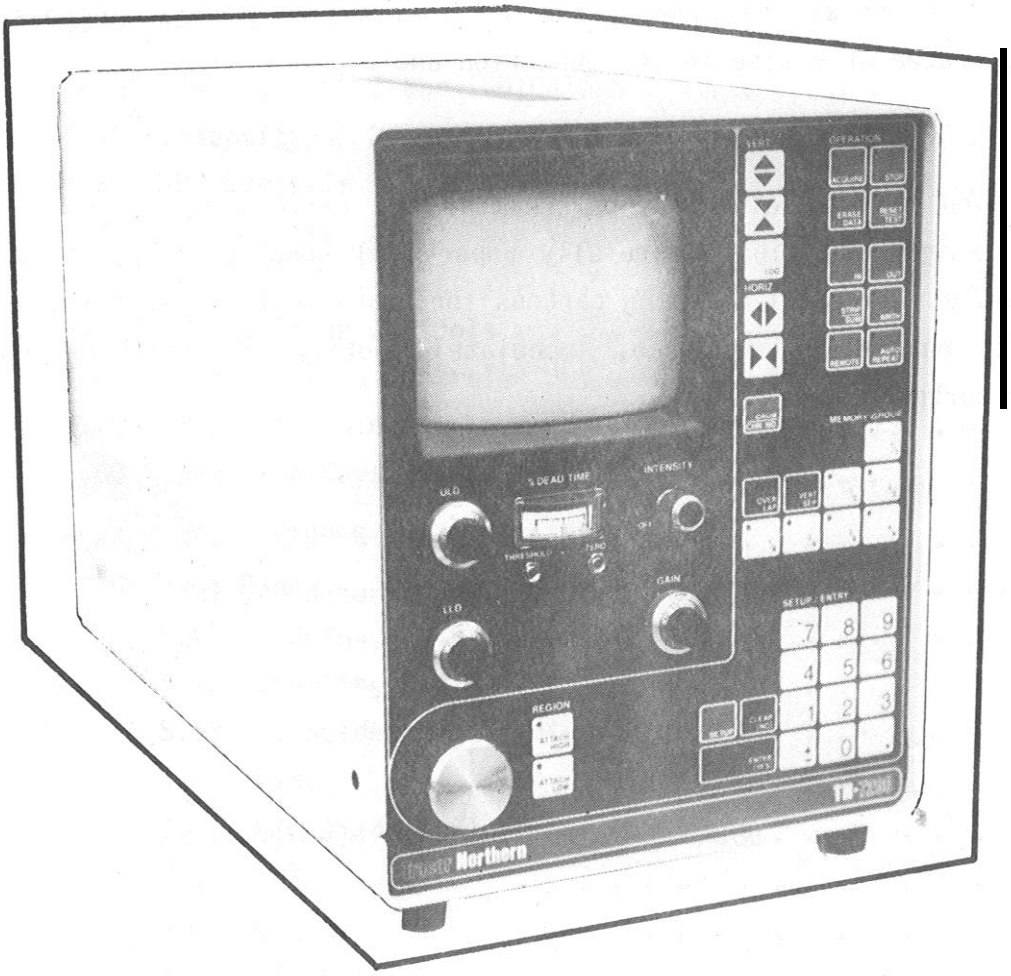
TN-7200

MULTICHANNEL ANALYZER

OPERATOR'S MANUAL



Tracor Northern

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UNPACKING

Upon receipt of shipment, examine all cartons for external damage. If no damage is visible, carefully unpack all components and inspect them for damage. Save all shipping cartons for reshipment if necessary.

If damage has occurred, immediately notify the shipping agent and Tracor Northern.

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1.00 BRIEF SYSTEM DESCRIPTION

The TN-7200 is a microprocessor-based multichannel analyzer. Standard features include:

- 50 MHz Wilkinson type ADC
- Two analysis modes:
  - Pulse Height Analysis
  - Multichannel Scaling
- Data processing capabilities
- 5 inch diagonal video monitor for spectral data display
- ASCII serial I/O port
- Front panel controls incorporating a set of pressure--sensitive switches for convenient control of data acquisition, display, data processing, parameter entry, and I/O.
- Built-in diagnostic programs to verify proper system performance.

SYSTEM DESCRIPTION

The TN-7200 is contained in an 8.5" x 11" x 15" chassis which can be used as a table-top unit, or mounted in a standard 19" rack (configuration must be specified at time of purchase). All normally used controls are accessible from either the front or rear panels. Table-top units have a fold-down support to provide an optimum viewing angle and convenient operation of the front panel.

2.00 THEORY AND OPERATING PRINCIPLES

The TN-7200 can perform data acquisitions in two basic modes: Pulse Height Analysis and Multichannel Scaling.

Pulse Height Analysis 2.10

Pulse Height Analysis (PHA) is the principle means of data acquisition for the TN-7200. In the most common application of pulse height analysis, a detector [NaI, Si(Li), Ge(Li)] is placed near a radioactive source, commonly a gamma emitter. When it is struck by a radioactive emission, the detector produces a voltage pulse whose amplitude is proportional to the energy of the incident radiation. Figure 2a is a graph of voltage pulses as they might appear at the output of an amplifier. PHA

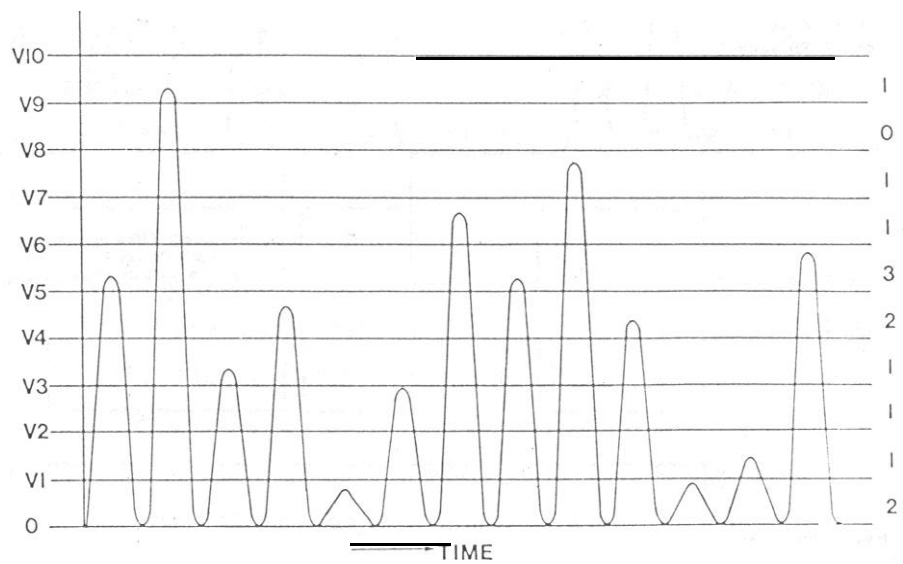


Figure 2a AMPLIFIER OUTPUT

Live Time/Dead Time/Real Time 2.11

The stream of pulses is then fed to the Analog-to-Digital Converter (ADC). Figure 2b illustrates what happens as pulses arrive at the ADC input. When the first pulse is detected, the ADC begins, the

conversion process. While this pulse is being converted and stored in memory, the ADC is unable to accept any other incoming pulses. This interval, from the time a pulse is accepted for conversion until it is stored, is called "Dead Time". The total dead time for an acquisition is the amount of time the ADC spent converting and storing incoming pulses. The % Dead Time Meter (front panel) indicates the instantaneous percentage of dead time during an acquisition.

PHA

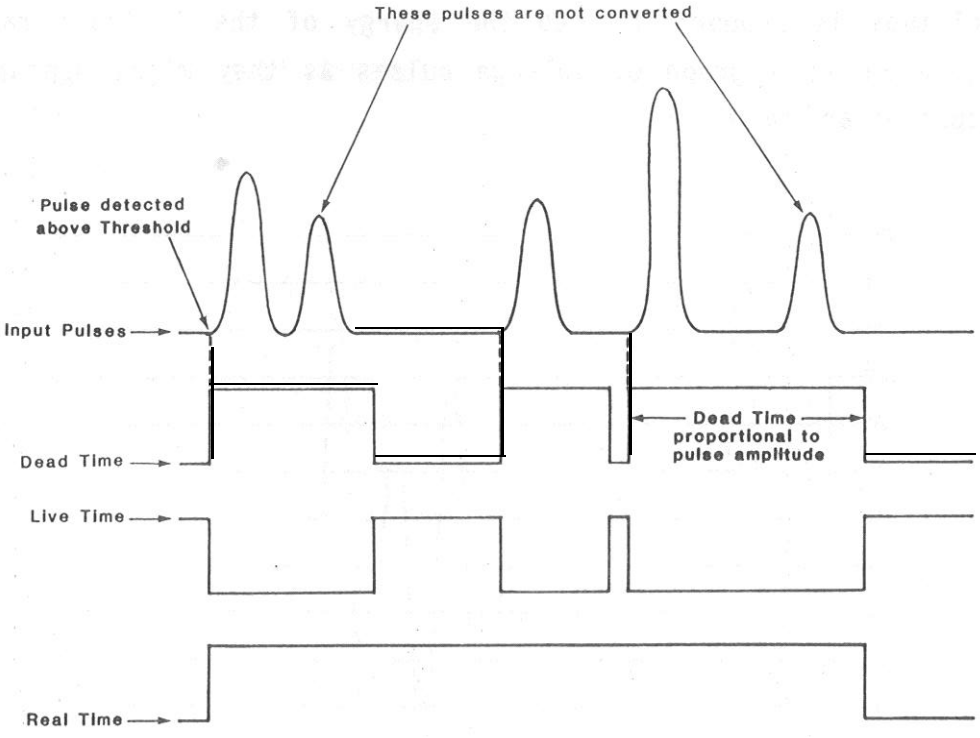


Figure 2b LIVE TIME/DEAD TIME/REAL TIME

After the first pulse has been converted and tallied in the proper data memory channel, the ADC can accept a new pulse for conversion. The interval, from. the time the preceding pulse was stored to the time a new pulse is accepted for conversion, is called "Live Time". The total live time for an acquisition is

displayed on the TN-7200 CRT. The sum of the live time and dead time is equal to the "REAL TIME" (or clock time) of the acquisition. The real time, in seconds, can also be displayed on the CRT. The total dead time for a given acquisition can be determined by subtracting the live time from the real time.

Conversion Gain 2.12

The ADC divides the total range of the input voltage into a number of discrete intervals called ADC channels. The number of ADC channels is referred to as the Conversion Gain. The Conversion Gain determines the number of different peak amplitudes that can be sensed by the ADC. In Figure 2a, since there are 10 voltage divisions (vertical scale) the Conversion Gain is 10. The ADC used in the TN-7200 provides Conversion Gain settings of 256, 512, 1024, 2048, and 4096. This means that, at its maximum Conversion Gain setting, the ADC can sense 4096 different peak amplitudes. PHA

Referring again to Figure 2a, the column of numbers on the right indicates the number of pulses that fell into each ADC channel. For each pulse which falls within a specific voltage interval, one "count" is tallied in the corresponding channel of the TN-7200 Data Memory.

Data Memory Storage 2.13

The data memory can have up to 4096 locations for the storage of count values. Data memory storage locations are also commonly referred to as "channels".

```
+ + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + +
+ Hereafter, "channels" or "data channels" will be used to indicate +
+ data memory storage locations. "ADC channels" will be used in    +
+ reference to the ADC.                                             +
+ + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + +
```

Figure 2c is a histogram, showing how the data memory would store the count values for the series of pulses in Figure 2a. For this example, the data memory has a fixed size of 10 data channels so horizontal axis is divided into 10 intervals. The vertical scale

indicates the number of counts per data channel. Since the conversion gain is 10 and there are 10 data channels, the entire input voltage range is represented by the histogram. As shown in figure 2c, the 3 counts in channel 5 correspond to the three pulses whose amplitudes were greater than or equal to V5 and less than V6.

PHA

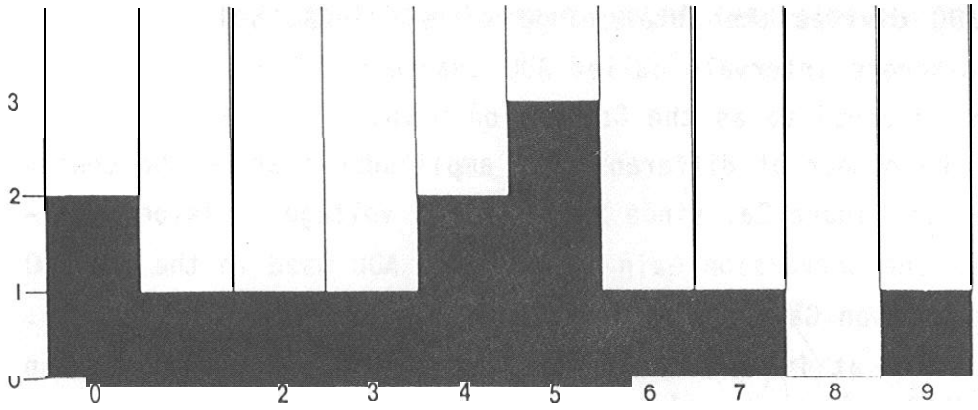


Figure PHA HISTOGRAM

Figure 2d shows a typical TN-7200 PHA spectrum. Each radioisotope produces a characteristic and readily identifiable spectrum of this type. Each point in the spectral trace represents the counts tallied in a single data channel. Even though the TN-7200 displays each channel as a single dot, remember that each channel represents a voltage interval.

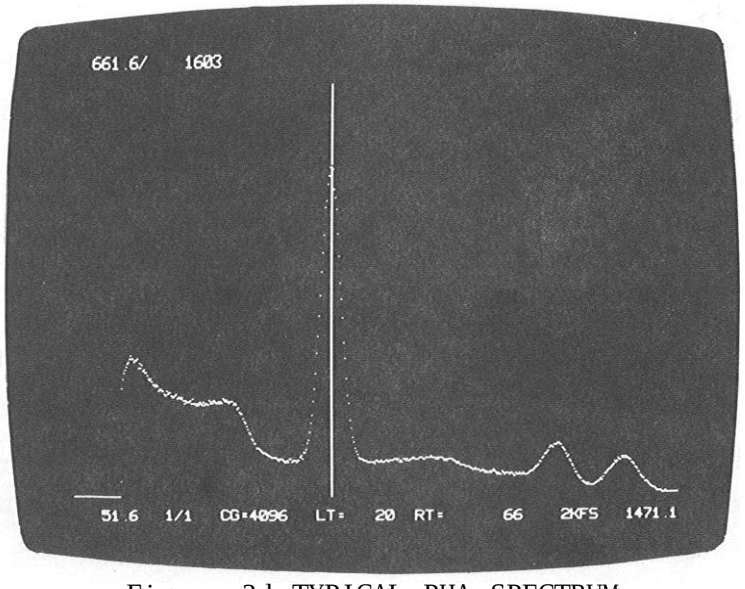


Figure 2d TYPICAL PHA SPECTRUM

Varying Conversion Gain

When a one to one relationship exists between the conversion gain and the number ofdatachannels (as in the previous example), the entire input range (every ADC count value) is stored in the data memory. For most acquisitions, the conversion gain is set equal to the number of data channels in the acquiring memory group causing the entire input range to be stored. However, as stated earlier, the TN-7200 ADC provides a number of different conversion gain settings. When the conversion gain is set so that there are more ADC channels than data memory channels, the full input range is not stored,

Figure 2e shows the stream of pulses from Figure 2a but with a conversion gain of 20. This means that there are now 20 ADC channels covering the full input range. Figure 2f shows how the lo-channel data memory would store the count values from Figure 2e. Only count values from the lower ten voltage intervals (V0-V9) are stored while the upper ten (V10-V20) are ignored since no storage locations exist for them.

PHA

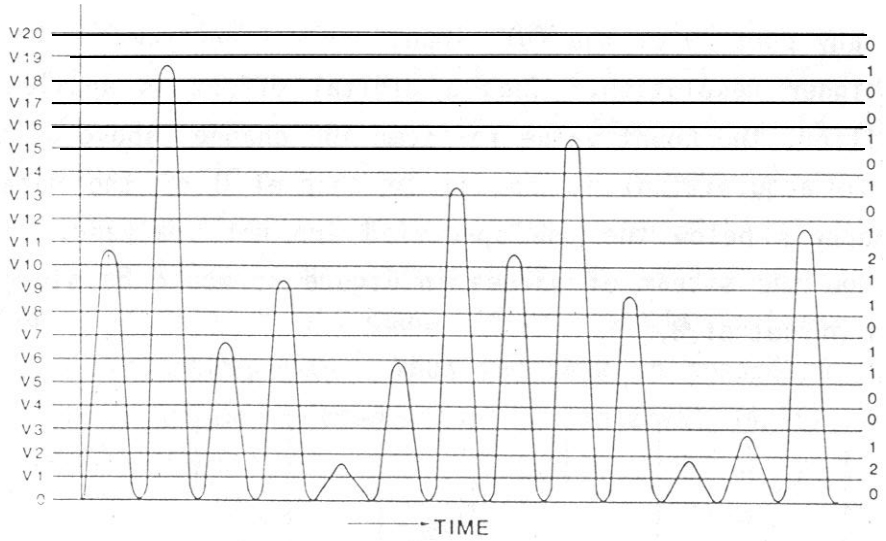
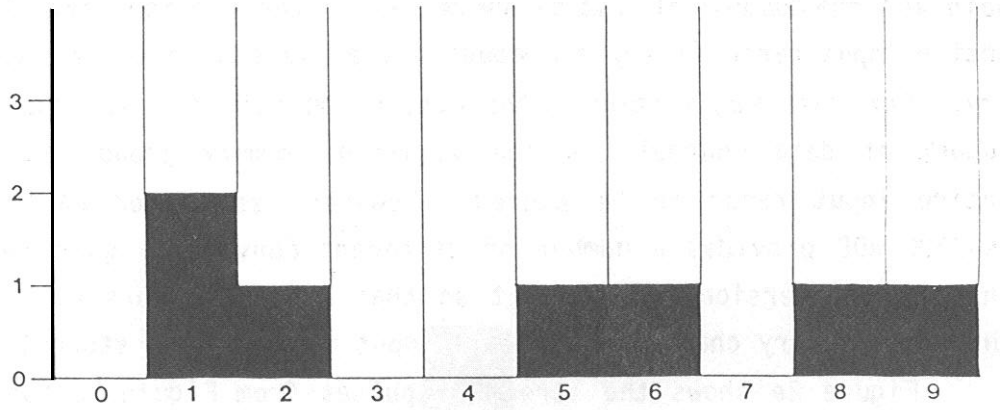


Figure 2e AMPLIFIER OUTPUT



PHA

Figure 2f CONVERSION GAIN = 20; DATA MEMORY SIZE = 10

2.15 Digital Offset

A comparison of the histograms in Figure 2c and 2f shows that the count values which were stored in channels 0 through 4 in Figure 2c are stored in channels 0 through 9 in Figure 2f. This represents an increase in resolution for that portion of the input range.

The TN-72D0 incorporates a feature called Digital Offset which allows any portion of the full input range (spectrum) to be acquired at a higher resolution. When a digital offset is applied to data acquisition, the count value for some ADC channel above 0 (specified prior to acquisition) is routed to channel 0 of the data memory. ADC channels below the one specified are not analyzed. Figure 2g shows how the stream of pulses in Figure 2e would be stored with a digital offset of 8.

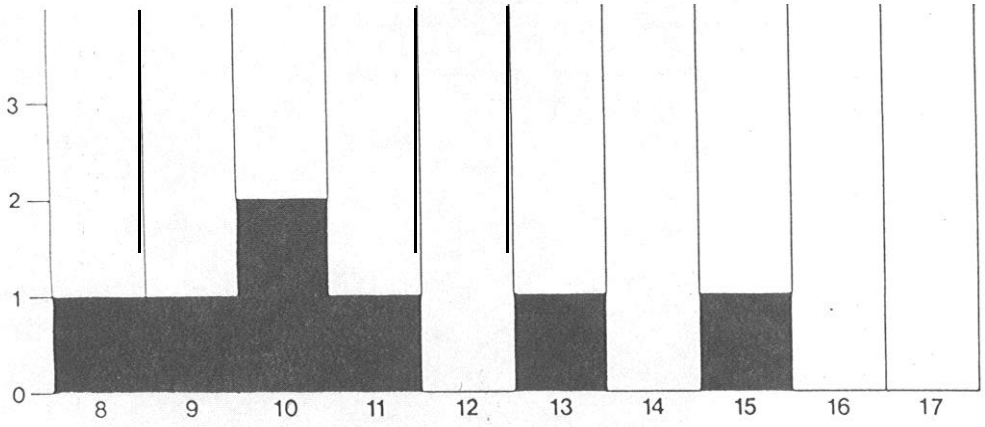


Figure 2g DIGITAL OFFSET = 8

The count values from the interval V8-V9 are routed to channel 0 of the data memory. The count values from the intervals V9-V17 are placed in the remaining data channels. The count values below V8 and above V18 are not analyzed.

Multichannel Scaling (MCS) 2.20

MCS analysis is used to obtain histograms representing frequency of occurrence (intensity) vs. elapsed time. The input signal is a train of pulses, each of which represents a single event. There is no information contained in the amplitude or width of these pulses - they are 'logic' pulses in the sense that the occurrence of a pulse signals an event. MCS operation effectively employs the data memory as a series of scalers (pulse counters). As the pulses are detected at the MCS input, they are counted in a high-speed register for a preset interval (dwell time). At the end of each interval the value in the scaler is added to the contents of the current memory channel and the scaler is cleared and advanced for the next dwell interval - the value of the scaler for this next dwell will be added to the next channel, and so on. When pulses have been tallied in all of the data memory channels being used for the acquisition, a "sweep" has occurred. The "sweep time' is the time it takes for one complete sweep (Sweep Time = Number of Data Channels * Dwell Time). MCS

Figures 2h and 2i illustrate MCS acquisition in simplified form. A series of incident logic pulses is shown in Figure 2h. The contents of memory after one MCS scan are shown in Figure 2i. An MCS spectrum is an integral histogram; that is, each channel represents the integral (total) of all counts within a time interval, not the instantaneous counting rate. Thus the peak in channel 4 represents the 5 events which were detected in the interval T4-T5. Figure 2j shows an MCS spectrum

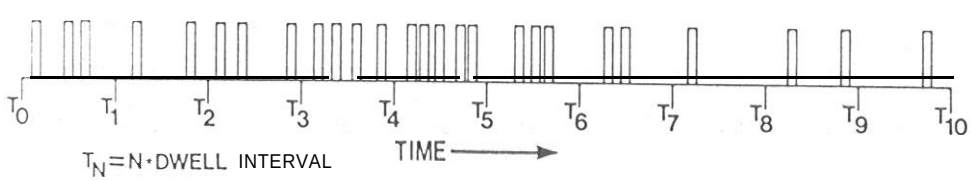


Figure 2h INCIDENT LOGIC PULSES

MCS

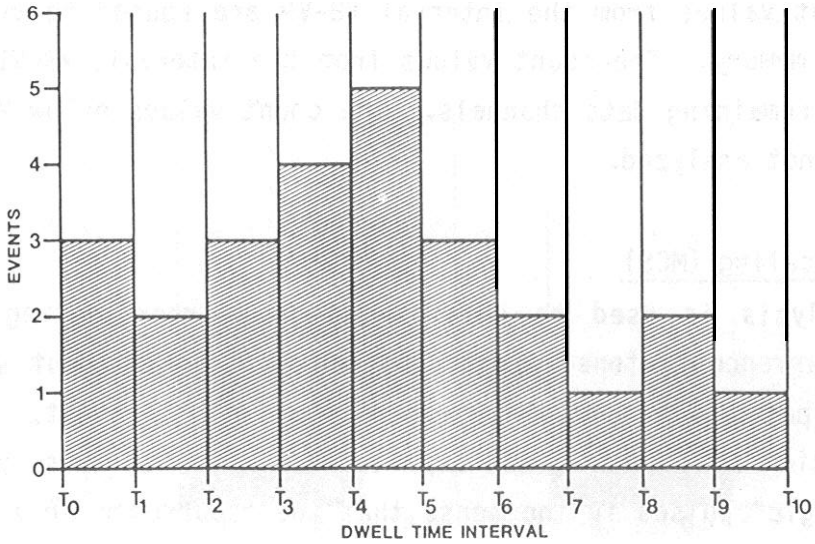


Figure 2i MCS HISTOGRAM

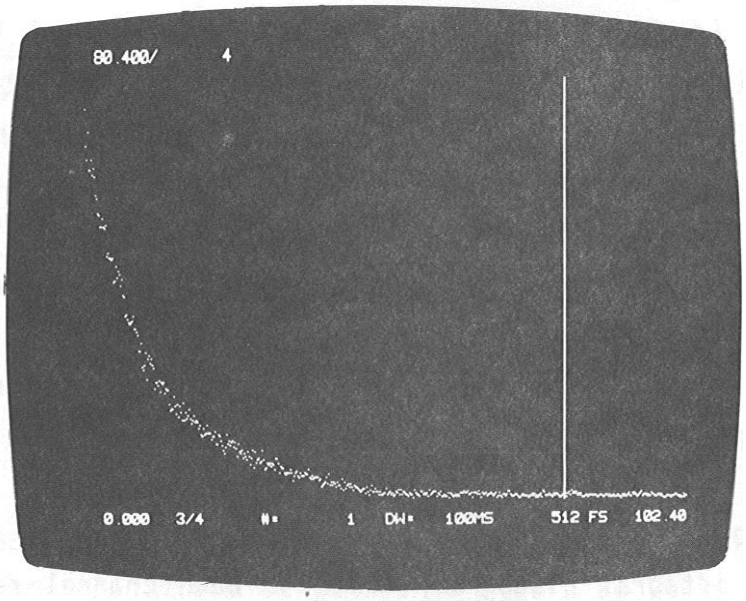


Figure 2j MCS SPECTRUM

MCS analysis is useful in several diverse applications where it is necessary to study the distribution of events vs. time. One of the simplest of such applications is the study of nuclear decay - the MCS spectrum then represents the exponential decay curve.

Many other applications involve the synchronization of the MCS scan to an external device. The channels of the MCS spectrum then are directly related to a position or condition of the external apparatus. Such applications, include Mossbauer analysis, the channels relate to source velocity, and X-ray "line scanning", where the channels represent the traverse of an electron beam on a sample.

3.00 INSTALLATION

Placement 3.10

Your TN-7200 is set up, as specified at the time of purchase, to stand alone as a unit or to be rack-mounted.

If your unit is a stand-alone model, it is equipped with a fold--down support to provide a better viewing angle during operation. To use the support, raise the front of the unit a few inches and swing the support down from its folded position.

Install rack-mountable units in a standard 19" equipment rack using the mounting hardware provided.

Power Requirements 3.20

The TN-7200 can be operated at either 120 VAC or 230 VAC. The desired line voltage can be selected with the selector switch on the rear panel.

Fuses 3.30

The fuse used in your TN-7200 depends on the power requirement. For 120 VAC units, a 1.5 amp SLO BLO 115 V fuse is used. For 230 VAC units, a .75 amp SLO BLO 220 V fuse is used.

Replacing a Fuse

To replace a fuse:

a) Disconnect the AC power from the unit;

b) Press the spring-loaded fuse clip on the rear panel until the catch releases and it pops out;

c) Remove the fuse clip and discard the old fuse;

d) Place a new fuse in the fuse clip; and

e) Insert the fuse clip in the rear panel, pressing in until it locks.

4.00 FRONT PANEL CONTROLS AND INDICATORS

INTENSITY/AC POWER - This switch has two functions: 4.10

a) It turns AC power on and off.

b) It controls the intensity (brightness) of the display.

ADC CONTROLS 4.20

FRONT PANEL CONTROLS

LLD (Lower Level Discriminator) - Sets the lower limit of pulse heights to be processed by the ADC.
Sets the lower SCA limit

ULD (Upper Level Discriminator) - Sets the upper limit for recognition of pulses by the ADC.
Sets the upper SCA limit

ZERO Sets the zero-amplitude intercept of the ADC. That is, the ADC is adjusted to place a hypothetical pulse of 0 amplitude in channel 0 of the data memory.

THRESHOLD Sets the discriminator level for the detection circuit. When the input signal rises above the threshold level, the ADC assumes that a pulse is present and begins the conversion.

THRESHOLD LED - LED brightness indicates the fraction of time that the input signal is above the threshold level.

% DEAD TIME Meter - Indicates the percentage of the total analysis that the ADC is not accepting incoming pulses

PREAMP GAIN - Adjusts the gain of the internal preamplifier; (Not used with an external amplifier)

FRONT PANEL **CONTROLS**

4.30 Setup/Entry Keys

SETUP - Enter Setup mode for programmed functions.

0-9 - Enter numeric parameters.

CLEAR (NO) - a) Clear current entry.
b) Clear ROI display.
c) Select next menu choice.

ENTER (YES) - a) Enter/confirm current parameter entry or menu choice.
b) Display previous RUI. Enable ROI display.
c) Attach ROI limits (with ATTACH HIGH OR ATTACH LOW).

± - a) Invert sign of current parameter entry.
b) Alternate display of Gross or Net ROI integrals.
c) Display horizontal grid bars.

. - a) Enter decimal point.
b) Fill in area beneath spectrum.
c) Display all ROIs.

4.40 Cursor

Cursor Control - (large silver knob)
a) Control Cursor movement.
b) Select menu choice.
c) Adjust vertical offset of overlapped spectrum.

4.50 Memory Group Controls

1/1,1/2,2/2,
1/4,2/4,3/4,4/4 - Select a portion of memory for display.

OVERLAP - Simultaneously display spectra from two different memory groups.

VERT SEP - - Permit adjustment of the vertical offset of the overlapped spectrum.

Display Scale Controls 4.60

- Increases the height of the displayed spectrum by decreasing the vertical scale.
- Decreases the height of the displayed spectrum by increasing the vertical scale.

LOG - Displays the data on a logarithmic scale.

- Horizontally expands the spectrum around the cursor; Permits use of the cursor control to "roll" through the expanded spectrum.
- Horizontally compresses the spectrum around the cursor.

FRONT PANEL CONTROLS

CALIB/CHN NO. - Alternately selects one of the two labeling modes for the horizontal axis: Calibrated values or channel numbers

Region of Interest (ROI) Keys 4.70

ATTACH LOW - Attaches the lower ROI limit to the cursor.

ATTACH HIGH - Attaches the upper ROI limit to the cursor

Operation Keys 4.80

These keys permit the setup and execution of analyzer functions as indicated:

ACQUIRE - Data acquisition in PHA or MCS mode. (Pressing ACQUIRE during acquisition causes the acquisition to end at the end of the next live time second or MCS sweep.)

STOP - Stop any and all currently executing analyzer functions

ERASE DATA - Erase data and reset the group descriptors in the currently selected memory group.

FRONT PANEL CONTROLS

RESET/TEST - Provides reset and test functions as follows:

System Reset - Reset all data descriptors, preset parameters, and calibration; also generate a ramp in the data memory

ROM Test - Test system ROM

RAM Test - Test system RAM

MEMORY TEST - Test system data memory; also generates a ramp in the data memory.

SERVICE - This program should only be used by qualified service personnel. Indiscriminate use of this program may cause a system crash. Refer to the TN-7200 Technical Manual.

IN - Provides input functions:

READ - Read data into the data memory.

SET BAUD RATE - Change the baud rate of the primary serial device..

ENTER LABEL - Enter a data label.

OUT - Provides output functions:

PRINT - Output to primary serial device.

SET BAUD RATE - Change baud rate of the primary serial device.

DISPLAY - Output to the CRT display.

STRIP/SUM - Provides the following data processing functions:

STRIP - Subtract the contents of one memory group from another.

SUM - Add the contents of one memory group to another.

MOVE - Transfer data between memory groups.

ARITH - Provides the following data processing functions:

ADD CONSTANT - Add a constant value to each channel of the selected memory group.

MULTIPLY - Multiply the contents of each data channel by a constant value.

DIVIDE - Divide the contents of each data channel by a constant value.

NORMALIZE - Divide the contents of each data channel by the current live time.

DIFFERENTIATE - Differentiate the contents of the selected memory group.

INTEGRATE - Integrate the contents of the selected memory group

SMOOTH - Perform 3-point smoothing of the contents of the selected memory group

FRONT PANEL CONTROLS

REMOTE - Enables the Remote Control option; Only functions when this option is installed in the unit.

AUTO REPEAT - Enable the automatic erase/acquire/output sequence

5.00 REAR PANEL CONTROLS AND CONNECTORS

Rear Panel 5.10

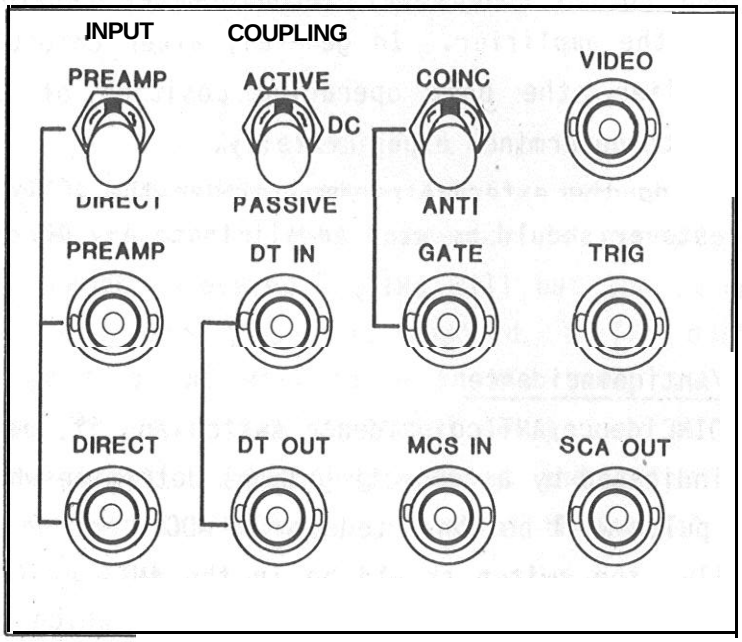


Figure 5a TN-7200 REAR PANEL

REAR PANEL CONTROLS

Input (PHA mode) 5.11

If an external amplifier is used, the PREAMP/DIRECT switch should be in the DIRECT position and the amplifier output should be connected to the DIRECT BNC.

If no external amplifier is used, the switch should be in the PREAMP position so that pulses are routed to the ADC's internal preamp. The detector output is then connected to the PREAMP BNC.

Coupling (Baseline Restorer) 5.12

The COUPLING switch provides positions for ACTIVE, DC (direct coupled), or PASSIVE baseline restoration.

The DC position should be used if the ADC is to be operated with external baseline restoration or when the ADC is converting DC or slow AC signals.

Both the ACTIVE and PASSIVE positions are for AC coupling.

The PASSIVE position should be used for unipolar pulses at low count rates (less than 20,000 counts per

This position provides slightly better resolution because it is less sensitive to noise conditions. However, it does not have the response needed tor high count rates.

The ACTIVE position should be used for higher count rates (greater than 20,000 counts per second) after careful pole zero adjustment of the amplifier. In general, after careful adjustment of the amplifier, the best operating position of the COUPLING switch should be determined experimentally.

REAR PANEL CONTROLS

When using the external preamp, either the ACTIVE or PASSIVE base line restorer should be used to eliminate any DC offset in the output.

5.13 Coincidence/Anticoincidence

The COINCidence/ANTIcoincidence switch and its associated BNC connector (indicated by a connecting line) determine whether or not an incoming pulse will be converted by the ADC.

Normally, the switch should be in the ANTI position so that the ADC will not convert undesired signals which appear concurrently at the ADC input.

If this switch is in the COINC position, the ADC will convert a pulse only if another pulse appears concurrently at the associated BNC. This can be used for gating the ADC so that DC signals or slowly varying AC signals can be accurately displayed.

5.14 Video

This BNC provides the output signal for the Video Printer option.

5.15 DT (Dead Time) IN/OUT

The ADC dead time resulting from a pulse is output as a TTL level (approximately +3.5V) on the DT OUT BNC. Even if a pulse is not converted by the ADC, it may create some dead time. The TTL signal is high for a period of time equal to the dead time.

Some amplifiers employ pile-up systems which generate additional dead time. This must be added to the ADC dead time for correct dead time compensation.

If the amplifier has no provision for dead time correction, the DT OUT connector should be wired to the DT IN connector with a short BNC cable.

If your amplifier has a provision for dead time correction, route the signal from DT OUT to the amplifier and route the corrected dead time signal from the amplifier to DT IN. The dead time signal is used by the TN-7200 to correct the live time clock, providing an accurate method of compensating for dead time in the ADC and amplifier.

TRIG 5.16

MCS sweeps can be triggered externally through the TRIG BNC (Figure 5b). The signal at this connector is normally set high. When TRIG is grounded, pressing ACQUIRE will put the TN-7200 into a waiting mode. When the ground is removed, a TTL positive true (+3.5V) pulse at this BNC will cause an MCS sweep to begin. The pulse width must be less than the total sweep time or the TN-7200 will return to automatic triggering mode at the end of the sweep. TRIG can also be used in PHA mode to control the actual start of an acquisition.

REAR PANEL *CONTROLS*

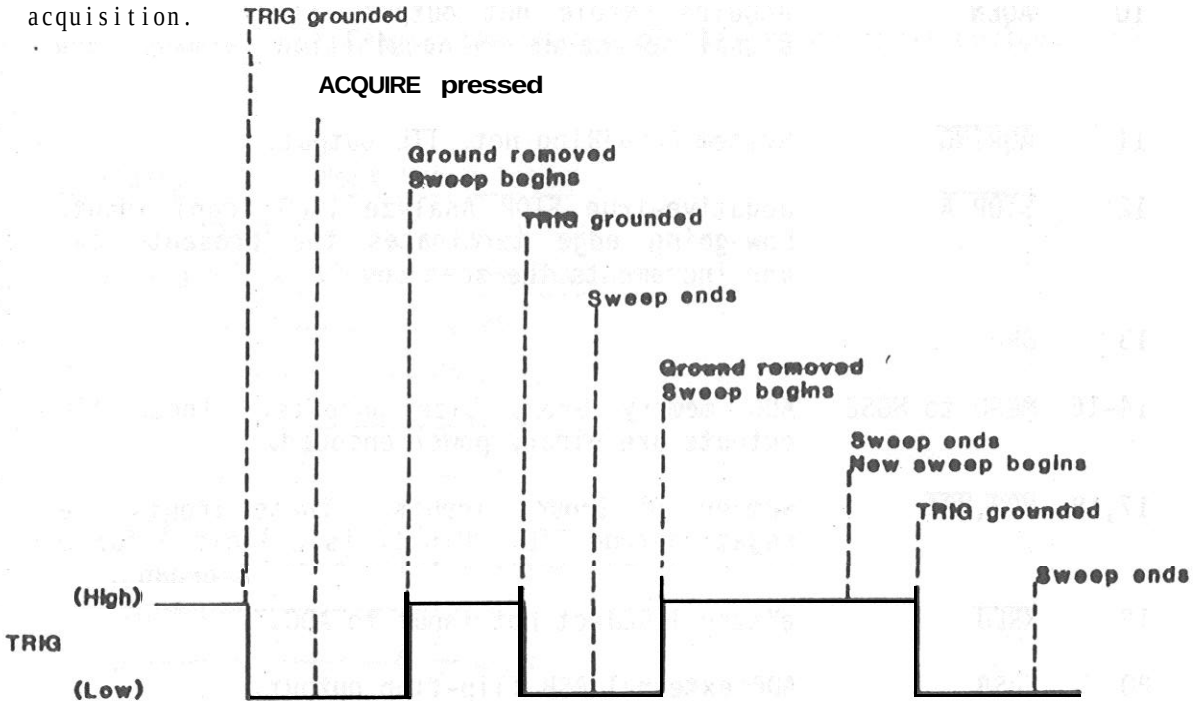


Figure 5b TRIGGERED ACQUISITION

MCS IN 5.17

This is the input connector for MCS analysis. Pulses routed to this input are counted into the data memory, channel by channel, according to the preset DWELL time.

5.18 SCA (Single Channel Analyzer) OUT

A signal is generated at this output whenever the input signal falls between the lower and upper level discriminators.

For MCS analysis, the SCA OUTput can be strapped to the MCS INput.

5.20 REAR PANEL CONTROL SIGNALS

REAR PANEL CONTROLS

This connector is a DB25S Type

Pin	Signal	Description
1-6	$\overline{\text{RA6-RA11}}$	Negative-true TTL input address routing lines for use with a multiplexer/router.
7	XB	ADC external Busy flip-flop output.
8	$\overline{\text{MCAD}}$	Memory transfer ADdress enable not. Negative-true TTL output.
9	GND	
10	$\overline{\text{AQEN}}$	AcQuire ENable not output. (Internally this signal serves as an acquisition "arming" and control function.)
11	$\overline{\text{AQRING}}$	System AcQuiRing not, TTL output.
12	$\overline{\text{STOP A}}$	Negative-true STOP Analyze (MCS scan) input. Low-going edge terminates the present scan and increments the scan count.
13	GND	
14-16	MGSO to MGS2	ADC memory Group Size outputs. These TTL outputs are binary power encoded.
17,18	$\overline{\text{NG2}}$,$\overline{\text{NG4}}$	Number of Groups inputs. These inputs are negative-true TTL. Pin 17 is a logic 0 for 2 groups or Pin 18 is a logic 0 for 4 groups.
19	$\overline{\text{XREJ}}$	external REJect not input to ADC.
20	XPSB	ADC external PSB flip-flop output.
21	$\overline{\text{ACNR}}$	AntiCoiNcidence Reject not input.
22	spare	
23	$\overline{\text{XMCLK}}$	MCS/dwell output.
24	$\overline{\text{XCLK}}$	MCS external dwell time CLOCK negative-true input.
25	ADD/$\overline{\text{SUB}}$	Control Add or Subtract of data to memory

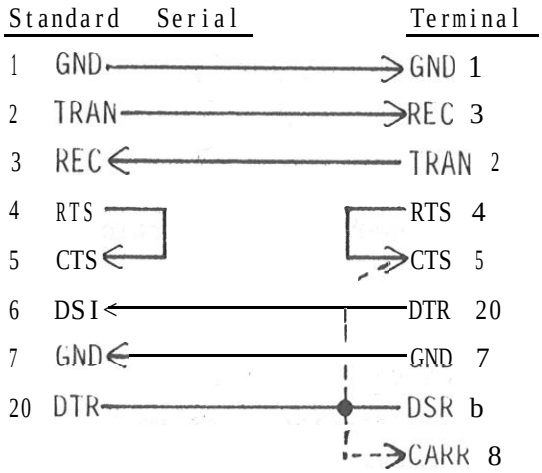
Terminal Connector Signals 5.30

Pin	Signal	Description
1	GND	Signal/chassis ground.
2	TRAN	Transmitted data (EIA) to external device.
3	REC	Received data (EIA) from external device.
4	RTS	Request to send (EIA) to external device.
5	CTS	Clear to send (EIA) from external device.
6	DSR	Data set ready (EIA) from external device.
7	GND	Signal/chassis ground.
8-11	not used	
12	RCL-	Received data (20 ma-) from external device.
13	TCL-	Transmitted data (20 ma-) to external device.
14-19	GND	Signal/chassis ground.
20	DTR	Data terminal ready (EIA) to external device.
21-23	GND	Signal/chassis ground.
24	RCL+	Received data (20 ma+) from external device.
25	TCL+	Transmitted data (20 ma+) to external device.

REAR PANEL CONTROLS

Standard Serial Port Setup Notes 5.40

To EIA Terminal 5.41



NOTES: 1. If terminal does not support RTS, tie CTS (5) to DSR (6).

2. If terminal needs CARR input, tie CARR (8) to (6).

REAR PANEL CONTROLS

5.42 To EIA Data Set

Standard Serial		Data Set
1 GND	⟷	GND 1
2 TRAN	→	TRAN 2
3 REC	←	REC 3
4 RTS	→	RTS 4
5 CTS	←	CTS 5
6 DSR	←	DSR 6
7 GND	⟷	GND 7
20 DTR	→	DTR 20

5.43 To Current Lopp Device (20 ma)

Standard Serial		C.L. Device
3 REC	←	
4 RTS	┐	
5 CTS	←	
6 DSR	┐	
20 DTR	←	
12 RCL-	←	TCL-
13 TCL-	→	RCL-
24 RCL+	←	TCL+
25 TCL+	→	RCL+

NOTES:
1. Additional connections may be necessary to enable the C. L. device.
2. If the C. L. device supports EIA control signals, then DSR, DTR, and GND may be connected as in section 5.31.
3. C. L. device must be a passive current loop device.

5.50 DIP Switches (Terminal Port, MICRDA Board)

Baud rate, parity, delay for carriage return, and line length are selectable through DIP switches and jumpers on the terminal board as follows

Switch S1

Baud Rate	Position 4	3	2
110 BAUD	ON	OFF	ON
150 BAUD	ON	ON	OFF
300 BAUD	ON	OFF	OFF
600 BAUD	OFF	ON	ON
1200 BAUD	OFF	OFF	ON
2400 BAUD	OFF	ON	OFF
4800 BAUD	OFF	OFF	DFF

Parity	Jumpers W6	W5	W4	W3
2 STOP BITS	X	OUT	X	X
1 STOP BIT	x	IN	X	X
NO PARITY	OUT	x	OUT	X
ODD PARITY	IN	X	IN	IN
EVEN PARITY	IN	X	IN	OUT

X=don't care

Delay and Line Length	Jumpers W2	W7
DELAY DISABLED	X	IN
DELAY ENABLED	X	OUT
72 CHAR LINE	IN	X
128 CHAR LINE	OUT	X

6.00 SPECTRAL DATA MEMORY AND MEMORY GROUP CONTROLS

Spectral Data Memory 6.10

As described in section 2.00, during data acquisition data is accumulated in the spectral data memory. The spectral data memory may have a total of 2048 (2K), or 4096 (4K) channels for the storage of count values.

MEMORY GROUP CONTROLS

The TN-7200 CRT is capable of displaying up to 512 data points. Consequently, when the data memory size is selected to be greater than 512 channels, the data is compressed and averaged to accommodate the smaller number of display points. As a result, one display point may represent two, four, or eight data memory channels. However, this data compression only pertains to the displayed spectral trace. All displayed numeric values are taken directly from the spectral data memory.

Memory Group Controls 6.20

Group Selection 6.21

The spectral data memory can be subdivided into two or four equal memory portions. This provides the TN-7200 with the ability to store more than one spectrum at a time.

1/1

1/2

1/4

The memory group controls are 'used to select a portion of memory for display, acquisition, data processing, overlap, or input-/output Table 1 shows the memory keys and their meanings.

Table 1 - MEMORY GROUP CONTROLS

		# of Channels Displayed	
Position	Meaning	2K	4K
1/1	full memory	2048	4096
1/2	first half	1024	2048
2/2	second half	1024	2048
1/4	first quarter	512	1024
2/4	second quarter	512	1024
3/4	third quarter	512	1024
	fourth quarter	512	1024

During acquisition, any portion of memory can be displayed while the acquisition continues in the originally selected portion.

During input or output, pressing a memory key has no effect.

6.22 Overlapping Memory Groups

The OVERLAP key provides the means to simultaneously display two spectra for comparison.

To overlap spectra:

a) Enable the memory key corresponding to the spectrum which is to be overlapped; and

MEMORY GROUP CONTROLS

b) Press OVERLAP. This spectrum is now the overlap spectrum. It will be overlapped on itself and the group descriptors (live time, etc.) will be displayed in the second line of the CRT;

c) Enable the memory key corresponding to the base group. That spectrum will immediately be displayed with its group descriptors in the normal position. The overlap group and its descriptors will remain on the display. Figure 6a shows overlapped spectra.

The TN-7200 will overlap memory groups without regard to their respective sizes. That is, a large memory group may be overlapped on a smaller one and vice versa.

After two spectra have been overlapped, the overlap spectrum can be manually positioned on the display for the best comparison to the base spectrum.

To position the overlap spectrum, press VERT SEP and rotate the Cursor Control. The overlap spectrum will move up or down depending on the direction of rotation.

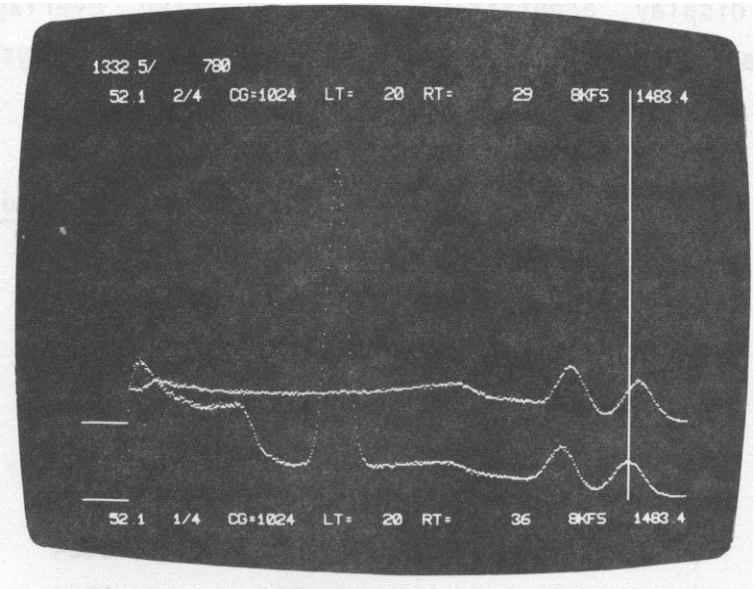


Figure OVERLAPPED SPECTRA

7.00 DISPLAY ELEMENTS

Figure 7a shows the basic TN-7200 data display. Refer to this figure for the display descriptions in the following sections.

KEY

A - Channel number or calibrated value of the current cursor channel.

B - Contents (number of counts) of the cursor channel.

c - The cursor.

D - The channel number or calibrated value of the lowest displayed data channel.

E - The currently selected memory group.

F - The current conversion gain setting.

G - The live time for the current acquisition.

H - The real time (clock time) for the'current acquisition.

I - The current vertical scale.

J - The channel number or calibrated value of the.highest displayed data channel.

K - The spectral trace.

The Spectral Trace **7.10**

The TN-7200's spectral trace (K) consists of up to 512 display points.

For PHA, each point represents the number of pulses within a narrow amplitude range that have been accumulated in a particular data channel, and together, all points make up a pulse height histogram as described in section 2.10.

For MCS, each point represents the total number of counts accumulated during a given time interval.

If the portion of the data memory selected for display is greater than 512, then the data will be compressed and averaged on a 2:1 (1024 channels), 4:1 (2048 channels), or (4096 channels) basis.

DATA
DISPLAY

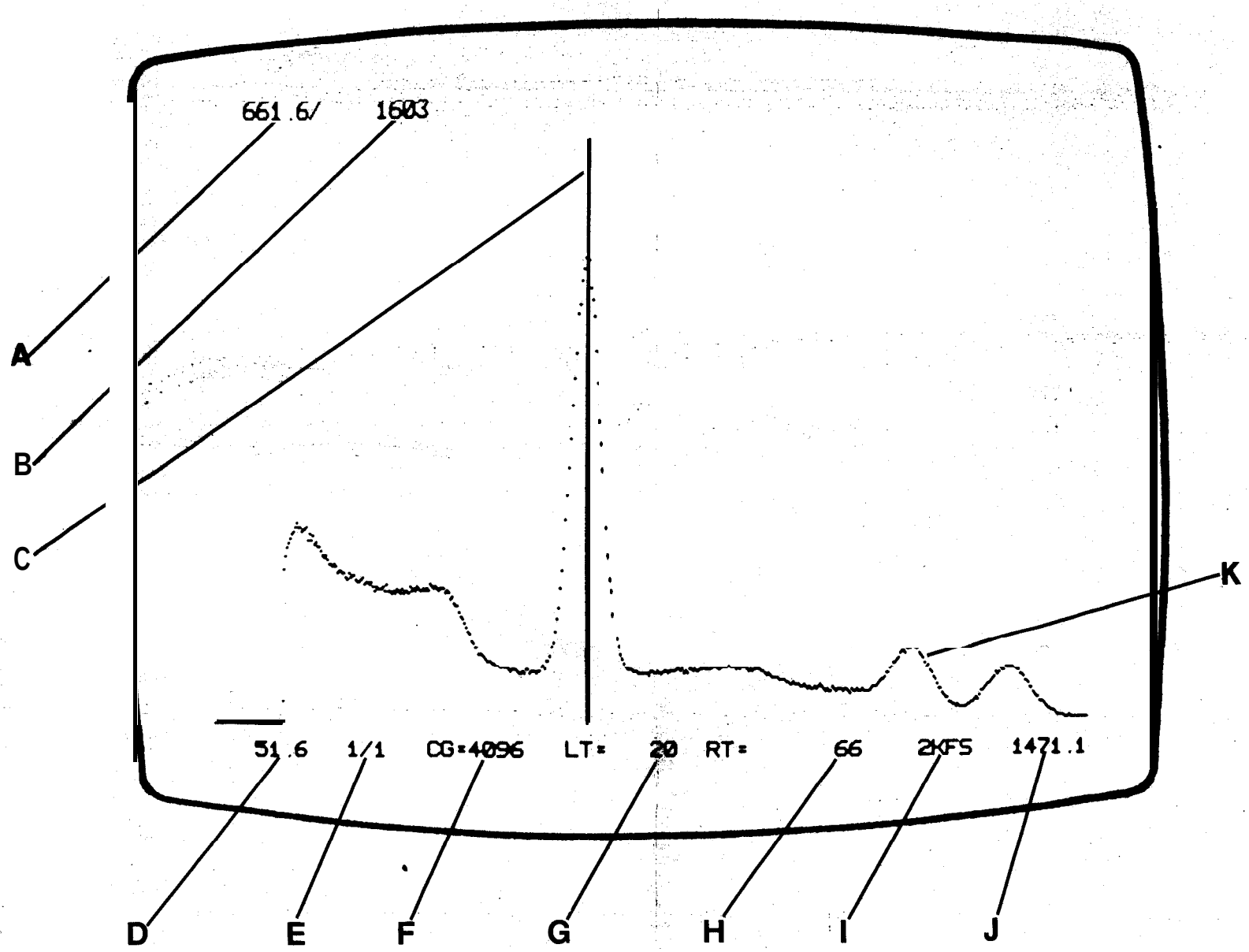


Figure 7a DATA DISPLAY

7.20 The Cursor

The vertical bar which extends from the top to the bottom of the display is called the cursor (C). The cursor can be moved throughout the spectrum to occupy any data memory channel. It is used to determine the count value for a particular channel (see section 10.30), to "roll" through an expanded spectrum (see section 8.20), and to set up Regions of Interest (see section 9.00).

To move the cursor, rotate the cursor control. This is the large silver control near the bottom of the front panel. Rotate the control clockwise or counterclockwise to move the cursor right or, left,. respectively.

DATA DISPLAY

The TN-7200 emits a series of clicks as the cursor control is rotated. One click is emitted each time the cursor moves to a different data memory channel. (The click can be disabled or enabled with a hidden key. Press the area to the immediate right of the ATTACH HIGH key.)

When the size of the displayed data memory group is greater than 512, the data is compressed. Under these circumstances, if the cursor control is rotated the TN-7200 may emit a click but the cursor will not appear to have moved. In fact, it will have moved in the spectral data memory. This is evident in the cursor message (see Section 7.30).

7.30 Basic Alphanumeric Display

The TN-7200 can use the entire display area to display alphanumeric information. In the basic display however (Figure 7a), only the top and bottom lines are used.

The top line of the basic display contains the cursor message. The number to the left of the / (A) represents the number of the data channel occupied by the cursor. On a calibrated display, this value could represent energy or some other units as determined by the operator. The number to the right of the / (B) indicates the number of counts in the cursor channel.

In the line immediately below the spectrum, the numbers to the extreme left and right (D and J) respectively indicate the lower and upper limits of the current display. In PHA mode, these numbers reflect data channel numbers or, on a calibrated display, energy values (see section 12.00). In MCS mode, these numbers

reflect dwell time intervals or, on a calibrated display, arbitrary units defined by the operator.

The second number from the left (E) indicates the currently displayed portion of the data memory.

The third number from the left indicates the current conversion gain setting.

The fourth number from the left (G) indicates the live time (PHA) or number of sweeps (MCS) of the current acquisition.

The next number (H) indicates the real time for the current acquisition (PHA) or the preset dwell time (MCS).

DATA DISPLAY

The next to last number in this line (I) is the vertical scale message. It indicates the maximum number of counts that can be displayed with the current vertical scale. The letters "FS" mean Vertical Full Scale. When the LOG key is in effect, the legend, "LOG" is displayed here.

Under different circumstances, many other alphanumeric messages appear. These are explained throughout the manual where appropriate.

8.00 DISPLAY MODIFICATION

The controls discussed in this section allow you to modify the spectral display. These controls can be used at your discretion to aid in viewing and interpreting spectral data.

Vertical Scale Controls 8.10

The three keys beneath the legend "VERT" control the vertical scale of the display.

Increase/Decrease Spectrum Height 8.11

It is possible to manually adjust the height of a displayed spectrum by increasing or decreasing the vertical scale. As the vertical scale decreases, the height of the spectrum increases and vice versa.

Press  to increase the height of a spectrum. This key can be pressed repeatedly until the minimum vertical scale of 16 is reached. Each time it is pressed, the current vertical scale is halved.

Press  to decrease the height of a spectrum. This key can be pressed repeatedly until the maximum vertical scale of 16, 777, 216 (16M) is reached. Each time it is pressed, the current vertical scale is doubled.

Logarithmic Display 8.12

A logarithmic (LOG) display of a spectrum is desirable when the spectrum contains many peaks of widely varying amplitudes.

To convert to a log display, press LOG. Figure 8a shows a typical log display. The vertical scale message now reads "LOG".

To return to a normal display, press LOG again.

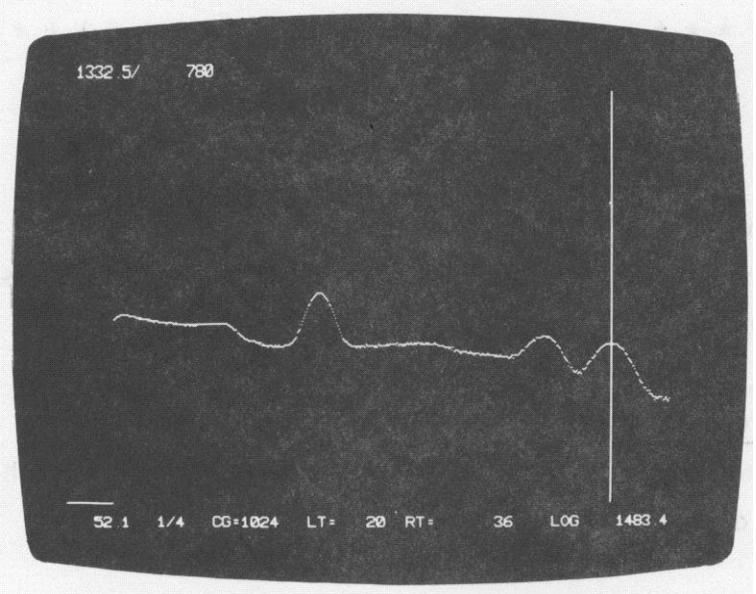


Figure 8a LOG DISPLAY

8.20 Horizontal Scale Control (Expand/Compress Spectrum)

It is often useful to horizontally expand a spectrum in order to view a particular portion in greater detail.

To horizontally expand a spectrum:

a) Move the cursor to the portion of the spectrum to be expanded; and

b) Press ◀▶.

When ◀▶ is pressed, the cursor channel is automatically placed in the center of the display. The spectrum is then expanded around this point. ◀▶ can be pressed repeatedly. Each time it is pressed, the spectrum expands by a factor of 2 until a minimum of 128 data channels is displayed.

When the display is expanded, you can "roll" through the spectrum using the cursor control. Move the cursor to the edge of the display and continue to rotate the cursor control in the same direction. If any channels exist beyond the limit of the display, they will "roll" into view. An entire spectrum may be scanned in this manner. The "rolling" action stops when the highest or lowest available data memory channel comes into view.

To horizontally compress a spectrum, press ▶◀. Compression, like expansion, occurs in factors of 2 around the cursor channel. ▶◀ can be pressed repeatedly until the currently selected memory segment is entirely displayed.

To immediately compress the spectrum so that the entire memory group is displayed, select a memory group of a different size. Selecting a different group of the same size or turning the group selector off and on has no effect on expansion.

"Shaded" Spectrum 8.30

It is possible to "shade" the area below a spectrum. An example is shown in figure 8b.

To "shade" a spectrum press the Decimal Point key in the numeric keypad.

To clear the shading, press the Decimal Point key again. The shading will also be cleared if the number of a currently defined ROI is entered.

This function will not work if an ROI is currently displayed.

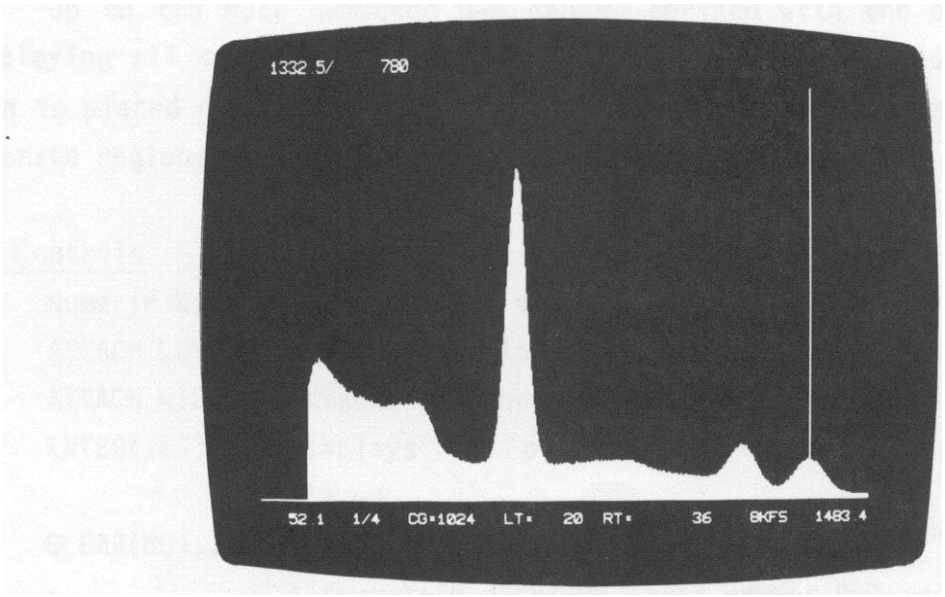
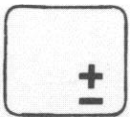


Figure 8b SHADED SPECTRUM

Horizontal Grid 8.40

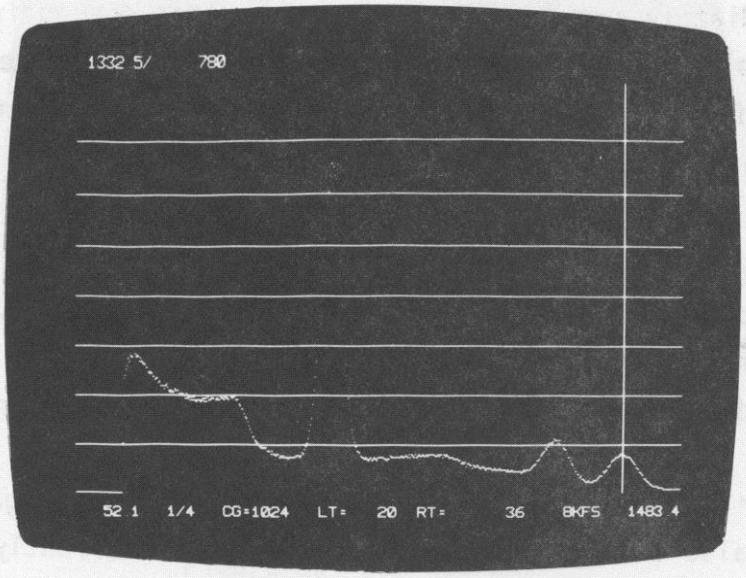
As shown in figure 8c, it is possible to place seven horizontal bars on the display. In a LOG display, only three bars are used.



To display the horizontal grid, press ±.

To clear the grid, press ± again.

This function will not work if an ROI is currently displayed.



DATA
DISPLAY

Figure 8c HORIZONTAL GRID

9.00 REGIONS OF INTEREST

A Region of Interest (ROI) is used to designate a portion of the spectrum that is of particular interest during data acquisition and analysis. An ROI is usually set up to provide a symmetrical "window" around a particular peak. This "window" can be seen on the display as a shaded area beneath the spectral trace and within the specified lower and upper energy limits of the ROI.

REGIONS OF INTEREST

Once defined, an ROI remains in the TN-7200 memory. It can easily be removed from and recalled to the display.,

Up to ten ROIs numbered O-9 can be defined with the option of displaying all currently defined regions simultaneously. No limitation is placed on the locations of upper and lower ROI limits so that separate regions may overlap.

ROI Controls 9.10

Numeric Keys..	Used to enter an ROI number
ATTACH LOW....	Attaches the lower ROI limit to the cursor
ATTACH HIGH...	Attaches the upper ROI limit to the cursor
ENTER(YES)....	Displays the previous ROI when none are displayed.
CLEAR(NO).....	Clears an ROI from the display
+.....	Alternately displays Gross or Net ROI integral
•.....	Displays all currently defined ROIs

Setting Up an ROI' 9.20

To define an ROI:

a) Enter the desired ROI number using the numeric keys. ROIs are numbered 0 through 9. This number will appear on the display as shown in Figure

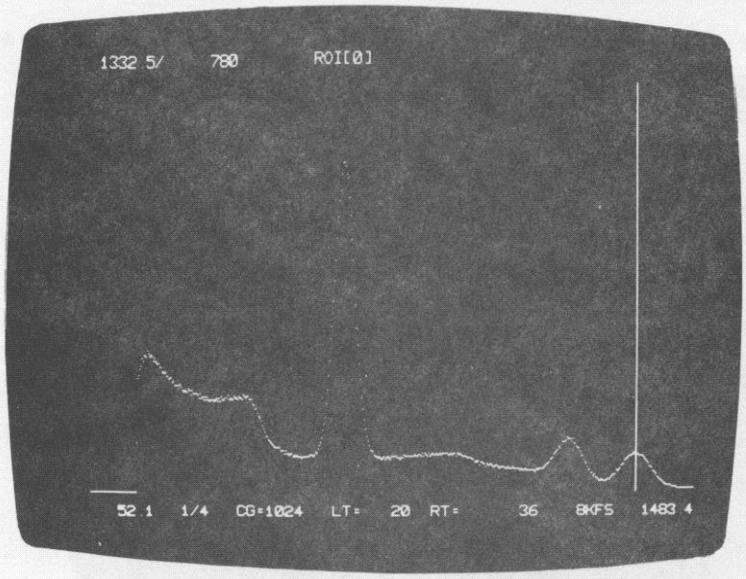


Figure 9a ENTER ROI NUMBER

ATTACH LOW

b) Move the cursor to the desired lower ROI limit. This is usually one of the channels where the left side of a peak merges with the baseline;

c) Press ATTACH LOW. There is a one second delay before the ROI limit is actually attached to the cursor. This is to allow for the ATTACH BOTH function (section 9.60). To eliminate the delay, press the ATTACH key twice in rapid succession. The lower ROI limit is now attached to the cursor. As shown in Figure 9b, the cursor no longer extends through the spectrum, but rides on top of it to show that an ROI limit is attached. Two numbers, separated by a colon, have appeared on the display following the ROI number. These are the channel numbers or calibrated values of the lower and upper ROI limits;

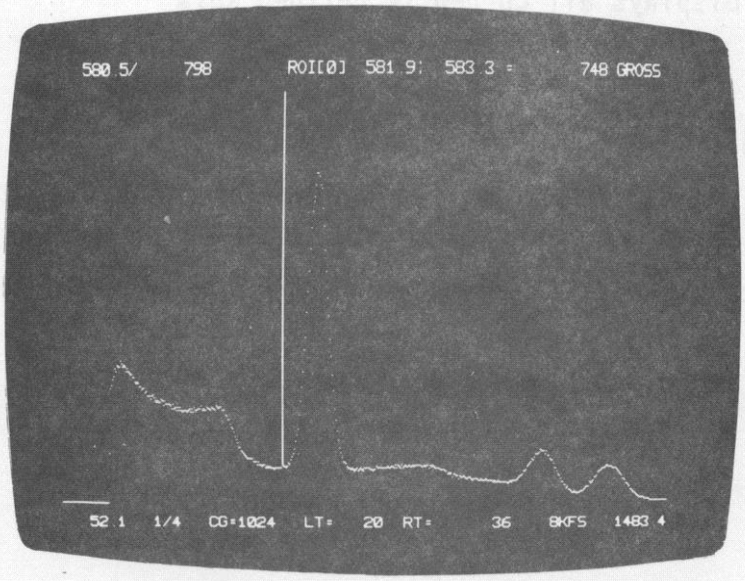


figure 9h LOW ROI LIMIT

d) Disable ATTACH LOW to attach the lower limit to the current cursor channel;

e) Move the cursor to the desired upper ROI limit. As shown in Figure 9c, this is usually one of the channels where the right side of the peak merges with the baseline;

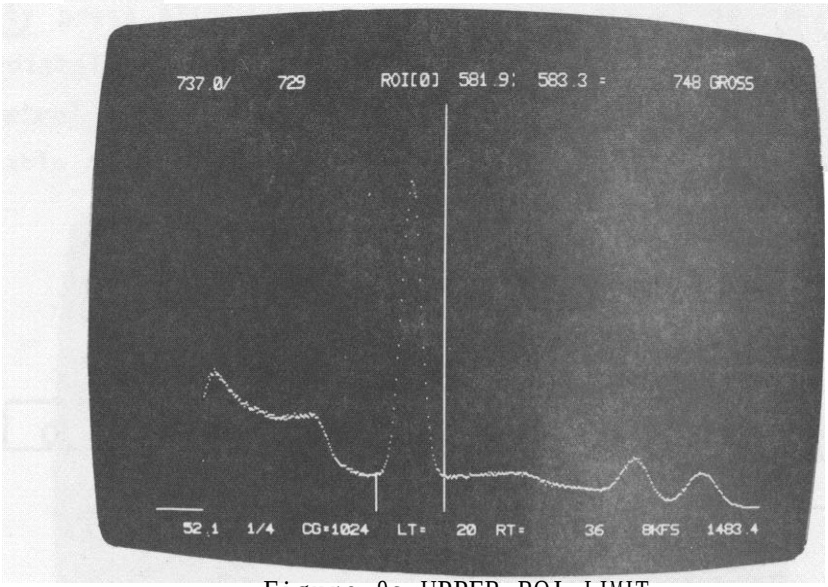


Figure 9c UPPER ROI LIMIT

f) Enable and disable ATTACH HIGH. The ROI is now set up as shown in figure 9d.

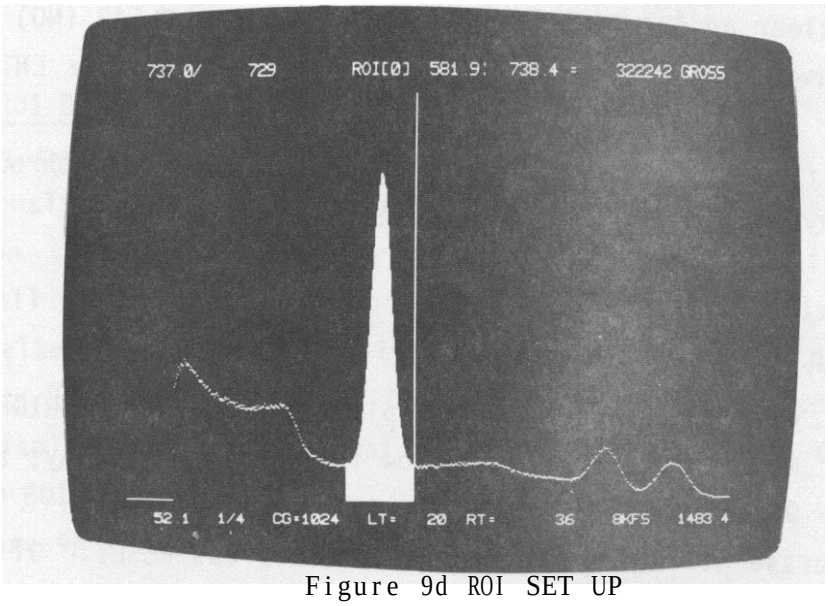


Figure 9d ROI SET UP

ROI Limits 9.30

Figure 9e shows how ROI limits are determined. Remember that each channel is itself an interval with lower and upper limits. When

you define an ROI, its width is taken from the lower limit of the LOW channel to the upper limit of the HIGH channel. The ROI message for Figure 9e would read "ROI[1] 2:10". The upper limit as shown in the ROI message is not actually in the ROI window. The width of the ROI (8 for Figure 9e) can then be determined from the difference of the displayed limits.

ROI LIMITS

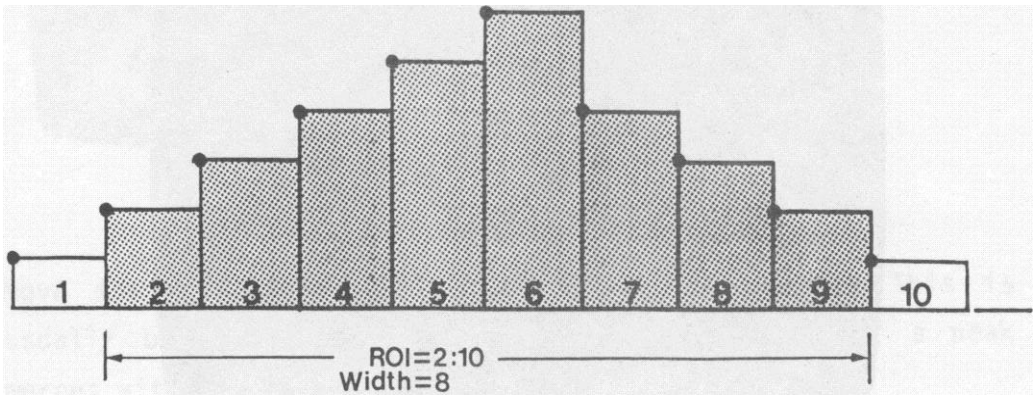


Figure 9e ROI LIMITS

9.40 Clear/Recall ROI

To clear an ROI from the display, press the CLEAR (NO) key.

To recall the previously cleared ROI, press the ENTER(YES) key.

To recall a specific ROI, enter its number through the numeric keypad.

9.50 ROI Erasure

To erase an individual ROI:

a) With the unwanted ROI displayed, press ATTACH HIGH;

b) Move the cursor to the low limit of the display; and

c) Disable ATTACH HIGH.

To erase all ROI definitions you can press RESET. Of course, all other parameters will be reset and all data cleared at the same time (see section 16.00).

ROI Movement (Attach Both Function) 9.60

After an ROI of any width has been set up, it is possible to move the entire ROI while still maintaining the relative positions of the upper and lower limits.

To do this, with the ROI displayed, press ATTACH HIGH and immediately press ATTACH LOW. As shown in figure 9f, the ROI will move immediately to center itself around the cursor. Rotation of the cursor control will then cause the entire ROI to move.

Disable ATTACH HIGH or ATTACH LOW to detach the cursor from the ROI

ATTACH BOTH

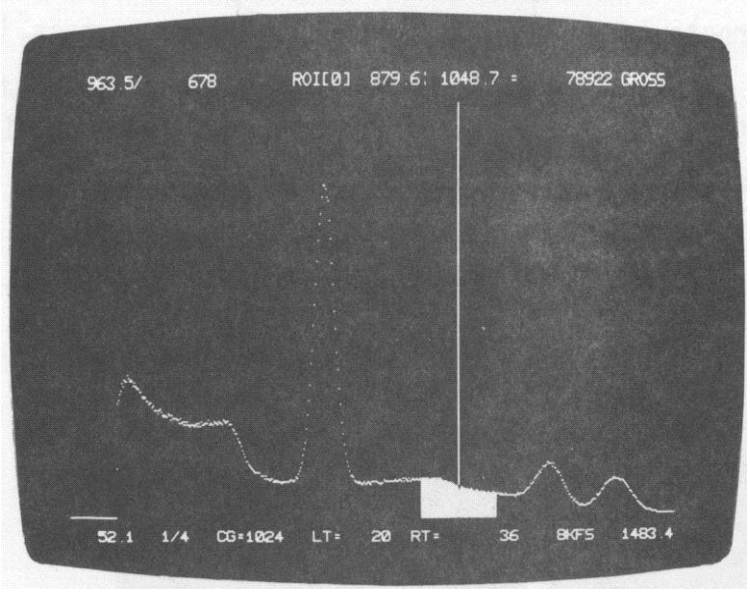


Figure 9f ATTACH BOTH ROI LIMITS

Multiple ROI Display 9.70

MULTIPLE ROI DISPLAY

When two or more ROIs have been set up, they may be displayed simultaneously. In a multiple ROI display, the ROI whose message appears on the CRT is considered the primary ROI and is heavily shaded. All other ROIs are secondary ROIs and appear lightly shaded.

To alternate between a multiple ROI display and a display of the primary ROI only, press the Decimal Point key. The primary ROI must be displayed prior to pressing the decimal point key to produce a multiple ROI display.

Figure 9h shows multiple ROI display.

To designate some other ROI as the primary ROI, simply enter the desired ROI number.

9.80 ROI Integrals

The TN-7200 automatically computes and displays the gross or net integral for the currently displayed ROI.

The Gross integral of an ROI is simply the total number of counts in that ROI.

The Net integral is the total number of counts in the ROI above a line interpolated between the end-points of the region.

When an ROI is set up, the TN-7200 automatically displays the gross integral in the ROI message.

ROI INTEGRALS

To alternate between a display of the net or gross integral, press +.

Figure 9g shows a net integral display. The shaded area of the region includes only that portion of the spectrum that is above the assumed background.

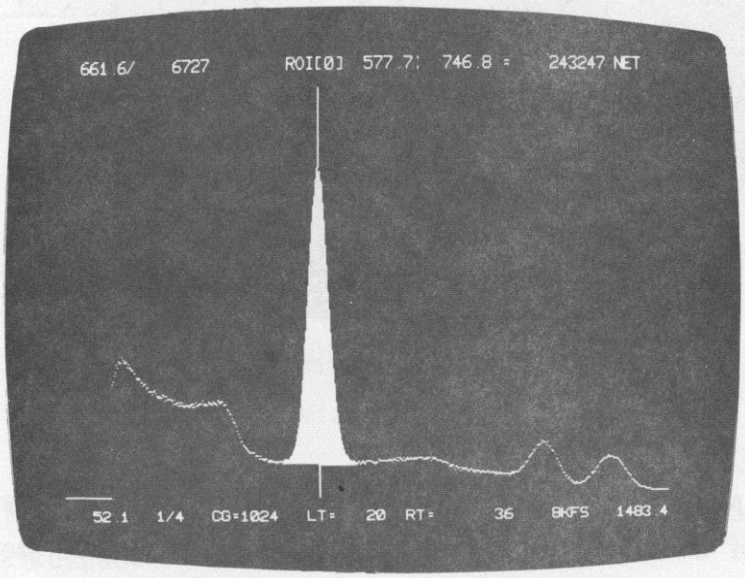


Figure 9g NET INTEGRAL

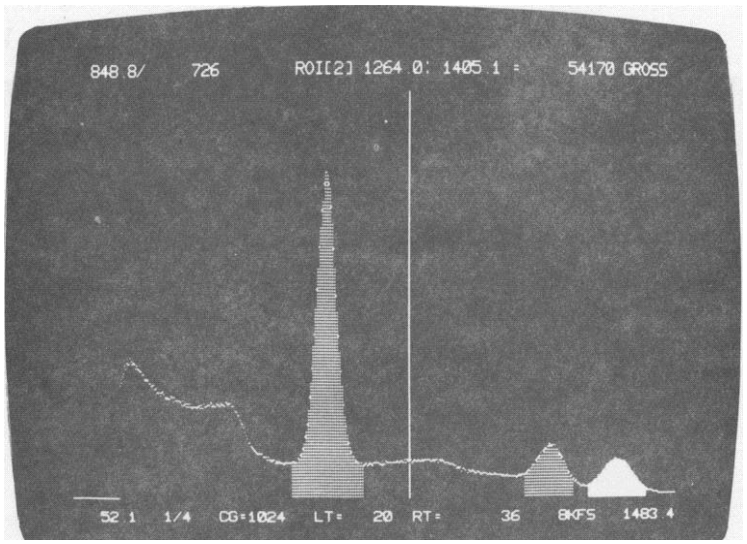


Figure MULTIPLE ROI DISPLAY

Preset Integral

9.90

The TN-7200 is programmed to stop an acquisition when the gross integral of ROI [0] reaches a predetermined value. You can enter this value through the PHA program (see section 13.10).

During acquisition, the TN-7200 compares the current gross integral with the preset integral once every second. Acquisition is stopped within one live-time second or one sweep after the preset value has been reached. This ensures that the integral value reached is at least that of the preset value.

In order for the TN-7200 to check for a preset integral, ROI [01] must be defined but not necessarily displayed.

PRESET INTEGRAL

10.00 ADC SETUP

The ADC controls are located immediately below the CRT. This section discusses each ADC control individually, giving its type and function, and also provides some guidelines for initial settings.

Lower Level Discriminator (LLD) 10.10

ADC SETUP

Type: 10-turn Helipot.

Function: Sets the lower limit of pulse heights to be processed by the ADC.

Setting Initially, LLD can be set slightly above 0 (about 0.25). During acquisition, if the Dead Time Meter indicates a high percentage of dead time, this may mean that LLD should be increased.

Upper Level Discriminator (ULD) 10.20

Type: 10-turn Helipot.

Function: Sets the upper limit for recognition of pulses by the ADC.

Setting: Initially the ULD can be set to its full clockwise position.

As shown in Figure 10a, the LLD and ULD establish an energy "window" above and below the levels of input noise or unwanted signals.

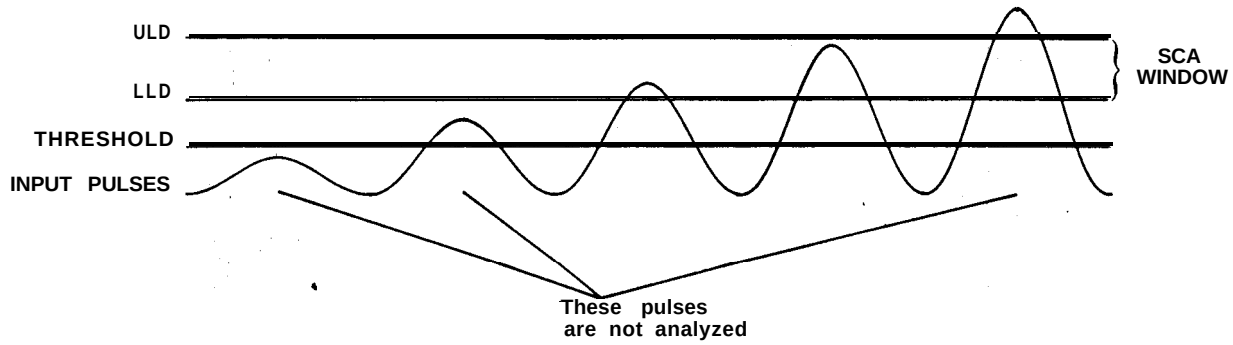


Figure 10a LLD AND ULD

When you are using the SCA OUTput (section 5.50), LLD and ULD should be set up to eliminate all pulses whose heights are below or above the desired range.

10.30 Preamp Gain

Type: 10-turn Helipot.

Function: Adjusts internal preamp gain to place the desired spectral energy 'range within the ADC's 0 to 8V input range; Determines the amount of amplification which is applied to the signals received from the detector before they are sent to the ADC; Designed for NaI type detectors using photomultiplier tubes or for the internal spectroscopy amplifier option. Not used with an external amplifier.

ADC SETUP

Setting: The preamp gain is normally set during acquisition. An increase in the gain increases the amplitudes of all pulses by the same multiplicative factor causing all peaks in an acquired spectrum to shift by the same relative amount to higher positions. However, the absolute peak shift will be the greatest for the highest-energy peaks. For example, increasing the amplifier gain by 2% will cause a peak, which'was previously observed at an apparent energy of 100 keV in an acquired spectrum, to be shifted to an apparent energy of 102 keV (2 keV shift), whereas a peak which appeared previously at 1000 keV will be shifted to an apparent energy of 1020 keV (20 keV shift). When using the internal preamp, either the ACTIVE or PASSIVE base line restorer should be used to eliminate any DC offset in the output.

10.40 Threshold

Type: Screwdriver adjustable potentiometer.

Function: Discriminates incoming pulses from low level noise present in the system.

Setting: Threshold level is set at the factory and does not normally require further adjustment. However, some adjustment may be necessary if an external amplifier is used.

Adjustment: To adjust Threshold:

a) Set up the TN-7200 for normal acquisition;

b) Place the PREAMP/DIRECT switch (rear panel) in the PREAMP position if the internal amplifier is to be used or in the DIRECT position if an external amplifier is to be used;

c) Remove all radioactive sources so that the amplifier output consists entirely of noise;

d) Press ACQUIRE;

e) Turn. the Threshold adjustment fully counter-clockwise or until the LED indicator is at full brightness;

f) Turn the Threshold adjustment clockwise until a steep decrease in LED intensity is observed. The LED should be off (or very dimly lit);

g) Return the radioactive source to its normal position for gamma ray detection and restart the acquisition;

h) Turn the Threshold adjustment one more full turn clockwise. If you are using a relatively "hot" source (high count rate), the LED may still be quite bright. If you are using a "weak" source (low count rate) the LED should remain at low brightness. If the LED brightness seems excessive for the count rate, turn Threshold clockwise until one-half turn either way has little effect on brightness. If more than one turn is required, check the amplifier pole-zero adjustment with an oscilloscope and the amplifier manufacturer's instructions.

Zero Level 10.50

Type: Screwdriver adjustable potentiometer.

Function: Sets the zero energy intercept of the ADC. That is, the ADC is adjusted to place a hypothetical pulse of 0 amplitude in channel 0 of the data memory.

Setting: The zero level is set at the factory and does not normally require further adjustment. However, for precise calibration or' if an external amplifier is

used, some adjustment may be necessary. The Zero control operates in a manner which is reversed from what might be expected; increasing this control (clockwise rotation) causes the apparent positions of all peaks in an acquired spectrum to shift downward (toward lower energies) by an equal amount. Similarly, decreasing the Zero control (counter-clockwise rotation) causes all peaks to shift to higher apparent energies by an equal amount.

ADC SETUP

\+ +

NOTE: Acquisition Mode, Conversion Gain, and Digital Offset are also ADC setup parameters. See Section 2.00 and Section 13.00.

\+ +

11.00 PROGRAM SETUP AND EXECUTION

This section demonstrates the operator/TN-7200 interaction that occurs during PROGRAM SETUP.

In the TN-7200 system, normal analyzer functions, such as data acquisition, are performed through the execution of predefined programs. These programs are controlled through the set of touchpad keys labeled OPERATION. Each of the OPERATION. keys controls a set of related programs. The basic function of each set of programs is indicated by the legend on the particular key (ACQUIRE, ERASE, DATA, etc.).

SETUP DIALOG

In many cases, you are permitted to make a number of specific choices or parameter entries before you execute a particular program. These entries take place through a setup dialog between you and the TN-7200.

INTERACTIVE SETUP DIALOG 11.10

The TN-7200's major analytical functions (for example, Data Acquisition, Data Processing, I/O) are implemented through ROM-based software. This software allows you to specify the functional parameters for each individual program through an Interactive Setup Dialog.

When you, have entered the SETUP mode and selected a particular function for setup, a dialog begins on the CRT screen. This dialog presents, in the correct order, the functional parameters that you must specify. By making appropriate responses to the questions in the dialog, you can perform a given operation according to your own specifications.

In order' to further simplify operation, the responses to certain key questions in a setup dialog dictate the nature and number of subsequent dialog choices which must be made. Instead of requiring you to specify all parameters which might be relevant to all applications, the dialog is programmed to ask only those questions which are relevant to the mode of operation as dictated by your earlier responses. This permits basic operations to be set up with very simple dialogs, yet provides for very detailed control when necessary.

All setup parameters are stored in memory so that you can repeatedly execute a function without re-entering the setup dialog. You need only re-enter the dialog to change some parameter.

11.20 SETUP Key

When SETUP is pressed, the LEDs for all of the OPERATION Keys begin flashing on and off. The CRT displays the message shown in figure lla. The TN-7200 is now in Setup Mode. Press any of the OPERATION keys to begin setting up programs. Any number of programs can be set up without exiting and re-entering the Setup mode.

When you are done setting up, disable SETUP, by pressing it again, to return to normal operating mode.

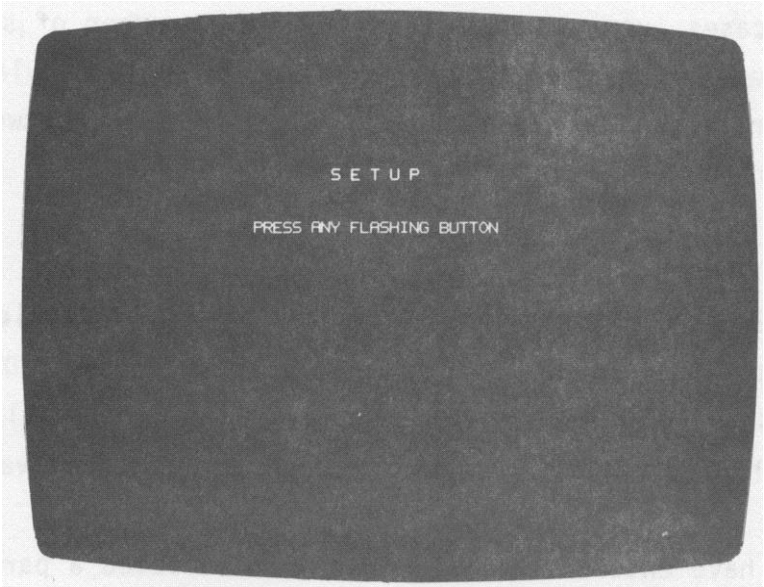


Figure lla SETUP MESSAGE

11.30 Setup Dialog and Dialog Controls

11.31 Program Selection

The first setup step involves program selection. When you press SET UP and an OPERATION key, the CRT displays a list of the programs associated with that key. Figure llb shows the list of programs that is displayed when SET UP and OUT are pressed. The pointer (little arrow) points to the currently selected program. You can use that program or move the pointer to a different selection.

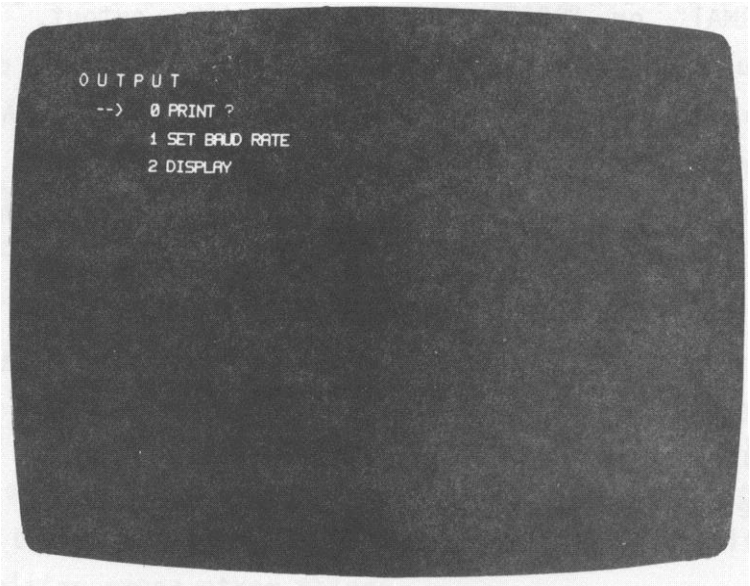


Figure 11b PROGRAM LIST

There are three methods to select a different program:

a) Rotate the cursor control. The pointer will move through the program list; or

b) Press CLEAR(NO). Each time you press CLEAR(NO), the pointer will move one step down the list; or

c) Enter the number (0-9) of the desired program through the numeric keypad. This number should correspond to the number which is displayed in the program list immediately before the program's name.

When you have selected a program for setup, proceed to the set-up dialog by pressing ENTER(YES).

Numeric Parameters 11.32

Many dialog questions permit you to enter an appropriate numerical value. These values can be entered through the numeric keypad. Use the plus/minus sign (+/-) and decimal point (.) where they are appropriate.

Press CLEAR(NO) to reset the currently displayed value to 0.

Press ENTER(YES) to accept the currently displayed value and move to the next dialog step.

Either/Or Choices 11.33

Many dialog questions permit you to select one of two choices. These choices are normally displayed as descriptive phrases such as

"STANDARD FORMAT" or "BRIEF FORMAT" -for data output. In some instances, your choice will determine: the remainder of the dialog.

When an either/or question is' displayed, press CLEAR(NO) to view the alternative.

Press ENTER(YES) to accept the currently displayed choice and move to the next dialog step.

11.40 Program Execution

When you have set up the desired program(s) and disabled the SETUP Key, the system returns to the normal operating mode;

Now you need only press the appropriate OPERATION keys to execute the selected programs.

SETUP DIALOG

12.00 TWO-POINT CALIBRATOR

The TN-7200's Two-Point Calibrator allows you to assign an arbitrary scale, in units other than channel numbers, to the horizontal axis.

Calibration Units 12.10

Normally, for PHA mode, calibration units are set up to reflect the energy of the incident radiation in keV or MeV. For MCS mode, units could be set up to reflect the angles of X-ray diffraction or detector position among other things.

Two-Point Calibrator Controls 12.20

CALIB/CHN NO.	- a) With SETUP, permits you to enter calibration values. b) During normal operation, alternately selects one of the two labeling modes for the horizontal axis: calibrated values or channel numbers.
Cursor	- Selects the data channels to which calibration values are assigned.
Numeric Keypad	- Used to enter calibration values.
CLEAR(NO)	- Sets the current calibration entry to 0.
ENTER(YES)	- Accepts the current calibration entry as the correct one.

Operation 12.30

The two-point calibrator scales the horizontal axis relative to two channels whose calibrated values you assign.

To perform two-point calibration:

a) Select the memory group to be calibrated using one of the Memory Group keys. The calibration you enter here will be applied to any acquisition done in a different memory group;

b) Choose two widely separated channels to which calibration values will be assigned. These channels are usually selected to correspond to some peaks or features in a spectrum. (You may wish to record these channel numbers for future reference.);

c) Press SETUP; and

d) Press CALIBICHN NO. As shown in figure 12a, the display will ask for the lower calibration value. Also, the cursor message is positioned beneath the "LOW CALIBRATION=?" message. The value on the left represents cursor channel number or, if CALIB/CHN NO. was enabled before SETUP, it represents the calibrated value. The number on the right represents cursor channel contents;

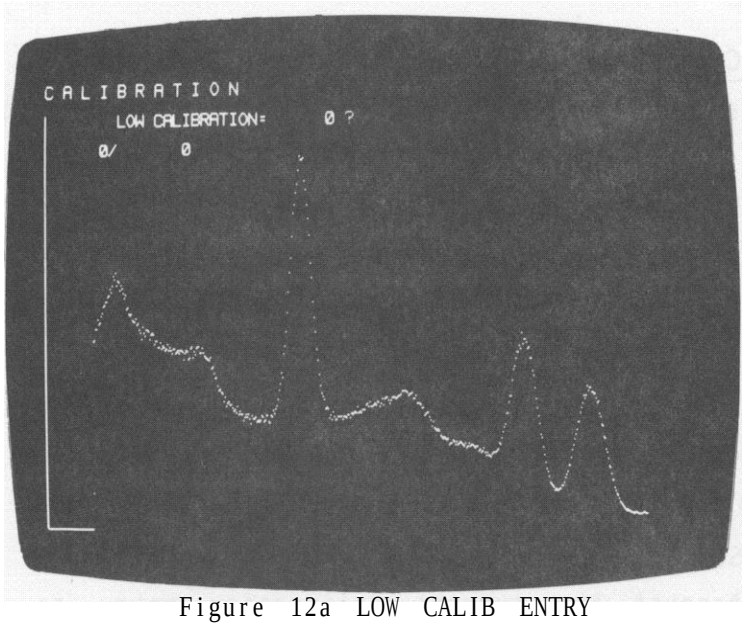


Figure 12a LOW CALIB ENTRY

e) Move the cursor to the channel which will be assigned the lower calibration value; and

f) Enter the low calibration value through the numeric keypad. This entry may range in value from 0.00000 to ±32767 with a maximum of five significant digits. As shown in Table 2, the possible resolution decreases as the calibration value increases. In the final calibration, the number of digits to the right of the decimal point is taken from the calibration entry with the fewest number of digits to the right of the decimal point. For example, if you enter 2.96 for the lower calibration value, and enter 500.7 for the high value, the

scale readings on the calibrated axis will only have one digit to the right of the decimal point.

TABLE 2 - CALIBRATION ENTRY PARAMETERS

RESOLUTION	MIN	MAX(+)
$\frac{1}{100,000}$	.00000	.32767
$\frac{1}{10,000}$	0.0000	3.2767
$\frac{1}{1,000}$	0.000	32.767
$\frac{1}{100}$	0.00	327.67
$\frac{1}{10}$	0.0	3276.7
$\frac{1}{1}$	0.	32767

g) When you have keyed in the correct value, press ENTER(YES). As shown in figure 12b, the display now asks for the high calibration value;

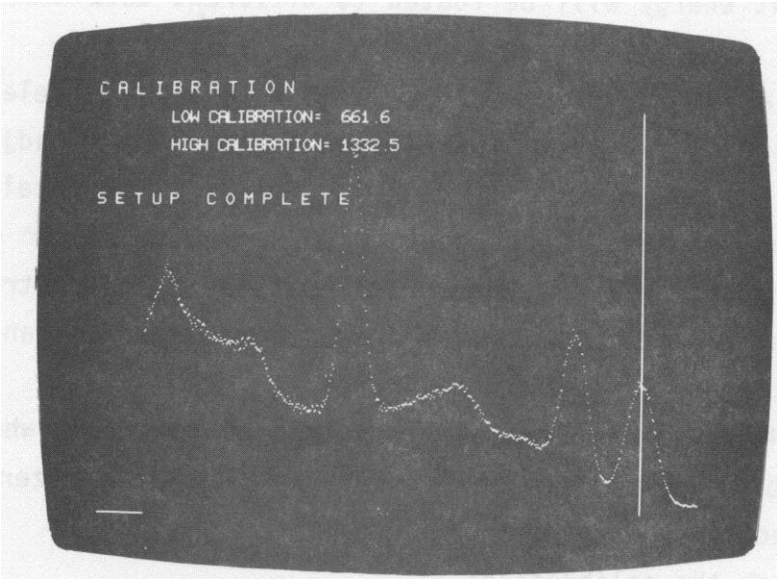


Figure 12b HIGH CALIB ENTRY

h) Move the cursor to the channel which will be assigned the high calibration value;

i) Enter the high calibration value. This entry has the same restrictions as the low calibration entry and must contain the same number of digits (the high calibration value may be a lower number than the low calibration value);

j) Press ENTER(YES). The calibration is complete. To return to the normal operating mode, disable SETUP.

You can now use the CALIB/CHN key to alternate between display of the calibrated scale or channel numbers. All display and output messages that relate to the horizontal scale (display limits, cursor message, region of interest message) will reflect the calibrated scale when the display is in the CALIB mode.

12.40 Maintaining Calibration

CALIBRATION

The calibration values that are assigned with the two-point calibrator are valid only for the Amp/Preamp Gain and ADC Zero Level settings at which the calibration was originally performed. Two spectra which were acquired with different gain and/or zero--level settings cannot be directly compared (channel-for-channel) even if the assigned calibration values are the same. The reason for this is that for different gain and zero-level settings, pulses of equivalent energy will be routed to different data memory channels.

Over a period of time, a certain amount of electronics "drift" can occur, making minor gain and zero-level adjustments necessary. If you intend to use the same two-point calibration over an extended period, you should make sure that proper gain and zero-level adjustments are made. This insures that spectral peaks appear in the proper channels and that separate spectra can be compared on a channel-for-channel basis.

The TN-7200 provides a simple method to determine whether or not your two-point calibration is still valid (gain and zero-levels have remained constant).

To check the calibration:

a) Enable CALIB/CHN NO. (LED lit);

b) 'Press SETUP; and

c) Press CALIB/CHN NO. The TN-7200 will enter the calibration setup mode and the cursor will jump to the channel to which the low calibration value was originally assigned. If the calibration was originally assigned according to a known peak, you can then determine whether or not the calibration is still accurate.

If adjustments are necessary you can either:

- Adjust the gain and/or zero-level to return to the old calibration; or

  Move the cursor to the new peak location and press ENTER (YES). The calibration will then be accurate for subsequent acquisitions.

13.00 ACQUIRE

The ACQUIRE key controls the setup and execution of the two data acquisition programs: Pulse Height Analysis (PHA) and Multi-channel Scaling (MCS).

ACQUIRE

PHA 13.10

To set up for PHA:

Press SETUP and ACQUIRE,

Select PHA from the displayed list,

Press ENTER(YES). The setup dialog proceeds as follows:

DISPLAY	RESPONSE
PHA	
CONVERSION GAIN=0? (0 = GROUP SIZE)	- Enter the desired conversion gain for the acquisition. The only legal entries are 0, 256, 512, 1024, 2048, and 4096. Any other entry will be rounded down to the nearest legal value. An entry of 0 means that the conversion gain will be set to the size of the data memory in which the acquisition occurs.
DIGITAL OFFSET=0?	- Enter the desired digital offset as described in section 2.00. This entry must be a multiple of 256 and may be no greater than 4096. Any other entry will be rounded down to the next legal value.
LIVE TIME=0? (0=INFINITE)	- Enter the desired preset live time. This number represents the live time in seconds and may range from 0 to 55535. An entry of 0 means that the acquisition will continue indefinitely.
PRESET INTEGRAL=0? (0=INFINITE)	- Enter the desired preset integral. This entry may be any integer

between 0 and 2,147,483,647. When the integral of ROI [0] reaches this value, the acquisition will stop. (Overrides preset live time.)

GROSS? / NET? - This choice allows you to specify whether the preset integral will be gross or net.

SETUP COMPLETE - Disable SETUP, select a memory group, and press ACQUIRE to acquire data.

To stop an acquisition before the preset is reached or if no preset was entered, press ACQUIRE again (LED blinks and then goes, out). The acquisition will stop at the end of the next live time second.

MCS

13.20 MCS

To set up for MCS:

Press SETUP and ACQUIRE,

Select MCS from the displayed list,

Press ENTER(YES). The setup dialog proceeds as follows:

DISPLAY	RESPONSE
MCS	
NO.SWEEPS=0? (0=INFINITE)	Enter the preset number of MCS sweeps. This is the number of times that pulses will be tabulated in each data memory channel., The maximum number of sweeps is 65,535. An entry of 0 means that the acquisition will continue indefinitely.
DWELL = 10? (0=EXTERNAL)	Enter the desired dwell time. This entry is in microseconds, milliseconds, or seconds (specified in the next question) in the range of 10 us to 65,535 us, 1 ms to 65,535 ms, or 1 second to 65,535 seconds. Enter 0 for External dwell control (sec. 5.20).
uS / MS / S	- This choice specifies the time base for the dwell value entered in the previous step. uS=microseconds, seconds, S=seconds.

PRESET INTEGRAL (0=INFINITE)	- Enter the desired preset integral. This entry may be any integer' between 0 and 2,147,483,647. When the integral of ROI[O] reaches this value, the acquisition will stop.
GROSS? / NET?	- This choice allows you to specify whether the preset integral will be gross or net.
SETUP COMPLETE	- Disable SETUP and press ACQUIRE to acquire data.

To stop an acquisition before the preset is reached or if none was entered, press ACQUIRE again (LED blinks and then goes out). The acquisition will stop at the end of the next sweep.

MCS

14.00 STOP

The STOP key provides a full-stop capability. That is, when STOP is pressed, any and all programs which are currently executing or pending execution (LED blinking) will be aborted immediately. The exception to this is AUTO REPEAT (see section 21.00).

There is no setup dialog involved with the STOP function in the basic TN-7200 system.

15.00 ERASE DATA

When ERASE DATA is pressed, only the currently selected portion of the data memory is affected; all data is cleared and the live time/sweep counter and digital offset are reset to zero.

There is no setup dialog involved with ERASE DATA in the basic TN-7200 system.

ERASE DATA

16.00 RESET/TEST

The programs associated with the RESET/TEST key are:

0 RESET
1 ROM
2 RAM
3 DATA MEMORY
4 SERVICE

RESET TEST

RESET 16.10

RESET

The RESET program provides a complete system reset:

All data is cleared from the data memory and a ramp is generated.

All preset parameters are reset to their initial values.

The ROI table is cleared and reset.

All program execution is aborted.

To reset the TN-7200:

a) Press SETUP and RESET/TEST;

b) Select RESET from the displayed list of options;

c) Press ENTER(YES);

d) Disable SETUP; and

e) Press RESET/TEST. A buzzer will sound and the system will be reset.

ROM 16.20

ROM TEST

This program performs a checksum test of all executive and option ROMs.

To execute the ROM test:

a) Press SETUP and RESET/TEST;

b) Select ROM from the displayed list of options and press ENTER (YES);

c) Disable SETUP and press RESET/TEST to perform the ROM test.

If the ROMs test out good, there is no reaction from the TN-7200.

If an error is encountered, a continuous tone will sound. To recover from an error, press RESET/TEST again.

16.30 RAM

RAM TEST

This program tests the CPU RAM using a modulo-9 rotating bit pattern. The setup procedure for a RAM test is the same as described in section 16.20 for a ROM test except that RAM is selected from the displayed list of options.

If no RAM errors are encountered, the system is reset.

If an error is encountered, a beep tone sounds and a message "xxxx FAILED", flashes on the screen. xxxx represents the CPU RAM address where the error was encountered. To recover from a RAM error, press STOP.

16.40 DATA MEMORY

DATA MEMORY TEST

This program tests the spectral data memory by generating and then verifying a test pattern (ramp). The setup procedure for a DATA MEMORY test is the same as described in section 16.20 for a ROM test except that DATA MEMORY is selected from the displayed list of options.

If no errors are encountered, there is no reaction from the TN-7200.

If an error is encountered, a beep tone sounds and a message, "E9xx FAILED", flashes on the screen. xx can represent one of the following:

BB - error in bits 16-23
BD - error in bits 8-15
C2 - error in bits 0-7

To recover from a DATA MEMORY error, press STOP.

16.50 SERVICE

SERVICE

The SERVICE program provides the means for qualified service personnel to patch in programs or data or to examine memory or registers.

This function should be performed by qualified service personnel only - misuse can in a system crash or loss of data. Refer to the TN-7200 Technical Manual for more information.

17.00 IN .

The IN key controls input to the TN-7200. The following programs are available in the standard system.

0 READ

1 SET BAUD RATE.

2 ENTER LABEL

IN

READ

17.10

READ DATA

The READ program is used in conjunction with a primary serial device (cassette tape) to read previously stored spectral data into the spectral data memory. No input is possible to a group where an acquisition is in progress or if the unit is in setup mode. Input may proceed to any non-acquiring memory group.

To read in data:

a) Select a memory group large enough to receive the incoming data;

b) Press SETUP and IN;

c) Select READ from the displayed list of options;

d) Press ENTER(YES);

e) Disable SETUP;

f) Press IN; and

g) Activate the device being used to input data. If no input device is connected, the message, "TERMINAL DISCONNECTED" will be displayed. When the, terminal is connected, this message'will disappear and input will begin.

SET BAUD RATE

17.20

BAUD RATE

This program controls the baud rate for the TN-7200.

To set the baud rate:

a) Press SETUP and IN;

b) Select SET BAUD RATE from the displayed list of options;

c) Press ENTER(YES);

d) Enter the desired baud rate. Any standard baud rate up to 4800 can be entered. You can also enter non-standard baud rates. The TN-7200 will convert your entry to the nearest programmable rate;

e) Press ENTER(YES); and

f) Disable SETUP. The baud rate is now set. You do not have to press IN again.

17.30 ENTER LABEL

You can enter a data label of up to 32 characters. This label will appear on the display and will be present in any output.

To enter a label:

a) Press SETUP and IN;

b) Select ENTER LABEL from the displayed list of options;

ENTER LABEL

c) Press ENTER(YES);

d) Disable SETUP;

e) Press IN. As shown in figure 17a, the ENTER LABEL message appears on the display. If you are using an ASCII terminal, you can enter the label through the keyboard of the terminal. Disable IN when the label is complete.

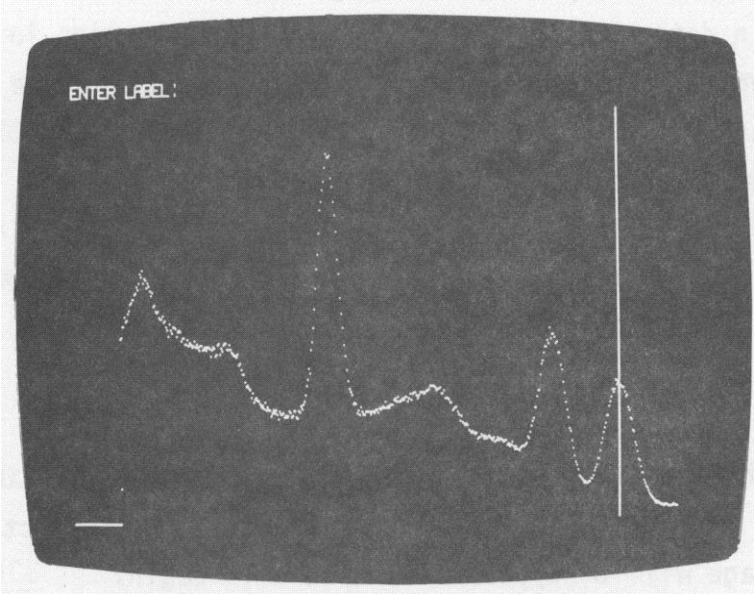


Figure 17a LABEL ENTRY

f) If you don't have a terminal, you can enter the label using the SETUP/ENTRY keys as follows:

Use one of the numeric keys to enter any number;

Now rotate the cursor control clockwise to "dial in" the desired character;

Repeat the two previous steps for each character until the label is complete;

Use the ENTER/YES or ± key to enter a space;
Use the CLEAR/NO key to delete the previously entered character;
Use ERASE DATA to clear the entire label.

ENTER LABEL

18.00 OUTPUT .

The OUT key controls the setup and execution of the TN-7200 Output programs. The following programs are available in the standard system:

OUT

0 P R I N T

1 SET BAUD RATE

2 DISPLAY

PRINT

18.10

PRINT

The PRINT program provides spectral data output to the primary serial device.

A standard TN-7200 comes complete with the necessary interface to connect to any standard serial I/O device. Printer/keyboard consoles which are commonly used for this purpose include:

Teletype----------ASR-33 and KSR-43

Digital Equipment Corp.-------LA-120 DECwriter

Texas Instrument----------Silent 700 Thermal Printer

The TN-7200 serial interface provides full-duplex 20 mA current-loop output for use with Teletypes or DECwriters, and also EIA voltage level output for use with devices such as the TI Silent 700 and Teletype KSR-43. Both current-loop and EIA voltage level output signals are available at the rear panel connector.

Procedure

To print spectral data:

a) Press SETUP and OUT;

b) Select PRINT from the displayed list of options; and

c) Press ENTER(YES). The setup dialog proceeds as follows:

DISPLAY	RESPONSE
PRINT	
0 SPECTRUM	- Use one of the methods described in section 11.21 to
1 SINGLE ROI	select the type of information to be output. Select SPECTRUM to output the currently

2 ALL ROIs — displayed spectral data. Select SINGLE RDI to output information about the currently selected ROI.

Select ALL ROIs to output information about all currently defined ROIs.

STANDARD FORMAT - This choice permits you .to choose one of two formats for output. The Standard Format provides information about the data as well as the data itself. The Brief Format outputs only data. The information included in the standard format is the same for all types of output. (Refer to the sample outputs at the end of this section.)

BRIEF FORMAT

PRINT

LINE LENGTH=128? - Enter the desired length for each line of output. Any number of characters between 0 and 255 is permissible.

SETUP COMPLETE - Disable SETUP. Before beginning output, there are a number of things you can do to further specify the final form of the output-see below. Press OUT to begin output.

Defining the Final Output Form

If you have selected SPECTRUM as the output type, then all currently displayed data channels will be printed. if you wish to print only a portion of the spectrum, use the ◀▶ key and the cursor to adjust the display until only those channels you wish to output are displayed.

If you have selected one of the ROI output types, then you have the option to output the contents of each channel within the ROI(s) or the ROI integrals only.

To output ROI integrals only, make sure that an 'ROI is displayed before pressing OUT.

Figures 18a - 18e show various output possibilities.

Errors

If the output terminal is not properly connected 'to the TN-7200, the following message' will be displayed when OUT is pressed: <<TERMINAL DISCONNECTED>> Press STOP to clear the error message.

Version Number

Live Time, Real Time

Acquisition Group Digital Offset
Subgroup Digital Offset
No. of MUX Channels
Binary Compression Power
Conversion Gain

Channel Numbers

```
TN-7200  X01A
**    LT=   10  RT=      33
*+    0    0 4096    0 4096
#  1717   64
<   1717>     720     715     784     754     765     812     776     806
<   1725>     796     817     786     781     807     826     814     855
<   1733>     816     799     818     854     854     791     808     793
<   1741>     827     888     860     817     842     865     871     802
<   1749>     855     865     795     865     809     827     843     816
<   1757>     838     911     834     850     858     797     783     799
<   1765>     774     834     794     774     799     799     781     757
<   1773>     782     708     765     770     778     798     762     708
 END
```

Figure 18a OUTPUT DATA

Low Channel Number
Calibrated Value for Low Channel
High Channel Number
Calibrated Value for High Channel

Calibrated Channel Numbers

Contents of Data Channels

```
TN-7200  X01A
* TN-7200 DATA LABEL
**    LT=   10  RT=      33
*+    0    0 4096    0 4096
*X 1743   661.6 3662  1332.5
#  1685  128
<  641.3>     543     539     576     568     616     568     565     614
<  644.1>     621     617     599     599     629     653     633     690
<  646.9>     626     662     658     660     656     675     698     716
<  649.7>     684     735     697     728     700     729     737     736
<  652.5>     720     715     784     754     765     812     776     806
<  655.3>     796     817     786     781     807     826     814     855
<  658.1>     816     799     818     854     854     791     808     793
<  660.9>     827     888     860     817     842     865     871     802
<  663.6>     855     865     795     865     809     827     843     816
<  666.4>     838     911     834     850     858     797     783     799
<  669.2>     774     834     794     774     799     799     781     757
<  672.0>     782     708     765     770     778     798     762     708
<  674.8>     764     751     697     741     735     702     724     671
<  677.6>     735     688     687     695     700     733     683     653
<  680.4>     652     587     613     633     636     610     627     609
<  683.2>     602     611     567     558     590     541     576     583
 END
```

Figure 18b CALIBRATED OUTPUT

Starting Channel for Output
Number of Channels Output

```
TN-7200  X01A
**    LT=   10  RT=      33
*+    0     0 4096    0 4096
*X 1743   661.6 3662  1332.5
ROI[5]  884.6:  917.8 =      9645 GROSS          97 NET
#  2381   95
<  884.6>     111     106     103      92      79     107     121     100
<  887.4>      92      81     101     121     110      92     118      96
<  890.2>     121     104      95     101      99     102     106      97
<  893.0>     110      92     108      92     109      87      97     118
<  895.8>      89     113     107     118     122      86     104      94
<  898.6>     106      90      96      96     111     105     102     104
<  901.4>     117     107      95     123      89     109     109      98
<  904.2>     109      99      94      97      73      99      89      96
<  907.0>     107     124     100     101     108      90     100      96
<  909.8>      87      92     100     102      97     106      87     112
<  912.6>      87      76      99     100      98     113      92     123
<  915.4>     122      93     103      98     105     123      90
 END
```

Figure 18c ROI DATA OUTPUT

ROI Number
Low ROI Limit
High ROI Limit
Gross Integral
Net Integral

```
TN-7200  X01A
**    LT=   10  RT=      33
*+    0     0 4096    0 4096
*X 1743   661.6 3662  1332.5
ROI[1]  166.5:  273.1 =     95509 GROSS       56469 NET
ROI[2]  371.4:  527.3 =     88604 GROSS        5202 NET
ROI[3]  588.5:  735.7 =    157971 GROSS      112924 NET
ROI[4]  784.3:  841.6 =     15548 GROSS         460 NET
ROI[5]  884.6:  917.8 =      9645 GROSS          97 NET
ROI[6]  954.2:  975.5 =      4791 GROSS          94 NET
ROI[7]  998.9: 1072.3 =     13499 GROSS       -1621 NET
ROI[8] 1110.8: 1246.8 =     36040 GROSS       15617 NET
ROI[9] 1257.6: 1423.7 =     28855 GROSS       17692 NET
 END
```

Figure 18d ROI INTEGRAL OUTPUT

Sequence Number
Data Label
Number of Sweeps
Dwell Time

```
TN-7200  X01A
SEQUENCE NO.     1 OF     3
* TN-7200 DATA LABEL
*-      #=     119     DW=      10 US
#     0   32
<.000000>      27      23      14      24      26       8      22      17
<.000080>      22      17      16      23      16      16      16      16
<.000160>      19      20      27      15      27      22      19      18
<.000240>      19      25      13      18      25      27      28      20
 END
```

Figure 18e SEQUENTIAL MCS OUTPUT

SET BAUD RATE

18.20

BAUD RATE

This program is exactly the same as the one described in section 17.20. If you change the baud rate with either of these programs, the setting for both input and output is changed.

DISPLAY

18.30

DISPLAY

This program is the same as the PRINT program except that all output proceeds to the TN-7200 CRT. As shown in figure 18g, up to 15 lines of output can be displayed at one time. If there are more than 15 lines of output, the next "page" can be displayed by pressing ENTER(YES).

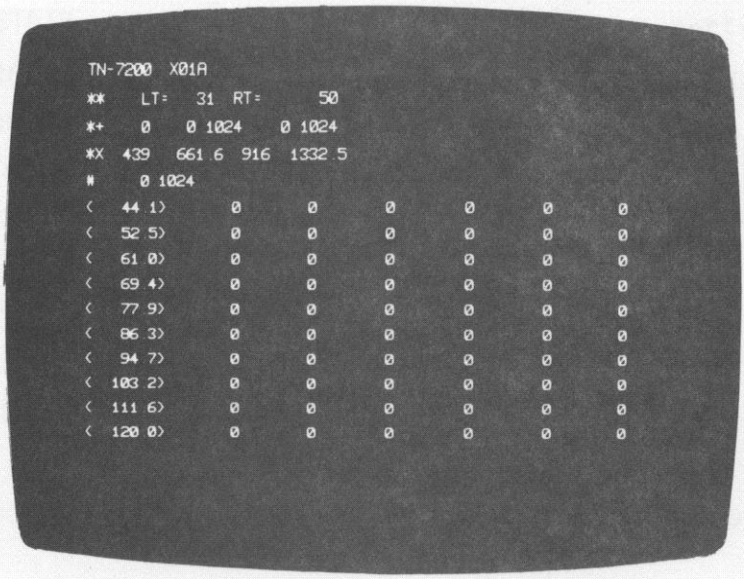


Figure 18g OUTPUT DISPLAY

19.00 STRIP/SUM

The STRIP/SUM key controls the following data processing programs:

0 STRIP

1 SUM

2 MOVE

STRIP/SUM

STRIP 19.10

The STRIP program subtracts the data in one portion of memory from another.

To perform a stripping operation:

a) Press SETUP and STRIP/SUM;

b) Select STRIP from the displayed list of options; and

c) Press ENTER(YES). The setup dialog proceeds as follows:

DISPLAY	RESPONSE
STRIP	
SOURCE GROUP=1/1?	- Select the source group by pressing one of the Memory Group keys. This group should contain the, data that will be subtracted from some other group.
NORMALIZE OFF?	- This choice permits you to normalize the two spectra.
NORMALIZE ON?	With normalize on, the data in the source group is multiplied by the ratio of the target group live time to the source group live time before the stripping operation takes place.
MULTIPLIER=1?	- Source group data will be multiplied by the number entered here before the stripping operation takes place. The multiplier can be any number between 0 and 65,535 with a maximum of five significant digits.
SETUP COMPLETE	- Disable SETUP, select the target group by pressing one of the Memory Group keys, and press STRIP/SUM to perform the strip.

19.20 SUM

SUM

The SUM program adds the data in one portion of memory to another. The setup dialog and operating procedures for SUM are exactly the same as those for the STRIP program described in section 19.10 except that SUM is selected from the displayed list of options.

19.30 MOVE

MOVE

The MOVE program moves data from one portion of memory to another.

To move data:

a) Press SETUP and STRIP/SUM;

b) Select MOVE from the displayed list of options; and

c) Press ENTER(YES);

d) Select the source group (data to be moved) by pressing one of the Memory Group keys;

e) Press ENTER(YES) and disable SETUP;

f) Select the target group (accepts the data) by pressing one of the Memory Group keys; and

g) Press STRIP/SUM to move the data.

20.00 ARITH .

The ARITH key controls the following data processing programs:

0 ADD CONSTANT
1 MULTIPLY
2 DIVIDE
3 NORMALIZE
4 DIFFERENTIATE
5 INTEGRATE
6 SMOOTH

ARITH

ADD CONSTANT 20.10

ADD CONSTANT

The ADD CONSTANT program adds a constant value to each channel of the selected memory group.

To add a constant:

a) Press SETUP and ARITH;

b) Select ADD CONSTANT from the displayed list of options and press ENTER(YES);

c) Enter the constant. Any integer from -999,999,999 to +2,147,483,647 is permissible;

d) Press ENTER(YES) and disable SETUP;

e) Select the memory group to which the constant will be added by pressing one of the Memory Group keys; and

f) Press ARITH to add the constant.

MULTIPLY 20.20

MULTIPLY

The MULTIPLY program multiplies the data in each channel of the selected memory 'portion by a specified value.

To multiply:

a) Press SETUP and ARITH;

b) Select MULTIPLY from the displayed list of options and press ENTER(YES).

Enter the value by which data will be multiplied. The multiplier can be any number from 0 to 65,535 (fractional values included) with a maximum of five significant digits;

d) Press ENTER(YES) and disable SETUP;

e) Press the desired Memory Group key to, select the memory group which contains the data to be multiplied;

f) Press ARITH to multiply the data.

20.30 DIVIDE

DIVIDE

The DIVIDE program divides the data in each channel of the selected memory portion by a specified value; The setup dialog and operating procedures for DIVIDE are the same as those for the MULTIPLY program described in section 20.20 except that DIVIDE is selected from the displayed list of options and only integer values are allowed for the divisor.

20.40 NORMALIZE

NORMALIZE

The NORMALIZE program divides the data in each channel of the selected memory group by the current live time or number of sweeps according to the formula:

$y'(i) = \frac{y(i)}{N}$ where N=the live time or number of sweeps

To normalize data:

a) Press SETUP and ARITH;

b) Select NORMALIZE from the displayed list of options and press ENTER (YES);

c) Disable SETUP;

d) Select the memory group to be normalized; and

e) Press ARITH to normalize the data.

20.50 DIFFERENTIATE

DIFFEREN-TIATE

The DIFFERENTIATE program performs differentiation of the data in the selected memory group according to the formula:

$y'(i) = y(i) - y(i-1)$ for $i = 1,2,....$

$y'(0) = y(0)$

The setup dialog and operating procedures for DIFFERENTIATE are the 'same as those for the NORMALIZE program described in section 20.40 except that DIFFERENTIATE is selected from the displayed list of options.

INTEGRATE

20.60

INTEGRATE

The INTEGRATE program performs integration of the data in the selected memory group according to the formula:

$$y'(i) = \sum_{j=o}^{i} y(j)$$

The setup dialog and operating procedures for INTEGRATE are the same as those for the NORMALIZE program described in section 20.40 except that INTEGRATE is s-elected from the displayed list of options

SMOOTH

20.70

SMOOTH

The SMOOTH program provides 3-point smoothing of spectral data according to the formula:

$y'(i) = 1/4(y(i-1)+2y(i)+y(i+1)$ for i=l, 2...N-2

$y'(0) = 1/4(3y(0)+y(1))$

$y'(N-1) = 1/4(y(N-2)+3y(N-1))$ where N = group size

The setup dialog and operating procedures for SMOOTH are the same as those, for the NORMALIZE program described in section 20.40 except that SMOOTH is selected from the displayed list of options.

21.00 AUTO REPEAT

The TN-7200's AUTO REPEAT feature permits you to perform the following sequence of functions for a pre-set number of cycles:

a) Erase data in the selected memory group;

b) Acquire into the selected memory group; and

c) Output the acquired data.

AUTO REPEAT

Entering the Number of Cycles

To enter the number of cycles:

a) Press SETUP and AUTO REPEAT:

b) Enter the number of cycles. Any integer from 0 to 65535 is permissible. An entry of 0 means that the AUTO REPEAT sequence will continue indefinitely;

c) Press ENTER(YES) and disable SETUP.

Operating in AUTO REPEAT Mode

To operate the TN-7200 in AUTO REPEAT mode:

a) Set up an acquisition preset. You must enter a preset live time/number of sweeps or a preset integral. If no preset is entered, the sequence will never pass the ACQUIRE mode.

b) Set up the OUTPUT program in the desired manner. Make sure that you are getting the proper data output.

c) Press AUTO REPEAT to begin the automatic sequence.

The output data will contain the current sequence number.

If output is proceeding to the TN-7200 CRT, the output display will last for 33 seconds or until ENTER(YES) is pressed.

To halt the automatic sequence. before the preset number of cycles is reached, disable AUTO REPEAT. The current sequence will be completed.

To halt the current sequence and move to the next one, press STOP.