Model 2016
Amplifier/TCA

User's Manual

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ISO 9001
SYSTEM
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CE

Canberra Industries, 800 Research Parkway, Meriden, CT 06450
Tel: 203-238-2351 FAX: 203-235-1347 http://www.canberra.com

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1. Introduction

The 2016 Amplifier-TCA provides the basic signal processing function for x-ray detectors used in high-rate applications such as EXAFS (Extended X-ray Absorption Fine Structure). The Amplifier provides gain, filtering, baseline restoration and ICR pulse discrimination. The TCA provides three computer controlled pulse height (energy) analyzers with selectable pileup rejector and different pulse output options suitable for counting. In addition the 2016 has a built-in multiplexing function which, under computer control, selects the amplifier output and SCA output from each of up to thirty-two 2016's in a system for routing to an MCA (multichannel analyzer) for window set up. All of this capability is in a single-wide NIM allowing large scale systems to be built compactly.

Amplifier Function

The 2016 amplifier is based on the Canberra Model 2025-2026 series of amplifiers which have been used extensively in x-ray and gamma-ray spectroscopy. The shaping time constants have been selected to enhance the throughput rate. The 2016A offers higher throughput rate while the 2016B has longer time constants needed for high resolution at lower rates and for low energy (<1 keV) applications.

Version	**Shaping (μs)**
2016A	1/8, 1/4, ½, 1, 2, 3
2016B	1/4, ½, 1, 2, 4, 6

Pulse Height Analyzer Function

The SCA function comprises three independently computer-controlled, single-channel analyzers each of which provides a logic pulse output for each input pulse falling within its preset energy window. Window settings are set using computer control over an Ethernet link to an Acquisition Interface Module (AIM). The AIM to 2016 module interface is accomplished through Canberra's Instrument Control Bus (ICB) for complete control of SCA settings and multiplexed output as described below. For convenience, the window is set symmetrically around a centroid voltage (energy) level. The module's pileup rejector, when enabled by computer, inhibits SCA outputs resulting from input signals that are distorted due to pile-up.

Multiplexer Function

The AIM also provides the Multichannel Analyzer function for set-up purposes when connected to an Analog to Digital Converter (ADC). The 2016's multiplexer function provides signal routing for set-up of each SCA window and normalization of signal levels (gain) using a multichannel analyzer. Typically the "SELECTED AMP" outputs are daisy chained to an ADC signal input and the "SELECTED SCA" outputs are daisy chained to the ADC GATE input. Then, depending on the gate mode chosen, the MCA will either accumulate or exclude only those events falling within the selected SCA window.

ICB Control

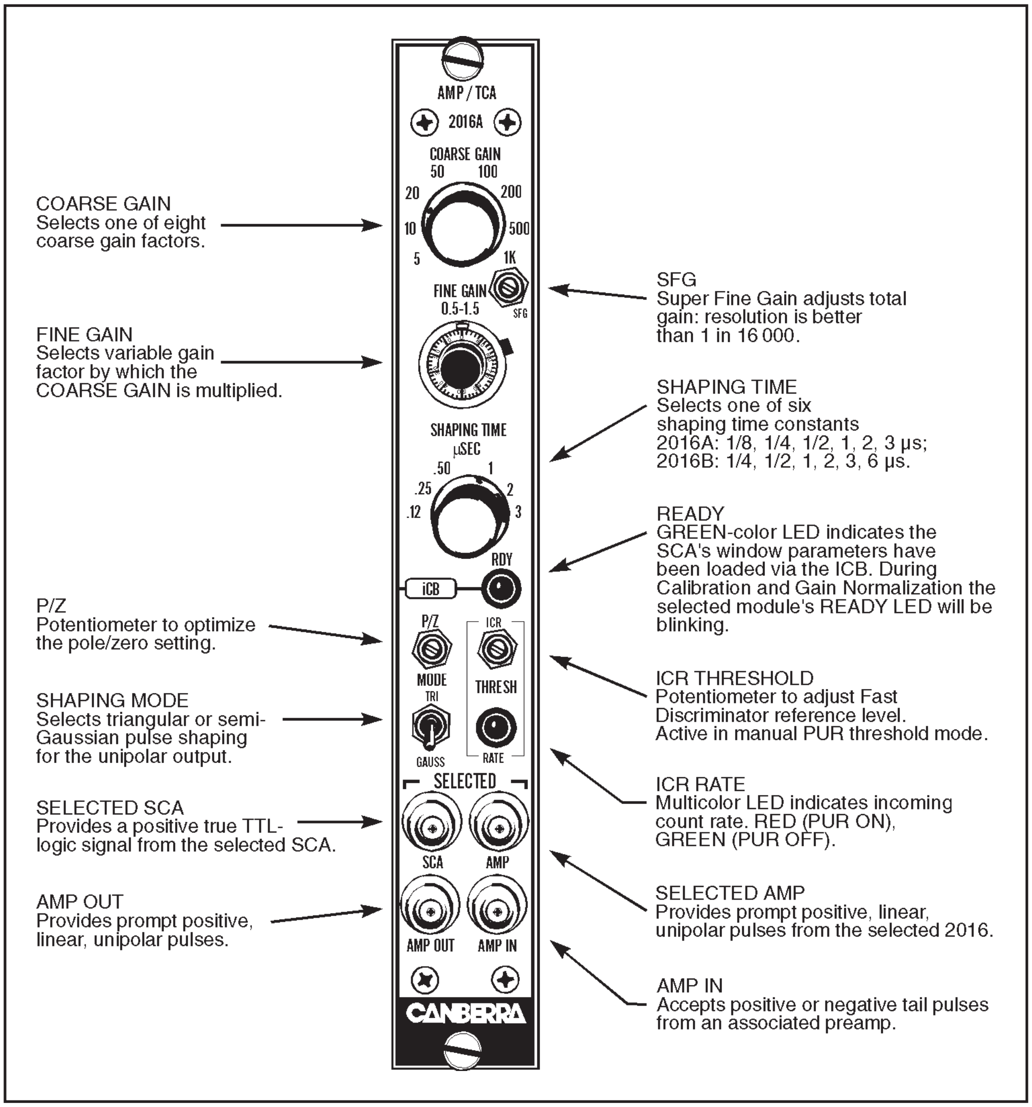
Control of SCA settings and selection of multiplexed outputs are accomplished via the ICB from an AIM. The ICB can address up to 16 slave devices from a single AIM which acts as a master. Thus, a typical 13-element detector array system will use a single AIM to address the HVPS, ADC and the required thirteen 2016 TCAs. Implementation of larger systems can be accomplished by adding more AIMs (i.e. a 30-element array will require two AIMs, 30 TCAs, one ADC and one HVPS).

Software to control the setup of the 2016 and other ICB NIM modules is available under Canberra's Genie-2000/Genie-PC and Genie-VMS software packages. Software setup is provided to control the SCA's centroid window on all three SCAs, SCA Polarity Invert, automatic or manual ICR Threshold, SCA select and PUR enable for each SCA. Additionally, the software verifies the instrument serial number and model number each time the input is opened for use.

2. Controls and Connectors

Front Panel Controls

This is a brief description of the front panel controls and connectors. For more detailed information, refer to Appendix A, *Specifications.*



COARSE GAIN
Selects one of eight coarse gain factors.

FINE GAIN
Selects variable gain factor by which the COARSE GAIN is multiplied.

P/Z
Potentiometer to optimize the pole/zero setting.

SHAPING MODE
Selects triangular or semi-Gaussian pulse shaping for the unipolar output.

SELECTED SCA
Provides a positive true TTL-logic signal from the selected SCA.

AMP OUT
Provides prompt positive, linear, unipolar pulses.

SFG
Super Fine Gain adjusts total gain: resolution is better than 1 in 16 000.

SHAPING TIME
Selects one of six shaping time constants
2016A: 1/8, 1/4, 1/2, 1, 2, 3 µs;
2016B: 1/4, 1/2, 1, 2, 3, 6 µs.

READY
GREEN-color LED indicates the SCA's window parameters have been loaded via the ICB. During Calibration and Gain Normalization the selected module's READY LED will be blinking.

ICR THRESHOLD
Potentiometer to adjust Fast Discriminator reference level. Active in manual PUR threshold mode.

ICR RATE
Multicolor LED indicates incoming count rate. RED (PUR ON), GREEN (PUR OFF).

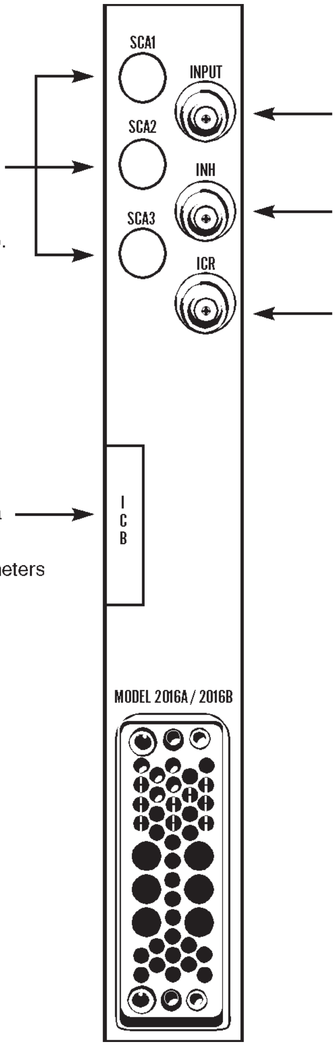
SELECTED AMP
Provides prompt positive, linear, unipolar pulses from the selected 2016.

AMP IN
Accepts positive or negative tail pulses from an associated preamp.

Figure 1 Front Panel Controls and Connectors

Rear Panel Connectors

This is a brief description of the rear panel connectors. For more detailed information, refer to Appendix A, *Specifications*.



SCA OUTPUTS
Provide a positive or negative (software selected) signal that corresponds to an event seen in each SCA energy window. SCA signal level and drive is dependent on the optional Output Driver selected (see Appendix A, Specifications).

INPUT
Accepts positive or negative tail pulses from an associated preamp.

INHIBIT
Accepts positve or negative (internally selected) standard TTL logic signal from an associated reset preamp or reset module.

ICR
Provides a positive true TTL logic signal corresponding to the input count rate.

ICB
Provides eight bidirectional data lines to and accepts the control signals from the ICB master. Control of programmable parameters is via this connector.

Figure 2 Rear Panel Connectors

Internal Controls

Amplifier Board

This is a brief description of the jumper controls on the Amplifier board; the jumpers are shown in their factory default positions. For more detailed information, refer to Appendix A, *Specifications*.

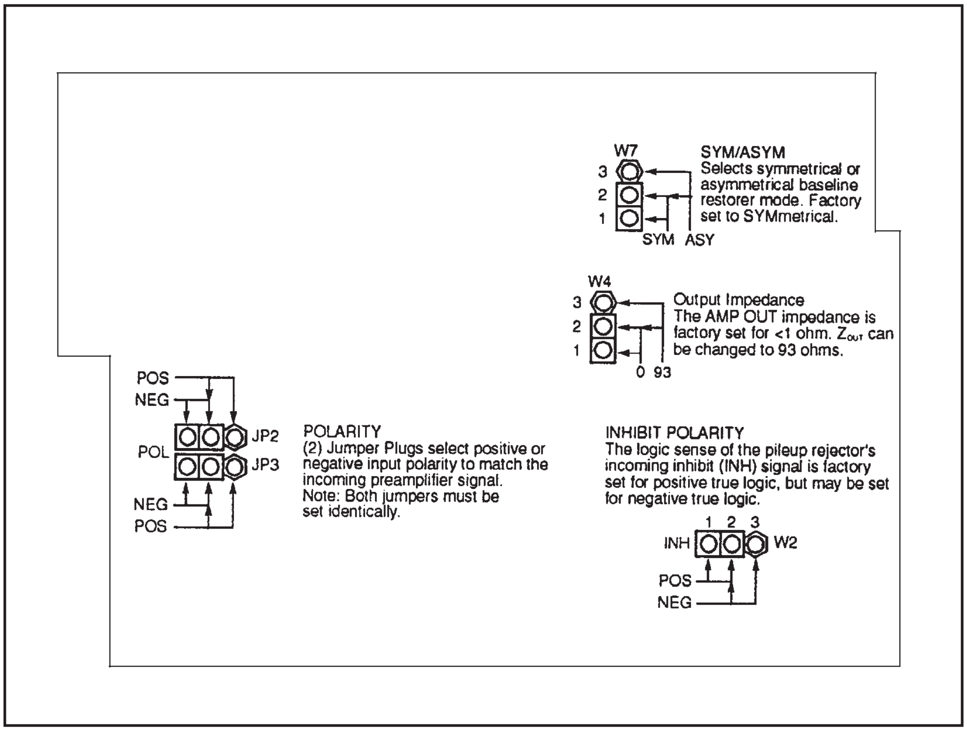


Figure 3 Amplifier Board Jumpers

TCA Board

The proper DAC voltage range is set at the factory with a jumper in position JP5 or position JP6. For proper operation of this unit, this voltage range jumper must not be moved.

There should be no jumpers installed in positions JP1, JP2, JP3 and JP4; these positions are for factory testing only.

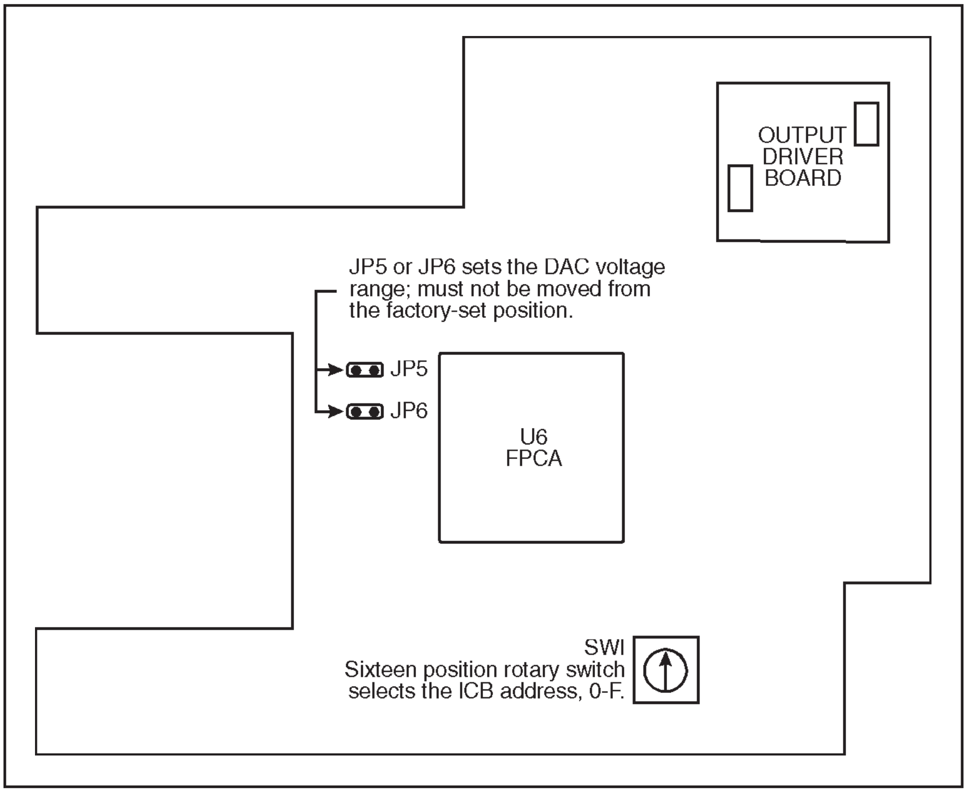


Figure 4 TCA Board Jumpers

3. Amplifier Operation

This section outlines the operation of the Model 2016 Amplifier-TCA amplifier section. Following these procedures will make you familiar enough with the instrument to be able to use it effectively in any situation.

Hardware Installation

The Canberra Model 2100 Bin and Power Supply, or other bin and power supply systems conforming to the mechanical and electrical standards set by DOE/ER-00457T will accommodate the Model 2016; the module requires ±24 V, ±12 V and ⎛6 V from the power supply. The right side cover acts as a guide for inserting the instrument. The module is secured in place by turning the two front panel captive screws clockwise until finger tight. It is recommended that the NIM Bin Power switch be OFF whenever the module is installed or removed.

The Model 2016 can be safely operated where the ambient air temperature is between 0 °C and +50 °C (+120 °F max). Perforations in the top and bottom sides permit cooling air to circulate through the module. When relay rack mounted along with other heat generating equipment, adequate clearance should be provided to allow for sufficient air flow through both the perforated top and bottom covers of the NIM Bin.

The standard cable sent with the Model 556 AIM for ICB is the C1560, which allows a total of 11 ICB modules to be controlled by the AIM within one NIM Bin. With array systems, it is desirable to control as many of the 2016 TCAs as possible with each AIM.

With a C1562 cable, the AIM can control up to 16 ICB modules, 11 in one Bin and five in a second Bin. This can be a combination of different modules or all 16 can be 2016 TCAs.

Caution Only 2016 modules are designed to operate properly in the extended Bin. Any Model 96xx ICB or Model 554 RPI must be installed in the same Bin as the Model 556 AIM (ICB Master).

Preventive Maintenance

Preventative maintenance is not required for this unit.

When needed, the front panel of the unit may be cleaned. Remove power from the unit before cleaning. Use only a soft cloth dampened with warm water and make sure the unit is fully dry before restoring power. Because of access holes in the NIM wrap, *do not* use any liquids to clean the wrap, side or rear panels.

Amplifier Setup

Before installing the 2016 in a NIM Bin, its internal controls should be set to their desired positions. When multiple 2016 TCA modules are being used, each must have a different ICB address. Figure 2.4 shows the location of SW1, which sets the module's ICB address.

For a single AIM system, the module's software address (channel number) and hardware ICB address (determined by SW1) are:

$$(\text{channel number})_{10} \doteq (\text{ICB})_{16} + 1$$

or

$$1 \rightarrow 16 \doteq 0 \rightarrow F + 1$$

When more than 16 modules are required, two AIMs are needed. The addresses from the first AIM which would also include other non-Amplifier/TCA modules, such as an ADC or HVPS, are still in the range of 1 → 16, corresponding to the ICB switch positions of 0 → F. Any non-ICB ADC (such as the Model 8715), must also be connected to the first AIM. All Amplifier/TCAs on the second AIM's Control Bus are channel numbered 17 → 32, corresponding to ICB switch positions 0 → F.

1. Insert the Model 2016 into a standard NIM Bin. Allow the total system to warm up and stabilize for approximately 15 minutes.

2. Set the Model 2016 controls as follows:

   SHAPING TIME · · · · 0.5μs

   MODE · · · · · · · · · Gaussian

   COARSE GAIN · · · · 1K

   FINE GAIN · · · · · · · 10

3. This will give approximately an 8 volt output when using a preamp with a gain of 100 mV/MeV and a ^{55}Fe radioactive source.

Preamp Fall Time Matching

Pole/zero compensation is critical when using resistive feedback preamplifiers. Pole/zero compensation must be readjusted whenever the shaping time is changed or when the 2016 is connected to a different detector. Refer to “Pole/Zero Matching” on pages 37 and 39 for instructions on adjusting the pole/zero compensation.

When a reset type preamp is used, pole/zero compensation is not required and the control must be set fully counterclockwise (infinity).

4. Operation With ADC and MCA

Figure 5 shows a typical array detector system configured for 2016 Amplifier/TCA calibration and operation. Each Preamp output is connected to a 2016 Amp Input. SCA parameters are computer controlled through the Model 556 AIM, utilizing Canberra’s Instrument Control Bus (ICB). All 2016 Selected SCA Outputs are connected to an ADC Gate Input. The 2016 Selected Amp Output is connected to an ADC Input. With the ADC configured for Delayed Peak Detect, the 2016 Selected SCA controls ADC conversion, allowing calibration of each 2016 Amplifier/TCA. When calibrating each 2016 Amplifier/TCA module, its SCA energy window is set up and SCA count analysis can begin.

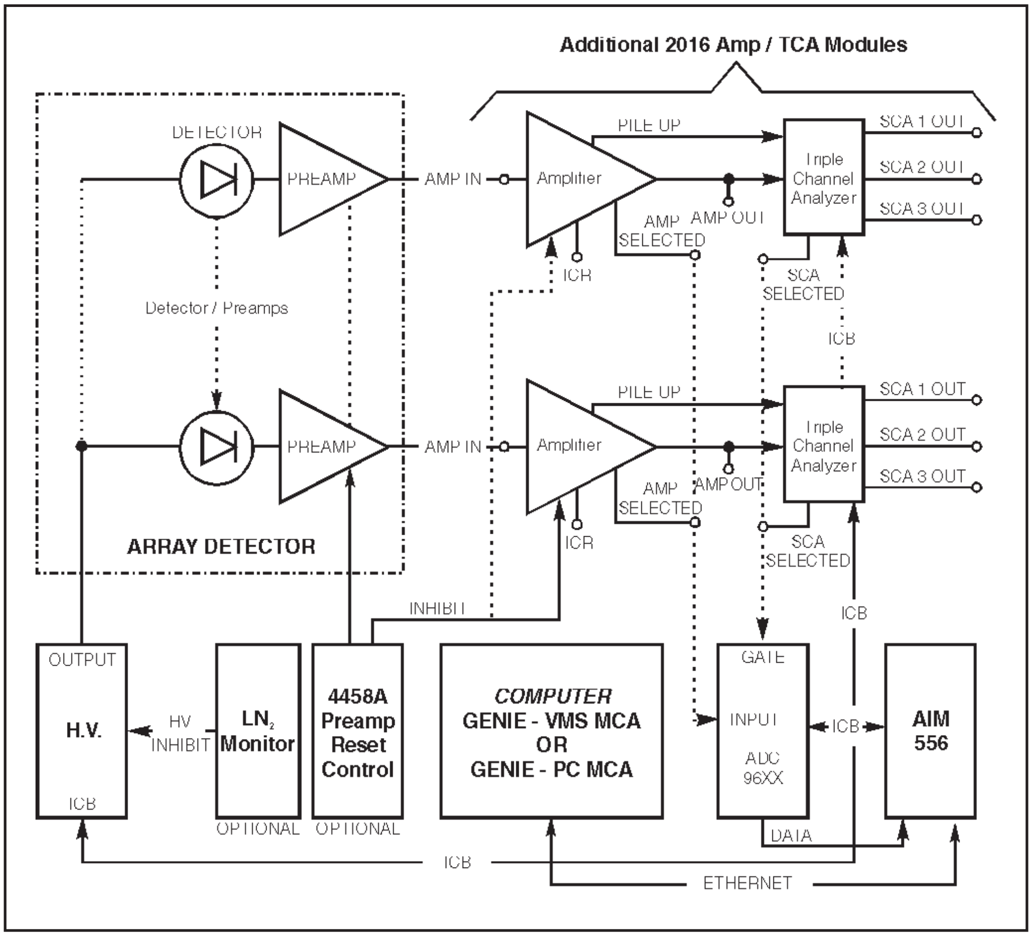


Figure 5 Typical 13-Element Array Detector System

ADC Setup

Please refer to your ADC user’s manual for specific ADC operating instructions.

Set the ADC’s GAIN and RANGE equal to the MCA memory group size. For instance, set the GAIN and RANGE to 4096 for an MCA with a 4096 channel memory size.

Set the ADC controls to:

LLD	0.02 V (fully counterclockwise)
ULD	10.5 V (fully clockwise)
Digital Offset	All Off
Peak Detect	Delayed

With a low count rate, use the ADC’s Inspect test point to set the ADC’s Peak Detect Delay to be greater than the SCA’s Output pulse. Refer to “ADC Peak Detect Adjustment” on page 44 for the procedure to be followed.

Spectroscopy Operation

Please refer to your MCA user’s manual for specific MCA operating instructions.

Start acquiring data in the MCA using the ^{55}Fe radioactive source previously placed near the detector. A spectrum should begin to appear on the MCA’s display.

Adjust the Amplifier’s GAIN so that spectrum is positioned conveniently on the display.

Use the Amplifier’s Super Fine Gain (SFG) when matching gains of other detectors, or when establishing a specific gain (energy per channel). This control provides 100 times more resolution than the Fine Gain Control.

5. Using the Genie-VMS Software

This chapter describes 2016 Amp/TCA calibration, normalization and setup using the Genie-VMS software. VMS software installation and setup is covered in “VMS Software Installation” on page 47.

Conventions

1. Each 2016 defined in the system is assigned a number, from 1 to n (this number is referred to as a channel).
2. Up to sixteen 2016 modules may be connected to each AIM.
3. 2016 numbers 1 through 16 are connected to the first AIM, 17-32 to the second AIM.
4. The ICB address of a 2016 is the 2016 number minus 1 (for example, 2016 number 1 is at ICB address 0).
5. The software is designed to accommodate a maximum of thirty-two 2016 modules per system configuration.

Starting the Genie-VMS Software

The 2016’s software is started from the Spectroscopy Assistant’s pulldown menu.

Calibration Procedure

The calibration procedure ensures that the amplifier gain and SCA windows are set so the SCA settings read directly in energy (keV). For example, the 5.9 keV x-ray peak from ^{55}Fe will be located at the centroid of an SCA window set to 5.9 keV.

It also ensures that the MCA energy calibration corresponds to the SCA. For example, MCA cursor located at 5.9 keV will be centered on an SCA window with that setting.

Performing the Calibration

1. When the detector datasources have been defined (page 48), select 2016 Amp/TCA Software from the Spectroscopy Assistant’s Applications menu.
2. Select Calibration from the next menu, as shown in Figure 6.

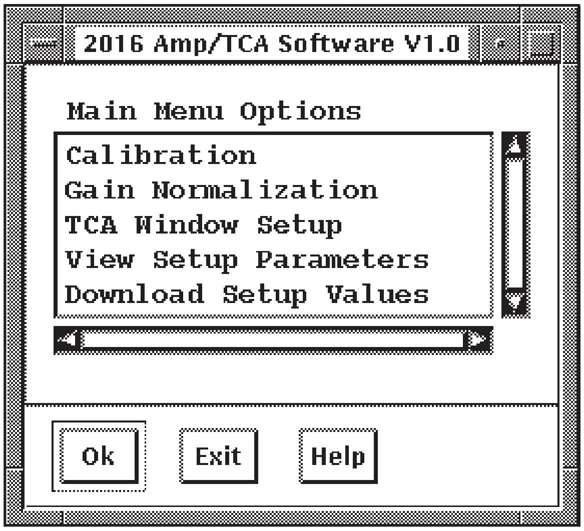
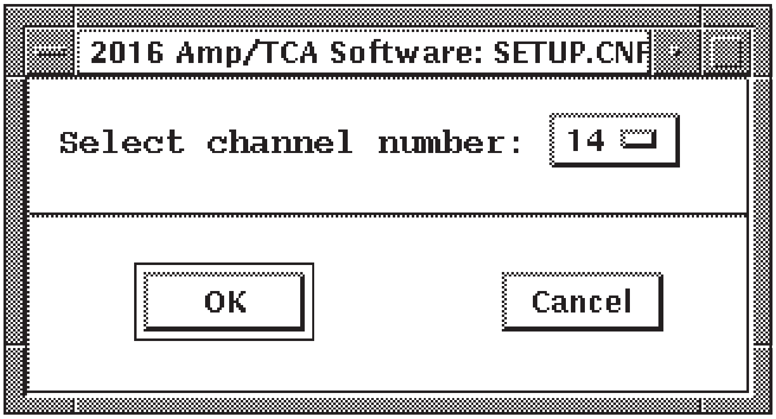


Figure 6 Starting the Calibration Procedure

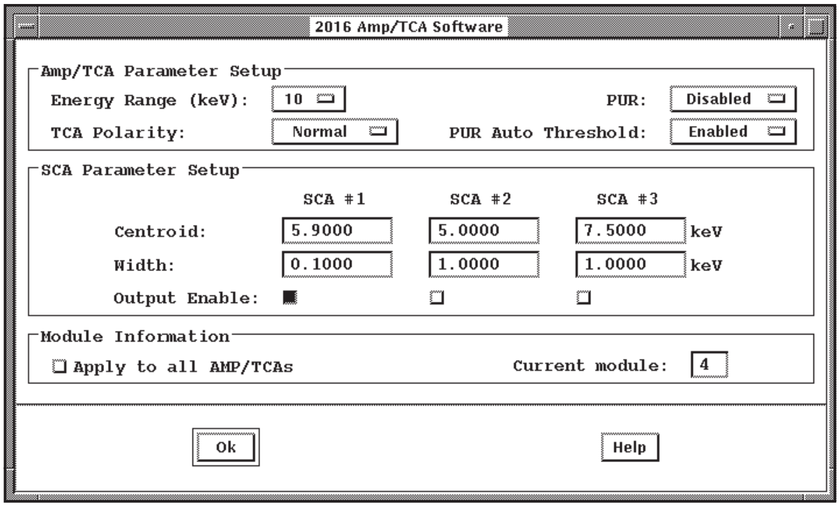
3. Now you’ll see the screen shown in Figure 7, which allows you to select the channel (that is, the specific 2016) that is to be calibrated.



Select channel number: 14

Figure 7 Selecting the 2016 to Calibrate

4. Press OK to enable the selected channel, default enable the first SCA on the selected channel, display the correct detector datasource in an MCA View Control window, reset the calibration information for the detector input, clear it and start acquisition. Now the screen shown in Figure 8 will be displayed. Adjust the selected 2016’s gain until the energies of interest are displayed in the selected SCA windows (Figure 8). The RDY LED on the selected module will start blinking.



Amp/TCA Parameter Setup

Energy Range (keV): 10

PUR: Disabled

TCA Polarity: Normal

PUR Auto Threshold: Enabled

SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	5.9000	5.0000	7.5000	keV
Width:	0.1000	1.0000	1.0000	keV
Output Enable:	■	☐	☐	

Module Information

☐ Apply to all AMP/TCAs

Current module: 4

Figure 8 Calibrating the Selected 2016's SCAs

5. Enter values (4 significant digit value between 0 and selected energy range for centroid, energy value for width) in the edit fields, then press Ok. Normally only the “primary SCA” (SCA number 1) needs to be used during Amplifier/TCA calibration. The dialog will disappear; the value(s) will be written to the selected 2016 and MCA memory cleared. If the Apply to all Amp/TCAs check box was selected, the Amp/TCA and SCA parameter adjustments will be applied to all channels (2016’s).

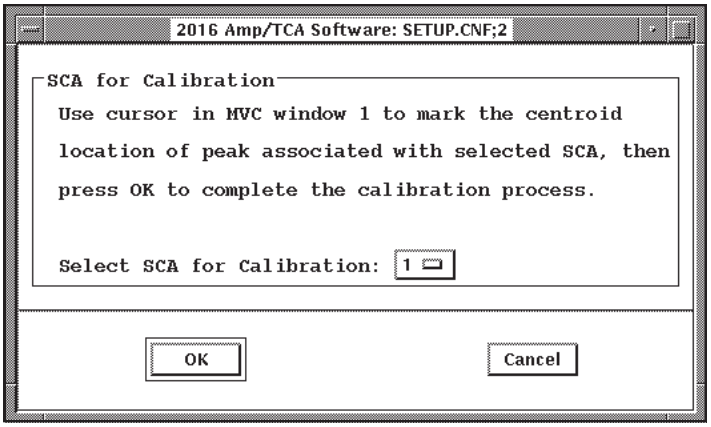
Adjust or Calibrate

When you press Ok, you’ll see a screen asking if you need to make more adjustments or if you’d rather begin the calibration process.

If ADJUST is pressed, you’ll be returned to the screen shown in Figure 8 to enter more adjustments.

If CALIBRATE is pressed, the values will be permanently stored in a setup file. You’ll now be presented with the screen in Figure 9, allowing you to choose the SCA to be used for calibration.

At this time, the software will calculate the energy calibration equation, store it into the corresponding detector input, and ask you to verify the gain normalization by looking at the MCA View Control window. Pressing OK will bring you back to the amplifier selection dialog shown in Figure 7, allowing you to select another channel (2016).



SCA for Calibration

Use cursor in MVC window 1 to mark the centroid location of peak associated with selected SCA, then press OK to complete the calibration process.

Select SCA for Calibration: 1

Figure 9 Choosing the SCA to Calibrate

6. The TCA window(s) are set for the peak energy of the calibration source (or x-ray lines). You'll manually adjust the amplifier gain until the peak of interest is in the window. Once an initial channel is calibrated, subsequent channels can simply be gain normalized (unless amplifier settings such as shaping time or energy range are different).

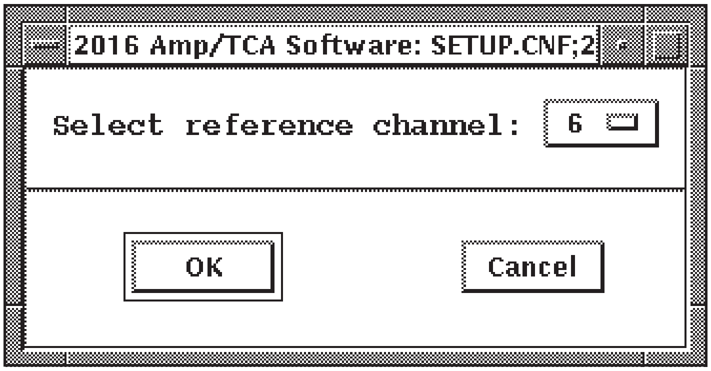
Gain Normalization Procedure

The gain normalization procedure provides for gain adjustments to ensure that the amplifier outputs from all channels are matched. Once this is done, SCA window settings can be changed by entering new values and using the "apply to all" check box to select different energies.

Performing the Gain Normalization

1. When at least one channel has been calibrated, you'll need to select the Gain Normalization procedure from the 2016 Amp/TCA Software main menu.

2. The procedure starts with the screen in Figure 7, which lets you select a channel to be gain normalized. Pressing Ok brings up the screen in Figure 10, which asks you to select a previously calibrated channel to use as the reference.



Select reference channel: 6

Figure 10 Selecting the Reference Channel

3. When the reference channel has been established, you'll be asked to position the peak of interest in the MCA View Control window. Move the MVC window's cursor to an energy of interest, then adjust the selected amplifier's gain until the peak centroid is at the cursor. Note that the software simplifies this by automatically selecting/enabling the first SCA of the selected channel, making the SCA window wide open, and causing the RDY LED on the selected module to start blinking.

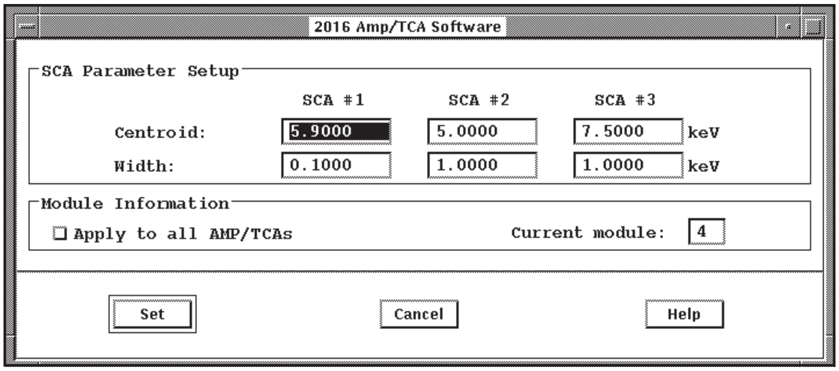
4. When the normalization is complete, press Ok to return to the screen in Figure 7 and select another channel to normalize.

TCA Window Setup

When the gain normalization is complete, you can run the TCA Window Setup procedure

1. Select TCA Window Setup from the 2016 Amp/TCA Software main menu.

2. The TCA setup proceeds as before. When the screen in Figure 11 appears, the SCA window values can be entered for the energy regions of interest on a channel by channel (or Apply to All) basis.



SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	5.9000	5.0000	7.5000	keV
Width:	0.1000	1.0000	1.0000	keV

Module Information

☐ Apply to all AMP/TCAs

Current module: 4

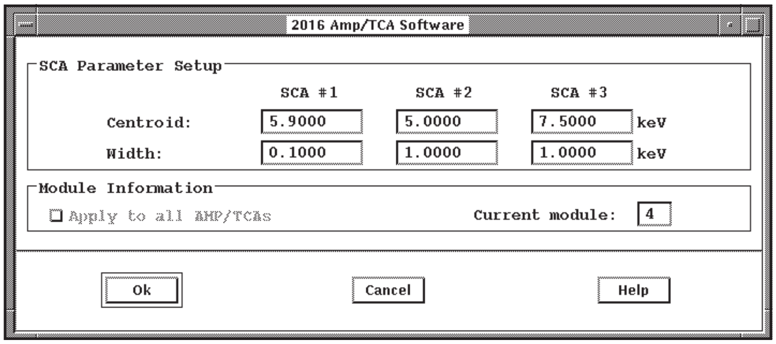
Figure 11 Setting the SCA Parameters

View Setup Parameters

This menu item lets you look at the SCA setup parameters for any 2016.

1. Select View Setup Parameters from the 2016 Amp/TCA Software main menu.

2. The procedure starts with Figure 7 and proceeds to the screen shown in Figure 12, which displays the parameters for the selected 2016’s three SCAs.



SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	5.9000	5.0000	7.5000	keV
Width:	0.1000	1.0000	1.0000	keV

Module Information

☐ Apply to all AMP/TCAs

Current module: 4

Figure 12 Viewing the Setup Parameters

Download Setup Values

This menu item lets you download setup values (as entered in the TCA Window Setup procedure, described above) to all modules. This would be used to restore settings if power was lost to any of the modules or to perform a complete system renitialization.

6. Using the Genie-PC/Genie-2000 Software

This chapter describes 2016 Amp/TCA calibration, normalization and setup using the Genie-2000/Genie-PC software. PC software installation and setup is covered in “PC Software Installation” on page 49.

Conventions

1. Each 2016 defined in the system is assigned a number, from 1 to n (this number is referred to as a channel).
2. Up to sixteen 2016 modules may be connected to each AIM.
3. 2016 numbers 1 through 16 are connected to the first AIM, 17-32 to the second AIM.
4. The ICB address of a 2016 is the 2016 number minus 1 (for instance, 2016 number 1 is at ICB address 0).
5. The software is designed to accommodate a maximum of thirty-two 2016 modules per system configuration.

Starting the Software

To run the 2016 Setup software:

Genie-2000: Click on the program item under Start | Programs | Genie-2000.

Genie-PC: Click on the program icon located in the Genie-PC folder on the desktop.

Refer to page 50 for details on defining the detector datasources; these definition must be created prior to starting the software.

Calibration Procedure

The calibration procedure ensures that the amplifier gain and SCA windows are set so the SCA settings read directly in energy (keV). For example, the 5.9 keV x-ray peak from ^{55}Fe will be located at the centroid of an SCA window set to 5.9 keV.

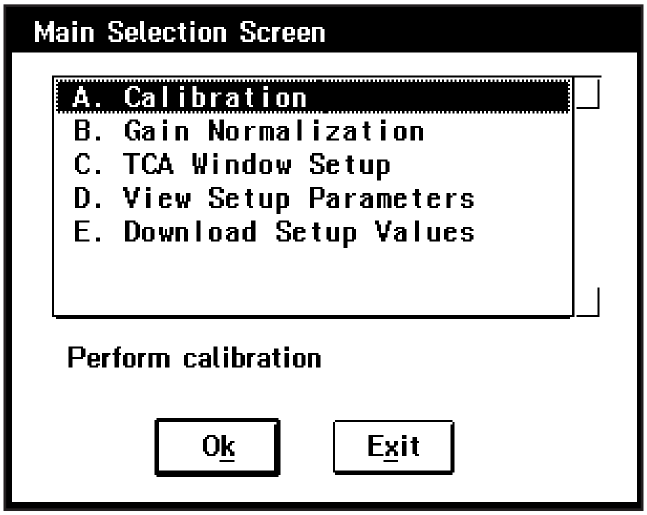
It also ensures that the MCA energy calibration corresponds to the SCA. For example, MCA cursor located at 5.9 keV will be centered on an SCA window with that setting.

Pre-Calibration Setup

Use an oscilloscope to view the amplifier output of each 2016 module; adjust the gain to give a pulse height that is approximately equal to the source energy divided by the energy range times 10 volts. For example using the 5.9 keV x-ray peak from ^{55}Fe and assuming an energy range of 10 keV, one would adjust each amplifier to (5.9 keV / 10 keV * 10 volts) which equates to about 6 volts.

Performing the Calibration

1. Select Calibration from the 2016 setup software's Main Selection Screen, as shown in Figure 13.



Perform calibration

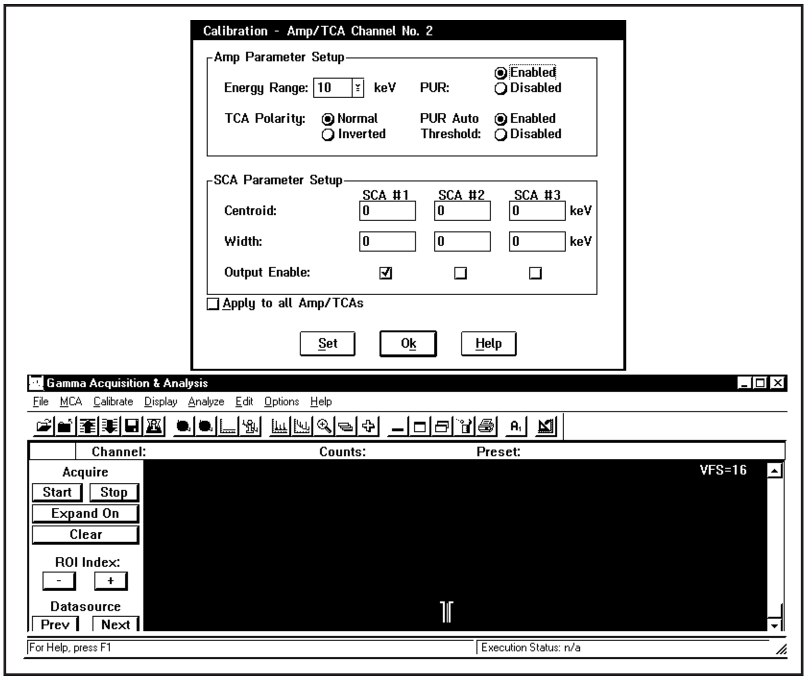
Figure 13 Starting the Calibration Procedure

2. Now you'll see the screen shown in Figure 14, which allows you to select the channel (that is, the specific 2016) that is to be calibrated.

Select channel number: 1

Figure 14 Selecting the 2016 to Calibrate

3. Press Ok to enable the selected channel (note that the RDY light will be blinking on the 2016 module selected). The Calibration screen will be displayed along with the MCA View and Control (MVC) window as shown in Figure 15.



Amp Parameter Setup

Energy Range: 10 keV

PUR: ● Enabled ○ Disabled

TCA Polarity: ● Normal ○ Inverted

PUR Auto Threshold: ● Enabled ○ Disabled

SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	0	0	0	keV
Width:	0	0	0	keV
Output Enable:	☑	☐	☐	

☐ Apply to all Amp/TCAs

Figure 15 Calibrating the Selected's SCAs

Only one SCA is needed to properly calibrate a given 2016 module; centroid/width values for all three SCA’s can be defined/adjusted later using the TCA Window Setup main menu option. Use the calibration screen as follows:

a. Set the energy range within the Amp Parameter Setup section. For example, 10keV for a range of 0 - 10keV; 20keV for a range of 0 - 20keV, etc. Choose the lowest range that covers your application's energy range of interest.

b. Within the SCA Parameter Setup section, enter the energy of the test calibration source in the centroid entry field for SCA #1 (for example, 5.894keV for ^{55}Fe).

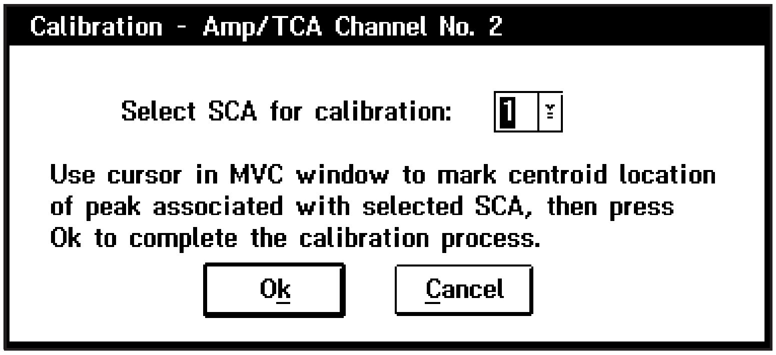
c. Next enter the desired SCA window width for SCA #1 in the width entry field. Set the window width to 2-3 times the expected FWHM detector resolution (for example, if under general operating conditions, the expected FWHM is 150eV, set the width to 0.300keV.

d. Enable the output for SCA #1 by checking the check box (this is selected by default when this screen is presented). Note also that the Apply to all Amp/TCAs check box at the bottom of the screen should not be selected at this time.

e. Press the SET button.

f. Adjust the fine gain on the selected 2016 module to center the calibration peak within the SCA window as viewed on the MVC window.

g. Once the peak has been properly centered, press the Ok button. You will now be presented with the screen shown in Figure 16. As noted on this screen, use the cursor in the MVC window to mark the peak location (centroid). When done, press Ok (make sure you have selected SCA #1).



Calibration - Amp/TCA Channel No. 2

Select SCA for calibration: 1

Use cursor in MVC window to mark centroid location of peak associated with selected SCA, then press Ok to complete the calibration process.

Figure 16 Choosing the SCA to Calibrate

h. Next the software will calculate the energy calibration equation and update the MVC window with this information. You will be asked to verify this calibration via a dialog, press Ok to complete the calibration process.

i. At this time, you will be returned to Figure 14. Select Previous to return back to the main menu; select Ok to calibration another 2016 channel. For most conditions, only one 2016 channel needs to be calibrated, the remaining channels can be setup via the Gain Normalization process (refer to next section for more details). Under certain operating conditions (primarily very short shaping times), it may be necessary to individually calibrate each channel to accommodate small differences in ADC / SCA peak detect timing.

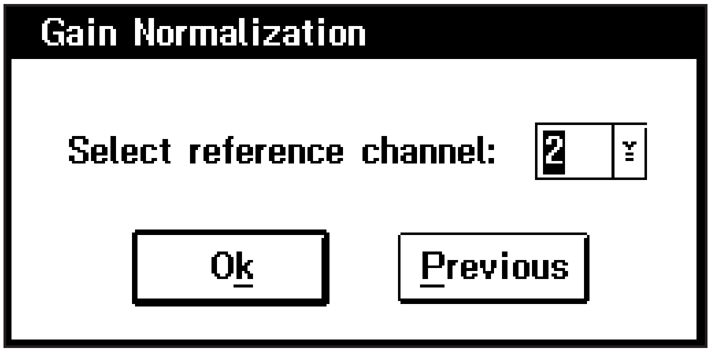
Gain Normalization Procedure

The gain normalization procedure provides for gain adjustments to ensure that the amplifier outputs from all channels are matched. Once this is done, SCA window settings can be changed by entering new values and using the “apply to all” check box to select different energies.

Performing the Gain Normalization

1. When at least one channel has been calibrated, you’ll need to select the Gain Normalization procedure from the 2016 Amp/TCA Software main menu.

2. The procedure starts with the screen in Figure 14, which lets you select a channel to be gain normalized. Pressing Ok brings up the screen in Figure 17, which asks you to select a previously calibrated channel to use as the reference.


Gain Normalization

Select reference channel: 2

Figure 17 Selecting the Reference Chanel

3. When the reference channel has been established, you'll be asked to position the peak of interest in the MCA View Control window. Put the cursor at the calibration peak energy value. (For example 5.894 keV for ^{55}Fe). Then adjust the amplifier gain until the peak centroid is at the cursor. Note that the software simplifies this by automatically selecting/enabling the first SCA of the selected channel, making the SCA window wide open, and causing the RDY LED on the selected module to start blinking.

4. When the normalization is complete, press Ok to return to the screen in Figure and select another channel to normalize.

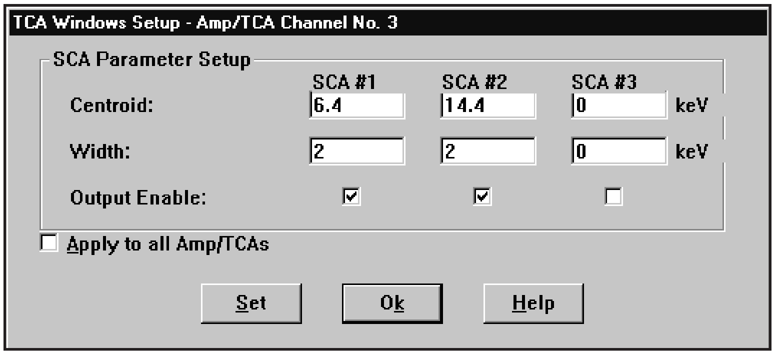
TCA Window Setup

When the gain normalization is complete, you can run the TCA Window Setup procedure:

1. Select TCA Window Setup form the 2016 Amp/TCA software main menu.

2. The TCA setup proceeds as before. When the screen in Figure 18 appears, the window values can be entered for the energy regions of interest on a channel by channel (or Apply to All) basis. Upon pressing the **<u>S</u>et** pushbutton, the dialog will disappear and the value(s) will be written down to the selected 2016 and MCA memory is cleared. If the *Apply to All Amp TCA's* check box was selected, the SCA parameter adjustments will be applied to all channels (2016s).

   Note that you can now review your selected settings and adjust them (both centroid and width) until you are satisfied that the desired data is being displayed. Continue to press the Set button while adjusting these values.



TCA Windows Setup - Amp/TCA Channel No. 3

SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	6.4	14.4	0	keV
Width:	2	2	0	keV
Output Enable:	☑	☑	☐	

☐ Apply to all Amp/TCAs

Figure 18 Setting the SCA Parameters

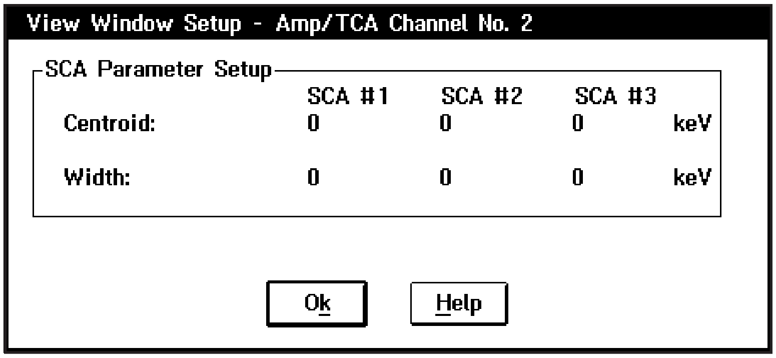
3. When the desired SCA settings are in place, press the OK button. The values will now be permanently stored in a setup file (which can be used at a later time to program the 2016 modules via the Download Setup Values main menu selection).

View Setup Parameters

This menu item lets you look at the SCA setup parameters for any 2016.

1. Select View Setup Parameters from the 2016 Amp/TCA Software main menu.

2. The procedure starts with Figure 14 and proceeds to the screen shown in Figure 19, which displays the parameters for the selected 2016's three SCAs.



View Window Setup - Amp/TCA Channel No. 2

SCA Parameter Setup

	SCA #1	SCA #2	SCA #3	
Centroid:	0	0	0	keV
Width:	0	0	0	keV

Figure 19 Viewing the Setup Parameters

Download Setup Values

This menu item lets you download setup values (as entered in the TCA Window Setup procedure, described above) to all modules. This would be used to restore settings if power was lost to any of the modules or to perform a complete system renitialization.

7. Circuit Description

Amplifier

The 2016 amplifier includes a differential input stage for polarity selection, followed by a differentiator, three low noise gain amplifier stages, three complex-pole active-filter stages (optimized for improved pulse symmetry), a gated active baseline restorer and a unipolar output amplifier providing semi-Gaussian or semi-triangular output pulse shaping. A bipolar stage is provided for SCA timing.

Input Amplifier

Gain amplifier 1 (schematic sheet 1) is a discrete low noise differential amplifier comprised of transistors Q1 through Q5, Q7, Q28 and Q29. This amplifier’s gain is selected by the coarse gain switch and relay K1 and is X1 for a coarse gain of 5 and X2 for coarse gains of 10 and higher. Polarity is selected by having the input signal drive Q29(+) or Q28 (–). The negative-going output signal provided by this stage drives the pole/zero circuit and the first differentiator.

Differentiator and Gain Stages

The input amplifier’s output signal is differentiated by C13 through C18A and resistor R25 (schematic sheet 2). The pole/zero compensation is performed by potentiometer RV3 and resistors R45 through R49 and R26. The time constants are selected by sections of the shaping switch.

The differentiated and pole/zero compensated signal is amplified by gain AMPs 2 (A1), 3 (A2) and 4 (A3) or gain AMPs 2 and 4, depending on the COARSE GAIN switch selection (schematic sheets 1 and 3). FINE GAIN and SFG (Super Fine Gain) are performed in concert with gain AMP 2 and potentiometers RV8 and RV1 respectively. The gain adjustment range of gain AMPs 2 through 4 are continuously adjustable from X2.5 to X750. Limiters in the feedback path of each amplifier eliminate op-amp saturation maintaining good overload recovery. The output signal of gain AMP 4 is normally negative and drives the FAST DISCriminator circuits and active integrators A4, A5 and A6

Gain Stage Stabilizer

A dc stabilizer (schematic sheet 2) is provided around the gain stage amplifiers to maintain the dc output at gain AMP 4 near zero volts over a wide range of temperatures and count rates. Transconductance amplifier A23 monitors the output of gain AMP 4 with respect to zero volts and generates a correction voltage that is summed in at the input of gain AMP 2. The stabilization loop time constant is determined by the transconductance current programming resistors R14 and R276 and capacitors C2 and C26 resulting in a time constant sufficiently long so as not to have an effect on the overall amplifier shaping transfer function.

Active Filters

Three active filter stages, A4, A5 and A6 (schematic sheet 4), produce complex pole pairs providing a near Gaussian pulse shape and a sharp cutoff frequency characteristic for optimal signal to noise ratio. The filter time constant is selected by the shaping switch and associated resistors and capacitors. The output signal from the third integrator is normally negative and drives the unipolar output amplifier.

Unipolar Output

The signal provided by the third complex pole integrator drives the unipolar output amplifier (schematic sheet 5) and associated driver, A8 and transistors Q21, Q22 and Q31. The unipolar output amplifier includes a single pole filter provided by feedback resistor R163 and capacitors C81 through C86; the time constant is selected by the shaping switch. For Gaussian shaping the unipolar output provides a semi-Gaussian pulse shape. However, if the triangular shaping is selected, relays K2 and K3 are activated which allow the signals from complex pole integrators A4, A5, and A6 to be summed at the input of the unipolar output amplifier, in the correct proportion, producing a semi-triangular output signal.

Baseline Restorer

The baseline restorer (schematic sheet 5) maintains the unipolar output signal baseline at ground reference, with precision, over a wide range of count rates. Transconductance amplifier A10 monitors the unipolar output signal and develops a correction voltage, having the correct amplitude and polarity, which is summed at the input of the unipolar output amplifier to reference the unipolar output signal baseline at zero volts. The baseline restorer is gated and operates only in the absence of or in between output pulses providing superior baseline control over a very wide range of count rates.

Restorer symmetry is selectable is selectable by ASYM/STM jumper plug W7. For the symmetrical restorer mode, positive and negative restoration slew rates are equal. When the asymmetrical is selected, the negative restorer slew rate is reduced substantially providing a softer restorer response for positive output signals

Restorer Gate, Auto Threshold and Auto Rate

Baseline correction (schematic sheet 6) is prevented during unipolar output signal intervals that exceed the baseline restorer threshold. Comparators A11A and A11B monitor the unipolar output signal and disable or gate off the baseline restorer for signals that exceed the automatic positive or negative threshold.

The auto baseline restorer threshold circuit, comprised of A9 and A24, peak detects the negative noise excursions of the unipolar output signal and generates a positive dc reference voltage equal to the average value of the unipolar output noise level. This voltage serves as the baseline restorer gating reference that maintains precision for a wide range of amplifier conditions and applications.

Transistors Q14, Q16, capacitor C92 and the baseline restorer gate signal (PBLR) produce a voltage reflecting the count rate (schematic sheet 5). This voltage in turn determines the correction rate of the baseline restorer.

Fast Discriminator

A Fast Discriminator circuit (sheet 6) is included to monitor the input events. This provides an output (ICR) to ratemeters as well as a visual indication of count rate given by a front panel LED. The SCA uses the output from the Fast Discriminator (FDO) to determine if multiple inputs are received during a pulse processing sequence. If pileup reject (PUR) is enabled, the SCA outputs are inhibited when pileup occurs.

The signal from AMP 4 is differentiated and pole/zero compensated before being amplified by A34. Amplifier/limiter A34 is baseline restored by transconductance amplifier and gating transistors Q36/Q37. The discriminator A21 generates a short timing pulse whenever the fast signal from A34 exceeds the threshold level.

This threshold level can be set automatically or manually by using a front panel adjustment. The AUTO threshold circuit (A20 and A22) peak detects the negative-going noise level and uses this absolute value for the threshold. Its operation is similar to the BLR threshold circuit described in “Restorer Gate, Auto Threshold and Auto Rate” on page 27.

Bipolar Amplifier and Crossover Timing

The signal from integrator stage 3 is differentiated, producing a bipolar signal at A7 (sheet 8). The shaping time constant is selected by a section of the shaping switch.

The crossover time when this bipolar signal goes negative provides a consistent reference point after the peak of the unipolar output. Comparator A37 turns this into a negative-going logic pulse for the SCA logic.

Inhibit Input

This input is usually generated during the recovery time associated with TRP or optical reset preamplifiers. During its active pulse width, the automatic threshold determining circuits, the baseline restorer and all SCAs are gated off.

Triple Channel Analyzer

Computer Controlled Logic

Computer control of the Triple Channel Analyzer (TCA) is provided by the Field Programmable Gate Array (FPGA) U6 and three dual DACs U7, U8 and U9. U6 provides the interface to the ICB and contains the registers required to hold the configuration of the SCA.

U3 is a nonvolatile RAM which contains the module Type ID and module serial number.

SW1 is a 16-position binary-encoded rotary switch which sets the module’s ICB address.

U7 through U9 are dual 12-bit serial DACs whose output are the LLD and ULD levels that determine each SCA energy window. These DACs are loaded by the FPGA with values it receives from the ICB. Each dual-DAC is loaded by sending it 24 clock pulses (SCLK) that shift in a data code on DIN; the accompanying chip select (CSn*) determines which of the three dual-DACs is loaded.

The DAC reference voltage (–3.5 volts) is obtained using a precision reference in a Zener diode configuration. Jumpers JP5, JP6 and RV1 select and adjust the DAC reference voltage.

SCA Front End

Input pulse discrimination is accomplished using six high speed comparators U10 through U15. Three precision voltage dividers in parallel split and scale the unipolar input pulse to be compatible with the DAC reference level. Comparators U10, U12, and U14 (schematic sheet 2) discriminate between the scaled unipolar signal and upper reference level (ULD) producing a TTL positive logic level when the unipolar signal is above the ULD level. U11, U13 and U15 (schematic sheet 2) discriminate between the scaled unipolar signal and lower reference level (LLD) producing a TTL positive logic level when the unipolar signal is above the LLD level.

SCA Logic

The FPGA uses the signals from the LLD and ULD comparators to determine if an input pulse satisfies any of the windows set for the three SCAs. The logic can most easily be described by the timing diagram in Figure 20. If an input causes an LLD crossing without a subsequent ULD detection before the peak is signaled, an SCA pulse can be generated.

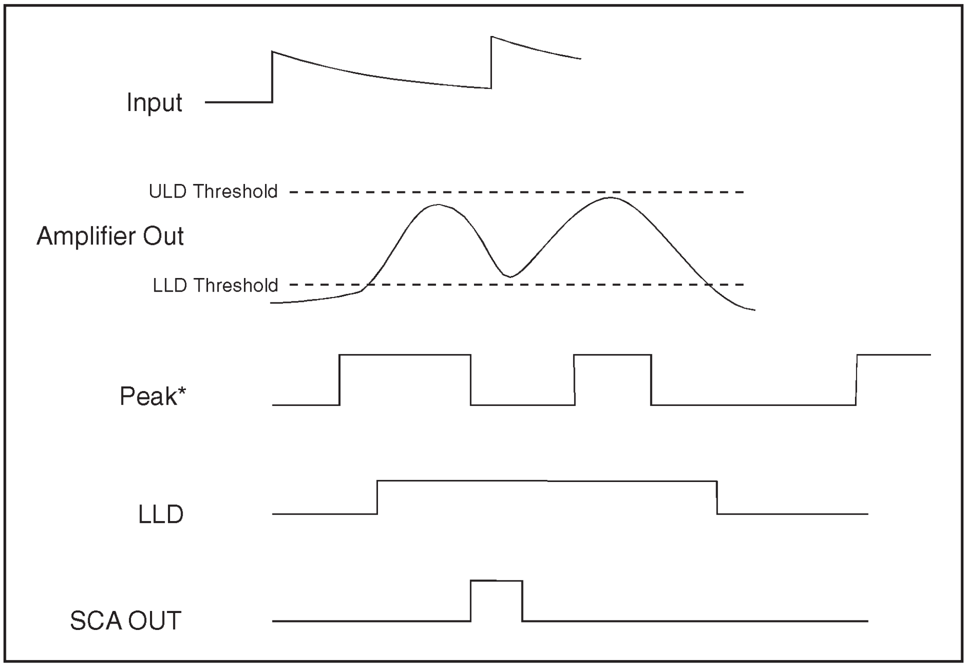


Figure 20 SCA Timing Diagram

An important point to note is that as count rates increase, it is likely that some pulses may not cause an LLD crossing because the previous pulse has not fallen below the LLD threshold; for this reason, the pulse shaping must be set consistent with the input count rate. As noted earlier, the peak signal is derived from the bipolar shaping amplifier and give a timing reference after the peak of the unipolar signal.

Pileup Rejector

As count rates increase, the possibility of peak pileup, a peak's amplitude being distorted by a succeeding pulse, increases. PUR logic, which can be enabled through the computer interface, will prevent SCA outputs if there is peak pileup. With this logic enabled, the outputs of the Fast Discriminator, and the LLD, ULD and Peak signals are used. Figure illustrates the various possibilities. As explained in the previous section, for an SCA signal to be generated, there must be an LLD crossing, then a Peak detection without a ULD. Assuming that all of the inputs meet these prior conditions:

1. Peak signals 1 and 2 will cause an SCA pulse because there was only a single Fast Discriminator pulse between them.
2. Peak Signal 3 will *not* generate an SCA pulse because more than one FDO was recorded between peaks 2 and 3.
3. Peak 4 shows the condition when multiple inputs are received but cannot be resolved by the Fast Discriminator circuits. This results in a single FDO and an SCA.

Implicit to this discussion is that the Reject logic is initialized (cleared) shortly after the PEAK* edge, as shown in the timing diagram in Figure 21.

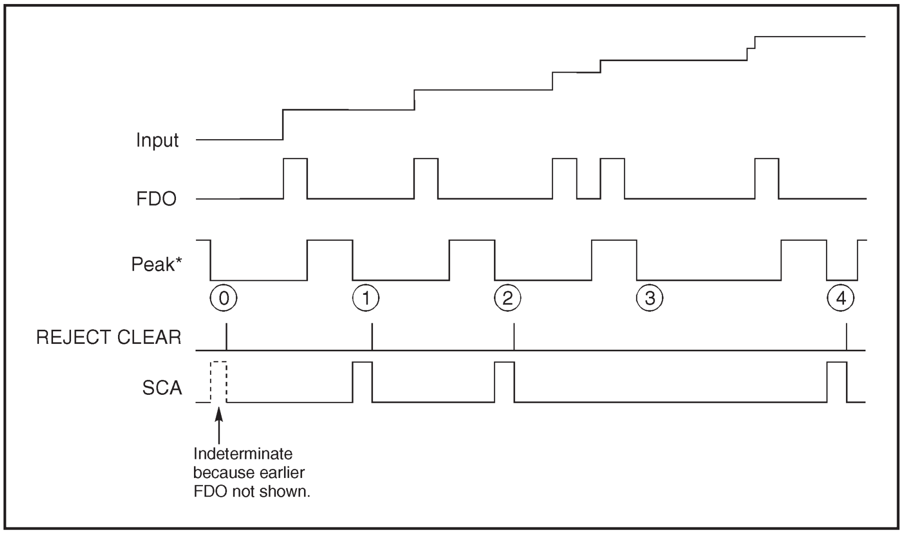


Figure 21 PUR Timing Diagram

SCA Output Drivers

The logic pulses developed in the FPGA are brought through a plug-in buffer board. Three types of boards can be inserted in the 2016:

- Fast NIM (negative pulse).
- TTL.
- TTL with 50 Ω drive.

A. Specifications

Inputs

INPUT - Accepts positive or negative tail pulses from an associated preamplifier; amplitude 10 V divided by the selected gain, 25 V maximum; rise time: less than shaping time constant; decay time constant: 40 µs to ∞; polarity set with internal jumpers; Z_{in} 2 kΩ > Z_{in} > 0.5 kΩ, depending on input POLARITY and COARSE GAIN; front and rear panel BNC connectors.

INHIBIT - Accepts a standard TTL logic signal from associated reset preamplifier; used to inhibit the SCAs and reset the pileup rejector during the preamplifiers reset cycle; positive true or negative true signal polarities, internal jumper plug selectable; loading: 4 kΩ resistor connected to +5 V for positive true or ground for negative true; rear panel BNC.

Outputs

AMP OUT - Provides positive, linear, actively filtered shaped pulses; amplitude linear to +10 V, 12 V max.; dc restored; dc level factory calibrated to 0.5 mV; Z_{out} = <1 Ω or 93 Ω, internally selectable; short circuit protected; front panel BNC.

SELECTED AMP - Provides positive computer selected, linear, actively filtered shaped pulses; amplitude linear to +10 V, 12 V max.; dc restored; output dc level factory calibrated to 0.5 mV; Z_{out} = 93 Ω; short circuit protected; front panel BNC. Computer determines if SELECTED AMP OUTPUT is active.

SELECTED SCA - Provides a standard positive TTL logic output signal coincident with computer’s selection of SCA one, two, or three; pulse width 0.1 µs, nominal; rise time and fall time <25 ns; Z_{out} = 51 Ω; 6mA drive capability for TTL high or low level; front panel BNC.

ICR - provides a standard positive TTL logic signal corresponding to input count rate; disabled by INHIBIT; positive true; width nominally 150 ns, TTL with 1 kΩ pull up resistor through 47 Ω output resistor; rear panel BNC.

SCA 1, 2, or 3

Fast NIM Option - Provides negative current output -16 mA into 50 Ω; rise time < 5 ns; pulse width <0.1 s; rear panel EPL00-250NTN LEMO connector.

TTL Option - Provides positive logic +5 V nominal pulse level; pulse width <0.1 μs; rise and fall times <25 ns; rear panel EPL00-250NTN LEMO connector.

50 Ω TTL Option - Provides positive logic +5 V nominal pulse amplitude; Z_{out} = 50 Ω; pulse width <0.1 μs; rise and fall times <25 ns; rear panel EPL00-250NTN LEMO connector.

Indicators

ICB READY - Green LED; on steadily indicates that the TCA parameters are loaded and active; blinking indicates that the selected SCA is active.

ICR RATE - Multi-colored LED; Red indicates that PUR is on; Green indicates that the PUR is off; the LED’s intensity is count rate dependent.

Pileup Rejector

PULSE PAIR RESOLUTION - 250 ns.

MINIMUM DETECTABLE SIGNAL - Limited by detector/preamp noise characteristics.

PUR Threshold - Auto or Manual Adjust mode; computer selectable.

PUR Enable - On or Off; computer selectable.

Internal Jumpers

RESTORER MODE - Two-position internal jumper selects SYMmetrical or ASYMmetrical baseline restorer modes; factory set to SYMmetrical.

POLARITY - Two 2-position internal jumpers must be set identically to select INPUT polarity; factory set to negative.

INHIBIT POLARITY - Two-position internal jumper selects INHIBIT input polarity, positive or negative true; factory set to positive.

AMP OUT IMPEDANCE - Two-position internal jumper selects Z_{out} <1 Ω or 93 Ω; factory set to <1 Ω.

Manual Controls

COARSE GAIN - Eight-position rotary switch selects gain factors of x5, x10, x20, x50, x100, x200, x500, x1000.

FINE GAIN - Ten-turn locking dial precision potentiometer selects variable gain factor of x0.5 to x1.5; resettability = 0.03%.

SFG (Super Fine Gain) - Multi-turn screwdriver potentiometer adjusts fine gain with a resolution of better than 0.0063%.

P/Z (Pole/Zero) - Multi-turn screwdriver adjustable pole/zero matching potentiometer optimizes amplifier baseline recovery and overload performance for the preamplifiers fall time constant and the amplifiers chosen shaping time; range: 40 μs to ∞.

SHAPING MODE (2016A) - Six-position rotary switch provides 0.125, 0.25, 0.5, 1, 2, and 3 μs shaping time constant.

SHAPING MODE (2016B) - Six-position rotary switch provides 0.25, 0.5, 1, 2, 4, and 6 μs shaping time constant.

ICR THRESH - Multi-turn screwdriver potentiometer adjusts PUR threshold to optimize pile-up selection; active in manual PUR threshold mode.

Computer Controls

SCA Window centroid and width; PUR enable/disable; TCA enable/disable and polarity; PUR threshold auto/manual.

Performance

GAIN RANGE - Continuously variable from x2.5 to x1500.

TEMPERATURE STABILITY - AMP OUT Gain: 0.005%/°C, dc level: 7.5 V/°C.

INTEGRAL NONLINEARITY - 0.04% over total output range for 2 μs shaping.

OVERLOAD RECOVERY - AMP OUT output recovers to within 2% of full scale output from x1000 overload in 2.5 non-overloaded pulse widths at full gain, at any shaping time constant, and with P/Z properly set.

PULSE SHAPING - Near-Gaussian or near-triangular shape; one differentiator; three active filter integrators realizing eight-pole shaping network.

RESTORER - Active gated.

SCA NONLINEARITY - <0.25% of full scale.

SCA STABILITY - <±0.005%/°C (50 ppm/°C) of full scale.

SCA RANGE - 1000:1.

SCA PULSE PAIR RESOLUTION - <250 ns using 0.125 µs shaping.

Power Requirements

+24V dc - 100 mA	+12 V dc - 175 mA	+6 V dc - 350 mA
–24 V dc - 120 mA	–12 V dc - 130 mA	–6 V dc - 200 mA

Physical

SIZE - Standard single-width NIM module 3.43 x 22.12 cm (1.35 x 8.71 in.) per DOE/ER-00457T.

NET WEIGHT - 1.5 kg (3.3 lb).

SHIPPING WEIGHT - 2 kg (4.4 lb).

Environmental

Operating Temperature Range - 0 to 50 °C.

Humidity - Up to 95% non-condensing.

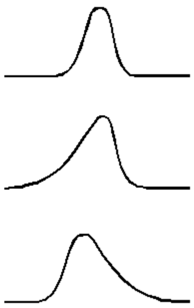
Tested to the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

Ordering Information

MODEL	SCA Output	SHAPING
2016A-1	Fast NIM Driver	0.125 µs - 3.0 µs
2016A-2	TTL	0.125 µs - 3.0 µs
2016A-3	TTL 50 Ω	0.125 µs -3.0 µs
2016B-1	Fast NIM Driver	0.250 µs - 6.0 µs
2016B-2	TTL	0.250 µs - 6.0 µs
2016B-3	TTL 50 Ω	0.250 µs - 6.0 µs

B. Performance Adjustments

At high count rates, the pole/zero (P/Z) matching adjustment (compensation) is extremely critical for maintaining good resolution and low peak shift. For a precise and optimum setting of P/Z matching, a scope vertical sensitivity of 50 mV/div should be used.



With correct P/Z, spectral peaks will appear symmetrical.

Undercompensated P/Z will produce low energy tailing.

Overcompensated P/Z will produce high energy tailing.

Higher scope sensitivities can also be used, but result in a less precise P/Z matching adjustment. However, most scopes will overload for a 10 V input signal when the vertical signal returns to the baseline. Thus the P/Z matching will be incorrectly adjusted resulting in a loss of resolution at high count rates.

When performing the following manual P/Z matching adjustments, set the scope’s vertical sensitivity to 50 mV/div and use a clamp box, such as the Canberra Model LB1502 Schottky Clamp Box, to view the unipolar signal. This will eliminate potential scope overload, and allow precise manual P/Z matching adjustment.

Pole/Zero Matching Using an Ultra LEGe Detector and ^{55}Fe.

1. Set the gain for a Unipolar Output signal of 8 to 10 volts.
2. Adjust the ^{55}Fe source count rate to be between 2 kcps and 25 kcps.
3. Using a clamp box, such as the Canberra Model LB1502 Schottky Clamp Box, observe the AMP OUT signal on the scope and adjust the manual P/Z control so that the trailing edge of the unipolar pulse returns to the baseline with no overshoots or undershoots.

Figure 22 shows the correct setting of the P/Z control. Figures 23 and 24 show under- and over-compensation for the preamplifier decay time constant. As illustrated in Figure 22, the AMP OUT signal should have a clean return to baseline with no bumps, overshoots or undershoots.

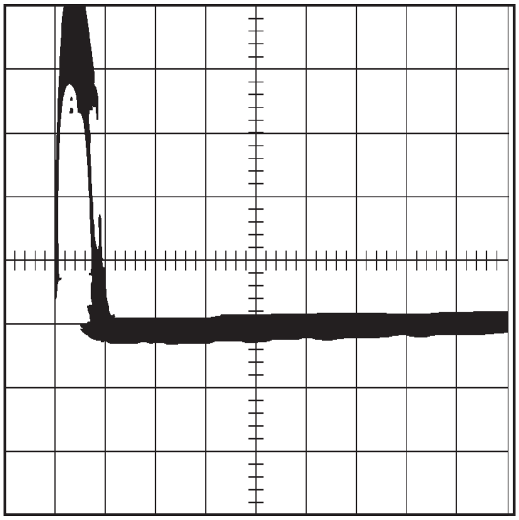


Figure 22 Correct Pole/Zero Compensation

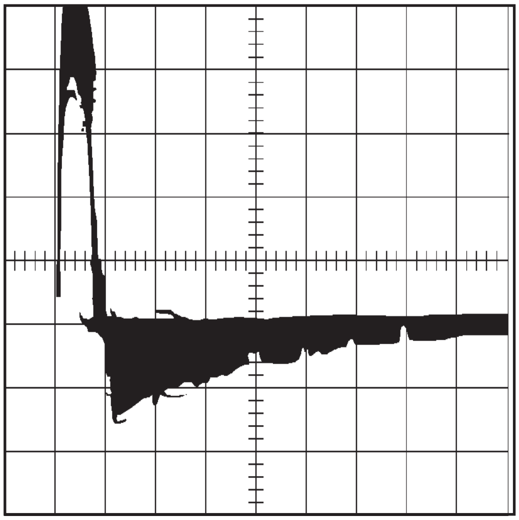


Figure 23 Undercompensated Pole/Zero

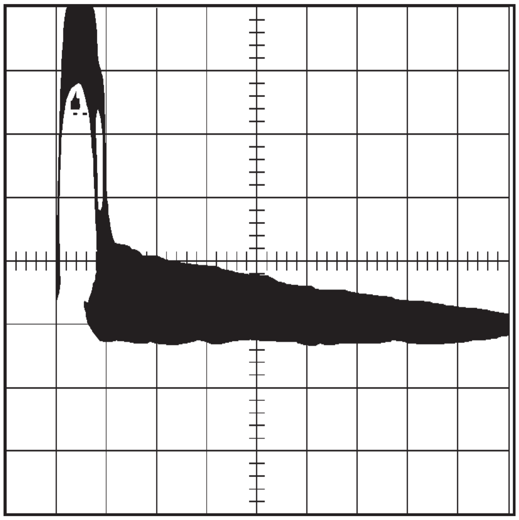


Figure 24 Overcompensated Pole/Zero

Scope
Vertical: 50 mV/div
Horizontal: 10 µs/div

Source ^{55}Fe
5.9 kev peak: 7 V amplitude
Count rate: ≈ 2 kcps
Shaping: 2 µs

Note Using a reset preamplifier the P/Z control is adjusted fully CCW. Some amplifier shapings might exhibit small undershoots. These arise primarily from amplifier shaping component tolerances and secondary time constants associated with the detector/preamp system. If an undershoot is present and is less than 20 mV, its impact on performance is insignificant. However, if small shaping undershoots are present, they should not be confused with preamp matching misadjustments undershoots, which exhibit a much longer time constant and have a larger performance impact. At high count rates, P/Z matching misadjustment will affect spectral peak shape and resolution.

Pole/Zero Matching Using a Square Wave Generator

1. Driving a preamp test input with a square wave will allow a more precise adjustment of the pol/zero matching. The square wave signal must be of good quality with a flat top and bottom.

2. The amplifier’s COARSE GAIN, SHAPING, and INPUT POLARITY controls should be set for the intended application.

3. Adjust the square wave generator for a frequency of approximately 1 kHz.

4. Connect the square wave generator’s output to the Preamp’s TEST INPUT.

5. Remove all radioactive sources from the vicinity if the Detector.

6. Using an oscilloscope, monitor the Model 2016’s AMP OUT unipolar signal. Set the scope’s vertical sensitivity to 5 V/div, and adjust the main time base to 0.2 ms/div. Adjust the square wave generator’s amplitude control (attenuator) for a AMP OUT signal of 8 V.

Note Both positive and negative unipolar pulses will be observed at the output. Reduce the scope vertical sensitivity to 50 mV/div. To prevent scope overload, use a clamp box, such as the Canberra Model LB1502 Schottky Clamp Box, and set the CLAMP/DIRECT switch to CLAMP. With the unipolar signal clamped, adjust the P/Z control as illustrated in Figure 25.

When adjusting the P/Z matching using the square wave technique, the calibration square wave generated by the oscilloscope can be used. Most scopes generate a 1 kHz square wave used to calibrate the vertical gain and probe compensation. Connect the scope Calibration Output through an attenuator to the preamp test input and perform the steps in this section again.

Figure 25 shows the correct setting of the MANUAL P/Z control. Figures 26 and 27 show under- and overcompensation for the preamplifier decay time constant. As illustrated in Figure 25, the unipolar output signal should have a clean baseline with no bumps, overshoots or undershoots.

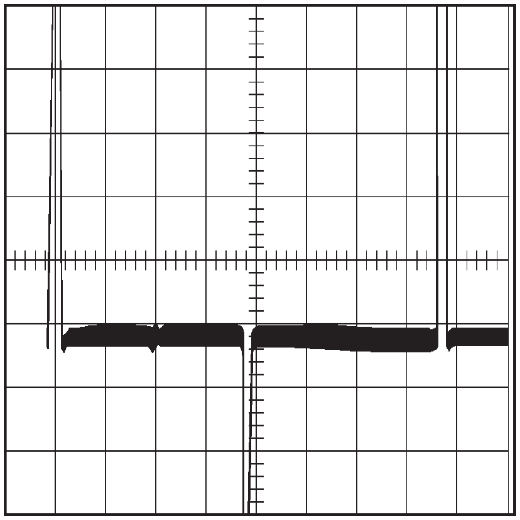


Figure 25 Correct Pole/Zero Compensation

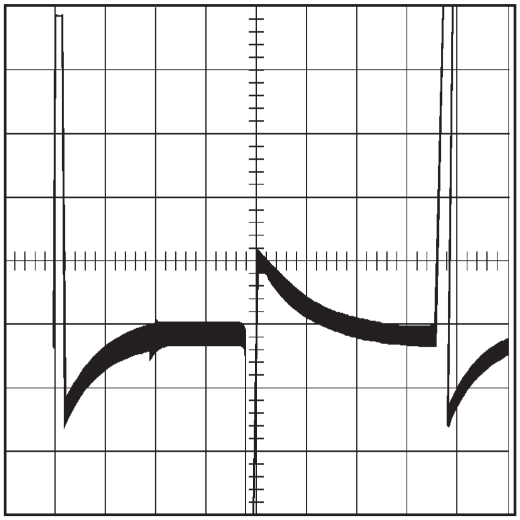


Figure 26 Undercompensated Pole/Zero

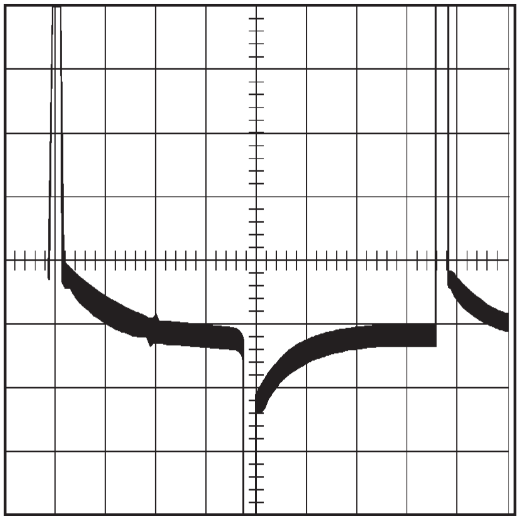


Figure 27 Overcompensated Pole/Zero

Scope
Vertical: 50 mV/div
Horizontal: 50 µs/div

Baseline Restorer Mode

The baseline restorer in the Model 2016 is flexible in that both the symmetrical and asymmetrical modes are offered. In the SYMmetrical mode, the restoration currents are identical for above and below the baseline. For the asymmetrical mode, the restorer current above the baseline (referenced to the positive output), is much less than that below the baseline.

The symmetrical restorer mode is used on Ge systems with fast shaping and high count rates or with low quality preamps, for scintillation and proportional counting, and with Si systems.

The symmetrical mode should always be used for detector systems which exhibit baseline discontinuities resulting from excessive noise and/or high voltage effects, preamp reset pulses and preamp secondary time constants. Secondary preamp fall time constants result in unipolar output undershoots making it difficult to optimize the amplifier preamp matching.

The asymmetrical restorer mode offers superior high performance for high resolution Ge spectroscopy.

Amplifier Shaping Selection

Shaping time constant selection generally is a compromise between optimizing throughput and resolution.

For germanium detectors, 4 µs shaping provides optimum resolution at low count rates, but 2 µs provides better performance over a wider range of count rates. For very high count rate applications the 2016A is recommended for its high throughput. For lower count rate and low energy applications, the 2016B is recommended for its better resolution.

For high resolution detectors, longer shaping time constants offer better signal to noise (S/N) ratio and reduced sensitivity to the effects of detector ballistic deficit. However, as the system count rate increases, resolution will degrade rapidly as a result of the amplifier’s long processing time and the effects of pulse pile-up.

The optimum shaping time constant depends on the detector characteristics (such as size, noise characteristics, collection characteristics), preamplifier and incoming count rate. The 2016’s shaping-time constant ranges for other common detectors are listed in the following table.

Detector	**Shaping (μs)**
Scintillation Photomultiplier [NaI(Tl)]	0.5, 1
Planar Implanted Passive Silicon (PIPS)	0.5, 1, 2
Gas Proportional Counter	0.5, 1, 2
Lithium Drifted Silicon [Si(Li)]	6, 12
Lithium Drifted Germanium [Ge(Li)]	2, 4
Planar Germanium	4, 6, 12
Silicon Surface-Barrier (SSB)	0.5
Ultra-LEGe	0.125, 0.25, 0.5
Ge Array Detector	0.125, 0.25, 0.5

Refer to the specific Detector Operator's Manual for the recommended shaping time. This will be a good starting point. Further refinements may be realized through experimentation. Collect spectra using shaping times above and below the recommended to find the one that provides optimal resolution performance for your particular detector and application.

Note The P/Z matching must be recalibrated each time the shaping is changed.

Operation With Reset Preamps

The Model 2016 is fully compatible with most reset type preamps. These include the Model 2101 Transistor Reset Preamp, the Model 2008 Optical Reset Preamp, and the Model HRR High Rate Reset Preamp.

Reset preamps use an electronic circuit, as opposed to a feedback resistor to restore the preamp output back to a reference level. As a result, the reset preamp output is a succession of step functions that staircase or ramp up to an upper limit that initiates a preamp reset.

P/Z Compensation With Reset Preamps

Since the reset preamp signal does not have the characteristic exponential fall time of RC preamps, pole/zero compensation is not required. When using the Model 2016 with a reset preamp, set the P/Z potentiometer to infinity, fully counterclockwise.

Using the Reset Preamp Inhibit Signal

The preamp reset event produces a large signal, which drives the amplifier into a severe overload condition. The Model 2016 recovers from overload events rapidly and monotonically, requiring approximately two non-overload pulse widths to fully recover.

Converting events during amplifier overload may produce spectral distortion and it is recommended that the SCA and amplifier be gated OFF during this time using the preamp INHIBIT signal. The preamp INHIBIT signal width should be adjusted to encompass the full unipolar signal recovery. The INHIBIT signal from the Model 2101 Transistor Reset Preamp, the Model 2008 Optical Reset Preamp or the Preamp Reset Module is positive true.

To properly make this adjustment:

1. Set the scope’s vertical sensitivity to 20 mV/div.
2. Using a clamp box, such as the Canberra Model LB1502 Schottky Clamp Box, connect the Amp Out signal to one of the scope’s inputs.
3. Connect the Inhibit signal to the scope’s other input.
4. Trigger the scope on the leading edge of the Inhibit signal.
5. Adjust the width of the Inhibit signal so that it ends when the amplifier’s output returns to within 2 mV of the baseline.

Triangular Shaping

The peaking time for triangular shaping is approximately 14% longer than Gaussian shaping with an equivalent shaping time. The longer peaking time is equivalent to increasing the shaping time. This effectively increases the choice of shaping time constants from 6 to 12 when both shaping modes are considered.

The longer peaking time provides improved signal-to-noise ratio (SNR) and reduced electronic noise. Triangular shaping is also less sensitive to the effects of detector ballistic deficit. Both factors benefit by improved resolution performance. But you should be aware that the resolution improvement gained, due to the longer overall signal processing time, is at the expense of reduced maximum throughput.

ICR Threshold Adjustment

Though the ICR threshold defaults to the automatic mode, in some cases you may want to set the ICR threshold manually. The ICR threshold must be set just above the system noise level to achieve optimum PUR performance. The ICR Auto Threshold Mode is enabled/disabled through a 2016 software switch.

1. Using the 2016 software, disable the PUR Auto Threshold setting.
2. Set the amplifier Gain and Shaping as required.
3. Remove all excitation sources from the vicinity of the Detector.

Optimizing the Discriminator

This procedure optimizes the discriminator sensitivity to insure the threshold is at its lowest setting, just above the noise level.

1. Adjust the 2016 ICR THRESH control fully clockwise. The ICR RATE LED indicator is off.
2. Adjust the ICR RATE control counterclockwise until the ICR RATE LED indicator glows green continuously if the PUR is off, or red if the PUR is on.
3. Adjust the control clockwise until the indicator blinks occasionally.
4. The PUR threshold is now properly set.

Note With PUR Auto Threshold disabled, the PUR Threshold must be rechecked and adjusted if the Detector/Preamplifier or Amplifier’s GAIN or SHAPING are changed.

ADC Peak Detect Adjustment

Normally, the ADC will start its conversion when the peak of the input signal is detected. With the Delayed Peak Detect feature found in all Canberra ADCs, SCA calibration is greatly simplified because the peak value is held by the ADC’s stretcher circuit until the end of the Delayed Peak period and allows the SCA’s output to be used as a GATE input to the ADC. At high count rates, however, this extended ADC window will allow later and larger pulses to be partially captured; this can dull the apparent sharpness of the SCA’s ULD cutoff. This is strictly an artifact of the ADC peak capture and is minimized by reducing the width of the Delayed Peak period.

To adjust the Delayed Peak period:

1. Select a source with moderate activity so that there are not a large number of piled up pulses.

2. Use the software to select an Amplifier/TCA. Its RDY LED will start blinking.

3. Select the amplifier’s shaping time constant.

4. Set the pole/zero compensation.

5. Connect the ADC’s Peak Detect INSPect test point to one of the scope’s input.

6. Connect the selected SCA’s Gate Input signal to the scope’s other input.

7. Trigger the scope on the Peak Detect signal.

8. Adjust the Peak Detect signal’s period so that it includes the SCA signal but does not go beyond it.

Calibration and Normalization

Most Canberra ADCs are calibrated so that a 10 volt input will cause the ADC to convert near the channel selected for the Conversion Gain. For example, with a Conversion Gain of 2K, the ADC will nominally convert a full scale (+10 V) pulse at channel 2020 ⎛20 channels. But as the amplifier’s pulse shaping is made faster, the ADC gain will drop and the 10 volt pulse will be converted at a lower channel. The 2016’s circuits are better able to respond to amplifier shapes so that it is necessary to calibrate the MCA spectra to the SCA setting.

To make this adjustment:

1. Set the ADC’s Peak Detect period as described in “ADC Peak Detect Adjustment” on page 44.

2. Using the software in the Calibration Mode, choose one of the available amplifiers.

3. Bring sources with known energy lines near the detector.

4. Set SCA windows to encompass these peaks. The individual SCAs in the module are enabled when their respective “Output Enable” is selected.

5. Adjust this amplifier's gain until these peaks are seen in the MCA spectrum. The RDY LED of the selected Amplifier/TCA will be blinking.

6. If all modules are to be set for the same energy range, TCA polarity, PUR, and Auto Threshold mode, select "Apply to all Amp/TCAs".

7. When the SCA calibration is complete, the MCA spectrum can then be calibrated. You must position the cursor on one peak centroid and select which SCA (1, 2 or 3) it corresponds to. This would normally be the highest energy peak.

8. Now calibration steps 3 through 6 can be repeated for the remaining Amplifier/TCA modules or, alternatively, to perform a Gain Normalization.

9. The Gain Normalization procedure uses the calibrated MCA and allows individual amplifiers to be selected and to manually adjust their Gain to position the spectrum at the proper locations. This will match the amplifier's gains to the calibrated module. The SCAs are forced to be at the widest limits and allow all pulses to be converted. Once again, the selected Amplifier/TCA will have its RDY LED blinking to aid in locating the amplifier to adjust.

C. VMS Software Installation

To install the Genie-VMS software, log in as SYSTEM and use the VMSINSTAL utility:

```
$ @sys$update:vmsinstal TCA mka500:
```

Where:

TCA is the name of the installation save set (VAX processors only. Use TCX for Alpha processors).

mka500: is the name of the backup device (substitute the appropriate name if mka500: is incorrect).

After installation is complete, edit the OpenVMS system startup command procedure (typically SYSTARTUP_V5.COM or SYSTARTUP_VMS.COM), and add the following line somewhere after the standard Genie-VMS 0198start procedure is called.

```
$ @nd_library:0913start.com
```

To use the software immediately, you may either reboot the machine, or execute the previous command directly from a DECterm.

Next, log in as the user that will be using the AMP/TCA software. Using this account, you must modify (or create) the XGSA_USR_RUN.DAT file in the SYS$LOGIN directory. This file is used to add menu options to the Spectroscopy Assistant. A demo XGSA_USR_RUN.DAT file is provided in the ND_0913_DEMO directory. You may copy this file if desired:

```
$ copy nd_0913_demo:xgsa_usr_run.dat sys$login:*.*
```

Or if you already have an existing XGSA_USR_RUN.DAT file, you may merge the new information into your existing file.

Defining the Detectors

To set up detector definitions to use the software, you must have one MCA configuration created for each AIM that is connected to an AMP/TCA module. You may have up to two AIMs. The first AIM will be used to communicate with AMP/TCA modules 1 through 16, and the second AIM is used for modules 17 to 32. To create the MCA configurations suitable for use with the AMP/TCA software, log into the account that will be using the AMP/TCA software, then execute the first of the two following lines. If you will be communicating with modules that are on a second AIM, execute the second line as well.

```
$ MCA CREATE DET01 NIxxx:1/chan=Ak ! AIM 1
$ MCA CREATE DET02 NIyyy:1/chan=Bk ! AIM 2
```

Where:
xxx and *yyy* are the AIM ethernet addresses.
A and *B* are the number of channels (example: 4, 8).

D. PC Software Installation

To install the software for a Genie-2000 (Windows 95/NT) system, refer to the first subsection below. To install the software for a Genie-PC (OS/2) system, refer to the second subsection.

Installing the Genie-2000 Software

1. If you are installing this software as an upgrade, make sure that no Genie-2000 software is running, including the VDM.

2. Put the disk labeled “Genie-2000 2016 Setup Software” in your floppy drive.

3. Open a DOS Prompt (command) window and type

   ```
   x:\setup
   ```

   where “x:” is the floppy drive designator.

4. To complete the installation, just follow the simple instructions you’ll see on the screen.

Installing the Genie-PC Software

1. If you are installing this software as an upgrade, make sure no Genie-PC software (including the VDM) is running.

2. Put the disk labeled “GENIE-PC AIM SFT Driver” into your floppy drive.

3. Open an OS/2 window session and, at the system prompt,y> type the following commands:

   ```
   a:
   cd 2016
   setup
   ```

   If you are using drive b:, make that your first command.

4. Follow the simple instructions provided by the software to complete the installation.

Defining the Detectors

To set up detector definitions to use the software, use the following guidelines:

1. To use the 2016 Setup software, you must have at least one AIM detector input definition loaded into the VDM’s runtime database (two AIM detector input definitions are required if more than sixteen 2016 modules are being configured). The first AIM will be used to communicate with 2016 modules 1-16; the second AIM is used for modules 17-32.

2. To create the detector input definitions, use the MCA Input Definition Editor to define the required AIM input definitions (refer to the Genie-PC Basic Operation Manual or the Genie-2000 Operations Manual for details on how to use the MCA Input Definition Editor).

3. Note that the first AIM input definition must be named DET01; if a second AIM input definition is required, it must be named DET02.

E. Installation Considerations

This unit complies with all applicable European Union requirements.

Compliance testing was performed with application configurations commonly used for this module; i.e. a CE compliant NIM Bin and Power Supply with additional CE compliant application-specific NIM were racked in a floor cabinet to support the module under test.

During the design and assembly of the module, reasonable precautions were taken by the manufacturer to minimize the effects of RFI and EMC on the system. However, care should be taken to maintain full compliance. These considerations include:

- A rack or tabletop enclosure fully closed on all sides with rear door access
- Single point external cable access
- Blank panels to cover open front panel Bin area
- Compliant grounding and safety precautions for any internal power distribution
- The use of CE compliant accessories such as fans, UPS, etc.

Any repairs or maintenance should be performed by a qualified Canberra service representative. Failure to use exact replacement components, or failure to reassemble the unit as delivered, may affect the unit’s compliance with the specified EU requirements.

Request for Schematics

Schematics for this unit are available directly from Canberra. Write, call or FAX:

Training and Technical Services Department
Canberra Industries
800 Research Parkway, Meriden, CT 06450
Telephone: (800) 255-6370 or (203) 639-2467
FAX: (203) 235-1347

If you would like a set of schematics for this unit, please provide us with the following information.

Your Name ______________________________________

Your Address ______________________________________

____

____

____

____

Unit’s model number ___________________________

Unit’s serial number ___________________________

Note: Schematics are provided for information only; if you service or repair or try to service or repair this unit without Canberra’s written permission you may void your warranty.

Warranty

Canberra’s product warranty covers hardware and software shipped to customers within the United States. For hardware and software shipped outside the United States, a similar warranty is provided by Canberra’s local representative.

DOMESTIC WARRANTY

Canberra (we, us, our) warrants to the customer (you, your) that equipment manufactured by us shall be free from defects in materials and workmanship under normal use for a period of one (1) year from the date of shipment.

We warrant proper operation of our software only when used with software and hardware supplied by us and warrant that our software media shall be free from defects for a period of 90 days from the date of shipment.

If defects are discovered within 90 days of receipt of an order, we will pay for shipping costs incurred in connection with the return of the equipment. If defects are discovered after the first 90 days, all shipping, insurance and other costs shall be borne by you.

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We are under no obligation to provide warranty service if adjustment or repair is required because of damage caused by other than ordinary use or if the equipment is serviced or repaired, or if an attempt is made to service or repair the equipment, by other than our personnel without our prior approval.

Our warranty does not cover detector damage due to neutrons or heavy charged particles. Failure of beryllium, carbon composite, or polymer windows or of windowless detectors caused by physical or chemical damage from the environment is not covered by warranty.

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