MCBs with menu and toolbar commands, as well as commands in our automated JOB streams. See the MAESTRO user manual for detailed information.

This appendix provides details about the List Mode that will enable experienced programmers, using the ORTEC CONNECTIONS Programmer's Toolkit with Microsoft® ActiveX® Controls to write custom software applications for acquiring and saving List Mode data. For additional information see:

http://www.ortec-online.com/solutions/applications-software.aspx?tab=2

A.1 List Mode Data

In List Mode, each detectable event that would normally be histogrammed as a spectrum is sent to the computer in the form of a pulse-height value along with a time stamp that indicates the time the pulse arrived. The data can be analyzed by the computer in real time to determine if some significant event has occurred or the data might be streamed to disk for analysis at a later time. In either case, the computer is intimately involved in the collection of the data.

In List Mode, the digiBASE transmits one 32-bit word for every detectable event in the NaI detector. The 32-bit word is encoded as shown in Table 5.

Table 5. Event Word

Bit	Description
31	0 for event
30-21	Amplitude of pulse
20-0	Time in microseconds that the event occurred

The time is a 21-bit number in units of µs. The number rolls over to 0 every 2.097152 s. In order to track the rollovers, a "time only" event is sent from the digiBASE to the computer every 1.048576 s. The format of the "time only" event is in Table 6.

Table 6. Time Stamp Word

Bit	Description
31	1 for time-only
30-0	Current time in microsecond

The digiBASE is equipped with a 128K first-in-first-out (FIFO) buffer that stores the data until the computer has time to read them. Should the computer stop reading data, the FIFO fills up and all further data are lost until the computer empties the FIFO.

A.2 Throughput Issues

In List Mode, each event received by the detector results in the transmission of a 32-bit data word to the computer. In extreme situations with multiple digiBASEs connected to a single computer, the data rate can overwhelm the computer. As an example, if a source is placed in front of the detector that results in 10 kcps accumulating in a histogram, ten thousand 32-bit data words must be transferred to the computer every second. The digiBASE is equipped with a buffer that can hold 128,000 conversions. In order to retrieve all of the list data, the computer must read the data from the digiBASE before the buffer fills up. In this example, the computer must read data from the digiBASE at least once every 12.8 seconds to avoid overflow. In practice, the computer must read more often than this because of the time required for data transfer.

The USB interface is also a limiting factor in throughput. The USB interface is capable of transferring 12M bits per second. In practice, overhead uses about 25% of the bandwidth so the USB bandwidth is approximately 9M bits per second. In our example, 320K bits per second must be transmitted, so the USB has more than enough capacity. If, however, multiple digiBASEs are in use simultaneously, they must all share the 12M bps. Therefore, no more than 9M/320K = 28 units can be supported at the 10kcps average data rate. This maximum also depends on the speed of the computer and the efficiency of the software that is emptying the digiBASE buffers. Any other peripherals on the USB bus will further reduce the maximum throughput of the system.

A.3 Sample Data Collection Application

This section shows a simple Microsoft® Visual Basic program that transfers list mode data from a digiBASE to the hard disk. The program was written with Visual Basic 6.0 and uses the Programmer's Toolkit.

A.3.1 ORTEC Connections Programmer's Toolkit (A11-BW)

The Programmer's Toolkit is a collection of ActiveX® controls that simplify communication with an ORTEC MCB. See the Toolkit user's manual for complete information on how to install and use the software. The remainder of this note assumes the reader has access to the manual.

A.3.2 Operation of the List Mode Data Collection Program

First, the operation of the program will be described and then the code itself will be described in detail. When the program is launched, a dialog box similar to Figure 17 will be displayed.

The column on the left lists all of the digiBASEs found on the system. To collect data, one or more digiBASEs must be selected by marking the checkbox next to the unit's name. Once the digiBASE has been selected, click the **Start** button to begin acquisition. The program will start collecting and storing list data in the file TESTDATA.BIN. Acquisition will stop when users click **Stop**.

The right-hand column is a status screen that shows statistics about the acquisition in progress.

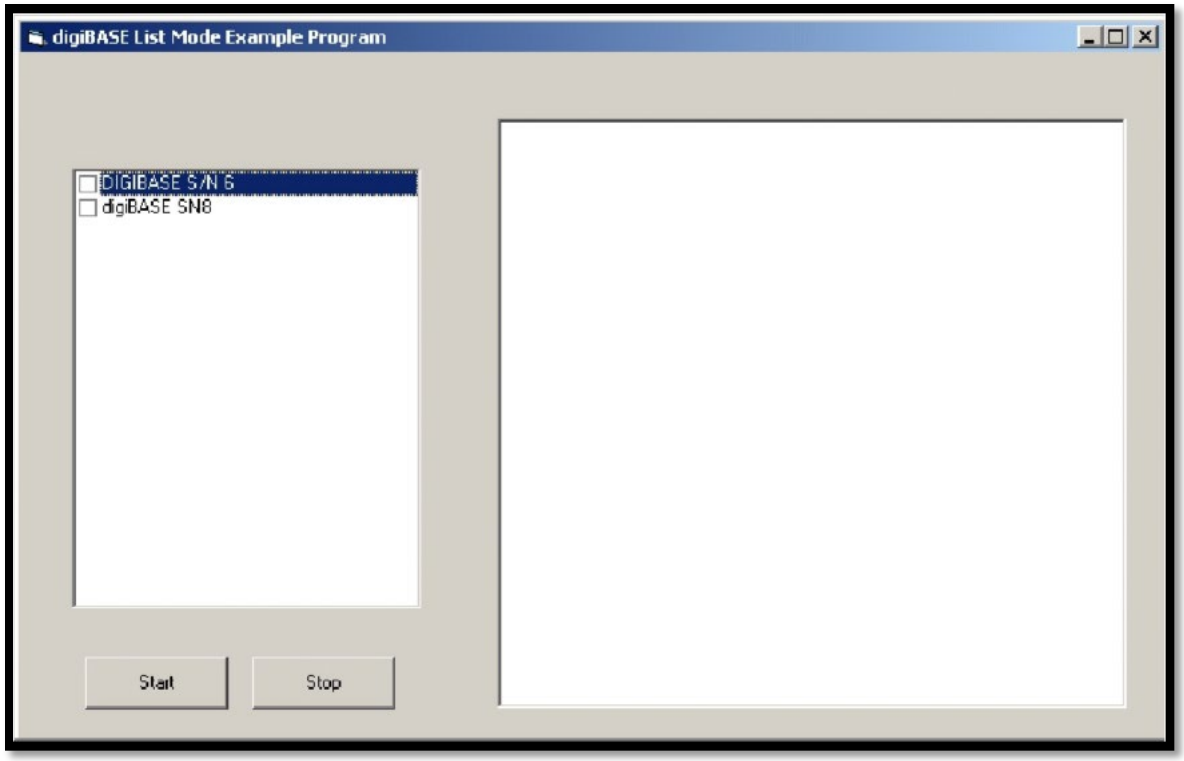

Figure 17. List Mode Example Program

A.3.3 Format of Stored Data

The format of the data in TESTDATA.BIN is identical to the format discussed in Section with one exception. When the computer asks the digiBASE for data, the interface software returns a buffer in which the first word is the number of bytes that were available. The word is stored in the file along with the data. An example file is show below:

00000010H 16 bytes (4 words) were available
10000009H 9 µs after starting, an event that was 80H in amplitude occurred
7FE000FFH 255 µs s after starting, an event that was 3FFH in amplitude occurred
08000200H 512 µs after starting, an event that was 40H in amplitude occurred
00000008H 8 bytes were available in next request
40000300H 768 µs after starting, an event that was 200H in amplitude occurred
00000020H 32 bytes were available in next request

When multiple digiBASEs are selected, each successive “packet” rotates between the selected units. For example in the previous example file, if two digiBASEs are involved in the acquisition, the first 16 bytes came from the first digiBASE, the next 8 bytes came from the second, the next 32 came from the first, and so on.

The program can be modified to whatever format is suitable for the particular application.

A.3.4 Source Code

The ListMode program is composed of a single Form Module with the following subroutines and functions.

```
Option Explicit
Dim bStop As Boolean
Dim uConn21(100) As Object
Dim TotalCounts(100) As Double
```

A.3.4.1 Declarations

bStop is a flag that is used to track when the **Stop** button has been clicked.

The uConn21 object variable is used to hold a Connection control for each digiBASE in the acquisition.

TotalCounts is used to track how many conversions have been sent to the hard disk for each digiBASE.

A.3.4.2 FORM_LOAD

```
Private Sub Form_Load()
lstUMCBI.CreateList
Dim i As Integer
For i = 1 To lstUMCBI.MaxSelection
   lstUMCBI.SelIndex = i
   lstMCBs.AddItem lstUMCBI.SelName
Next i

End Sub
```

When the VB form is loaded, the list of digiBASEs is created in the list box on the left of the form. lstUMCBI is a ULIST control that is part of the CONNECTIONS Toolkit. It holds a list of MCBs connected to the computer. This code gets the names out of that list and puts them in the list box on the form (lstMCBs).

A.3.4.3 START_CLICK

The START_CLICK function is the heart of the data collection. This function is executed in response to clicking the Start button on the form.

```
Private Sub 7cmdStart_Click()
Dim i
Dim Version As String
Dim SerialNumber As String
Dim StartTime As Date
Dim StopTime As Date

rtbStatus.Text = “”
rtbStatus.SelStart = 0
rtbStatus.SelLength = 0

For i = 1 To lstMCBs.ListCount
   If lstMCBs.Selected(i - 1) Then
```

```
        Set uConn21(i - 1) = CreateObject("UMCBI.CONN.2")
        lstUMCBI.SelIndex = i

        uConn21(i - 1).Address = lstUMCBI.SelAddress
        uConn21(i - 1).Open
        Version = Trim(uConn21(i - 1).Comm("SHOW_VERSION"))
        SerialNumber = Trim(uConn21(i - 1).Comm("SHOW_SNUM"))
        Version = Left(Version, Len(Version) - 1)
        Version = Mid$(Version, 3)
        SerialNumber = Mid$(SerialNumber, 3)
        rtbStatus.SelText = lstUMCBI.SelName & " Version = " & Version & "
 Serial Number = " & SerialNumber
        PrepareMCB i - 1
        TotalCounts(i - 1) = 0

    End If
Next i
'
' sTART ALL
'
Dim lData As Variant
Open "TestData.bin" For Binary As #1
StartTime = Time()
For i = 1 To lstMCBs.ListCount
    If lstMCBs.Selected(i - 1) Then
      uConn21(i - 1).Comm "START"
    End If
Next i
'

'  Loop Collecting data
'
bStop = False
Dim oldtime
oldtime = Timer
While Not bStop

    For i = 1 To lstMCBs.ListCount
      If lstMCBs.Selected(i - 1) Then
        lData = uConn21(i - 1).GetRawData(0, 16384)
        ReDim Preserve lData(lData(0) \ 4) As Long
        Put #1, , lData
        TotalCounts(i - 1) = TotalCounts(i - 1) + lData(0) \ 4
      End If
    Next i
    DoEvents
    If Timer - oldtime > 3 Then
      For i = 1 To lstMCBs.ListCount
        If lstMCBs.Selected(i - 1) Then
          rtbStatus.SelText = "MCB " & i & " Total Conversions=" & TotalCounts(i - 1) &
Chr$(10)
        End If
```

```
        Next
        oldtime = Timer
    End If
    If oldtime > Timer Then oldtime = Timer
Wend
StopTime = Time()
rtbStatus.SelText = “Started: “ & StartTime
rtbStatus.SelText = “  Finished:” & StopTime
Dim Elapsed
Elapsed = (StopTime - StartTime) * 3600 * 24
rtbStatus.SelText = “  Elapsed=” & Format$(Elapsed, “0s”) & Chr$(10)
For i = 1 To lstMCBs.ListCount
      If lstMCBs.Selected(i - 1) Then
        rtbStatus.SelText = “MCB “ & i & “ Got “ & TotalCounts(i - 1) & “ Conversions = “ &
Format$(TotalCounts(i - 1) / Elapsed, “0.0") & “ cps” & Chr$(10)
        RestoreMCB i - 1
      End If
Next i
Close #1
End Sub
```

The function begins by clearing out the status box on the form. It then enters a for…next loop that creates a connection control for each digiBASE that has been checkmarked in the list box. Each digiBASE is interrogated and its version and serial number are displayed in the status box (rtbStatus). In addition, each digiBASE is prepared for acquisition by calling the PrepareMCB function.

After the for…next loop, the data file is opened and then each MCB is started.

```
(uConn21(i - 1).Comm “START”)
```

After starting, the “While Not bStop” loop is entered. This loop is executed until the **Stop** button is clicked.

In the While loop, data is requested from each selected MCB with the GetRawData(0, 16384) method. This function causes the digiBASE to transmit up to 16383 conversions. The first word in the returned buffer reports the number of conversions that were actually available to be returned.

The REDIM command resizes the data array to the size that was returned by the GetRawData method. This prevents extraneous data from being written to the disk file.

The data is written to the disk file with the Put command.

The DoEvents command gives time for the **Stop** button to be clicked.

The remaining portion of the “While loop” prints out status information every 3 seconds.

Once **Stop** is clicked, the bStop flag gets set and the program exits from the while loop. The remaining portion of the subroutine prints out some statistics about the average count rate and the file is closed.

A.3.4.4 STOP_CLICK

```
Private Sub cmdStop_Click()
bStop = True
End Sub
```

When the **Stop** button is clicked, the bStop flag is simply set. The START_CLICK function will notice the flag and stop acquisition.

A.3.4.5 PrepareMCB

```
Sub PrepareMCB(Index)
uConn21(Index).Comm “STOP”
uConn21(Index).Comm “CLEAR”
uConn21(Index).Comm “SET_MODE_LIST”
End Sub
```

This function sends the commands to prepare the digiBASE to collect List data. STOP stops and acquisition in progress. CLEAR clears the data currently in the unit. SET_MODE_LIST puts the digiBASE into List Mode.

A.3.4.6 RestoreMCB

```
Sub RestoreMCB(Index)
uConn21(Index).Comm “STOP”
uConn21(Index).Comm “SET_MODE_PHA”
End Sub
```

RestoreMCB puts the digiBASE back into normal pulse height analysis (PHA) mode. The digiBASE must be in PHA mode for MAESTRO to function normally.

A.3.4.7 Performance

> **NOTE** As mentioned previously, the maximum count rate that can be attained without the lost of data from the FIFO file is a function of the throughput capacity of USB; the number of digiBASEs connected to the computer; and the speed, memory, and operating system that are employed for the measurement. The following performance description is designed to help users estimate the performance of their system.

Three digiBASEs were connected to the system. Suitable sources were placed on the detectors such that 50 kcps were being placed in the histogram of each of the three detectors (150 kcps total rate for all three). The program was able to read and store the data without loss of information.

As a test of the maximum attainable rate, the rate on one of the detectors was increased to 100 kcps for a total rate of 200 kcps. The system once again did not lose information. The rate was further increased until overflow of the FIFO began occurring. At that point, the combined rate was 240 kcps. There was no other peripheral on the USB bus and the computer *was dedicated to running the program.*