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New External Triggering Options Instructions for Spectrometers with Firmware Version 3.0 and Above

Overview

Ocean Optics spectrometers with Firmware Version 3.0 and above (currently HR2000+, Maya2000Pro, USB2000+ and QE65000) provide several methods of acquiring data (see table below). In the Normal/Free-Run mode, the spectrometer is "free running." That is, the spectrometer is continuously scanning, acquiring, and transferring data to your computer, according to parameters set in the software. In this mode, however, there is no way to synchronize the scanning, acquisition, and transfer of data with an external event. However, trigger pulses for synchronizing an external event with the spectrometer are available.

To synchronize data acquisition with external events, other modes of acquiring data are available. Each mode involves connecting an external triggering device to the spectrometer and then applying an external trigger to the spectrometer before the software receives the data. The length of the integration time and the source for the integration clock depend upon the mode chosen. All other acquisition parameters are set in the software.

Also see the **External Triggering Options Instructions** for triggering information for other Ocean Optics spectrometers with firmware versions below 3.0.

Triggering Mode	Description	Use This Trigger Mode When You ...
Normal/Free-Run	Spectrometer acquires spectra continuously.	No synchronization to other events is needed
Software	Integration time is set in the software. Software receives a trigger event and transmits spectra obtained in the data acquisition cycle in which the trigger occurred.	Are using a continuous illumination source, and the light intensity is constant before, during, and after the trigger. Need to set the integration time in the software.

Triggering Mode	Description	Use This Trigger Mode When You ...
External Hardware Level Trigger	Integration time set via software on a chip in spectrometer. The spectrometer waits for a sharp rise in voltage on the trigger input pin, and then acquires spectra until the voltage is removed.	Need a continuous acquisition whenever a certain condition is met, such as: - when reacting to a sample being present or - when a sample reaches a specific state that you want to measure
External Synchronous Trigger	Spectrometer acquires data from an external trigger event (such as a push button) until the next time the trigger is activated, at which time the spectrometer ceases spectral acquisition and begins a new acquisition. Integration time cannot be set, since the trigger can fire at random intervals.	Must synchronize your scans to an external clock source Are using a lock-in amplifier Are using a chopper
External Hardware Edge Trigger	Integration time set via software on a chip in spectrometer. The spectrometer waits for a sharp rise in voltage on the trigger input pin, and then acquires spectra. This trigger acquires one spectrum each time that there is a sharp rising edge (if an acquisition is not already in progress).	Are using a pulsed excitation source or light source in your experiment (such as a laser or flash lamp) Are doing LIF (fluorescence with pulsed excitation) or phosphorescence experiments Need to synchronize an acquisition with an external event

Setting Up for External Triggering

IMPORTANT: Voltage Regulation

The *maximum* recommended voltage on the Triggering Pin is 5.5 V. If your triggering device exceeds this voltage, you must regulate or condition the signal (via transistor buffering, transformer isolation or opto-isolation, for example) or isolate the signal from the spectrometer.

Note

To use one of the External Triggering options, you must know the specifications and limitations of the triggering device. The design of the triggering device may prevent you from using one of the external triggering modes as it is described in these pages.

Pinout Diagrams for Ocean Optics Spectrometers

HR2000+, Maya2000Pro and QE65000

For external triggering, supply a line from Pin 10 of the multi-pin connector on the HR2000+, Maya2000Pro or QE65000 spectrometer to your triggering device.

2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
1	3	5	7	9	11	13	15	17	19	21	23	25	27	29

Pin-out Diagram of 30-pin Connector on HR2000+, Maya2000Pro and QE65000 Spectrometers

USB2000+

For external triggering, supply a line from Pin 7 of the multi-pin connector on the USB2000+ spectrometer to your triggering device. Be sure to also use Ground Pin 6 when triggering

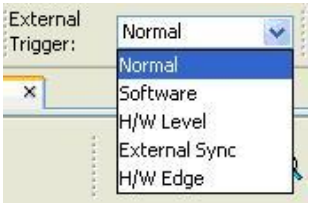
20	18	16	14	12	10	8	6	4	2	A2
19	17	15	13	11	9	7	5	3	1	A1

Pin-out Diagram of 22-pin Connector on USB2000+ Spectrometers

Setting Integration Time in Software

Software, External Hardware Level Trigger and External Hardware Edge Trigger modes can have the integration time set via SpectraSuite.

Use the External Trigger selection box on the Trigger toolbar to set the trigger mode of the spectrometer to **Software**.



Note

Once you select an external trigger mode, your computer will appear unresponsive. This is normal, as the computer is waiting for a trigger. You must apply one more trigger to the spectrometer after selecting a new trigger mode.

External Triggering vs. Triggering an External Event

There could be some confusion between the concepts of External Triggering and triggering an external event. The following sections explain each of these concepts:

- **External Triggering** – An event outside the sampling system (such as a push button, lever activation, or laser pulse) triggers the voltage level on the spectrometer's trigger pin and instructs the spectrometer to begin spectra acquisition.
- **Triggering an External Event** – When triggering an external event, the spectrometer instructs an external device (typically a lamp such as the PX-2 or the LS-450) to illuminate immediately prior to spectral acquisition.

Triggering Mode Descriptions

The following sections specify the Trigger modes for Ocean Optics spectrometers with firmware versions 3.0 and above and associated timing sequences.

For the Maya2000Pro, HR2000+and USB2000+, the timing sequences specified are for the trigger mechanism interacting with a single-depth FIFO. The hardware implementing these Trigger modes may enhance the capability and performance by implementing buffering schemes using larger or multiple FIFOs.

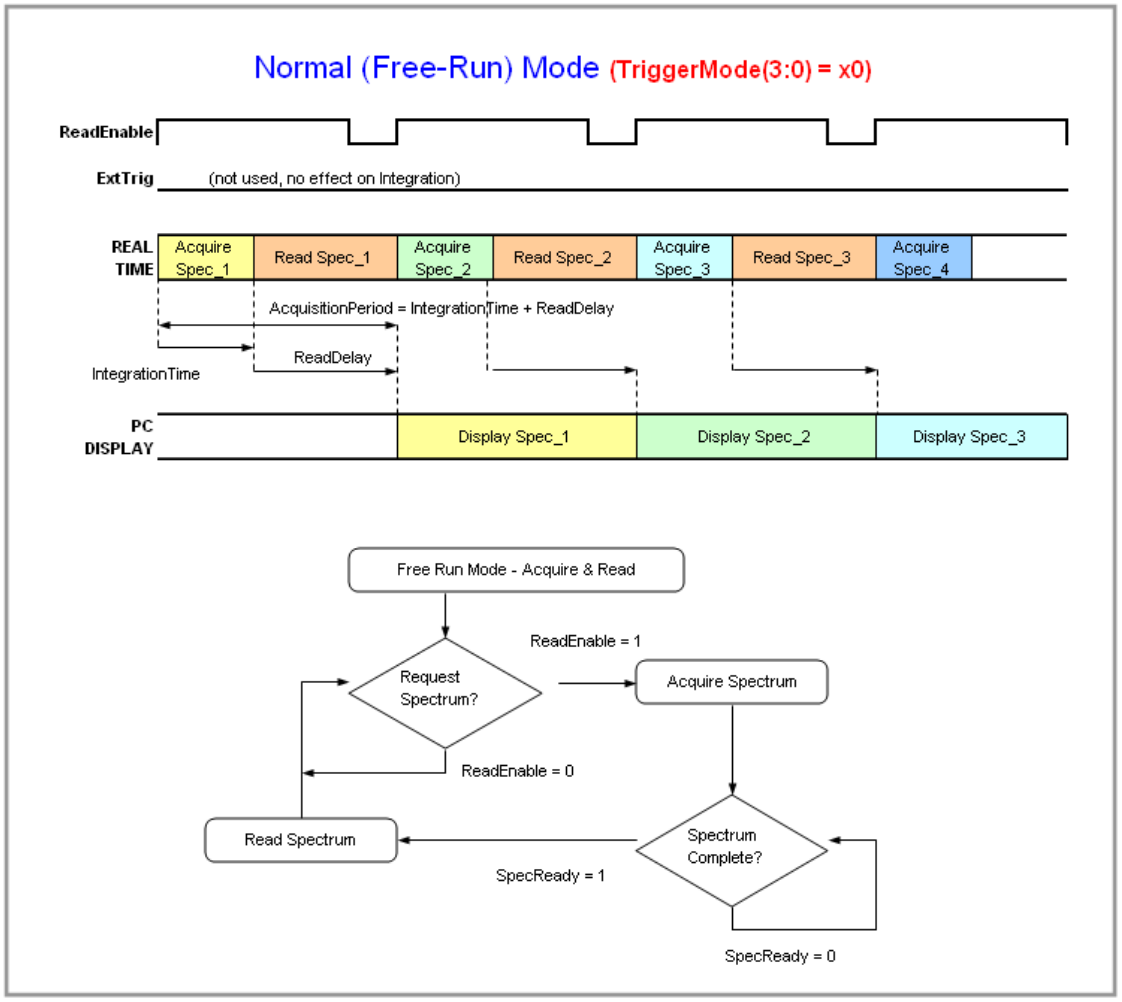
For the QE65000, the timing sequences specified are for the trigger mechanism interacting with a triple-depth FIFO. The hardware implementing these Trigger modes enhances the capability and performance by implementing a buffering scheme using multiple FIFOs.

Normal Mode

In the Normal (Free-Run) mode, the spectrometer continuously acquires spectra. This data is made available for reading as soon as all the data is stored in the FIFO.

For the Maya2000Pro, HR2000+ and USB2000+, this is also referred to as the nonbuffering mode because only one spectrum is stored within the FPGA and not multiple spectra. In this scenario, ReadEnable is generated by the software/firmware to initiate each new acquisition. Since only one spectrum is stored at a time in the FPGA, a new integration cannot be started until the FIFO data has been fully retrieved by the software.

For the QE65000, integrations are continuously performed with the most recent three spectra available to the software. If the software fails to retrieve spectra as new data is acquired, older data gets dropped in favor of newer data.

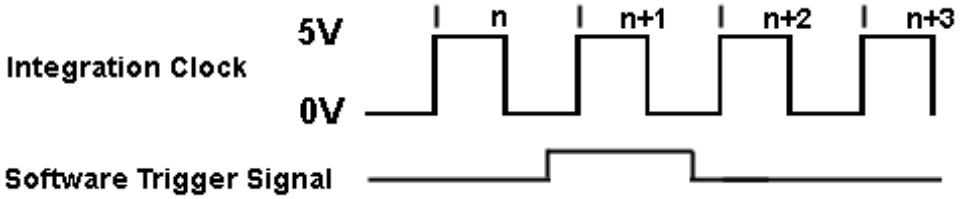


Normal Mode Timing Sequence

Software Trigger Mode

In this level-triggered mode, the spectrometer is “free running,” just as it is in the Normal mode. The spectrometer is continually scanning and collecting data. With each trigger, the data collected up to the trigger event is transferred to the software. If you continuously apply triggers (for example, by holding down the button on via an external switch), this mode is equivalent to operating in the Normal mode.

In the Software Trigger mode, you set the integration time (as well as all other acquisition parameters) in the software. The source for the integration clock comes from the A/D converter.



*If the software trigger is asserted during integration cycle **n**, the photons from this integration period will be read out and digitized at the start of integration cycle n+1*

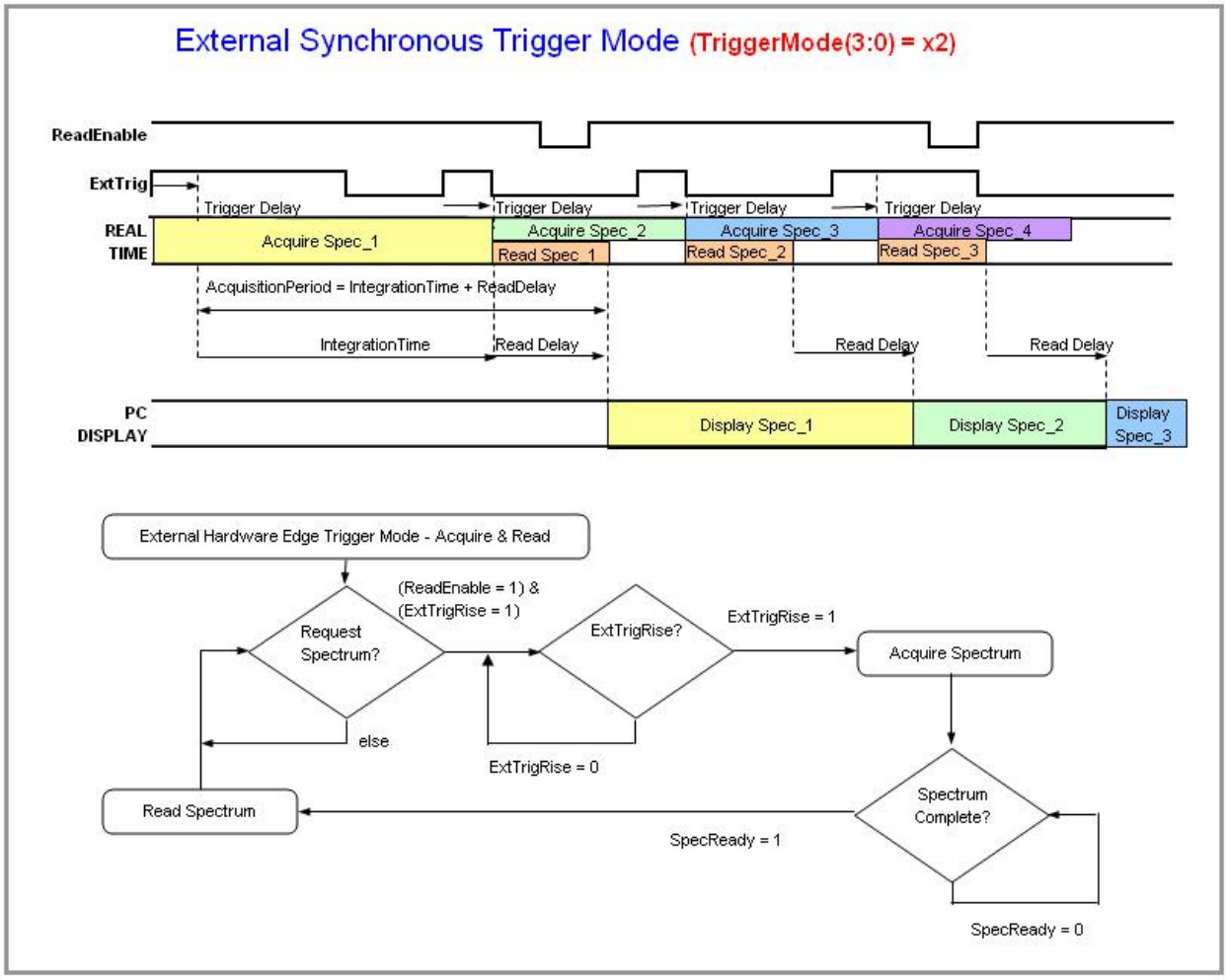
External Software Triggering – Trigger Timing

External Synchronous Trigger Mode

In the External Synchronous Trigger Mode, two external triggers are required to complete a data acquisition. The first rising edge starts the integration period and the second rising edge stops the integration while starting the next integration. Thus the integration time is the period between the two external trigger pulses. After the each integration period, the spectra is retrieved and written to the FIFO in the FPGA.

For the Maya2000Pro, HR2000+ and USB2000+, as in all nonbuffered modes, no further integrations are possible until the software has read the entire contents of the FIFO.

For the QE65000, three spectrum buffers provide software with the most recent spectral acquisitions.

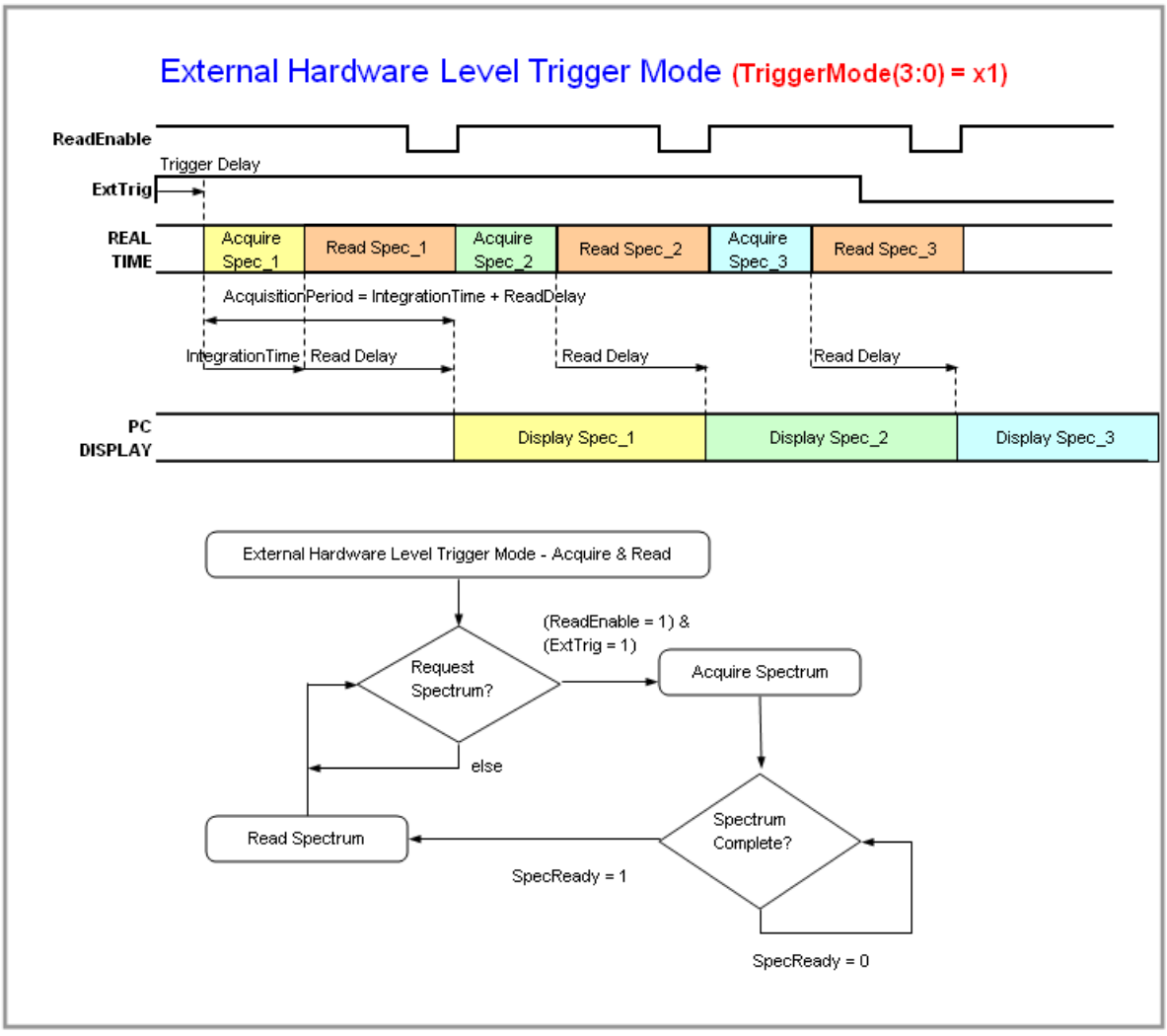


External Synchronous Trigger Mode Timing Sequence

External Hardware Level Trigger Mode

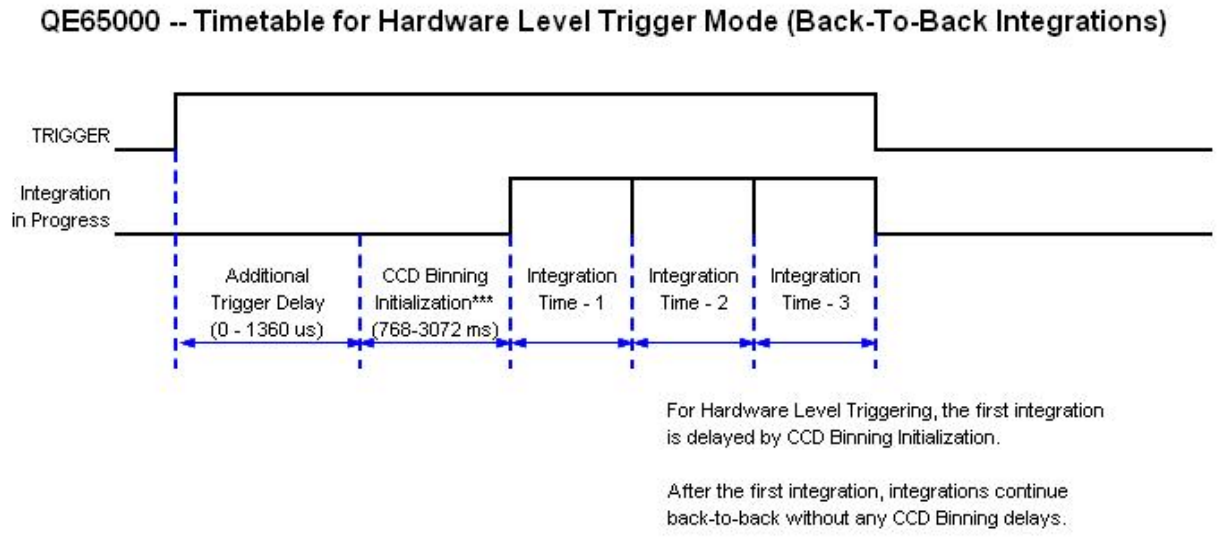
In the External Hardware Level Trigger mode, a rising edge detected by the FPGA from the External Trigger input starts the integration period specified through the software interface. After the integration period, the spectrum is retrieved and written to the FIFO in the FPGA. As long as the trigger level remains active in a logic one state, back-to-back acquisitions will occur, as in the Normal mode, until the trigger transitions to an inactive level.

For the Maya2000Pro, HR2000+ and USB2000+, as in all nonbuffered modes, no integrations are possible until the software has read the entire contents of the FIFO.



External Hardware Level Trigger Mode Timing Sequence

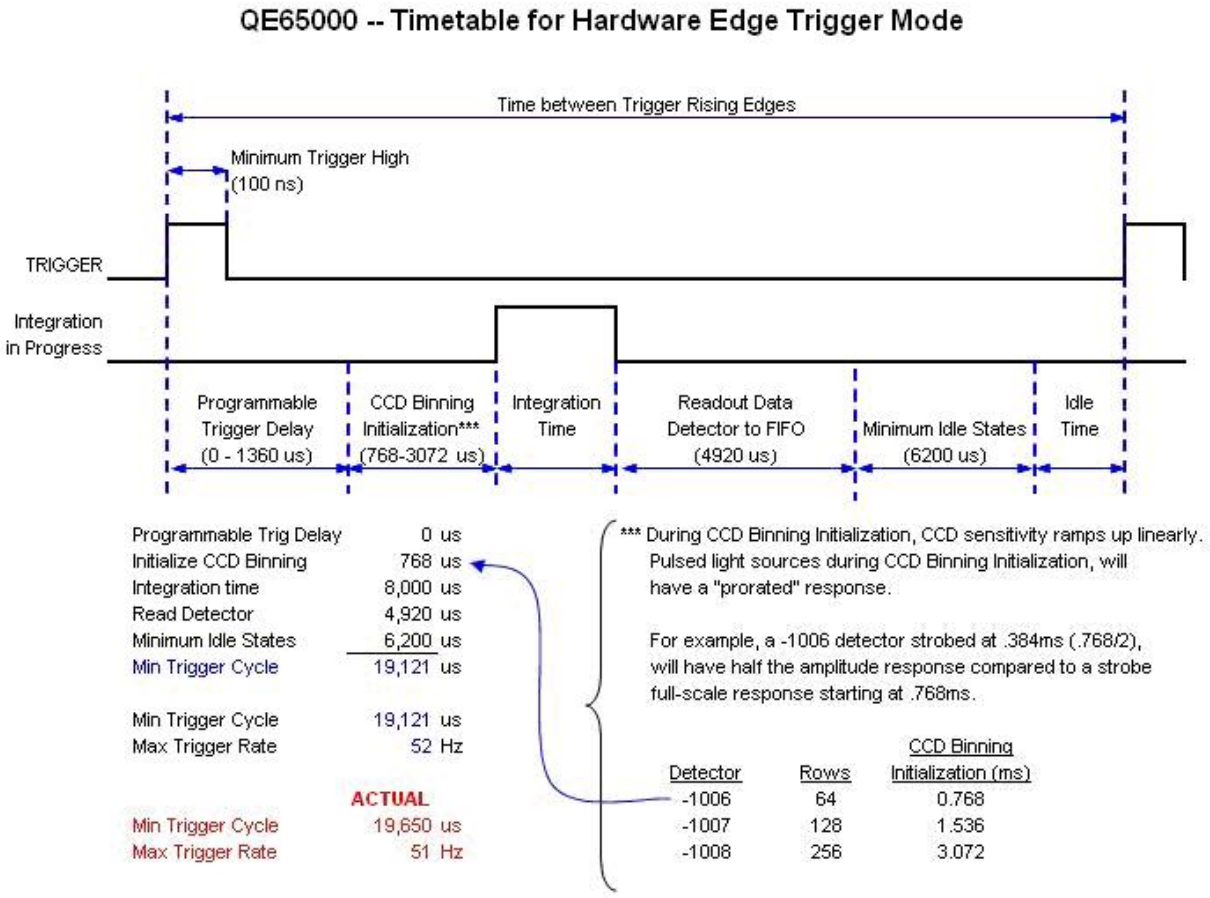
For the QE65000, three spectrum buffers provide software with the most recent spectral acquisitions.



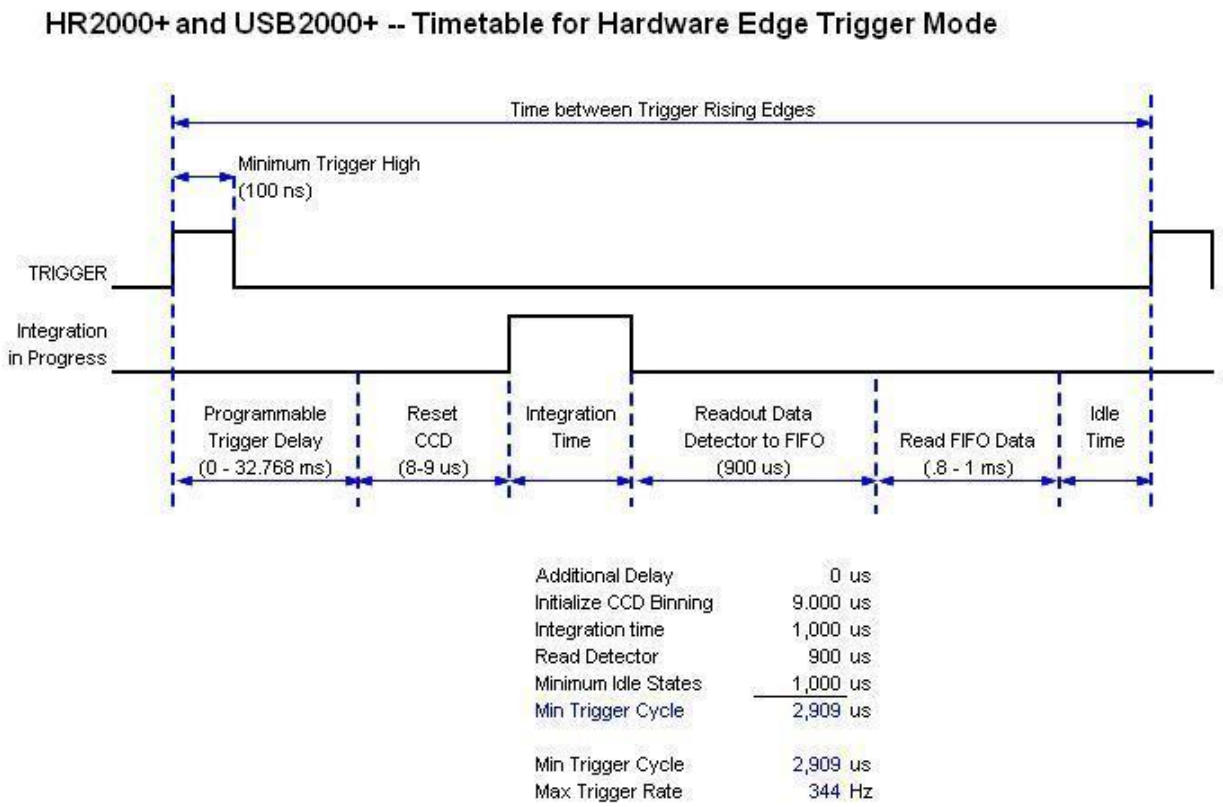
QE65000 Hardware Level Trigger Mode

External Hardware Edge Trigger Mode

In the External Hardware Edge Trigger mode, a rising edge detected by the FPGA from the External Trigger input starts the integration period specified through the software interface. After the integration period, the spectrum is retrieved and written to the FIFO in the FPGA. Only one acquisition will be performed for each External Trigger pulse, no matter what the pulse's duration is. As in all nonbuffered modes, no subsequent integrations are possible until the software has read the entire contents of the FIFO.



Maya2000Pro and QE65000 Hardware Edge Trigger Mode Time Table



HR2000+ and USB2000+ Hardware Edge Trigger Mode Time Table

USB Command Description for Triggering

The USB command Set Trigger Mode sets the spectrometer trigger to one of the trigger mode states as shown below.

HR2000+ and USB2000+ Set Trigger Mode

Data Value = 0 ➔ Normal (Free running) Mode
Data Value = 1 ➔ Software Trigger Mode
Data Value = 2 ➔ External Hardware Level Trigger Mode
Data Value = 3 ➔ External Synchronization Trigger Mode
Data Value = 4 ➔ External Hardware Edge Trigger Mode

Maya2000Pro and QE65000 Set Trigger Mode

Data Value = 0 ➔ Normal (Free running) Mode

Data Value = 1 ➔ External Hardware Level Trigger Mode

Data Value = 2 ➔ External Synchronous Trigger Mode

Data Value = 3 ➔ External Hardware Edge Trigger Mode