ORTEC®

digiBASE-E™

High-Performance, Power-over-Ethernet Multichannel Analyzer/PMT Base for Scintillation Detectors

Hardware User's Manual

AMETEK®

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Advanced Measurement Technology, Inc. ("AMT")

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SAFETY INSTRUCTIONS AND SYMBOLS

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

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

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.

SAFETY WARNINGS AND CLEANING INSTRUCTIONS

DANGER Do not attempt to open the cover of this instrument as this can expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being cleaned.

WARNING Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

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.


LINK
100
A
IN
B
OUT
LAN PoE
+3.3V
ORTEC®
digiBASE-E™
CONNECT
FAULT
ON
OUT
IN

1. INTRODUCTION

The ORTEC® digiBASE-E™ is a complete spectroscopy solution for most scintillation detectors. It includes high voltage, digital signal processing of the detector pulse stream, and high-performance multichannel analyzer functionality all within a standard 14-pin PMT base, and offers conversion gain settings of 256, 512, 1024, and 2048 channels.

The digiBASE-E can be used with numerous scintillators. NaI(Tl) detectors have been historically the most popular; but with its new trapezoidal digital filter, the digiBASE-E is also compatible with the newer, faster scintillators, such as LaBr3(Ce). The digiBASE-E has almost three times the throughput of the original digiBASE®. With the appropriate scintillator, the estimated maximum throughput is 196k cps at a 532k cps input rate.

The integral Ethernet RJ45 connector features Power-over-Ethernet (PoE), allowing a simple, single-cable connection to the LAN or PC.

Flexible gating logic makes it easy to configure multiple digiBASE-Es as part of an integrated system where synchronized data acquisition is needed. Events can be correlated to <100 milli-seconds. This makes the digiBASE-E ideal for remote monitoring applications and detector networks and arrays.

1.1 DIGIBASE-E ADVANTAGES

1.1.1 Gain Stabilization

Because NaI(Tl) detector gain is sensitive to changes in ambient temperature and magnetic fields, the digiBASE-E 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.

1.1.2 Flexible Acquisition Modes

The digiBASE-E supports both the familiar Pulse Height Analysis (PHA) acquisition mode and List Mode acquisition. In list mode, each gamma-ray interaction event is recorded in terms of both energy (as in PHA mode) and time of occurrence (not recorded in PHA mode). The resulting data set can be sorted on the basis of both time and energy. This has proven invaluable in many applications such as homeland security, where, for example, a source is moving relative to a detector. Data without the source present can be discarded on the basis of time of occurrence, potentially enhancing signal-to-noise.

In addition to PHA and List modes, an external input allows the digiBASE-E to perform as a 32-bit counter for low-voltage TTL (LVTTL) pulses. The counter can be read through the MAESTRO MCA emulation software or user-created software.

1.1.3 Flexible Gating

In measurement systems employing multiple detectors, there is often a need to synchronize data acquisition (for example in a mobile gamma-ray search system the data from all detectors must be correlated to correctly map out the activity distribution over an area). DigiBASE-E

provides flexible gating features; events from multiple spectrometers may be correlated to within <100 milliseconds. This is achieved by the use of a gate input and a gate output. The gate input can accept multiple signal types, which can be enabled from the supplied MAESTRO MCA Emulation Software or from a user program. Command syntax is provided in Chapter 5 . The gate input modes are:

- **Coincidence Gate mode** – In this mode, during acquisition, the gate is only open to the passage of data when this input is "True."
- **Trigger mode ("ACQ gate")** – In this mode, application of a "True" pulse to the gate starts data acquisition.
- **Routing mode** – In PHA mode, the presence of a "True" level results in data being routed to an alternate spectral memory.
- **List Mode Event Gate** – In this mode the presence of a TRUE level at the gate input results in the associated list mode event(s) receiving a data tag. The gate output is a bridged version of the gate input. It provides the "master output" for use with "slave" digiBASE-E instruments in a multi-detector system. In this mode, the master gate out connects to the slave gate(s) in.

For more detailed information on the digiBASE-E gate modes, see Section 2.2.

1.1.4 Spectrum Analysis Made Easy

The digiBASE-E is supplied with ORTEC's MAESTRO® MCA Emulation Software (A65-BW). MAESTRO has 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.

For complete quantitative analysis, ORTEC offers the GammaVision MCA Emulation and Analysis Software for Scintillation Detector Spectra (A66SV-BW). In addition, ORTEC offers the A11-B32 CONNECTIONS Programmer's Toolkit for those who wish to integrate the digiBASE-E into their own software systems. The Toolkit offers Microsoft® ActiveX® controls to simplify programming with National Instruments LabVIEW®, and Microsoft Visual C++ and Visual Basic.

1.2 HOST COMPUTER AND SOFTWARE REQUIREMENTS

The digiBASE-E is completely computer-controlled and can be operated with any suitable version of ORTEC CONNECTIONS software, including the supplied MAESTRO (v6.08 or later); communicating via CONNECTIONS (v6.12 or later). The digiBASE-E connects via an RJ45 (8P8C) port.

NOTE	Users must have Windows administrator-level access to install ORTEC software.

1.3 ABOUT THIS MANUAL

This manual describes the digiBASE-E, tells how to connect it in a complete spectroscopy system, gives instructions on configuring the hardware settings (such as high voltage, presets, and gain), supplies the firmware commands and responses, and provides details on List Mode operation. Complete details on using the control software are in the MAESTRO *Software User's Manual* as well as the manuals for GammaVision and other ORTEC software applications[1].

[1] For the purposes of this manual, when referring to MAESTRO, it means the ORTEC MCA emulator/analysis application being used (e.g., MAESTRO, GammaVision, etc.).

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2. GETTING STARTED

2.1 THE DIGIBASE-E

Figure 1 shows the digiBASE-E connectors on both the top and bottom panels, including the pin assignments for the socket base, which accepts JEDEC B14-38 PMT pin bases (Table 1). The digiBASE-E operates on Power over Ethernet (PoE). The CAT5E Ethernet cable runs to a single-port PoE injector that requires an AC power source (see the specifications in Chapter 4).

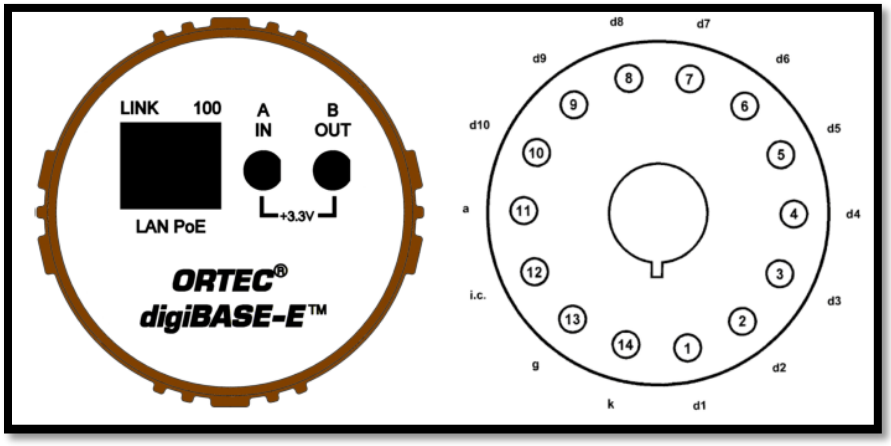

Figure 1. The digiBASE-E Connectors

Table 1. JEDEC B14-38 PMT Pin Base Pinouts

d1-d10	Dynodes 1-10
a	Anode
i.c.	Internal connection
g	Grid
k	cathode

2.2 DATA ACQUISITION (GATE) MODES

In multi-detector measurement systems, there is often a need to synchronize data acquisition (for example, in a mobile gamma-ray search system the data from all detectors must be correlated to correctly map the activity distribution over an area). The digiBASE-E provides flexible gating features; events from multiple spectrometers may be correlated to within <100 milliseconds. This is achieved by the use of a gate input and a gate output.

The gate input can accept multiple signal types, which users can select from the ADC property page in MAESTRO (supplied) or from a customer-written program (command syntax is described in Chapter 5).

The gate input modes are as follows. Note that a low signal is <0.8 V and high is >2.0 V.

- **None** – No gating is performed; all detector signals are processed. Can be used within MAESTRO.

- **Acq Control** – Once software initiates the data acquisition process, the actual data acquisition is in effect as long as the A input signal is high. The B output can be used to control a sample changer. Can be used within MAESTRO.

- **Acq Trigger** – Once software initiates the data acquisition process, actual data acquisition does not start until the Input A signal transitions from low to high. Data acquisition continues until stopped by software. Can be used within MAESTRO.

- **Coinc Gate** – When Input A is low, real time and live time operate normally, but no counts are stored in memory. When Input A is high, normal acquisition occurs. Can be used within MAESTRO.

- **Event Counter** – Input A acts as a 32-bit (rising-edge) event counter for LVTTL pulses. The contents of the counter can be monitored on the Status tab under **Acquire/MCB Properties...** in MAESTRO and with the SHOW_MONI_VAL 0 firmware command. Input impedance is 5-kΩ to +3.3V, protected to ±10 V. Can be used within MAESTRO.

- **Routing** – If Input A is high, the spectrum histogram data are routed to an alternative data memory. Otherwise, the data are handled as a regular spectrum histogram. Currently, there are two ways to access the data in the alternative data memory:

    - Customer-written software
    - Using MAESTRO and the ORTEC **Diag.exe** utility simultaneously. To do this:
        a) Start MAESTRO and use the detector droplist on the toolbar to select the digiBASE-E and display the histogram in its regular memory.
        b) From **My Computer**, go to **C:\Program Files\Common Files\ORTEC Shared\UMCBI** and run the **Diag.exe** program. Click on the detector droplist at the top of the window and select the digiBASE-E. Position the MAESTRO and Diag windows as needed.
        c) In the **Command** field in Diag, enter **SET_VIEW 1** and click on the **SEND** button.
        d) *Close and reselect the MAESTRO spectrum window for this digiBASE-E.* The histogram in the alternative data memory will be displayed in the MAESTRO spectrum window.
        e) To return to the regular histogram memory, enter **SET_VIEW 0**, click on **Send**, then *close and reselect the MAESTRO detector window* for this digiBASE-E to redisplay the regular spectrum histogram.

NOTE	The SET_VIEW command affects only the PC that issued the command. A user who accesses the same digiBASE-E from a different PC will initially see the regular (SET_VIEW 0) spectrum view.

- **Sync** – This applies only to list mode and a daisy-chain configuration (maximum 12 units per daisy chain). Input A is the time synchronization pulse. A transition from low

to high at Input A causes a sync timestamp to appear in the list mode data stream. Requires customer-written software.

- **Sync Master** – This applies only to list mode and a daisy-chain configuration. In a daisy-chained setup (maximum 12 units per daisy chain), only one digiBASE-E can act as SyncMaster. The SyncMaster is responsible for generating a pulse at 100 ms intervals, and the pulse is replicated to the other daisy-chained digiBASE-Es. Requires customer-written software. The software must distinguish the IP address of the master unit from the slaves.

2.3 SOFTWARE AND HARDWARE INSTALLATION

Installation takes just a few straightforward steps. See the quick-reference diagram in Figure 2.

1) Install the accompanying CONNECTIONS Driver Update Kit (p/n 797230) *first*, being sure to mark the **digiBASE-E** checkbox on the Instrument Families screen.
2) If using GammaVision, install it before installing MAESTRO.
3) Install the accompanying MAESTRO MCA Emulation Software (A65-BW).
4) Set the digiBASE-E's coarse gain jumper as desired (the factory default is 1×), then mount the detector on the digiBASE-E.
5) Connect the single-port PoE injector to an ac power supply
6) Connect the PoE injector to a network or a host PC.
7) Connect the digiBASE-E to the PoE injector.
8) Run the accompanying digiBASE-E Ethernet Device Controller program to locate all digiBASE-Es on the network and attach to the desired unit(s). *Be sure to read Section 2.3.4.1 on IP addressing.*
9) Run the MCB Configuration program to establish communication between the digiBASE-Es (and any other ORTEC MCBs) and the ORTEC software application(s).

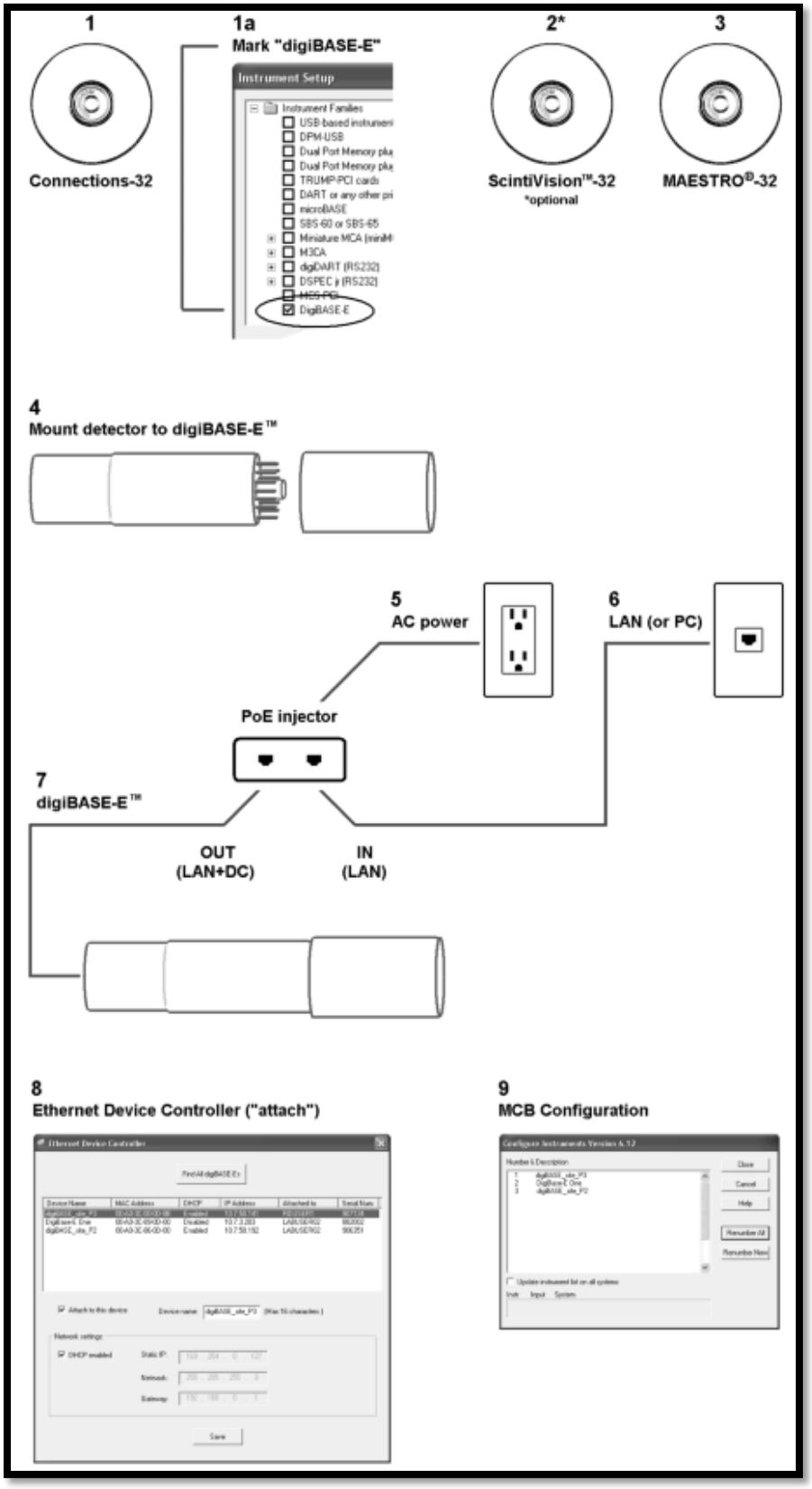

Figure 2. Installation Quick-Reference

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 **digiBASE-E** checkbox, as shown in Figure 3. Otherwise, the digiBASE-E will not be able to communicate with the PC and MAESTRO.

If there are also other types of MCBs attached to this computer, refer to the installation instructions in the corresponding hardware manuals or in the ORTEC MCB Connections Hardware Property Dialogs Manual (p/n 931001, on the install CD). Alternatively, users can install the other device drivers later, as described in the Connections Driver Update Kit Instructions.

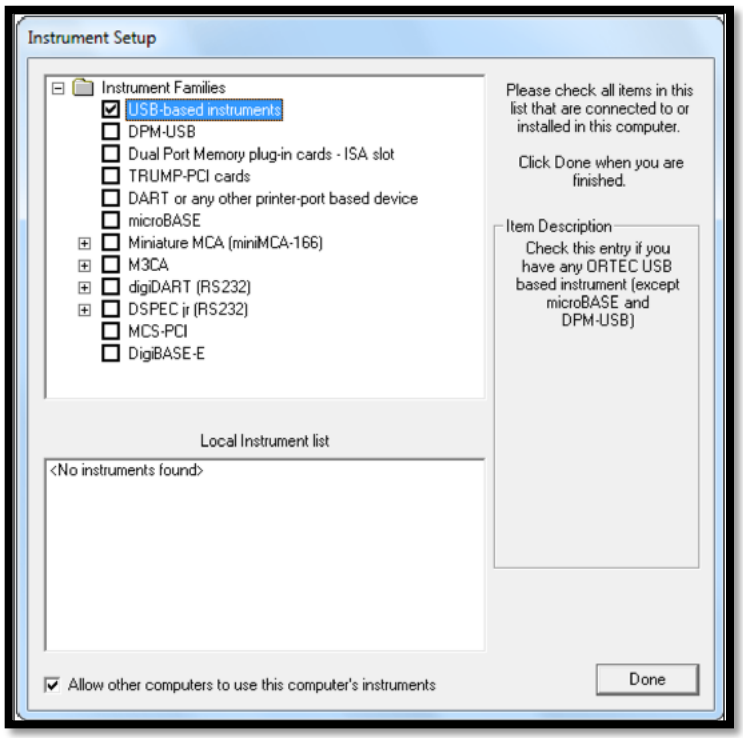

Figure 3. Choose "DigiBASE-E"

2.3.2 Steps 2 (Optional) and 3: Install the Spectroscopy Applications

Next, install the ORTEC software applications on the PC that will control the digiBASE-E.

2) The digiBASE-E is supplied with MAESTRO. However, if users will also be installing GammaVision for the first time on this PC (i.e., if it is not already installed), it is important to install it ***before*** MAESTRO, according to the instructions in the GammaVision *User's Manual*.

3) Next, install the accompanying version of MAESTRO according to the instructions in its *User's Manual*.

2.3.3 Steps 4 through 7: Hardware Setup and Installation

4) The coarse gain for the digiBASE-E is set with a jumper on the analog board. The available settings are 1×, 3×, and 9×; the factory default is 1×. If users wish to use a different setting, see the instructions in Appendix A. *Be sure to record the setting used (users may wish to label the digiBASE-E housing with the current coarse gain setting).*

   Now attach the detector to the digiBASE-E according to the detector data sheet.

5) Attach the PoE injector to its ac power cord and connect it to an ac power supply. The power ON indicator will light.

6) Power on the host PC. If working in a standalone (non-networked) configuration and using a laptop (or desktop PC) that has a wireless LAN card, disable the card's wireless networking function. Some laptops automatically disable the network interface card to conserve the battery when not connected to an ac power supply. Ensure that the network interface card is enabled. In most cases, there will be no need to change the firewall settings.

   The digiBASE-E is supplied with two 10 ft (3 m) CAT5E Ethernet cables. Attach one CAT5E cable to the IN (LAN) jack of the PoE injector, then connect it to the PC's Ethernet adaptor or to the LAN.

7) Attach the second CAT5E cable to the PoE injector's OUT (LAN+DC) jack, and connect it to the digiBASE-E.

IMPORTANT – DHCP SERVER AND DYNAMIC ADDRESSING

If using the network's Dynamic Host Configuration Protocol (DHCP) server to assign a dynamic IP address to the digiBASE-E (see Section 2.3.4.1), users must power on the PoE injector and connect it to the LAN *before* connecting the second CAT5E cable to the digiBASE-E. This is because, for the first 10 seconds the digiBASE-E is connected to the LAN, it broadcasts an IP address request to the DHCP server. If it receives no response, it defaults to the factory-assigned IP address discussed in Section 2.3.4.1 (*which it is strongly recommend to read before using the digiBASE-E*). If the 10 second window is missed, simply disconnect/reconnect the network cable from the digiBASE-E to cycle its power. (If connecting to a standalone PC [no network available], see Section 2.3.4.1)

2.3.4 Step 8: Use the Device Controller Program to "Attach" to the digiBASE-E

This section tells how to use the Ethernet **DeviceConnection** program to locate all (powered on) digiBASE-Es on the network, and "attach" to the units users wish to control from the PC. This attachment process flags the instrument as "belonging" to the PC. Then, when users then run the MCB Configuration to locate all ORTEC MCBs on the network (Section 2.3.5), any digi-BASE-Es attached will be displayed as if they are physically connected to the PC (even if they are on other network nodes). The MCB Configuration interface will not display any digiBASE-Es not attached.[2]

- Click on the Ethernet Device Controller icon on the desktop. (Or use **My Computer** or Windows Explorer to navigate to **C:\Program Files\Common Files\ORTEC Shared\UMCBI** and open the **DeviceController.exe** file.) Figure 4 shows the initial screen.

[2] This is unlike other ORTEC MCAs, which (if powered on) are displayed by the MCB Configuration program even if they are not attached to the local PC. Most ORTEC MCAs use only the MCB Configuration program to set up communication with the PC. The digiBASE-E communicates differently than other ORTEC instruments; the Ethernet Device Controller handles those differences.

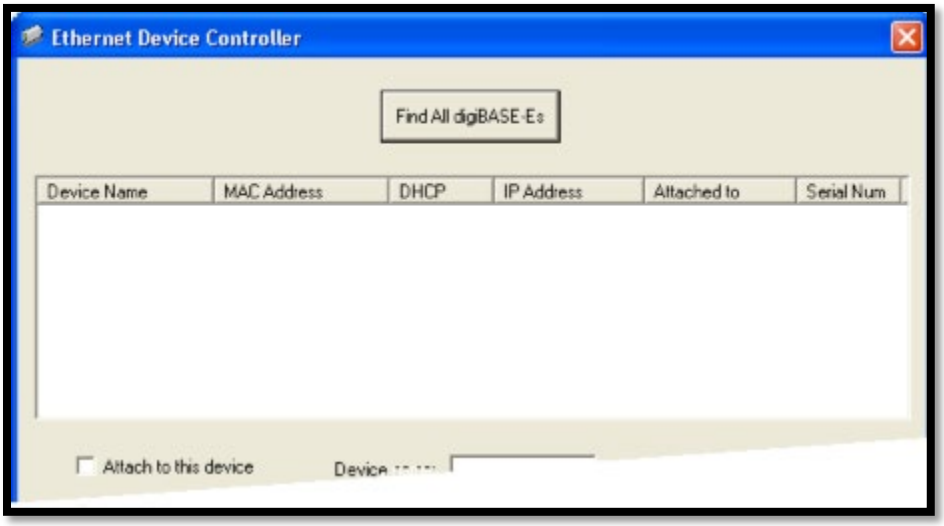

Figure 4. The Initial (Blank) Device Controller Screen

- Click on the **Find All digiBASE-Es** button. Within 10–20 seconds, the screen will update with all located (powered on) digiBASE-Es. Figure 5 shows a device controller window displaying three digiBASE-Es.

- Click on the digiBASE-E users wish to control from this PC, then mark the **Attach to this device** checkbox and confirm that it is desired to attach. Users must then decide on IP addressing for this unit; see Section 2.3.4.1 for details. Repeat for each digiBASE-E it is desired to use.

NOTE	If another user(s) has already attached to this digiBASE-E, a message box will appear as notification. See the note in Section 2.4 about multi-user access.

- When the user has attached to each digiBASE-E and is satisfied with the IP addressing for each, click on the **Save** button to save this configuration to the PC, then click on the window's **Close** (×) icon. The final step will be to run the MCB Configuration program, as discussed in Section 2.3.5.

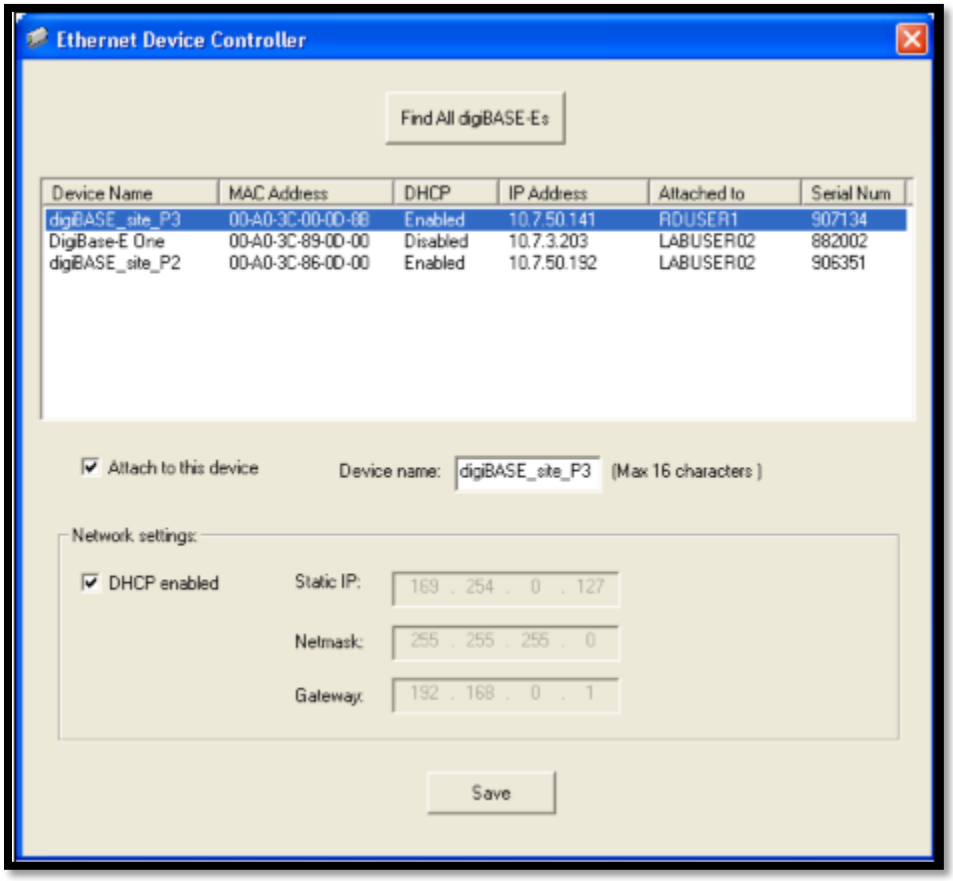

Figure 5. Three digiBASE-Es detected

Note that in the above image the highlighted unit is attached to the PC (“Attach” checkbox is marked).

2.3.4.1 IP Addressing – Dynamic vs. Static

The Ethernet Device Controller program gives users two ways to establish an IP address for the digiBASE-E:

- Automatic assignment of a dynamic IP address by the network’s Dynamic Host Configuration Protocol (DHCP) server.
- Manual assignment of a static IP address.

Dynamic

It is recommended to use the DHCP option, where available, because it is simplest and least prone to address incompatibility issues. If one or more powered-on digiBASE-Es are connected to a network with a DHCP server, it will assign each digiBASE-E a dynamic IP address. Then when users run the digiBASE-E Ethernet Device Controller software, they can choose to accept the assigned address for each instrument or unmark the **DHCP** checkbox to switch to the manual option.

Static

If assigning static IP addresses (for standalone applications or for networks without a DHCP server) consult the network administrator first. An incorrect setting in any of the IP address fields will prevent the digiBASE-E from communicating properly. ***Be sure to see Section 2.5 on moving statically addressed digiBASE-Es without incurring communication errors.***

The digiBASE-E is factory-assigned the static IP address 169.254.0.127.[3] If users connect a new digiBASE-E to a PC that does not have network access, this is the IP address seen the first time users run the accompanying digiBASE-E Ethernet Device Controller program. *Note that it can take 5 or more minutes for the PC and digiBASE-E to establish communication.* During this period, Windows will typically display an "acquiring network address" message in the lower-right corner of the screen.

If using multiple digiBASE-Es on a non-networked PC, all will initially have the same factory-default IP address. Run the Ethernet Device Controller program, then attach to and manually assign a unique IP address to each, otherwise they will not communicate correctly. (Suggestion: change the value in the fourth dot section [triad], 127, to 126 for the second digiBASE-E, 125 for the third digiBASE-E, and so on.)

IMPORTANT – READ SECTION 2.5 AND RECORD STATIC IP ADDRESSES

Section 2.5 tells how to move a digiBASE-E with a static IP address to a different network without encountering communication errors. However, if users assign the digiBASE-E a static IP address, *it is strongly recommended that users record the IP address, subnet mask, and default gateway*, and store this information where it can be retrieved. Users could need it if the instrument is moved to a network with an incompatible subnet address. (In most cases of incompatible addressing, the Ethernet Device Controller program will display the digiBASE-E's static address. However, for the cases in which the device controller program cannot read the static address, if it is not recorded and available users must contact an ORTEC representative or the ORTEC Global Service Center for assistance.)

Lease Time for IP Addresses

The digiBASE-E will retain a dynamic IP address as long as it remains connected to the network and powered on via an IEEE 802.3af device, or for the length of the IP address lease (an adjustable property of the DHCP server). If users take the digiBASE-E offline for longer than the lease time and the lease expires, users must re-run the Ethernet Device Controller program so it can acknowledge the new IP address. A digiBASE-E with a manually assigned IP address will retain that address until it is changed, regardless of connection/disconnection.

2.3.5 Step 9: Run MCB Configuration to Establish Communication with the MCBs

This is the final installation step. It establishes communication between the digiBASE-E and the ORTEC spectroscopy software. Following is an abbreviated discussion of the operation and use of the MCB Configuration program. It is strongly recommend that users read the instructions for the CONNECTIONS Driver Update Kit for complete details on customizing MCB

[3] This address falls within the Automatic Private IP Addressing range (169.254.0.0 to 169.254.255.255). See Microsoft support article 220874, *How to use automatic TCP/IP addressing without a DHCP server.*

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-E is connected and powered on as described above.

2) Connect and power on all other local and network ORTEC instruments that it is desired to use, as well as their associated PCs. 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, enter **mcb** in the "search programs and files" box, then click on 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 PC and the network and display the *Master Instrument List* of instruments found (Figure 6).

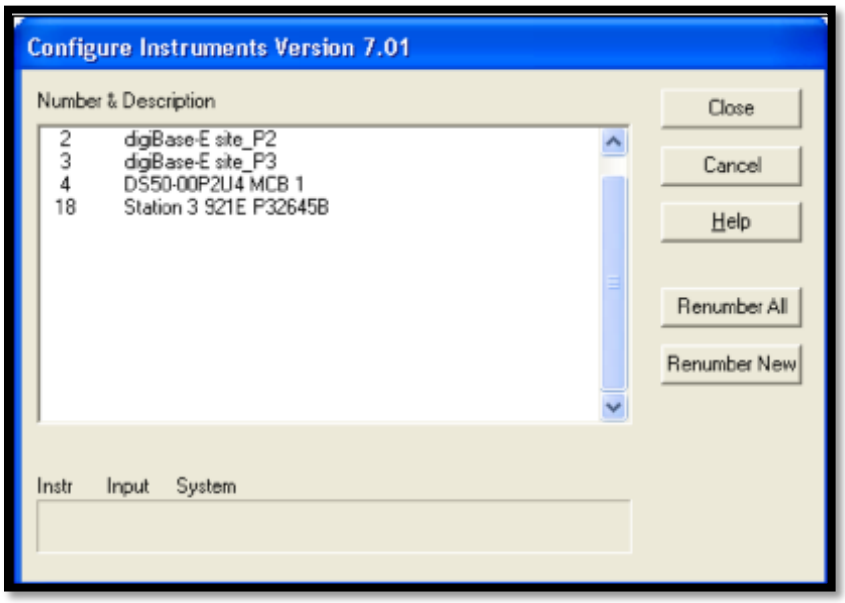

Figure 6. MCB Numbering and Descriptions

NOTE Once users have "attached" to a digiBASE-E as described in Section 2.3.4 – whether it is connected to the LAN or directly to a PC – users can use the MCB Configuration program's command line and the -L (local discovery only) flag to locate only the ORTEC MCBs that are physically connected to the PC plus any attached digiBASE-Es. See the command line discussion in the Connections Driver Update Kit instructions.

2.3.5.1 Configuring a New Instrument

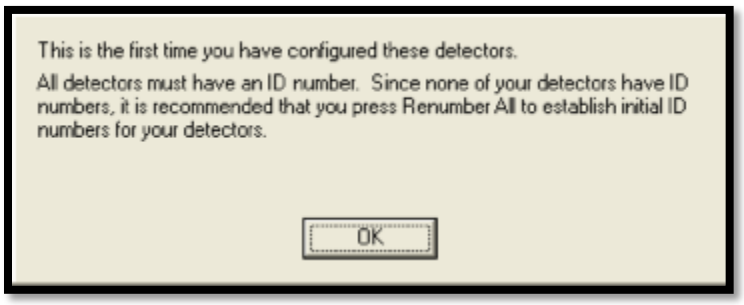

Figure 7. Assign a Non-Zero ID Number

The first time a new instrument is detected, the dialog shown in Figure 7 will be a reminder that all new instruments must be assigned a unique, *non-zero* ID number.[4] Click on **OK**.

See the CONNECTIONS Driver Update Kit for instructions on customizing ID Numbers and Descriptions, or simply click on the **Renumber New** button to renumber only the new instruments.

NOTE	It is recommended *not* using the **Renumber All** button. In addition, it is strongly recommended ***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 ORTEC GammaVision® or ISOTOPIC spectroscopy applications.

REMINDER	Be sure to run the Ethernet Device Controller program, followed by MCB Configuration, any time users attach a new digiBASE-E (or any other new ORTEC MCB) to the PC or network.

2.4 MULTIPLE USERS CAN ATTACH TO THE SAME DIGIBASE-E

As with all other ORTEC multichannel buffers, multiple users can view and control a particular digiBASE-E from different points on the network. Each user must run the Ethernet Device Controller program, attach to the digiBASE-E, then run MCB Configuration. To keep other users from changing the hardware settings and/or affecting data acquisition on a specific digiBASE-E (i.e., to limit others to read-only access), MAESTRO and other ORTEC applications have a **Lock/Unlock Detector** command on the **Services** menu.

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

2.5 MOVING A STATICALLY ADDRESSED DIGIBASE-E TO A DIFFERENT NETWORK OR PC

Moving a digiBASE-E with a dynamically assigned IP address is easy – just disconnect it from one network and connect it to another (see also the IMPORTANT note on page 10). However, if moving a digiBASE-E with a manually assigned (static) IP address to a network or PC with a different subnet address, *be sure to do the following to avoid IP address incompatibilities*:

- Before disconnecting from the current PC or network, re-run the Ethernet Device Controller program.
- For each manually addressed digiBASE-E to be moved, click to highlight the instrument and *mark the* **DHCP** *checkbox*.
- Click on the **Save** button, then close the device controller window.
- The digiBASE-E(s) is now configured to accept a new dynamic or static IP address.

If this procedure is not followed and the subnet addresses are incompatible, users will incur a series of “connection failed” errors when users run the Ethernet Device Controller program. See Section 3.2.1 for instructions on restoring connectivity.

3. USING THE DIGIBASE-E

3.1 DIGIBASE-E MCB PROPERTIES IN MAESTRO

This section discusses the hardware setup dialog seen within MAESTRO and other CONNECTIONS programs when users select the **MCB Properties...** command under the **Acquire** menu. The digiBASE-E 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 on **Close**. As users enter characters in the data-entry fields, the characters will be underlined until the cursor is moved 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 PC on the network can modify this value.

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

3.1.1 Amplifier

Figure 8 shows the Amplifier tab. This tab contains the controls for **Gain** and **Pile-up Rejection.**

Set the amplifier coarse gain to 1x, 3x, or 9x, by setting the gain jumper described in Appendix A, then adjust the **Fine** gain with the horizontal slider bar or the edit box, in the range of 0.33 to 1.0. Note that, while the coarse and fine gain controls together cover an amplification range of 0.33 to 9, *only the fine gain is shown at the top of the **Gain** section on this property page.*

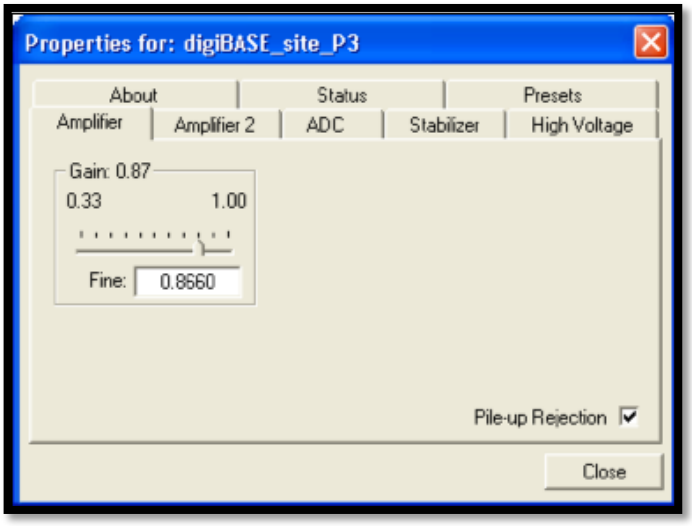

Figure 8. digiBASE-E Amplifier Tab

> **NOTE** Users must know the coarse-gain jumper setting for the unit (the factory setting is 1x). Users may wish to put a label on the digiBASE-E housing indicating the current jumper setting.

Pile-up Rejection is used to reject overlapping pulses, improving the peak shape. This checkbox allows users to disable the PUR. This feature is normally enabled and is only turned off for special detectors.

3.1.2 Amplifier 2

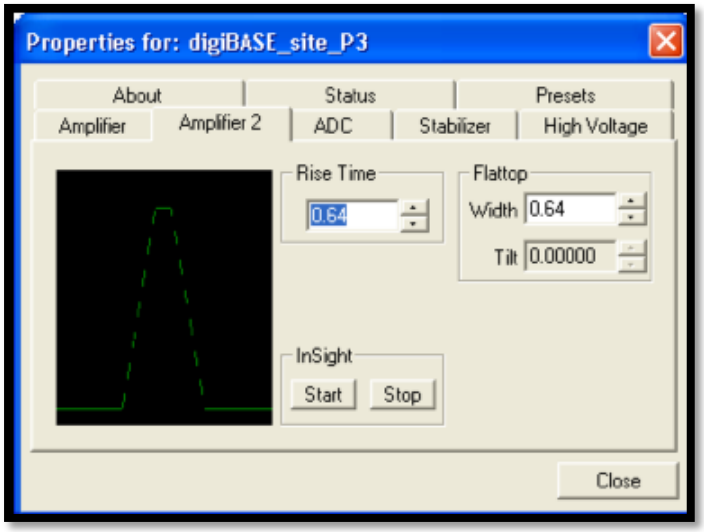

Figure 9. digiBASE-E Amplifier 2 Tab

Figure 9 shows the Amplifier 2 tab, which contains the shaping controls and accesses the InSight™ Virtual Oscilloscope mode.

The choice of **Rise Time** allows users to precisely control the tradeoff between resolution and throughput. Increase the rise time for better resolution at expected lower count rates. When unusually high count rates are anticipated, reduce the rise time for higher throughput with somewhat worse resolution.

Valid settings range from 600 ns to 2 µs in 40 ns steps. Note that the **Rise Time** setting is both the rise and fall times; thus, changing the rise time has the effect of spreading or narrowing the quasi-trapezoid symmetrically.

The **Flattop Width** adjusts the width of the top of the quasi-trapezoid from 40 ns to 2.0 µs in 40 ns steps.

The dead time per pulse is $(3\ X\ Rise\ Time) + (2\ X\ Flattop\ Width)$.

For the more advanced user, the InSight mode allows users to directly the digiBASE-E's advanced shaping parameters and adjust them interactively while collecting live data. To access the InSight mode, click on **Start**, then refer to the discussion in the MAESTRO *User's Manual*. Note that only the **None**, **PosBLDisc**, and **Peak** mark types are available; and the shaping parameter controls on the InSight sidebar are not functional.

3.1.3 ADC

This tab (Figure 10) 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.

The digiBASE-E operates at a **Conversion Gain** of 256, 512, 1024, or 2048 channels.

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

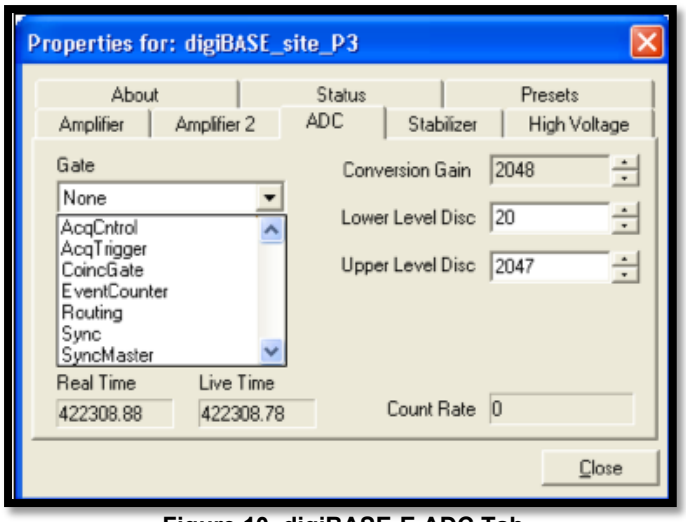

Figure 10. digiBASE-E ADC Tab

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

3.1.3.1 Gate

The digiBASE-E supports eight gate modes, but only six are useful within MAESTRO and GammaVision (the others require customer-written software).

- **None** – No gating is performed; all detector signals are processed.
- **Acq Control** – Once software initiates the data acquisition process, the actual data acquisition is in effect as long as the A input signal is high. The B output can be used to control a sample changer.
- **Acq Trigger** – Once software initiates the data acquisition process, actual data acquisition does not start until the Input A signal transitions from low to high. Data acquisition continues until stopped by software.
- **Coinc Gate** – When Input A is low, real time and live time operate normally, but no counts are stored in memory. When Input A is high, normal acquisition occurs.
- **Event Counter** – Input A acts as a 32-bit (rising-edge) event counter for LVTTL pulses. The contents of the counter can be monitored on the Status tab (Section 3.1.7). To clear the counter, click on the **Clear Spectrum** button on the MAESTRO toolbar or issue **Acquire/Clear**.
- **Routing** – If Input A is high, the spectrum histogram data are routed to an alternative data memory. Otherwise, the data are handled as a regular spectrum histogram. Currently, there are two ways to access the data in the alternative data memory; these are discussed in Section 2.2.

3.1.4 Stabilizer

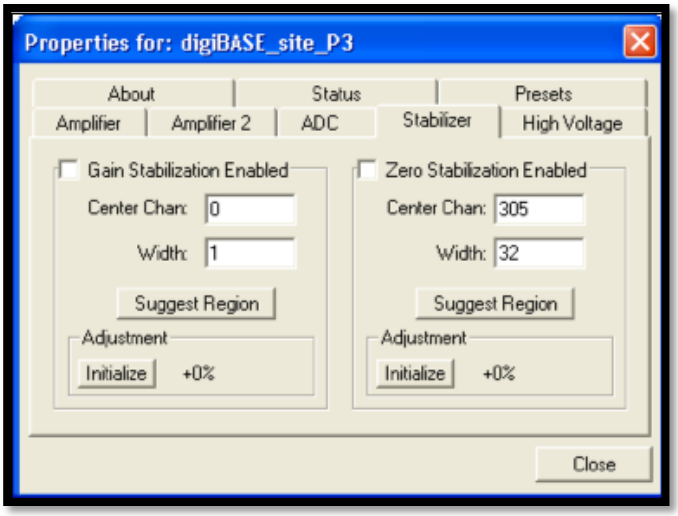

Figure 11. digiBASE-E Stabilizer Tab

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

The stabilizer tab (Figure 11) 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.

3.1.5 High Voltage

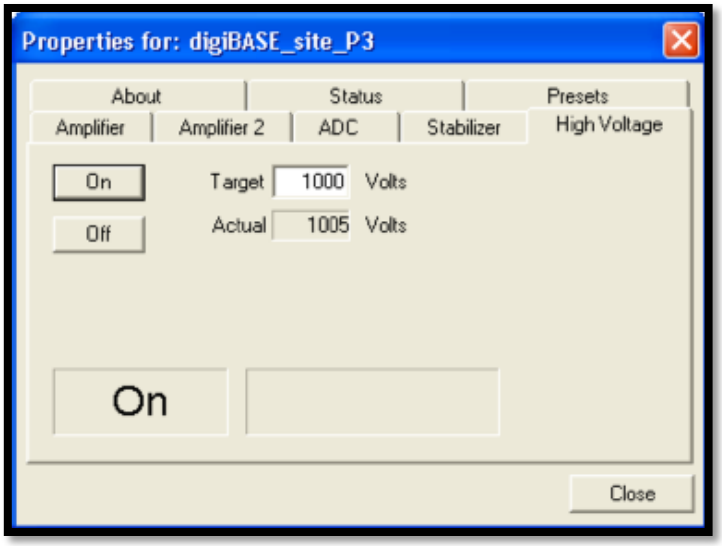

Figure 12. digiBASE-E High Voltage Tab

Figure 12 shows the High Voltage tab, which allows users to turn the high voltage on or off; and set and monitor the voltage. Be sure to refer to the detector data sheet for the proper voltage setting.

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.

3.1.6 About

This tab (Figure 13) displays hardware and firmware information about the currently selected digiBASE-E as well as the data **Acquisition Start Time** and **Sample** description. In addition, the **Access** field shows whether the digiBASE-E 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.

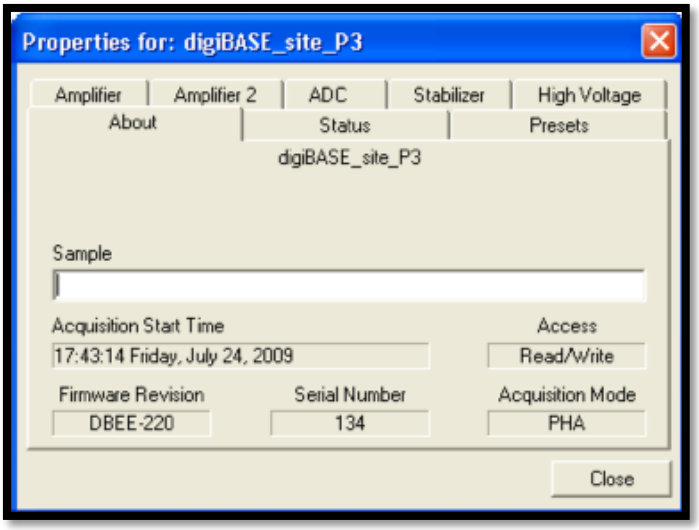

Figure 13. digiBASE-E About Tab

3.1.7 Status

Figure 14 shows the Status tab. The 32-bit **Enable Counter** functions when the **Gate** function on the ADC tab is set to **EventCounter** and the digiBASE-E is actively acquiring data in a spectrum. Under these conditions, the counter accrues the number of events at the A-IN 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.**

Users can also retrieve the counter value with the SHOW_MONI_VAL 0 firmware command.

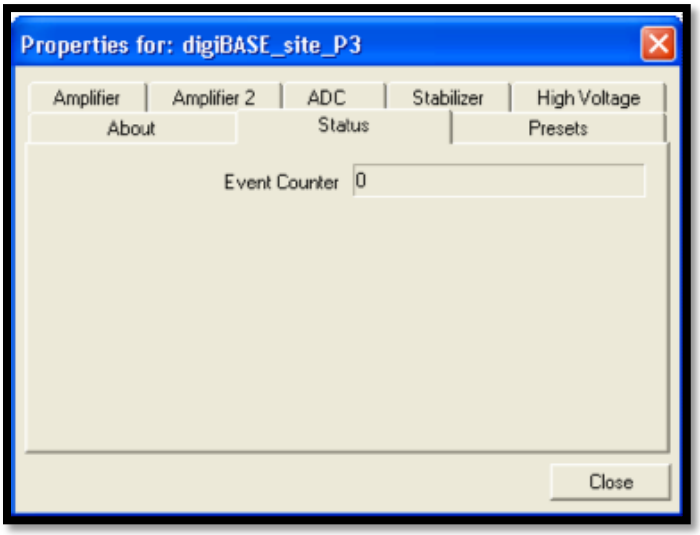

Figure 14. digiBASE-E Status Tab

3.1.8 Presets

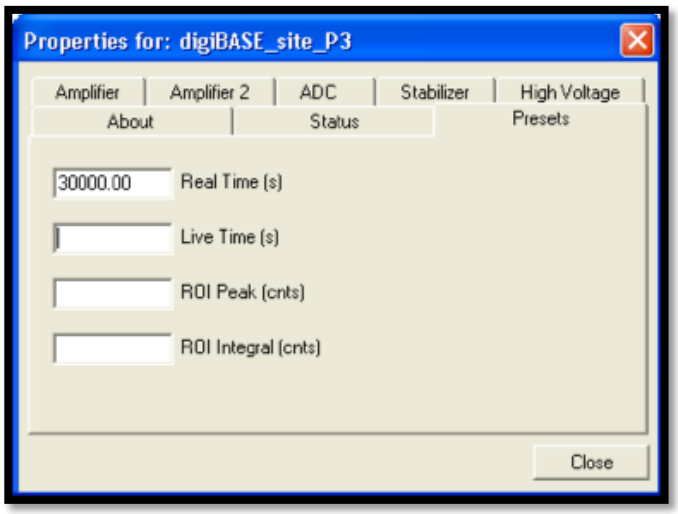

Figure 15. digiBASE-E Presets Tab

Figure 15 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. 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 users 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 vary active samples will be counted for the 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 users **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 MCA stops counting when any ROI channel reaches this value unless there are no ROIs marked in the MCA, in which case that MCA continues counting until the count is manually stopped.

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

3.2 TROUBLESHOOTING

3.2.1 Connection Failed / Socket Error (Incompatible Static IP Address)

If a digiBASE-E with a *static IP address* is moved to a different network or PC without following the instructions in Section 2.5, the IP address currently assigned to the digiBASE-E could be incompatible with the new network or PC.

Symptom: Running the Ethernet Device Controller generates a set of "connection failed" error messages and/or the Device Controller window does not display the serial number of this digiBASE-E. Attempting to mark the Attach box generates a socket error message.

Users will need the static IP address, subnet mask, and default gateway settings for this digiBASE-E, recorded per the IMPORTANT note on page 13 . In some cases, the Ethernet Device Controller program will display these settings even for an instrument with an incompatible IP address. *However, if the settings are not displayed and this information is not recorded and available, users will require assistance from an ORTEC representative or the ORTEC Global Service Center.*

- Open the Windows network connections dialog for the PC (Figure 16). Click on the LAN entry and select **Properties**. (Note that the following figures show the network dialogs for Windows XP. The screens for Windows 7 will be slightly different.)

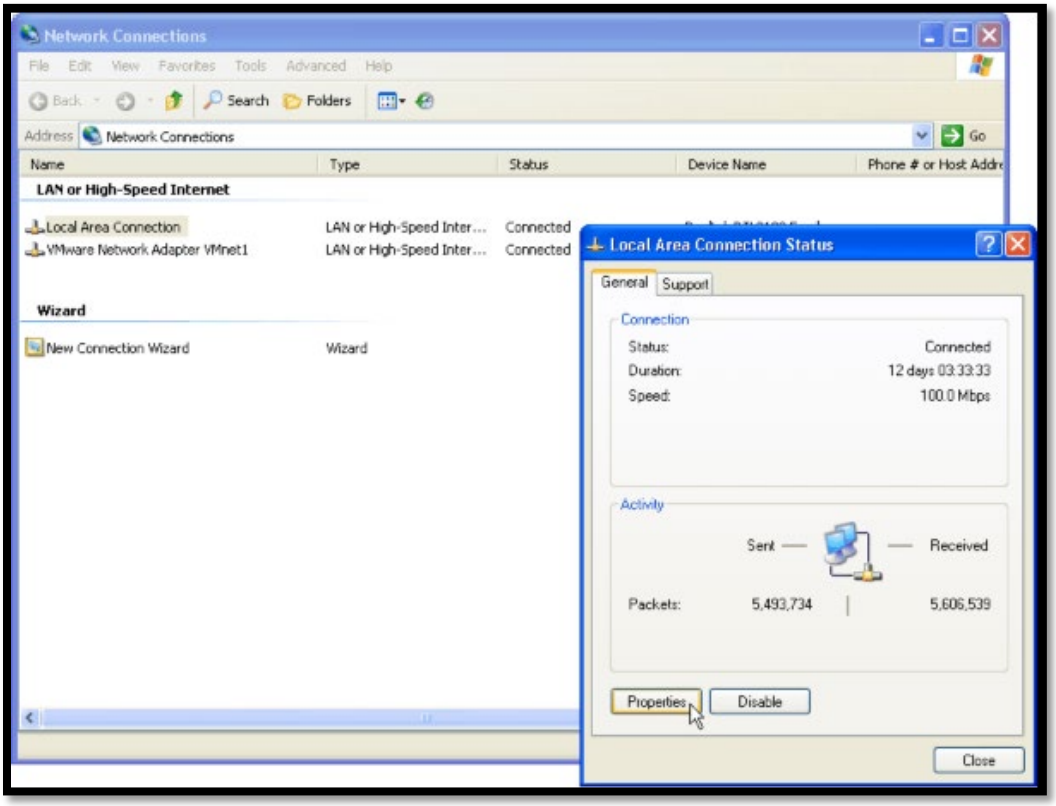

Figure 16. Access the LAN Properties for the PC

- Select the **TCP/IP** entry from the list of network protocols (Figure 17) and select **Properties**.

- Figure 18 shows the TCP/IP properties dialog. Select the **Use the following IP address** option (i.e., the option that allows users to manually enter the IP address).

- Set the first two bytes (dot address sections) of the **IP address** and the **Subnet mask** to the values recorded for the digiBASE-E; see the circled portions of Figure 18. Click on **OK**.

- Re-run the Ethernet Device Controller program. It should now locate the digiBASE-E and display its serial number without generating errors.

- Click to highlight the digiBASE-E. If users will be using the new network's DHCP server to assign an IP address, simply mark the **DHCP** checkbox, click on **Save**, and close the device controller program window.

  If manually setting the IP address, leave the **DHCP** box unmarked, enter an IP address compatible with the new network, **Save**, and close the device controller program window.

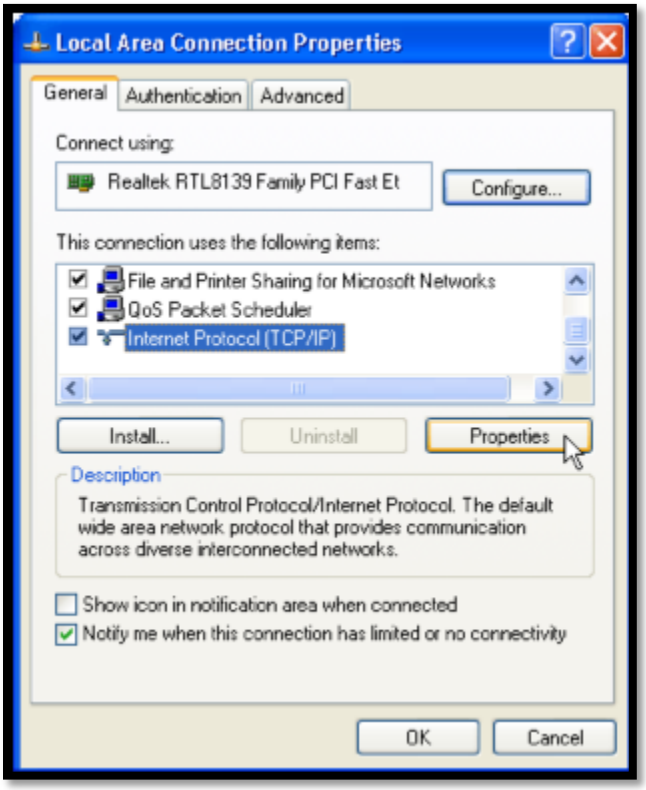

Figure 17. Select the TCP/IP Protocol

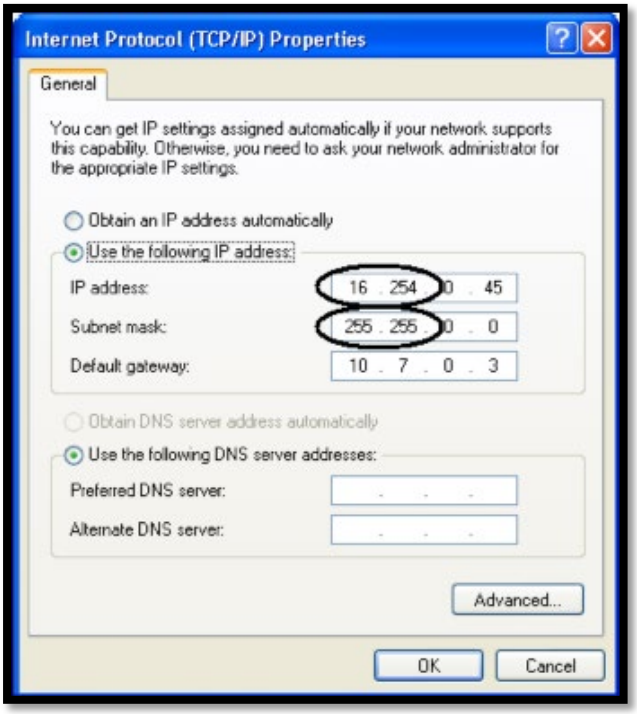

Figure 18. Manually Enter Subnet Settings Matching the digiBASE-E Settings

- Return to the PC's TCP/IP properties dialog (Figure 18) and either re-select the **Obtain an IP address automatically** setting or return the manual entry to its original IP address. Click on **OK**, then back out of the LAN properties dialogs.

- Run MCB Configuration per normal (Section 2.3.5).

- If users still cannot communicate with the digiBASE-E, contact an ORTEC representative or the ORTEC Global Service Center.

3.2.2 Cannot Communicate with MAESTRO or GammaVision

If properly installed and functioning MAESTRO software (or other Connections programs) cannot find and communicate with the digiBASE-E, or if the digiBASE-E is listed on the MAESTRO detector drop list but generates an "illegal detector!" error, check the following:

- Repeat the hardware installation instructions at the start of this chapter to ensure the digiBASE-E is properly connected to its single-port PoE injector or other IEEE 802.3af-compliant PoE switch, and to the ac power supply for the PoE injector. Also make sure the injector/switch is properly connected to an ac power supply.

- Re-run the Ethernet Device Controller software, click the **Find All digiBASE-Es** button, and make sure the program locates the digiBASE-E *by serial number*. If the IP address lease has expired, this will assign a new IP address. If the device controller program generates a connection failure and/or socket error for this digiBASE-E and fails to display the serial number, the instrument's current IP address is incompatible with the network; go to Section 3.2.1.

- Click to highlight the desired digiBASE-E then mark the **Attach** checkbox.

- Once the Ethernet Device Controller program has located the digiBASE-E and **Attach**ed to it, re-run the MCB Configuration program according to the instructions in Section 2.3.5. (See also the CONNECTIONS Driver Update Kit instructions for more detailed information on this operation.)

- If the digiBASE-E is not displayed on the Master Instrument List, shut down and restart the PC, then re-run the MCB Configuration program.

- If users still cannot communicate with the digiBASE-E, contact an ORTEC representative or the ORTEC Global Service Center.

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4. SPECIFICATIONS

4.1 PERFORMANCE

Conversion Gain 256, 512, 1024, or 2048 channels, selectable in software.

Coarse Gain Gain settings of 1, 3, and 9, controlled by jumper setting as described in Appendix A.

Gain 0.33–1.0.

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.[5]

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.

Digital Filter Shaping-Time Constants

- **Rise Time** 600 ns to 2 µs in 40 ns steps.
- **Flattop** 40 ns to 2 µs in 40 ns steps

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-E 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.

Throughput Maximum throughput with the appropriate scintillator is 196k cps with a 532k cps input rate. Note that peaking time (*Rise Time* + *Flattop*) should not be less than ~4× the light collection time of the scintillator; i.e. NaI should not be less than about ~1 µs.

List Mode Acquisition Each valid event is converted to a digital value and transmitted to the computer along with a time stamp accurate to 160 ns. See Appendix .

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

Histogram Mode Acquisition data are histogrammed within the digiBASE-E. Data channels are 31 bits. Most significant bit is ROI bit.

Spectrum Transfer Transfer of any single spectrum takes ≤15 ms. This transfer is independent of the acquisition and does not create dead time for the acquisition of additional data.

4.2 INPUTS

A-IN SMA input connector accepts LVTTL signals (+3.3 V) that function depending the **Gate** setting on the ADC tab under **Acquire/MCB Properties...** in MAESTRO; see Section 2.2. Input impedance is 1 kΩ to +3.3 V, protected to ±5 V.

B-OUT A second SMA connector with nominal 100-Ω output Z provides a bridged output for the signal provided to the A-IN input. This output provides the SyncMaster signal if this digiBASE-E is designated the SyncMaster unit as discussed in see Section 2.2.

LAN PoE RJ45 (8P8C) jack accepts Power-over-Ethernet (PoE) from the accompanying single-port injector or any other IEEE 802.3af switch.

4.3 USE WITH LANTHANUM CHLORIDE AND LANTHANUM BROMIDE DETECTORS

The latest lanthanum halide detectors are appearing with 12-pin PMTs for the smaller size (1 in. × 1 in.) crystals on 1.5 in. PMTs, and 8-stage (as opposed to 10-stage), 14-pin bases on 2 in. and 3 in. PMTs for the larger crystal sizes. If required, compatibility can be achieved through the use of adaptors. Contact ORTEC or a detector vendor for more information.

4.4 COMPUTER CONTROLS AND INDICATORS

All controls and readouts are implemented in the MAESTRO MCA Emulation Software included with the digiBASE-E. For more complex applications, such as spectrum analysis, the digiBASE-E is completely compatible with the GammaVision spectroscopy application software. Use the A11-B32 Connections Programmer's Toolkit for creating custom software.

4.5 ELECTRICAL, MECHANICAL, AND ENVIRONMENTAL

Dimensions 2.5 in. (6.35 cm) diameter × 4.7 in. (11.94 cm) length

Weight

- **Net** 0.79 lbs. (0.36 kg)
- **Shipping** ~5 lbs. (2.27 kg)

Power Requirement ≤3 watts from PoE

Ambient Operating Environment −10 to +60°C at 0-80%; non-condensing humidity.

NOTE	The digiBASE-E 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.

Synchronous Operation Up to 12 digiBASE-Es can be daisy chained with one unit assigned the SyncMaster gate mode (SET_GATE 7) and all slaves assigned the Sync gate mode (SET_GATE 6) for time correlation of ≤100 ms between all units.

4.6 FEATURE MASK BITS

The following table describes the feature bits from the SHOW_FEATURES command discussed on page 50. If the feature is supported in the digiBASE-E, the bit is set to 1; if the feature is not supported, the bit is 0.

Table 2. Feature Mask Bits

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

Bit	Meaning
25	Support for flattop optimization (ENA/DIS_OPTI)
26	Stoppable AutoPZ (STOP_PZ_AUTO)
27	Network support (e.g., DSPEC)
28	Multi-drop serial support (e.g., MicroNOMAD®)
29	Software-selectable DPM address (SET_DPM_ADDR)
30	Multiple devices (e.g., 919)
31	Software-selectable ADC gate mode (SET_GATE…)
Beginning of 2nd word	
32	Software-downloadable firmware
33	Time histogramming functions available (e.g., 9308)
34	Software-selectable lower-level discriminator
35	Software-selectable upper-level discriminator
36	MCS-mode SCA input available
37	MCS-mode positive TTL input available
38	MCS-mode fast-negative NIM input available
39	MCS-mode discriminator input available
40	Software-switchable MCS-mode discriminator edge
41	Software-programmable MCS-mode discriminator level
42	Software-programmable SCA upper and lower thresholds
43	Software-selectable MCS-mode input sources
44	Uncertainty/statistical preset (SET_UNCERT_PRES)
45	Features vary by input (SHOW_FEATURES depends on device/segment; multi-input MCBs only)
46	Software-selectable HV shutdown mode (SET/SHOW/VERI_SHUT)
47	Software-selectable shaping time constants (SET_SHAP)
48	Explorable shaping time constants (SHOW_CONFIG_SHAP)
49	Advanced shaping time (SET_SHAP_RISE, SET_SHAPE_FLAT, etc.)
50	Software-selectable BLR (ENA/DIS/SHO_BLR_AUTO SET/SHO/VERI_BLR)
51	SHOW_STATUS command supported (returns $M record)
52	Overflow preset (ENA/DIS/SHO_OVER_PRES)
53	Software-enabled, MicroNOMAD-style audio clicker (ENA/DIS_CLICK)
54	Software-readable thermistor (SHOW_THERM)
55	Floating-point fine gain (SET/SHO/VERI/LIST_GAIN_FINE)
56	Software-enabled pileup rejector (ENA/DIS/SHO_PUR, SET/VERI_WIDT_REJ)
57	Alpha-style HV power (SHOW_HV_CURRENT)

Bit	Meaning
58	Software-readable vacuum (SHOW_VACUUM)
59	Acquisition alarms (ENA/DIS/SHO_ALARM)
60	Hardware acquisition trigger (ENA/DIS/SHO_TRIG)
61	Ordinal numbers for shaping times (SET_SHAP 0, SET_SHAP 1)
62	Query gain ranges (LIST/VERI_GAIN_FINE, …_COAR, …_CONV)
63	Routable inputs (SET/SHOW_INPUT_ROUTE)
Beginning of 3rd word	
64	External dwell support (ENA/DIS_DWELL_EXT)
65	Selectable SUM or REPLACE MCS modes (ENA/DIS_SUM)
66	External start of pass support (ENA/DIS/SHO_START_EXT)
67	Explorable with MCS list commands (LIST_SOURCE, LIST_LLSCA, LIST_ULSCA)
68	Device supports the MDA preset
69	Software-selectable ADC type (Matchmaker™)
70	Has ability to daisy-chain MCBs (DART)
71	ZDT functions available (DSPEC Plus)
72	DSPEC Plus-style Insight triggering (LIST/SET_TRIG_SAMP)
73	Multiple inputs per connection (for example, OCTETE® Plus)
74	Hardware count-rate meter (SH_CRM)
75	Has multiple ZDT modes (SET/SHOW/LIST_MODE_ZDT)
76	Has multi-nuclide MDA preset
77	Has MCS Replace then Sum mode (SET_RPLSUM)
78	Has programmable external dwell voltage capability
79	No Peak Preset feature (M^3CA and OASIS)
80	Programmable pulser (OASIS)
81	Programmable Vacuum/HV interlock (OASIS)
82	Programmable Current/HV interlock (OASIS) 0
83	Explorable Stabilizer (LIST_GAIN_ADJU, LIST_ZERO_ADJU)
84	Has programmable input impedance (MCS)
85	Advanced shaping-time feature has no CUSP (digiDART, DSPEC jr)
86	Selectable HV rise-time (SET/SHOW/LIST_HV_RISE) (SBS-60)
87	Explorable ADC_GATE settings (LIST_GATE, SET_GATE n)
88	Monitor command support (SHOW_MONI_MAX/LABEL/VALUE)
89	SMART-1 detector support (SHOW_MONI_MAX/LABEL/VALUE)
90	Nuclide report (SET/SHOW_NUCL_COEF, SET/SHOW_ROI_NUCL, …)

Bit	Meaning
91	Interactive display features such as Nuclide Report
92	Advanced stored spectra (SH_SPEC_COUNT, SET/SHOW_SPEC_ID, MOVE)
93	SET/SHOW_VIEW in MCBs with dual-port memory or printer port interfaces, LIST_VIEW in all MCBs
94	Connected to MCB via RS-232 (slow) port
95	No SET_HV_POSI, SET_HV_NEGA, ENA_NAI and DIS_NAI
Beginning of 4th word	
96	Low Frequency Rejector (ENA/DIS/SHOW_LFR)
97	Resolution Enhancer (ENA/DIS/SH_RENHANCER, SET/SHOW_RETABLE idx, val)
98	SET_MODE_RELIST for Resolution Enhancer List Mode
99	Readable Sample mode time per channel (SH_TIME_SAMPLE)
100	Adjustable Sample mode time per channel (SET/LIST_TIME_SAMPLE)
101	List Mode data streamed and formatted as in digiBASE-E
102	Supports ETP mode (ENA/DIS/SHOW_ETP)
103	List Mode data streamed and formatted as in DSPEC PRO
104	SET/SHOW/LIST_PZ using floating point microseconds
105	Risetime, flattop width and cusp not user changeable from property page
106	High Voltage not user changeable from property page
107	Coarse and fine gain not user changeable from property page
108	PZ and flattop tilt not user changeable from property page
109	LFR not user changeable from property page
110	Synch List Mode is available
111	DSPEC-PRO Auxiliary BNC input available
112	SET_DISPLAY is NOT used to select ZDT data vie
113	ID Reports (DO_ID, SHOW_REPORT, SHOW_REPO_LINES)
114	Has Neutron Detector (SHOW_CRM2 returns valid number)
115	List Mode data streamed and formatted like digiBASE-E

5. FIRMWARE COMMANDS AND RESPONSES

Software communication with the digiBASE-E takes place through the CONNECTIONS software layer. Connections is used by all ORTEC software, and the CONNECTIONS Programmer's Toolkit (A11-B32) is available for other software development.

5.1 CONNECTIONS

In CONNECTIONS, the communication consists of sending command records to the MCB API and receiving response records from the MCB API. Both command and response records consist of a sequence of printable ASCII characters followed by an ASCII carriage return. The single exception to this rule is the "#B" response record for the WRITE command, which contains binary integer numbers. All commands eventually respond with a percent response record (so named because the response begins with an ASCII percent sign "%") which signifies the completion of the command. SHOW and STEP commands respond with a dollar response record (which begins with an ASCII dollar sign "$") followed by a percent response record. The WRITE command can respond with multiple pound sign records (which begin with an ASCII pound sign "#") but eventually completes by sending a percent response record. All other commands result in a single percent response record upon completion.

5.1.1 Command Records

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 verbs, nouns, and modifiers in the command header are mnemonic words such as the verb ENABLE or the noun OVERFLOW that relate to the function performed by the MCB API when it executes the command. The first four letters of any word will always be enough to uniquely identify the word when composing commands for an MCB API. For example, the command **ENABLE_GAIN_STABILIZATION** can be abbreviated to **ENAB_GAIN_STAB**.

Numeric parameters follow the command header separated by one or more spaces. Specific commands require up to three parameters, separated by commas, which specify numeric quantities related to the operation of the MCB, such as live time or conversion gain. The command **SET_WINDOW 0,1024** has two parameters, 0 and 1024, which set the window of interest to start at channel 0 and continue for 1024 channels.

Some parameters listed in the command dictionary are considered optional and are distinguished from mandatory parameters by being surrounded by brackets in the command prototype line (e.g., **SET_WINDOW [start,length]**). Commands that have optional parameters may be sent to the MCB API without the optional parameters, in which case the behavior will be changed as explained in the command description.

An optional checksum may be added to the end of any command sent to MCB API. The checksum is a 1-byte unsigned integer sum of all of the characters in a command, treated as unsigned integers, up to and including the comma or space(s) that separates the checksum from the command. The checksum simply appears as an extra parameter added to the end of the command parameter list. For commands that do not normally have parameters, the

checksum appears as the only parameter separated from the header by one or more spaces. All optional parameters must be included in a command if a checksum is to be provided so that the checksum is not mistaken by the MCB API as a parameter. For example, the SET_WINDOW command must include the two optional parameters, start and length, if the checksum is provided (e.g., **SET_WINDOW 0,1024,209**).

5.1.2 Percent Response Records

The MCB API responds to all commands with a percent response record that signifies the completion of the command. Percent response records contain two error code numbers, and a 1-byte checksum as follows:

%aaabbbccc<CR>

where % represents the ASCII % character, **aaa** represents the macro error code, **bbb** represents the micro error code, **ccc** represents the checksum and <CR> represents the ASCII carriage return character signifying the end of the record. 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. Following is a list of all percent responses for the digiBASE-E:

Unconditional Success:

%000000069<CR>	No errors detected. Command executed as specified.
%000005074<CR>	Device already started or stopped. The START or STOP command was ignored.
%000006075<CR>	Device preset already exceeded. The START command was ignored.
%000016076<CR>	START requested but amplifier not pole-zeroed since last power-up. START was attempted anyway.
%000032074<CR>	START requested but high voltage not enabled. START was attempted anyway.
%000064079<CR>	Specified parameter was rounded to the closest legal value.

Note that the above responses can be combined to indicate a combination of warnings such as:

%000048081<CR>	Amplifier was not pole-zeroed nor was high voltage enabled. The START was attempted anyway.
%000037079<CR>	Device already started and high voltage not enabled. The command was ignored.
%000053077<CR>	Device already started, high voltage not enabled, and amplifier was not pole-zeroed. The command was ignored.
%000038080<CR>	Device preset already exceeded and high voltage not enabled. The command was ignored.
%000054078<CR>	Device preset already exceeded, high voltage not enabled, and amplifier was not pole-zeroed. The command was ignored.

Power-Up Alert: Power-up just occurred and the selftest results are:

%001000070<CR>	All power-up selftest passed.
%003000072<CR>	Battery backed-up data lost.

Command Syntax Errors:

%129001082<CR>	Invalid command verb.
%129002083<CR>	Invalid command noun.
%129003084<CR>	Invalid command verb and noun.
%129004085<CR>	Invalid command modifier.
%129005086<CR>	Invalid command verb and modifier.
%129006087<CR>	Invalid command noun and modifier.
%129007088<CR>	Invalid command verb, noun, and modifier.
%129132087<CR>	Invalid command (verb, noun, and modifier valid but not together).

Communication Errors:

%130128084<CR>	Command checksum incorrect (only when optional checksum provided).
%130129085<CR>	Command record too long.

Execution Errors:

%131128085<CR>	Invalid 1st command parameter.
%131129086<CR>	Invalid 2nd command parameter.
%131130078<CR>	Invalid 3rd command parameter.
%131132080<CR>	Invalid number of command parameters.
%131134082<CR>	Invalid device or segment selected.
%131135083<CR>	Command not allowed while acquisition in progress.
%131136084<CR>	Command not allowed in current mode of operation.
%131137085<CR>	Hardware failure detected while processing command.

5.1.3 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).
$Gxxxxxxxxxxccc<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.

5.1.4 Command Catalog

This section lists each command with a description of its operation. The descriptions include a list of any unusual responses that may result. As described in previous sections, the usual response from a command is a **%000000069<CR>** response, which represents a macro error code of 0 and a micro error code of 0 (no errors).

All execution error responses, if any, are listed for each command. 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. Refer to Section 5.1.2 for information about error responses.

In the following catalog, the commands are listed in alphabetical order, each starting with a command prototype line. Upper-case letters, numeric digits, blank spaces, and special symbols such as the underscore (**_**) and comma (**,**) in the prototype line are *literal text to be sent to the MCB exactly as they appear*. Lower-case 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*. Lower-case letters enclosed in quotes represent *alphanumeric character strings* rather than numerical values. Items in the command prototype that are surrounded by square brackets “[...]” are optional items and are not always required.

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.
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

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).
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

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_NAI
Switches the stabilizers to Ge mode. See ENABLE_NAI.

DISABLE_PUR
Turns off the pulse pileup rejector. See also ENABLE_PUR.

DISABLE_THRESHOLD_AUTOMATIC
DISABLE_THRESHOLD_SAMPLE
DISABLE_TRIGGER_SPECIAL
No function in the digiBASE-E. These commands have been included for backward compatibility.

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.

ENAB_HV
Turns on the high voltage enable output of the digiBASE-E and sets the HV to the target HV value. See also DISABLE_HV and SHOW_HV.
Execution Errors:
%131137085<CR> The high voltage could not be enabled due to a high voltage shutdown condition.

ENABLE_NAI
Switches the stabilizers to NaI mode. The stabilizers use the “fine” adjustment in NaI mode and the “very fine” adjustment in Ge mode. See DISABLE_NAI.

ENABLE_PUR
Turns on the pulse pileup rejector. See also DISABLE_PUR.

ENABLE_REMOTE
No function in the digiBASE-E . This command has been included for backward compatibility.

ENABLE_THRESHOLD_AUTOMATIC
Enables automatic determination of the positive and negative thresholds. See also DISABLE_THRESHOLD_AUTO, SHOW_THRESHOLD_AUTO, SET_THRESHOLD_NEGATIVE, and SET_THRESHOLD_POSITIVE

ENABLE_THRESHOLD_SAMPLE
ENABLE_TRIGGER_SPECIAL
No function; included for backward compatibility.

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

INIT
Resets the digiBASE-E to factory defaults.

INIT_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.

INIT_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-E operates at a conversion gain of 256, 512, 1024, or 2048 channels.
Response:
GAIN_CONV 256 512 1024 2048

LIST_GAIN_FINE
Lists the valid fine-gain settings. digiBASE-E has a fine gain range between 0.33 and 1.0.
Response:
GAIN_FINE 0.33 1.00 2097152 6291456

LIST_GATE
Lists the available gate modes for the digiBASE-E. The order of the modes returned with this command determines the index number used with the SET_GATE command. See also SHOW_GATE.
Response:
GATE None AcqCntrol AcqTrigger CoincGate EventCounter Routing Sync SyncMaster

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

LIST_ROI_SAMPLE
Lists the various status bits that can be displayed in InSight mode.
Response:
ROI_SAMP <none> PileUpReject NegBLDisc BLR PosBLDisc Busy Gate PeakDet

LIST_SHAP_FLAT
Displays the valid flattop settings in microseconds.
Response:
SHAP_FLAT 0.04 2.00 1 50 Settings are 0.04 to 2.00 in 40 ns steps.

LIST_SHAPE_RISE
Lists the valid rise-time settings in microseconds.
Response:
SHAP_RISE 0.6 2.00 15 50 Settings are 0.6 to 2.00 in 40 ns steps.

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

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

RESET
Resets the digiBASE-E to the state just after power is applied. This command responds with a **%** response that indicates power-up just occurred.

RESET_REMOTE
Resets any UART error conditions when sent to the digiBASE-E via the Ethernet.

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

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 digiBASE-E 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_DISPLAY
SET_FRONT_BYP
No function in the digiBASE-E; included for backward compatibility.

SET_GAIN_ADJUSTMENT value
Sets the gain stabilization adjustment to an arbitrary value from −65535 to 65535. This adjustment is usually made only by the gain stabilizer and reset to 0 with the INITIALIZE_GAIN_STABILIZATION command. See also SHOW_GAIN_ADJUSTMENT.
Execution Errors:
%131134082<CR> The command was attempted when the currently selected device was other than device 1.

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.
Execution Errors:
%131128085<CR> The specified channel number would create a peak that was less than the minimum width (3 channels) or would be outside the device’s range.
%131136084<CR> The command was attempted while gain stabilization was enabled.

SET_GAIN_CONV value
Sets the conversion gain. The conversion gain defines the number of channels within the device that will used for spectral data. See also SHOW_GAIN_CONVERSION.
Legal Commands:
SET_GAIN_CONVERSION 0<CR> Conversion gain set to default (2048).
SET_GAIN_CONVERSION 256<CR> Conversion gain set to 256 channels.
SET_GAIN_CONVERSION 1024<CR> Conversion gain set to 1024 channels.

SET_GAIN_FINE value
Sets the fine gain to value. Value is a floating point value from 0.3333 to 1.0000. *Note that this command does not reflect the setting of the coarse-gain jumper discussed in Appendix .* See also SHOW_GAIN_FINE.
Legal Commands:
SET_GAIN_FINE 0.55 <CR> Fine gain set to 0.55.

SET_GAIN_POSITIVE
Sets the amplifier input polarity to positive.

SET_GAIN_PRESET count
No function in the digiBASE-E; included for backward compatibility.

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.
Execution Errors:
%131128085<CR> The specified number of channels would create a peak that was less than the minimum (3-channel) width or would be outside the device's range.
%131136084<CR> The command was attempted while gain stabilization was enabled.

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.
Legal Commands:
SET_GATE 0<CR> Gate modeNone.
SET_GATE 1<CR> Gate mode AcqCntrol.
SET_GATE 2<CR> Gate mode AcqTrigger.
SET_GATE 3<CR> Gate mode CoincGate.
SET_GATE 4<CR> Gate mode EventCounter.
SET_GATE 5<CR> Gate mode Routing.
SET_GATE 6<CR> Gate mode Sync.
SET_GATE 7<CR> Gate mode SyncMaster.

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

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

SET_LIVE ticks
Sets the live-time counter to the specified number of ticks. The number represents live time in units of 20 ms (50 ticks/s). Normally this value is set by the digiBASE-E during data acquisition. See also CLEAR_COUNTERS and SHOW_LIVE.
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

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.
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

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_OUTPUT value
This sends the value to the Change Sample output (B-OUT on the digiBASE-E). SET_OUTPUT 1 sets the output voltage high; SET_OUTPUT 0 sets the output voltage low. These commands are respectively equivalent to SET_OUTPUT_HIGH and SET_OUTPUT_LOW. See also SHOW_OUTPUT. See also STEP_OUTPUT.

SET_OUTPUT_HIGH [output-num]
Sets the Change Sample output to the high level. The digiBASE-E has only one sample-changer BNC, therefore, if a value for output-num is included, it must be zero (output-num is provided for compatibility with other ORTEC instruments). See also STEP_OUTPUT.

SET_OUTPUT_LOW [output-num]
Sets the Change Sample output to the low level. The digiBASE-E has only one sample-changer BNC, therefore, if a value for output-num is included, it must be zero (output-num is provided for compatibility with other ORTEC instruments). See also STEP_OUTPUT.

SET_RADIX_BINARY
Not used; included for backward compatibility.

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_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_FLAT value
Sets the width of the flattop to value. Value is in microseconds, ranging from 0.04 to 2.00 in steps of 0.04. See also SHOW_SHAP_FLAT.

SET_SHAP_RISE value
Sets the rise time to value. Value is in microseconds, ranging from 0.6 to 2.00 in steps of 0.04. See also SHOW_SHAP_RISE.

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

SET_TRUE ticks
Sets the true-time counter to the specified number of ticks. The number represents true time in units of 20 ms (50 ticks/sec). Normally this value is set by the digiBASE-E during data acquisition. See also CLEAR_COUNTERS and SHOW_TRUE.
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

SET_TRUE_PRESET ticks
Sets the true-time preset to the specified number of ticks (20 ms/tick). During data acquisition when the true-time counter reaches the preset number of ticks, the preset is complete, and the acquisition is stopped. Setting a true-time preset to 0 ticks disables the preset. The preset should always be set to a multiple of one second. See also CLEAR_PRESETS and SHOW_TRUE_PRESET.
Execution Errors:
%131135083<CR> The command was attempted while spectrum acquisition was in progress. No action was taken.

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

SET _VIEW value
Supports the digiBASE-E **Routing** gate mode. Switches the data view in the MAESTRO spectrum window between the regular histogram memory (SET_VIEW 0) and the alternative histogram memory (SET_VIEW 1). Note that this command affects only the spectrum view for the local PC. Users attached to this digiBASE-E via other network nodes will, by default, see the regular histogram memory data in MAESTRO.

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.
Execution Errors:
%131128085<CR> The start channel was higher than the conversion gain.
%131129086<CR> The length specified one or more channels that were too high conversion gain.
%131132080<CR> The start channel was specified without a length. If one value is given, the other must also be given.

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.
Execution Errors:
%131128085<CR> The specified channel number would create a peak that was less than the minimum width (3 channels) or would be outside the device's range.
%131136084<CR> The command was attempted while zero stabilization was enabled.

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
Execution Errors:
%131128085<CR> The specified number of channels would create a peak that was less than the minimum width (3 channels) or would be outside the device's range.
%131136084<CR> The command was attempted while zero stabilization was enabled.

SHOW_ACTIVE
Returns a 1 if the digiBASE-E is active (i.e., acquiring spectral data) or 0 if it is not active.
Responses:
$C00000087<CR> Not active.
$C00001088<CR> Active.

SHOW_BT
Returns the digiBASE-E's board temperature in degrees Celsius.
Responses:
$F45.50<CR> Board temperature is 45.5℃.

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-E), 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_CRM
Returns the current reading of the count-rate meter.
Response:
CRM 00000021530 Current input count rate is 21530 counts/s.

SHOW_DATA_APPLICATION "string"
If string matches "string1" in a previous SET_DATA_APPLICATION command, then string2 from that command is returned. The response is a $F record.
Execution Errors:
%131138085<CR> The specified string could not be matched.

SHOW_DET_TEMP
As of this release, functions for special-order Scionix detector with Rodan NTC thermistor 05CB102K. Returns the detector temperature in degrees Celsius.
Response:
DET_TEMP 0000026.962955

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

SHOW_FEATURES
Responds with four 32-bit masks indicating which features are present in the MCB. See Appendix A.6 for a complete description of each bit in the mask.
Example Responses:
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 for the digiBASE-E, which can be 256, 512, 1024, or 2048 channels.

Responses:

$C01024094<CR> Conversion gain reported as 2048 channels.

SHOW_GAIN_FINE

Returns the current fine gain setting (*not the coarse gain setting; see Appendix*). See SET_GAIN_FINE.

Sample Response:

GAIN_FINE 000000.44439999 Fine gain is set to 04444.

SHOW_GAIN_POLARITY

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

Responses:

$IPOS<CR> Always positive in digiBASE-E.

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. The digiBASE-E gate modes are discussed in Section 2.2. See also SET_GATE and LIST_GATE.

Example Responses:

$F0None<CR> Gate disabled.
$F1AcqCntrol<CR>
$F2AcqTrigger<CR>
$F3CoincGate<CR>
$F4EventCounter<CR>
$F5Routing<CR>
$F6Sync<CR>
$F7SyncMaster<CR>

SHOW_HV

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

$Dvvvvvsssssccc

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-E).

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:

$Dvvvvvsssssccc<CR>

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

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

Example Responses:

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

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_LIVE_REMAINING
Reports the current live-time remaining in units of 20 ms (50 ticks/s). See also SET_LIVE_REMAINING.
Responses:
$G0000000000075<CR> Live-time remaining reported as disabled.
$G0000000001076<CR> Live-time remaining reported as 1 tick.
... ...
$G4294967295132<CR> Live-time remaining reported as 4294967295 ticks.

SHOW_LLD
Shows the lower-level discriminator setting. See also SET_LLD.
Responses:
$C00050092 The LLD is 50.

SHOW_MODE
Reports 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-E 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_OUTPUT
Reports the status of the "Change Sample" output port. The output port status is reported as a 16-bit number that is 0 or 1, depending on the level last set by a SET_OUTPUT_HIGH or SET_OUTPUT_LOW command.
Responses:
$C00000087<CR> Change Sample output currently low.
$C00001088<CR> Change Sample output currently high.

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_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-E.

SHOW_SHAP_FLAT

Reports the width of the flattop in µs. See also SET_SHAP_FLAT.

Responses:

SHAP_FLAT 000000000000.64	Flattop setting 0.64 µs.

SHOW_SHAP_RISE

Displays the rise-time setting in µs. See also SET_SHAP_RISE.

Responses:

SHAP_RISE 000000000000.64 Rise time setting 0.64 µs.

SHOW_SNUM

Responds with a $F record indicating the serial number of the digiBASE-E.

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-E.
Bit 1: Bias supply overload (0=overload, 1=normal). Always 1 in digiBASE-E.
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 current true-time in units of 20 milliseconds (50 ticks per second). See also CLEAR_COUNTERS and SET_TRUE

Responses:

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

SHOW_TRUE_PRESET

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

Responses:

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

SHOW_TRUE_REMAINING

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

Responses:

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

SHOW_ULD

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

Responses:

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

SHOW_VERSION

Reports the digiBASE-E 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:

$FDBEE-220<CR> digiBASE-E firmware version 2.2 reported.

SHOW_VERS_LOGIC

Lists the FPGA firmware version.

Response:

$FFPGA version=32771

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-E.

Execution Warnings:

%000004073<CR>	No segment selected (occurs with other warnings).
%000005074<CR>	The acquisition is already started (no changes made).
%000006075<CR>	A preset was exceeded (acquisition was not started).
%000032074<CR>	High voltage is disabled.

The actual response record may be a combination of any of the above records depending on the warning conditions.

STEP_OUTPUT

Causes a pulse to be output on the Change Sample output port. The level of the Change Sample output is changed then returned to the level present when the STEP_OUTPUT command was received. The duration of the intermediate level varies but is never less than 2 µs. Use the SET_OUTPUT_HIGH or SET_OUTPUT_LOW commands to establish an initial output level.

Responses:

$C00000087<CR>	Initial and final level on Change Sample was low.
$C00001088<CR>	Initial and final level on Change Sample was high.

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-E.

Execution Warnings:

%000005074	Acquisition already stopped (no changes made).

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APPENDIX A. SETTING THE COARSE GAIN JUMPER

The digiBASE-E has 3 coarse gain settings, 1×, 3×, and 9×, determined by setting a jumper within the unit. the factory setting is 1×.[6] To change the coarse gain:

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

- Disconnect the digiBASE-E from PoE cable and wait 1 minute for the internal circuits to completely discharge.
- With a 5/16-in. wrench, remove the nut from the A INPUT and B OUTPUT connectors.
- 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 smallest of the three boards. It is labeled ANALOG BOARD and p/n 921007.
- Orient the digiBASE-E so the tube socket faces away. In this orientation, when the jumper bridges the left-most and center pins, the coarse gain is 1. When the jumper bridges the right-most and center pins, the coarse gain is 3. The gain is 9 when the jumper is removed (turned at 90° to the connector and placed on only one pin to avoid losing it). These settings are illustrated in Figure 19.
- 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 A INPUT and B OUTPUT connectors.
- *Note the new coarse gain setting for this unit. There is no software-based way to read this setting (i.e., users must remove the shroud and inspect the jumper if they are unsure of the coarse gain setting).* Users may wish to put a label on the housing noting the gain setting.

[6] Fine gain is software-controlled within MAESTRO; see Section 3.1.3.

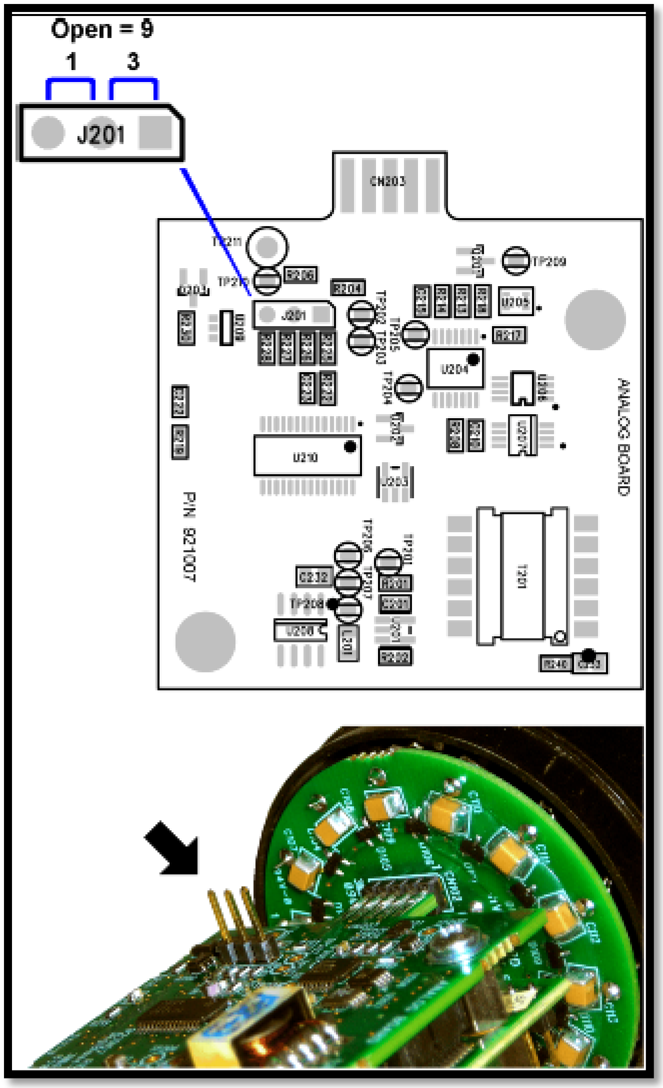

Figure 19. Setting the Coarse Gain Jumper

APPENDIX B. LIST MODE

The digiBASE-E 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 the List Mode MCBs with menu and toolbar commands, as well as commands in the 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 (A11-B32), to write a custom software application program that can collect List Mode data and write it to a disk file. If writing software for daisy-chained units that trigger off a master unit, the software must distinguish the IP address of the master unit from the slave IP addresses. Users can also contact an ORTEC representative or the ORTEC Global Service Center to obtain sample C++ code showing how to start list mode acquisition, retrieve raw data from the digiBASE-E, save the data to disk, and parse the raw data.

B.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.

List Mode data consists of 32-bit words, each comprising two 16-bit words in Little Endian format. The data is read out via the DMA channel or the HSREADDATA port. Data is formatted as follows:

Peak Data (80 ns ticks)

Data[31:30]	=	3
Data[29]	=	Memory Routing bit
Data[28:17]	=	Conversion Data[11:0]
Data[16:0]	=	RealTime PreScale [17:1]

Time Stamp (every 10 ms)
First word:

Data[31:30]	=	2
Data[29:0]	=	Realtime[29:0]

Second word:

Data[31:30]	=	1
Data[29:0]	=	Livetime[29:0]

External Sync Stamp (each 100 ms if generated from a digiBASE-E sync pulse)[7]

Data[31:30] = 0

Data[29:0] = Realtime[12:0],Prescale[17:1]; note that these are two separate entities, not a single number.

[7] This sync pulse is a time-stamp sync. Because each digiBASE-E uses its own internal clock, when operating multiple digiBASE-Es together, they tend to diverge. The sync pulse is used to correct the divergence.