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N.E. 427

NUCLEAR ELECTRONICS

Equipment:	Tektronix 2235A Portable Oscilloscope Ortec 485 Amplifier or Ortec 571 Amplifier Ortec 419/Canberra 1407/Hamner NP-10A Pulse Generator PGT MCA8000 Personal Computer Multi-channel Analyzer
References:	Tektronix 2235AA Manual, pp. 1-1 to 1-7; pp 2-3 to 2-8; pp 2-11 to 2-12 MCA8000 Instruction Manual 485 Amplifier Manual, pp. 1 to 7 571 Amplifier Manual, pp. 1 to 3 419 Pulse Generator Manual pp. 1 & 4
Reading	Tektronix: The XYZ's of Oscilloscopes, pp. 11, 18-32, 45-50

Electronic Equipment

Most nuclear counting equipment uses transistorized modules (NIM) which derive their power from a bin into which the module is plugged. Never insert or remove modules without turning off the bin power, otherwise modules may be damaged. Never apply D.C. voltages to signal inputs otherwise transistors may be damaged. Never apply high-voltage without checking lead connections (high-voltage supplies typically have an independent on/off switch).

Different connectors and cables are used for high voltage lines and signal lines. MHV and SHV (shielded) connectors are for high voltage; SHV connect HV supply through TC 164 preamp. BNC connectors are usually used for signal lines.

There is a drawer in the laboratory that contains folders with instruction manuals for all the equipment in the lab. If you are unfamiliar with the equipment, read the manual before using the equipment.

Power Supplies: NIM bins provide power for most counting circuits. High voltage power supplies provide voltage for GM tubes, proportional counters, and photomultiplier tubes. Connect HV supply only with power turned off and voltage controls at lowest available setting. Turn on power after connections are made. Some HV supplies have a time delay that assures that rectifier tubes have warmed up before voltage can be applied. Gradually increase voltage. Listen for voltage breakdown and, if possible, watch for breakdown on scope.

Amplifiers amplify and shape pulses from counter. Gains are typically 5-1000. Gain must be low enough that amplifier does not overload. When overloading occurs amplification deviates from linearity and pulse shape changes: pulses develop flat tops. Flat tops will occur at the maximum voltage output of the amp (~10-12 V). A typical timescale for each pulse shape is ~ 1 microsecond, so a time setting ~ microseconds on the scope is appropriate for viewing individual pusles. Gain must be high enough that smallest pulses that are to be counted have an amplitude greater than 0.2 V, which is the low-level voltage discrimination level of the MCAs. Always note the polarity of the amplifier, since it needs to be properly matched to the detector or pre-amplifier polarity to produce a positive voltage pulse.

Preamplifiers are low gain amplifiers. Their principal function is to provide impedance matching to drive the signal cables between the counter and the amplifier. They also shape the pulses. The preamplifiers derive their power from the supply of the main amplifier. Preamplifiers often provide a connection from the HV power supply to the counter and contain a high voltage capacitor which insulates the high voltage from the preamplifier input. Watch out for noise signal pick-up from monitors and ground-loops on the pre-amp s.

(Integral) Discriminator produces pulses of uniform height from input pulses larger than the (adjustable) discriminator level or bias. Be sure that amplifier output pulse has correct sign for discriminator input (usually positive).

Single Channel Analyzer (SCA) produces logical pulses of uniform height after receiving signal input within a range of pulse voltage heights. This range of height is referred to as the window. Both the width of the window and its position are adjustable. SCA's can also serve as integral discriminators if the window can be opened wide enough.

Multichannel Analyzer permits simultaneous analysis of the entire pulse height spectrum and consists effectively of many (512, 1024) SCA's all of which have the same window width. The key parameters for controlling the MCA are the conversion gain and memory size. Conversion gain and memory size of 1024 are recommended, since the pulse height voltage is approximately the channel number / 100. The MCA's input voltage range is 0- 10 V.

Scaler (also called counter/timer) counts logic pulses from discriminator SCA output. Be sure that input pulses have proper sign. Scalers often have built-in adjustable discriminators.

Timer turns scalers off after preset time. (Canberra 2071A scaler has internal timer).

Coincidence Analyzer records two (or three) pulses which occur within an adjustable time interval. Logic pulses of uniform height are produced when the input pulses meet the coincidence requirement. Analyzer may also be used in anticoincidence mode, i.e., it puts out a pulse when the input pulses do not occur within a preset time interval.

Delay Circuit delays a pulse by a selected length of time (200 ns to 6 □s). This circuit is used in connection with the coincidence analyzer to compensate for time differences in different counters.

Procedure:

A. Amplifiers and Oscilloscopes

1. Briefly skim pp. 1-1 to 1-7 of the Tektronix 2235A manual for a quick overview of the oscilloscope performance.

2. Read carefully pp 2-3 to 2-8; identify and learn the function of all of the controls.

3. OPERATOR'S CHECKS AND ADJUSTMENTS. This is the beginning of the "hands on" activity in this lab. Procedures are listed in the Tektronix 2235A manual starting on page 2-11.

BASELINE TRACE -- follow this procedure as directed in the manual. In the future, if you have problems with an oscilloscope, this procedure will help you ensure the oscilloscope settings are correct.

TRACE ROTATION -- check the trace rotation, but DO NOT attempt adjustment without consulting the instructor (normally not required).

PROBE COMPENSATION -- perform the check described on p. 2-12, but DO NOT attempt adjustment without consulting the instructor (normally not required).

VERTICAL DEFLECTION TEST -- follow the procedures 1 to 9, (ignore 10).

4. Connect a pulse generator to the amplifier as shown. The probe or a BNC cable can be used to connect the amplifier to the scope.

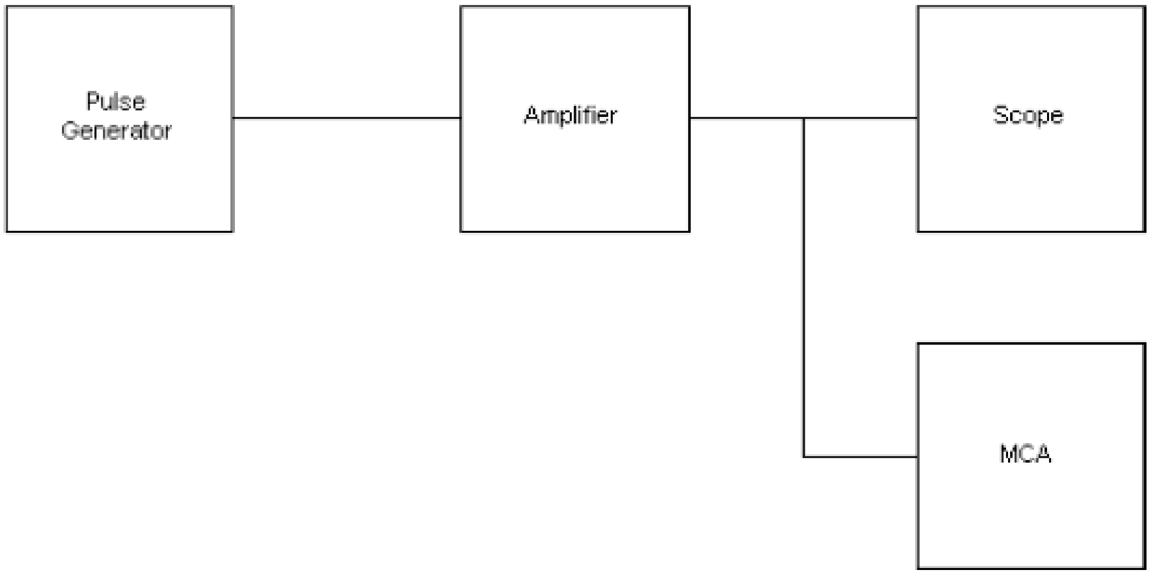
Set the rise time of the pulser to ~50-100 nanoseconds. If your pulser has variable fall time, set it to ~50 microseconds. Turn on the pulse generator and adjust the pulse generator output for a positive, 100 mV pulse. Trigger on CH1, sweeping at 1μsec/div. Adjust the gain of the amplifier for a gain of 50. Now vary the input pulse amplitude to investigate the linearity of the amplifier. At what output level does the amplifier saturate? If your pulser has variable rise time, look at the effect of changing the rise time. Examine the amplifier output using both a BNC connector and a x10 probe.

Notes: Pulse Generator maximum output voltage is 1V
Maximum fine gain on 485 amplifier is ~3:1
The polarity of the pulse generator output must match the selected input polarity on the amplifier.

B. Introduction to the MCA8000 Analyzer (a.k.a MCA). Refer to the MCA8000 manual and the summary instructions for operating the MCA.

1. The multichannel analyzer (MCA) used in many of the experiments in 427 is on a separate board connected to the PC and is controlled from the keyboard and mouse. You may log in as usual to CAE or you may operate in a stand-alone mode. After entering Windows, the MCA may be loaded by clicking on the QtmGold icon.

2. Connect the pulser, amplifier, scope and MCA together as shown in the following block diagram.



3. Turn on the computer and MCA. Launch the MCA software. Note that the MCA must be turned on before the software is launched.

4. Read through the summary instructions provided in the MCA blue folder. While acquiring a spectrum, familiarize yourself with the controls by doing steps 1 through 6, 8, and 9 in the manual. If needed, full instructions for the MCA are located in the MCA manual.

5. Establish the following settings.

Energy=2.0 MeV full scale
Group Size=1024
Conversion gain=1024
Group=1
ADC Zero=0%
ADC LLD=1.0%
ADC ULD=100%
PHA mode

6. Send a pulse from the amplifier to the MCA. Adjust the output of the amplifier using the pulser and the amplifier gain controls to give a pulse of ~4 volts. **NOTE**: Be sure the polarity of the pulser and the input polarity switch of the amplifier agree, e.g. if the pulser is set to produce negative pulses, the amplifier should be set to "**negative**".

7. Collect a spectra. What channel does the peak appear in? Switch the energy scale to 4 MeV full scale. Now where does the peak appear?

8. Go back to an energy scale of 2 MeV full scale. Switch the group size and conversion gain to 512. Now where does the peak appear? Note that for the group size or the gain to be changed, there must be no data in the spectrum and the MCA not currently acquiring data. The energy scale can be changed at will.

9. Change the fine gain on the amplifier. Does the peak do what you expect? Compare the amplifier output as measured on the MCA to that of the oscilloscope. Is the response of the amplifier linear?

10. Set a region of interest around the peak. What do the "net integral" and "FWHM" boxes tell you? Select peak identity. What is the system trying to tell you?

11. Look at the information under:

Analysis Tools: ROI Data
Analysis Tools: ROI Detail

12. Change the real time, live time, peak, and integral settings under presets. Collect a spectra for each case. Do you understand the differences in these settings?

13. Make sure you can successfully save, retrieve, and print spectra. If data is saved into an ASCII format, once the header is removed from the ASCII file, the data can be read into Excel as

fixed width delimited data for further analysis if necessary.

14. Copy spectra and metafiles into a word document.

15. Look at View: Setups. Would this be good information to save, along with data, for a laboratory report?