

SPECTECH

ICS 10

**Integrated Computer
Spectrometer**

Operating Manual

May 1995

Spectrum Techniques, Inc.

Oak Ridge, Tenn. USA.

TABLE OF CONTENTS

Installation.

Connecting detector
Setting the input selector
Loading software

Operation.

High Voltage and Gain
Zero control
ADC conversion gain
Lower and Upper discriminators
Preset Time
Regions of Interest
Integrals and Preset Count modes

The Menubar.

Files, Setup, Data and Print
Edit
Mode, Pulse Height Analysis, Multichannel Scaling
Calculations
Energy calibration
Stripping
Background subtraction
Smoothing
Peak Summary
Overlay
ISOMATCH

Multichannel Scaling.

Setting the MCS input selectors

Card Configuration.

Dip switches and port addressing
Multi-card installations

Specifications.

INSTALLATION

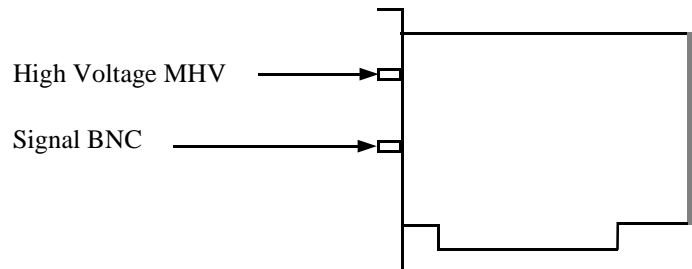
Your ICS 10 Integrated Computer Spectrometer has been factory configured to operate directly in most IBM compatible PC's. System requirements are 512k minimum memory and EGA or VGA graphics. Port addresses have been set at base 210, which normally will not conflict with other installed devices. If problems occur and the ICS 10 card does not respond correctly to the software commands, refer to the technical reference section elsewhere in this manual or consult the factory for reconfiguring the port address.

WARNING - ELECTRICAL SHOCK HAZARD

TO AVOID POSSIBILITY OF ELECTRICAL SHOCK, ALWAYS TURN OFF THE COMPUTER POWER BEFORE INSTALLING THE CARD OR CONNECTING THE EXTERNAL CABLES. DANGEROUS HIGH VOLTAGE CAN EXIST ON THE CARD AND AT THE EXTERNAL HV CONNECTOR WHEN THE UNIT IS OPERATING. NEVER REMOVE OR CONNECT CABLES WITH THE COMPUTER RUNNING.

The ICS 10 card is shipped from the factory with the internal amplifier enabled. This configuration requires the use of a simple voltage divider type photomultiplier tube-base. The anode signal from the base may be connected directly to the ICS 10 input BNC connector and the high voltage connected to the MHV connector.

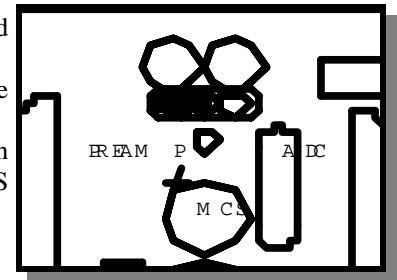
The BNC and MHV connectors appear similar , so exercise care when making these connections.



If you plan to use an external preamplifier/amplifier combination, it will be necessary to bypass the on-board amplifier by reconfiguring the jumper selector to gain direct access to the peak detector and ADC input.

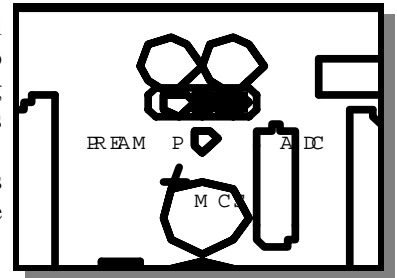
JMP 1 Selection in MCA mode.

Normal mode selects the on-board preamplifier/amplifier. Use with detectors containing a voltage divider type tube base. ICS amplifier is active and system gain may be controlled from the ICS software.



For systems utilizing an external preamplifier/amplifier, direct access to the ADC may be obtained by moving the jumper to the ADC position as shown.

In this mode the on-board amplifier is bypassed and software control of the gain is ineffective.



After the card has been installed and the detector connected, switch on the computer and load the ICS 10 program from the disk supplied.

{Drive}:\ICS10.EXE

The program software is not copy protected so at this stage you may wish to make a backup copy and if available, install it in a working directory on the hard drive. A PIF file is included if you choose to operate the software as a DOS application running under WINDOWS. The ICS 10 has been designed for this purpose and does not generate any interrupts which could interfere with the operating system.

Also included on the program disk is a demonstration spectrum named ICSDemo.SPE and the ISOMATCH library of isotopic gamma emissions. Use these files to familiarize yourself with the operation of the ICS 10 system without having to collect data from the scintillation detector.

If your computer system does not have a mouse, it will be necessary to access the operating buttons and drop down menus from the key board.

For the menubar use the convention ALT_{highlighted letter}.

For the screen buttons press the keyboard letter corresponding to the underlined character on the button.

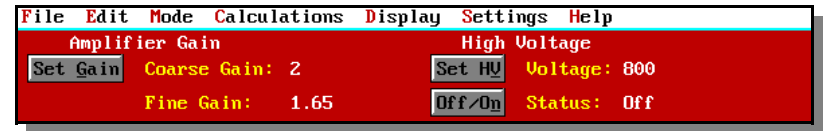
OPERATION

Once the program is running it will be necessary to configure the system parameters for correct operation and calibration.

Place a gamma emitting check source near the detector face. Cs-137 is a good choice for many applications

Set High Voltage and Amplifier.

Click on the  (keyboard h)



Set the amplifier COARSE GAIN to 8, and the FINE GAIN to 1 as a starting position.

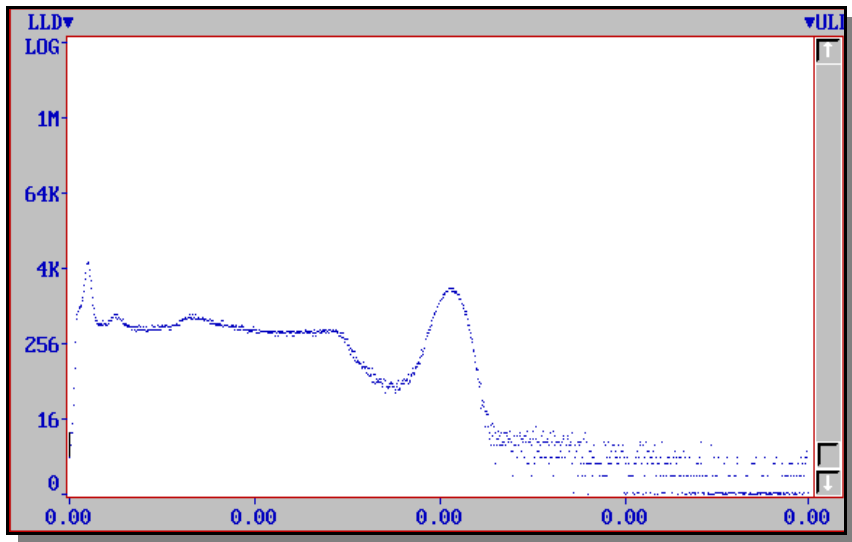
Set the HIGH VOLTAGE to 600 volts and **turn on the ON/OFF switch**.

Start the data acquisition and adjust the gain and/or high voltage until the 662 keV peak is approximately mid-scale. Do not exceed the maximum high voltage rating of the detector PMT, usually 1200 volts. Most modern detectors have sufficient gain for operation below 1000 volts.

Some users prefer to set the 662 keV peak at channel number 662 to produce a calibration of 1 keV / channel. Because of the non-linear response of NaI(Tl) detectors, this will produce only an approximate calibration over the entire energy range. A more accurate calibration will be obtained use the quadratic function included with the ICS 10 E-CAL routine described later in this manual

Zero Control.

This control may be accessed through the instrument panel when installed in the computer and sets the zero intercept of the ADC conversion. The control is factory set and normally does not require further adjustment. However, when operating in the Energy Calibrated mode a zero offset may be noticed when the marker is positioned in the first channel of the spectrum. This offset may be eliminated by adjusting the ZERO control, but will necessitate a complete energy recalibration. A small offset of a few keV is inconsequential and should be ignored.



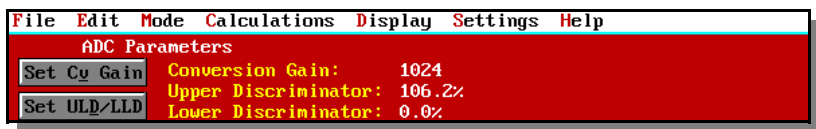
Set ADC Conversion Gain.

The default setting is 1024 channels (maximum gain). This is preferred for most scintillation detector applications and generally no adjustment is required. For certain uses such as alpha spectroscopy, it may be necessary to change this parameter to either 512 or 256 channels.

Click on the



(keyboard a)



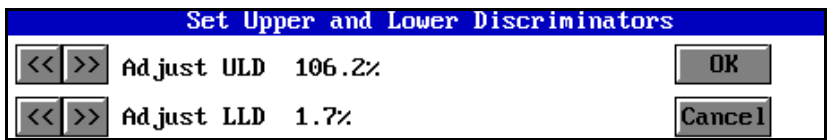
Set LLD/ULD.

At this stage it may be convenient to set the LOWER and UPPER discriminator levels to eliminate unwanted noise and high energy signals. If the LLD is set too low, detector noise may produce excessive system deadtime.

Click on



(keyboard d)



Preset Time.

Two preset time modes are available with the ICS 10.

PRESET LIVE TIME provides automatic correction for counting losses caused by the system deadtime. Events which occur during the pulse processing cycle are lost to the system so the timer is automatically updated to compensate for these losses. When operating at excessively high count-rates the deadtime meter will indicate a high value and the actual counting time may be more than doubled. Increasing the LLD setting can help reduce some high deadtime effects and is described later in this manual.

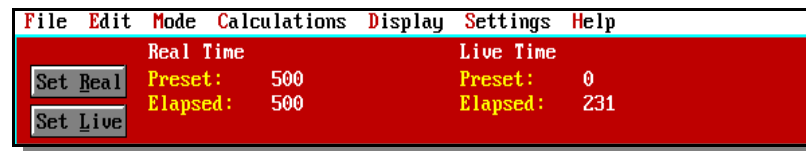
PRESET REAL TIME sets the counting timer to run for actual clocktime and makes no correction for losses due to deadtime effects.

Both the LIVE TIME and REAL TIME values are record on the ICS 10 screen and saved in the file during data storage.

Click on



(keyboard t)



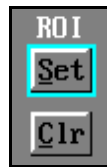
Regions of Interest.

Region of interest (ROI) selection is an advanced feature which provides instantaneous computation of peak gross and net counts. These values may be used along with isotope decay tables and detection efficiency to calculate absolute or relative isotopic activities. ROI's must not overlap and be separated by at least one channel for correct area calculation. Up to 14 different groups of multiple ROI's are possible using the color selector from the drop down SETTINGS menu. Normally, peaks from a single isotope are marked in one color and separate colors used to differentiate different isotopes.

Regions may be setup and cleared using the mouse, keyboard cursor controls, or a combination of both.

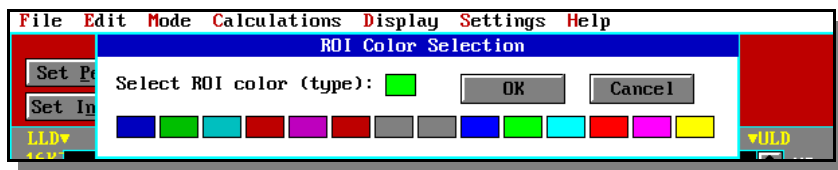
To SET a ROI

Click on



(keyboard s)

Move the marker to the beginning of the peak and click or spacebar. then move the marker to the end of the peak and click or spacebar to color the channels covered. Move to the next peak and repeat the process choosing a different color from the SETTINGS menu if required.



To CLEAR a ROI

Click on



(keyboard c)

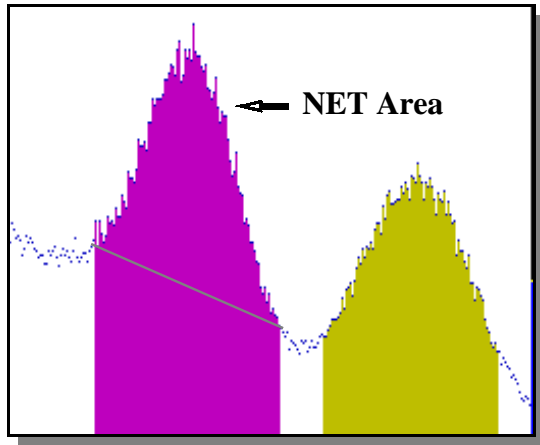
Move the marker to the beginning of the region of interest and click or spacebar. Move the marker beyond the end of the region and click or spacebar again. This will delete the entire ROI.

To CLEAR all ROI's

Select CLR ROI as above and click on ERASE (keyboard e) or strike DEL. This will clear all ROI's from the data memory and screen.

Integrals and Preset Count.

When the marker is positioned in a region of interest, the ICS 10 software automatically calculates the gross and net area of the region. In order to minimize statistical effects at the ROI endpoints, a 3-point averaging technique is applied. The contents of channels $(n-1)$, (n) , and $(n+1)$ are summed and averaged to derive the content of the endpoint channel for the net area computation. A linear interpolation is performed between these averaged endpoint values and counts below the Compton edge are subtracted to arrive at the net area of the peak.



To select the integrator



Click on

(Keyboard i)

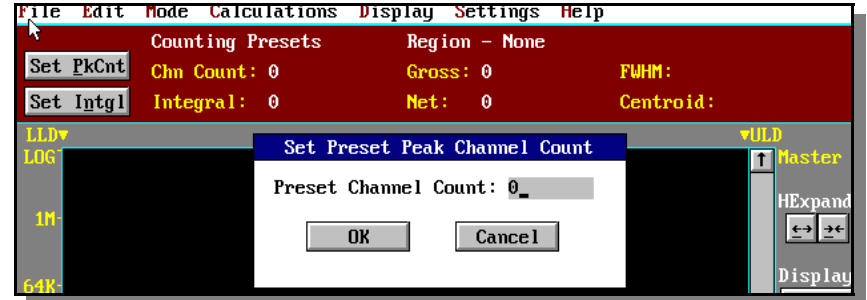
Position the marker in the peak of interest. The Gross and Net areas are automatically computed and displayed in screen data window



Acquiring data for a preset count is possible using the REGION select. Two mode are possible.

Set Peak.

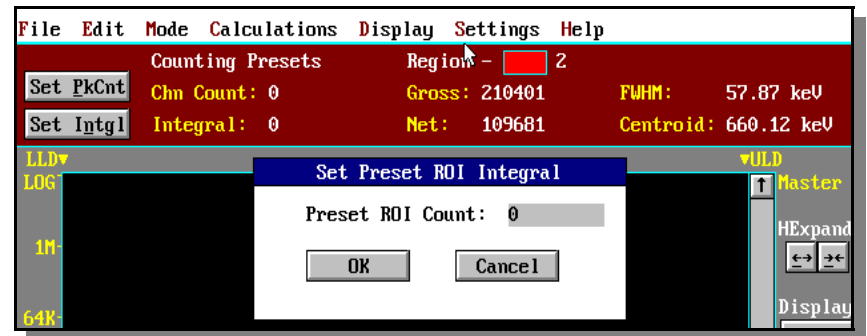
Counting will terminate when the content of any channel in the entire spectrum reaches the preset value.



Set Integral.

In this mode only one ROI color may be used but any number of separate peaks may be set with ROI's. The gross integrals of all the ROI's are totalized and when this value reaches the preset integral, counting will be terminated.

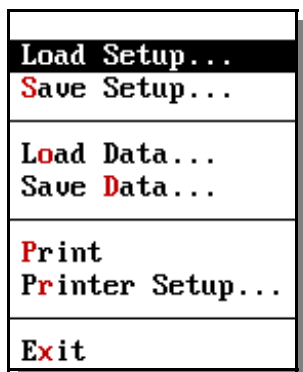
To set an integral count it is necessary to first establish a ROI and then position the marker within the region.



THE MENUBAR

Many advanced functions are possible via the pulldown menus. This section describes each operation in the sequence they appear.

FILE. (keyboard ALT_f)



Load Setup / Save Setup.

Once the ICS 10 has been setup and calibrated, all operating parameters may be stored as a disk file for subsequent retrieval. If power is lost, it is a simple and convenient process to reload the setup file and quickly restore the analyzer to its previous operating condition. *Don't forget to turn-on the high voltage!*

Load Data / Save Data.

Spectrum data from the ICS memory and parameter conditions may be saved as disk files for subsequent retrieval. Two options are possible with the SAVE command.

A binary file with the file extension **.SPE**

A spreadsheet compatible file with the extension **.TSV**

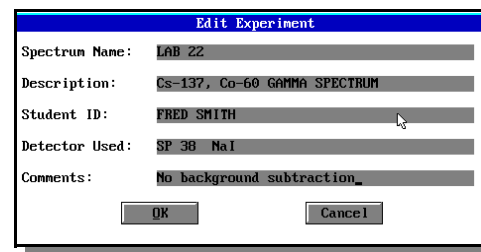
Only binary .SPE files may be reloaded into the ICS data memory!

Print / Print Setup.

Selects and prints data to common printers when operating under DOS. WINDOWS users may prefer to import data into spreadsheet files for editing, graphing and printing.

EDIT. (keyboard ALT_e)

Edit provides a means of inserting text into spectral file headers for referencing specific measurements.



This text is saved along with data and parameter information in .SPE and .TSV files.

MODE. (keyboard ALT_m)



Selects operating mode.

Pulse Height Analysis.

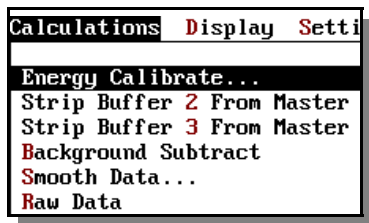
The normal operating mode for collecting sample emission spectra. The amplitude of each detector pulse is measured by the ADC and stored as an amplitude (energy) spectrum.

Multichannel Scaling.

This mode is used for measuring time related phenomena such as half-life decay or single photon counting. Incoming events are counted for specific predetermined times (dwell time) and stored in sequential memory locations. (See section MULTICHANNEL SCALING.)

CALCULATIONS. (keyboard ALT_c)

The CALCULATIONS menu make it possible to perform many advanced operations with the ICS 10.

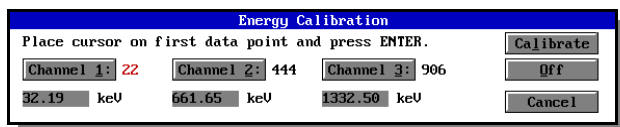


Energy Calibrate.

The energy calibration feature allows the marker to read directly in energy units. Two calibration functions are possible, a 2-point linear, or a 3-point quadratic fit. In order to perform an energy calibration, it is first necessary to acquire a spectrum using known isotopes. Cs-137 together with Co-60 works well for many applications, producing gamma lines at 32keV, 662keV, 1173keV and 1332.5keV.



First enter the calibration units to be used.

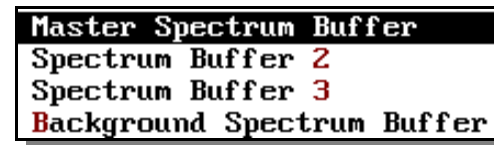


Position the marker at the highest channel of the first peak and enter the peak energy value. Move the marker to the high point on the second peak to be used for the calibration and repeat the procedure. At this stage, if only a 2-point calibration is to be used, exit by clicking on the CALIBRATE button. If a 3-point calibration is required, continue by moving the marker to the peak channel of the third peak, enter its energy and click on CALIBRATE. The system will now be calibrated and the marker position will read directly in energy.

To return to the channel mode, restore the menu and click the OFF button.

SPECTRUM STRIPPING

The ICS 10 is organized with three computer memory data buffers, plus a separate computer memory BACKGROUND buffer and the active on-card data memory.



The on-card memory is used for collecting spectral data from the ADC and cannot be overwritten by computer data manipulations.

MASTER SPECTRUM BUFFER is used to display data stored in the on-card memory.

SPECTRUM BUFFERS 2&3 are computer storage areas which may be used for temporary storage of data during manipulation.

BACKGROUND SPECTRUM BUFFER is a special buffer used for storing the environmental background of the detector system.

The STRIP function allows data stored in buffers 2&3 to be subtracted from the master buffer using livetime normalization. For example, if the master buffer contains data accumulated for 1000 sec. livetime, and buffer 2 contains data collected for 2000 sec. livetime, 50% of buffer 2 will be subtracted from the master buffer and the residual spectrum will then be displayed in the master buffer. The contents of the ADC memory is not changed by this operation

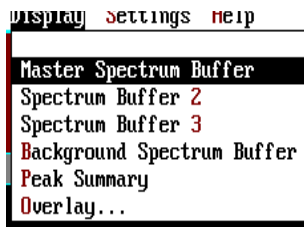
Background Subtract. (keyboard b)

This is a special case of spectrum stripping. The detector background is stored in the background buffer, usually for a long collection time. When background subtract is executed, the livetime fraction of the background spectrum is automatically subtracted from the contents of the master buffer. This provides a convenient method of removing naturally occurring background from a sample spectrum and can be very useful when working with low level environmental samples.

Smooth Data. (keyboard s)

The smoothing function only works on the master buffer and cannot modify data stored in the on-card memory. When executed, smoothing performs a 3-point averaging of the data using the algorithm $\frac{(n-1)+(n)+(n+1)}{3}$.

DISPLAY. (keyboard d)



The DISPLAY function provides a means of accessing the various memory fields as explained previously.

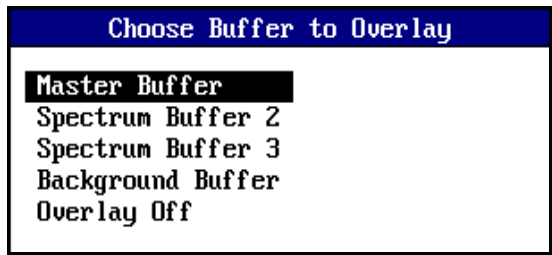
Peak Summary.

If regions of interest have been set around peaks in a spectrum, the PEAK SUMMARY provides a convenient method of displaying peak information in tabular form. Readout will be in energy units if the energy calibration is active.

Peak	ROI	Centroid	FWHM	Gross	Net
10-32		31.11 keV	10.65 keV	143018	98352
400-482		660.12 keV	57.87 keV	210401	109681
754-834		1175.46 keV	67.37 keV	75576	31364
862-947		1334.55 keV	77.57 keV	51850	26365

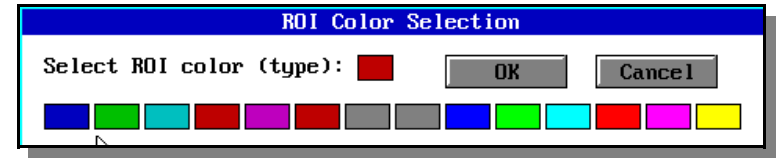
Overlay.

The four data storage buffers may be sequentially superimposed over each other for visual comparison.



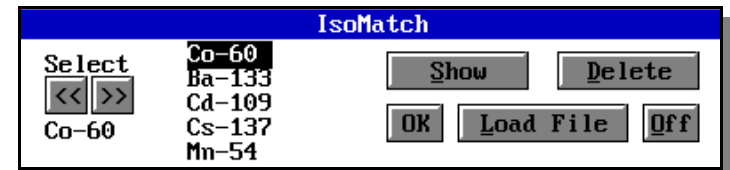
SETTINGS. (keyboard s)

The SETTINGS menu allows access to the ROI color selector and ISOMATCH peak identifier.

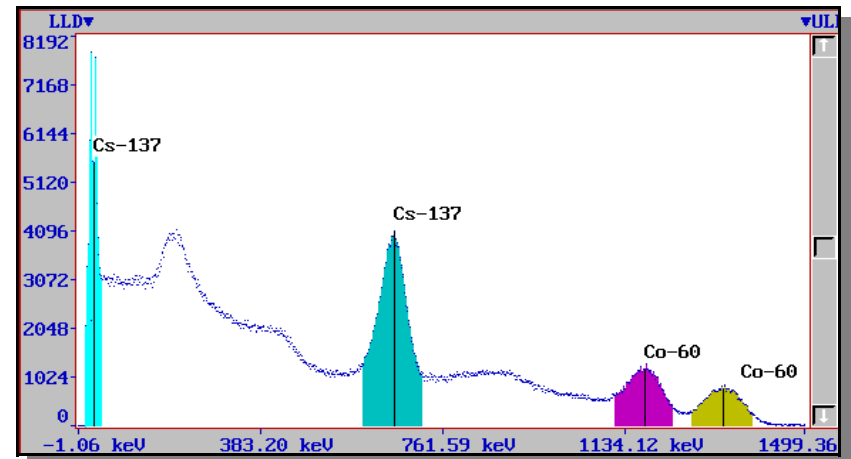


ISOMATCH.

Prior to running ISOMATCH, the ICS 10 must be accurately energy calibrated otherwise the peak markers will be misaligned. The ISOMATCH library contains a listing of significant gamma ray emissions for many common isotopes and may be edited using a text editor.



Select the isotope of interest and click SHOW. Markers will be superimposed over the spectrum at the corresponding energies of gamma emissions for the selected isotope. Each marker is also labelled with the isotope name for rapid identification of peaks. Multiple isotopes may be displayed simultaneously by selecting and clicking SHOW. The ISOMATCH library may be edited use a text editor and other libraries may be created and stored with other filenames.



MULTICHANNEL SCALING.

Multichannel Scaling provides a means of recording time correlated data such as half-life decay or single photon counting. In this mode the ADC is bypassed and incoming events are routed directly into memory.

The ICS 10 is factory configured to use its internal amplifier and discriminators to process detector signals prior to routing to the MCS counter. This scheme presents a convenient method of counting the complete spectrum or a selected range such as a single photopeak.

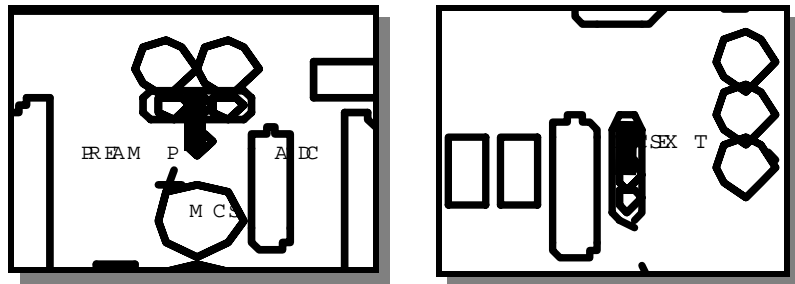
First acquire a spectrum of the sample to be counted using the Pulse Height Analysis mode. While acquiring the spectrum, adjust the LLD and ULD to select the energy range of interest (For example, selecting only the 662keV peak from Cs-137 can eliminate unwanted background and produce a superior decay curve from the Cs-137/Ba-137 generator.)

From the MODE menu select MCS.

Enter the DWELL TIME for each memory location (channel). Remember the total pass time will be (1024 x dwell time).

Erase any current memory data and click start. The ICS 10 will proceed to count incoming events for the selected dwell time, store the total in the first channel location, reset the counter and repeat the cycle storing each total in sequential channels.

If you wish to use an external pulse generation system such as a coincidence circuit, it will be necessary to bypass the on-board amplifier and discriminators. An MCS jumper selector is included on the card and when set to the EXT position, the input BNC connector is routed directly to the MCS counter. When operating in this mode, the MCS input requires positive TTL signals (>2.5v, >150ns duration).



Jumper Settings for External MCS.

DIP-SWITCHES AND PORT ADDRESSING.

The port address of your ICS 10 card is factory set to HEX 210, (DEC. 528). This is an address field normally reserved for a XT expansion unit and is generally available for plug-in cards.

If for any reason the software does not recognize the ICS 10 card or does not appear to function correctly, it is possible to reconfigure the port address as per the following table using switches 4 through 10. (A3-A9).

A command line switch must be included for addresses other than HEX 210

MULTI-CARD INSTALLATION.

Up to a maximum of eight ICS 10 cards may be installed and operated with a single computer providing bus slots are available and sufficient power can be supplied from the power supply. when installing multiple cards, it is necessary to assign each card a different address using the card select switches 1 through 3. (A0-A2).

Each card is accessed and controlled using the command line switch *c(card #)*.

Once a card has been started it will continue to acquire data in an autonomous manner independent of the of the ICS software until a new instruction set is downloaded to that particular card using the appropriate command line switch. In this way it is possible to switch between and control multiple cards installed in a single computer system.

A convenient way of accessing multiple ICS cards is to use WINDOWS to set up individual DOS icons for each card in the system with the appropriate command line switch assigned to each icon. It is then possible to open each ICS card application by clicking on the icons and switching between them using the WINDOWS *Alt+Tab* command

The *c* switch and *p* switch may be combined in a single command line as shown in the following example.

ICS10 p536 c2

This will select card number three at address HEX 218

ICS 10 PORT ADDRESS DECODING.

										<u>HEX</u>	<u>DEC.</u>	<u>Command Line</u>
1	2	3	4	5	6	7	8	9	10	210	528	ICS10 (default)
1	2	3	4	5	6	7	8	9	10	218	536	ICS10 p536
1	2	3	4	5	6	7	8	9	10	310	784	ICS10 p784
1	2	3	4	5	6	7	8	9	10	318	792	ICS10 p792
1	2	3	4	5	6	7	8	9	10	330	816	ICS10 p818
1	2	3	4	5	6	7	8	9	10	338	824	ICS10 p824
1	2	3	4	5	6	7	8	9	10	340	832	ICS10 p832
1	2	3	4	5	6	7	8	9	10	348	840	ICS10 p840
A0	A1	A2	A3	A4	A5	A6	A7	A8				

SPECIFICATIONS

Hardware.

Physical: single IBM-XT compatible card includes preamplifier, amplifier, detector high voltage, 1024-channel multichannel analyzer with data memory, LLD and ULD. Fully compatible with many scintillation detectors and commercial tube bases.

Data Input: BNC connector for direct connection to PMT anode signal. On-board jumper to bypass amplifier for use with positive unipolar or bipolar signals from external amplifier or alpha/beta spectrometers, 0-8volt range.

HV Output: MHV (or optional SHV) connector supplies positive 0-1280volt @ 1mA maximum current to power scintillation detector. High voltage is fully regulated and computer controlled in 5volt increments.

Amplifier: on-board combination preamp./amplifier for use with scintillation detectors and PMT's. Computer controlled coarse and fine gain from x2 to x1000.

ADC: Wilkinson type with 80MHz clock and computer selected conversion gain of 1024, 512, or 256 channels. Direct input accepts pulse peaking times of 1sec. to 10sec. Includes dead-time correction when used in Live-time mode.

LLD & ULD: independently computer controlled in 4-channel increments over entire input range. Operates prior to ADC for reduced system dead time.

Modes: MCA for pulse height analysis, or MCS for half-life decay or other time related studies.

Timers: Real-time or Live-time operation selectable in 1-second increments for PHA, or dwell times from 10msec. to 600sec. per channel in MCS mode.

Data Memory: on-board static RAM, 1024 channel x.3 Bytes for data, plus region-of-interest flag.

Zero Level: 10-turn potentiometer, through panel.

Deadtime: system dead-time is computed and displayed on screen during acquisition.

Power: +5V, 12V from computer bus. On-board regulated for stability and noise rejection. 9-watts total.

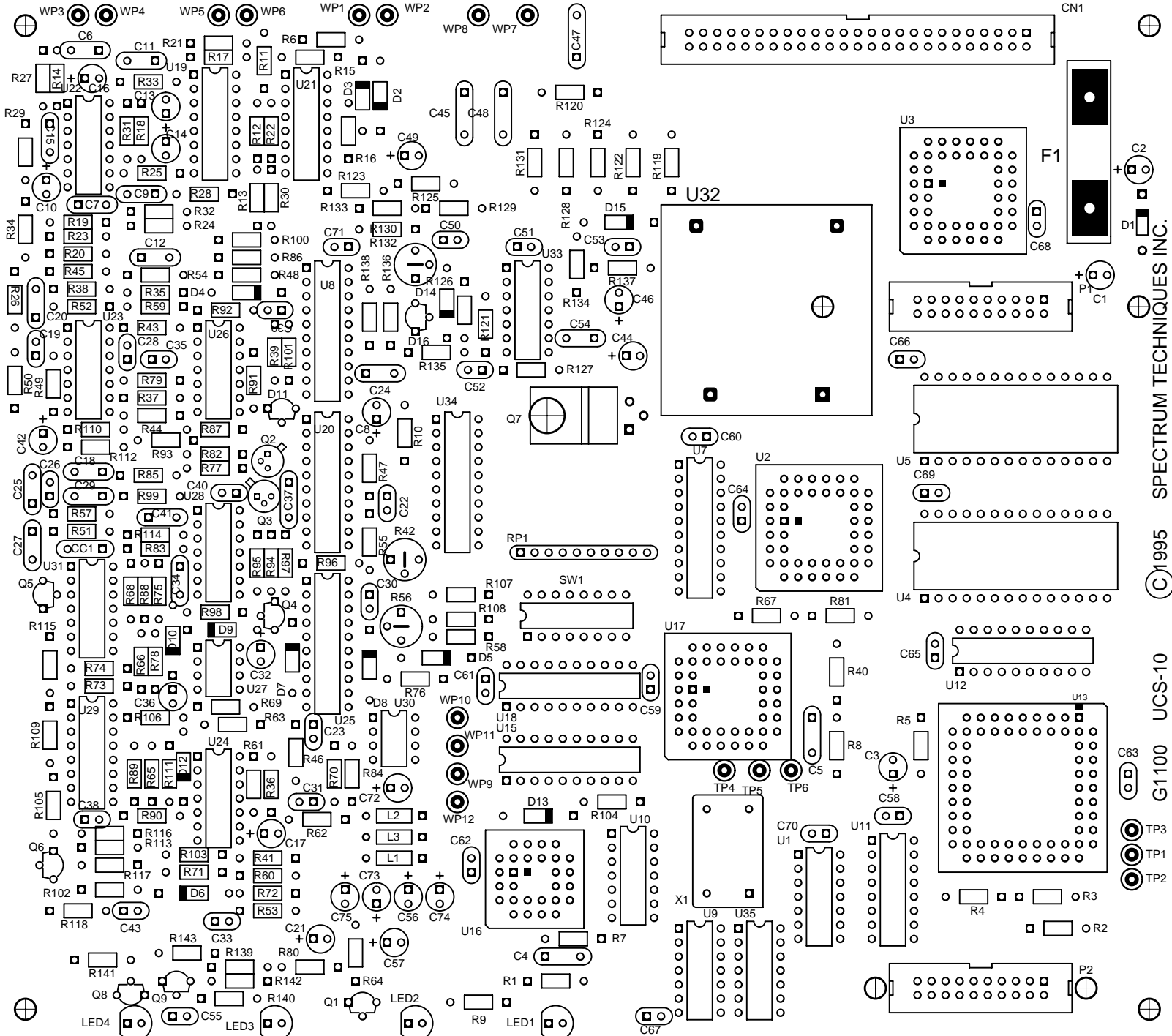
Software.

- System:** operates under DOS or Windows with 512K minimum memory requirement.
- Display:** EGA or VGA color graphics, 350x640 pixels. Vertical scale adjust from 32 to 16M and LOG display. Horizontal 1024 channels with expansion down to 128 channels.
- Time Mode:** preset live-time or preset real-time selection. Both times are recorded and displayed.
- Count Mode:** preset count mode for selected channel or gross Region-of-Interest.
- ROI'S:** multiple Regions-of Interest using color coding.
- Integral:** when cursor is in ROI, computes gross area, net area with end point averaging, centroid and FWHM.
- Energy Cal:** 2-point linear or 3-point quadratic converts cursor position reading directly to energy units. (Time units in MCS mode.)
- Bkgd Buffer:** used to store background spectrum for time normalized background subtraction.
- Subtract:** subtracts channel-by-channel time normalized data stored in Background Buffer from display data.
- Data Buffers:** 2 additional software buffers for storing spectra. Used with COMPARE feature.
- Compare:** overlays data memory spectrum with up to 3 additional spectra stored in Buffers.
- Smooth:** 3-point, or 5-point smoothing of displayed data.
Does not modify data in on-board memory.
- Control:** software control of High Voltage, Amplifier Gain, Lower and Upper level discriminators, and ADC Conversion Gain.
- File:** save or load data file and header information in binary, or spreadsheet compatible formats.
- ROI File:** saves ROI data, centroid, FWHM, gross and net integrals, and header information in spreadsheet compatible format.
- ISOMATCH:** isotope library text file with peak markers and labeling for overlaying on spectrum for quick isotope identification. Library may be edited and extended using word processor or text editor programs.

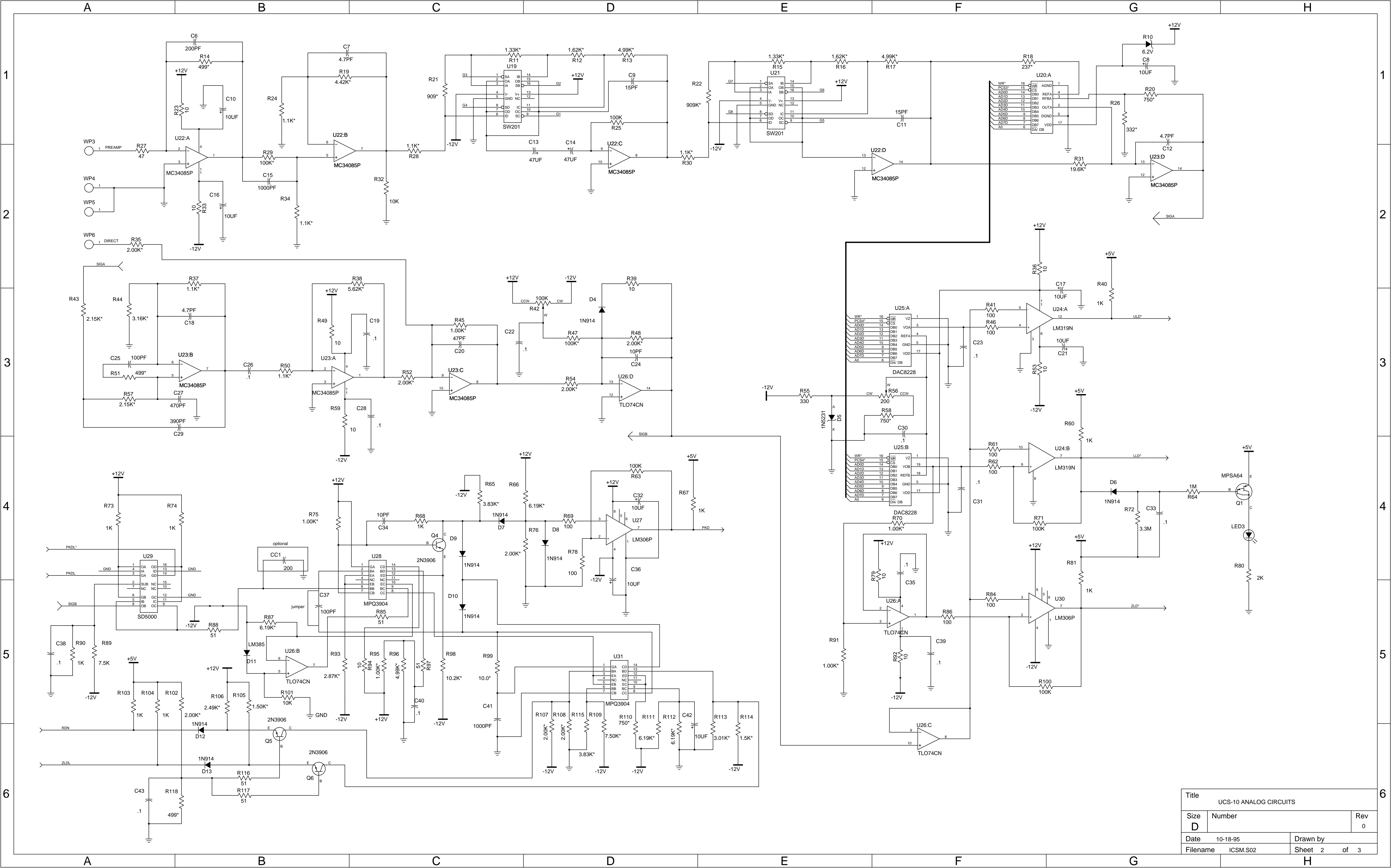
SPECTRUM TECHNIQUES, INC.

106 Union Valley Road
Oak Ridge, TN 37830
USA.

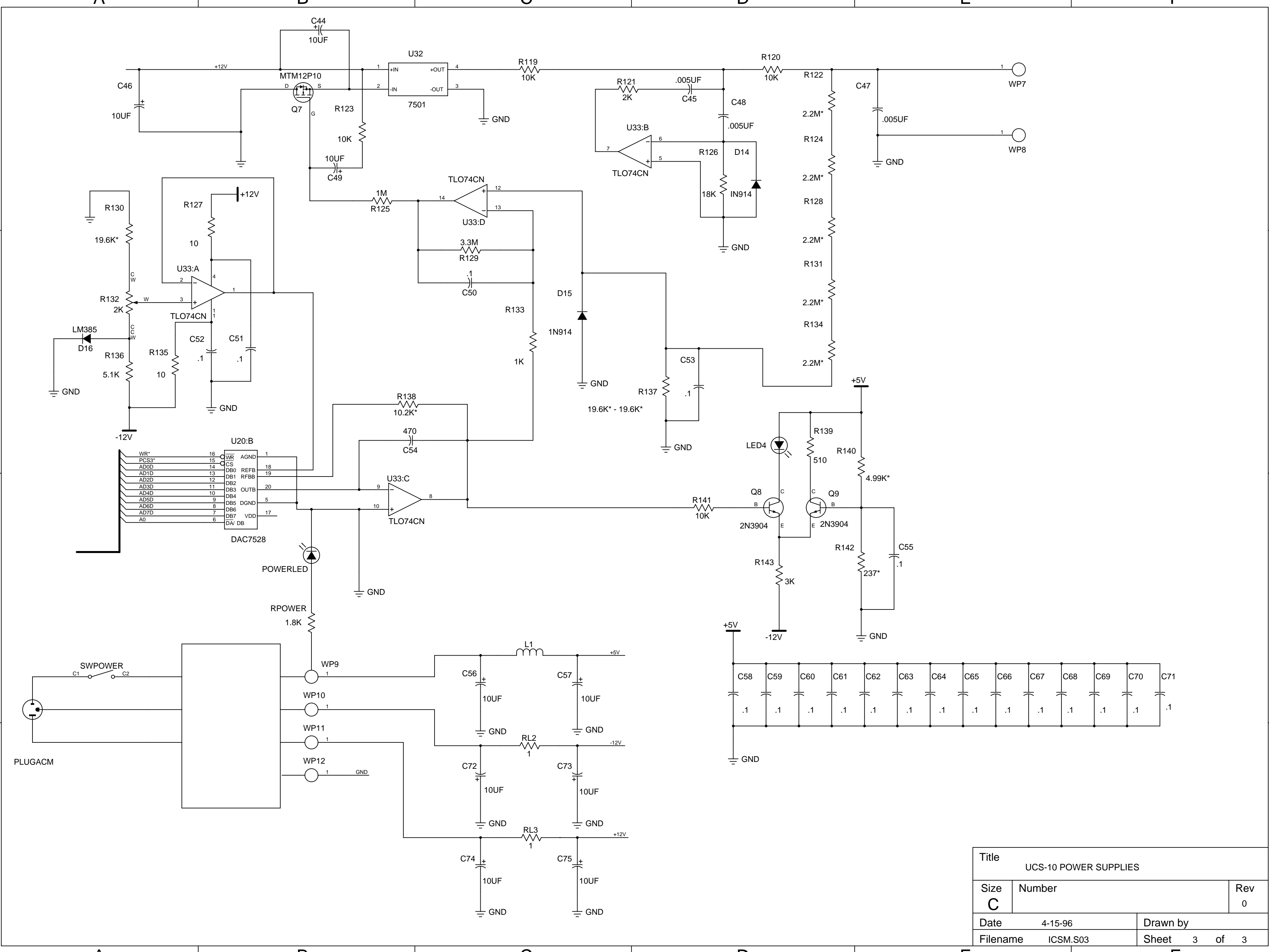
Tel. (615) 482-9937 Fax. (615) 483-0473
support@spectrumtechniques.com
www.spectrumtechniques.com



©1995 SPECTRUM TECHNIQUES INC. G1100 UCS-10



Title			UCS-10 ANALOG CIRCUITS		
Size	Number				Rev
D					0
Date	10-18-95		Drawn by		
Filename	ICSM.S02		Sheet 2 of 3		



Title			UCS-10 POWER SUPPLIES		
Size	Number				Rev
C					0
Date	4-15-96		Drawn by		
Filename	ICSM.S03		Sheet 3 of 3		