

# LabVIEW Pulse Height Analyzer

---

## OVERVIEW

This program uses a high-speed digitizer card to read a sequence of pulse trains from the output of a pulse-shaping amp or similar device. The pulses are analyzed according to their height, and a count is added to a corresponding bin for each pulse height. The maximum sample rate of the digitizer is 100 megasamples/second, and the maximum voltage measurable by the digitizer is 10V. The digitizer resolution 14 bits, or 610 microvolts. The digitizer has an internal amplifier that allows it to make higher resolution measurements (specified by the VERTICAL RANGE control), but the maximum signal level is proportionally reduced.

## OPERATION OF CONTROLS

TAKE DATA starts a new data collection process. Some program actions cannot be taken during data collection--these are shown by disabling the relevant buttons. Any new data is added to the existing set.

CLEAR clears the data set. It may be used at any time.

SAVE DATA opens a dialog box so the user can save the data file. The file is in the form of two columns of numbers; the first column is the voltage corresponding to a particular bin, the second is the number of counts in each bin. Note: the current data set is also saved by the program when it is exited using STOP PROGRAM. This file is automatically reloaded when the program is started.

LOAD OLD DATA allows the user to look at a previously saved data set.

PRINT DATA brings up a black & white dialog box containing a copy of the current graph and some useful parameters. Choosing OK from this dialog prints the contents of the dialog box on the default printer.

ANALYZE DATA opens a window which allows the user to fit curves to the data. The curves and data can be printed to the default printer. Further instructions on using the fitting window are available in that window.

STOP PROGRAM stops the program entirely. To restart, use the small ARROW BUTTON.

## DIGITIZER PARAMETERS

"Low level disc (V)" sets the minimum pulse height that will be recorded. When used with triggered modes, this also sets the (analog) trigger point of the digitizer.

"Linked to trigger?" when checked sets the analog trigger to be equal to the Low Level Discriminator setting. This control is only active when (a) a triggered mode is being used and (b) the trigger channel is the same as the Input Channel.

"Input" selects which inputs are used to collect the data. You can select digitizer "Ch 0" or "Ch 1", or you can select a special mode "Ch 0 coinc Ch 1". The special mode compares Ch 0 with Ch 1. It is assumed

that the input to Ch 1 is a TTL level gate pulse that is coincident with the variable pulse coming in on Ch 0. Only if Ch 1 is above threshold will Ch 0 get recorded and subsequently analyzed. If the coincident input is used, it is recommended that "Continuous" mode also be used, otherwise many coincident counts may not get recorded.

"Run time (s)" sets the data collection time. To run continuously, set this value to "0". Subsequent runs add to the existing data set. Data must be CLEARED if the user wants a fresh run.

"Vertical range" sets the maximum voltage that will be read by the digitizer. Any voltage above that value will be read as equal to the vertical range value. Lower values of the vertical range setting can be used if one needs a higher resolution for smaller voltage signals. (An internal amplifier increases the signal sent to the analog-to-digital converter.)

"Sample Rate (Hz)" sets the rate at which the digitizer samples the input waveform. This control should be set high enough to accurately digitize input pulses, but not much higher. If the input pulses have a long time constant, one can lower this value to improve the responsiveness of the program.

"Record Length (points)" sets the size of the input buffer used to hold the digitized waveform. The total time that a single waveform grab takes is  $(\text{Record Length})/(\text{Sample Rate})$ .

"Mode" selects the mode of operation of the digitizer. There are 4 modes:

1. "Continuous" is essentially a zero dead time mode. The digitizer fills its buffer in a continuous loop which is read out in chunks of a minimum size specified by the "record length." This is the most efficient mode for collecting high count rates or for collection coincident counts (see "Input"), but it makes the greatest demands on the computer. If the digitization rate is too high, one will get buffer overwrite errors.
2. "Triggered: EXT" takes data only if the signal on external trigger input is above the trigger threshold (all triggers are positive edge).
3. "Triggered: Ch 0" takes data only if the signal on the channel 0 input is above the trigger threshold. If the Input is also set to Ch 0 and the "Linked to trigger" box is checked, the trigger is set by the Low Level Discriminator.
4. "Triggered: Ch 1" takes data only if the signal on the channel 1 input is above the trigger threshold. If the Input is also set to Ch 1 and the "Linked to trigger" box is checked, the trigger is set by the Low Level Discriminator.

(Version 1-4x, 20 October 2015)

## **DATA WINDOW OPERATIONS - PULSE HEIGHT HISTOGRAM:**

"Counts" is equal to the sum of the counts in all bins.

"Elapsed time" is the time since TAKE DATA was clicked.

"Update (cyc)" gives the number of acquisition cycles between histogram updates. The graph will appear to update more slowly as this parameter is increased, but the number of counts added will be greater with each update.

"Bins" gives the number of histogram bins chosen. NOTE: this parameter is active only when the data set is empty. Otherwise the number of bins, and their range, is set by the existing data set.

"Min" and "Max" set the minimum and maximum voltage that will be counted. These controls also control the min and max of the graph x-axis itself.

The yellow vertical cursor shows the current value of the low level discriminator.

## **DIGITIZER INPUT:**

This window shows the raw data coming into the digitizer. It is only active when the "Show Input" button is ON and data is being collected. The horizontal yellow cursor shows the current value of the low level discriminator. The horizontal axis length is determined by the "Record length" control. Under normal operations, this window should be used with "Show Input" set to OFF, since updating this display increases dead time in triggered acquisition and may limit the maximum data collection rate.

## **\* PROGRAM PECULIARITIES \***

The maximum count rate achievable depends on many factors, such as the computer speed, the sample rate, record length, and histogram update rate. The default settings are OK for a source of moderate activity, and are a compromise between good count rates and user responsiveness. To maximize the program's ability to count rapid pulses, you should choose a long record length and a large number of acquisition cycles between histogram updates.

When the program first starts, it loads the set of data it had on last closing. This will also force the program to choose that data set's values of histogram bin size and extent. Any data collected after will be added to the set already in memory. Thus, to start a completely new collection, you should always clear the data first.

If triggered data collection is started without a (good) signal to the digitizer, the program will timeout with an error message.

The program assumes that the digitizer has an internal designation of "Dev1".

[David B. Pengra, 20 October 2015]