EQUIPMENT USAGE NOTE

Spectech UCS30

UNIVERSITY of TASMANIA

April 26, 2021

Spectrum Techniques Universal Computer Spectrometer

Summary

The Spectech UCS30 is a tool used for collecting spectra. It is not an intelligent device: for it to function correctly, it is necessary understand what is the spectrum to be collected, and how to correctly configure the acquisition software.

Common pitfalls

Common issues encountered whilst using the device:

- **The `USX` software cannot connect to the device**
  - Ensure that the UCS30 is powered on
  - Power cycle the USC30
  - Power cycle the acquisition computer
- **No counts are being registered in any channels**
  - Ensure that the magnitude of the input signal is $0 - 8\,\mathrm{V}$
  - Ensure that UCS30 `Mode` is correct, that is, set to `PHA - Direct In` (see figure 1)

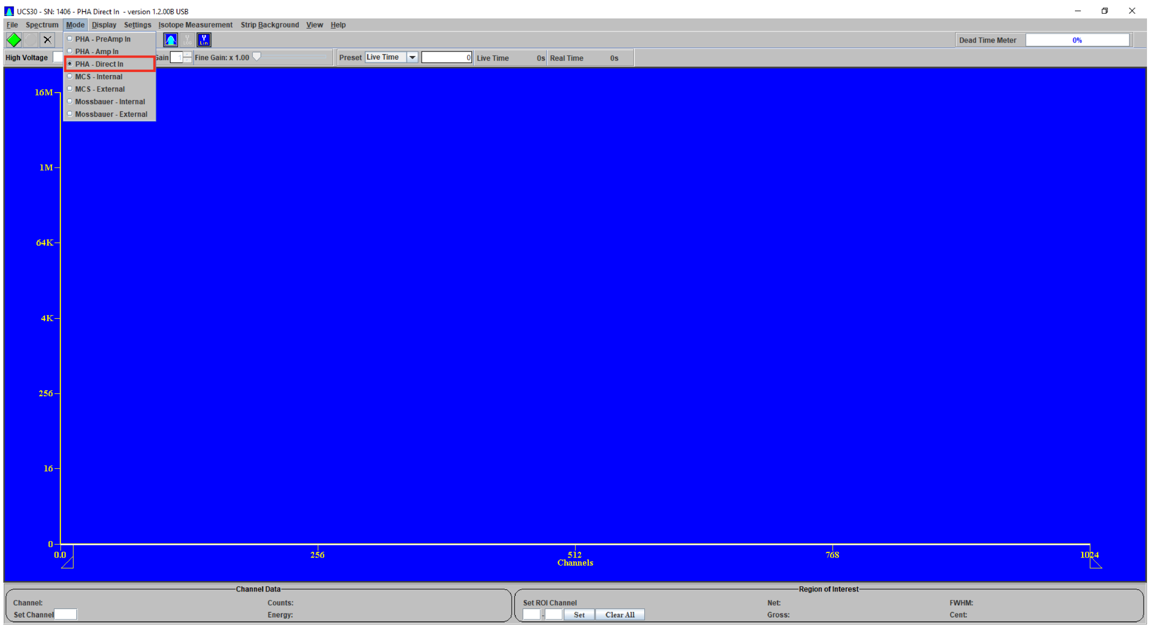


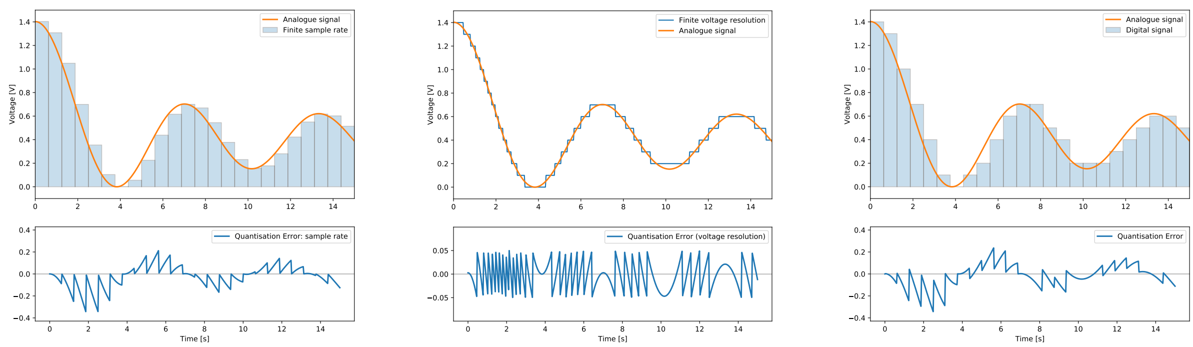
Figure 1: Location of the `PHA - Direct In` mode in the USX software

The device

The device manufacturer (Spectrum Techniques) refers to the Spectech UCS30 as a "Universal Computer Spectrometer"; to the uninitiated this title is somewhat nebulous. A better description is a multichannel analyser, which is a system designed to record pulses - typically coming from a charged particle detector - and often, to produce a histogram of frequency versus the amplitude of the detected pulses. Through careful experimental design, it is often possible to connect the amplitude of output pulse of a detector to the energy of the particle which triggered the detection event, and therefore the histogram of frequency of detector pulse amplitude is akin to an energy spectrum of charged particles being detected.

How does it function?

The output of a charged-particle detector is an analogue signal. We usually condition and manipulate this signal, but it remains an analogue signal. At some point, we want to interface this signal with a computer, which means translating the signal into something which a computer can interpret. Such a translation is achieved with an Analogue-to-Digital Converter (ADC), which functions exactly as one might expect: a signal continuous is both time and voltage is *sampled* and a signal which is discritised in time and voltage is produced and used as a digital version of the signal. Hopefully it is clear that the digital signal is not necessarily a perfect representation of the analogue signal, and the quality of the approximation is ultimately governed by two parameters: the quantisation error (often expressed as bit-depth) and the sampling rate. Figure 2 gives a brief illustration of the digitisation process: an analogue signal is sampled at some finite sample rate, the amplitude of the signal is discretised, and the digital signal which is both discretised and sampled.



(a) Finite sampling rate (b) Discrete voltage steps (c) A digitised signal

Figure 2: An analogue signal discretely sampled in time, voltage, and both time and voltage.

In the case of a multichannel analyser, a detector pulse is first digitised and then the maximum amplitude of the pulse is recorded. In software, a histogram is then produced of the number of times a signal is detected against the maximum pulse amplitude. Note that the amplitude is not registered as a voltage, but rather the channel number of the corresponding digital representation of the voltage. Explicitly, the input voltage range of the device (V_{max}) of the device is split into 2^N channels, with N being the number of bits used to represent the amplitude. This means that each channel has a width of $V_{\text{max}}/2^N$, and should a voltage value fall in this range, it will be registered in that channel. Important considerations when using a multichannel analyser are:

- What is the maximum voltage that can be measured?
- How accurately can the voltage be determined as to discriminate between pulses of different heights?
- How long does it take to record the pulse and measure the pulse height?

In this case, the answers to the above questions are $V_{\text{max}} = 8\,\text{V}$, the voltage is represented with a bit depth of $N = 10$, and the signal is processed fast enough for us not to care about processing time.

How does one drive it?

The system is something that well-approximates a *plug-and-play* utility. When the devices is properly connected, one can open the `USX` software and more-or-less start acquiring data immediately: to collect a spectrum (or more correctly, an amplitude histogram) click on the green diamond in the top left hand corner.

Importantly, if one is to collect meaningful results, the input signal must be appropriately conditioned, that is, with a maximum amplitude of 8 V. Secondly, the UCS30 settings must be configured correctly, the key setting being that the `Mode` is set to `PHA - Direct In`. In this case, the UCS30 is operating in *Pulse-Height Analyser* mode and the signal is being directly processes. The other modes are what they say on the tin: `PHA - PreAmp In` would be appropriate for a signal direct from a detector, that is, into a preamp and amplifier and `PHA - Amp In` would be suitable for a reamplified signal which required further amplification. The reason such settings exist is that the UCS30 also has an on-board high-voltage power supply, meaning that both powering the detector and signal conditioning can be performed using the device; however, external control over the detection system and signal conditioning is elucidating.

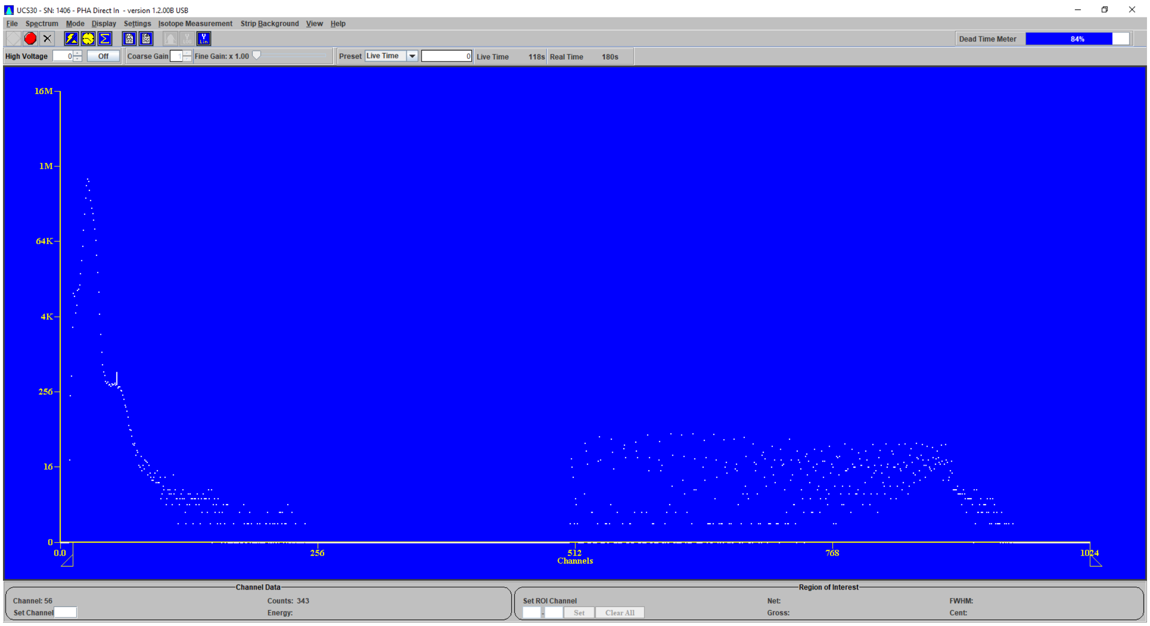


Figure 3: A screenshot of the `USX` software processing data from the UCS30

A screenshot of the `USX` interface is shown in figure 3. The available functions are largely self explanatory, although somewhat limited. For processing and interpreting data, one is best to use their programming language of choice; data can be exported as a comma separated value file through `File` → `Save` and adjusting the `Files of Type` parameter.

Additional resources

- The manufacturer's website, including download links for the software and driver
- The instruction manual
- POLUS is a resource for all things related to experimental physics at UTAS