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ANS Technologies Inc.

ANIQSpec Integrated Spectroscopy System

Electronics

ANIQSpec is a Multi-Channel Analyzer spectroscopy system (MCA). A spectroscopy system begins with a detector that outputs voltage pulses. The detector is typically powered with an applied high-voltage, and the signals are sent through an amplifier, which also shapes the pulses. The amplified pulses are fed into an Analog-to-Digital Converter (ADC), which generates the digital signal suitable for computer data representation. Each time a pulse hits the detector, its voltage is determined, and this information is sent to the MCA, which is interfaced with the PC.

The purpose of the MCA is to receive and store this data, and transfer it to the PC memory on command, along with the acquisition time. The board has a 4096-channel memory, and each channel represents a small voltage interval. Each time a pulse is received from the ADC (while the MCA is active), the contents of the appropriate channel is incremented by one. The MCA responds to commands from a software package, which include start/stop data acquisition, transfer data to the PC, and clear the memory of the MCA.

In addition, ANIQSpec comes with a general I/O board to receive signals from thermocouples, RTDs and a variety of sensors, as well as send both analogue and digital control signals to external apparatuses.

The ANIQSpec Integrated Spectroscopy System comprises six components and assorted cables and adapters. These components are:

ANIQVME:	VME Backplane Chassis, Model ANIQSpec-702
ANIQ USB-PPI:	USB-Parallel Port Interface Module, Model ANIQSpec-801
ANIQMCA14:	Spectroscopy Module, Model ANIQSpec-503
ANIQHV:	High-Voltage Power Supply and Preamp Power Supply, Model ANIQSpec-501
ANIQHVGe:	High-Voltage Power Supply and Preamp Power Supply, Model ANIQSpec-504
ANIQIO:	I/O Module and Connection Block, Models ANIQSpec-600 & ANIQSpec-601

Figure 1 : ANIQSpec Integrated Spectroscopy System

Each of these modules will be described hereunder. With each Integrated Spectroscopy System, there will be one chassis and one Parallel Port Interface. There will also be one Spectroscopy Module and one ANIQHV for each detector channel ordered.

ANIQVME: VME Backplane Chassis, Model ANIQSpec-702
The ANIQVME Chassis was designed by ANS Technologies to provide the smallest possible chassis for the typical requirement, namely one- or two-detector-channels. It is equipped with five VME 3U slots, and a power supply with two switches. There is a VME connector at the back of each module that fits into the VME backplane of the chassis. The power supply, connected to the VME backplane, and has three outputs: +5, +12 and -12 volts. Two switches on the front panel of the chassis interrupt the +5 and +12 volt lines. A model with eight slots is also available for three- or four-detectors.

*ANIQ USB-PPI: USB-Parallel Port Interface Module, Model ANIQSpec-801*
The Interface Module provides the communication between the PC and the VME backplane of the chassis (and hence the other modules). It is usually plugged into the leftmost slot, and connected to either the parallel port by an IEEE-1284 compliant M-M cable, or via a USB connection. Which connection is used is selected by jumper.

ANIQMCA14:   Spectroscopy Module, Model ANIQSpec-503
The ANIQMCA14 Spectroscopy Module is a combination amplifier, flash ADC and MCA. The user may either connect the output of either a NaI or a Ge detector to the amplifier input. This board, like the others in this package, is a half-height unit that fits a VME 3U Slot. It contains 32-bit memory and plugs into a VME-A24D16 3U backplane, mounted in a chassis. One ANIQMCA14 board is required for each detector, and each board has jumpers to set its ID number. This ID number is used by the

software to reference the board. All the ANIQMCA14 boards installed in the chassis communicate via the backplane to the interface board. Thus, the software controls four utterly independent detectors (each detector has its own amplifier, ADC and 4096-channel on-board memory). The software packages control all four boards simultaneously, and each board acquires data independent of the PC.

Figure 2 : ANIQMCA14 Spectroscopy Module
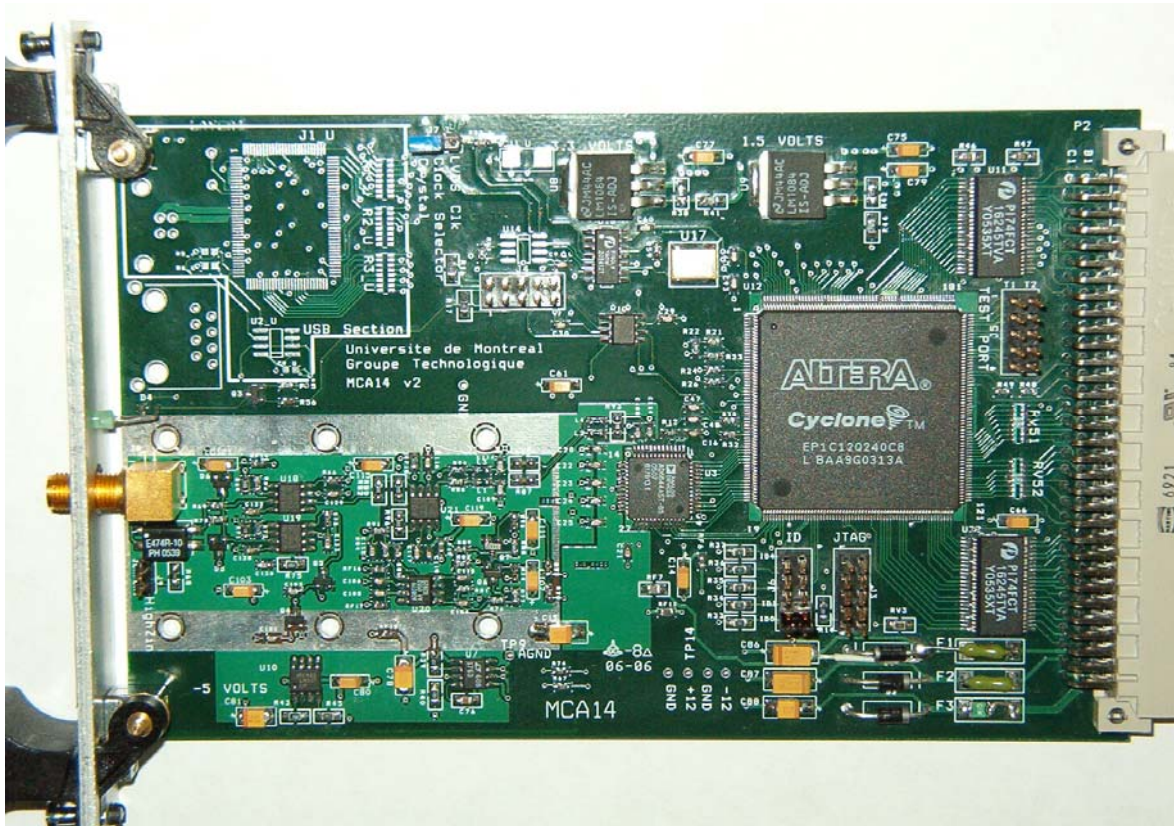
The operating parameters of the ANIQMCA14 are selected via software, and include the peaking time (for pulse shape analysis), the input polarity, the ADC gain and the LLD. For Ge detectors, the user may also set the pole zero correction and an additional pulse shaping parameter to compensate for variation in risetime as a function of energy. This gives the MCA14 excellent resolution for Ge detectors, limited only by the detector itself.

ANIQHV: High-Voltage Power Supply and Preamp Power Supply, Model ANIQSpec-501
This unit is powered by +12 volts and outputs 1 mA at +1000 volts. It is a highly stable, regulated power supply. The supply is mounted on a VME board and the circuit allows the user to conveniently apply power to NaI photomultipliers. The entire interface is on the front panel. The HV output is via an SHV connector, and is controlled from 0-1000 volts by a trim potentiometer labelled "Gain". There is a series of ten LEDs that illuminate from bottom to top as each step of 100 volts is passed. There is also a test point tuned so that one volt on the test point is 1000 volts HV output. The test point has been provided so that voltages in between steps of 100 volts may be accurately applied, should the user desire to do so. A DB9 connector is provided to supply power to a standard NaI preamplifier that operates at 12 volts. These lines have inductive and capacitive filters to stop any noise from the VME backplane.

ANIQHVGe: High-Voltage Power Supply and Preamp Power Supply, Model ANIQSpec-504
This unit is powered by +12 volts and outputs 200 µA at +5000 volts. It is a highly stable, regulated power supply. The supply is mounted on a VME board and the circuit allows the user to conveniently apply bias to Ge detectors. The entire interface is on the front panel. The HV output is via an SHV connector, and is controlled from 0-5000 volts by a trim potentiometer labelled "Gain". There is a series of ten LEDs that illuminate from bottom to top as each step of 500 volts is passed. There is also a test point tuned so that one volt on the test point is 5000 volts HV output. The test point has been provided so that voltages in between steps of 500 volts may be accurately applied, should the user desire to do so. A DB9 connector is provided to supply power to a standard Ge preamplifier that operates at 12 & 24 volts. These lines have inductive and capacitive filters to stop any noise from the VME backplane. In addition, this power supply ramps the HV over a period of two minutes, to prevent leakage current across the Ge crystal. There is also an INH input which prevents the application of the bias if the detector is warm.

ANIQIO: I/O Module and Connection Block, Models ANIQSpec-600 & ANIQSpec-601
The analog input section of the ANIQIO board may be used to read voltages from thermocouples, resistance temperature devices (PT100 RTDs) and other devices. There are 16 single-ended channels, which may also be configured in pairs for differential operation. The input may be configured as unipolar (max 20 volts) or bipolar (-10 to +10 volts max). The gain may be adjusted to yield a precision of better than 0.1 mV for thermocouples. The connection block is also equipped with a temperature sensor for cold junction compensation. Up to eight four-wire RTDs may be connected. The ANIQIO board provides an RTD reference current, and the ADC compensates so that the voltage reading is independent of the number of RTDs or the length of their lead wires.

There are also five analog output channels. These channels have 12-bit outputs that have been configured to give between 0 and 4.095 volts in increments of 1 mV. This configuration may be customized for each customer to yield more voltage at the cost of precision.

Finally, the ANIQIO board is equipped with eight digital IO channels. In the output mode, each channel may be configured to give either a TTL voltage (3.33 volts), or act as a switch. This allows the use of either TTL or switch relays.

There is one jumper, which determines the board number. This allows the software to operate up to four ANIQIO boards in a single chassis. The rest of the configurations are done by software. A program called IOViewer is provided that controls all the features of one board on a single display. Multiple instances of IOViewer may be run to control up to four ANIQIO boards.

ANIQMCA Spectrum Acquisition and Analysis Software

General Operation
ANIQMCA is designed to acquire spectral data in single periods, and display the spectrum in graphical mode. It controls and downloads data from the ANIQSpec Spectroscopy Modules. ANIQMCA allows the user to open a number of documents, limited only by the memory of the PC. Each document is a histogram with an array size of either 1024, 2048 or 4096 channels. Each channel contains an integer from 0 to 2^{32}.
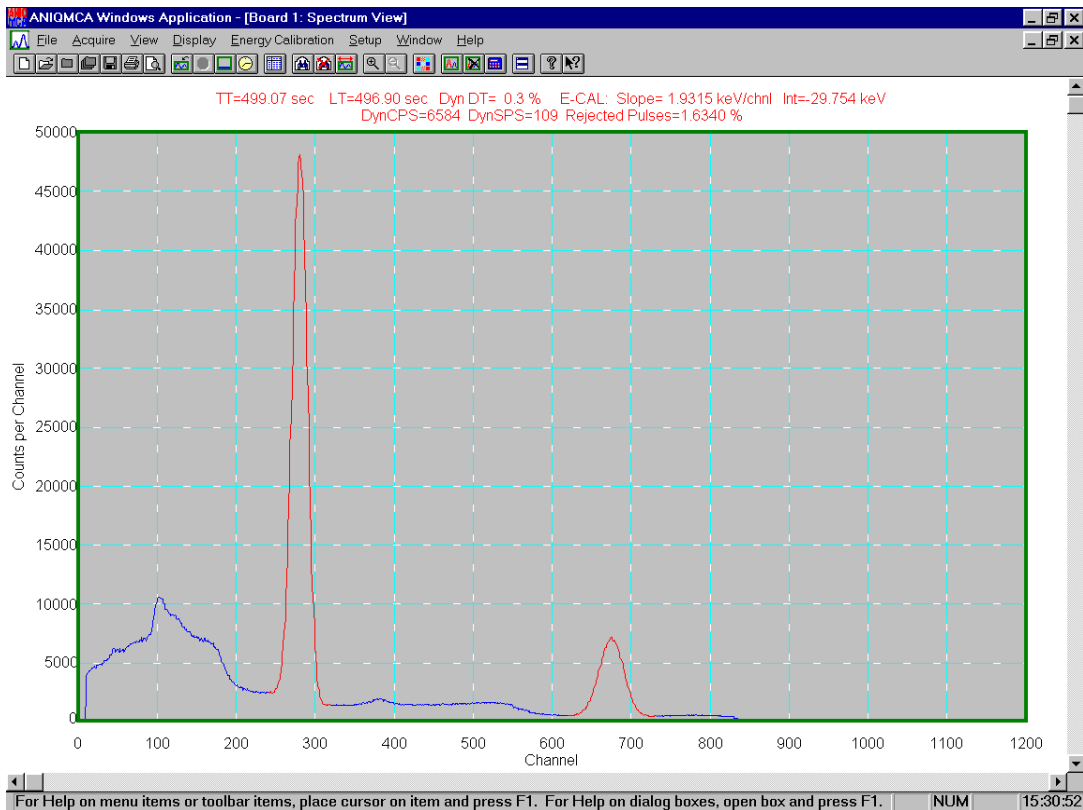
On-Line and Off-Line Documents

When one creates an on-line document, a dialog box allows the association of the document with one of up to four ANIQSpec Spectroscopy Modules. When an on-line document is created, the associated board is immediately accessed, and the histogram data stored on the MCA board is copied to the document. Further, if ANIQMCA finds that this board is acquiring data, it begins its acquisition loop. Thus, if ANIQMCA has closed while one or more boards are acquiring, they continue to acquire (until any preset is reached). ANIQMCA may be restarted, and the data recovered. **Most importantly, the user may open as many on-line documents as there are MCA boards, and each one may have its live acquisition started and stopped independently.** The data may be saved on disk in an MCA file. An off-line document is created by reading an MCA file.

Spectrum View and Data View

The Spectrum View shows the spectrum graphically. There is a header that displays the True Time (TT), Live Time (LT) and percentage Dead Time (DT). If an energy calibration is in effect, the slope and intercept are also displayed. If an on-line document is displayed, the True Time and Live Time are read from the MCA board, while the calibration is read from the ANIQMCA.INI file.

Figure 3 : On-Line Spectrum View

If an off-line document is displayed, all the data is taken from the disk file's header, except the Dead Time which is calculated from the True and Live Times, and is thus an average. The number of counts is autoscaled, but this may also be modified with the PageUp, PageDown and Home keys. The range may also be manually or automatically scaled, and there is a Zoom feature to view close-ups temporarily. The user may set up to ten Regions-of-Interest (ROIs) on the spectrum. These ROIs are used both to calibrate the energy, and to perform analysis of a photopeak contained therein. If there is no energy calibration, the slope defaults to 1 keV/chan and the intercept defaults to 0 keV, thus making

the Channel Number and Energy numerically equal. The Data View will display a table of the raw data, with columns for Channel Number, Energy and Counts. Also displayed, for each ROI, are data giving the range of the ROI in Channel Number and Energy, the centroid of the peak, the peak FWHM, the sum of the counts in the ROI, along with the counts per live second, and the area of the peak above the Compton background, in both Counts and CPS.

Figure 4 : On-Line Data View
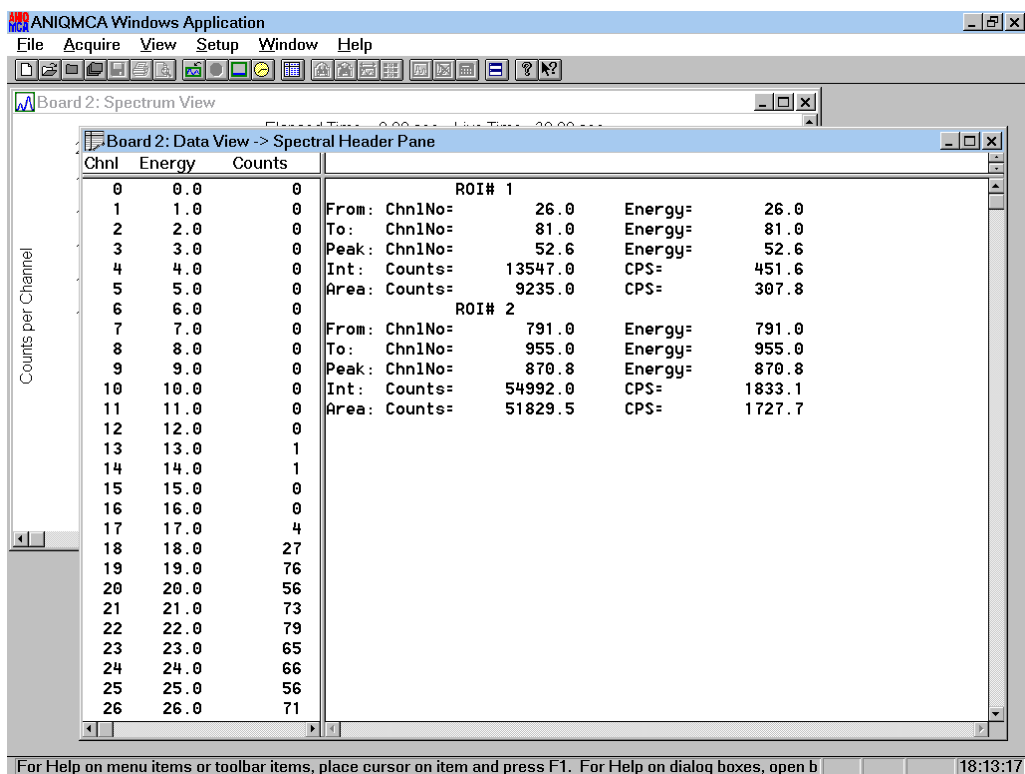
Hardware Control
ANIQMCA is also used to define, save and transmit certain parameters and to the ANIQSpec spectroscopy modules. The parameters are sent to the board's memory, and control how the input voltage pulses are analysed. If signals arriving at the amplifier have voltages exceeding the maximum (saturation), they are rejected and not processed by the ADC. However, the dynamic saturations per second and the percentage rejected may be displayed on the Spectrum View, and thus allow the user to determine if the input voltage is too high. If the rejected pulses are due to high-energy signals that are not of interest, it is not necessary to reduce the input gain. The rejection process does not hamper the acquisition of those pulses not being rejected.

Saving Documents
The contents of on-line documents may be saved in the MCA file format, to be viewed at a later date. This format also saves the energy calibration, the number of channels, the live and true acquisition times, as well as several other parameters. When a save is performed, the on-line document remains unchanged. Acquisition may continue, and the file saved again, potentially with the same name. The histograms of both on-line and off-line documents may be saved in ASCII format for viewing with other software. The contents of two off-line documents may be summed.

IOViewer Data Acquisition Software

General Operation

IOViewer is a general control, display and recording software for use with the ANIQIO board. Multiple instances of IOViewer may be called, one for each ANIQIO board present. A file with extension IOV is used to record the settings of the various I/O channels, as well as record the results of the periodic scan of the ANIQIO board attached. The "Scan Rate" determines the frequency the ANIQIO board is scanned and the display is updated. The "Write Rate" determines the frequency the data is written to the IOV file.

Figure 5 : IOViewer Input and Display View

Analog Inputs

The analog inputs are processed according to a set of input parameters. The "Mode" determines whether the inputs are to be configured as Referenced Single-Ended (RSE) or Differential (Diff). In the RSE mode, any channel's input voltage may be measured with respect to a common ground. In Diff mode, the input to Channels 0 to 7 may be measured with respect to Channels 8 to 15, respectively. The "Sensor" parameters determines which type of sensor is being used for that channel, be it a simple voltage signal, an RTD or one of five types of thermocouples. Channel 0 may be used for cold-junction compensation if thermocouples are used. The voltage read from the board is displayed, as is a result based on a calibration. For thermocouples and RTDs, the calibrations are internal to IOViewer, and the result is in terms of temperature. For simple voltage signals, the user may enter a linear calibration and give a name to the units.

Analog Outputs

The user may output a voltage via one of five AO channels. Within IOViewer, one merely enters the voltage in the box, and hit return. The appropriate voltage is output.

Digital I/O

For each of eight digital I/O channels, the user first selects the "Signal", be it input or output. If output is selected, the user may select the "Out Type" for that channel, be it TTL or switch, and the desired results, either TRUE or FALSE. If "Out Type" is TTL, TRUE sends a 3.3 volt level, otherwise a zero volt level. If "Out Type" is Switch, TRUE turns on the switch, false turns it off. For both Output and Input, the result is shown at each scan.

Table 1 : ANIQSpec General Specifications

PC	486DX/16 MB RAM or better. At least 128 MB RAM recommended.
Maximum Count Rate	Total Rate of 200,000 counts per second with less than 10% deadtime.
Operating Environment	Windows XP/2000/ME/98/95/3.1
Backplane	VME-A24D16 3U
Power Supply	Output +5V, 5A max ; +12V, 2A max; -12V, 0.2A max
Chassis	6.5" W x 8" D x 5.5" H
USB-PPI Board	VME 3U Slot, Interface to EPP 1.9 Parallel Port or USB 2.0
ANIQHV Board	1 kV, 1 mA; 0.001% regulation; stability 25ppm/°C; voltage display; control pot or remote control; chassis 2" x 4" x 7"; power 24Vdc, 1A

Table 2 : ANIQMCA14 Specifications

Amp/ADC/MCA Board	VME 3U Slot; SMA input to Amp/ADC/MCA, jumper ID select; 300 mA power consumption
Amp	Pulse shaping, input polarity, LLD and pole zero compensation controlled by software; stability 200ppm/°C
ADC	Flash ADC; 300 ns process time; 0.03% integral stability; 1% differential stability; stability 100ppm/°C. ADC Gain controlled by software.
Processor	ALTERA Cyclone EP1C12Q240C8 programmed with ANIQ firmware
Memory	On processor, 15 ns access time
Software	ANIQMCA software, which controls up to 4 boards, displays the spectra, data and ROIs, and features a number of analysis tools.

Table 3 : ANIQIO Specifications

IO Board	VME 3U Slot, Interface to connector block with 50-pin cable.
Processor	ALTERA EP1K30 TC144-3 programmed with ANIQ firmware
Analog Inputs	16 single-ended analog inputs (pairs may be configured in differential mode). Inputs may be up to 20 volts unipolar or 10 volts bipolar. Voltage precision less than 0.1 mV (for thermocouples). On-board cold junction compensation. Four-wire PT100 RTDs may be directly connected and are calibrated for any length of wire.
Analog Outputs	5 analog outputs of 0-4.096 volts in increments of 1 mV (12-bit).
Digital I/O	8 DIO channels. Outputs may be either TTL voltages or switch mode.