Model 9660/9660A ICB Digital Signal Processor

9231014G

User's Manual

ISO 9001 SYSTEM CERTIFIED

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The information in this document describes the product as accurately as possible, but is subject to change without notice.

Printed in the United States of America.

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Table of Contents

Notes

1. Introduction

The CANBERRA Model 9660 Digital Signal Processor represents the state of the art in high rate/high resolution pulse processing subsystems for gamma spectroscopy. Using high speed DSP circuits and sophisticated filtering algorithms, the Model 9660 replaces the traditional shaping Amplifier/Analog to Digital Converter (ADC) combination in traditional analog based spectroscopy systems.

The Model 9660 accepts programming information over the 8-bit wide CANBERRA Instrument Control Bus (ICB). ICB NIMs connect to this bus via a host module such as the Model 556 Acquisition Interface Module (AIM) as part of a hierarchy of networked acquisition and control managed by a Genie family computing platform.

With traditional analog signal processing, the detector signal is amplified, shaped, filtered and baseline restored by the shaping amplifier. The signal is then digitized by the ADC at the end of the processing chain. The Model 9660 performs pre-conditioning and amplification of the signal presented by the preamplifier, then digitizes the signal directly at a very high sampling rate. The filtering, baseline restoration and optimization processes are then applied to the digitized data using real time digital processing algorithms. This reduces noise effects while making possible the use of more efficient and sophisticated filtering algorithms than can be achieved in the analog domain. The net result is a reduced processing time for better throughput with improved resolution and enhanced stability.

The weighting function applied in the Model 9660 filter algorithm produces a symmetrical and near ideal Triangular/Trapezoidal filter function. Trapezoidal shaping requires less processing time for equivalent resolution obtained with semi-Gaussian shaping. The result is less dead time, less pileup, more events processed and higher throughput. Conversely, superior resolution results when the trapezoidal processing time is increased to match a particular semi-Gaussian processing time. The duration of the trapezoidal flat top can be automatically or manually adjusted to eliminate detector ballistic deficit and charge collection effects. Triangular shaping is optimal for small detectors which don’t exhibit ballistic deficit or charge collection irregularities and is obtained by reducing the trapezoidal flat top to zero.

With the Model 9660, users can achieve count throughput rates in excess of 100 000 counts per second. In general the trade off between resolution and throughput is unsurpassed when compared to traditional analog electronics. For example, a trial run comparing the fastest available analog system, the CANBERRA 2024 Amplifier and 8715 ADC to the 9660 produced a peak resolution of 2.4 FWHM at 70 000 cps for the 9660-compared to 2.6 FWHM for the 2024/8715.

Traditionally, the spectroscopist had to make tradeoffs between resolution and throughput – the higher the throughput, the poorer the resolution and vice versa. While this tradeoff still occurs, the 9660 user will observe higher overall throughput or better resolution at a lower throughput than with analog electronics.

Most adjustments are made through the graphical user interface of the Genie software environments. Equivalent batch procedure commands are also available in the environments. All ICB NIM parameters are stored in the single data file structure of the Genie family, allowing verification of correct set up from one experiment to the next. All ICB NIMs feature a characteristic READY LED to indicate operational status. Software commands initiate automatic measurement of and correction for ballistic deficit effects. 9660's which include an "A" suffix in the model number (9660A) have the automatic pole/zero option installed. To verify the model please check the serial number tag located on the NIM power connector. For the Model 9660A the pole/zero adjustment can be performed automatically - the process is initiated by the software command. The pole/zero may also be adjusted manually by the software. For the Model 9660 without the automatic pole/zero option the pole/zero is adjusted manually from the software.

The Model 9660 includes a two-point digital stabilizer that provides both gain and zero stabilization. The stabilizer is programmable and allows adjustment interactively. Adjustment menus in the software allow the stabilizer to be turned on and off, or placed in a "hold" state which freezes the adjustments for subsequent counts.

2. Controls and Connectors

Front Panel

This is a brief description of the 9660 ICB DSP's front panel LED indicators and connectors. For more detailed information, refer to Appendix A, Specifications.

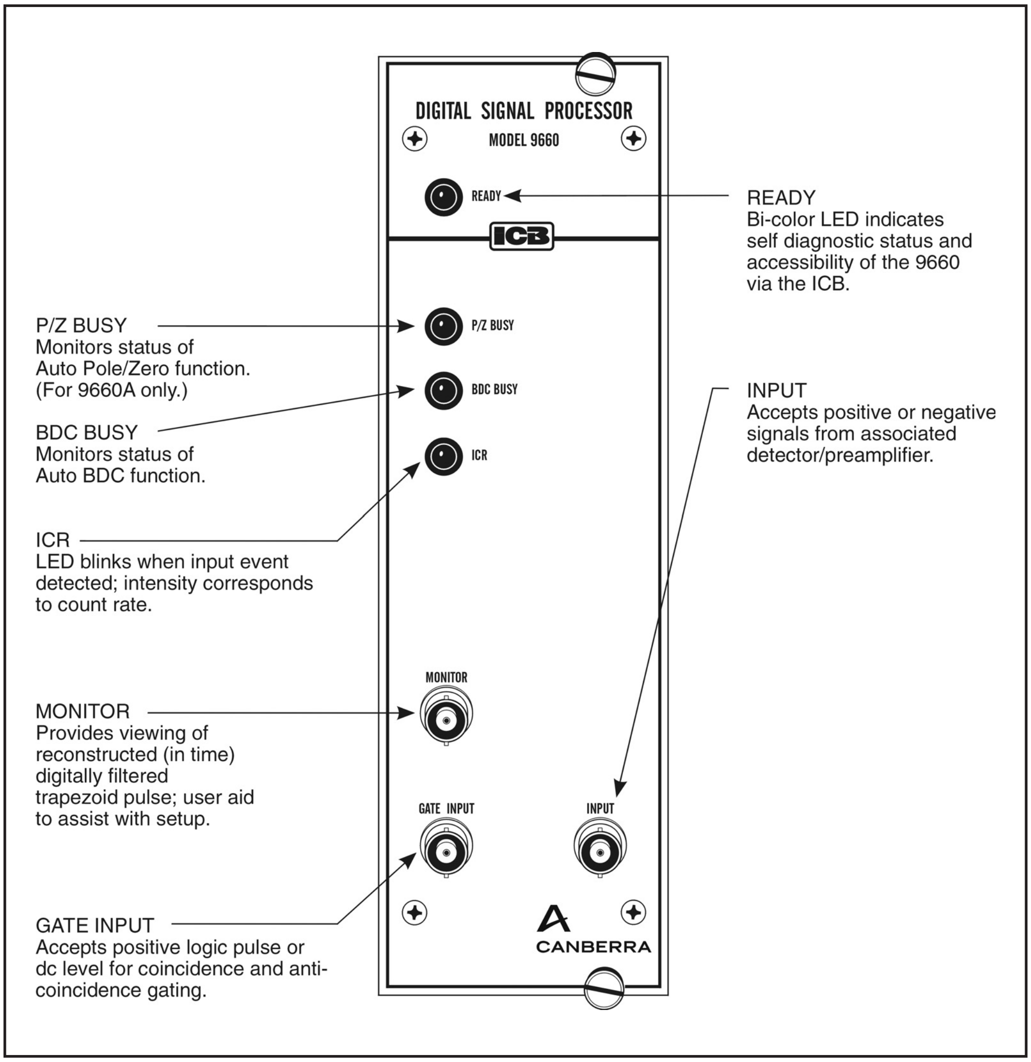


Figure 1 Front Panel Connectors

Rear Panel

This is a brief description of the 9660 ICB DSP's rear panel connectors. For more detailed information, refer to Appendix A, Specifications.

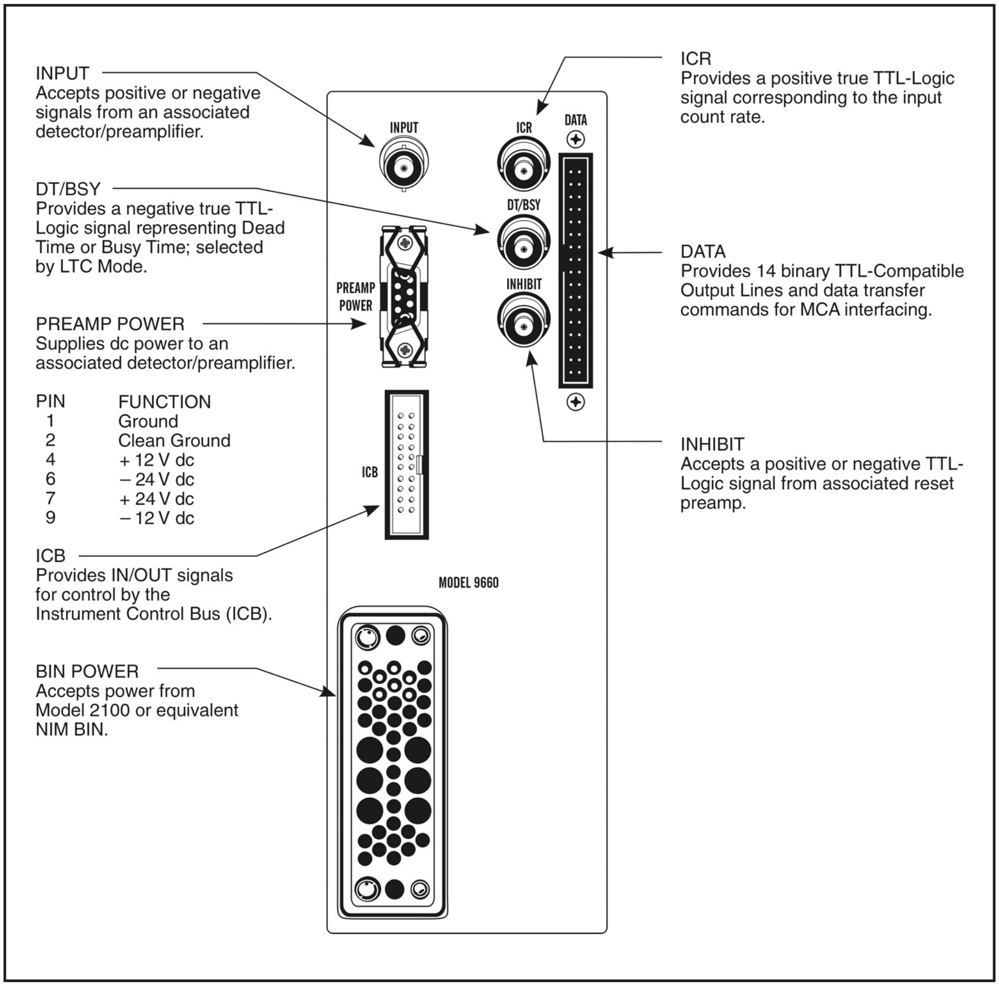


Figure 2 Rear Panel Connectors

Internal Controls

Front End Board

The two Front End Board jumpers, JP7 and JP8, are not installed on the board; they are used only during factory calibration.

SW1 is the ICB slave address switch. Select one of sixteen addresses (0 through 9, A through F) for the 9660. The address must be unique in any one system. The factory default is address.

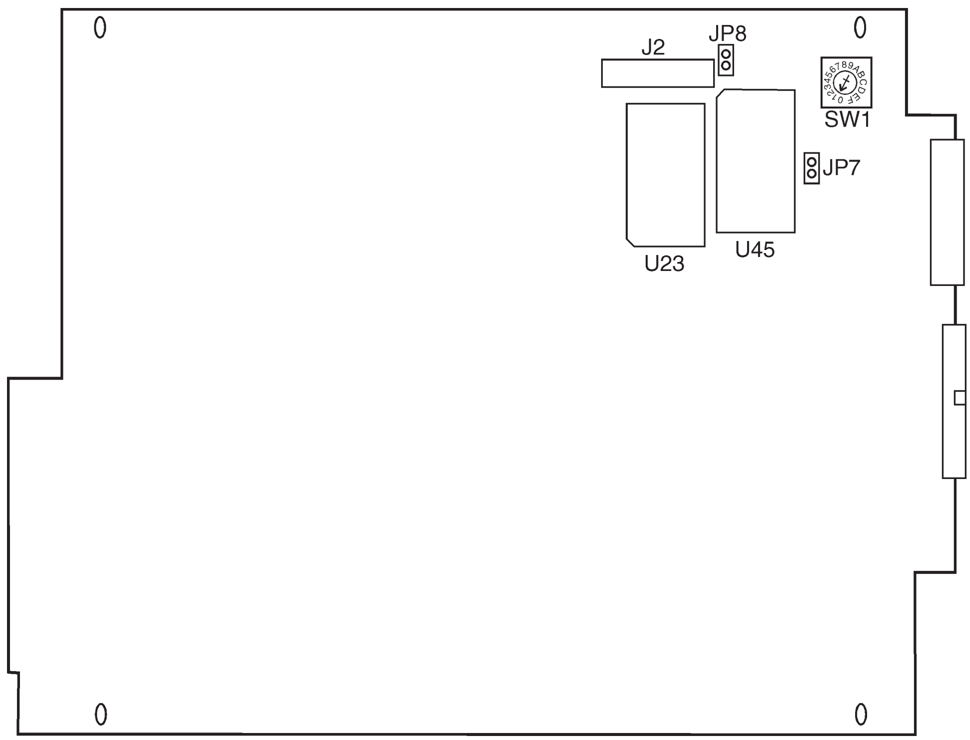


Figure 3 Internal Controls, Front End Board
Right Side Cover Removed

Digital Board

Digital Board jumpers are installed at the factory to configure the 9660. If the jumpers are removed by mistake, please replace them as shown in Figure 4.

W6 - jumper plug installed.

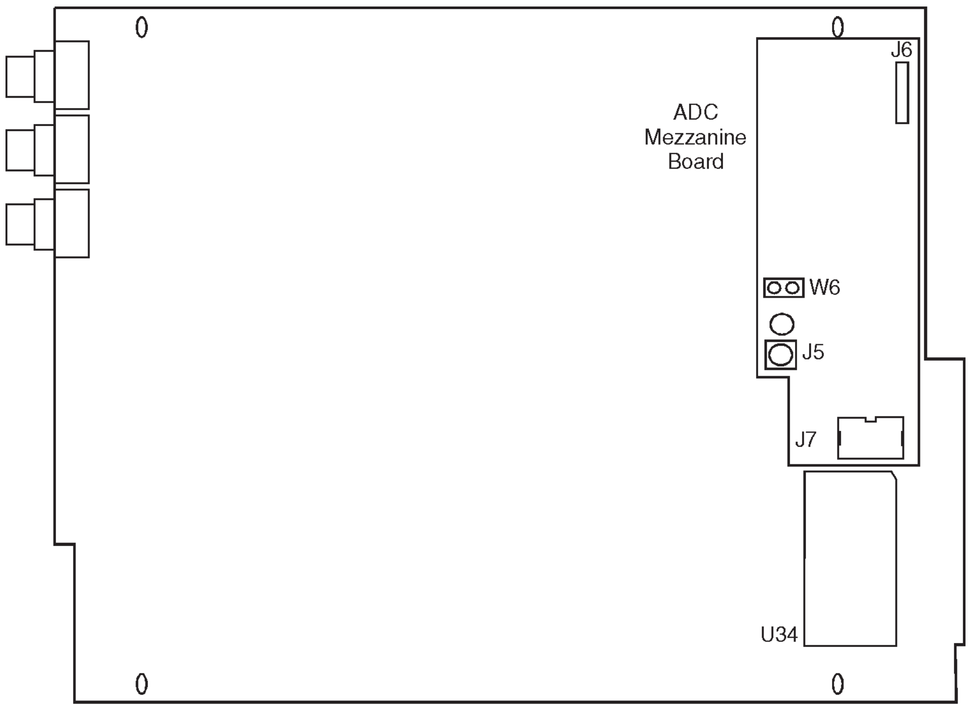


Figure 4 Internal Controls, Digital Board
Left Side Cover Removed

3. Genie™ 2000 User Interface and Controls

The following discussion provides basic information on the user interface and functional operation of the setup controls for the Model 9660 ICB Digital Signal Processor. Additional details and discussion can be found in Chapter 6, *Setup and Operation*, Chapter 7, *PUR/LTC Operation*, and Appendix B *Performance Adjustments*.

Unless noted otherwise, all controls are programmable through the host computer software. For proper operation, an ICB master (Model 556/556A AIM module) and appropriate software (Genie-PC, Genie™ 2000, or Genie-VMS) are required. For specific details on using the host computer software, please refer to the appropriate software user's manual.

Defining a Detector Input

The first step in using a 9660 module is to define a detector input definition at the host computer that specifies this type of device. The MCA Input Definition (MID) Editor is used for this purpose under Genie-PC and Genie-2000 (the MID Setup Wizard can also be used under Genie-2000). To define a detector input using a 9660 module, the user should select the MCA named "AIM/DSP" from the MCA Selection menu then click on the **Add** button (Figure 5).

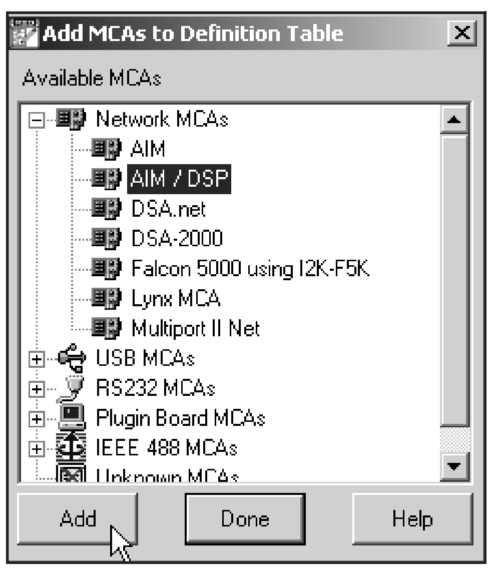


Figure 5 MCA Selection Dialog

Once the MCA has been added, then you must configure the Ethernet and memory size of the AIM module through the Devices/MCA menu (Figure 6). The 9660 module is thought of as three devices by the Genie-PC / Genie-2000 software: DSP Gain, DSP Filter, and Stabilizer. The ICB address of the 9660 must be defined via the Devices menu for any one of the aforementioned devices.

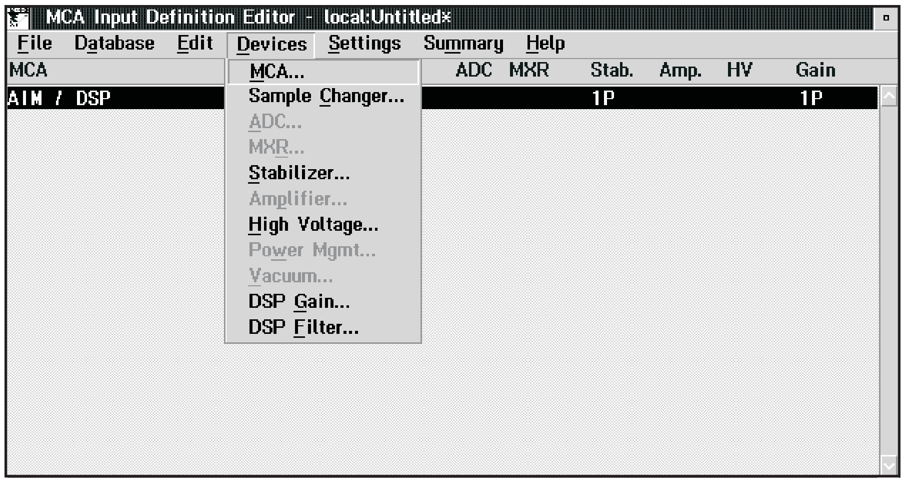


Figure 6 Device Menu for AIM with DSP Input

All of the programmable settings are supplied with initial default settings. Note that some parameters can be only programmed via the MID Editor (configuration only parameters), some can be only programmed via the Adjust screen (adjust only parameters), some can be programmed in both places. In any event, if the setting is adjusted, then the new value is remembered as part of the detector input definition and used in subsequent operations involving the detector input. To simplify setup, the various parameters have been grouped by function under the device names mentioned earlier.

MID Editor

The following section describes those parameters for the 9660 that can be accessed from the MID Editor via the Settings menu.

Stabilizer Parameters

The Stabilizer settings screen (Figure 7) for the 9660 contains the following controls.

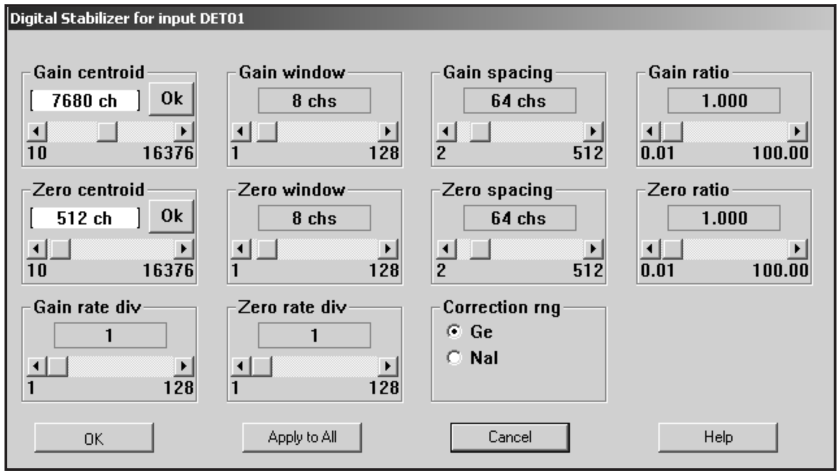


Figure 7 MID Editor's Stabilizer Settings Dialog

Gain Centroid

Sets the centroid (in channels) of the reference peak at the high end of the spectrum for gain stabilization (Figure 8).

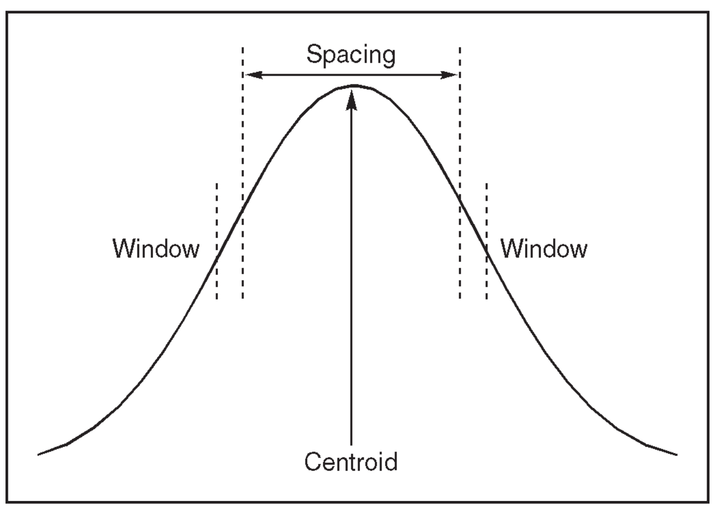


Figure 8 Relationship Between Stabilizer Functions

Gain Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the gain reference peak.

Gain Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the windows’ edges are not on the flat part of the peak.

Gain Rate Div

The Gain Rate Divisor sets the count rate dividers at the input to the correction register for Gain. For high count rate reference peaks, increasing the Divider value will smooth out the correction applied to the system and minimize any peak broadening. This control can only be set via the MID Editor.

Gain Ratio

The Gain ratio value is interpreted by the stabilizer as the ratio to maintain between the two gain windows (ratio = upper window / lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

Zero Centroid

Sets the centroid (in channels) of the reference peak at the low end of the spectrum for zero intercept stabilization.

Zero Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the zero reference peak.

Zero Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the windows edges are not on the flat part of the peak.

Zero Rate Div

The Zero Rate Divisor sets the count rate dividers at the input to the correction register for Zero intercept. For high count rate reference peaks, increasing the Divider value will smooth out the correction applied to the system and minimize any peak broadening. This control can only be set via the MID Editor.

Zero Ratio

The Zero ratio value is interpreted by the stabilizer as the ratio to maintain between the two zero windows (ratio = upper window / lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

Correction Rng

Correction range: 1% (Ge) or 10% (NaI). This control selects the Gain Correction range that can be provided to correct for drift. Select ±1% for a germanium detector or ±10% for a sodium iodide detector. This control can only be set via the MID Editor.

DSP Gain Parameters

The DSP Gain settings screen (Figure 9) for the 9660 contains the following controls.

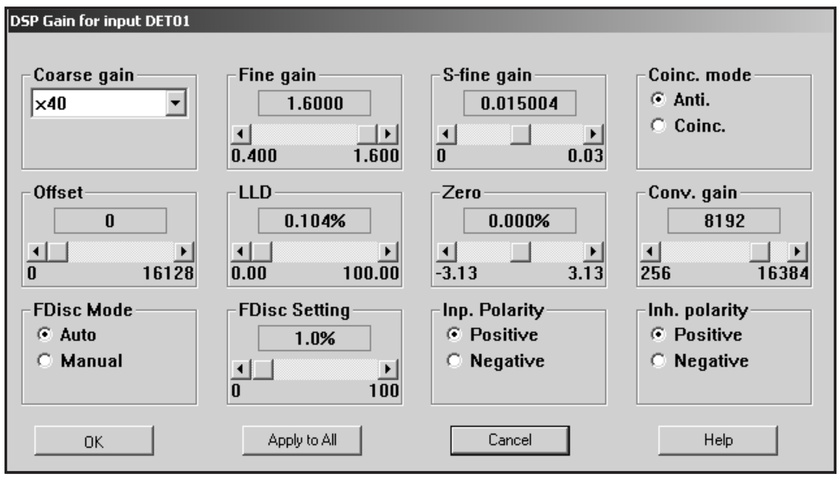


Figure 9 MID Editor's DSP Gain Settings Dialog

Coarse Gain

Sets the device's coarse gain. It's best to choose the highest Coarse Gain which, combined with the Fine and Super-Fine Gains, will produce the total desired gain.

Fine Gain

Sets the device's Fine Gain multiplier.

S-Fine Gain

Sets the device's Super-Fine Gain value.

The combination of Coarse and Fine Gain sets the overall system gain to match the requirements of the detector and energy application; overall gain is continuously variable from x2.0 to x1536. The Fine Gain factor is dependent on the Super-Fine Gain (SFG) value. With the SFG set to 0.0000e^{-2}, the Fine Gain covers a range of x0.4 to x1.6. The SFG value adds to the Fine Gain factor and covers a range of 0.0000e^{-2} to 3.0000e^{-2}.

Coinc Mode

Sets the devices gating mode (ANTIcoincidence or COINCidence). In COINCidence mode, a positive GATE pulse enables the conversion of the event in process (in ANTI-coincidence mode, a positive GATE pulse disables the conversion of the event in process). To enable/disable an event, the GATE pulse must occur during the trapezoid rise time and flat top. The Trapezoid signal timing may be viewed on the MONITOR Output. The GATE pulse duration must be equal to or greater than 50 nanoseconds. This control can only be set via the MID editor.

Offset

Sets the devices digital offset in channels. The digital offset shifts the memory assignment of the device’s conversions to the left (e.g. an offset value of 4096 would shift channel 4096 down to correspond to channel zero of the memory).

LLD

Sets the devices Lower Level Discriminator (LLD) as a percentage of the ADC’s full scale.

Zero

Sets the device’s zero intercept as a percentage of the device’s full scale.

Conv. Gain

Sets the device’s conversion gain. It can be set from 256 to the maximum number of channels supported by the device. The gain will change by a factor of two. Note that this value is automatically copied down to the 9660’s internal Conversion Range parameter.

FDisc Mode

Sets the device’s Fast Discriminator threshold mode. AUTO allows the threshold to be optimized automatically above the system noise level; MANUAL allows the threshold to be manually adjusted.

FDisc Setting

Sets the device’s Fast Discriminator threshold level (when MANUAL Fdisc Mode is selected). The range is 0 to 100%.

Inp. Polarity

Sets the device’s Input signal polarity to either Positive or Negative. The device’s input polarity must match the preamplifier’s output polarity. This control can only be set via the MID Editor.

Inh. Polarity

Sets the device’s Inhibit signal polarity to either Positive or Negative. If you are using a TRP preamplifier, the Inhibit Polarity control matches the polarity of the device’s Inhibit (reset) input to the polarity of the preamp’s Inhibit output. This control can only be set via the MID Editor.

DSP Filter Parameters

The DSP Filter settings screen (Figure 10) for the 9660 contains the following controls.

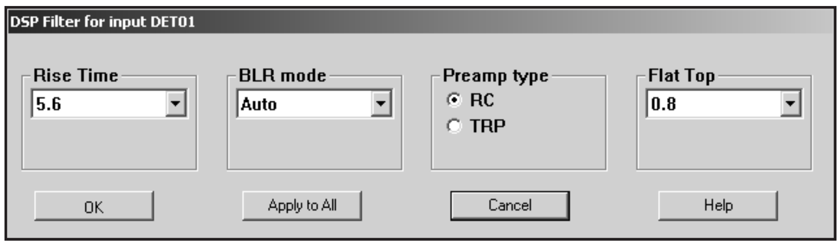


Figure 10 MID Editor's DSP Filter Settings Dialog

BLR Mode

Sets the baseline restorer mode. With a setting of AUTO, the baseline restorer is automatically optimized as a function of trapezoid shaping time and count rate. With settings, of SOFT, MEDIUM and HARD, the baseline restorer is set to fixed rates as selected.

Preamp Type

Selects the Preamplifier type as either TRP (Transistor Reset Preamp type) or RC (RC coupled preamp type). RC enables the pole/zero adjust screen in the **MCA | Adjust | Filter Device** screen; TRP disables pole/zero adjustment. This control can only be set via the MID Editor.

Rise Time

Symmetrically sets the rise time and fall time of the digital filter time response. As with conventional Gaussian shaping, the degree of noise filtering is proportional to the rise time selection. The rise time can be selected from 35 rise/fall times ranging from 0.4 to 28 µs.

Flat Top

Sets the flat top portion of the digital filter time response. The flat top matches the filter to the detector charge collection characteristics to minimize the effects of ballistic deficit. The flat top time can be selected from 21 flat top selections ranging from 0 to 3 µs.

Acquisition Window Adjust Screen

The following section describes those parameters for the 9660 that can be accessed from the Adjust dialog screen. Note that the Adjust screen for a given device may actually be composed of several screens, which are accessed by using the **Next/Prev** pushbuttons.

Stabilizer Parameters

The Stabilizer settings screen (Figure 11) for the 9660 contains the following controls.

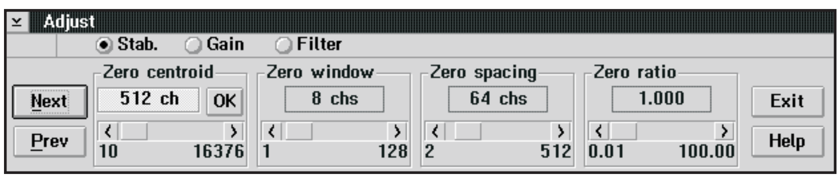


Figure 11 Adjust Screen's Stabilizer Settings

Gain Centroid

Sets the centroid (in channels) of the reference peak at the high end of the spectrum for gain stabilization.

Gain Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the gain reference peak.

Gain Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the windows' edges are not on the flat part of the peak.

Gain Mode

Sets the Gain Stabilization mode to Off, On or Hold.

Off disables gain stabilization and sets the correction adjustment to 0.

On enables gain stabilization, allowing the Stabilizer to compare the incoming data to the gain Centroid and Window settings, then compensate for data below (or above) the Centroid.

Hold disables gain stabilization, but maintains the current correction adjustment at the Stabilizer's output.

Gain Ratio

The Gain ratio value is interpreted by the stabilizer as the ratio to maintain between the two gain windows (ratio = upper window / lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

Zero Centroid

Sets the centroid (in channels) of the reference peak at the low end of the spectrum for zero intercept stabilization.

Zero Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the zero reference peak.

Zero Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the windows edges are not on the flat part of the peak.

Zero Mode

Sets the Zero Stabilization mode to Off, On or Hold.

Off disables zero stabilization and sets the correction adjustment to 0.

On enables zero stabilization, allowing the Stabilizer to compare the incoming data to the zero Centroid and Window settings, then compensate for data below (or above) the Centroid.

Hold disables zero stabilization, but maintains the current correction adjustment at the Stabilizer's output.

Zero Ratio

The Zero ratio value is interpreted by the stabilizer as the ratio to maintain between the two zero windows (ratio = upper window / lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

DSP Gain Parameters

The DSP Gain settings screen (Figure 12) for the 9660 contains the following controls.

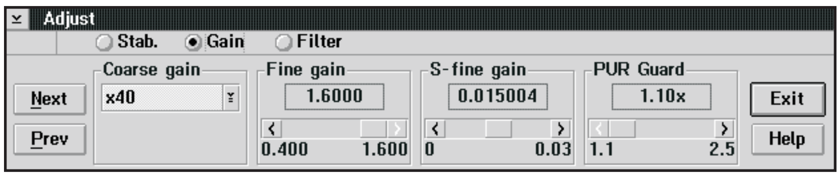


Figure 12 Adjust Screen's Gain Settings

Coarse Gain

Sets the device’s coarse gain. It’s best to choose the highest Coarse Gain which, combined with the Fine and Super-Fine Gains, will produce the total desired gain.

Fine Gain

Sets the device’s Fine Gain multiplier.

S-Fine Gain

Sets the device’s Super-Fine Gain multiplier.

The combination of Coarse and Fine Gain sets the overall system gain to match the requirements of the detector and energy application; overall gain is continuously variable from x2.0 to x1,536. The Fine Gain factor is dependent on the Super Fine Gain (SFG) value. With the SFG set to $0.0000e^{-2}$, the Fine Gain covers a range of x0.4 to x1.6. The SFG value adds to the Fine Gain factor and covers a range of $0.0000e^{-2}$ to $3.0000e^{-2}$.

Offset

Sets the devices digital offset in channels. The digital offset shifts the memory assignment of the device’s conversions to the left (e.g. an offset value of 4096 would shift channel 4096 down to correspond to channel zero of the memory).

LLD

Sets the devices Lower Level Discriminator (LLD) as a percentage of the ADC's full scale.

Zero

Sets the device's zero intercept as a percentage of the device's full scale.

Conv. Gain

Sets the device's conversion gain. It can be set from 256 to the maximum number of channels supported by the device. The gain will change by a factor of two. Note that this value is automatically copied down to the 9660's internal Conversion Range parameter.

FDisc Mode

Sets the device's Fast Discriminator threshold mode. AUTO allows the threshold to be optimized automatically above the system noise level; MANUAL allows the threshold to be manually adjusted.

FDisc Setting

Sets the device's Fast Discriminator threshold level (when MANUAL Fdisc Mode is selected). The range is 0 to 100%.

PUR Guard

Sets the device's guard time (GT) multiplier to reject trailing edge pileup in the event of detector/preamp anomalies. The PUR guard sets the pileup reject interval, which is defined by GT x $TR_{isetime}$ + TF_{lattop}.

LT Trim

Allows adjustment of the trapezoid pulse evolution time or dead time to optimize LTC performance. The adjustment range is 0 to 1000; the default value of 250 provides good LTC performance for a wide range of applications.

LTC Mode

Sets the amplifier's Pulse Pileup Rejector and Live Time Corrector. When PUR is On, the pileup rejector and live time corrector (LTC) are enabled. Off disables the pileup rejector and LTC. LFC enables the pileup rejector and LFC interface; LTC is disabled.

Inhibit Mode

Selects inhibit mode. NORMAL instructs the device to gate off while the INHIBIT Input is true. In RESET mode, the inhibit time is automatically extended to account for the system overload recovery time or while external INHIBIT Input is set true.

DSP Filter Parameters

The DSP Filter settings screen (Figure 13) for the 9660 contains the following controls.

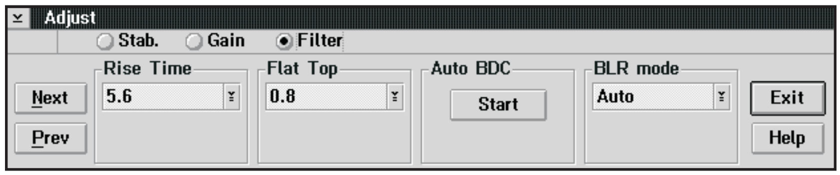


Figure 13 Adjust Screen's Filter Settings

BLR mode

Sets the baseline restorer mode. With a setting of AUTO, the baseline restorer is automatically optimized as a function of trapezoid shaping time and count rate. With settings, of SOFT, MEDIUM and HARD, the baseline restorer is set to fixed rates as selected.

Rise Time

Symmetrically sets the rise time and fall time of the digital filter time response. As with conventional Gaussian shaping, the degree of noise filtering is proportional to the rise time selection. The rise time can be selected from 35 rise/fall times ranging from 0.4 to 28 µs.

Flat Top

Sets the flat top portion of the digital filter time response. The flat top matches the filter to the detector charge collection characteristics to minimize the effects of ballistic deficit. The flat top time can be selected from 21 flat top selections ranging from 0 to 3 µs.

Pole/Zero

Sets the device’s pole/zero setting (0 to 4095). The values 1 to 4095 represent 1.7 ms to 40 µs; a value of zero sets the pole/zero compensation off (infinity).

Auto P/Z (9660A only)

Available only for the 9660A with the automatic pole/zero option installed. Initiates automatic p/z process at the device.

Auto BDC

Initiates automatic BDC process (optimizing of the trapezoidal flat top parameters to match the collection time of the detector) at the device.

4. Genie VMS User Interface and Controls

The following discussion provides basic information on the user interface and functional operation of the setup controls for the Model 9660 ICB Digital Signal Processor (DSP).

Unless noted otherwise, all controls are programmable through the host compute software. For proper operation, and ICB master (e.g. Model 556/556A AIM module) and appropriate software (GENIE-VMS 5.0 or higher) are required.

Defining a Detector Input

The first step in using a 9660 module is to define a detector input definition at the host computer that specifies this type of device. To do this, follow the instructions in the *Model 48-0726 Genie-ESP System User's Manual* in Appendix A, under "Configuring ICB Modules for your System". That process is also briefly described here.

1. First, get control of the AIM module that you will use to control the DSP device:

```
$ MCA RESERVE NI30C
```

2. Next, get a list of the ICB devices attached to the AIM. You should see the CI9660 DSP device listed if it is properly attached and communicating with the AIM.

```
$ CONFIG/DEV ICB
```

3. Then release the AIM with the following command:

```
$ MCA RELEASE NI30C
```

Follow the instructions provided in the *Model 48-0726 Genie-ESP System User's Manual*, Appendix A, "Configuring ICB Modules for your System", and create the Computer-controlled NIM setup file that contains the setup information for your devices. The file is stored in the LIB_MCA: directory.

Then, use the PARS/GUI utility to edit the DSP setup parameters. If you also have a computer controlled HVPS, you should also set it up. The main menu of the PARS/GUI utility is shown in Figure 14. To setup the 9660 module, select the DSP Module menu option.

Note: The DSP device is mutually exclusive with the AMP and ADC device. If you have specified a DSP device address, then MCA control software will not allow you to communicate with an ICB AMP or ICB ADC. On the other hand, if you have not specified the DSP device address, the software will allow you to control an AMP and or ADC. You cannot use a DSP in conjunction with either an AMP or ADC.

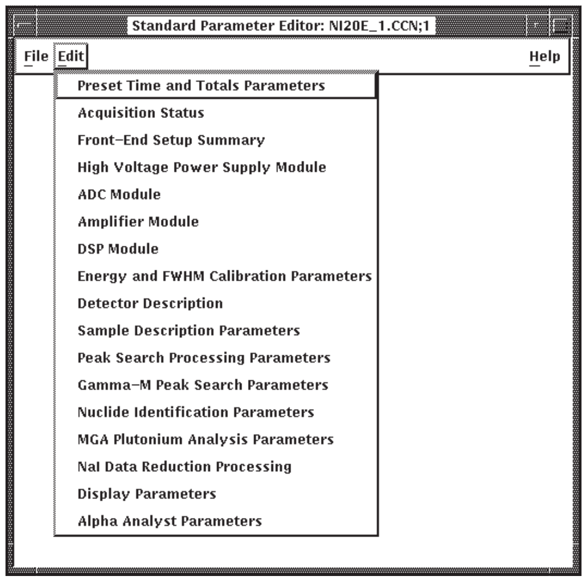


Figure 14 Standard Parameters Editor
Main Menu

When you select the DSP Module option, you will see a dialog like the one shown in Figure 15. Each of the setup parameters should be set up to match the device/detector configuration that you will be using. A description of each of the parameter settings is provided here in this chapter. In addition, a table of the suggested default values for all of the parameters is provided at the end of this section.

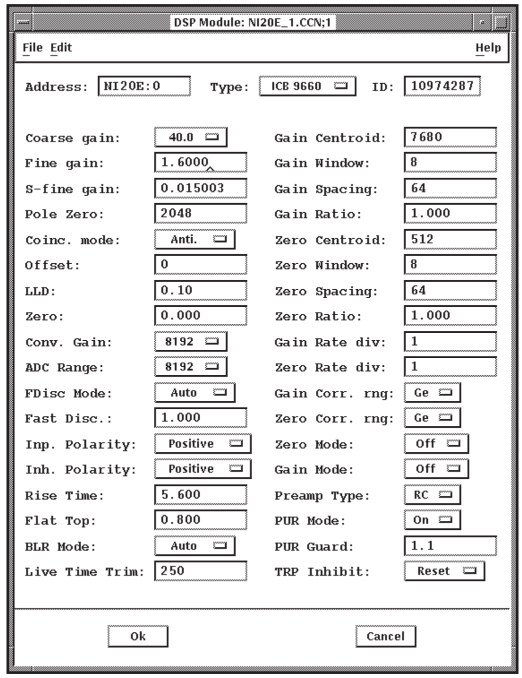


Figure 15 Standard Parameters Editor -
DSP Module Option

ICB DSP 9660 Setup Parameters

The following are descriptions of the parameters for the 9660 that can be accessed from the PARS/GUI editor.

DSP Address

Sets the ICB address of the 9660 DSP module. Here you should enter the fully qualified address of the device, including the AIM prefix. For example, if the ICB address of the device is set to 6, and the AIM that you are using to communicate with the device is NI30C, the enter NI30C:6 for the address. Note that if the DSP address is not blank, you cannot use an ICB Amp or ADC with this input of the AIM. The DSP is mutually exclusive with the AMP and ADC.

DSP Type

Selects the type of DSP device. Currently, the only supported DSP device is the model 9660.

DSP ID

Sets the serial number of the DSP. If you do not know the number, enter “0", and the software will automatically query the serial number from the device at run time.

Coarse Gain

Sets the device's coarse gain.

Fine Gain

Sets the device's Fine Gain multiplier.

S-fine Gain

Sets the device's Super-Fine Gain multiplier.

The combination of Coarse and Fine Gain sets the overall system gain to match the requirements of the detector and energy application; overall gain is continuously variable from x2.0 to x1536. The Fine Gain factor is dependent on the Super Fine Gain (SFG) value. With the SFG set to 0.0000e-2, the Fine Gain covers a range of x0.4 to x1.6. The SFG value adds to the Fine Gain factor and covers a range of 0.0 to 0.03. The overall system gain is defined as:

Overall gain = coarse gain * (fine gain + super fine gain)

Pole Zero

Sets the devices' pole zero setting (0 to 4095). The values 1 to 4095 represent 1.7 ms to 40 s; a value of zero sets the pole/zero compensation off (infinity).

Coincidence Mode

Sets the devices gating mode (ANTIcoincidence or COINCidence). In COINCidence mode, a positive GATE pulse enables the conversion of the event in process (in ANTIcoincidence mode, a positive GATE pulse disables the conversion of the event in process). To enable/disable an event, the GATE pulse must occur during the trapezoid rise time and flat top. The Trapezoid signal timing may be viewed on the MONITOR Output. The GATE pulse duration must be equal or greater than 50 nanoseconds.

Offset

Sets the devices digital offset in channels. The digital offset shifts the memory assignment of the device's conversions to the left (e.g. an offset value of 4096 would shift channel 4096 down to correspond to channel zero of the memory).

LLD

Sets the devices Lower Level Discriminator (LLD) as a percentage of the ADC's full scale.

Zero

Sets the devices' zero intercept as a percentage of the device's full scale.

Conversion Gain

Sets the devices' conversion gain. It can be set from 256 to the maximum number of channels supported by the device. The gain will change by a factor of two.

ADC Range

Sets the devices' ADC conversion range. It can be set from 256 to the maximum number of channels supported by the device. Typically the ADC range and the conversion gain will be set to the same value.

Fast Discriminator Mode

Sets the devices' Fast Discriminator threshold mode. AUTO allows the threshold to be optimized automatically above the system noise level; MANUAL allows the threshold to be manually adjusted.

Fast Discriminator Setting

Sets the devices' Fast Discriminator threshold level (when MANUAL Fast Discriminator Mode is selected). The range is 0 to 100%.

Input Polarity

Sets the device's Input signal polarity to either positive or negative. If you are using a TRP preamplifer, the Inhibit Polarity control matches the polarity of the device's Inhibit (reset) input to the polarity of the preamplifier's Inhibit output.

Inhibit Polarity

Sets the device's Inhibit signal polarity to either positive or negative. If you are using a TRP preamplifer, the Inhibit Polarity control matches the polarity of the device's Inhibit (reset) input to the polarity of the preamplifier's Inhibit output.

Rise Time

Symmetrically sets the rise time and fall time of the digital filter time response. As with conventional Gaussian shaping, the degree of noise filtering is proportional to the rise time selection. The rise time can be selected from 35 rise/fall times ranging from 0.4 to 28 µs. The software will choose the closest allowable number based on the number you enter.

Flat Top

Sets the flat top portion of the digital filter time response. The flat top matches the filter to the detector charge collection characteristics to minimize the effects of ballistic deficit. The flat top time can be selected from 21 flat top selections ranging from 0 to 3 µs. The software will choose the closest allowable number based on the number you enter.

BLR Mode

Sets the baselines restorer mode. With a setting of AUTO, the baseline restorer is automatically optimized as a function of trapezoid shaping time and count rate. The settings are SOFT, MEDIUM, and HARD. The baseline restorer is set to fixed rates as selected.

Live Time Trim

Allows adjustment of the trapezoid pulse evolution time or dead time to optimize LTC performance. The adjustment range is 0 to 1000; the default value of 250 provides good LTC performance for a wide range of applications.

Gain Centroid

Sets the centroid (in channels) of the reference peak at the high end of the spectrum for gain stabilization.

Gain Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the gain reference peak.

Gain Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the window’s edges are not on the flat part of the peak.

Gain Rate Div

The Gain Rate Divisor sets the count rate dividers at the input to the correction register for Gain. For high count rate reference peaks, increasing the Divider value will smooth out the correction applied to the system and minimize any peak broadening.

Gain Ratio

The Gain Ratio value is interpreted by the stabilizer as the ratio to maintain between the two gain windows (ration = upper window/lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

Zero Centroid

Sets the centroid (in channels) of the reference peak at the low end of the spectrum for zero intercept stabilization.

Zero Window

Sets the width (in channels) of the upper and lower sampling windows on either side of the zero reference peak.

Zero Spacing

Sets the spacing (in channels) between the upper and lower sampling windows. The windows should be placed so that a shift in the reference peak reflects a significant change in count rate through the window. For broad peaks, the spacing should be set so that the windows' edges are not on the flat part of the peak.

Zero Rate Div

The Zero Rate Divisor sets the count rate dividers at the input to the correction register for Zero intercept. For high count rate reference peaks, increasing the Divider value will smooth out the correction applied to the system and minimize any peak broadening.

Zero Ratio

The Zero ratio value is interpreted by the stabilizer as the ratio to maintain between the two zero windows (ratio = upper window/lower window). For instance, a value of 1 would be appropriate for a pure Gaussian peak.

Gain Correction Range

Correction range: 1% (Ge) or 10 (NaI). This control selects the Gain Correction range that can be provided to correct for drift. Select ±1% for germanium detector or ±10% for a sodium iodide detector.

Zero Correction Range

Correction range:1% (Ge) or 10% (NaI). This control selects the Zero Correction range that can be provided. Select ±1% for a germanium detector or ±10% for a sodium iodide detector.

Zero Mode

Sets the Zero Stabilization mode to off, on, or hold.

Off disables zero stabilization and sets the correction adjustment to 0.

On enables zero stabilization, allowing the stabilizer to compare the incoming data to the zero centroid and window settings, then compensate for data below (or above) the centroid.

Hold disables zero stabilization, but maintains the current correction adjustment at the stabilizer's output.

Gain Mode

Sets the Gain Stabilization mode to off, on, or hold.

Off disables gain stabilization and sets the correction adjustment to 0.

On enables gain stabilization, allowing the stabilizer to compare the incoming data to the gain centroid and window settings, then compensate for data below (or above) the centroid.

Hold disables gain stabilization, but maintains the current correction adjustment at the stabilizer's output.

Preamp Type

Selects the preamplifier type as either TRP (Transistor Reset Preamp) or RC (RC coupled preamp type). RC enables the pole zero setting adjustment in the **MCA | Adjust | Amp** screen; TRP disables pole zero adjustment.

PUR/LTC Mode

Sets the amplifier's Pulse Pileup Rejector and Live Time Corrector (LTC). When PUR is on, the pileup rejector and LTC are enabled. Off disables the pileup rejector and LTC. LFC enables the pileup rejector and LFC interface; LTC is disabled.

PUR Guard

Sets the device's guard time (GT) multiplier to reject trailing edge pileup in the event of detector/preamp anomalies. The PUR guard sets the pileup reject interval, which is defined by GT x TRisetime +TFlattop.

Inhibit Mode (TRP Inhibit)

Selects inhibit mode. NORMAL instructs the device to gate off while the INHIBIT is true. In RESET mode, the inhibit time is automatically extended to account for the system overload recovery time or while external INHIBIT is set true.

Auto BDC

Initiates the automatic BDC process (optimizing of the trapezoidal flat top parameters to match the collection time of the detector) at the device. The Auto P/Z and Auto BDC processes cannot be performed simultaneously.

Auto P/Z (9660A only)

Available only for the 9660A with the automatic pole/zero option installed.

Initiates the automatic pole/zero (P/Z) process at this device. Note that you cannot perform an Auto P/Z on a TRP type preamp. The Auto P/Z and Auto BDC processes cannot be performed simultaneously.

9660 Default Values

The following table shows the suggested default values for the 9660 setup parameters. These values generally serve as a good starting point.

Parameter	Default Value
Coarse Gain	40
Fine Gain	1.6000
Super Fine Gain	1.5003e-2
Pole Zero Setting	2048
Coincidence Mode	Anti
Offset	0
LLD	0.0103%
Zero	0.0%
Conversion Gain	8192
ADC Range	8192
Fast Discriminator Mode	Auto
Fast Discriminator	1.0%
Input Polarity	Positive
Inhibit Polarity	Positive
Rise Time	5.6
Flat Top	0.8
BLR Mode	Auto
Live Time Trim	250
Gain Centroid	7680
Gain Window	8
Gain Spacing	64
Gain Ratio	1.00
Zero Centroid	512

Zero Window	8
Zero Spacing	64
Zero Ratio	1.00
Gain Rate Div	1
Zero Rate Div	1
Gain Correction Range	Ge
Zero Correction Range	Ge
Zero Mode	Off
Gain Mode	Off
Preamp Type	RC
PUR Mode	On
PUR Guard	1.1
Inhibit Mode	Reset

5. Monitor Output

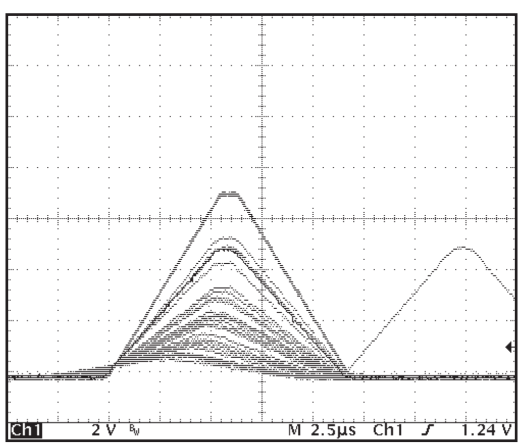
The Monitor Output is provided as a visual aid to assist with parameter setup and verify operation of the Model 9660 ICB Digital Signal Processor. The Monitor Output uses a Digital to Analog Converter (DAC) to convert or reconstruct the sampled digital filtered signal (with trapezoidal weighting function) into the analog time domain for viewing.

The Monitor Output has 12 bits of resolution and an 8 volts dynamic range which reflects full scale for the selected MCA Conversion Gain. It is only intended to drive the input of an oscilloscope for viewing, as it has limited drive capability. Using the Monitor Output to drive accessories other than an oscilloscope, such as traditional ADC's, Mixer Routers, etc. is not recommended.

In addition to the reconstructed Trapezoid signal, a small amount of digital noise may also be observed mixed in with the signal. This is an artifact of residual noise pickup associated with the monitor output reconstruction DAC and associated circuitry, and is normal. The digital filter data being processed does not contain this noise.

Trapezoid Output

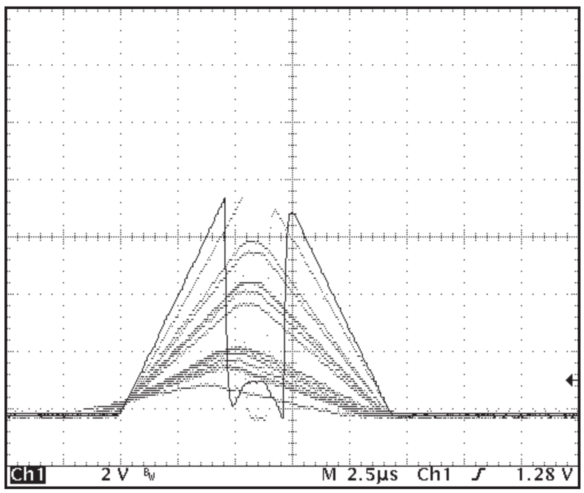
The reconstituted trapezoid waveform provided on the monitor output is similar to the output of a traditional spectroscopy amplifier when verifying operation and setup. Figure 16 shows a typical trapezoidal waveform as viewed on the Monitor Output when using a germanium detector and ^{60}Co source, with the 9660 FILTER set for a Rise Time of 5.6 µs and Flat Top of 0.8 µs.



Scope:
Vertical: 2 V/div
Horizontal 2.5 µs/div

Figure 16 Typical Monitor Output

The maximum trapezoid output level at the Monitor Output is 8 volts. However, because of the extended range of the 9660's digital filter, the digital-to-analog converter which generates the monitor output can be over driven past its 12-bit range. When this happens, the monitor output will be seen to "wrap around" or jump negative before it continues displaying the trapezoidal waveform. In Figure 17, the 9660's gain was increased slightly to demonstrate the wrapping effect. As long as the MCA memory or spectral range is not exceeded, the monitor output "wrapping" will not affect the MCA spectrum, since the dynamic range of the digital filter is significantly larger than that of the Monitor Output.

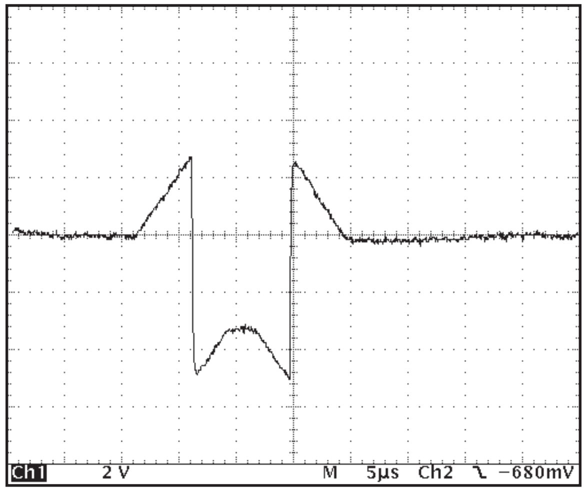


Scope:
Vertical: 2 V/div
Horizontal 2.5 µs/div

Figure 17 Monitor Output Showing "Wrap Around"

The range of the monitor output is also affected by detector noise, gain and selection of shaping time. When the 9660 senses increased detector noise, it automatically increases the signal baseline to maintain the signal and noise within the dynamic range of the fast digitizing ADC. The DC gain of the digital filter is proportional to the processing time and the baseline (DC) component and can become proportionately large for long filter rise times. Since the monitor output circuit includes a baseline subtractor, the range of the filter appears to shift in the negative direction when significant noise is present, especially at long shaping times.

Figure 18 shows the type of waveform generated at the Monitor Output when the 9660 is connected to a detector driven by a low energy ^{55}Fe source. The Filter Rise Time and Flat Top are set relatively long, 8.0 µs and 2.4 µs respectively.



Scope:
Vertical: 2 V/div
Horizontal 5 µs/div

Figure 18 Output Range Shifted by Detector Noise

This source requires a high system gain to position its peaks in the mid to upper portion of the selected MCA spectral range. For this case, the baseline or DC component of the trapezoid signal is large and signal wrapping begins to occur at slightly over 3 volts then jumps down to approximately 5 volts below zero. Even though the Monitor Output wrapping appears to be significant here, the Trapezoid waveform remains useful when verifying setup and optimizing the Pole/Zero.

The wrapping effect is proportional to the gain setting and also to the filter rise time selection, as mentioned earlier. In the event it is troublesome, momentarily reduce the rise time or gain to a lower setting and the wrapping effect will be significantly reduced or eliminated. Verify or optimize the setup; when completed, return to the desired rise time and/or gain setting. Again, the MCA spectrum is not affected, due to the large dynamic range of the 9660's digital filter.

Note The optimum Pole/Zero setting is independent of the Filter Rise Time and Flat Top setting. For further information regarding the effect of "wrap around" when setting the Pole/Zero, please refer to "Rise Time and Flat Top Adjustments" on page 63.

Using the Monitor Output to Verify System Gain

The 9660 gain settings are calibrated to produce the same system gain (in keV/channel) as a traditional analog system with the same settings. For a given detector, radiation source and MCA setup (conversion gain, conversion range, etc.), the resultant MCA spectral peaks will be located in approximately the same MCA channel location for both the 9660 and the traditional analog system.

The 9660 gain factor can be verified using the Monitor Output. However, keep in mind the Monitor Output signal is reconstructed in the analog time domain and is only a visual aid to assist with setup and verify operation. The Monitor Output is scaled to 8 volts full scale MCA collection as opposed to 10 volts for most traditional analog spectroscopy amplifiers. This scale factor (10/8) must be taken into consideration when verifying the 9660 gain factor.

For example when the 9660 Gain is set as follows:
Coarse Gain: 120
Fine Gain: x0.8337
SF Gain: $0.0000e^{-2}$

- The calculated gain is 120 x 0.8337 = 100.04

- The amplitude of the Monitor Output signal measures 4 volts

- The Input signal measures 0.05 volts.

- The 9660 measured gain (corrected for the 8 volt full scale range) is 4/0.05 x 10/8 = 80 x 1.25 = 100

6. Setup and Operation

This chapter is a quick setup guide, and outlines the operation of the Model 9660 Digital Signal Processor. More detailed information about specific functions can be found in Chapters 2 through 6 and the Appendices at the end of the manual. Following the procedures below will make you familiar enough with the instrument to be able to use it effectively in many situations.

Setting the ICB Address

The ICB Address Selector (SW1) is a 16-position rotary switch accessible through a hole in the right side-cover. Its position and address selection must be unique in any one ICB system. That is, it must be different from all other ICB modules connected to the associated Instrument Control Bus (ICB). For individual modules, the factory default address is #1; for systems, the address will vary for each module in the system.

For complete information on setting up and configuring your Genie Spectroscopy system, please refer to the Genie manual set for your Genie software.

Installing the 9660 in a NIM Bin

The Model 9660 ICB Digital Signal Processor requires a NIM Bin which provides ± 6 volts. The Canberra Model 2100 Bin and Power Supply, or equivalent bin and power supply systems conforming to the mechanical and electrical standard set by DOE/ER-0457T will accommodate the Model 9660. The right side cover of the two-width NIM module acts as a guide for insertion of 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 9660 can be operated where the ambient air temperature is between 0 °C and 50 °C (+126 °F maximum). Perforations in the top and bottom sides permit cooling air to circulate through the module. When rack mounted with heat generating equipment, adequate clearance should be provided to allow for sufficient air flow through both perforated top and bottom covers of the NIM bin.

ICB/MCA Connections – Model 556/556A AIM

A 34-pin rear panel Data connector and 20-pin ICB connector provide all the necessary signals for interfacing to the Model 556/556A AIM MCA. For a detailed description, see Appendix C, MCA and ICB Interface Connectors.

Note 556 AIM modules manufactured prior to April of 1992 may exhibit a problem and require a rework. The problem symptom is an 8k spectral shift or digital offset. If you experience this problem, or have a 556 AIM manufactured prior to April of 1992, please contact the Customer Service Department in Meriden, Connecticut at (800) 225 - 6370.

- Connect the C-1703-2 MCA interface cable between the data connector on the 9660's rear panel and the Model 556/556A AIM module.

- Connect the Model C-1560 12-port ICB Connecting Cable between the ICB connectors on the rear panels of the Models 9660 ICB DSP and 556/556A AIM modules.

Initialization and Self-Diagnostics

When power is first applied to the Model 9660, it will go through an initialization and self diagnostics process. The BDC Busy LED on the front panel will blink for duration of the process, which requires 15 to 20 seconds to complete. The Ready LED normally remains off during the power-up process.

If the self diagnostics were successful and communication is established with the Model 556/566A AIM, the BDC Busy LED will turn off and the Ready LED will remain off.

If the Model 9660 detected a hardware error during the initialization process, the Ready LED (lit yellow) will go on continuously and remain on. This could result from a fault in the 9660 module or a faulty or unconnected ICB cable. Please consult the factory if necessary.

When a device has been selected through the application software, the Ready LED (lit green) will be on continuously, indicating that communications between the host computer and the Model 9660 has been established.

Spectroscopy System Setup

Figure19 shows a typical gamma spectroscopy system.

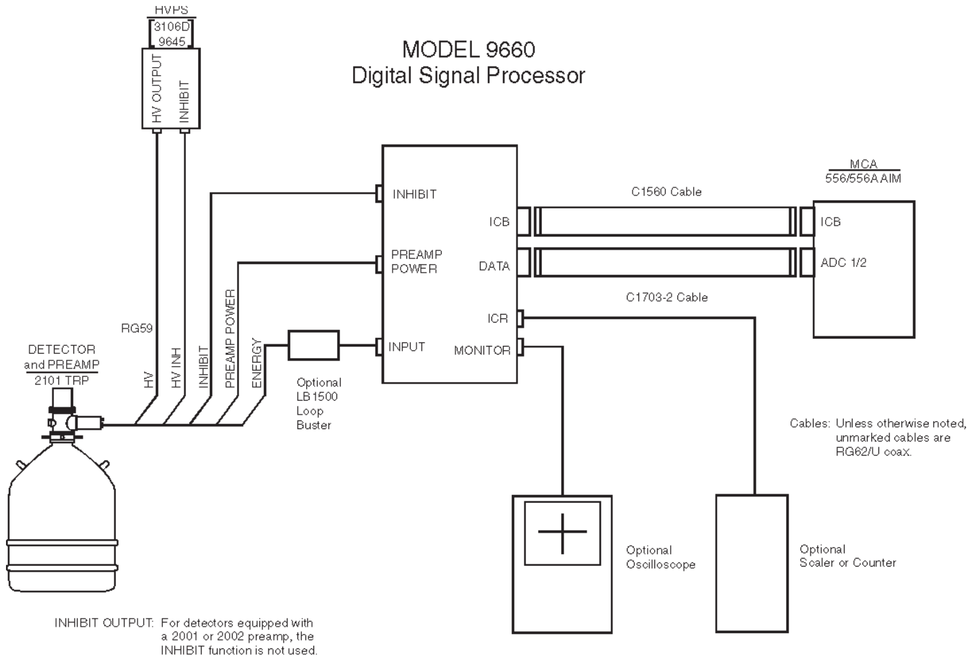


Figure 19 Typical Gamma Spectroscopy System

Perform the following steps to set up your spectroscopy system:

1. Insert the Model 9660 Digital Signal processor into a Model 2100 or equivalent NIM Bin.

2. Connect the intended Detector/Preamp to the 9660. Preamp power is provided by means of a 9-pin Amphenol connector located on the rear panel of the Model 9660. Connect the Preamp Output signal to the 9660 INPUT BNC. If the detector preamp is a reset type, connect the Inhibit Output signal to the Inhibit Input on the rear of the 9660.

Note Multiple ground connections to the detector preamp (preamp power, signal BNC cable, HV power supply cable, etc.) can setup ground loops which may be sensitive to EMI noise pickup. These effects can cause resolution degradation, excessive dead time and erratic count rate (ICR) measurement.

If you experience any of these problems, make sure the preamp cables are tightly bundled together and routed away from EMI noise sources such as motors, AC switching equipment, computers, monitors, etc.

If necessary, use the optional LB1500 Loop Buster provided with the 9660 in series with the preamp signal cable. The LB1500 Loop Buster reduces the sensitivity of the 9660 input to ground loop induced noise. Best performance is obtained with the LB1500 installed at the energy or output BNC on the preamp.

3. Connect the Detector/Preamp High Voltage Input to a suitable High voltage Power supply such as a Model 9645 ICB Programmable HV Power Supply. The High Voltage Power Supply should be installed in the same NIM Bin as the 9660 to reduce the possibility of ground loops and noise pickup. Please refer to the Operating Manuals of the Detector, High Voltage Power and any other accessories for specific hook up and operating instructions.

4. Turn the NIM Bin power on. At power up, the Model 9660 will go through an initialization and self-diagnostic process as described in “Initialization and Self-Diagnostics” on page 34.

5. Turn on the High Voltage Bias Supply and adjust as required by the Detector manufacture’s specifications. Allow the 9660 and Detector system to warm up and stabilize.

6. The setup instructions that follow will allow you to get the 9660 set up and running with a typical detector and to become acquainted with its operation. For the following setup, a detector with preamp gain of 500 mV/MeV and a ^{60}Co radioactive source will produce a 6.5 to 7 volt trapezoid signal at the Monitor Output. The 1332 keV ^{60}Co peak should collect in channel 6500 to 7200 on the MCA when setup for a 8192 memory or spectrum size.

   The various parameters are grouped into three device types: Stabilizer, Filter and Gain

   For this quick setup and check of the 9660, many of the parameters may not require adjustment; leave them set to the default values. Parameters using default values are marked with an asterisk (*).

7. MID Editor Settings. Please verify or set the following setup parameters in your Genie Spectroscopy System’s MCA Input Definition (MID) Editor. For complete information on editing MID files, refer to the MID Editor chapter in your Genie manual set.

   7a. DSP Filter Parameters

*Preamp Type:	RC
Inp Polarity:	Set Positive or Negative to match the preamp signal polarity of the intended detector.
Inh Polarity:	If the detector has an RC type preamp, this function is not applicable and it is not necessary

to make selections or changes. If the detector has a reset preamp, set Positive or Negative to match the polarity of the inhibit signal generated by the preamp. The Canberra 2101 TRP and 2008 preamps produce a positive Inhibit signal.

*Coinc mode: Anti

There are many other parameters that can be adjusted in the MID Editor, but it isn't necessary to adjust them now. They will be adjusted using the MCA/Adjust Screens in the following step (#8). When you make adjustments, be sure to save the MID File.

8. MCA Adjust Screens. The following parameters can be accessed and set using the Gain and Filter Device Adjust screens. The adjustments can be saved to the datasource's CAM file by using the **File | Save** command.

8a. Gain Device Adjust Screen

Coarse Gain:	x15
Fine Gain:	x1.0002
SF Gain:	$0.0000e^{-2}$
*FDisc Mode:	Auto
*FDisc Setting:	1.0%
*LT TRIM:	250
*LTC Mode:	On
*PUR Guard:	1.1x
*Offset:	0 Ch
*LLD:	0.101%
*Zero Adj:	0.000%
*Conv Gain:	8192
*Inhibit Mode	Reset

8b. Filter Device Adjust Screen

*Rise Time:	5.6 µs
*Flat Top:	0.8 µs
Auto BDC:	Do not Initiate Auto BDC at this time
BLR Mode:	Auto

Pole/Zero:	2048
Auto P/Z:	Available only on the 9660A. If equipped, do not initiate Auto P/Z at this time.

Note Please see “Rise Time and Flat Top Adjustments” on page 63 for additional information on setting the Rise Time and Flat Top settings and their relationship to traditional Gaussian shaping times.

8c. Stabilizer Device Adjust Screen

*Gain Mode:	OFF
*Zero Mode:	OFF

Detector Matching

The following section discusses how to adjust and optimize the Pole/Zero (can be set automatically for Model 9660A) and use the Auto BDC function. Pole/Zero compensation is extremely critical for achieving good performance at high count rates when using detectors with RC preamps. It is equally important for good overload recovery due to high energy and cosmic events. The Pole/Zero adjustment range accommodates RC preamp fall times of 40 µs to 1.7 ms. When a reset type of preamp is used, P/Z compensation is not required and must be set to infinity represented by a value of “0.” If using a detector with a Reset preamp such as the Canberra 2101 or 2008, change the preamp type from RC to TRP. With TRP selected, the Pole/Zero compensation is automatically set to a value of “0" representing infinity or no compensation. If the RC mode is selected the P/Z SETTING must be set to “0.” Please refer to “Operation with Reset Preamps and Selecting Inhibit Mode” on page 72 for additional information when using Reset preamps.

Note Once the Pole/Zero is optimized for the intended detector, the digital filter parameters (Rise Time and Flat Top) can be changed as required without the need to make further Pole/Zero adjustments. However, the Pole/Zero compensation *must* be readjusted if the detector is changed.

The Auto BDC function sets the trapezoid flat top to the correct length insuring that all the detector charge is collected for accurate energy analysis.

Automatic Pole/Zero Matching (9660A only)

The Automatic Pole/Zero option is installed only on the 9660A. To verify the model number please check the serial number tag located on the NIM power connector hood.

The Automatic Pole/Zero (P/Z) feature will give good results for most detector applications and count rates. However, it may be necessary to optimize the P/Z compensation manually at extremely high count rates or for specific applications where the digitally filtered trapezoid signal is prevented from returning monotonically to the baseline. The feedback resistor on some RC preamps may exhibit non-ideal characteristics which produce multiple time constants making the tail pulse fall time non-monotonic. This behavior may become problematic at high count rates causing significant baseline perturbations and resolution degradation. NaI detectors may have multiple time constants due to AC coupled preamps and the scintillator interactions. In these situations it might be possible to minimize performance degradation by fine tuning the pole/zero manually. To adjust the Pole/Zero refer to “Manual Pole/Zero Matching” on page 41.

To initiate the Auto Pole/Zero process, please follow the directions below:

1. Adjust the ^{60}Co radioactive source for an incoming count rate (ICR) between 1 and 20 kHz. The Auto Pole/Zero may fail to converge if the incoming count rate is not within this count rate range. The incoming count rate can be verified by looking at ICR on the **MCA | Adjust | Status Page** of the Acquisition and Analysis window. Select “Update” to update the ICR Status whenever the radioactive source is adjusted.

Note Although any radioactive source may be used, the most accurate adjustment is obtained using simple sources such as ^{57}Co, ^{137}Cs or ^{60}Co. The Auto P/Z operates properly with spectral peaks are located within 25% to 100% of the system dynamic range. However best performance is obtained with the system gain adjusted to place the primary peaks within the top 75% to 95% of the system dynamic range. These recommendations also apply when adjusting the Pole/Zero manually on systems without Auto Pole/Zero. Once completed, replace the calibration source with the sample to be analyzed and adjust the system gain as required.

2. In the **MCA | Adjust** screen, click on the FILTER button, then click on the Next button until the Adjust screen with the Auto P/Z button appears.

3. Click the AUTO P/Z “Start” button, to start the Auto Pole/Zero. While the pole/zero is converging, “Wait” will be posted in the Adjust screen's Status box.

   The pole/zero value can be viewed on the Filter Device Adjust screen under “Pole/Zero” or on the Status Page. The pole/zero value must be updated each time an Auto P/Z is performed or when the slider bar is changed. To update the pole/zero value momentarily switch the Device Adjust screens by clicking on the Stab button or the Gain button, then back to the Filter Device Adjust screen.

If convergence is achieved within two minutes, the new pole/zero value can be verified as indicated in step 3 above. If the pole/zero was unsuccessful, an error message will be posted in the error dialog box.

4. Unsuccessful Pole/Zero and Error Messages

If the Auto Pole/Zero operations fails to converge when initiated one of the following messages will be displayed in the error dialog box to provide diagnostic information regarding the problem. The error message can be cleared by clicking on Ok in the error dialog box.

a. Pole/zero not possible with TRP

You have attempted to initiate an Auto P/Z operation with the Genie environment and hardware configured for a TRP detector; that is, a detector fitted with a reset type preamp. The Auto P/Z function is disabled when a TRP preamp is selected. If you are using a detector with an RC preamp, please go to the MID Editor and set the Preamp Type to "RC".

b. Pole/zero failed to converge

This message may result from any of the following reasons:

P/Z Time Out Error – The Auto P/Z has failed to complete within a maximum time of two minutes. The preamp fall time could be outside the 40 µs to 1.7 ms pole/zero adjustment range or the incoming count rate (ICR) is below 1 kHz. The Auto Pole/Zero will not converge properly if the ICR is less than 1 kHz. Additional causes may be excessive noise or abnormal variations of the Trapezoid baseline. This could result from excessive detector microphonics, high voltage arcing in the detector or preamp, secondary preamp signal time constants or a damaged detector. For those cases, P/Z compensation must be performed manually. Please refer to "Manual Pole/Zero Matching" on page 41.

The Incoming Count Rate is Too High – The incoming count rate (ICR) exceeds 20 kHz. The Auto Pole/Zero will not converge properly if the ICR exceeds 20 kHz. For this condition, the error message will be posted very quickly; long before the two minute time out.

5. Pole/Zero Value

   The four-digit value, located under the pole/zero slider bar, is a reference number which varies from 0 to 4095 representing the pole/zero adjustment range. The values 1 to 4095 represents a time constant range of 1.7 ms to 40 µs. The value "0" can only be set manually; this setting is for no compensation which represents infinity required for Reset type preamps.

   The Pole/Zero value for successive Auto Pole/Zero initiations may vary slightly. This is normal and results from statistical variation associated with the algorithm and system baseline noise.

   If Reset Mode was selected, the four digit value will be set to "0", which is required for proper operation with reset-type preamps.

6. Manual Fine Tuning Using the Pole/Zero Slider Bar

   With the RC Pole/Zero Mode selected, the Pole/Zero may be adjusted manually or the Pole/Zero compensation value, resulting from the automatic operation, may be trimmed by adjusting the associated slider bar on the Filter Device Adjust screen. This operation permanently overwrites the Auto value and may be used to fine tune the Pole/Zero setting to optimize performance at high rates. For additional discussion on manual Pole/Zero adjustment, refer to "Manual Pole/Zero Matching" on page 41.

7. Verifying Pole/Zero Accuracy

   The precision of the Auto P/Z operation can be verified by observing the reconstructed Trapezoid signal on the Monitor Output. Observe the trailing edge of the Trapezoid signal as it returns to the baseline, it should return with no over or undershoot. Set the oscilloscope vertical range to an appropriate sensitivity. Use a Canberra Schottky Clamp Box, Model 1502 or equivalent to prevent oscilloscope overload.

   For additional discussion on Pole/Zero verification and manual adjustment, refer to "Manual Pole/Zero Matching" on page 41.

Manual Pole/Zero Matching

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

With correct P/Z, spectral peaks will appear symmetrical;.while under compensated P/Z will produce low energy tailing. Over compensated P/Z will produce high energy tailing. An example of each condition is shown in Figure 20.

Higher mV/div scope settings (sensitivity) can also be used, but this will result in a less precise P/Z matching adjustment. Most scopes will overload for a 10 V input signal and will exhibit overload aftereffects when the signal returns to the baseline. Thus the P/Z matching will be incorrectly adjusted resulting in a loss of resolution at high count rates.

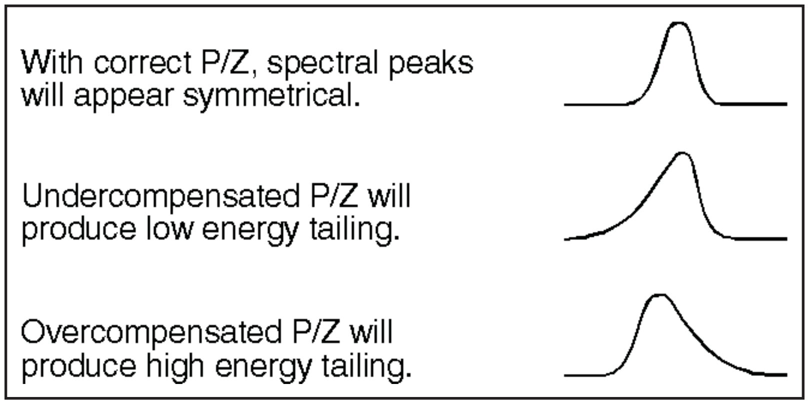


Figure 20 Pole/Zero Compensation - Examples

To prevent scope overload and increase the P/Z matching accuracy, a clamping circuit such as the Canberra Model LB1502 Schottky Clamp Box should be connected at the scope input.

P/Z Matching Using a Ge Detector and ^{60}Co

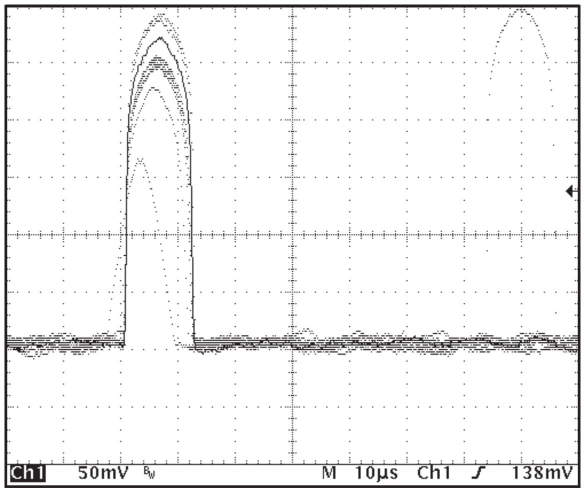
1. Adjust the radiation source count rate to be between 2 kcps and 20 kcps. Observe the trapezoidal waveform on the monitor output.

2. Verify that the preamp type in the filter device MID editor is set to “RC”. Adjust the Pole/Zero slider bar, located in the Filter Device Adjust screen, so that the trailing edge of the trapezoid pulse returns to the baseline with no overshoots or undershoots.

Figure 21 shows the correct setting of the P/Z adjustment, while Figures 22 and 23 show under- and over-compensation for the preamplifier decay time constant. As illustrated for correct P/Z compensation, the monitor output signal should have a clean return to the baseline with no bumps, overshoots or undershoots.

Note Some systems may exhibit small undershoots when the monitor output returns to baseline. These arise primarily from 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 undershoots are present, they should not be confused with undershoots caused by preamp matching misadjustment, which exhibit a much longer time constant and have a larger performance impact.

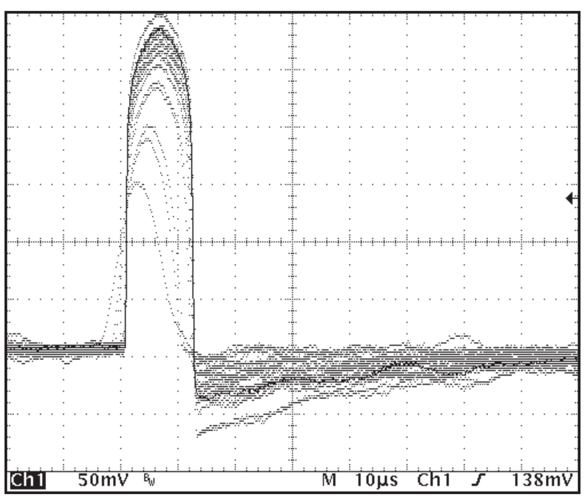
At high count rates, P/Z matching misadjustment will affect spectral peak shape and resolution.



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

Source: ^{60}Co
1.33 MeV peak at 6 V amplitude
Count rate: 2kcps
Shaping: 5.6 µs rise time
0.8 µs flat top

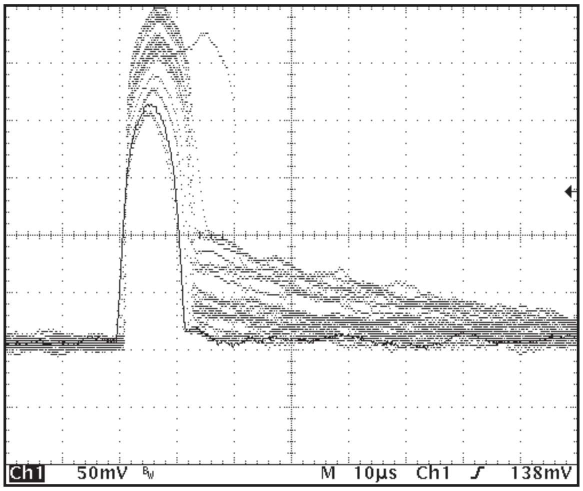
Figure 21 Correct Pole/Zero Compensation



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

Source: ^{60}Co
1.33 MeV peak at 6 V amplitude
Count rate: 2kcps
Shaping: 5.6 µs rise time
0.8 µs flat top

Figure 22 Undercompensated Pole/Zero



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

Source: ^{60}Co
1.33 MeV peak at 6 V amplitude
Count rate: 2kcps
Shaping: 5.6 µs rise time
0.8 µs flat top

Figure 23 Overcompensated Pole/Zero

Automatic Ballistic Deficit Correction

In order to optimize performance with detectors of different sizes and varying charge collection times, the 9660 and 9660A includes Automatic Ballistic Deficit Correction (BDC). Ballistic deficit occurs when the signal from a detector is passed through a filter whose shaping time is too short. When this happens, the filter is unable to completely process all of the charge collected by the associated detector/preamplifier. This can cause a “deficit” in the pulse height value which does not accurately represent the energy of the event. Because the collection time of a detector can vary from one pulse to the next, ballistic deficit may lead to loss of resolution and distortion of the MCA energy peak shape. The effect becomes more pronounced with large detectors and high energies.

Low energy tailing often indicates the presence of ballistic deficit. For traditional analog signal processing, users are forced to manually inspect the peak shape of the MCA energy spectrum and optimize the shaping time selection. For detectors that exhibit ballistic deficit, the shaping time is often increased to improve resolution, but at the expense of throughput. The Trapezoidal shaping function employed in the 9660 allows independent adjustment of the Rise/Fall time and Flat Top. The Rise/Fall time sets the noise filtering characteristics and the Flat Top adds sufficient time for the charge to be collected and integrated. As a result, the ballistic deficit effects can be minimized by adjusting the Flat Top time without burdening the Rise/Fall time. This results in a overall shorter processing time and higher throughput compared to Gaussian shaping and traditional analog signal processing.

Optimizing the Flat Top on the 9660 is automatic and easy; manual adjustment is *not* necessary. Automatic adjustment of the Flat Top time is performed by initiating the Auto BDC (ballistic Deficit Correction) function. A sophisticated algorithm measures the detector pulses, determines the range of detector rise times, and sets the digital filter trapezoid flat top for full charge integration. After the 9660 has adjusted the flat top, variations in detector rise time will not affect the output.

The instructions presented below assume the 9660 is set up as outlined in “Spectroscopy System Setup” on page 34. The BDC does not change the Rise Time setting; use the 5.6 µs default value or set as desired. For additional information on setting the Rise Time please refer to Appendix B, “Performance Adjustments”.

To initiate the Auto BDC process, perform the following steps:

1. Adjust the ^{60}Co radioactive source for an incoming count rate (ICR) between 1 and 20 kHz. The Auto BDC may fail to converge if the incoming count rate is not within this count rate range. The ICR can be verified by viewing the Status Page. Select **MCA | Adjust | Status** from the Acquisition and Analysis window, then “Update” to update the ICR status whenever the radioactive source is adjusted.

Note Although any radioactive source may be used, the most accurate adjustment is obtained using simple sources such as ^{57}Co, ^{137}Cs or ^{60}Co. The Auto BDC operates properly with spectral peaks located within 25% to 100% of the system dynamic range. However, best performance is obtained with the system gain adjusted to place the primary peaks within the top 75% to 95% of the system dynamic range. Once the Auto BDC has completed, replace the calibration source with the sample to be analyzed and adjust the system gain as required.

2. Initiating Auto BDC:

   Note: The Gain and Pole/Zero should be set prior to initiating the Auto BDC function.

   Select the Filter Device Adjust screen (under the MCA | Adjust menu) and press the AUTO BDC “Start” button. The BDC BUSY LED on the 9660 will illuminate for the duration of the process. During this time, normal operation of the 9660 is suspended while detector rise time data is being acquired.

Note Spectral data acquired during the Auto BDC process may be corrupted and should be discarded or cleared when the auto BDC Process has completed.

Upon completing a successful BDC and setting of the Trapezoid Flat Top, the BDC BUSY LED will extinguish. Verify the new Flat Top setting. The Filter Device screen must be updated to show the new value, momentarily switch the Device Adjust screens by clicking on the Stab or Gain button, then back to the Filter Device Adjust screen.

3. Unsuccessful BDC and Error Messages

   If the Auto BDC operation fails to complete after initiation, the BDC BUSY LED will turn off and the message “General SAD error” will be posted in the error dialog box. Click on the Ok button to clear the message.

   The BDC operation could have failed for one of the following reasons:

   a. **BDC Time Out Error** – The Auto BDC has failed to complete within a maximum time of five minutes. This may result if the detector/preamp signal is not connected or the incoming count rate (ICR) is below 1 kHz. Additional causes may be excessive noise or abnormal variations of the Trapezoid baseline. This could result from excessive detector microphonics, high voltage arching in the detector or preamp, secondary preamp signal time constants or a damaged detector. For this case, the Flat Top may be set manually; select FLAT TOP under the Filter parameter group.

   b. **Incoming Count Rate Too High** – The incoming count rate (ICR) exceeds 20 kHz. The Auto BDC will not operate properly if the ICR exceeds 20 kHz. For this condition, the error message will be posted very quickly, long before the time out occurs.

Spectroscopy Operation

Please refer to the Model 556/556A AIM and MCA Software User’s Manuals for specific operating instructions for your MCA.

Place a low activity ^{60}Co source on the detector. Set the MCA to COLLECT or ACQUIRE. For the 9660 setup performed in “Spectroscopy System Setup” on page 34, the 1332 keV ^{60}Co peak should collect in channel 6500 to 7200 for a detector preamp gain of 500 mV/MeV and 8192 memory or spectrum size.

Adjust the 9660’s gain to position the ^{60}Co peaks to the desired MCA spectral location. The Super Fine Gain (SFG) control provides 100 times more resolution than the Fine Gain. Use the SFG when matching the gains of several detectors or when establishing a specific gain calibration (energy per channel).

7. PUR/LTC Operation

The Model 9660 ICB Digital Signal Processor includes a pileup rejector and live time corrector. The pile up rejector inspects for pulse pileup and allows only non-piled up events to be processed and stored into the spectrum. The result is a reduced number of counts in the pileup region and reduced spectral interference for improved quantitative measurement and analysis.

To compensate for dead times associated with rejected pulses and amplifier processing times, the Model 9660 generates a dead time (DT) signal which extends the collection time by the appropriate amount.

Pileup Rejection With a Live Source

The pileup rejector monitors the signal processing activities of the fast discriminator (fast channel) and digital filtered signal (slow channel) and allows only signals resulting from a single detector event to be processed and stored in the spectrum. The fast discriminator detects the arrival of input events and is capable of discriminating between multiple events separated by less than 500 ns. If the fast discriminator detects two or more events within the processing time of the slow channel, the event is contaminated by pileup and is discarded.

The fast discriminator threshold is automatically adjusted just above the system noise level for accurate operation. However, for the discriminating researcher or special circumstances the threshold can be optimized manually. For instructions on adjusting the threshold manually, see “Manual Fast Discriminator Threshold” on page 72.

The following steps will demonstrate the operation of the Pileup Rejector and its ability to reduce spectral interference.

1. Connect the Model 9660 and set it up as described in “Spectroscopy System Setup” on page 34.

2. For the following demonstration of the Pileup Rejector, a ^{57}Co source will be used. As a result the system gain will need to be increased; set the gain as follows:

   Coarse Gain: x40
   Fine Gain: x1.6000
   SF Gain: 0.0000e^{-2}

Leave the remaining functions as previously setup. Verify that the LTC mode is set ON; the function is located on the Gain Device Adjust screen.

Note: The pile up rejector (PUR) and Live time corrector (LTC) operate as an integral system. The function LTC ON, OFF, LFC controls both the PUR and LTC functions.

3. Pole/Zero Compensation

   The Pole/Zero was previously adjusted and it is not necessary to do it again. If for some reason readjustment is necessary, please follow the directions “Detector Matching” on page 38.

4. Adjust the 9660 Gain to locate the 122 keV ^{57}Co peak in channel 3500. This is to allow the Pileup region and sum peaks to be viewed in the upper half of the spectrum.

5. Readjust the ^{57}Co incoming count rate (ICR) for 50 kcps.

6. Set the MCA preset to 60 seconds Live Time.

7. Set the MCA acquire to OFF, clear the memory and set acquire to ON. Accumulate a spectrum with the LTC ON.

8. Save the spectral file or print the spectrum or make note of the background counts and sum peaks for comparison with the LTC set OFF.

9. Set the LTC to OFF, clear the memory and set acquire to ON. Accumulate a spectrum with the LTC OFF.

10. Compare the two spectra, LTC ON and OFF. If the MCA is equipped, use the compare function to overlap the two spectra. See Figure 24:

The spectra shown in the comparison are for an ICR of 50 kcps and 4 µs Gaussian Equivalent Processing Time (Rise Time: 5.6 µs and Flat Top: 0.8 µs). Note the reduction in magnitude of both the sum peaks and background counts. Also note the improved resolution of the sum peaks. The background reduction and improved resolution are directly indicative of the Pileup Rejector’s capabilities, since only sum peak pulses which are indeed 100% in coincidence are processed.

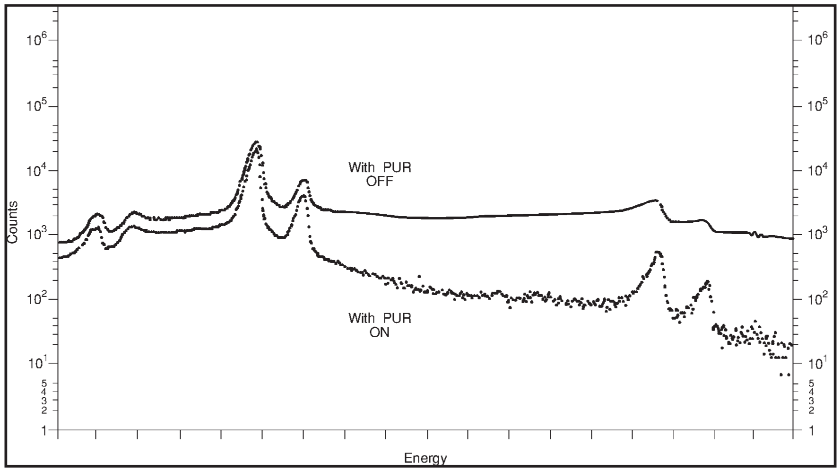


Figure 24 Comparing ^{57}Co Spectra w/PUR On and Off

Live Time Correction With a Live Source

To compensate for events rejected due to pile-up and processing time, a system dead time is derived by the live-time correction function. The dead time signal controls the MCA “Live-Time” clock which extends the acquisition time by the appropriate amount.

The accuracy of the Live Time Correction (LTC) deployed on both traditional analog electronic and the 9660 Digital Signal processor is dependent on the operation of the Fast Discriminator (fast channel) and the pulse evolution time or dead time of the shaped signal (slow channel). In the case of the 9660 DSP, the slow channel is the digital filtered trapezoid signal. Accurate Live Time Correction is obtained when the energy threshold and dynamic range of the fast channel and slow channel are the same. In practice however, the energy threshold of the fast channel is forced to be much higher compared to the slow channel. In order to obtain good pulse pair or timing resolution, the fast channel employs little or no noise filtering. As a result, the signal to noise ratio is much worse, requiring a higher energy/noise threshold.

To optimize the LTC accuracy on traditional systems, the ADC LLD is adjusted or optimized to normalize the energy threshold of the slow and fast channels. However, this has the undesirable effect of affecting the spectral low energy cutoff.

On the 9660 DSP, the “LT Trim” function allows minor adjustment of the pulse evolution time or dead time of the digital trapezoid signal to normalize the fast and slow channel energy thresholds without affecting the spectral low energy cutoff threshold. The LT Trim has an adjustment value of 0 to 1000 and the default value is 250, which gives good Live Time correction performance for most applications. In the steps that follow, Live Time Correction accuracy is measured using the “two source method” which monitors the area of a reference spectral peak when subjected to varying rates of background counts. Typical LTC performance (reference peak area variation) using the default LT Trim setting is typically less than 3% for dead times of 50%. The discriminating user can improve performance further, for the intended application, by calibrating the system using the “Two Source Method” and optimizing performance using the LT Trim.

The following steps are designed to demonstrate and verify the effectiveness of the Live Time Correction function. The verification/optimization process uses the “Two Source Method” which assumes that source “A” is ^{60}Co and source “B” is ^{137}Cs. The 1173.2 keV peak of ^{60}Co will be used as a reference. The upper peak, at 1332.5 keV, is not a good choice because the sum peak of ^{137}Cs at 2 x 661.6 = 1323.2 keV would interfere with the measurement.

1. Connect the Model 9660 and setup described in “Spectroscopy System Setup” on page 34.

2. Verify LTC is set ON.

3. Pole/Zero Compensation

   The Pole/Zero was previously adjusted and it is not necessary to do it again. If for some reason readjustment is necessary, please follow the directions in “Detector Matching” on page 38.

4. Set the MCA’s preset to 500 Live seconds.

5. Position the ^{60}Co source near the Ge detector and adjust for an incoming count rate of 2 to 5 kcps. The 1173.2 keV ^{60}Co reference peak should be at approximately 80% of the spectral full scale range. If necessary, adjust the 9660 gain to properly locate the peak.

Note: Once in place, the source should not be moved or altered in any way for the remainder of the experiment!

6. Clear the MCA and acquire a spectrum for 500 live seconds. Record the net area of the 1173.2 keV ^{60}Co peak.

7. To the ^{60}Co source, add approximately 25 kcps of ^{137}Cs to make the total incoming rate 30 kcps.

8. Clear the MCA, Collect a new spectrum for 500 live seconds, and record the net area of source the 1173.2 keV ^{60}Co reference peak.

9. Compare the net area of the 1173.2 keV ^{60}Co peak acquired in step 6 and compute the percentage change.

10. If improvement is needed, try adjusting the LT TRIM slightly and repeat steps 6 through 9 until an optimum setting is achieved. The LT Trim function is located on the Gain Device Adjust screen. The value can be decremented/incremented over a range of 0 to 1000 using the adjust slide bar (the default setting is 250).

Note: Lowering the LT Trim value will increase the system dead time and counts in the reference peak area at high count rates.

Since the detector-source geometry was maintained and the preset Live Collection time was held constant, the ^{60}Co (1173.2 keV) net area can be used as a standard when comparing the effect of adding background counts Cs^{137} (661 keV).

11. Set the LTC ON/OFF switch to Off. Repeat steps 4 through 9. Compare the deviation of source “A’s” spectrum when the LTC is ON and the LTC is OFF.

With the LTC OFF, large changes will be observed in the reference net peak are as a function of count rate. With the LTC set ON, changes in the reference peak net area will be significantly reduced. The Live Time corrector extends the collection time compensating for signal processing time and events rejected due to pileup.

Note: Performance may vary and is dependent on factors such as spectrum energy distribution, detector characteristics such as geometry, size, and detector ballistic deficit.

PUR Guard

The PUR Guard Time (GT) function is provided to optimize the performance of the Pileup Rejector. The pile up reject interval is defined as GT x T_R+$T_{Flat\ Top}$ where:

GT = PUR Guard Time selection; 8 selections ranging from 1.1 to 2.5 are provided

T_R = Filter Rise Time selection

$T_{Flat\ Top}$ = Filter Flat Top selection

With the default (minimum) PUR GT setting (1.1x) the pile up reject interval and the Peaking Time are the same; see Figure 25.

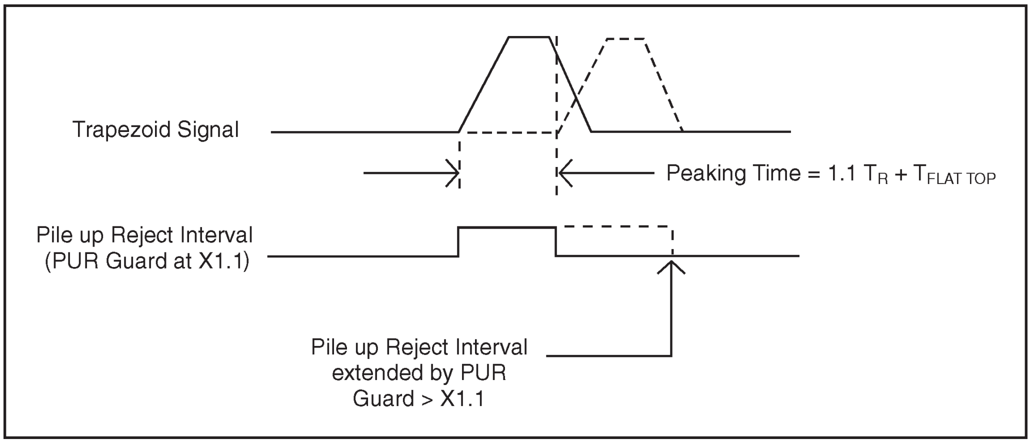
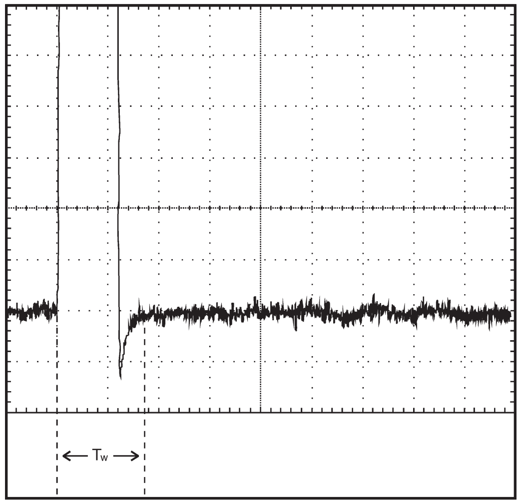


Figure 25 PUR Reject Interval

Subsequent events arriving within the PUR reject interval are rejected, events occurring afterwards are accepted. Increasing the Guard Time extends the pile up rejection interval to protect subsequent events from being corrupted by anomalies associated with the tail of the previous event. As expected, throughput is reduced as the Guard time and pile up rejection interval are increased. The maximum Guard Time setting (2.5x) requires the previous event to fully return to the baseline before subsequent events are accepted. The default Guard Time (1.1x) is minimum and provides optimum performance and maximum throughput for most detector applications.

For the example shown above, the second event begins before the first returns to the baseline. This is not normally a problem and the second event should be accepted for maximum throughput. However, if the tail of the first event exhibited detector-induced anomalies, the second event would be corrupted and should not be accepted. To prevent acceptance of this corrupted event, the PUR Guard should be increased as shown.

Some detectors with RC preamps may exhibit secondary time constants which is evident by a short lived undershoot or ring on the trailing edge of the shaped signal (see Figure 26).



Scope:
Vertical: 10 µs/div
Horizontal 20 mv/div

Figure 26 Preamplifier Secondary Time Constant

This behavior is usually due to non-ideal characteristics of the preamp feedback resistor. Events that fall on the tail of an event which exhibits this behavior will become corrupted or distorted when minimal guard time is selected. In this case, the spectral peaks will be distorted with excessive high or low side tailing at high count rates. Events that arrive too close and are corrupted by the tail of the previous pulse can be rejected by increasing the Guard Time. For problematic detectors this will reduce spectral distortion at high count rates, but at the expense of reduced throughput.

PUR Guard Setup

The default PUR Guard Time is 1.1x. This Guard Time is minimum and does not extend the pile up rejection interval beyond the peaking time. For events that exhibit secondary time constants or other anomalies, measure the pulse width from the leading edge to where it returns to the baseline and becomes stable. This is noted as time T_W in Figure 26. The required guard time is determined by dividing T_W by the Peaking Time ($1.1T_R + T_{Flat\ Top}$).

For example:

- The filter rise time is set to 5.6 µs and the flat top is set to 0.8 µs.
- The Peaking Time is: 1.1 x 5.6 µs + 0.8 µs = 7.0 µs. T_W for a stable baseline is 15.0 µs.
- The desired guard time setting is: T_W/Peaking Time = 15.0/7.0 = 2.1

If the calculated guard time falls in between available selections, set the PUR Guard for the next higher setting. The pileup rejection interval will now be extended beyond the peaking time. Subsequent events that occur within the pileup reject interval of 15 µs will be rejected. After this instance, the anomaly associated with the tail of the previous pulse is over and subsequent events can be accepted. As noted earlier, extending the PUR interval by adding Guard Time will degrade throughput. Highest throughput is obtained with the PUR Guard set for minimum; x=1.1.

The PUR Guard adjust function is located on the Gain Device Adjust screen. The value can be decremented/incremented using the adjust slide bar. The adjust range is 1.1x to 2.5x (the default setting is 1.1x).

PUR Guard Adjustment Using a Live Spectrum

As mentioned earlier, detector/preamplifier induced effects on the trailing edge of the shaped signal will cause spectral distortion; low or high side tailing.

At moderate to high count rates, observe the shape of the spectral peaks. They should appear symmetrical. Low or high side tailing may indicate the presence of preamplifier-induced effects corrupting the trailing edge of the shaped signal. This could also be due to a misadjusted pole/zero. Verify the Pole/Zero is correctly optimized (refer to “Detector Matching” on page 38.

If the Pole/Zero is not the problem, set the PUR Guard to 2.5x and acquire a new spectrum. If the symmetry of spectral peaks improves, this affirms that trailing edge pileup effects associated with the shaped signal are responsible. Reduce the PUR Guard time to the next lower setting of 2.3x and re-acquire a spectrum. If the symmetry and FWHM of the spectral peaks remain good, reduce the PUR Guard time again to the next lower setting. Repeat this procedure until spectral distortion begins to reappears, then set the PUR Guard time to the next higher setting.

Live Time Correction Using the LFC Module

The Model 9660 Digital Signal processor can be used with the Model 599 Loss Free Counting Module (LFC). The 599 LFC provides the ability of correcting for counting losses as they occur in real time, rather than extending the measurement duration as in conventional live time correction. The LFC module dynamically monitors the counting losses and generates a fractional weighting value N. The LFC and MCA update the intended memory address using an ADD-N memory transfer instead of the traditional ADD-1.

The intended MCA must support multiple ADD-N or multiple ADD-1 operations. Please reference the 599 LFC Operator Manual for specific details and operating instructions.

LFC System Setup

1. Connect the 9660 DSP, 599 LFC and 556/556A AIM as shown in Figure 27.

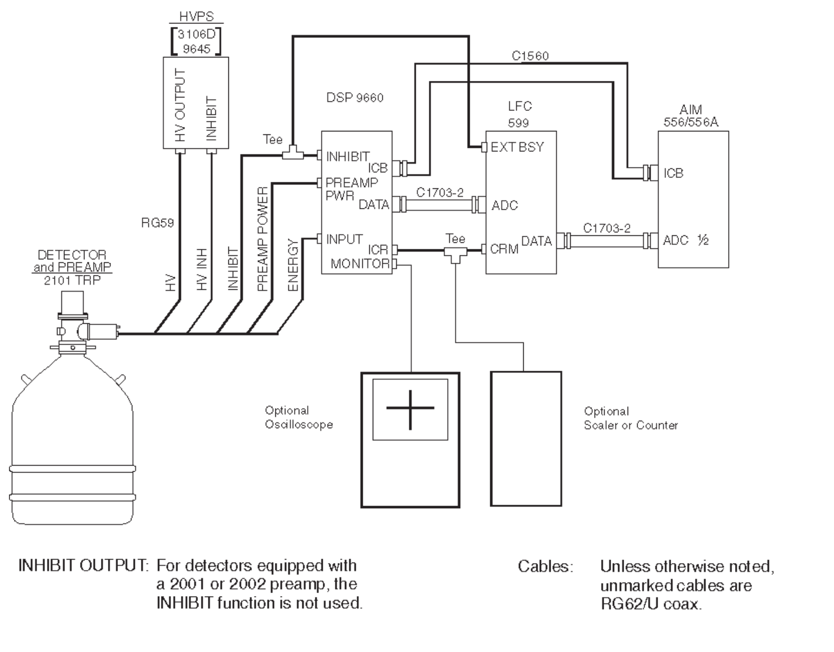


Figure 27 LFC System Setup

2. On the MCA Adjust Screen, set the LTC Mode on the 9660 DSP to LFC; this will enable Loss Free Counting. The LTC Mode selection is located on the Gain Device Adjust Screen.

3. Follow the directions and calibration instructions as indicated in the *Model 599 LFC User's Manual*.

4. Initially set the PET Monostable as indicated in step 3.5.1 (Gaussian Shaping Amplifiers) of the *Model 599 LFC User's Manual*.

5. Calibrate or optimize the PET Monostable adjustment using the Two Source Calibration Method as indicated in step 3.5.2 of the *Model 599 LFC User's Manual*.

A. Specifications

Inputs

INPUT - Accepts positive or negative signals from an associated preamplifier; amplitude ±10 V divided by the selected gain, ±12 V maximum; rise time: less than the selected flat top time setting; decay time constant: 40 µs to 1.7 ms for RC Preamp mode, infinity for TRP mode; Z_{in} varies with Coarse Gain and polarity setting from 500 to 2k.

GATE IN - Accepts a positive logic pulse or dc level; high amplitude ≥+2.5 V, Low amplitude ≤+400 mV, 0 to +7 V maximum; dc coupled; open input allows PHA operation; Loading is 1k to +5 V with Coincidence selected and 1k to 0 V for Anticoincidence; width ≥50 ns; In COINC (ANTIcoincidence) mode a positive (negative) logic pulse or dc level during the rise time and flat top of the trapezoidal waveform will enable the conversion in process; if the GATE IN is low (high) during this time the impending conversion will be disabled; the reconstructed trapezoidal waveform may be viewed on the MONITOR output.

INHIBIT - Accepts a standard TTL logic signal; functionality is dependent on which Inhibit Mode is selected. NORM selected: resets and inhibits the pileup rejector and extends the Dead Time signal for the duration of the INH signal; RESET preamp selected: inhibits the 9660 during the preamplifier reset cycle, the leading edge of the INH signal resets the pileup rejector and initiates the 9660 to automatically disable pulse processing and extend the system dead time for the duration of the resultant overload event. The total inhibit time is the OR" of the external INH signal and the 9660 reset disable time, whichever is longer. Positive true or negative true signal polarities, user selectable; minimum pulse width is 1 µs; loading 4.7K; logic high ≥+3.6 V, logic low ≤+1 V; 0 to +12 V maximum; rear panel BNC connector.

ICB - Provides for connection to the Instrument Control Bus. Computer control of the Model 9660 is through this bidirectional interface; rear panel 20-pin ribbon cable connector.

Outputs

MONITOR - Provides viewing of sampled data, reconstructed in time; digitally filtered Trapezoidal/Triangular pulse; amplitude linear to +8 V, 8 V max; $Z_{out} \approx 50\ \Omega$; short circuit protected; front panel BNC connector; provided as a user aid to assist with setup.

ICR (Incoming Count Rate) - Provides a standard TTL logic signal; frequency corresponds to input count rate; positive true; width ≈ 150 ns, Z_{out} ≈ 50 Ω; rear panel BNC connector.

DATA - Provides 14 binary TTL-compatible output lines and the data transfer commands required for MCA interface; data interface is compatible with the Canberra Model 556/556A Acquisition Interface Module (AIM), rear panel 34-pin ribbon cable connector.

DT/BSY - Rear panel BNC with two functions: Dead Time or Busy, selected by LTC Mode; TTL output with 47 Ω series resistor; rear panel BNC connector.

Front Panel Indicators

READY - Indicates operational status. Bi-color LED: green when on-line, yellow for fault or error, off when the module is waiting computer recognition.

BDC BUSY - Green LED, monitors status of AUTO BDC (Ballistic Deficit Correction) matching function, ON continuously while trapezoid flat top is automatically matched to the charge collection time of the detector, OFF when proper matching is achieved, active only when AUTO BDC mode is enabled.

ICR - Green LED indicator, blinks for every input event detected by the Fast Discriminator; intensity corresponds to input count rate.

ICB Programmable Controls

The programmable controls are grouped by the associated device adjust menu.

Gain Device Adjust Menu
System gain is continuously variable from x2.0 to x1536.

Coarse Gain - x5, x15, x40, x120, x330, x960.

Fine Gain - Range: x0.4 to x1.6.

S-FINE Gain (SFG) - Range: $0.0000e^{-2}$ to $3.000e^{-2}$; the SFG adds to the FINE Gain Value; resolution is better than 1 part in 16 000.

Conv Gain - Selections of 256, 512, 1024, 2048, 4096, 8192, or 16 384 channels. Represents the full scale resolution of the input signal. Conversion range is set to equal the selected conversion gain.

Offset - Offsets the spectrum to the left; subtracts 0 to 16 256 channels in binary multiples of 128 channels.

LLD - Digital Lower Level Discriminator for minimum input acceptance level; adjustment range 0.0% to 100% of the spectrum full scale range.

Zero Adjust - Digital Zero Adjustment; ±3.13% of the spectrum full scale range.

FDisc Mode - AUTO, MANUAL; AUTO: Fast Discriminator (FD) threshold is optimized automatically; MANUAL: Fast Discriminator signal is over a range of 0 to 100%.

FDisc Setting - Allows adjustment of the Fast Discriminator threshold level when MANUAL DISC THRES is selected. The adjustment range is 0% to 100%; also serves as a user aid when manually setting the Fast Discriminator.

LT Trim - Allows adjustment of the trapezoid pulse evolution time or dead time to optimize Live Time Correction (LTC) performance. The adjustment range is 0 to 1000; the default value of 250 provides good LTC performance for a wide range of applications.

LTC Mode - ON, OFF, LFC

> ON: Enables pile-up rejector and live time corrector (LTC). LTC generates dead time to extend the acquisition time to compensate for events that are piled-up and rejected.
>
> OFF: Pile-up rejector and LTC disabled.
>
> LFC: Enables pile-up rejector and LFC interface, LTC function disabled; when used with Model 599 LFC Module counting losses are corrected in real time.

PUR GUARD - NORM, ADJUST; Selects guard time multiplier “GT” in increments of 1.1, 1.3, 1.5, 1.7, 1.9, 2.1, 2.3 and 2.5 to reject trailing edge pile up in the event of detector/preamp anomalies; guard time extends from peak detect time by the amount ($GT \times T_R + T_{FlatTop}$); “GT=1” selects minimum resolving time for maximum throughput.

Inh Polarity - Selects either POSITIVE or NEGATIVE inhibit polarity.

Inp Polarity - Selects either POSITIVE or NEGATIVE input polarity.

Inhibit Mode - Selects either NORM or RESET inhibit modes; with NORM selected, the system is gated off while external INHIBIT is set true. In RESET mode, the inhibit time is automatically extended to account for the system overload recovery time or while external INHIBIT is set true.

Coinc Mode - Selects either COINCidence or ANTIcoincidence gating. In the COINCidence mode (ANTIcoincidence) a positive GATE pulse enables (disables) the conversion of the present input.

Filter Device Adjust Menu

Rise Time - 35 rise and fall times ranging from 0.4 µs to 28 µs; step size dependent on rise time range; may be viewed on MONITOR output.

Flat Top - 21 flat top time selections ranging from 0 to 3 µs; increment size dependent on flat top range; may be viewed on MONITOR output.

BLR Mode - AUTO, HARD, MEDIUM, SOFT; AUTO: The baseline restorer is automatically optimized as a function of trapezoid shaping time and count rate; HARD, MEDIUM, or SOFT: Sets the baseline restorer to fixed rates as selected.

Pole/Zero - Displays the current Pole/Zero setting; value ranges from 0 to 4095. 1 to 4095 represents 1.7 ms to 40 µs; a value of zero sets the pole/zero compensation off or to infinity; adjustment enabled when RC preamp type is selected; increment/decrement value using the associated slider bar.

Auto P/Z (9660A only) - Available only for the 9660A with the automatic pole/zero option installed. Computer command initiates the automatic p/z process.

AUTO BDC - Computer command initiates process of optimizing the trapozoidal flat top parameters to match to charge collection time of the detector.

Preamp Type - RC, RESET; selects the Pole/Zero mode; RC: pole/zero is adjusted by computer command; range: 40 µs to infinity; RESET: Sets pole/zero at infinity for use with pulsed charge restoration (RESET) preamplifiers.

Stabilizer Device Adjust Menu

Gain Mode - ON, OFF, HOLD; ON/OFF: enables or disables the Gain Mode; HOLD: disables the stabilizer Gain Mode, but maintains the current Gain correction factor; Centroid (0 to 16 376 channels), Window (1 to 128 channels), Spacing (2 to 512 channels) ratio (0.01 to 100), correction rate (1 to 512); correction range of 1% for Ge and 10% for NaI detectors.

Zero Mode - ON, OFF, HOLD; ON/OFF: enables or disables the Zero Mode; HOLD: disables the stabilizer Zero Mode, but maintains the current Zero correction factor; Centroid (0 to 16 376 channels), Window (1 to 128 channels), Spacing (2 to 512 channels) ratio (0.01 to 100), correction rate (1 to 512); max. correction range of 1% for Ge and 10% for NaI detectors.

Performance

SPECTRUM BROADENING - The FWHM of ^{60}Co 1.33 MeV gamma peak for an incoming count rate of 2 kcps to 100 kcps will typically change less than 6% for 2.8 µs rise/fall time, 0.6 µs flat top and proper P/Z matching. These results may not be reproducible if the associated detector exhibits an inordinate amount of long rise time signals.

INTEGRAL NONLINEARITY - ≤±0.025% of full scale over the top 99.5% of selected range.

DIFFERENTIAL NONLINEARITY - ≤±1% over the top 99% of the range including the effects from integral nonlinearity.

GAIN DRIFT - ≤50 ppm/°C.

ZERO DRIFT - ≤10 ppm/°C.

OVERLOAD RECOVERY - Recovers to within 1% of full scale output from x1000 overload is 2.5 non-overlapped pulse widths of full gain, at any shaping (processing time), and with pole/zero properly set.

Pileup Rejector/Live Time Corrector

PULSE PAIR RESOLUTION - 500 ns.

FAST DISCRIMINATOR THRESHOLD - Set automatically or manually.

DEAD TIME CORRECTION - Extended Live-time correction, accuracy of reference peak area changes 5% (3% typical) up to 50% system dead time for 4 µs Gaussian equivalent processing time.

Power Requirements

+24 V dc – 90 mA	+12 V dc – 200 mA	+6 V dc – 1.5 A
–24 V dc – 90 mA	–12 V dc – 150 mA	–6 V dc – 1.2 A

Connectors

With the exception of the NIM BIN and preamp power connectors, all signal connectors are BNC type.

Preamp Power - Rear panel, Amphenol, type 17-10070.

Data - Rear panel, 34 pin ribbon

ICB - Rear panel, 20 pin ribbon.

Cables

A 12 port ICB connecting cable and 34 pin data cable are supplied with each Model 556/556A AIM. If the cables are ordered separately, please specify the following:

- Model C1560 12-port ICB connecting cable
- Model C1703-2 AIM/AMX data cable.

Physical

SIZE - Standard double-width NIM module 6.86 x 22.12 cm (2.70 x 8.71 in.) per DOE/ER-00457T.

NET WEIGHT - 1.8 kg (4.0 lb).

SHIPPING WEIGHT - 2.7 kg (6 lb).

Environmental

OPERATING TEMPERATURE RANGE - 0 to 50 °C.

HUMIDITY - Up to 80% relative non-condensing.

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

Ordering Information

9660 - ICB programmable Digital Signal processor

9660A - ICB programmable Digital Signal Processor with automatic pole/zero option installed.

B. Performance Adjustments

This appendix describes how to make several performance adjustments: adjusting the rise time and the flat top, matching the pole/zero manually, setting the baseline restorer, setting the fast discriminator threshold, and operating the 9660 with reset preamps.

Rise Time and Flat Top Adjustments

The digital filter employed in the 9660 has a Triangular/Trapezoidal weighting or shaping function. The processing time (Shaping) is set by the Rise Time and Flat Top selections and is generally a compromise between optimizing throughput and resolution. Having the ability to independently set the Rise Time and Flat Top allows greater flexibility when optimizing the processing time or shaping for a wide variety of detector applications. The Rise Time sets the noise filtering characteristics of the Digital Filter while the Flat Top allows for the charge collection time of the particular detector. Independent adjustment of the flat top allows the shaping function to be optimized for detectors with long charge collection time, without a large increase in the overall processing time. For small detectors with minimal charge collection time variation or ballistic deficit, the trapezoidal shape reduces to triangular shaping when the Flat Top is set to minimum or zero. The triangular/trapezoidal shaping function is symmetrical. The fall time cannot be set independently, it always equals the Rise Time selection.

Shaping is adjusted by selecting the Rise Time and Flat Top, which determine the Trapezoid pulse shape and optimizes performance for the specific detector, spectral energy range and count rate. As in any signal processing application, a performance tradeoff exists between high resolution and high throughput. For example when using a small Ge detector, 5.6 µs rise time and 0.8 µs flat top settings provide optimum resolution over a wide range of count rates. However, a 2.8 µs rise time and 0.6 µs flat top will degrade low count rate resolution performance slightly, but results in less resolution broadening and peak shift over a much wider count rate range.

For ultra high counting and throughput rates, rise time and flat top settings of less than 1 µs may be used. For this case, optimum resolution is traded off for increased count rate performance. For high resolution detectors, longer rise time settings offer a better signal to noise (S/N) ratio and longer flat top settings reduce the effects of ballistic deficit. However, as the system count rate increases, resolution may degrade more rapidly due to increased processing time and the effects of pulse pile-up.

For most Ge detector applications, digital trapezoidal shaping provides Gaussian equivalent resolution with half the processing time. Faster processing time means the 9660 provides significantly greater throughput than a traditional analog system with its processing or shaping times set for equivalent resolution. When using small Ge detectors which are optimized for high count rate performance, throughputs of 100 kcps can be achieved. To achieve 100 kcps and higher throughput, the highest spectral peak must not exceed 80% of full scale. For more information on count rate performance, refer to Canberra's Application Note "Performance of Digital Signal Processors for Gamma Spectroscopy". Please contact your sales representative to request a copy.

However, the settings which realize reduced processing time, high throughput and equivalent resolution for Ge detectors may be a bit aggressive for some low energy applications. For these applications, which include LEGe, Si(Li) and X-ray detectors, resolution will be equal to or better than that obtained with traditional analog systems when the Rise Time and Flat Top filter parameters are optimized for resolution. For this case, the trapezoidal rise time parameter is increased so that the processing time and throughput are equivalent to Gaussian shaping.

Table B.1 lists the 9660 Rise Time and Flat Top settings which optimize performance for high throughput/good resolution and optional setting for best resolution/lower throughput when using Germanium Coaxial detectors.

Table B.1 Gaussian Shaping vs. Throughput and Resolution

Gaussian Shaping (µs)	Highest Throughput[1] Rise Time/Flat Top	Highest Resolution[2] Rise Time/Flat Top
0.5 µs	0.8 µs/0.2 µs	1.2 µs/0.2 µs
1.0 µs	1.2 µs/0.6 µs	2.8 µs/0.6 µs
2 µs	2.8 µs/0.6 µs	5.6 µs/0.6 µs
4 µs	5.6 µs/0.8 µs	12 µs/0.8 µs
6 µs	8.8 µs/1.2 µs	18.4 µs/1.2 µs
12 µs	16.8 µs/2.4 µs	28 µs/2.4 µs

Note 1: Optimized for high throughput, good or equivalent Gaussian shaping resolution.
Note 2: Optimized for highest resolution, equivalent Gaussian shaping processing time/throughput.

Table 1 lists settings for optimizing throughput or resolution. Of course a setting in between can be chosen to optimize performance for a specific application. The Gaussian Equivalent Shaping Times are suggested as starting values. You may change these values to enhance throughput or resolution as required by your application.

As previously mentioned, the shaping times recommended for highest throughput produce a trapezoidal pulse response which has approximately one-half the processing time when compared with traditional analog Gaussian shaping amplifiers. These settings result in almost twice the throughput compared to traditional analog pulse processing, with little or no resolution degradation in most high energy Ge detector applications.

The shaping times recommended for highest Resolution produce a trapezoidal pulse response with a processing time that is equivalent to traditional analog signal processing. Longer rise time and flat top settings provide better noise filtering and reduced ballistic deficit. However, as the system count rate increases, resolution and throughput may degrade as a result of increased processing time and the effects of pulse pile-up.

The optimum shaping-time constant depends on the detector characteristics (such as size, noise characteristics and collection characteristics), preamplifier and incoming count rate. Settings for typical germanium coaxial detectors have been discussed above. Table B.2 lists 9660 rise time and flat top settings for other common detectors.

Table B.2 Settings for Other Common Detectors

Detector	Rise Time/Flat Top (ms)
Scintillation [NaI(Tl)]	0.8/0.2 or 1.2/0.6
Planar Implanted Passivated Silicon (PIPS) (Silicon Charged Particle)	0.8 / 0.2, 1.2/0.6 or 2.8/0.6
Proportional Counter	0.8/0.2, 1.2/0.6 or 2.8/0.6
Lithium Drifted Silicon [Si(Li)]	8.8/1.2 or 16.8/2.4
Coaxial Germanium	2.8/0.6 or 5.6/0.8
Low Energy Germanium	5.6/0.8, 8.8/1.2 or 16.8/2.4

Refer to the specific Detector Operator's Manual for the recommended shaping time. A good starting point is the Gaussian equivalent processing time selections listed in the table on page 64. The Rise Time and Flat Top setting can be optimized further through experimentation. Collect spectra using rise time and flat top settings above and below the recommended settings, to optimize resolution performance for your particular detector and application.

Flat Top Setting

The 9660 allows independent selection of rise time and flat top. A detector with long charge collection times will require a flat top long enough to process all the charge from the detector (see “Automatic Ballistic Deficit Correction” on page 44). If the flat top is too short, it may result in low side spectral tailing and degraded resolution (However, if these symptoms occur at high rates only, the P/Z setting may be misadjusted. In this case, first verify the correct P/Z setting and readjust if necessary). To set the flat top manually, start with a long value, then collect a spectrum and verify good resolution and peak symmetry. Reduce the flat top and repeat the process. Continue until resolution and peak symmetry begin to degrade, then set the flat top to the next higher value. The optimal (shortest) flat top will allow the best throughput.

The rise time setting can be optimized separately to achieve the best count rate/resolution compromise. However, the optimum flat top for a detector depends somewhat on the rise time selection. Therefore, the best correction for ballistic deficit will be achieved by running the Auto BDC function again or manually checking the flat top setting if the rise time is increased or decreased by a factor of two or more.

Triangular shaping may give enhanced resolution performance for small detectors having little variability in charge collection time. To set the unit for triangular shaping, adjust the rise time to the desired value and set the flat top to zero.

Pole/Zero Matching - Supplementary Information

Using a Square Wave Generator

1. Driving the preamp test input with a square wave will allow a more precise adjustment of the preamp matching.

2. The 9660s GAIN, RISE TIME, FALL TIME and INPUT POLARITY settings should be adjusted for the intended application.

3. Adjust the square wave generator for a frequency of approximately 100 Hz.

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

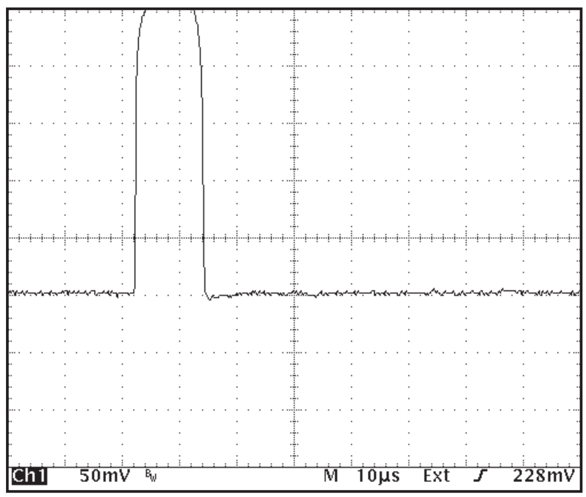
5. Remove all radioactive sources from the vicinity of the detector.

6. Set the scope’s Channel 1 vertical sensitivity to 2 V/div, and adjust the main time base to 10 µs/div.

7. Observe the Model 9660s Monitor output. If you are using an LB1502 Clamp Box, set the switch in the DIRECT position. Adjust the scope

triggering so that the positive trapezoid output is observed, then set the square wave generator's amplitude control (attenuator) for an amplitude of 6 V.

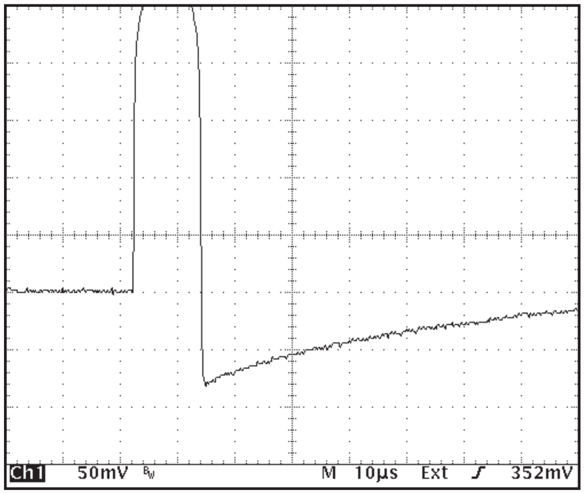
Change the scope vertical sensitivity to 50 mV/div. To prevent scope overload, clamp the Monitor output signal by moving the LB1502 Clamp Box switch to the CLAMP position. Adjust the Pole/Zero slider bar for correct pole/zero compensation. Figure 28 shows the correct P/Z setting.



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

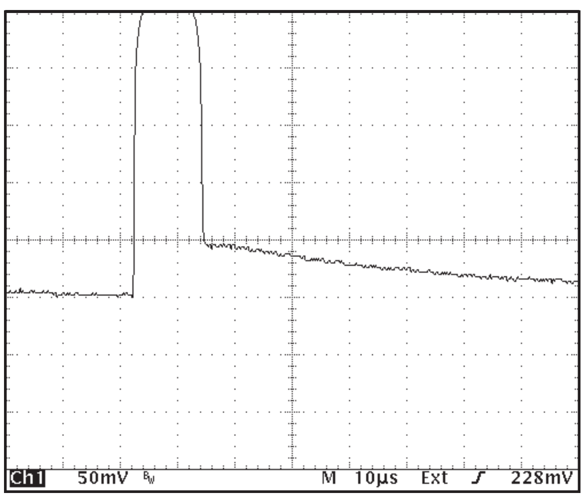
Figure 28 Correct Pole/Zero Compensation

Figures 29 and 30 show under- and over-compensation for the preamplifier decay time constant. As illustrated in the correct Pole/Zero compensation example, the monitor output signal should have a clean return to the baseline with no bumps, overshoots or undershoots.



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

Figure 29 Undercompensated Pole/Zero

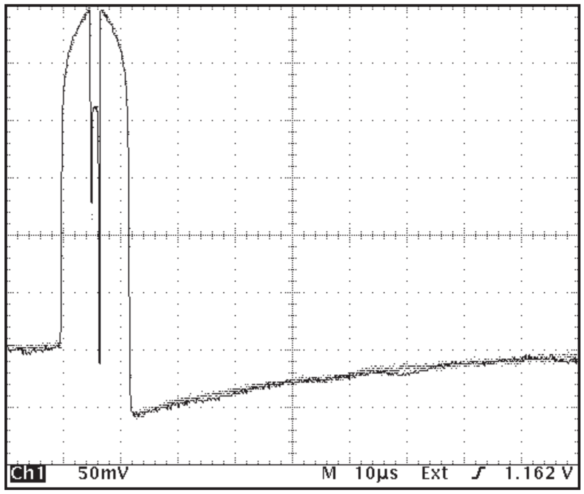


Scope:
Vertical: 50 mV/div
Horizontal: 10 µs/div

Figure 30 Overcompensated Pole/Zero

Pole/Zero Matching and “Wrap Around”

When the monitor output is processing large signals, the output may “wrap around” as the signal reaches the maximum level. Often a clamp box such as the LB1502 can still be used to make the pole zero adjustment (see Figure 31, where the gain has been adjusted to produce “wrap around”).

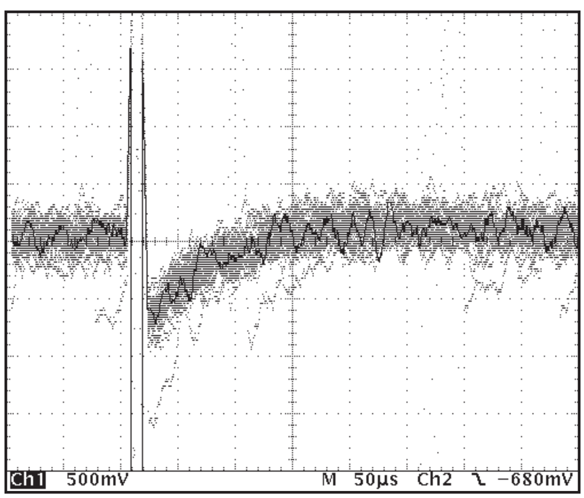


Scope:
Vertical: 50 mV/div
Horizontal: 10 µs/div

Source: ^{60}Co
Count rate: 2 kcps
Shaping: 5.6 µs rise time
0.8 µs flat top

Figure 31 Undercompensated Pole/Zero with Wrap Around

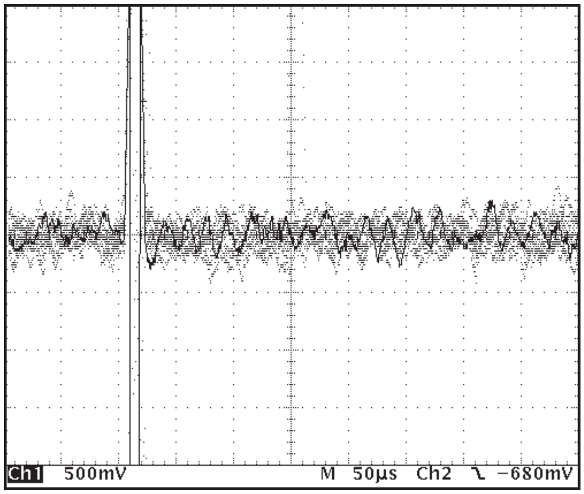
However if the signal is very noisy, the noise may exceed the range of the clamp box and the pole zero adjustment should be made by viewing the monitor output directly (see Figures 32, 33 and 34).



Scope:
Vertical: 500 mV/div
Horizontal: 50 µs/div

Source: ^{60}Co
Count rate: 2 kcps
Shaping: 8 µs rise time
2.4 µs flat top

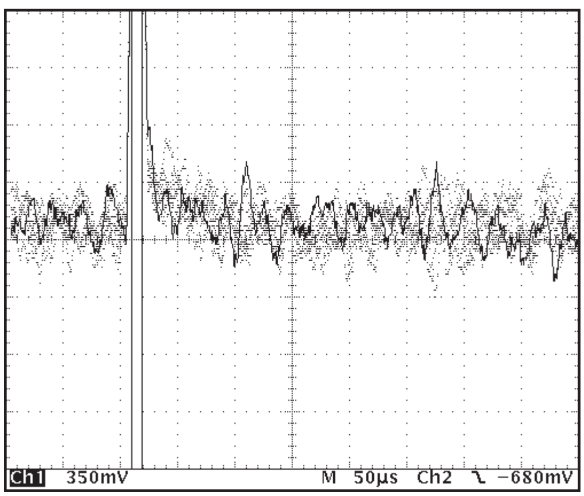
Figure 32 Undercomp. Pole/Zero with Noisy Detector



Scope:
Vertical: 500 mV/div
Horizontal: 50 µs/div

Source: ^{60}Co
Count rate: 2 kcps
Shaping: 8 µs rise time
2.4 µs flat top

Figure 33 Correct Pole/Zero Comp with Noisy Detector



Scope:
Vertical: 500 mV/div
Horizontal: 50 µs/div

Source: ^{60}Co
Count rate: 2 kcps
Shaping: 8 µs rise time
2.4 µs flat top

Figure 34 Overcompensated Pole/Zero with Noisy Detector

There are several ways to reduce “wrap around.” At the high gains used with low energy sources, there are two contributors to the effect. The first is the pulse height itself; the second is the elevated baseline due to amplified detector noise. If the effect is troublesome, try using a higher energy source and lowering the gain when optimizing the pole/zero. Lowering the gain will reduce both pulse height and noise to eliminate “wrap around,” while maintaining good signal/noise conditions for adjusting the pole zero. When completed, return the 9660 gain to the setting required for the intended application. If a high energy source is not available, the “wrap around” can still be decreased by simply lowering the gain or rise time setting. This will lower the digital filter’s gain and sensitivity to offset and reduce the wrap around effect. Although this also lowers the pole/zero error sensitivity or magnitude, it can be compensated for by increasing the sensitivity of the oscilloscope. When done optimizing the Pole/Zero, return the gain or rise time back to the setting required for the intended application.

For further discussion of the “wrap around,” effect, please refer to “Trapezoid Output” on page 29.

Baseline Restorer

The digital baseline restorer in the Model 9660 is flexible and allows adjustment for varying baseline conditions affected by detector type, noise and count rate. The baseline restorer rate is selected using the BLR mode drop down menu in the Filter Device Adjust screen.

With the Baseline set to AUTO, the digital baseline restorer is automatically set for optimum performance throughout the usable input count rate range.

The restorer can also be set to three manual settings: SOFT MEDIUM and HARD. These setting can be used with detectors having exceptionally stable baselines at all rates, or with detectors which at high rates develop unusual noise, requiring a somewhat lower restoration rate than provided by AUTO Rate. The SOFT selection significantly reduces the baseline restorer’s restoration rate. This may prove to be advantageous in some low count rate/low energy applications. With the SOFT selected, the restorer’s low frequency noise suppression effectiveness is reduced. The ambient low frequency noise and the implementation of noise reduction techniques regarding setup can easily be assessed and tested.

For situations where a higher than normal restoration rate is required, the restorer rate may be set to MEDIUM or HARD, which increases restoration rate proportionately. This can improve performance at extremely high input counting rates or where more control is required to maintain the baseline, such as with some NaI(Tl) scintillation detector systems.

Manual Fast Discriminator Threshold

In some cases, you may want to set the Fast Discriminator threshold manually. For best performance, set the threshold just above the system noise level.

1. Set the Amplifier Gain and shaping as required.

2. Set the FDisc Mode in the Gain Device Adjust screen to “Manual”.

3. Remove all excitation sources from the vicinity of the detector.

4. Use the FDisc setting slider bar in the Gain Device Adjust screen to set the fast discriminator threshold just above the system noise as indicated in step 5.

5. The following steps optimize the discriminator sensitivity to insure the threshold is at its lowest setting, just above the noise level:

   Adjust the FDisc Setting to 0%. The ICR LED indicator continuously glows green.

   Next, increase the FDisc Setting level until the ICR LED indicator is no longer on continuously, but shows low activity by blinking green occasionally. The fast discriminator threshold is properly set.

Note With the Fast Discriminator in the manual mode, the threshold must be re-checked and adjusted if the Detector/Preamplifier is changed or the 9660s GAIN is changed.

Operation with Reset Preamps and Selecting Inhibit Mode

The 9660 Digital Signal processor is fully compatible with most pulsed reset preamplifiers. Reset preamps use an electronic circuit, as opposed to a feedback resistor, to restore the preamp back to a reference level. As a result, the preamp output is a succession of step functions that staircase or ramp up to an upper limit or threshold that initiates a preamp reset.

Configuring the Preamp Reset Mode

When using a Transistor Reset Preamp (TRP), it may be necessary to disable the Reset Delay feature, if present, on the associated preamplifier. If the Reset Delay feature is left enabled, small phantom peaks may result slightly before or after each of the main spectral peaks.

If you are using a Canberra Model 2101 preamplifier, disable the Reset Delay using these three steps:

1. Remove all signal and power connections from the preamp.

2. Remove the preamp cover and change jumper plug W1 from position A to position B. Jumper plug W1 is located on the main PC board next to RV1.

3. When done, reinstall the preamp cover an reconnect the preamp to the 9660 as before or as indicated in “Spectroscopy System Setup” on page 34 and in Figure 19.

For additional information on the Reset Delay feature and jumper plug W1, please refer to the *Model 2101 User’s Manual*.

Pole/Zero Setting for Reset Preamps

Since the Reset Preamp output signal is a step function instead of the classical tail pulse, with exponential decay, Pole/Zero compensation is not required. For this application, the Pole/Zero should be set off or to infinity. On the 9660, this is accomplished by setting the preamp type to RESET. The preamp type can be changed in the Filter Device MID Editor. If RESET is selected, the Pole/Zero is automatically set to a value of zero, corresponding to a fall time of infinity, and no further adjustment is required. If RC is selected, the pole zero value in the Filter Device Adjust screen must be manually set to zero.

Using the Reset Inhibit

During the preamp reset interval, the preamp reset event produces a large signal to the 9660 driving it into severe overload. The 9660 automatically senses preamplifier reset events and gates off pulse processing during the associated overload event. However, to obtain optimum performance, especially at high count rates, it is recommended the preamplifier’s Inhibit signal be connected to the Inhibit Input on the 9660. Figure 35 below shows Trapezoid Signal, Preamp Output and Inhibit Signals.

The 9660 system inhibit is initiated or derived from the preamp inhibit signal. The optimum system inhibit time can be set automatically by the 9660 or adjusted manually. For automatic inhibit, set the Inhibit Mode, Gain Device Adjust screen, to “Reset”. When using the RESET mode of operation, the correct system inhibit time is automatically set. It is not necessary to make critical adjustments of the inhibit signal at the preamp. However, the preamp inhibit signal should be set to its minimum value. Please consult the Detector/Preamp Operator manual for this adjustment.

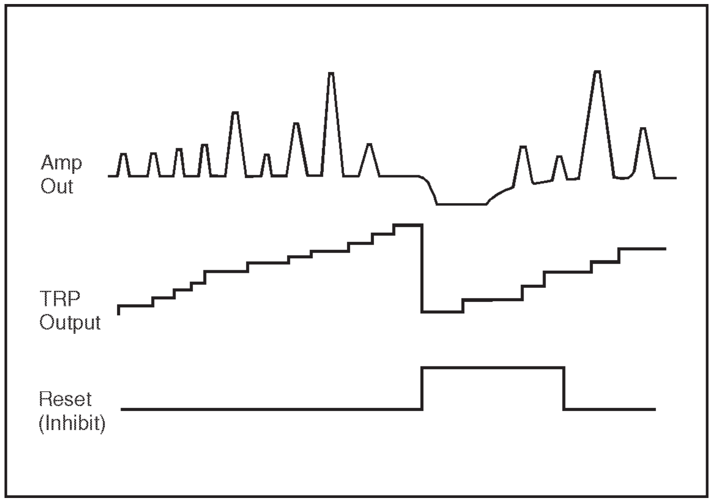
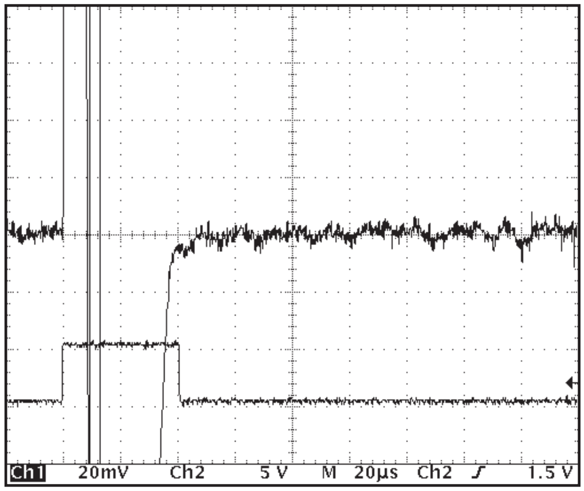


Figure 35 Monitor Output, TRP Output, TRP Inhibit

Note When using the automatic RESET inhibit mode, the system inhibit is the time interval automatically generated by the 9660 “OR” the external inhibit duration which ever lasts longer. For proper operation set the preamp inhibit time to minimum or it can override the optimum inhibit time generated by the 9660.

When setting the inhibit time manually, set the TRP Inhibit to NORMAL. The TRP Inhibit mode is selected in the Gain Device Adjust screen. The inhibit time of the preamp must now be manually adjusted to encompass or extend to the point where the trapezoid signal returns back to the baseline.

Using a “Tee” connector, connect the preamp’s Inhibit signal to the INHIBIT BNC connector located on the rear panel of the 9660. Monitor the preamp’s Inhibit signal and the 9660s Trapezoid signal, viewed on the Monitor Output, using an oscilloscope. Use a clamp box, such as the Canberra Model LB1502, when viewing the Trapezoid signal to prevent scope overload. Trigger the Oscilloscope on the leading edge of the preamp Inhibit signal. Adjust the preamp inhibit time so that it returns to zero volts after the negative Trapezoid (negative overload) signal returns to the baseline (see Figure 36). Consult the Detector/Preamp Operator manual for this adjustment.



Scope:
Horizontal: 20 µs/div
Vertical: 50 mV/div
Vertical: 5 V/div

Figure 36 Setting Reset Preamp Inhibit Pulse Width

The 9660's overload recovery time is approximately 40 µs with the Rise time set to 5.6 µs and Flat Top set to 0.8 µs and using a Canberra Model 2101 preamp and ^{60}Co source.

C. Data and ICB Interface Connectors

This appendix provides information that is helpful when interfacing to an MCA.

MCA Data Transfer

A typical conversion and data transfer sequence is illustrated below (Figure 37):

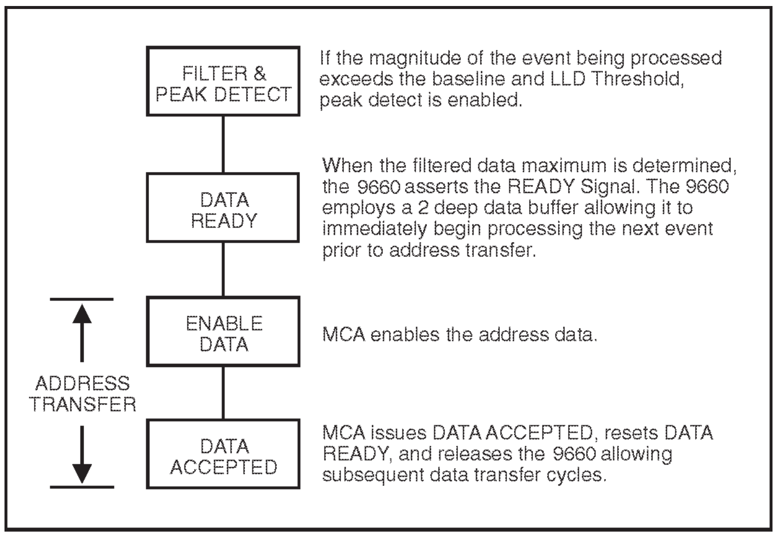


Figure 37 Typical Conversion and Transfer Sequence

The result of the digitization and digital filtering is a 14-bit binary coded number or address. At the conclusion of the conversion, the address data is transferred into a holding register and the data transfer signal DATA READY is set true. The address data is now valid and can be accessed and used by the MCA or CPU.

Due to a two-deep data buffer, the 9660 can begin processing the next event even though data transfer to the memory unit is still in process.

The address lines are driven by tri-state drivers activated by ENABLE DATA, which is initiated by the data memory device.

When transfer is complete, the memory device sets DATA ACCEPTED true, releasing the 9660 to begin the next pending transfer sequence.

Data Connector

This 34-pin ribbon connector (J102) provides all the necessary signals for connection to the MCA. Negative true signals are shown with a trailing asterisk (ACEPT*); all other signals are positive true.

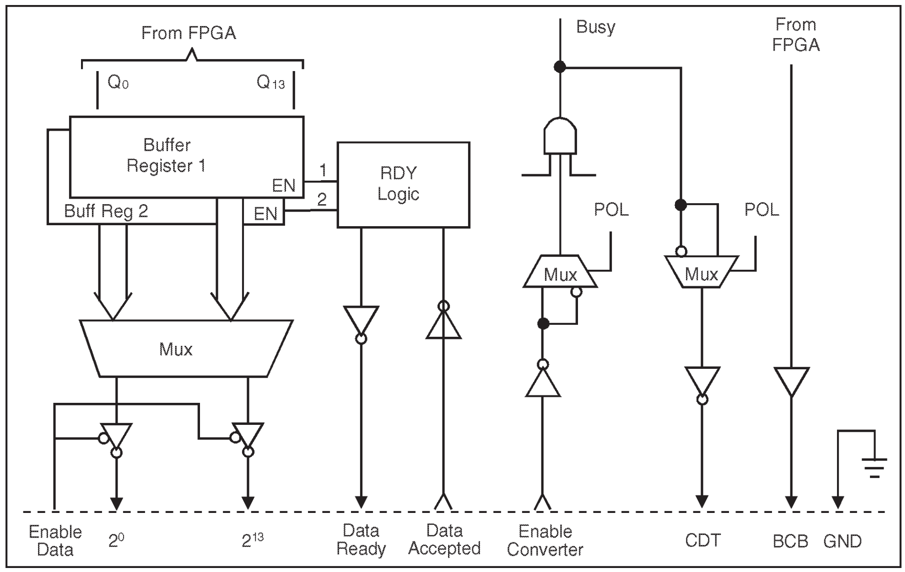


Figure 38 Representative Interfacing Logic

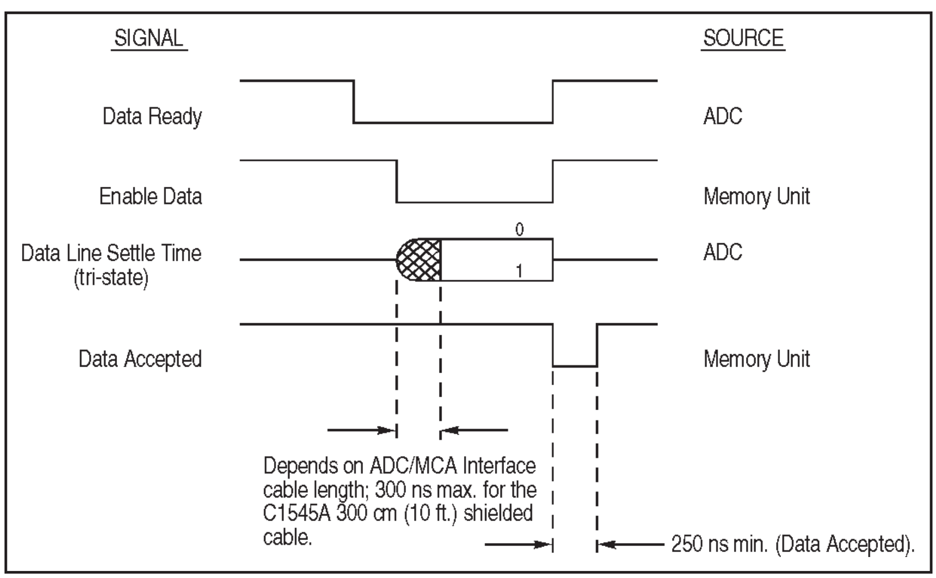


Figure 39 Data Transfer Timing Diagram

PIN	SIGNAL	PIN	SIGNAL
1	GND	2	ACEPT*
3	GND	4	ENDATA*
5	GND	6	CDT* or CDT
7	GND	8	ENC* or ENC
9	GND	10	READY*
11	GND	12	OPEN
13	ADC13*	14	ADC0*
15	ADC7*	16	ADC1*
17	ADC8*	18	ADC2*
19	ADC9*	20	ADC3*
21	ADC10*	22	ADC4*
23	ADC11*	24	ADC5*
25	ADC12*	26	ADC6*
27	OPEN	28	OPEN
29	OPEN	30	OPEN
31	OPEN	32	OPEN
33	BCB*	34	OPEN

Signal Functions

This section describes the function of each interface signal in detail. All input and output signals are TTL compatible. Unless otherwise noted, the input signal levels are:

Low = 0 to 1.0 volts
High = 2.0 to 5.0 volts

And the output signal levels are:

Low = 0 to 0.5 volts
High = 3.0 to 5.0 volts

All input and output signals are considered to be a logic 1 for a high voltage level unless the signal name is followed by an asterisk (*), in which case the signal is considered to be a low voltage level.

SIGNAL	PIN	DESCRIPTION
ADC0*	14	OUTPUT: Binary data 2^0 (LSB)

ADC1*	16	OUTPUT: Binary data 2^1
ADC2*	18	OUTPUT: Binary data 2^2
ADC3*	20	OUTPUT: Binary data 2^3
ADC4*	22	OUTPUT: Binary data 2^4
ADC5*	24	OUTPUT: Binary data 2^5
ADC6*	26	OUTPUT: Binary data 2^6
ADC7*	15	OUTPUT: Binary data 2^7
ADC8*	17	OUTPUT: Binary data 2^8
ADC9*	19	OUTPUT: Binary data 2^9
ADC10*	21	OUTPUT: Binary data 2^{10}
ADC11*	23	OUTPUT: Binary data 2^{11}
ADC12*	25	OUTPUT: Binary data 2^{12}
ADC13*	13	OUTPUT: Binary Data 2^{13}
ENDATA*	4	INPUT (Enable Data): Used to enable the tri-state buffers driving the 14 bits of data onto the output lines ADC0* through ADC13*.
READY*	10	OUTPUT (Data Ready): Indicates that data is available for transfer to the MCA. READY* will be reset after receipt of signal ACEPT*.
ACEPT*	2	INPUT (Data Accepted): Signals the ADC that the data has been accepted by the MCA. ACEPT* may reset when READY* resets (handshake).
ENC* or ENC	8	INPUT (Enable Converter): This signal enables or disables the 9660 DSP. Enable/Disable polarity is programmed with selection of MCA type through the MCA menu.
CDT* or CDT	6	OUTPUT (Composite Dead Time): This signal indicates the time when the 9660 is busy and cannot accept another input event. Enable/Disable polarity is programmed with selection of MCA type through the MCA menu.
BCB*	33	OUTPUT: Provides a negative true logic signal, approximately 250 ns wide; initiated by PK Detect and conclusion of PUR guard. This signal is required by the Model 599 LFC Module.

GND	1,3,5,7,9,11	DC common for all interface signals.

ICB Connector

This 20-pin ribbon connector, J106, provides all the necessary signals for connecting the Instrument Control Bus (ICB). Negative true signals are shown with a trailing asterisk; Address/Data signals (LDn) are positive true.

Pin	Signal	Pin	Signal
1	GND	2	LD0
3	LD1	4	GND
5	LD2	6	LD3
7	GND	8	LD4
9	LD5	10	GND
11	LD6	12	LD7
13	GND	14	LWE*
15	GND	16	LDS*
17	GND	18	LAS*
19	GND	20	LSRQ*

Interface Signal Functions

This section describes the function of each interface signal in detail. All input and output signals are TTL compatible. Unless otherwise noted, the input signal levels are:

Low = 0 to 1.0 volts
High = 2.0 to 5.0 volts

And the output signal levels are:

Low = 0 to 0.5 volts
High = 3.0 to 5.0 volts

All input and output signals considered to be a logic 1 for a high voltage level unless the signal name is followed by an asterisk (LWE*), in which case the signal is considered to be a logic 1 for a low voltage level. The direction of the signal is referenced to the amplifier.

Signal	Pin	Direction	Description
LD0	2	Input/Output	Address/Data line 0 (LSB)
LD1	3	Input/Output	Address/Data line 1
LD2	5	Input/Output	Address/Data line 2
LD3	6	Input/Output	Address/Data line 3
LD4	8	Input/Output	Address/Data line 4
LD5	9	Input/Output	Address/Data line 5
LD6	11	Input/Output	Address/Data line 6
LD7	12	Input/Output	Address/Data line 7
LWE*	14	Input	(Write Enable) This signal is active when the ICB Master is writing to the ICB.
LDS*	16	Input	(Data Strobe) Used to latch the data into a slave during a write cycle or gate the data onto the bus during a read cycle.
LAS*	18	Input	(Address Strobe) Used to latch the address which the ICB Master is accessing into the slave units.
LSRQ*	20	Output	(System Request) This signal is set when the slave requires service from the ICB Master.
GND	1, 4, 7, 10,13, 15,17,19	———	DC common for all interface signals.

D. 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 to the specified EU requirements.

For technical assistance, call our Customer Service Hotline at 1-800-255-6370 or email techsupport@canberra.com.

Preventive Maintenance

Preventive 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.

CANBERRA

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If defects in materials or workmanship are discovered within the applicable warranty period as set forth above, we shall, at our option and cost, (A) in the case of defective software or equipment, either repair or replace the software or equipment, or (B) in the case of defective services, reperform such services.

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