OPERATING MANUAL

MODEL 5820A
CROSS CHANNEL
SPECTRUM ANALYZER

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2nd Edition

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TABLE OF CONTENTS

CHAPTER V - OPERATIONAL VERIFICATION

APPENDIX A - TUTORIAL

APPENDIX B - SUMMARY OF 5820 CONTROLS AND OPERATIIONS

APPENDIX C - BASIC TROUBLESHOOTING PROCEDURE

APPENDIX D - CHANGING AC LINE VOLTAGE

APPENDIX E - PROGRAMMING EXAMPLES FOR THE IEEE INTERFACE

APPENDIX F - SUMMARY OF THE IEEE INSTRUCTIONS FOR THE WAVETEK ROCKLAND 5820A SPECTRUM ANALYZER

APPENDIX G

APPENDIX H - MEMORY MAP AND FORMAT

CHAPTER I
GENERAL INFORMATION

1-1. INTRODUCTION

This Operator's Reference Manual for the WAVETEK ROCKLAND 5820A Cross-Channel Spectrum Analyzer, like the 5820A itself, is a tool. As with any tool, you should know something about it before you start to use it.

The manual, by itself, will not teach you all about spectrum analysis or how to use the 5820A in every possible way for your particular application. Spectrum analysis, especially using a modern digital, Fast Fourier Transform (FFT) spectrum analyzer, is a complex topic. And the range of applications is very broad. New, important uses are being added all the time by workers in many different fields.

However, this manual does contain the information you'll need to install, properly operate, and verify the performance of the 5820A. It is a reference volume of specifications and procedures. But it is more than just a book of facts about operating the 5820A Cross-Channel Spectrum Analyzer. Since it is organized as a tutorial, it provides "hands on" exercises on the 5820A to help you learn to use the instrument as quickly and efficiently as possible -- whether you are already familiar with other spectrum analyzers or a new-comer to this technology.. Once you become proficient with the basics of the 5820A, you will be able to perform your regular analysis operations more easily than ever before - and indeed may perform some operations that used to be impossible!

In general, throughout this manual, -- and in CHAPTER III in particular -- features and procedures will be introduced first followed by a general description. Then, depending on the particular subject, there will be an appropriate exercise for the 5820A. Try it! In this way, you are likely to be introduced to some related concepts in addition to the main one.

In those instances, where a short discussion of technical or theoretical information is considered helpful, it will be provided along with the procedural material. However, you sometimes will be referred to either an appendix or to another accompanying document ("Spectrum Analysis - Theory, Implementation & Applications", abbreviated SATIA) which was written earlier by the WAVETEK ROCKLAND Engineering Staff. That document contains useful theoretical material about spectra, Fourier Transform mathematics, and the overall architecture of an ideal modern FFT Spectrum Analyzer - like the WAVETEK 5820A.

If the "Spectrum Analysis" book has not been included with this manual, you can obtain one by contacting:

WAVETEK ROCKLAND, INC.
10 Volvo Dr.
Rockleigh Industrial Park
Rockleigh, NJ 07647

Do not hesitate to direct questions unanswered by this manual, comments, praise, or even criticism about the 5820A to your WAVETEK ROCKLAND Sales/Technical Representative. Keep your Representative abreast of the ways in which you use your WAVETEK Spectrum Analyzer.

1-2. SAFETY NOTES

Caution: In keeping with standard safety practice, the case of the 5820A is grounded through the power cord. If the instrument must be connected to a two-wire receptacle, use a parallel-ground adapter and connect the short lead securely to the ground.

You should review and observe the precautions presented in CHAPTER II and wherever they occur elsewhere in this manual.

1-3. DESCRIPTION

The WAVETEK 5820A is a high- accuracy cross-channel frequency spectrum analyzer. It can input two separate time-domain signals, digitize each input, and produce graphic and alphanumeric display information about the character of the signals such as:

* Power Spectrum
* Phase Spectrum
* Transfer Function
* Coherence

* Power Spectrum of Time Averaged Signals
* Coherent Output Power
* Ratio and Difference Spectra
* Power Spectral Density

You specify the analysis tasks for the 5820A via easy-to-use keys and interactive "menus" you can call up on the CRT.

The 5820A uses a network of processors to perform Fast Fourier Transform computations, control its versatile CRT display, manage data storage, and communicate with additional instruments such as plotters, computers, controllers, and calculators.

The 5820A can perform its analysis over the frequency range of 0 Hz to 50KHZ. Within this range, narrower frequency spans can be positioned anywhere for close-up (zooming-in) analysis in both single and cross-channel modes (that is, two channels at a time). It has up to 10 millihertz resolution at low frequencies.

The 5820A has a full-scale amplitude sensitivity of from -70dBV to a maximum of +20dBV with an overall range exceeding 80 dB.

The range of 5820A's features is quite comprehensive. A glance through the partial list below will give you an idea of just how versatile it is. A detailed discussion of each of them will be found in CHAPTER III AND IV.

* Zoom (looking at a portion of the entire frequency range)
* GPIB (General Purpose Interface Bus), an IEEE STD 488/1978 Digital Interface
* Tracking Signal Generator
* Transient Capture
* Analog Plot Out
* Digital Plot Out
* Engineering Units
* Autoranging
* External Sampling
* Simultaneous Time/Frequency Display
* Log Frequency Scale
* Full & Split-Screen Display
* Time Averaging
* Edited Transfer Function

1-4. SPECIFICATIONS

FREQUENCY

FREQUENCY MODES
0-50KHz Span:

The selected measurement is performed over the range of 0-50 KHz

Start to 0 Hz:
The selected measurement is performed over the range defined by the SPAN control with a start frequency of 0 Hz.

About Start:
The selected measurement is performed over the range defined by the SPAN control with constant start frequency.

About Center:
The selected measurement is performed over the range defined by the SPAN control with constant center frequency.

FREQUENCY RANGE:
0.02 Hz to 50 KHz

FREQUENCY SPANS:
2 Hz to 50 KHz in 2-5-10 sequence, except 25 KHz span is available instead of 20 KHz. Same spans are available in all Frequency Modes.

DISPLAY MODES:
Linear or Log frequency axis.

FREQUENCY ACCURACY:
The center frequency of each calculated line is accurate to ±0.001%.

FREQUENCY RESOLUTION:

Standard:
Cursor resolution is limited by the calculated line spacing for the selected span and operating mode (see Table 1-4). Cursor frequency readout worst case error is ±0.5% or ±0.25% of span, depending on span and processing mode.

Improved Accuracy:
When measuring frequencies of discrete spectra, cursor resolution is improved by at least a factor of 10 resulting in a worst case error of ±0.05% of span.

TABLE 1-4

	Single-channel		Dual- or Cross-channel	
SPAN	Calculated Line Spacing (β)	Cent/Start Resolution	Calculated Line Spacing (β)	Cent/Start Resolution
50 KHz	125 Hz	-	250 Hz	-
25 KHz	62.5 Hz	250 Hz	125 Hz	250 Hz
10 KHz	25 Hz	50 Hz	50 Hz	100 Hz
5 KHz	12.5 Hz	50 Hz	25 Hz	50 Hz
2 KHz	5 Hz	50 Hz	10 Hz	50 Hz
1 KHz	2.5 Hz	50 Hz	5 Hz	25 Hz
500 Hz	1.25 Hz	50 Hz	2.5 Hz	25 Hz
200 Hz	1.0 Hz	50 Hz	1.0 Hz	25 Hz
100 Hz	0.5 Hz	25 Hz	0.5 Hz	2.5 Hz
50 Hz	0.125 Hz	2.5 Hz	0.25 Hz	2.5 Hz
20 Hz	0.1 Hz	5.0 Hz	0.1 Hz	2.5 Hz
10 Hz	0.025 Hz	0.5 Hz	0.05 Hz	0.25 Hz
5 Hz	0.0125 Hz	0.5 Hz	0.025 Hz	0.25 Hz
2 Hz	0.01 Hz	0.5 Hz	0.01 Hz	0.25 Hz

In Single-Channel mode 2,5 and 10 Hz Spans are available to a maximum frequency of 500 Hz; 20 and 50 Hz Spans are available up to 5 KHz. In Dual or Cross-Channel mode, 2,5 and 10 Spans are available to a maximum frequency of 500 Hz; 20, 50 and 100 Hz Spans are available up to 5 KHz. In all cases, the maximum usable frequency is indicated on the front panel.

POWER SPECTRUM AMPLITUDE

FULL SCALE SENSITIVITY RANGE

Log:

The calibrated attenuator range is +20 dBV to -70 dBV single tone RMS maximum input level, in 1.0 dB ±0.2 dB steps.

Linear:

The calibrated attenuator range is 10 volts to 320 microvolt single tone RMS maximum input level in 12% ± 2% steps.

AUTORANGE

When activated, the full scale sensitivity of both channels is automatically adjusted, prior to the start of processing; any data block which causes an overload will not be processed.

DISPLAY MODES

Log:

80 dB range; 10 dB/div. full-screen,
20 dB/div. split-screen
40 dB range; 5 dB/div. full-screen,
10 dB/div. split-screen
20 dB range; 2.5 dB/div. full-screen,
5 dB/div. split-screen

Linear:

Constant voltage/division

Reference Level:

Provides for additional gain steps and attenuation steps of displayed function. Settability is 1 dB on the 80 dB range, 0.5 dB on 40 dB range and 0.25 dB on the 20 dB range.

DYNAMIC RANGE

2-Tone Amplitude Linearity:
±0.1 dB ±0.001% of full scale down to >70 dB below full-scale.

Distortion Products:
>70 dB below full-scale.

Spurious Responses:
>70 dB below full-scale or -120 dBV, whichever is greater.

Typical Equivalent Input Noise:
-155 dBV/$\sqrt{Hz}$ (18 nanovolts/$\sqrt{Hz}$ for frequencies greater than 100 Hz).

DC Response:
>20 dB below full-scale.

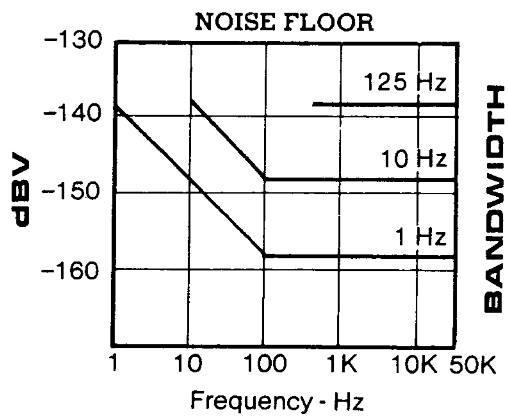
AMPLITUDE ACCURACY

		Improved Accuracy
Accuracy at Passband Center	±0.5 dB	±0.5 dB
Hanning Weighting	+0, - 1.5 dB	±0.1 dB
Flat Weighting	+0, - 4.0 dB	±0.1 dB

Overall Amplitude Accuracy in IMPROVED ACCURACY mode is ± 0.6 dB at any point.

AMPLITUDE RESOLUTION:
0.1 dB (Log), 0.1% (Linear)

OVERLOAD INDICATORS:
Individual overload indicators are provided for each channel. Overload occurs when input level exceeds full scale. Occasional overload will only prevent processing of the data block which caused the overload; the remaining data blocks will be processed properly.



POWER SPECTRUM PHASE

PHASE DISPLAY RANGE
Full Screen: From +180 degrees to -180 degrees, 45 degrees/division

Split Screen: From +180 degrees to -180 degrees, 90 degrees/division

PHASE RESOLUTION: 0.1 degree

TRANSFER FUNCTION

TRANSFER FUNCTION DISPLAY MODES
Magnitude:
Full-Screen or Split-Screen, same display modes as Power Spectrum amplitude.

Phase:
Full-Screen or Split-Screen, same display as Power Spectrum Phase.

TRANSFER FUNCTION MEASUREMENT RANGES

Magnitude:
From +170 dB full scale to -90 dB full scale (Log).
From 3x10 full scale to 3x10 full scale (linear).

Phase:
+180 degrees to -180 degrees.

TRANSFER FUNCTION ACCURACY
Magnitude: ± 0.5 dB
Phase: ± 1 degree

TRANSFER FUNCTION RESOLUTION
Magnitude: 0.1 dB (log) 0.1% (Linear)
Phase: 0.1 degree.

EDITED TRANSFER FUNCTION: When selected, those portions of the Transfer Function where the coherence is below a preset level, are blanked out from the display.

OTHER MEASUREMENTS

COHERENCE FUNCTION
Measured and displayed over a range of 0.0 (bottom line of display) to 1.00 (top line of display) 0.125/div. full-screen, 0.25/div. split screen. Cursor resolution: 0.01.

COHERENT OUTPUT POWER
Measured and displayed with the same specifications as power spectrum amplitude.

TOTAL POWER READOUT
Provides readout of total power in selected span, calibration in dBV, V RMS, or EU.

POWER SPECTRAL DENSITY
Provides readout of noise power per unit bandwidth (1 Hz); calibration in dBV/$\sqrt{Hz}$, V RMS/$\sqrt{Hz}$, or EU.

RATIO & DIFFERENCE
Measures and displays the ratio or difference between a present function and a previously measured and stored function.

ENGINEERING UNITS (EU)
Allows the operator to calibrate both vertical and horizontal scales in terms of arbitrary units (e.g. 100 mV/g and CPM).

TIME FUNCTION
The time-domain waveform is displayed ; valid amplitude and time measurements may be made only in the 50 KHz span. At all other spans, time measurements are valid and amplitude is less than or equal to the correct value.

AVERAGING

MODES
Spectrum and Time

TYPES
Exponential in free-run, Linear otherwise; Peak, for storing the maximum value at each frequency or time cell.

NUMBER OF AVERAGES:
1 to 256 in binary sequence, displayed on the CRT.

CONTROLS:
Start, Stop, Resume, and Store.

TRANSIENT CAPTURE

TRANSIENT MODES
Free Run:
The new measurement is automatically initiated at the completion of the previous measurement.

Internal:
The new measurement is initiated when the selected input signal (select Ch A or Ch B) meets the specified threshold level.

External:
The new measurement is initiated when an external trigger signal meets the specified threshold level.

Tracking Signal:
The new measurement is initiated when the tracking signal meets the specified threshold level.

IEEE-488:
The new measurement is initiated on command through the GPIB interface.

TRANSIENT CONTROLS
Threshold:
Transient capture level can be selected by a continuous vernier; the positive or negative going transition can be selected.

Auto/Single:
Transient capture may be armed and automatically rearmed after a transient is captured; or, a single transient may be captured.

PRETRIGGER:
Fixed at 1/16 of the time record length.

DISPLAY

FORMAT
Full Screen (Front/Back):
Electronic graticule with 8 vertical by 10 horizontal divisions.

Split Screen (Top/Bottom):
Electronic graticule with 4 each vertical by 10 horizontal divisions.

Trace Displayed:
Any two of the following traces may be simultaneously displayed: Power Spectrum A, Power Spectrum B, Phase A, Phase B, Time A, Time B, Transfer Function Magnitude, Transfer Function Phase, Coherence, Coherent Output Power.

In single-channel measurements, two power spectra may be simultaneously displayed: the Max Frequency Spectrum (0-50 KHz, 0-5 KHz, or 0-500 Hz) and the selected span (zoomed) Spectrum; the portion being zoomed-in is identified by the intensified portion of the trace.

Text:
Maximum of four 64 character lines of alphanumeric text plus associated time-domain or frequency-domain plots and a 16 character Status line; or a maximum of twenty 50 character lines of alphanumeric text only.

Menus:
Measurement Mode, Display Format, Readout Calibration, Display Modifiers, Transient Capture, Tracking Signal, Recording, and View Setup.

STORAGE All spectral calculations of a measurement set; any two at a time may be recalled for display, along with their calibrations.

CRT SIZE:
4 in. high by 5 in. wide.

INPUT CHANNELS

INPUT IMPEDANCE:
1 Megohm, 50 pf nominal

ABSOLUTE MAX. INPUT VOLTAGE:
200 V peak for sensitivity settings between -10dBV and +20dBV; 40 V peak for all other settings.

INPUT COUPLING:
AC with 0.5 Hz cutoff, DC (not recommended for sensitivity settings -50 dBV or higher) and Grounded.

DC ISOLATION:
Input low may be connected to chassis ground or floated up to 30V to break ground loops and reject common mode signals; in the float position, each input circuit is true differential.

COMMON MODE REJECTION:
$>$60 dB at 50 -60 Hz.

Max. common mode voltage is 7.5V for sensitivity settings higher than -20dBV, 75V for 0dBV and -10dBV settings, 200V for +10dBV and +20dBV settings.

INPUT CHANNEL CROSSTALK:
Less than -150dB.

OUTPUT SIGNALS

TRACKING SIGNAL GENERATOR

Noise:
"White" or periodic noise signal whose spectrum is bandlimited and band translated to match the selected measurement span.

Pulse:
A burst of a sine wave at a frequency equal to the center of the selected measurement span.

Level:
0-40dB attenuator in 10dB steps, plus 0-10dB Vernier.

ANALOG PLOTTER

Vertical:0-1.5 V full-scale.

Horizontal:0 to 1.0 V full-scale.

Pen Lift:Open collector, 30 V max.

Sweep Speed:2 selectable with adaptive rate.

CRT OUTPUTS

Vertical:0 to 1.5 V full-scale

Horizontal:0 to 1.0 V full-scale.

Intensity:-1.0 V to +5.0 V;
increased voltage decreases intensity.

REMOTE OPERATION

IEEE 488-1978 INTERFACE

Programming:
All front panel controls except the CRT controls, AC POWER switch, THRESHOLD Vernier, 0-10dB TRACKING SIGNAL Vernier, and GND/FLOAT switches are remotely programmable through the GPIB Interface.

Data Input:
Data for any measurement that can be performed by the instrument plus alphanumeric text can be input via the GPIB.

Data Output:
Instrument setup and any measurement that can be viewed on the CRT can be output through the GPIB.

Digital Plotting:
Digital plots with user-definable size may be obtained on commonly available plotters including two four-color plotters; an external calculator or controller is not required.

DIGITAL DATA IN:
12-bit serial digital data may be input to the FFT processor of the Analyzer, bypassing its input signal conditioners and A/D Converter.

CRT INPUTS

Vertical:0 to 1.5 V full-scale.

Horizontal:0 to 1.0 V full-scale.

Intensity:-1.0 V to +5.0V;
increased voltage decreases intensity.

MISCELLANEOUS

EXTERNAL SAMPLING
An external TTL signal may be used as the sampling clock for digitizing input signals. Frequency calibration in this mode of operation is given in ORDERS. Max.frequency of this external signal is limited to 220 KHz, resulting in internal sampling rate of 110 KHz.

SELF-TEST
A self-test function is provided.This mode is entered by pressing the RESET button twice.

RESET:
The RESET key forces the instrument to come up with a predetermined setting of front panel controls.

TEST SIGNAL:
An internal test signal may be applied to both channels to verify proper operation.

GENERAL

POWER REQUIREMENTS
115 or 230 VAC, ±10% 48-66 Hz, less than 200 VA.

OPERATING TEMPERATURE:
0° C to $+45^{\circ}$C.

SIZE:
8.0 in. (20.3 cm) high, 18.5 in (47.0 cm) wide, 18.8 in (47.8 cm) deep,overall; 7.0 in (17.8 cm) high, 19.0 in (48.3 cm) wide, 18.0 in (45.7 cm) deep, rack mount.

WEIGHT 46 lbs. (21.0 Kg.) net, 60 lbs (27.0 Kg.) shipping.

1-5. OPTIONS
Optional equipment for the WAVETEK ROCKLAND 5820A includes:

Option -01 Rack Mounting kit consisting of rack slides, top cover, and rack ears (Installation is described briefly in next Chapter).

Option -02 Front or Rear Panel Covers.

CHAPTER II
INSTALLATION

2-1. INTRODUCTION

This chapter describes how to properly and safely install your WAVETEK Model 5820A Cross-Channel Spectrum Analyzer. Remember at all times that, as well designed and constructed as it is, the 5820A has certain requirements you must adhere to in order to keep it working for you.

2-2. INSPECTION

If your 5820A has been factory shipped, check the shipping carton for signs of damage. If there are any, immediately notify the shipper. If no carton damage is evident, clear some space and, with due care, remove the 5820A from the carton. SAVE THE ORIGINAL PACKING MATERIAL FOR ANY FUTURE STORAGE OR SHIPPING NEEDS!
Inspect the instrument for any signs of damage and check your order and the packing list against the items shipped to be sure you have everything. If there are any problems, be assured that WAVETEK ROCKLAND stands behind all its products. Look over the warranty at the front of this manual. If everything seems in order, let's move on.

2-3. INSTALLATION

No matter where you place the 5820A, remember that it generates heat. As with any forced-ventilation instrument, care should be taken not to block normal airflow. Air flows IN through the rear panel fan and OUT through the slots of the bottom cover. Do not block this airpath.

The Operating Temperature for the 5820A is 0 to 45 degrees Celsius.

2-3-1. Surface-mounted Installations

The plastic feet on the bottom of the 5820A are designed to provide sufficient clearance for heat dissipation in surface-mount installations. The rubber tips on the feet will protect supporting surfaces. A fold-down tilt stand on the bottom may provide a more convenient viewing angle. The side-panels extend past both the forward and rear panels in order that the 5820A can be placed either face-down or face-up. Operating the instrument in a vertical position is possible - just be sure there is adequate connecting cable clearance and that there are no objects on the ground which might cause damage.

A caution: As with any costly electronic gear, use it as a coffee table at your own risk!

2-3-2. Rack-mounted Installation

The 5820A may be mounted in a standard 19" rack using the optional Rack Mounting Kit.

Rack Mounting procedure: remove the four screws holding the rear panel to the case. Slide the 5820A forward out of the case. Mount the slides, rack ears, and cover using the screw holes provided.

Air flow precautions and requirements are the same as for surface mounting. At least a 3" space should be left in the rear to facilitate airflow.

2-4. POWER REQUIREMENTS

The 5820A will operate from either 115 or 230 Vac +/-10% at 48-66 Hz. See Appendix D, Changing AC Line Voltage, to set the line voltage for your location. It draws less than 200 VA. BEFORE connecting power, make sure that the instrument is compatible with the nominal line voltage and that a fuse with the proper rating is installed; 3-Amp Slow-blow @ 115 VAC and 1.5-Amp @ 230 VAC.

As cautioned in CHAPTER I:

WARNING

In keeping with standard safety practice, the case of the 5820A is grounded through the power cord. If the instrument must be connected to a two-wire receptacle, use a parallel-ground adapter and connect the short lead securely to ground.

2-5. GENERAL OPERATING PRECAUTIONS

Do not exceed the following limits:

ABSOLUTE MAXIMUM INPUT SIGNAL LEVEL:

200 V peak for sensitivity set between -10 dBV and +20 dBV

40 V peak for all other settings (i.e., < -10 dBV).

Input Low to Chassis, Isolated: 30 V.

CHAPTER III

MANUAL OPERATION: FUNDAMENTALS

3-1. INTRODUCTION

It makes sense to learn a complicated subject in stages. This chapter, CHAPTER III, starts with the most basic and introductory aspects of the Model 5820A Spectrum Analyzer and leads onward to a comprehensive understanding of the manual operation of the instrument. Then, in CHAPTER IV, you'll find out how to operate the 5820A remotely - for example, by a computer. The objective of this manual is to help you begin applying the 5820A quickly, effectively, and with confidence to the tasks for which you or your organization purchased it.

This manual has been designed to serve the needs of two types of users. First, there are the veteran users of Spectrum Analyzers. They primarily need a listing of 5820A specifications and straightforward descriptions of its features and operating procedures. If that describes your needs, you will find a written and pictorial summary of the controls and their functions in Appendix B.

The other type of user will be the relative newcomer to spectrum analyzers, if not to the whole subject of spectrum analysis.

To satisfy both groups, this manual makes heavy use of simple exercises and examples with illustrations. We hope the experienced user will not find the exercises too trivial, but simply move through them at the greater speed their expertise will allow.

The topic sections of this material are organized around the separate functional groups of controls and indicators which are on the front operator's panel of the spectrum analyzer. After you've started using the 5820A, you'll want to be able to access information by subject; we've set it up to stand as a reference manual, providing more detail than the summary in Appendix B.

As a tutorial, however, you'll use the manual somewhat differently. Sometimes, you may be asked to skip ahead to a section to read just the opening few paragraphs for the sake of introduction. Or, you may be asked to press a key or two simply on faith that its effect will soon be revealed. Your patience will be rewarded.

One thing is certain. As long as you don't plug the power cord into the wrong voltage socket, fail to ground it properly, exceed the signal input limitations (see CHAPTER II, Section 2-5), or knock the 5820A off the workbench, you should feel free to experiment. You probably can't set the controls in any way that will harm the instrument. So set aside this manual whenever you choose. If you're unsure or curious about something, try it.

It's not a bad idea to read a section before embarking on the exercises. But remember that these are designed as "hands on" lessons so you'll want the 5820A in front of you as you study.

You won't need any other equipment to complete the tutorial exercises (except for three short lengths of coaxial cable with BNC connectors). We'll use signals produced by the 5820A itself as source signals for the exercises. Since the 5820A is a cross-channel spectrum analyzer, you'll want two different signals for comparative purposes. Your 5820A will have come with an instructional exercise module, a simple electronic circuit for use in these exercises. In Appendix A, you'll find a description of the module.

3-2. DISPLAY, INDICATORS, CONTROLS, and CONNECTORS

On the facing page is a fold-out featuring the front panel of the 5820A (Figure 3-2). Whether you're looking at the picture or at the real instrument, notice how the keys, knobs, switches and BNC connectors are grouped into a number of white outlined sections. Look them over, reading all the labels.

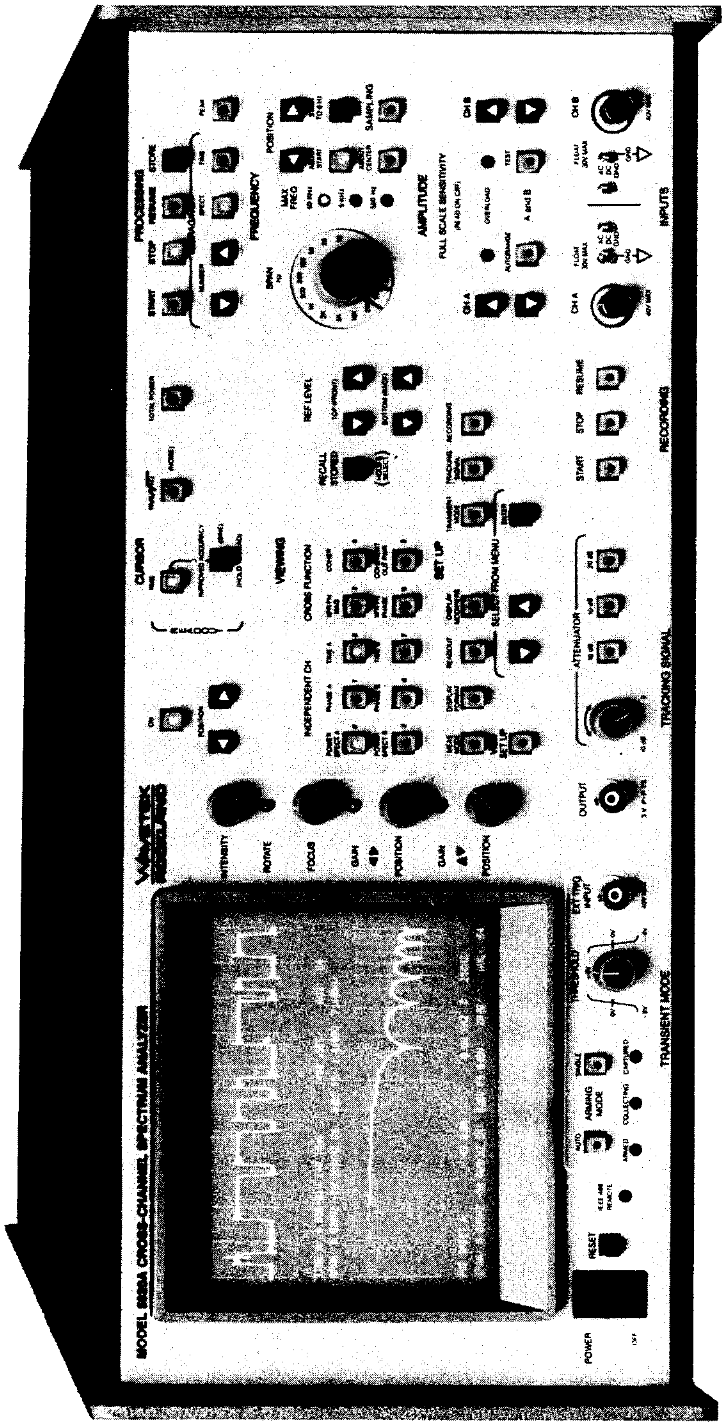


Fig. 3-2   MODEL 5820A FRONT PANEL

3-3. POWERING-UP

Taking all precautions described in the Power Requirements section of CHAPTER II (Section 2-4), connect the 5820A to a suitable power source. Press the power switch in the lower left hand front corner to ON. Refer to Figure 3-3A.

You should observe three things:

1 - The cooling fan of the 5820A started up.

2 - Certain lights (LEDs) will have come on:

a- the red LEDs for AMPLITUDE OVERLOAD may have flashed momentarily, then gone out.

b- yellow LEDs will be illuminated on the keys for CURSOR ON & RMS, PROCESSING START & SPECT, VIEWING POWER SPECT A & POWER SPECT B, FREQUENCY ABOUT CENTER.

c- one of the three green LEDs under FREQUENCY MAX FREQ should be lit (depends on Frequency Span dial setting, to be explained later).

3 - The CRT should briefly display a split-screen image similar to that shown in Figure 3-3B. Then the word "AUTOCALIBRATION" will appear momentarily (indicating that the 5820A is performing an autocalibration operation). Then the split-screen display should reappear. The 5820A front panel should appear as shown in the illustration, Figure 3-3B, below.

Before proceeding after a power-up, press RESET to assure that all functions are properly initialized.

If absolutely nothing happens when you first power-up, first check the power source, then the fuse which is located on the rear panel next to the power cord. If power is getting to the 5820A but nothing still happens when you turn it ON or if fuses keep on blowing, or if the fan or LEDS don't come on, turn OFF the power switch and follow the procedures in Appendix C.

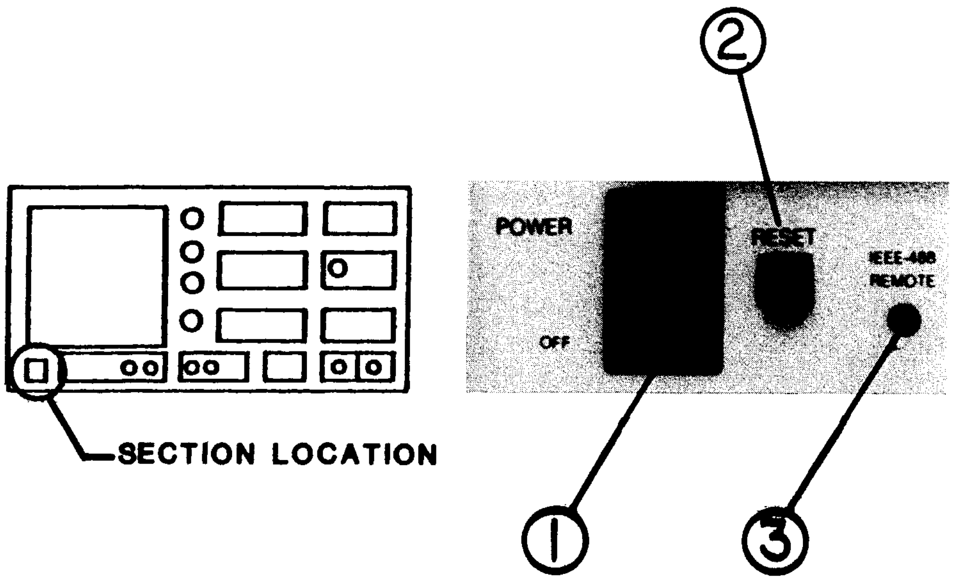


Fig. 3-3A Power-Up Section

(1) Applies power to the instrument when the top is pushed in; at this point the instrument goes through a pre-determined power-up and self-test procedure; following this, the instrument comes up in a pre-determined or preset state, which may be seen by pressing the VIEW SET UP Key (see Section 3-5).

(2) Restores the instrument to the same preset state as when turning power on and clears all memories. Pressing twice in quick succession causes diagnostics to run.

(3) When lit, it indicates that the instrument is under remote control via the GPIB interface.

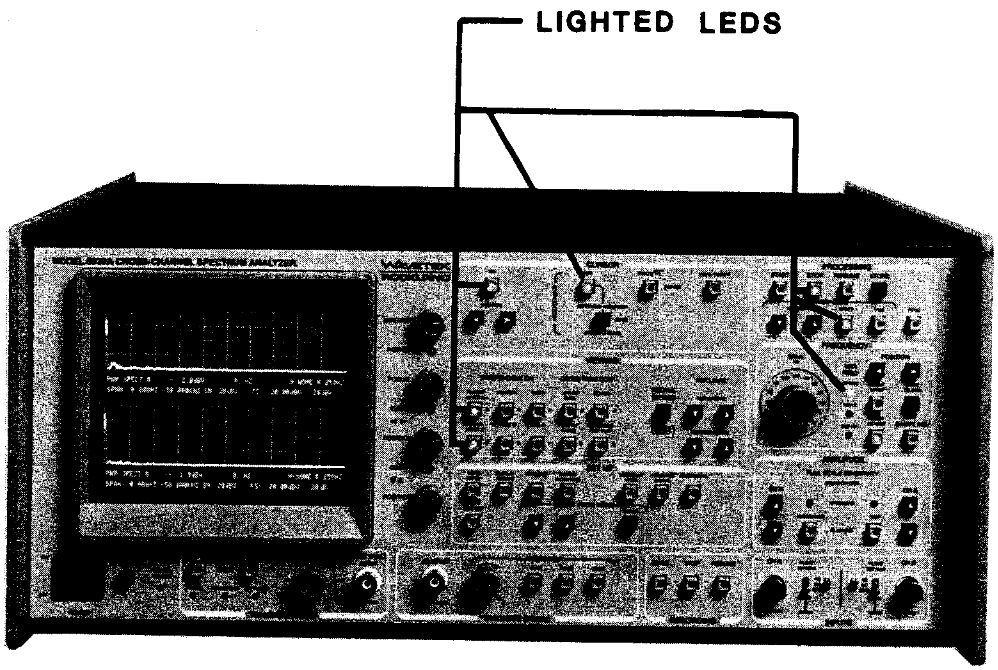


Fig. 3-3B Front Panel After Power-Up

If items 1 (fan) and 2 (LEDs) operate properly but there is no image on the CRT or it doesn't appear centered or sharp, it is most probable that the CRT controls merely need adjustment. Go straight to Section 3-4, CRT Display Controls, to learn how to adjust the CRT.

3-4. CRT DISPLAY CONTROLS

Four knobs (INTENSITY, FOCUS, POSITION [horizontal], and POSITION [vertical]) and three adjustment screws give you control over the appearance of the information displayed on the CRT (see Figure 3-4). The knobs set the brightness, sharpness, and placement of the image on the screen. The set screws (which are probably at their optimum factory positions already) control the rotation and the size of the display. Changing any of these knob or screw settings in no way effects the input signal or the data itself.

Note that extreme settings inadvertently made during shipping, unpacking, or prior operation may have caused the display either to be too dim or too far off screen to be seen. If, after powering-up, no normal set-up display (see Figure 3-4-1A) appears, make sure the display isn't just being hidden by misadjusted control settings.

3-4-1. CRT Display Data - definitions and format

When you have a well-defined display on the screen, study it for a few moments. Note that there are two graphs displayed. Below each graph are two lines of alphanumeric data. The data refer to the graph immediately above them. The upper is labeled "PWR SPECT A". The lower is labeled "PWR SPECT B".

Figures 3-4-1 A and B portray the two primary types of displays (split-screen and full-screen respectively) which you can select and the location and definition of the individual data items on the displays.

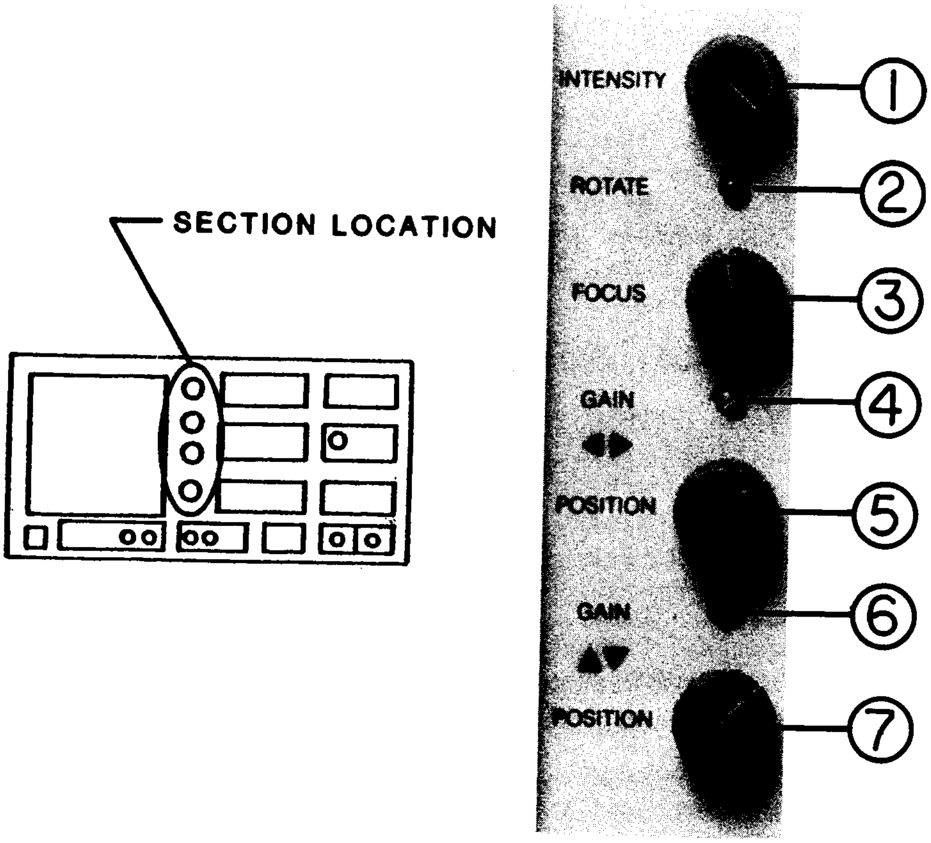


Fig. 3-4 CRT Controls

① Clockwise rotation increases the intensity of CRT display.

② Rotates entire display clockwise, or counterclockwise.

③ Adjusts the focus, or sharpness of the display.

④ Clockwise rotation increases horizontal size of the display.

⑤ Moves display left or right, without changing its size.

⑥ Clockwise rotation increases vertical size of the display.

⑦ Moves display up or down, without changing its size.

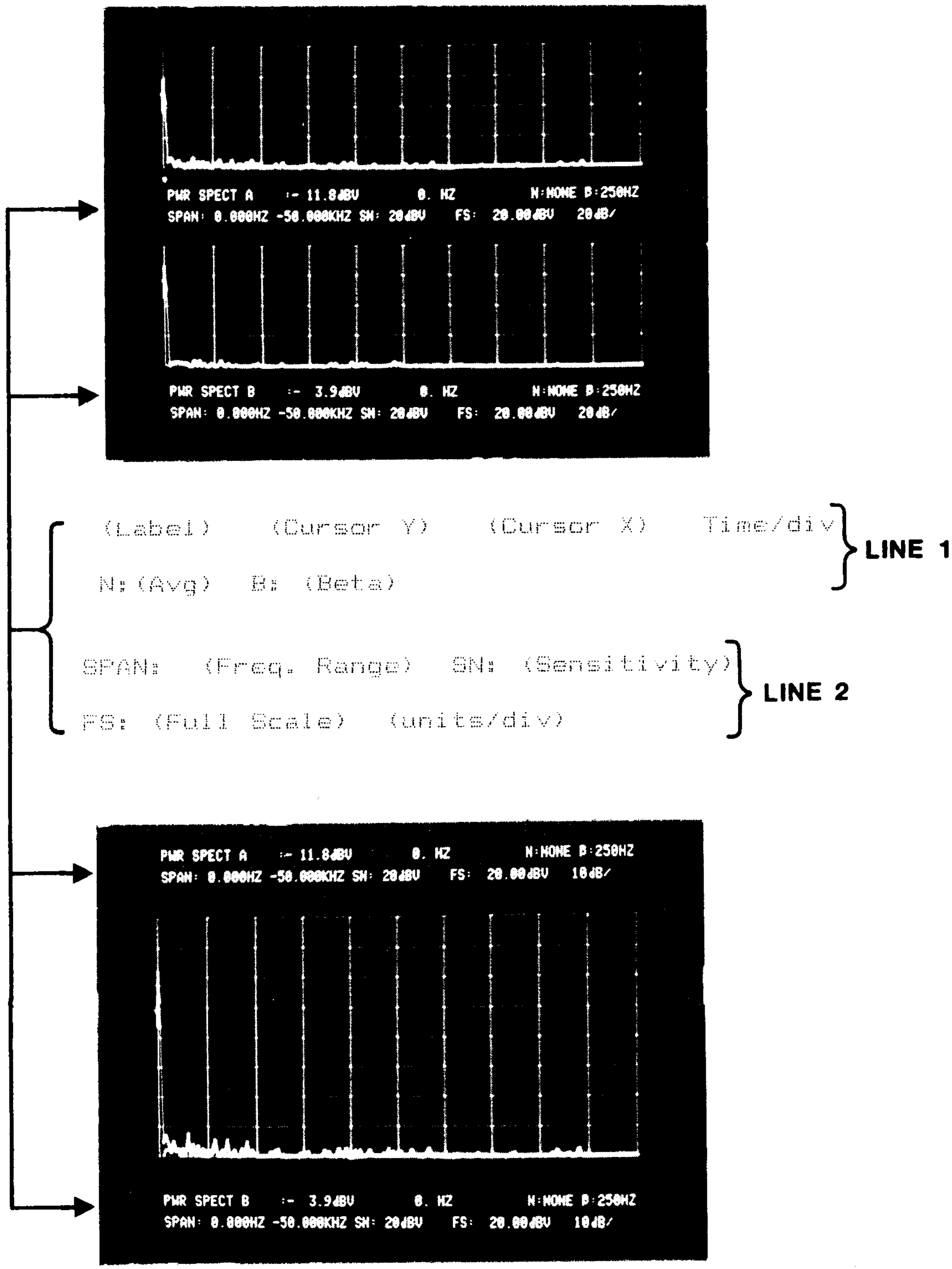


Fig. 3-4-1 Readout and Display Formats

Key to Figure 3-4-1 A,B Alphanumeric data entries:

Label = name of function being displayed (e.g, PWR SPECT A or B, PHASE A or B, TIME A or B, XFR FN MAG, XFR FN PHASE, COHER, COHERENT OUT PWR)

Cursor Y = value of Y-axis data at current cursor position (see CURSOR Section 3-10). Usually in units of dBV, dB, Volts, or dimensionless depending on function being displayed (see table below). User-determined engineering units may also be used (see Section 3-5).

Function	Units
PWR SPECT	dBV or Volts
PHASE	Degrees
TIME	Volts
XFR FN MAG	dB or dimensionless
XFR FN PHASE	Degrees
COHER	dimensionless
COH OUT PWR	dBV or volt rms

Cursor X = X-axis position of cursor (see CURSOR Section 3-10). Usually in units of Hz, KHz, mSEC although user-defined engineering units may also be used (see Section 3-5).

Time/div = amount of time (in micro-, milli-, or seconds) per horizontal scale division. One-tenth value of full-scale range which starts (0 sec.) at left. Present only for TIME A or B function displays.

Avg. = number, N, of samples averaged together in the AVERAGING modes. "NONE" if N = 0; "PEAK" if in Peak mode; an integer (2,4,8,16,32,64,128, or 256) otherwise.

Beta = nominal bandwidth of each digital filter used in the computation of the Discrete Fourier Transform in units of Hz.

Freq. Range = starting (low) frequency to ending (high) frequency of SPAN under analysis. User-defined engineering units may also be used (see Section 3-5-4).

Sensitivity = maximum signal input level acceptable without overload. Initially set by 5820A at +20 dBV at POWER-UP or RESET. Then user sets desired sensitivity via the AMPLITUDE SENSITIVITY Section keys. In units of dBV, Volts, or user-defined units. Not displayed for XFR FN MAG, XFR FN PHASE, or COHER.

Full Scale = value of top of graph scale in same units as Cursor Y. Set either by user via AMPLITUDE SENSITIVITY Section keys, and also by VIEWING Section REF (Reference) LEVEL keys.

Units/div = number of units (e.g. dB, Volts, degrees, etc.) represented by each division of the Y-axis of the graph. There are four divisions on each graph in split-screen mode and eight divisions in full-screen mode. Set by menu choices in SET UP Section Display Format menu.

Exercise #1

For right now, try the following exercise: sequentially press any two of the unlit gray keys in the VIEWING section. Press an unlit key in the CURSOR section. Press any key that strikes your fancy. All 5820A keys are either momentary contact or PUSH ON/PUSH OFF; just press and release.

Note how the CRT display has changed each time you pressed a key. Actually, how you've now got the 5820A set up really isn't the issue at this moment. These are exercises to raise your awareness of the 5820A's operating features.

3-4-2. RESET to 5820A Preset State

Press the RESET key located near the POWER switch. Everything about the front panel - the lit LEDS and the CRT display - should look exactly as they did when you first powered-up (as in Figure 3-3B). In fact, anytime you press RESET, the 5820A will assume this same preset status. We'll examine that in more detail in a few paragraphs. For reference, the Preset State into which the 5820A is placed by either initial powering-up or RESET is given in the table below:

Instrument Preset State

Section	Preset Setting
Amplitude	20 dBV full-scale sensitivity autorange off, test signal off.
Frequency	Span as set on front panel starting @ 0 Hz.
Processing	Start activated, number of averages: none, spectrum averaging on.
Cursor	on @ 0 Hz, RMS readout.
Viewing	Power spectrum A & B; ref. level normal.
Set up	Cross-channel mode, auto weighting function, split-screen, 80 dB range, display modifiers: none, transient mode: free run, tracking signal: off, recording: off.

3-5. The SET UP Section

The CRT is your primary window onto the information the 5820A produces about the input signal(s). It's also part of the human-engineered operation and control features of the instrument because videotext "menus" of what to measure, how to display it, how the display should be calibrated, and the status of the system at any moment can be presented there whenever you wish.

You should look over and read the captions on Figure 3-5, an illustration of the SET UP Section control keys.

When any of the eight gray keys of the SET UP section are pressed, two things will happen. First, the yellow LED in the pressed key will light. That's true of any and all of the 5820A's gray function selection keys. This makes it easy to tell at a glance what function controls have been activated. In many cases, and always in the SET UP Section, the activation (and LED-lighting) of one key will bring about the de-activation (and, logically enough, LED-extinguishing) of another key.

The other occurence will be the appearance of new information on the CRT display, namely the "menu" associated with the key.

We'll review the menu for each SET UP key in the following order:

VIEW SET UP
MEASUREMENT MODE
SELECT FROM MENU (three keys)
DISPLAY FORMAT
READOUT
DISPLAY MODIFIERS
RECORDING
TRANSIENT MODE
TRACKING SIGNAL

In the course of that review, you'll perform a number of exercises, including some that will require the instructional exercise module.

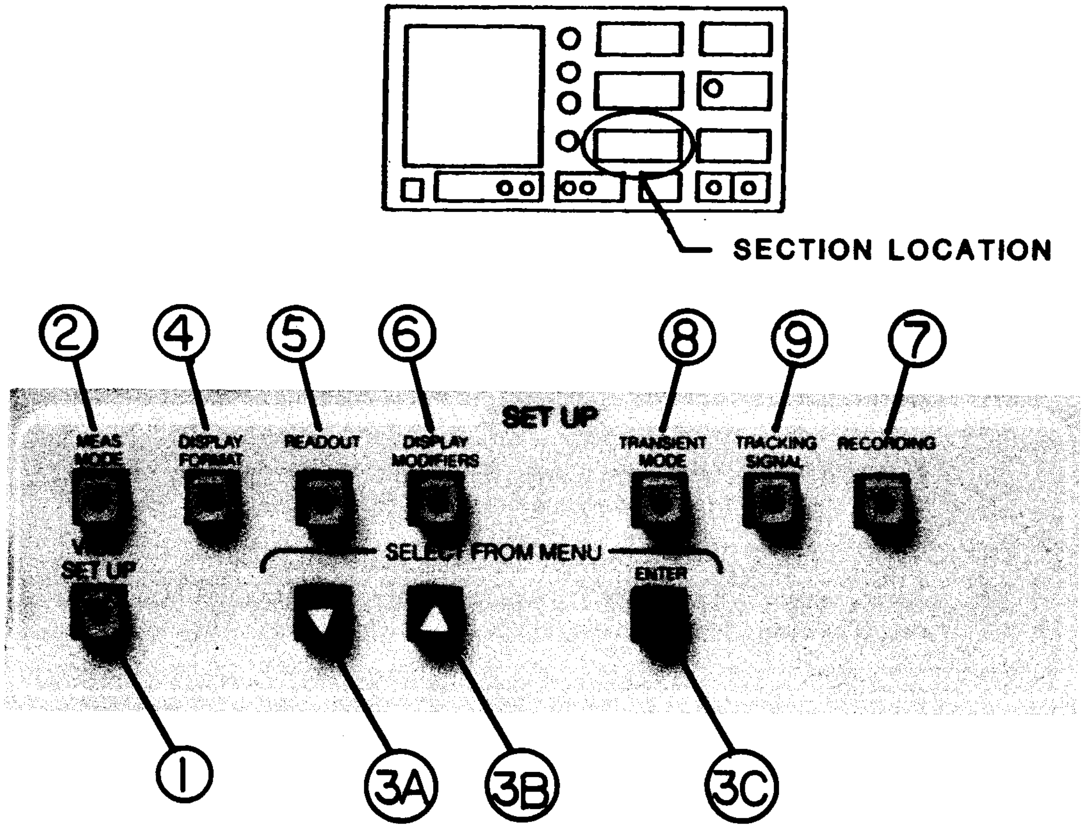


Fig. 3-5 SET UP Section

(1) View Set Up
Provides a condensed listing of the set up state of the instrument.

(2) Measurement Mode
Determines whether input samples are taken from CH A, CH B, or both. Also specifies the choice of weighting function.

(3A) Moves the cursor down ▼ one line per keystroke. When the last line is reached, pressing the key again will position the cursor next to the top line of the menu.

(3B) Moves menu cursor up ▲ , one line per keystroke. When the top line is reached, pressing the key again will position the cursor next to the bottom line of the menu.

(3C) Enters the menu selection on line next to cursor.
Selection entered indicated by asterisk (*).

(4) Display Format
Provides choice of full or split screen display; linear or log frequency axis, linear or log amplitude axis, and full-scale vertical range.

(5) Readout
Allows for vertical and horizontal scale calibration, in terms of standard or engineering (arbitrary) units.

(6) Display Modifiers
For editing Transfer Function measurements. and for comparing (ratio, difference) a measurement with a previously stored one.

(7) Recording
Determines the type of hard copy output to be obtained; also provides calibration of X-Y recorder.

(8) Transient Mode
Determines Free Run, or Triggered operation and the choice of trigger signal source.

(9) Tracking Signal
Determines the type of tracking signal to be connected to the device under test.

3-5-1. VIEW SET UP Menu

As Figure 3-5 tells you, the VIEW SET UP key provides a condensed listing of the set up state of the 5820A. The VIEW SET UP menu is different from all the others in that it only provides a summary of status rather than a means of changing some aspect of the 5820A's set up.

Earlier, you saw that the RESET key put the 5820A into a predetermined status. Press RESET again and then press the VIEW SET UP key. Note that its LED lights up and that the CRT screen is filled with an alphanumeric listing.

This is a summary of the current set up state of the instrument. It should look like Figure 3-5-1A below.

```
---------------------------------------
                SET UP
---------------------------------------
  CH.A SN: 20 dBV
  CH.B SN: 20 dBV
  SPAN: 0.000HZ -(SEE NOTE)HZ
  N:NONE, SPECT AVG
  MEASUREMENT MODE: CROSS CHANNEL
  WEIGHTING FN: HANNING
  INTERNAL SAMPLING
  FREE RUN
  MODIFIERS: NONE
  [V/R] A = 1.0 E +00   B = 1.0 E +00
  TSG: OFF
---------------------------------------
```

Note: SPAN to current setting of Frequency Span dial.

FIGURE 3-5-1A

On your 5820A CRT display of the menu, look at the two top entries on the list (CH. A and B SN. - that is, Amplitude Sensitivity). Now press either of the two "up"-pointer black keys in the AMPLITUDE section. Next, turn the SPAN dial in the FREQUENCY section. You should have noted that certain SET UP listing values changed. What they've changed to isn't important quite yet.

As we proceed, all the entries on the list will take on meaning. For now, note that the "MEASUREMENT MODE" entry indicates a "CROSS CHANNEL" setting. Press and release the VIEW SET UP key. Its LED will go out; the SET UP summary will be replaced by a split-screen display modified by your experimentation with the controls in this exercise.

Don't be surprised if you really can't see much of a trace on the CRT. Since there is, as yet, no signal input, you're only seeing the internal noise of the 5820A - and there's not much of that.

Exercise #1

Just to assure yourself that the 5820A is working, turn the SPAN dial in the FREQUENCY Section to 50K. Then, press the TEST key in the AMPLITUDE Section. This applies an internally generated signal to both channels. It should look like Figure 3-5-1B. We'll use this signal source later for some exercises.

Please press the TEST key again to turn off the test signal.

3-5-2. MEASUREMENT MODE Menu

Recall that the Figure 3-5 caption for the MEASUREMENT MODE key said that it determines whether input samples are taken from CH A, CH B, or both. Also specifies the choice of weighting function.

Exercise #1 - Calling the Menu

First, in the VIEWING section, press the POWER SPECT B key; then the POWER SPECTRUM A key. That will insure that you are looking at the same display we are discussing here.

For future reference, whichever VIEWING section key is pressed most recently when the 5820A is in cross channel mode is drawn as the upper display (graph and alphanumeric data) in split-screen mode or has the upper alphanumerics and the brighter trace on the graph in the full screen mode.

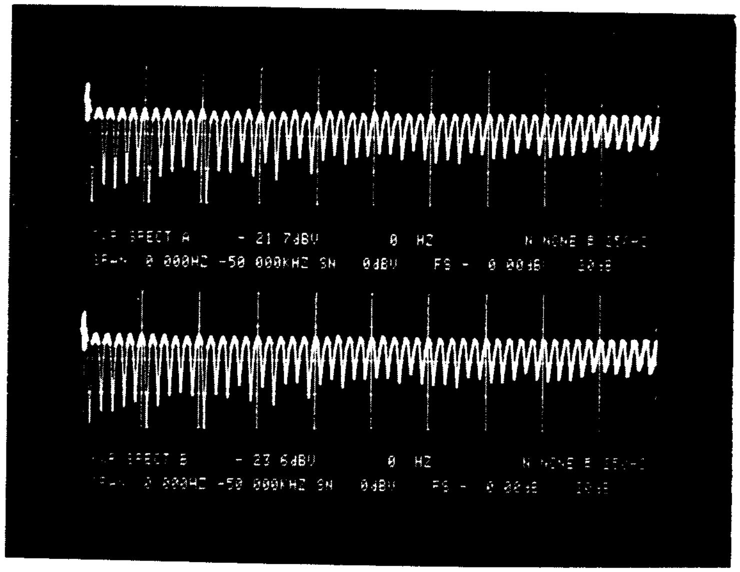


Fig. 3-5-1B Spectrum of the Test Signal

Now, press the MEASUREMENT MODE key. On the CRT, you'll see a menu of options under MEASUREMENT MODE (see Figure 3-5-2 below).

MEASUREMENT MODE

[*] CROSS CHANNEL
[ ] SINGLE CHANNEL A
[ ] SINGLE CHANNEL B

WEIGHTING FUNCTION:
[*] AUTO: HANNING IN FREE RUN
UNIFORM IN TRANSIENT
[ ] HANNING
[ ] UNIFORM

FIGURE 3-5-2

This particular menu has two groupings: Channel Selection and Weighting Function. Each possible selection has a pair of brackets in front of it. The option currently in effect has an asterisk * within the brackets. You might wish to compare the current settings with the summary given by VIEW SET UP.

<u>Exercise #2</u> - Selection via the cursor

The flashing cursor is used to select the desired option. The three "SELECT FROM MENU" (black) keys described in Figure 3-5 are used to position the cursor next to the desired selection. Pressing the ENTER key selects that menu option.

As an exercise, use the cursor to change the Channel selection from CROSS CHANNEL to SINGLE CHANNEL A. Press and release the MEASUREMENT MODE key to observe the change in the graphic display.

If the FREQUENCY SPAN dial was set at 50K, you'll see a single, full-screen trace. Otherwise, there will be two traces in split-screen. LOOK AT THE ALPHANUMERIC DATA! Look at the display label. Note also the change in the VIEWING key LEDs. The PWR SPECT B LED should have gone out.

As simple as this exercise is, you will see several different things taking place. Complete explanations are on the way.

<u>Exercise #3</u>

You may want to experiment a little here by turning the SPAN dial in the FREQUENCY section one step at a time (give the 5820A a moment to change the CRT display).

As you turn the FREQUENCY SPAN dial, pay attention to the values next to the words "SPAN" and "B:" on the CRT. Notice also, how the alphanumeric lettering of the SPAN and "B" (for beta = bandwidth) went momentarily to "reverse video" (dark letters on light field). That's to point out what values have just been changed. It is feedback you'll receive whenever you change a setting.

We'll deal with FREQUENCY SPAN selection a bit later. But now you're getting a good feel for the way you interact with the various SET UP Section menus to make the 5820A show and do what you want. You'll work with the other SET UP Section menus in the same way you've done here.

Weighting Functions

The second group of options in the MEASUREMENT MODE menu relates to Weighting Functions, functions which modify the shape of the Discrete Fourier Transform filters for different applications.

The HANNING weighting function helps give better resolution for isolating a single spectral line in a group of closely spaced spectral lines, particularly when the amplitudes of the spectra are close to each other.

The UNIFORM weighting function should be used for measuring transient signals.

The AUTO option usually employs the correct function automatically, but there may be cases when you will want to choose the weighting function yourself.

You will find more about the meaning of WEIGHTING FUNCTION on pages 13-15 of SATIA.

3-5-3. DISPLAY FORMAT Menu

Refering to the caption in Figure 3-5, the DISPLAY FORMAT menu provides a choice of full or split screen display, linear or log frequency axis, linear or log amplitude axis, and full-scale vertical range. Pressing the key will produce the CRT display reproduced in Figure 3-5-3 below.

DISPLAY FORMAT

POWER SPECTRUM AMPLITUDE:
[*] 80dB RANGE
[ ] 40dB RANGE
[ ] 20dB RANGE
[ ] LINEAR

FREQUENCY AXIS:
[*] LINEAR [ ] LOG

SCREEN:
[ ] FULL [*] SPLIT
[ ] MAX SPAN BACKGROUND (SINGLE CH.ONLY)

FIGURE 3-5-3

The 5820A allows you to have data represented with either a linear or a logarithmic scale on both the Frequency (X-axis) and the Amplitude (Y-axis).

Refering to the CRT display illustrations in Figures 3-4-1A and 3-4-1B, you can see that there are always 10 Frequency axis scale divisions. There are 8 Amplitude axis divisions in full-screen mode and 4 divisions for each trace in split screen mode. If two functions are displayed in the full screen mode, then one will appear dimmer. The CRT's intensity must be high enough so the dimmer trace can appear.

The LINEAR Amplitude scale has a range from 10 volts to 320 microvolts. The actual range used is selected via the AMPLITUDE SENSITIVITY controls (see Section 3-9) and the REF LEVEL controls in the VIEWING Section (see Section 3-12). Volts per division, therefore, decreases as the full scale amplitude is reduced.

In addition to the single LINEAR scale, spectral Amplitude may be represented in three different size Logarithmic scales :

	dB/Scale Division	
RANGE	FULL SCREEN	SPLIT SCREEN
80 dB	10 dB	20 dB
40 dB	5 dB	10 dB
20 dB	2.5 dB	5dB

Scale selection only provides a way to "zoom" in or out on a vertical portion of the display; the Sensitivity or Full-scale is not effected here.

The last item on the menu relates to Single Channel Free Run Spectrum Averaging. In this measurement mode, it is possible to display the narrowband and Max Span (50 KHz, 5 KHz or 500 Hz depending on the Span that was selected) spectra simultaneously. The menu allows you to suppress the Max Span display, but not its computation, so that you can display the narrowband spectrum only or the narrowband spectrum and the corresponding time or phase function.

3-5-4. READOUT Menu

READOUT allows for vertical and horizontal scale calibration in terms of standard or engineering (arbitrary) units. This menu is different from the others in that it is branched and multi-screen. In other words, depending on certain choices you make within one menu, different subsequent menus will appear in the videotext display.

To move on to the next videotext screen (or return to the start of the entire sequence when a branch is finished), you will enter the cursor asterisk in the [*] CONTINUE bracket. To completely exit the READOUT menu, press the READOUT key to de-activate it. When the READOUT key is first pressed ON, the menu depicted in Figure 3-5-4A will appear:

```
-------------------------------------------

    [*] VERTICAL AXIS
    [ ]     OR
    [ ] FREQUENCY AXIS
            ?

[ ] CONTINUE
-------------------------------------------
```

FIGURE 3-5-4A

First, we'll follow out the choices involved in calibrating the vertical axis.

VERTICAL AXIS CALIBRATION

In your practical application of the 5820A, you may be measuring an amplitude in terms of a dimension relevant to that particular application. For example, you might be measuring acceleration in "Gs", temperature in degrees Kelvin, or pressure in P.S.I.. To use the spectrum analyzer, you will have somehow transformed the signal in "your" units into a voltage-units signal via a transducer. Vertical axis calibration represents the relationship of the user's signal dimensions through the transducer to volts into the 5820A (this assumes that the signal relationship is frequency-independent).

The vertical axis dimensions can be calibrated "with respect to" (abbreviated as WRT) the user's reference or, in normal usage, to 1.0 VRMS (Volts RMS). The second vertical calibration menu screen, shown in Figure 3-5-4B, allows you to choose normal or special calibration:

```
---------------------------------------

              VERTICAL AXIS

      [*] WRT REFERENCE
              OR
      [ ] WRT 1.0 VRMS

  [ ] CONTINUE
---------------------------------------
```

FIGURE 3-5-4B

(Note: to comprehend this section, you should understand the function of the Cursor. See Section 3-10 of this manual for details.)

If you will not be using 1.0 VRMS as the reference as in the Figure 3-5-4B example (note the asterisk), you will be presented with the Figure 3-5-4C screen. First you will select as the reference either:

(A) - the amplitude at the current Cursor position, or

(B) - a Volts/Reference unit ("R" will always mean the Reference Unit in this section).

Then, you'll need to indicate whether Channel A or B is the channel being calibrated.

```
---------------------------------------

        VERTICAL AXIS CALIBRATION

[ ]  CURSOR     [ ]  VOLTS/REF
[*]  CH A       [ ]  CH B

UNITS
 [*] dBR
 [ ] dBR/√HZ
 [ ] R
 [ ] R/√HZ

AMP  AT CURSOR = +012.0 DBR

USE FRONT PANEL KEYPAD TO ENTER UNDERLINED FIELDS.
USE [ENTER] KEY TO TOGGLE [+/-].
[*] APPLY SAME CALIBRATION FACTOR TO OTHER
CHANNEL.
[ ]  CONTINUE
---------------------------------------
```

FIGURE 3-5-4C

In the example above (Figure 3-5-4C), a recalibrated Cursor is to serve as the reference for Channel A. Once these reference parameters have been established, the videotext asking for UNITS will appear. In our example, dBR (decibel-Reference Units) has been selected.

Now you must enter the value which the reference, the current cursor position in this example, is to have.

Notice that the value of the cursor has been entered as +012.0 dBR in this example. That is the new value for amplitude at that vertical axis position. You have been able to select a point on the CRT trace and make it the reference for all subsequent amplitude data display values, either for one or both channels. How that numerical value is entered is the subject of the following discussion.

ENTERING NUMERICAL VALUES

Many of the videotext menu screens, the one you just looked at for example, ask you to enter numerical values for your reference. The place in the videotext where the numbers are to be entered is indicated with underline marks on the CRT.

Take a look at the 10 gray function select keys (POWER SPECT A, PHASE A, etc.) in the VIEWING section of the 5820A front panel. Numbers 0 to 9 are inscribed next to these keys. These 10 keys perform a dual function: in addition to calling up the function on the CRT, they act as a keypad for numeric data entry in READOUT axis calibration.

The ENTER key of the three black SELECT FROM MENU keys in the Set up Section can be "toggled" to enter either the "+" or "-" as appropriate.

Suppose you were measuring stress forces in a moving object and had a transducer that generated 2.0 volts for each "G" of acceleration. It would be convenient to have the 5820A amplitude values read as "G" values instead of dBV which you would have to convert to get "Gs". The example presented by Figure 3-5-4D accomplishes just that:

VERTICAL AXIS CALIBRATION

```
[ ]  CURSOR        [*] VOLTS/REF
[ ]  CH A          [*] CH B

VOLTS/REF=2.00E+00

  or
+006.1dBV=+000.0 dBR

USE FRONT PANEL KEYPAD TO ENTER UNDERLINED FIELDS.
USE  ENTER  KEY TO TOGGLE  +/- .
 [*]APPLY SAME CALIBRATION FACTOR TO OTHER
CHANNEL.
[ ]  CONTINUE
```

FIGURE 3-5-4D

In the Figure 3-5-4D example above, the same calibration was selected for the other channel, CH A.

FREQUENCY AXIS CALIBRATION

Recalibration of the Frequency axis can be just as useful as that of the amplitude axis. The procedure utilized in eliminating the effects of flutter during tape recorded data analysis is a case in point. Refer to the discussion of External Sampling in Section 3-8-2.

The operations involved in performing Frequency axis calibrations are similar to those presented for Amplitude axis calibration: the use of a branched, multi-screen menu and numeric data entry via the keypad. If you were to select "FREQUENCY AXIS" in Figure 3-5-4A instead of Amplitude axis, the next videotext display would be like Figure 3-5-4F below:

```
                FREQUENCY AXIS

    [*] HZ
    [ ]OR
    [ ] ORDERS
    [ ] ?

[ ] CONTINUE
```

FIGURE 3-5-4F

You can specify the frequency axis to be read out in terms of Hertz or "Orders". "Orders" is something like the relationship of harmonics to a fundamental. It is the ratio of the currently measured quantity to the value specified by you as the "Order" quantity. For example, if 2 KHz is defined as the 01.00 ORDERS quantity, a 1 KHz value will readout as 00.50 ORDERS while a 4.500 KHz value will readout as 02.25 ORDERS.

If calibration is to be in terms of Hertz, the next screen will be as in Figure 3-5-4G. Calibration in terms of Orders will be discussed in segment 3-5-4H.

```
---------------------------------------

              FREQUENCY AXIS

     [*] WRT REFERENCE
            OR
     [ ] WRT DC
            ?

     [ ] SET FREQUENCY AT CURSOR TO ZERO

[ ] CONTINUE
---------------------------------------
```

FIGURE 3-5-4G

DC or 0 Hz, is the normal reference for the frequency axis. It should be selected when returning the 5820A calibration to normal reference.

If you want to choose a different reference, you should have the cursor positioned at the frequency axis location which will become the new zero. Then, place the asterisk in [ ] SET FREQUENCY AT CURSOR TO ZERO.

If calibration will be in terms of Orders (rather than Hz), the menu shown in Figure 3-5-4H will be generated.

```
---------------------------------------

        FREQUENCY AXIS CALIBRATION

     FREQ. AT CURSOR = XX.XX ORDERS

USE FRONT PANEL KEYPAD TO ENTER UNDERLINED FIELDS.

[ ] CONTINUE
---------------------------------------
```

FIGURE 3-5-4H

3-5-5. DISPLAY MODIFIERS Menu

The menu generated by this key provides for editing Transfer Function measurements, and for comparing (ratio, difference) a measurement with a previously stored measurement.
Pressing the DISPLAY MODIFIERS key will produce the following menu on the CRT:

DISPLAY MODIFIERS

[*] NONE
[ ] EDIT XFR FN
[ ] EQUALIZE WITH STORED FN [RATIO]
[ ] COMPARE WITH STORED FN [DIFFERENCE]

FIGURE 3-5-5

Edit Transfer Function, EDIT XFR FN, will cause the 5820A to decrease the brightness on the CRT display of those portions of the Magnitude and Phase function displays which are invalid or suspect due to low coherence. See the VIEWING Section 3-12.
EQUALIZE, Equalization, works with Power Spectrum A and B, Transfer Function Magnitude and Phase, and Coherent Output Power. This causes the ratio, on a point-by-point basis, of a new signal input and a previously stored function to be displayed. Equalization can be useful in removing the effect of a transducer from the signal.

COMPARE, a difference operation, works with Power Spectrum A and B, and Coherent Output Power. The difference between a current signal function and one previously stored is computed on a point-by-point basis and displayed. Difference can be used to remove specific effects such as background noise.

3-5-6. RECORDING Menu

This key-selected menu determines the type of hard copy output to be obtained; it also provides for calibration of an X-Y recorder.

The RECORDING menu is illustrated in Figure 3-5-6. However, discussion of RECORDING mode operations will be found in the RECORDING Section 3-14.

Note that "FS" stands for Full-scale in the figure below.

```
---------------------------------------

                RECORDING
 [*] OFF
[ ]  DIGITAL PLOTTER
ANNOTATE?
[*] YES
[ ] NO

 [ ] X-Y PLOTTER
CALIBRATION:
[ ]  0,0
[ ]  FS,FS
[ ]  0.1FS,0.1FS

---------------------------------------
```

FIGURE 3-5-6

3-5-7. TRANSIENT MODE Menu

This menu allows you to choose either free running or triggered operation. The trigger signal source is also chosen here. You would use triggered mode for transient signal analysis.

In free-run, the 5820A is continuously processing data. In the triggered mode, the slope and level of the incoming trigger signal tells the 5820A when to start processing. Use in this latter mode is covered in the TRANSIENT MODE Section 3-13.

The TRANSIENT MODE menu is reproduced in Figure 3-5-7 below.

TRANSIENT MODE

[*] FREE RUN

OR TRIGGER SOURCE:

[ ] EXTERNAL
[ ] CHANNEL A
[ ] CHANNEL B
[ ] TRACKING SIGNAL
[ ] IEEE-488

FIGURE 3-5-7

A useful discussion of transient capture and spectrum computation may be found on pages 19 - 20 of SATIA.

3-5-8. TRACKING SIGNAL Menu

Use of this menu determines the type of tracking signal to be connected to the device under test. Press the key to get the menu reproduced in Figure 3-5-8 below.

TRACKING SIGNAL

[*] OFF
[ ] NOISE
[ ] PERIODIC NOISE
[ ] PULSE: TRANSIENT MODE ONLY

FIGURE 3-5-8

The menu is used to select the type of signal to be output by the 5820A's built-in Tracking Signal generator. The TRACKING SIGNAL generator in the 5820A operates in three modes: a random and periodic noise generation mode and a pulsed output mode.

The spectrum of all three signal sources are matched to the spectral range under observation, i.e., each signal source corresponds to a bandpass signal. For example, the pulse is really a burst of a sinewave whose frequency equals the center of the analysis span.

Periodic noise is a random signal over a time interval equal to the data collection interval for one spectrum and repeats for each collection interval. It is used for quick analysis of a linear system only,since small non-linearities are not removed as in the processing and averaging of random noise.

You will be using the output of the TRACKING SIGNAL Generator as a signal source in most of the exercises which follow. You will be refered to the TRACKING SIGNAL Output Section 3-7 to make the required connections and settings.

3-6. Signal INPUTS

The signal INPUT section provides for connection of input signals and determines what type of coupling is to be used. Read over the description of each INPUT section item depicted in Figure 3-6.

Before connecting any device to either INPUT terminal, be sure none of the signal level limits listed below are exceeded:

Peak Input signal level:
* 200 V peak, -10 dBV to +20 dBV full-scale (F-S) Sensitivity.
* 40 V peak, for all other full-scale sensitivity ranges.
* Input Low to Chassis, Isolated: 30 V.

3-6-1. Input Isolation

To permit measurements where ground loops may be present, each input (CH A and CH B) may be individually isolated. Refer to the FLOAT/GND switches depicted in Figure 3-6. Remember that the 5820A's power supply cord must be properly grounded to avoid an unsafe operating condition.

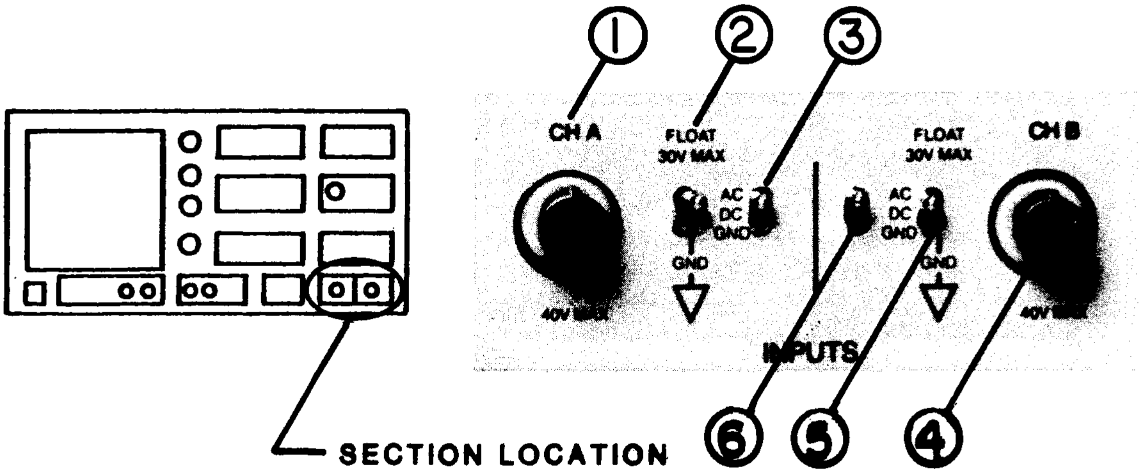


Fig. 3-6 Input Section

(1) Input BNC Connector for Channel A.

(2) Selects whether Channel A input low terminal (BNC shell) is floating (up) or connected to chassis ground (down).

(3) Selects whether Channel A input circuit is AC coupled, DC coupled, or grounded. (When grounded it will not short-circuit the external signal source).

Note:

DC coupling between -50 and -70 dBV full-scale sensitivity settings is not recommended

(4) Input BNC Connector for Channel B.

(5) Selects whether Channel B input low terminal (BNC shell) is floating (up) or connected to chassis ground (down).

(6) Selects whether Channel B input circuit is AC coupled, DC coupled, or grounded (When grounded, it will not short-circuit the external signal source).

Note:

DC coupling between -50 and -70 dBV full-scale sensitivity settings is not recommended

3-6-2. AC/DC/GND Coupling

For the more accurate measurement of certain frequency ranges, some signal couplings are better than others. AC coupling is useful for analyzing signals which have either a high DC offset or a large, slowly changing DC. AC coupling acts like a high pass filter with a -3 dB point at 0.5 Hz.

DC coupling is used for low frequency analysis and transient analysis.

3-7. TRACKING SIGNAL Output Section

This section provides the output signal from the internal Tracking Signal generator. It's also possible to attenuate the tracking signal level anywhere from 0 to 50 dB using combinations of the attenuator keys and the 0-10 dB vernier.

One of two types of tracking signals, NOISE spectrum(white or periodic) or PULSED "flat" spectrum (for use in transient mode only) can be selected via the TRACKING SIGNAL menu in the SET UP section (see Section 3-5-8 of this manual). Refer to Figure 3-7 for an illustration of the controls of the TRACKING SIGNAL Output Section.

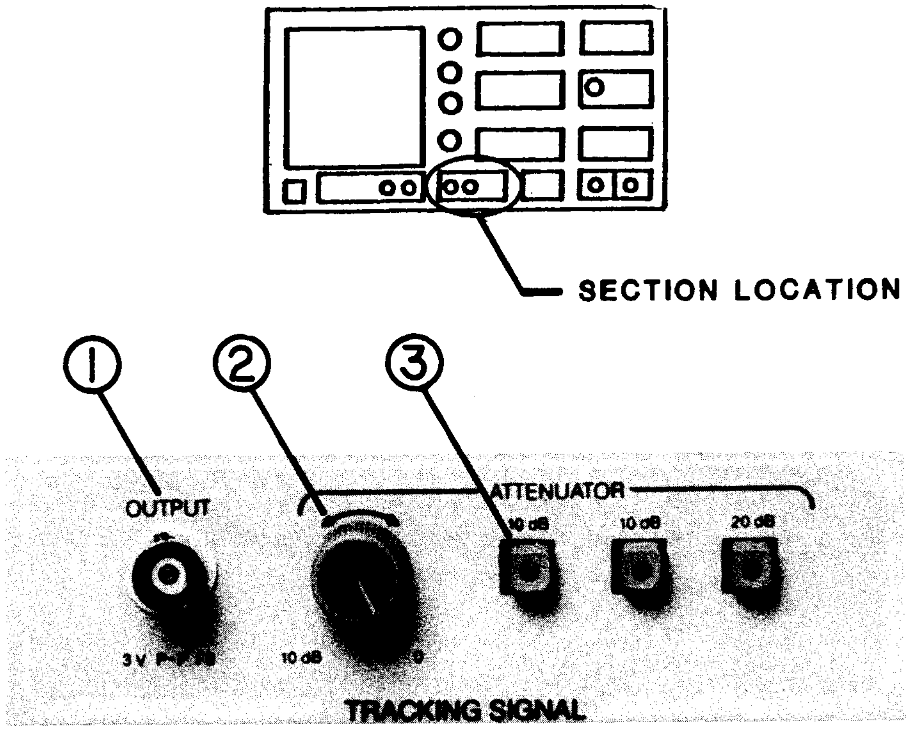


Fig. 3-7 Tracking Signal Generator

(1) Output BNC connector for connecting the tracking signal to the device under test. Max. output voltage is 3V, p-p.

(2) 0-10 dB vernier attenuator of tracking signal output amplitude.

(3) 40 dB attenuator of tracking signal output amplitude, in 10 dB steps.

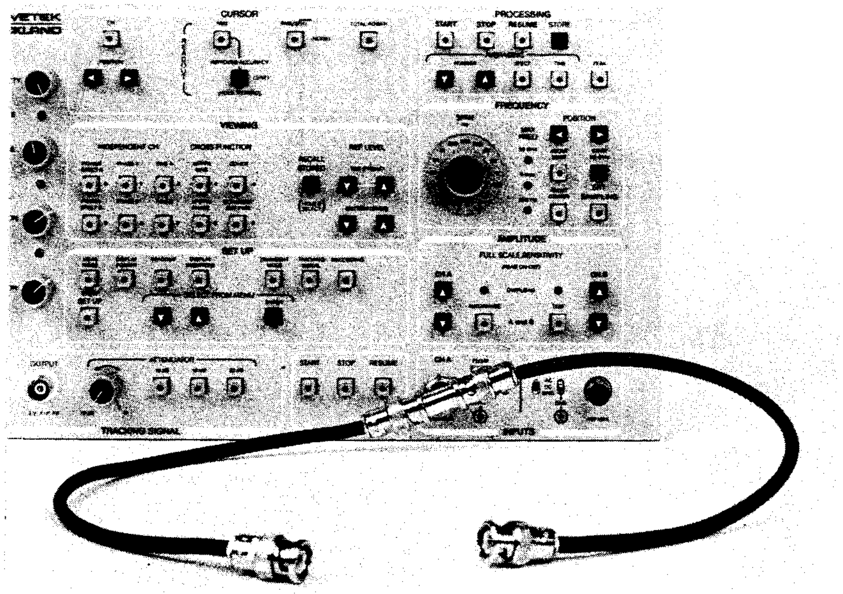


Fig. 3-7-1A

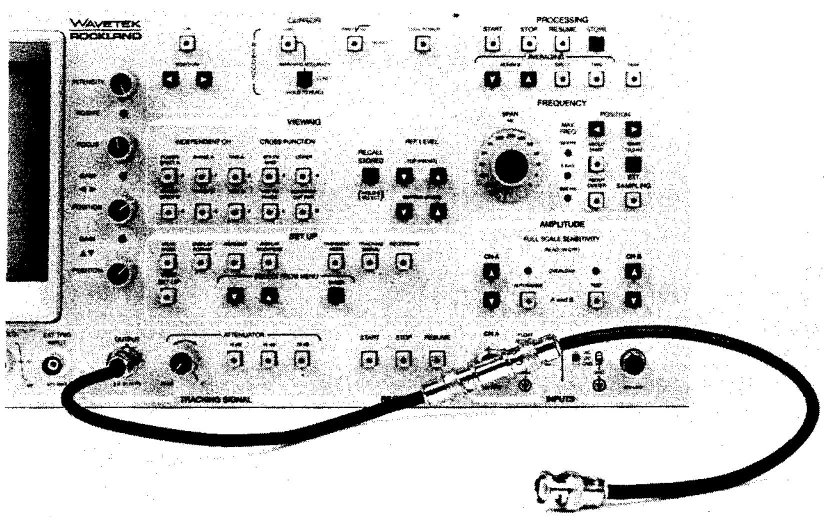


Fig. 3-7-1B

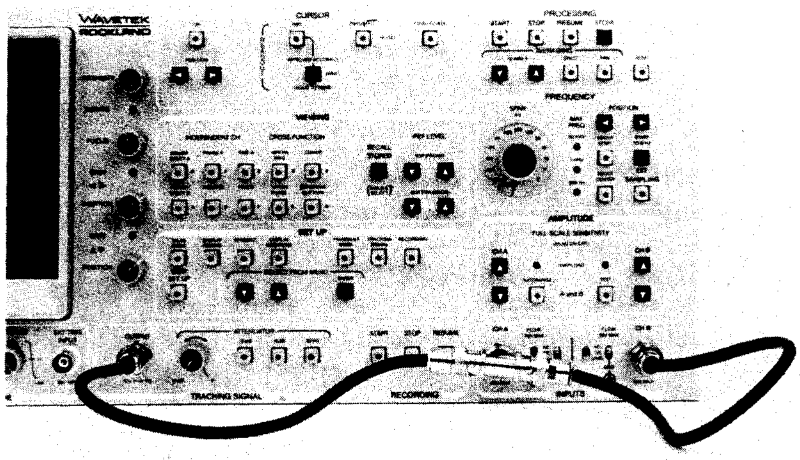


Fig. 3-7-1C

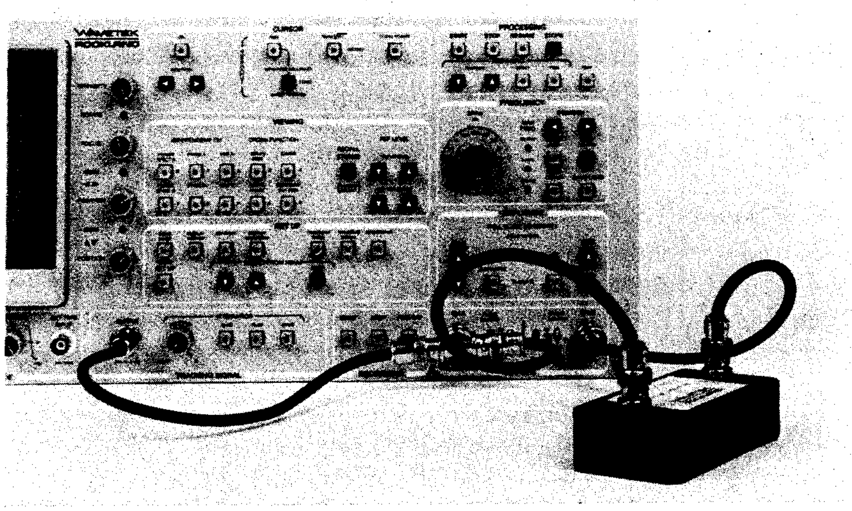


Fig. 3-7-1D

Figures 3-7-1 A,B,C,D Exercise with Noise

3-7-1. AN EXERCISE WITH NOISE

For this and all subsequent exercises, you'll need three short (about 1/3 meter) coaxial cables with BNC connectors, and one BNC "T" connector. The Instructional Exercise Module will be needed soon too.

A- For efficiency's sake, set the FREQUENCY SPAN dial for a Span value lK (lKHz) or larger. Smaller values can take a while to produce a display - something we'll explain in the FREQUENCY Section.

B- Set the coupling switch for both CH A and CH B on the INPUT Section to AC coupling and the FLOAT/GND switches to GND.

C- Connect two of the coaxial cables to the "T" connector and then the "T" connector to the CH A INPUT as shown in Figure 3-7-1, step A.

D- RESET the 5820A. Even if you don't yet have a good idea of how to interpret the two power spectra (CH A and CH B) graphs yet, you can see that they look rather quiet. They are, as we've noted earlier, because there is as yet no input signal.

E- Refering back to your work with the SET UP section, call up the menu to activate the TRACKING SIGNAL to produce NOISE. Take a look at the CRT graphic display. There should be nothing different yet.

F- Connect one of the pieces of coax to the OUTPUT BNC of the TRACKING SIGNAL section as shown in Figure 3-7-1B. Now you are feeding the Tracking Signal NOISE into the CH A input. Make sure all the Tracking Signal Attenuators are off.

That fluctuating trace which has just appeared on the upper CRT graph display comprises the line-segments joining the data points computed by the 5820A. The 5820A is using the time-domain Noise signal to compute the 201 power spectrum data points for each channel.

A more detailed review of the theory and engineering of this process will be found on pages 9-13 of SATIA.

G- Now connect the other coaxial cable to the CH B INPUT as in Figure 3-7-1C. The two graphs may be changing too rapidly for easy comparison. Try pressing the STOP key in the PROCESSING Section (refer to Section 3-10). Not surprisingly, the two waveforms look the same since they represent analyses of exactly the same signal.

H- Restart the processing of the Noise signal by pressing the START or RESUME key in the PROCESSING Section (refer to Section 3-10 to learn what the difference between START and RESUME is.)

I- To really make comparison of the two (CH A and CH B) waveforms easy, overlay the two graphs into one FULL Screen via the DISPLAY FORMAT "SCREEN" option (refer to Section 3-5-3). Because first one display and then the other is updated as processing continues, you see the two displays flashing almost together, but not quite in sync. STOP the processing again. They should be in exact congruence.

J- Restart processing and return the screen to SPLIT SCREEN mode.

3-7-2. A SUMMARY

So far you've learned a lot of basic set up procedures:

* POWERING UP (safely)

* RESETing to the predetermined Reset state; determining what that state is via the lit LEDs and the SET UP display.

* Location of controls; getting a good CRT image; a general understanding of the format of the CRT displays.

* Selecting certain display and other parameters by interaction through SET UP menus.

* Procedures and requirements for putting signals into the 5820A, including the TRACKING SIGNAL generated by the 5820A itself.

* Basic manipulation of the displays to position the graphs and the alphanumeric data in the most useful places.

* If you've read any of the supplemental SATIA material, you have a basis for understanding the

principles of digital frequency spectrum analysis.

* For the sake of producing illustrative effects, you've had a taste of operating some of the controls in almost all the other control panel sections. You're probably moving along very rapidly. We'll now move on to more advanced but still fundamental material.

3-8. FREQUENCY Span Settings

The FREQUENCY Section allows you to set the frequency range (span width and position) over which measurements will be performed. You can also cause the 5820A to be driven from an external sampling clock.

Refer to Figure 3-8 for a basic description of the operation of each control.

The 5820A implements 201 or 401 digital filters to analyze whatever signal(s) are presented to it. They are used 201 per channel when the 5820A is in the cross channel mode. In single channel mode, 401 filters are generally used for the one channel.

The nominal bandwidth (B, for "beta") of each filter depends on the frequency span being measured and the channel mode. Beta is also thought of as the spacing between filter centers.

Suppose you were making a single channel measurement of the full 0 to 50 KHz span. Each filter's B would be 125 Hz wide (50,000 Hz/400 = 125 Hz per filter).

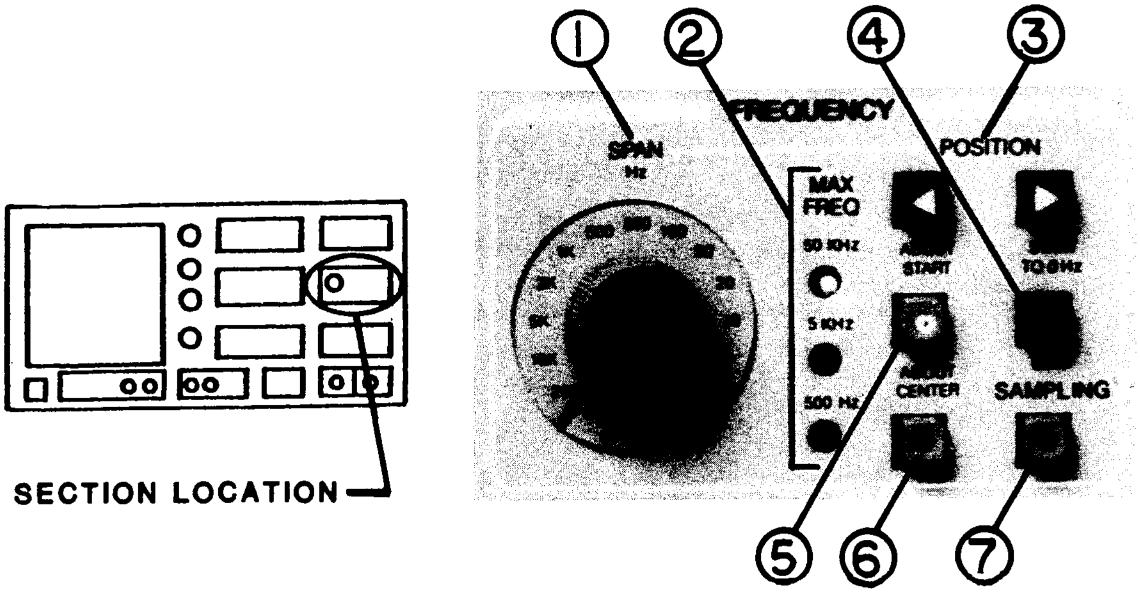


Fig. 3-8 Frequency Section

(1) The SPAN control specifies which portion of the input spectrum will be analyzed in all but the 50 KHz position; when set in this position, the entire 0-50 KHz spectrum is analyzed. The SPAN width is indicated on the CRT.

(2) The MAX FREQ indicators show the maximum frequency range that the selected SPAN can be positioned to cover.

(3) Moves the selected SPAN down ◀ or up ▶ throughout the available frequency range. When pressed and held, span position will move continuously; otherwise, position will move one step per keystroke.

(4) When momentarily pressed, it defines the selected SPAN to start at DC.

(5) When activated, the portion of the spectrum being viewed begins at a constant start frequency; its width is specified by the SPAN control.

(6) When activated, the portion of the spectrum being viewed is centered at a constant center frequency; its width is specified by the SPAN control.

(7) When activated, it selects external sampling control for digitizing input data. The external (TTL) signal must be applied through the BNC connector on the rear panel.

As another example, consider a cross channel (201 filters per channel) measurement of a 12.75 KHz to 14.75 KHz span (a total of 2 KHz wide). Each filter's B would be 10 Hz (2,000 Hz/200 = 10Hz per filter).

You should study the table of frequency span - bandwidth data in the Frequency specifications reproduced below. Especially note the maximum frequency restrictions. In Single-channel mode, the 2, 5, and 10 Hz spans are available on the 5820A to a maximum frequency of 500 Hz. The 20 and 50 Hz spans are available up to 5 KHz. In Cross-channel mode, the 2, 5, and 10 Hz spans are available to a maximum of 500 Hz. The 20, 50, and 100 Hz spans are available up to 5 KHz. One of the three green LEDs next to the Frequency Span dial will light to indicate what the maximum usable frequency span is for any particular setting. You will be able to position your span anywhere within the limits set by MAX. FREQUENCY.

	Single-channel		Dual- or Cross-channel	
SPAN	Calculated Line Spacing(β)	Cent/Start Resolution	Calculated Line Spacing(β)	Cent/Start Resolution
50 KHz	125 Hz	-	250 Hz	-
25 KHz	62.5 Hz	250 Hz	125 Hz	250 Hz
10 KHz	25 Hz	50 Hz	50 Hz	100 Hz
5 KHz	12.5 Hz	50 Hz	25 Hz	50 Hz
2 KHz	5 Hz	50 Hz	10 Hz	50 Hz
1 KHz	2.5 Hz	50 Hz	5 Hz	25 Hz
500 Hz	1.25 Hz	50 Hz	2.5 Hz	25 Hz
200 Hz	1.0 Hz	50 Hz	1.0 Hz	25 Hz
100 Hz	0.5 Hz	25 Hz	0.5 Hz	2.5 Hz
50 Hz	0.125 Hz	2.5 Hz	0.25 Hz	2.5 Hz
20 Hz	0.1 Hz	5.0 Hz	0.1 Hz	2.5 Hz
10 Hz	0.025 Hz	0.5 Hz	0.05 Hz	0.25 Hz
5 Hz	0.0125 Hz	0.5 Hz	0.025 Hz	0.25 Hz
2 Hz	0.01 Hz	0.5 Hz	0.01 Hz	0.25 Hz

In Single-Channel mode 2,5 and 10 Hz Spans are available to a maximum frequency of 500 Hz; 20 and 50 Hz Spans are available up to 5 KHz. In Dual or Cross-Channel mode, 2,5 and 10 Spans are available to a maximum frequency of 500 Hz; 20, 50 and 100 Hz Spans are available up to 5 KHz. In all cases, the maximum usable frequency is indicated on the front panel.

Table 3-8-1 Frequency Span-Resolution-Span Settability

The alphanumeric data associated with each CRT display graph will always tell you both the span start (low) and end (high) frequencies and the B(beta)andwidth of the filters. Refer to Figure 3-3-C,D (CRT display illustrations).

Look to pages 21-22 of SATIA for a supplementary discussion of Frequency Measurements topics. Note also that by using menus presented by the READOUT key (see Section 3-5-4), you can recalibrate the frequency axis to engineering units other than Hertz.

3-8-1. Exercises

Exercise #1

A- Set the FREQUENCY SPAN to 50K. Press RESET. the "ABOUT CENTER" LED should be ON right now.

B- Set up the 5820A in single channel mode with Max Span in the background (if necessary, refer to Sections 3-5-2 and 3-5-3) on Channel A.

C- Feed a NOISE signal to Channel A (refer to Section 3-7-1 if necessary). Observe the CRT, especially the SPAN and B (beta) values.

D- Notice that just to the left of the B (beta) on the CRT are the characters "N: NONE". This has to do with the number of spectra averaged together for display (more about that later in Section 3-11-2 and on pages 15-17 of SATIA).

Locate the PROCESSING section controls. While watching the place where the word "NONE" is on the CRT, press the rightmost black NUMBER key (the "up" arrow) twice, pausing after the first time to note the effect (if necessary, refer to Section 3-10 for more detail).

Take a moment, if you'd like, to experiment with the AVERAGING NUMBERs keys. However, "N: 4" will be sufficient for our purposes here (that is, to have a reasonably smooth plot to look at).

E- Begin turning the FREQUENCY SPAN dial clockwise one position at a time to select narrower span widths. This is known as "zooming in" on the frequencies.

Pause until the graphical display has a chance to change.

Look closely at the CRT display. Notice that as soon as you made your first change, the 5820A automatically drew a display both for the span you selected (uppermost), and for the full 0 to 50 KHz range. Also, on the lower full screen display, the brighter portion of the trace represents the span being displayed in "close-up" on the upper plot.

Displaying both the selected span and the full range span in single channel mode is a regular feature of the 5820A.

As you step downward through smaller and smaller spans, you'll see three things:

1- The upper plot of the selected span always is flat (constant average energy per bandwidth) across the range. However, the 0 to 50KHz plot reveals that the Noise generator output changes considerably with each span change. Generating approximately constant energy output per bandwidth only in the span under observation maximizes the dynamic range of the 5820A.

2- As the span width becomes smaller, the time for a new plot to appear and to be subsequently updated takes an increasing amount of time. This is because the minimum time interval, T, for which a digital bank-of-filters must be exposed to the time-domain signal is related to the filter bandwidth, B, by the formula:

$$T = 1/B \text{ (seconds, Hertz)}$$

This phenomenon is true for all digital bank-of-filter instruments. Refer to page 6 of S.A.T.I.A. for a more detailed theoretical explanation.

3- The span selected has always stayed centered around 25KHz. That's because the 5820A is in the ABOUT CENTER mode and was started in the 0 to 50 KHz range - whose center is 25KHz.

Exercise #2

Set up as for Exercise #1; review the function of the FREQUENCY POSITION control keys in Figure 3-8. Then:

A- Set SPAN to 50K; then to 25K. Notice that the Span range starts at 12.500KHz (to 37.500KHz, a total of 25KHz).

B- Press the ABOUT START key in the FREQUENCY Section. Now begin turning the SPAN selection dial through different spans. Notice that, down to 100 Hz, they all produce spans which begin at 12.500KHz.

At 50 Hz, Span Start drops to 625 Hz and the 5 KHz MAX FREQ LED lights. Recall that the Frequency specifications stated certain restrictions of span availability. This is an example.

You can change the span starting position to zero (0) at any time simply by pressing the black START TO 0 HZ key. If you're already in the ABOUT START mode, subsequent span selections will, of course, all have 0 as their start frequency.

If, when you press START TO 0 HZ, the 5820A is in the ABOUT CENTER mode, subsequent frequency selections will be centered about the midpoint of 0 and the span size when the key was pressed. For example, if the span size is 25K and the 5820A is in the ABOUT CENTER mode when you press the START TO 0 HZ key, the new center will be at 25,000/2 or 12.500 KHz. If that's at all unclear, experiment a little. The 5820A provides a great deal of flexibility.

Exercise #3

This exercise will present several new concepts and procedures. Only one, the use of the FREQUENCY SPAN POSITION control, will be directly related to the FREQUENCY Section. The others will involve being able to measure POWER AMPLITUDE at a particular frequency.

For this exercise, you'll need the Instructional Exercise Module (IEM). This circuit is a very simple 10 KHz (approx.) notch filter.

A- Set up the 5820A to input the Tracking

Signal NOISE directly into CH A and through the IEM into CH B. Refer to Figure 3-7-1D.

B- Set up to read the signals in Cross Channel and Split Screen mode. Press the POWER SPECT B key in the VIEWING Section if it is not already lit (activated).

C- As you did in Exercise #1, increase the PROCESSING AVERAGING to N= 4. This will make the traces much easier to read for this exercise. The CRT display should appear as it does in Figure 3-8-1.

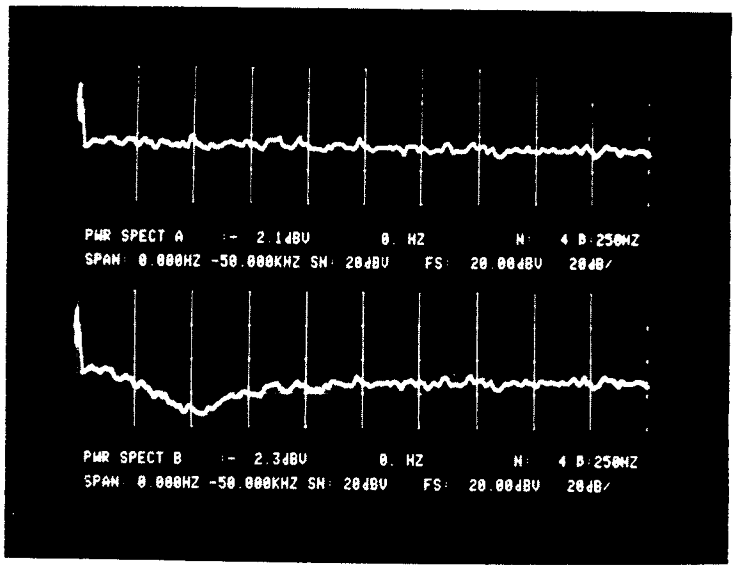


Fig. 3-8-1 Input-Output Power Spectra to IEM

Power spectrum A shows the typical flat trace of the Tracking Signal generator.

Power Spectrum B shows a pronounced "dip". Whether in linear or logarithmic frequency axis scale (it's in linear right now, but you might want to use the the DISPLAY FORMAT menu to see a logarithmic display for a moment), the frequency (horizontal, X-) axis always has ten divisions. To determine the frequency of the "dip" caused by the filter, you could simply count over the two divisions, note that on the 50K scale, each division equals 5K (division size = SPAN SIZE/10), and thereby conclude that the circuitry of the IEM is sharply attenuating the signal at 10KHz.

A more convenient and accurate method is to use the CURSOR.

D- First, locate the CURSOR section of control and examine the two black-with-white-arrowheads POSITION keys. When you press either one, you'll see the Cursor, a short, bright, vertical line, move across the CRT traces. Press the appropriate (left or right movement) CURSOR POSITION key until the moving CURSOR is positioned at the lowest point on the B power spectrum.

You may have noticed that when you "jogged" the cursor position keys, the cursor moved in increments of 1 Beta (one bandwidth). When you held the cursor key, the cursor moved continuously. That is characteristic of the Cursor's action.

As you pressed the Cursor Position key(s), you should have seen two alphanumeric data fields go to reverse video: Cursor Amplitude (leftmost) and Cursor Frequency (rightmost). If all the attenuators (including the vernier knob) in the TRACKING SIGNAL output section are off (or zeroed), the power amplitude across the CH A power spectrum should be around -25 to -30 dBV.

Positioning the Cursor at the lowest visible part of the CH B power spectrum, you should see that its frequency (look at the alphanumeric data) is at or very near 10KHz and that its power amplitude is considerably lower than that shown for the unfiltered

CH A signal. Make a note of the amplitude value for a later comparison.

We will wait until we come to the AMPLITUDE Section (3-9) before talking more quantitatively about the amplitude of the CH B spectrum. In that section, you'll also learn how to change the sensitivity of the 5820A, revealing lower level signal components. For now, one more thing about basic FREQUENCY Section controls - positioning the frequency span.

Exercise #4

A- Leave the 5820A set up exactly as it was in Exercise #3. Press the START TO 0 HZ and the ABOUT START keys to eliminate any effects from your experimentation at the end of exercise #3.

In analyzing the performance of the IEM you might like to look more closely at the frequency range around the amplitude notch it induces. There are several different procedures you could use but all involve repositioning (or "Range Translating" as it's also known) the Span. Here is one approach.

B- Turn the Span dial to 25K. By coincidence in this example, that put the area of interest close to the center of the CH B TRACE. Note that, because the 5820A is in the ABOUT START frequency positioning mode, the span range is now 0 to 25KHz.

C- Press the ABOUT CENTER key and set the SPAN for 5K. Now the span is 5K wide - from 10K to 15K - centered on 12.5K (recall the earlier exercises).

D- To center this span around the 10KHz mark, press the left-arrow black FREQUENCY POSITION key. It operates very much like the CURSOR controls except that the span range changes instead of the cursor location.

You can rapidly move and then "jog" the range to be precisely centered on 10KHZ - THE RANGE OF 7.5000KHz - 12.5000KHz. Because the 5820A is now in the ABOUT CENTER mode, each time you change the span dial to a smaller span, it will be centered on 10KHz. Try it.

You could repeat Exercise #1, and see the brighter part of the 50K span display "move" along it as you change the position of the narrower portion of the span with the Position keys.

If you're just learning about the 5820A, you may be wondering what to do to see the lower-level signal component seemingly "squashed" against the bottom of the trace. You can proceed directly to AMPLITUDE Settings, Section 3-9, which comes next after the following discussion of the EXTERNAL SAMPLING key's use, a somewhat more advanced topic.

3-8-2. EXTERNAL SAMPLING

The EXTERNAL SAMPLING key, when activated, selects external sampling contol for digitizing input data. It determines whether the 5820A's internal clock or an external clock will control the collection of input data. Normally, the internal clock is used. However an external clock can be used to normalize the frequency axis to another parameter. This capability is particularly useful in machine vibration analysis.

The external clock signal applied through the rear panel, is split into 2 clocks, each at half the frequency of the external clock and each used to control a different channel.

Another useful example is the reduction of the effects of flutter on data analyzed from analog tape recorders. If a stable 50 KHz tone is recorded on one channel of the recorder as data is recorded on another, then the 50 KHz tone can be used as an external clock, corresponding to 25 KHz sampling rate per input channel. This will permit spectrum analysis up to 10 KHz bandwidth. At the same time, flutter effects will be eliminated because, as the tape speed varies, its effect is the same on the data and the sampling clock.

The span settings determine the frequency resolution in the same manner as for internal sampling. Span settings below 200 Hz for dual channel operation and below 100 Hz for single-channel operation are not permitted.

The cursor frequency readout is calibrated in units of FR, where the external sample clock frequency equals 1024 FR units. The span settings determine the degree of frequency expansion or "zoom" performed on the input data. The maximum span of 50 KHz ("no zoom") corresponds to a frequency range of 0 to 400 FR. If a specific narrower span is desired, then the span width and position may be selected accordingly. Table 3-8-2, Column A, shows the span in FR units for a given setting of the front panel SPAN knob. Column B shows the number of frequency points displayed for each span setting. The frequency resolution equals the span divided by the number of frequency points as shown in Column C.

The external sampling clock is supplied to the 5820A using the rear panel BNC jack marked "EXT SAMPLING CLOCK IN (TTL)" or pin 1 of the "REMOTE DATA IN" CONNECTOR.

The external sampling clock must be a TTL signal capable of driving 2 standard TTL loads. The active edge is the negative-going edge and duty cycle is not critical; however, the minimum pulse width at high or low logic levels is 100 nsec.

The maximum frequency of the external sampling clock is 220 KHz. In dual channel operation, the effective sampling rate is one-half of the external sampling clock frequency. In single-channel operation, the sampling rate equals the external sample clock frequency with one exception: in the 50 KHz span, two external sample clock pulses are required for each data sample. Table 3-8-2, Column D shows the effective sampling rate for a maximum external clock frequency of 220 KHz. Note that the readout expressed in FR units is always relative to the frequency of the external sample clock frequency (not the effective sampling rate) where the external sample clock frequency equals 1024 FR units.

There is no lower frequency limit for the external sampling clock; however, care must be taken to avoid violation of the Nyquist criterion (see pages 10-11 of SATIA): the frequency bandwidth of input signal cannot exceed one-half of the effective sampling rate.

The 50 KHz lowpass filter present in the input stage of the 5820A will help bandlimit the input signal sufficiently in most cases where the external sampling clock is at its maximum frequency of 220 KHz. If there are any signals present above 66 KHz, they can alias into the displayed spectrum. However, the 50 KHz filter will attenuate the aliased signals. At 66KHz, aliased signals are attenuated at least 32 dB improving to 70 dB attenuation above 78 KHz.

If a lower sampling frequency is used then a filter is needed before the signal is applied to either channel. For a fixed filter with fast rolloff, set the cutoff at about 0.4 times the lowest sampling frequency. If the sampling rate varies over a wide range, then a filter whose cutoff tracks the sampling frequency is recommended.

TABLE 3-8-2 "FREQUENCY" READOUT IN EXTERNAL SAMPLING

A) CROSS CHANNEL

	A	B	C	D
SPAN SETTING	SPAN IN FR UNITS	FREQ POINTS	FREQ RESOLUTION FR UNITS	EFFECTIVE SAMPLING RATE FOR EXT CLOCK = 220 KHZ
50K	400	200	2	110 KHZ
25K	200	200	1	110
10K	80	200	0.4	110
5K	40	200	0.2	110
2K	16	200	0.08	110
1K	8	200	0.04	110
500	4	200	0.02	110
200	1.6	200	0.008	110

B) SINGLE CHANNEL

50K	400	400	1	110
25K	200	400	0.5	220
10K	80	400	0.2	220
4K	40	400	0.1	220
2K	16	400	0.04	220
1K	8	400	0.02	220
500	4	400	0.01	220
200	1.6	200	0.008	220
100	0.8	200	0.004	220

3-9. AMPLITUDE Settings

On the CRT display, "SN", Full Scale Sensitivity, refers to the maximum signal level the 5820A can accept without overloading. On LOG scale, the absolute maximum for the 5820A is +20 dBV. You can adjust it down to -70 dBV. In LINEAR scale, the maximum level can be set from an absolute maximum of 10 Volts down to 320 microvolts.

The 5820A has a finite amplitude dynamic range. The weakest signal the instrument can distinguish is between 70 and 90 dB lower than the full scale sensitivity, depending on Span size. Response is spurious-free to better than -70 dB below full-scale. This means, for example, that if full scale sensitivity were set at, say, 10 dBV, you could distinguish signals at least as weak as -70 dBV.

The AMPLITUDE Section control keys enable you to set full scale sensitivity. You can more precisely match full scale sensitivity to the actual signal levels, either manually (in 1 dBv steps log scale or 1% linear steps) or automatically. Indicators in the section also provide for overload indication.

It is also possible to adjust the sensitivity automatically by pressing the AUTORANGE key. When this key is pressed, the sensitivity of the two channels is changed, in 10 dB steps, to the highest possible value that does not cause an Overload. It should be noted that the two channels are treated independently and, therefore, one channel may converge to its final value much before the other one. In single channel mode, only the selected channel is adjusted. Once the optimum level is reached, Autoranging stops to allow the Averaging of spectra. The AUTORANGE LED stays on and the Autoranging function is repeated wheneve a Start of Averaging is performed.

The control key for connection and display of the internal test signal is also located here. You may have used that key and the test signal in Section 3-5-1B to check the proper operation of the 5820A in general and the CRT in particular.

Refer to figure 3-9 for a basic explanation of the function of each control.

The specifications for this section are reproduced below.

A discussion of Amplitude-axis Parameters, especially of the most commonly used units (Volts, Volts Squared, dBV) may be found on pages 24-25 of SATIA.

3-9-1. OVERLOADING

It is good operating practice to set the sensitivity of each channel so that the OVERLOAD light just begins to come on. Then reduce the sensitivity until the light extinguishes or only occasionally flickers.

Occasional overloads will not freeze processing; the 5820A will simply ignore (not process) the overloading data block. Therefore, valid measurements can be made in the presence of overloads.

When an Overload condition exists continuously for more than 3.5 secs or 10 consecutive Data Blocks contain an Overload, the message CONT OVLD is printed in reverse video on the Status line (third line from the bottom of the screen). The message stays on, even if the Overload condition no longer exists, until the Averager is restarted or the cursor is moved. The message only means that a significant number of data blocks were not processed. It does NOT mean that processing has stopped or that the data presented are invalid.

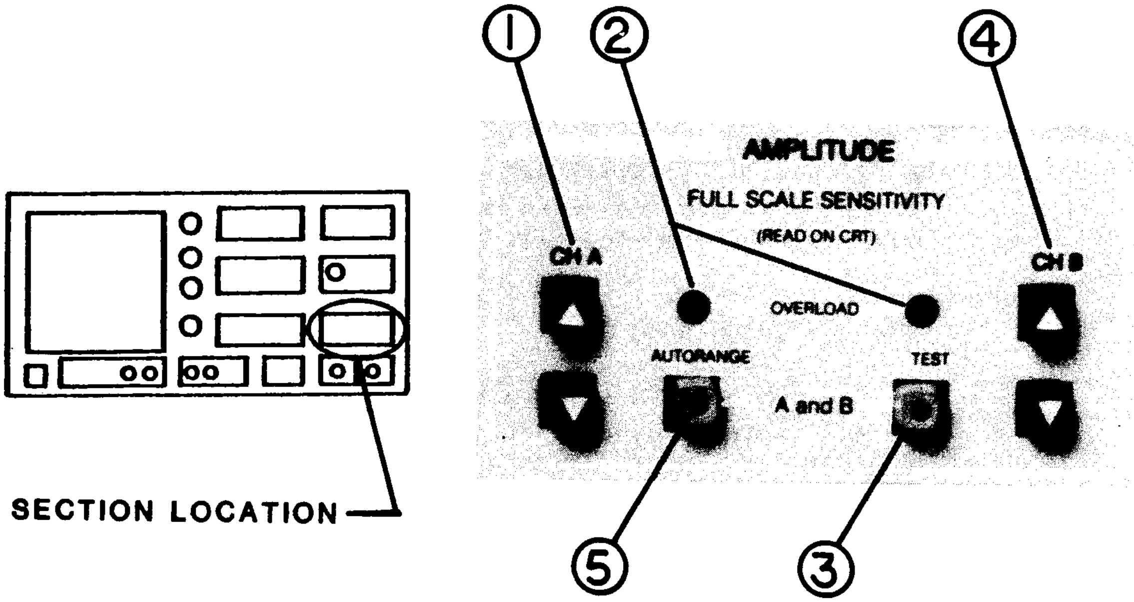


Fig. 3-9 Amplitude Section

(1) Allows for increasing ▲ or decreasing ▼ full scale sensitivity of Channel A. When pressed and held sensitivity will advance in steps of 10 dB; otherwise, sensitivity will advance in steps of 1 dB per keystroke. Full-scale sensitivity is indicated on the CRT.

(2) Independent overload indicators for each channel. Overload occurs when input level exceeds full scale. Reduce corresponding channel sensitivity until OVERLOAD light extinguishes, or flashes only occasionally. Occasional overload will only prevent processing of the particular data block which caused the overload; the remaining data blocks will be processed properly. When an overload lasts more than a predetermined length of time, the statement (CONT OVLD) appears on the CRT. It is only a message that a significant number of data blocks were not processed. It does not mean that processing has been stopped.

(3) When activated, an internally generated test signal is applied to both channels, to provide a quick indication of proper instrument operation.

(4) Allows for increasing ▲ or decreasing ▼ full scale sensitivity of Channel B. When pressed and held sensitivity will advance in steps of 10 dB; otherwise, sensitivity will advance in steps of 1 dB per keystroke. Full-Scale sensitivity is indicated on the CRT.

(5) When activated, full-scale sensitivity of both channels wil be automatically selected to be at the maximum allowable levels to prevent overloads. Any data block which causes an overload will not be processed. In this mode, full-scale sensitivity is changed in 10 dB steps only.

3-9-2. Exercises

Exercise #1

With the 5820A set up as in Exercise #4 of the previous section (3-8-2), use the AMPLITUDE SENSITIVITY controls to fully reveal the bottom of the trace produced at 10KHZ by the notch filter.

Set the amplitude sensitivity to just before overload as described above. Notice what alphanumeric display values change and the effect on the position and definition of the trace. Use the Cursor to measure the amplitude of the low point on the CH B(notch filter) trace. Compare it with the value obtained in Section 3-8-1, Exercise #3.

Exercise #2

Use the Tracking Signal attenuator keys and vernier to lower the tracking signal level (do it in 10dB steps). Use the Amplitude Sensitivity keys to keep sensitivity at the right level to reveal the signal without overloading. Measure the amplitude low point each time. Does the overall attenuation match the attenuators settings ? Is the filter-induced attenuation constant over the signal input range? (should be "yes" to both questions).

Exercise #3

Try changing the amplitude display range (see DISPLAY FORMAT Section 3-5-3). Note that the scale range has no effect on the signal or the sensitivity of the 5820A (no overloading or "SN" differences). Only the "height" of the vertical display scale is modified to allow you to "zoom-in" or "zoom-out" on a portion of the amplitude range. The range you set here is analogous to the Frequency SPAN width setting for the Frequency axis.

Exercise #4

There are four keys - black with white arrows - in the VIEWING Section. They're labeled REF LEVEL and they are for each channel's amplitude very much like the SPAN position keys in the FREQUENCY Section. Their use does not change sensitivity but rather positions the display "window" selected as the amplitude display range. You can position it anywhere from the current maximum full-scale sensitivity to 80 dB lower.

Experiment with these keys to "move" the displays up and down. Notice that alphanumeric data changes and what stays the same.

3-10. The CURSOR

The CURSOR is a brightness-intensified marker which can be positioned anywhere along the CRT graphic trace(s). Its Frequency position (i.e., position on the X-axis) and the Amplitude (i.e., Y-axis) value at that frequency are displayed in the alphanumeric data area whenever the CURSOR is turned ON.

Refer to Figure 3-10 for a basic explanation of the function of each control in the CURSOR Section.

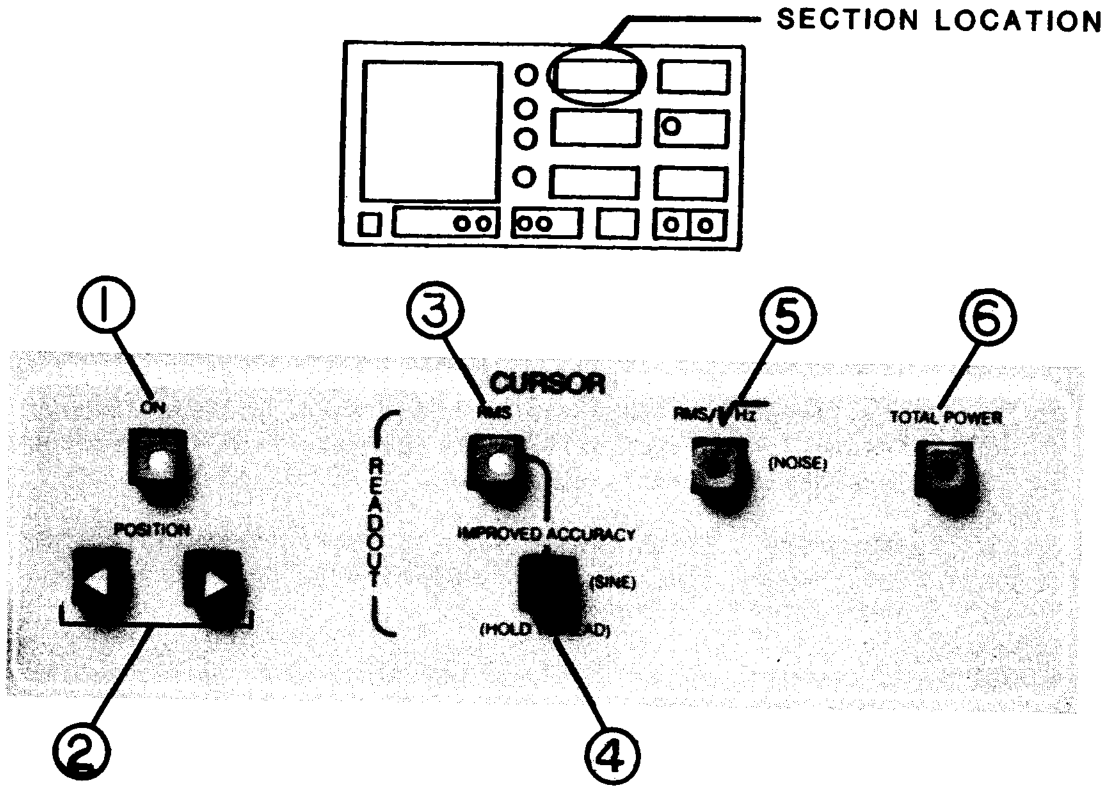


Fig. 3-10 Cursor Section

(1) When activated, it turns on the cursor and its corresponding readouts.

(2) Allows for moving cursor left ◀ or right ▶ throughout the display. Pressing and holding down either key will cause the cursor to move continuously; otherwise, the cursor will move one frequency or time cell per keystroke. When the cursor has been moved to either end of the display, the next keystroke will position it at the opposite end of the display (wrap-around feature).

(3) When activated, the cursor amplitude readout is in RMS units. Use this for measuring discrete line spectra, or time waveforms.

(4) When pressed and held, it increases the accuracy of amplitude and frequency readouts when measuring discret line spectra.

(5) When activated the cursor amplitude readout is power spectral density (RMS value per unit bandwidth). Use this for measuring noise spectra.

(6) When activated, the cursor amplitude readout is equal to the total power in the frequency span being used excluding DC.

Figure 3-4-1 show where the CURSOR frequency position and amplitude value are displayed.

3-10-1. RMS/ $\sqrt{Hz}$ and TOTAL POWER

With normal RMS measurements, you obtain a reading of power amplitude as if you had a true-RMS voltmeter at the output of each bandwidth filter. When comparing spectra using filters of the same bandwidth, straightforward comparisons can be made. However, it is often useful to be able to normalize results to compare spectra measured with different filter bandwidths. The RMS/ $\sqrt{Hz}$ key provides that normalized measure called, also, spectral density. The amplitude value obtained is as if all measurements had been made with filters having a 1 Hz bandwidth.

Exercise #1

A- Set up the 5820A in split-screen, maximum span in background, Channel A only mode. Set SPAN to 10K. Use the SPAN POSITION keys to move SPAN start to 20 KHz. Feed the tracking signal noise to Channel A. As usual, adjust sensitivity for non-overloading results. Set averaging for 8 samples.

As we've pointed out before, the 10KHz trace will be flat (constant power per filter) while the 50K trace will show a sharp drop of power distribution outside the span under observation. The tracking signal generator is designed to modify the noise signal to put the same power into the span under observation regardless of its width. The 50K trace is the total modifed signal.

B- Position the cursor at the center of the screen (25K) so that you are reading the same frequency on both traces. You'll see that the RMS amplitude readings are very different: power per filter is higher in the 50K trace. Note, however, that Beta (bandwidth) is 125 Hz for the 50K trace and only 25 Hz for the 10K trace.

C- Press the RMS/ $\sqrt{Hz}$ key. The power per Hz should be about the same for each of the traces across the span under observation. The RMS/ $\sqrt{Hz}$ function has normalized the two traces, eliminating the effect of observing different filter bandwidths.

Exercise #2

We've been talking about the power output of the tracking signal generator being constant regardless of the width of the span under observation. You can measure the total power within a span using the TOTAL POWER key.

A- Set the 5820A into single channel Channel A mode. Set SPAN to 25K and continue feeding the tracking signal noise as the input. Set Averaging N to 8. Properly adjust sensitivity.

B- Press the TOTAL POWER key and record the power content of the 50K span (lower trace) and the narrower span (upper trace) as you turn the SPAN dial to narrower widths. You should see that both remain at fairly constant values. Most of the power of the signal is concentrated into the span under observation. If you take an RMS/ $\sqrt{Hz}$ reading for each span setting, you'll clearly see that more power is being "packed in" per Hertz within the span under observation.

See pages 27 and 28 of SATIA for a more detailed discussion of these topics.

3-10-2. IMPROVED ACCURACY

Digital Spectrum Analyzers usually do not make accurate amplitude and frequency measurements of periodic signals which produce discrete line spectra. This is due to the so-called "picket fence" effect wherein the frequency to be measured happens to fall between two adjacent digital filters. Filters are not perfectly rectangular in shape; therefore, frequencies lying off-center of the filter bandwidth do not have their amplitude accurately measured.

The 5820A implements a unique computational process to correct this inaccuracy by better than a factor of 10. You should only use the IMPROVED ACCURACY key when making PERIODIC signal measurements!

Exercise #3

When you activate the TEST key in the AMPLITUDE Section, a test signal is output to both channels. The signal is a periodic random noise signal producing a series of discrete line spectra with a nominal amplitude of -26 dBV. The fundamental of that series is 1001.9569 Hz.

A- Set the 5820A into single Channel A mode. Set the SPAN dial for 50K. Set the cursor to read in RMS. Activate the TEST key.

B- Use the cursor to find the 48th harmonic's peak (spectral line). It should occur at the 48.125 KHz position. Take note of the amplitude.

C- Press the IMPROVED ACCURACY key. For the 48th harmonic, you should instead obtain a frequency reading of around 48.093 KHz, much closer to the true value of 48 X 1001.9596 Hz (48.0938312 Hz, to be exact). The IMPROVED ACCURACY key function of the 5820A will always improve the accuracy of discrete line spectra measurements.

3-11. PROCESSING Modes

The controls in this section allow you to select spectrum or time averaging. The number of averages, N, can be specified here. Starting and stopping the processing of data and its storage for comparison with subsequent calculations also are features of this section.

The captions in Figure 3-11 describe the function and operation of each of the control keys.

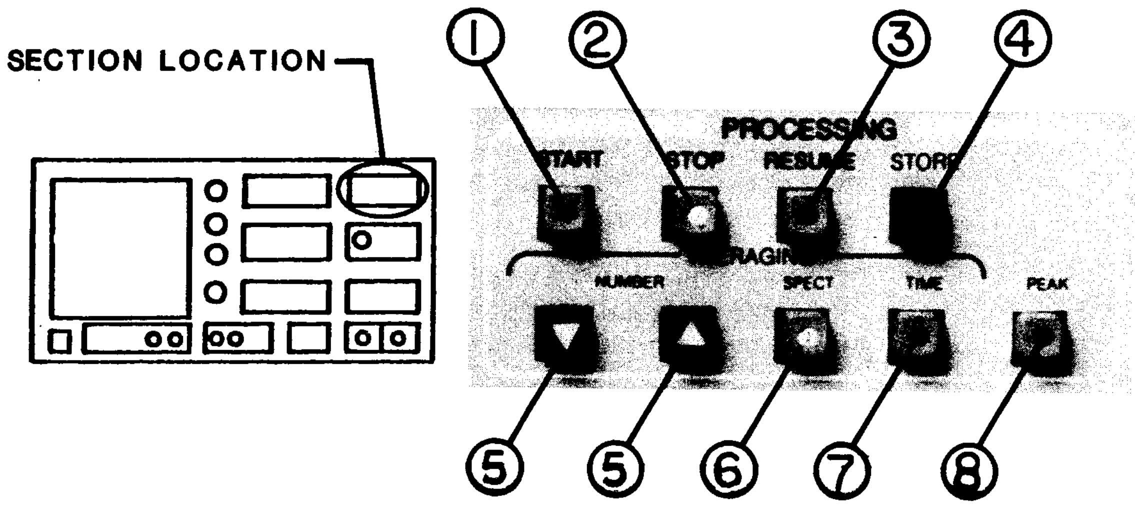


Fig. 3-11 Processing Section

(1) When activated, it clears the memory and starts the selected processing.

(2) When activated, it halts the processing.

(3) When activated, it restarts the selected processing without clearing the memory.

(4) When momentarily pressed, it will cause fundamental measurements and associated calibration data to be stored for later recall (see VIEWING) and comparison. For example, in cross-channel mode, calibrated power spectra A and B and cross spectrum AB will be stored, from which transfer function, coherence and coherent output power are derived. The word STORING appears on the CRT.

(5) Allows for increasing ▲ or decreasing ▼ the number of averages from 0 thru 256 in binary steps. The number of averages is shown on the CRT.

(6) When activated, it selects ensemble averaging of spectral measuremens.

(7) When activated, it selects ensemble averaging of the time function in either Channel A or Channel B (not both). Time averaging requires processing to be initiated by a trigger signal (see Transient Mode). The time function that is averaged corresponds to the output of a bandpass filter, whose bandwidth is equal to the SPAN setting, and center or start frequency as set by the POSITION setting (see FREQUENCY section). The spectrum amplitude and phase of the averaged time function is also calculated and it may be displayed, if selected (see VIEWING).

(8) When activated, PEAK causes the averager to store the maximum value at each frequency or time cell over the ensemble of data blocks being processed.

NOTE:

The number of averages selected is equivalent to the time constant of an exponential averager.

When the START Key is pressed, linear averaging is initiated (START Key light flashes). When the number of averages selected is reached, averaging becomes exponential (START Key stays on).

When the STORE key is pressed, all data needed to compute Power Spectrum A and B, and cross-spectrum AB, plus the front panel settings of Span and Sensitivity are retained in a special memory area. From this information, transfer function magnitude and phase, coherent output power and coherence may be calculated. These functions can be recalled later for comparative purposes. The use of STORE-ing and RECALL is demonstrated in exercises in Section 3-12-3.

3-11-1. About Averaging.

Very few repetitive signals are perfectly "steady" and free from both random and systematic anomalies. Unfortunately, the random components that appear in a sequence of instantaneous spectra may actually obscure the characteristic spectrum of the signal. If perturbations in the amplitude of a bandwidth filter output represent low-frequency random "noise" in the original signal, averaging the values of amplitude sequentially over several spectra will tend to tell us what the "true" or characteristic signal spectrum underlying the random variations of noise looks like.

The 5820A offers two modes of true averaging, SPECTRAL and TIME and a special PEAK measurement mode.

1- SPECT (Spectral) averaging is exponential when the measurement is in free-run (i.e., not triggered/transient mode). In that case the newest spectral data is weighted in the averaging process so that the most recent data has a larger influence on the average than it would if it were just another of the N samples in the series.

When SPECTRAL averaging is undertaken in the triggered/transient mode, averaging is linear. That is pure arithmetic averaging of the form:

Avg. = sum of sample values/number of samples, N

Exercise # 1 in section 3-8-2 used spectral averaging to smooth and display the characteristic signal being output by the notch filter that was greatly obscured by the noise variations of the Tracking Signal that was serving as the input to the filter.

2- TIME Averaging allows one to average transient signals. THE TIME DOMAIN SIGNAL (RATHER THAN THE SPECTRA) ARE AVERAGED POINT BY POINT. The averaging is initiated by a trigger signal. The principle application is to enhance the measurement signal/noise ratio of a recurring event that is synchronous with a trigger.

Take, for example, measurement of car engine knock which is synchronous with engine firing. This is a very noisy signal occurring in sync with a trigger. If you were to average, say, 256 triggered signals together, the S/N ratio will be improved by the square root of 256 = 16. Because this is a triggered measurement, it is conducted in the Transient Mode. See TRANSIENT MODE Operations, Section 3-13.

Processing time is minimized by viewing time, instead of spectrum, until the time averaging is complete.

3- PEAK Mode: this is not true averaging. In this mode, the averager stores the maximum value at each frequency or time cell. It is useful for signal drift measurement, etc.

Pages 15-17 of SATIA discuss Linear, Exponential (the two SPECTRAL modes), and Peak averaging while pages 17-20 cover the averaging of transient spectra.

3-12. VIEWING Measurements

It is through the keys of the VIEWING Section that you actually select which measurements are to be displayed:

POWER SPECTRUM on CHANNELS A and B*
PHASE SPECTRA on CH A and B*
TIME DOMAIN OF CH A and B signals*
TRANSFER FUNCTION MAGNITUDE and PHASE**
COHERENCE FUNCTION**
COHERENT OUTPUT POWER**

* Selected channel must be activated via MEASUREMENT MODE menu.

** Both channels must be activated for input.

A previously STOREd function can be recalled and then compared (difference) or equalized (ratio) with a newly selected function.

In conjunction with selections made via the SET UP section's DISPLAY FORMAT menu, the subject matter and the format of its presentation on the CRT are specified in the VIEWING Section.

The sequence in which keys are depressed defines the arrangement of the function's display. As long as the appropriate inputs (i.e., Channel A, Channel B, or both) are turned on, the trace of any two functions may be displayed simultaneously; pressing a key activates the corresponding display while pressing again erases it. Pressing a third key when two others are activated will cause the first activated of the two to be de-activated. The most recently activated entry will always be the top trace in a split-screen display, or the "front" (brighter) trace in a full-screen display.

This section also provides for display gain or attenuation.

Review the caption in Figure 3-12 for an explanation of the function of each key.

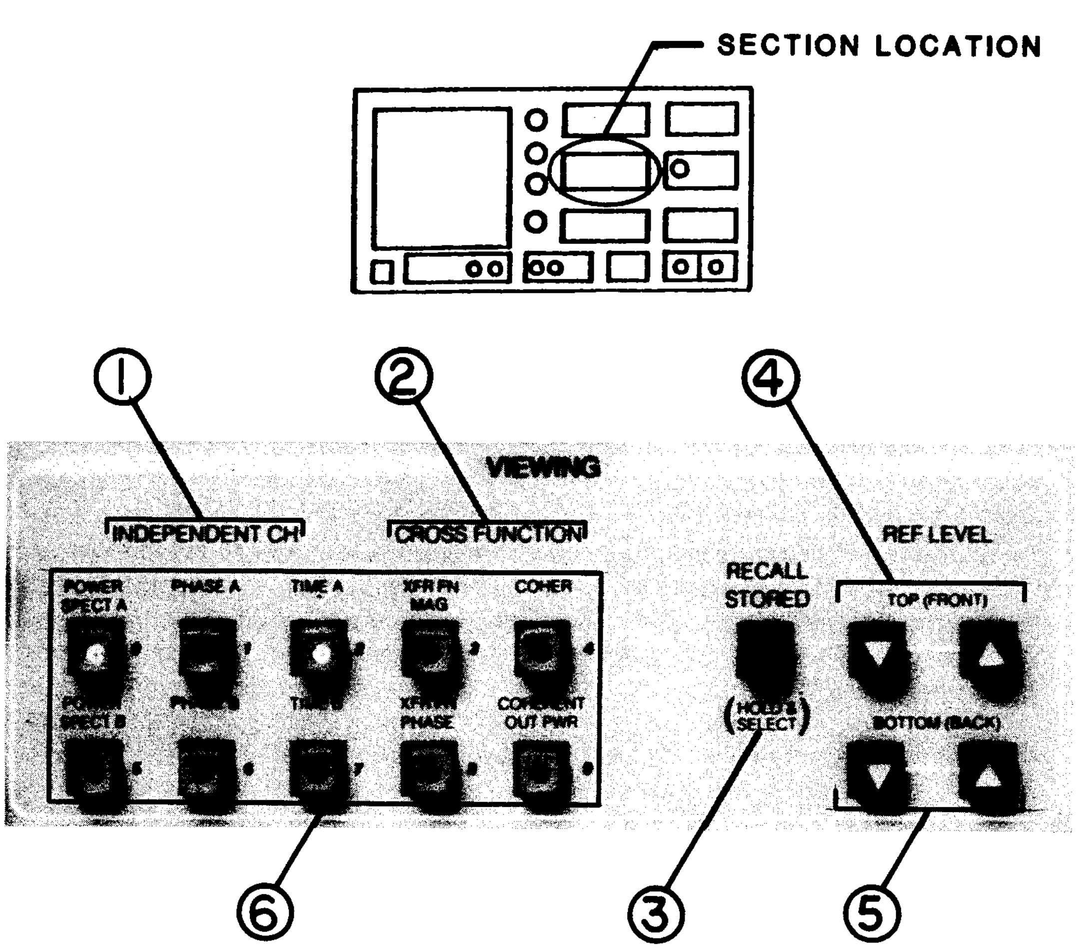


Fig. 3-12   Viewing Section

(1) Independent Channel: Six functions are available in single-channel measurements: power spectrum (Ch.A, Ch B), phase spectrum (Ch A, Ch B) and the time waveform (Ch A, Ch B).

(2) Cross Function: Four functions are available in cross-channel measurements: transfer function magnitude, transfer function phase, coherence, and coherent output power.

(3) To recall a stored function for display, press and hold this key, and then enter the desired function key. Repeat the procedure to remove the stored function from display. Time functions and single-channel phase spectra cannot be stored or recalled.

(4) Allows for increasing ▲ , or decreasing ▼ display gain of the top trace in split-screen display, or the front trace in full-screen display. When

pressed and held, display gain will change in steps of 10 dB; otherwise, display gain will change in steps of 1 dB per keystroke.

(5) Allows for increasing ▲ ,or decreasing ▼ display gain of the bottom trace in split-screen display, or the back trace in full-screen display. When pressed and held, display gain will change in steps of 10 dB; otherwise,display gain will change in steps of 1 dB per keystroke.

(6) Engineering Units: These ten keys revert to a numeric keyboard (0-9) for entering vertical and horizontal scale calibrations in arbitrary units. Engineering unit calibration is selected in the SET UP section.

The six independent channel measurements, CH A/B Power Spectrum, Phase, and Time are probably completely familiar to all users of Spectrum Analyzers. However, the four Cross Functions, Transfer Magnitude and Phase, and Coherence and Coherent Output Power may be somewhat less familiar.

3-12-1. Tranfer Function Measurements - a discussion

The Transfer Function characterizes a linear network - for example, comparing the output of an electrical or mechanical device to its input. The measurement of the Transfer Function requires a cross channel Spectrum Analyzer and a drive signal which is applied both to the input of the device under test and to Channel A of the Analyzer. The output of the device under test is applied to Channel B of the Analyzer.

Rather than the direct ratio of input to output, the 5820A computes the power spectrum of Channel A and the cross spectrum between Channels B and A, both the real and imaginary parts. Then, the 5820A calculates the ratio cross-spectrum to power spectrum A. This yields an optimum estimate of the transfer function. The result, which is the transfer function of the device under test, in terms of Magnitude and Phase, is presented on the CRT.

In the process, the 5820A also applies correction factors to the calculation in order to compensate for amplitude and phase differences of its own input circuits. The result is Transfer Function measurement of exceedingly high accuracy and resolution.

The built in Tracking Signal generator, as we have used it in many of the examples and exercises, can be utilized to provide the drive signal to the device under test. So the Transfer Function can be measured without the need for any other instrumentation. This means that the 5820A can function as a low-frequency Network Analyzer with real-time measurement speed.

3-12-2. Coherence Measurements - a discussion

The calculation of the transfer function, discussed above, is based on the premise that the device under test behaves as a linear network and no portion of the output signal is caused by something that's not part of the input signal). In the real world, this is not always the case: device non-lineariies and noise are present to a greater or lesser extent.

The 5820A addresses the real world by calculating Coherent Output Power and Coherence Function. Coherent Output Power is a measurement of the part of the observed output signal caused by the input signal power.

The Coherence Function is simply a normalized quantity which indicates how much of the observed output is caused by the input. Its value ranges from 1.0 to 0.0. A value of 1.0 indicates that 100% of the output is due to the input and that the calculation of the transfer function is valid. A low value nearer to 0.0 indicates that the measurement is not valid.

When this occurs, the Edited Transfer Function feature, selected via the SET UP - DISPLAY MODIFIERS menu, may be utilized. Its purpose is to eliminate (i.e., reduce the intensity of) those portions of the Magnitude and Phase of the function that are invalid or suspect due to low coherence or low input power. This way, you don't waste your time taking precise readings of inaccurate measurements.

Besides verifying the validity of the transfer function measurement, the Coherent Output Power and Coherence Function are also useful in studying "cause and effect" relationships, especially when complex sytems are involved. Measurements can quickly pinpoint a malfunctioning part of the system.

3-12-3. Exercises

<u>Exercise #1</u> - Comparing averaging/peak traces via STORE/RECALL STORED

A- Set up for a noise signal into Ch A with a Power Spectrum display. Produce a 64N spectral average. Spectral averaging has reached 64 samples when START LED stops flashing. Press STORE to store.

B- Reduce averaging N to 2. Recall 64N trace by holding down the black RECALL STORED key in the VIEWING Section and pressing the desired Ch A Power Spect A key. Place the 5820A in full-screen mode to overlay and compare the effects of averaging on the noise signal.

C- Increase the averaging N. You'll see that at some point additional averaging has little added effect.

D- Press the PEAK mode key. Allow some time for the new trace to reach its maximum. Compare the two traces.

Exercise #2 - Transfer Function

- perform a XFR FN (Transfer Function) measurement between the tracking signal on Ch A and through the notch filter into Ch B. Notice the smoothness of the trace over the entire range. Using the cursor, you can see, quantitatively, the roll-off of the filter.

Exercise #3 - Coherence Test

A- With 5820A set up as in Exercise #2, set averaging to 4 or 8 to reduce the variance to insure a good coherence estimate. Perform coherence test measurement on inputs as in #2. Note that coherence is 1.00 or very close to it all across the span, indicating that 100% of the output is due to the input.

Exercise #4 - Edit XFR Function

A- Set SPAN to 10K. Activate the TEST signal (in the Amplitude section) for Channels A and B. Use a bit (4 or 8) of averaging for smoothing of noise. After observing their power spectra, examine the Magnitude and Phase Transfer functions. Since they are exactly the same signals, they should both be very nearly flat.

B- Press the COHERENCE and POWER SPECT A keys. Notice that the Coherence is high (about 1.00) only where there is an input signal.

C- Activate each of the XFR FN keys again while leaving COHERENCE on too. Use full-screen mode for best comparison. Enter the DISPLAY MODIFIERS menu to activate the EDIT XFR FN option. Notice that the brighter segments of the displays show that the measurements are valid only where coherence is high (where there was a signal input from the periodic discrete spectra signal of the test signal generator).

3-13. TRANSIENT MODE Operations

The Transient Mode section provides controls for triggered operation so that transient signals which might last only a few milliseconds (or might be much longer) and occur infrequently or randomly through time can be captured and analyzed. TRANSIENT MODE of operation is selected in the SET UP Section.

Refer to the captions in Figure 3-13 for an explanation of the function of each control in this section.

Unlike the normal "free-run" analysis mode in which a continuous stream of signal data is processed, transient mode analysis operates on a signal only when commanded to do so by the trigger circuits. Computations are performed on only a single block, or time window, of data per each triggering.

The THRESHOLD dial is used to define the amplitude and the slope of the trigger signal that will cause the 5820A to start collecting a block of data.

Five different sources may provide the trigger signal for Transient Mode operation. They are listed for selection in the Transient Mode menu of the SET UP section see Figure 3-5-7). The five Trigger Sources are:

EXTERNAL
CHANNEL A
CHANNEL B
TRACKING SIGNAL
IEEE-488

The first four sources on the list cause a new measurement to be initiated when the selected input signal meets the specified threshold level.

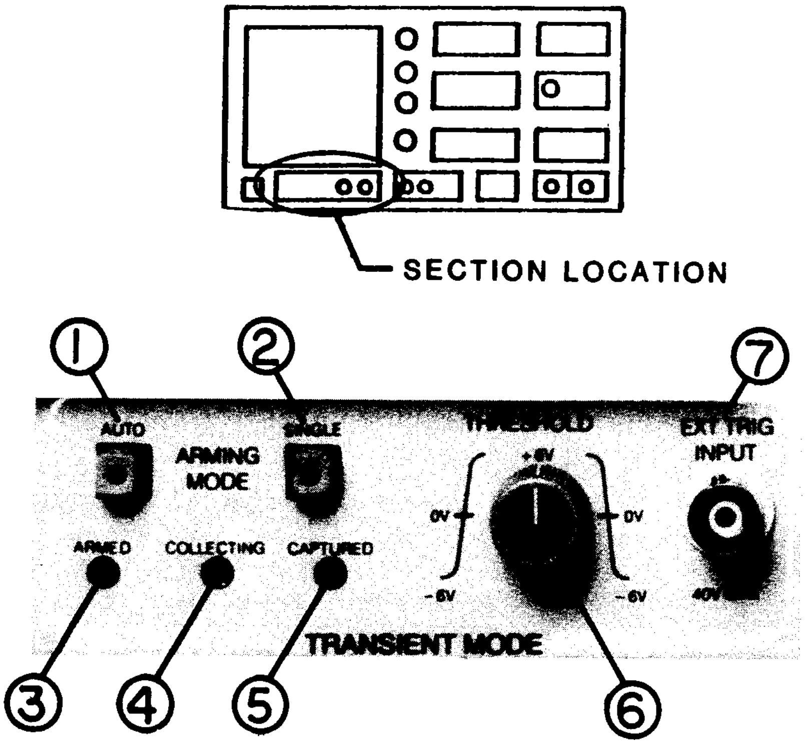


Fig. 3-13 Tranent mode controls

① When activated, transient capture is armed and automatically rearmed after a transient is captured.

② When activated, transient capture is armed to capture ony one transient.

③ Indicates transient mode is armed.

④ Indicates that data is being collected; useful in high resolution modes, when data collection may take many seconds to complete.

⑤ Indicates that a block of data has been captured.

⑥ Defines amplitude and slope of external trigger signal required to start collection of a data block.

⑦ BNC connector for connecting an external trigger signal.

The first of these, EXTERNAL, is from any source that might be appropriate and is connected to the EXT TRIG INPUT (BNC) connector. See Figure 3-13.

The IEEE-488 selection specifies that the new measurement is initiated on command through the General Purpose Interface Bus (GPIB). You'll find more on that in CHAPTER IV - REMOTE OPERATION.

There are two ARMING MODES, AUTO and SINGLE. The mode should be set before pressing the PROCESSING START key which initiates Transient Mode activation. As transients are collected by the 5820A, the trace of each is normally displayed one after the other. However, as we discussed in Section 3-11-1, TIME AVERAGING, it is possible to specify that N transients be averaged together, point by point. This is especially useful when analyzing irregularly occurring events which do occur in synch with a trigger signal. The example of car engine knock was given. TIME AVERAGING can significantly improve the signal to noise ratio in a case like this.

Exercise #1

A- Using the 10K filter on Ch B as we've done before, center a 5K span on 10KHz.

B- Place the 5820A in Transient Mode with the Tracking Signal as the trigger source. Activate the Tracking Signal in the PULSE mode. Set sensitivity to just before overload as usual.

C- With Spectral Average set to NONE (this will cause triggering to continue indefinitely), ARM the 5820A's Transient Mode in AUTO. Press the START key.

D- Adjust the THRESHOLD until flickering of the green COLLECTING LED indicates a satisfactory triggering level has been obtained.

E- Display TIME A to see when the trigger pulse is being output (make sure Tracking Attenuators aren't killing the pulse!). Display POWER SPECT B to see the spectra as they come in.

F- Increase the averages to 16 or 32 and START processing. When processing stops (STOP LED is on), STORE the results.

G- Set the Transient Mode to FREE-RUN; set Tracking Signal to NOISE. START an 8 to 32 averages processing of free-run signal. Use the STORED RECALL to compare the free-run transfer function with the transient-triggered transfer function. They should be very similar.

3-14. RECORDING on a Plotter

This section controls the digital plotter or X-Y recorder connected to the appropriate connectors on the rear panel (see Figure 3-14a). Recorder selection and calibration is made in the SET UP - RECORDING section (see Section 3-5-6).

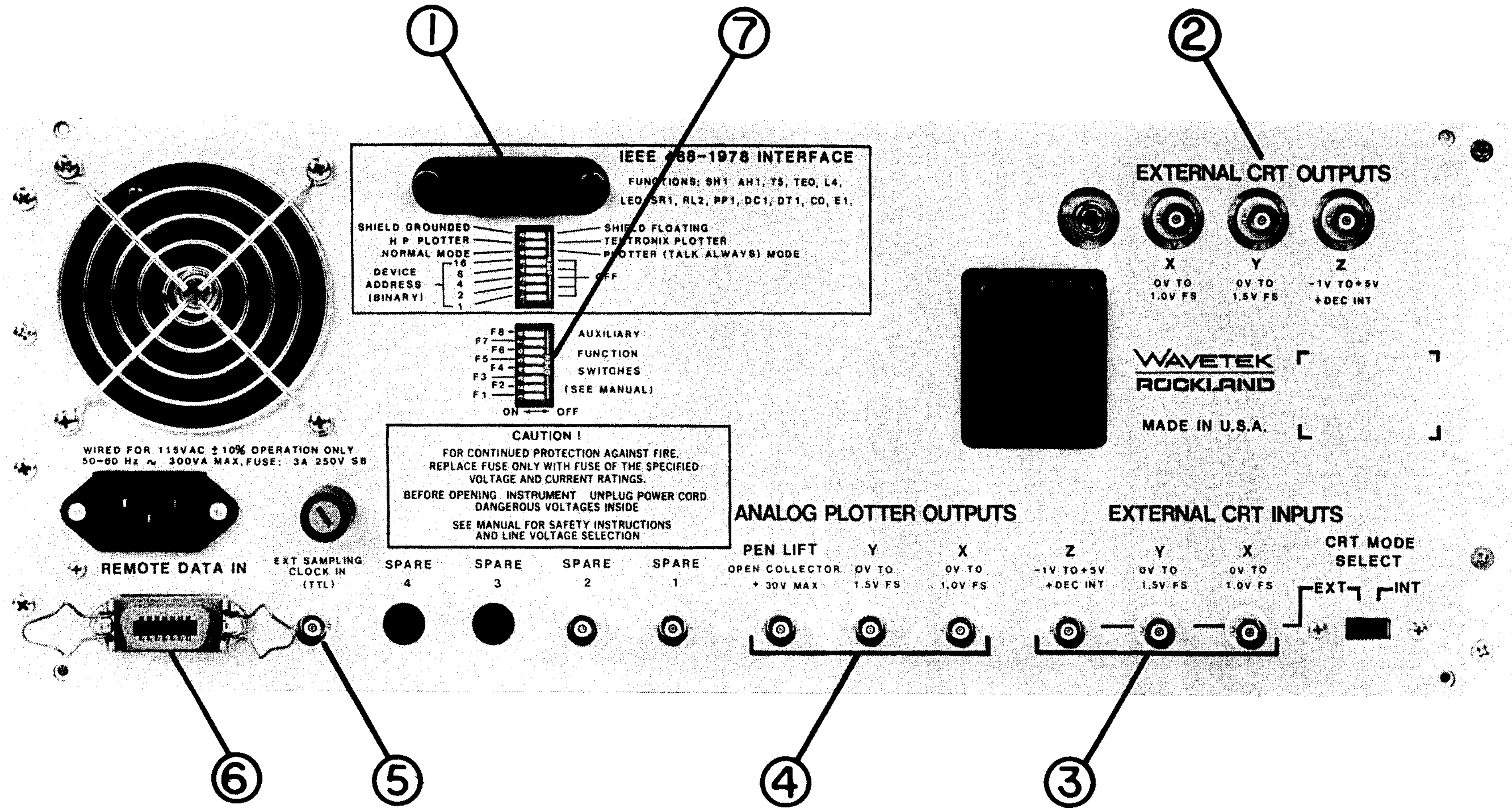


Fig. 3-14A Rear Panel

The rear panel has the following connectors and controls.

(1) GPIB/Digital Plotter Interface.

Standard IEEE-488 Connector and selector switches for remote control or sensing and for connecting the instrument to digital plotters without a separate controller, by placing the instrument in the TALK ALWAYS mode. The spectrum analyzer will interface with the following digital plotters with GPIB:

HP 7225A/B
HP 9872B/S
HP 9872C/T
TEK 4662
TEK 4662-31
TEK 4663

(2) Display Outputs

Signals are provided to drive an external CRT display in parallel with the built-in display. The frequency response of the external display must exceed 3 MHz for X- and Y- axes and exceed 5 MHz for the Z-axis.

(3) Display Inputs

External CRT signals can be connected to the built-in display, so it can be used as a stand-alone display for another signal whose bandwidth is less than 100 KHz on each channel.

(4) Analog Plotter Interface

Signals are available to drive an external X-Y recorder; two speeds with adaptive rate can be selected from CRT menu by setting position F3, Auxiliary switch, to ON for normal rate, OFF to faster.

(5) External Sampling Clock

By using an external sampling clock, one can obtain stationary spectra of non-stationary signals. This capability is particularly useful in machine vibration analysis, or removal of tape recording wow and flutter.

(6) Digital Data Input

Serial Data can be directly applied to the FFT processor of the instrument, bypassing its input signal conditioners and A/D converter.

(7) Auxiliary Function Switch

Provides additional control functions. For example, position F3 selects the rate that data is output to an analog plotter.

See Figure 3-14b for an explanation of the function of the control keys in the RECORDING section.

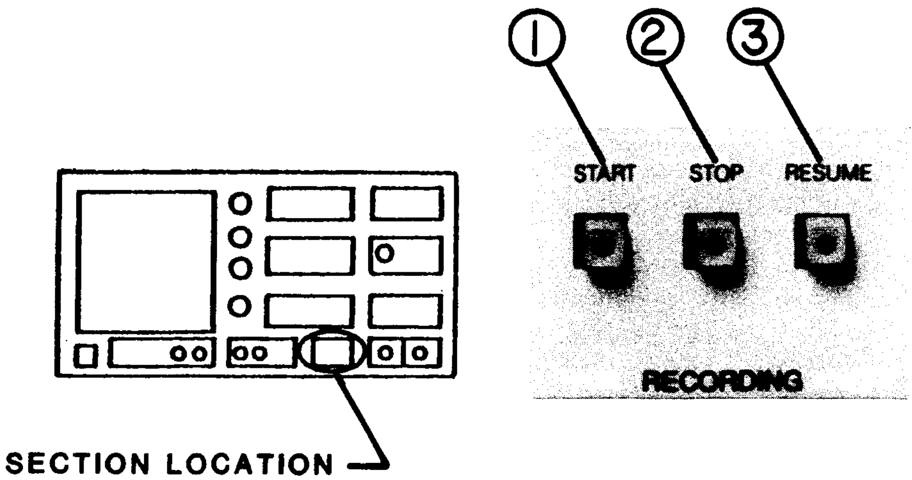


Fig. 3-14b Recording section

(1) Starts the plotter in the "0" position.

(2) Stops the plotter.

(3) Resumes plotting from position in which it was stopped.

There are three ways to obtain hard-copy documentation of your measurements:

a- You can take a picture of the CRT display with a scope camera; add to it a photo of the current setup state of the instrument for more comprehensive documentation.

b- Connect an analog X-Y recorder to plot the CRT traces; no alphanumerics are possible in this case - the information has to be handwritten on the plot.

c- (Best method) Connect a digital plotter directly to the 5820A (no computing controller is needed). The 5820A will cause fully annotated plots to be produced complete with different colors for the traces, the graticule, and the alphanumerics. They will be produced in the size you desire. If you add the setup state information either alongside or on another page, you will have total documentation of your measurement.

3-14-1. RECORDING on a Digital Plotter

The Model 5820A spectrum analyzer will interface to several different GPIB digital plotters. Some are:

HEWLETT PACKARD

Model HP 7225A/B with personality module 17601A.
This is a single color GPIB plotter for
8 1/2"x 11" plots.

Model HP 9872B/S
This is the 4 color GPIB plotter on
11"x17" plots.
The "S" version provides a paper advance
feature which is not controlled by the
5820A.

Model HP 9872C/T
These GPIB plotters replaced the
HP 9872B/S plotters and provide
8 colors, on 11"x17" paper
of which 4 are used.

(The HP 9872A cannot be used since it does not have the "listen only" feature needed to operate with the 5820A analyzer).

TEKTRONIX

Model Tek 4662
This is a single color digital GPIB plotter for 10"x15" plots.

Model Tek 4662-31
The option 31 adds a mechanical 8 color turret to the standard 4662 plotter which is not controlled by the 5820A..

Model 4663
This is the two-color GPIB plotter for 17"x22" plots.

These steps are required to generate a digital plot:

1. 5820A configuration:

   a. Put 5820A into "TALK ALWAYS" mode by pressing the right side of the 3rd switch from the top on the rear panel.
   b. Select the plotter's manufacturer with the 2nd switch from the top.
      1) Press the left side for HP
      2) Press the right side for Tektronix.
   c. Activate plot mode from RECORDING MENU.
      1) Move cursor to DIGITAL PLOTTER
      2) Enter the "*" with ENTER button.
      3) Remove Recording menu from CRT.

2. Plotter configuration:

   a. Set up limits of plots as desired (power up default for maximum size is allowable).
   b. Activate Listen always (listen only).
      1) HP plotters - move switch to listen only.
      Tek 4662 series -
      switch A = 0
      switch B = C (hexadecimal)
      switch C = 0 or 1 (for device addresses greater than 15)
      switch D = don't care
      NOTE: These switches must be set with power off.

3. Start - Press Start in RECORDING section of 5820A to initiate plot.

If all these steps are taken, you should not experience any problems.

NOTE: Since the Tektronix plotters contain a separate character buffer, the STOP button on the 5820A will not immediately halt the plot. This will only occur when the information in the character buffer has been transmitted to the paper.

3-14-2. RECORDING on an Analog Plotter

Vertical, horizontal and pen lift signals are provided from the rear panel for driving the analog plotter. The input signals are:

Vertical: 0 to 1.5V full scale.
Horizontal: 0 to 1.0V full scale.
Pen Lift: Open collector, 30V max.

Two plotting speeds may be selected by setting switch position F3 of the AUXILIARY FUNCTION SWITCHES on the rear panel. ON corresponds to normal rate and OFF is faster. Both rates are adaptive, i.e. slow down for large pen movements.

To generate an analog plot do the following: (see Figure 3-5-6)

a. Activate the X-Y plotter mode from the RECORDING menu.

a. Calibrate the display with respect to the graticules in the plot paper. 0.1FS points are used for log paper, otherwise calibrating with the origin, 0-0, and full scale,FS-FS, points is adequate.

c. Select desired speed rate by setting F3.

d. Press START in RECORDING section to initiate plot.

3-15. EXTERNAL CRT and INTERNAL CRT MODES

An external CRT may be connected in parallel with the built-in display. The required characteristics for the external CRT are :

OUTPUTS	VOLTAGE	FREQ RESPONSE
X	0V to 1V FS	3 MHz
Y	0V to 1.5V FS	3 MHz
Z	-1 to +5v, positive going voltage decreases intensity	5 MHz

The internal CRT may be used to view external signals by changing the CRT MODE SELECT on the rear panel from INT to EXT. The characteristics of the signals that can be analyzed are:

INPUTS	VOLTAGE	FREQ RESPONSE
X	0V to 1.0V FS	100 KHz
Y	0V to 1.5V FS	100 KHz
Z	-1V to +5V, positive going voltage decreases intensity.	

3-16. REMOTE DATA INPUT

Operation of the Remote Data Mode is provided by means of the rear panel REMOTE DATA IN connector. In this mode, the user supplies an external 12-bit data stream representing input samples for the processor. This takes the place of the 12-bit serial data stream normally supplied by the internal A/D converter and therefore must be in the same format. The user also supplies the serial data clock. Synchronization at the word and data block level is provided by signals present in the connector.

The user may send samples at the sampling rate determined by the internal sampling clock of the system, or at a rate determined by the External Sample Clock which then acts as a word strobe. For convenience, this signal can be supplied through one of the pins in the REMOTE DATA IN connector instead of the rear panel BNC connector. See Section 3-8-2 for a description of the External Sampling Mode.

3-16-1. REMOTE DATA IN Connector

Below is a list of the signals present on the 14-pin REMOTE DATA IN connector. Pins 1 through 7 are on the top row, left to right. All pins on the bottom row are GROUND.

PIN	SIGNAL	PIN	SIGNAL
1	SMPCLK	8	GROUND
2	SERCLK	9	GROUND
3	REMEN	10	GROUND
4	(NOT USED)	11	GROUND
5	SERDATA	12	GROUND
6	CONVERT	13	GROUND
7	READY	14	GROUND

The mating plug is a CINCH #57-30140 or equivalent. When wiring this plug, use either twisted pair or flat cable to minimize crosstalk and noise. When using twisted pair, connect one wire of the pair to one of the seven signal lines and the other wire of the pair to its adjacent ground pin. When using flat cable, alternate signals and grounds across the cable. Standard mass termination products for flat cable will accommodate this scheme. Keep the total cable length less than six feet.

All signals levels are TTL. Signals sent to the 5820 should be driven by buffer gates such as type 7437 or equivalent. Signals driven by the 5820 should be terminated in the user's interface by 1K ohm pullup resistors to +5V and received by a type 7414 Schmitt-trigger or equivalent gate.

SIGNAL	DIRECTION	DESCRIPTION
REMEN	FROM USER	REMOTE DATA MODE ENABLE - The user must send this line low (true) to enter the Remote Data Mode. This line must be held low during the entire duration of this mode.
READY	FROM 5820	READY FOR DATA - When the 5820 detects the REMEN line true, it terminates any current processing and prepares to enter the Remote Data Mode. When it is ready to receive externally supplied data, the 5820 sends READY high (true).
CONVERT	FROM 5820	CONVERT -The CONVERT signal is sent low (true) by the 5820 to initiate transmission of the next 12-bit serial word by the user. The duration of the low logic level is always approximately 2.93 usec and the spacing of these pulses is equal to the period of the sampling clock, whether internally or externally supplied.
SERCLK	FROM USER	SERIAL DATA CLOCK -The negative-going edge of this signal clocks the data on the SERDATA line into the serial buffer register. When not active, this line should be held at the high logic level. Twelve pulses are required to load the serial input word. This transmission sequence must begin following the negative-going edge of the CONVERT pulse and be completed before the next negative-going edge of CONVERT. This interval will always be at least 3.9 usec. A recommended waveform for SERCLK is a gated 4 MHz square wave pulse train, triggered by the negative-going edge of CONVERT. This will guarantee operation for any sampling rate.

SIGNAL	DIRECTION	DESCRIPTION
SERDATA	FROM USER	SERIAL INPUT DATA - Remote serial input data is entered on this line in 2's complement form with the most significant bit first. Each data bit must be stable during the interval from 25 nsec before through 25 nsec after the negative-going edge of each of the twelve SERCLK pulses.

OVERALL TIMING RELATIONSHIPS

Input data samples are used by the 5820 in group or block form. After the receipt of a given block of data, internal processing must take place before the next block can be accepted. The number of samples in an input block depends on the following factors:

1) Frequency Span Setting
2) Dual- or Single-Channel Mode
3) Initialization Sequence Enabled or Disabled
4) Max Span Display Enabled or Disabled (Single Channel Mode Only)

The effects of these factors are discussed below and summarized in the table which follows.

Frequency Span Setting

The Frequency Span Setting determines the frequency resolution of the spectrum and consequently the time duration of the data block. Since the sampling rate is constant over the various span settings (50 KHz to 200 Hz), the number of input samples per block is inversely proportional to the span setting. Refer to the table for a complete list of the various values.

Single- or Dual-Channel Mode

With some exceptions, the number of samples and the time duration of the input sample block doubles in single channel mode as compared with dual channel mode. Refer to the table for exact parameters.

Initialization Sequence Enabled or Disabled

When consecutive data blocks are not contiguous records, the digital filters must be initialized at the beginning of each block to eliminate transients. This is achieved by setting the rear panel Auxiliary Function Switch F1 to the ON position. In this position, the 5820 expects the user to send additional zero samples before the actual data block samples.

If consecutive data blocks are contiguous records, then set Auxiliary Function Switch F1 to the OFF position. In this case no initial zero samples are expected or required.

The table shows the number of CONVERT pulses (and hence the number of input words per block) for both conditions of the F1 switch. In case the switch is OFF, the number of CONVERT pulses equals the number of actual input samples taken. In case the switch is ON, the INITIAL PULSES column of the table shows the number of initial pulses (and zero input samples required) for removing filter transients prior to the actual input data samples.

Max Span Background Enabled or Disabled

In single-channel mode only, the operator can elect to display the max span frequency spectrum along with the selected span spectrum. In this case, two alternating types of input data blocks are collected: one for the max span and one for the selected span. The sequence for the max span block is identical to the sequence for the single-channel 50 KHz span. This alternates with the sequence for the selected span as shown in the table. Both of these sequences are appropriately affected by the INIT line.

Block Sample Sequence

The order of samples sent during each block of data depends upon the mode and span setting. If the initializing sequence is enabled, then the appropriate number of initial or zero samples must be sent prior to the actual data. The table shows the order of samples for the actual data segment of the block after the initializing sample sequence, if present. The first sample is labeled T0, the second T1, etc.

Note also that the ACTUAL INPUT DATA SAMPLES PER CHANNEL column shows samples per channel and in the case of dual channel mode, the number shown is half the total number of samples required. As an example, in the 5KHz span, dual-channel mode, with the initializing sequence enabled, the user would first send 102 zero samples followed by B0, A0, B1, A1,....., B5118, A5118, B5119, A5119. The total number of samples sent for each block would be:

102 + 5120 +5120 = 10342.

MODE	SPAN (Hz)	ACTUAL INPUT DATA SAMPLES PER CHANNEL	TIME WINDOW (mS)	CONVERT PULSES	"EXTRA" INITIAL* PULSES:	STARTING SAMPLE SEQUENCE T0	T1	T2	T3	T4
	50K	512	4	1024	12	A0	B0	A1	B1	A2
	25K	1024	8	2048	22	B0	A0	B1	A1	B2
D	10K	2560	20	5120	52	B0	A0	B1	A1	B2
U	5K	5120	40	10240	102	B0	A0	B1	A1	B2
A	2K	12800	100	25600	252	B0	A0	B1	A1	B2
L	1K	25600	200	51200	502	B0	A0	B1	A1	B2
	500	51200	400	102400	1002	B0	A0	B1	A1	B2
	200	128000	1000	256000	1252	B0	A0	B1	A1	B2
	50K	1024	8	2048	12	X	S0	X	S1	X
S	25K	4096	16	4096	21	S0	S1	S2	S3	S4
I	10K	10240	40	10240	51	S0	S1	S2	S3	S4
N	5K	20480	80	20480	101	S0	S1	S2	S3	S4
G	2K	51200	200	51200	251	S0	S1	S2	S3	S4
L	1K	102400	400	102400	501	S0	S1	S2	S3	S4
E	500	204800	800	204800	1001	S0	S1	S2	S3	S4
	200	256000	1000	256000	1251	S0	S1	S2	S3	S4

* EXTRA INITIAL PULSES FOR "ZERO" INITIALIZING SAMPLES PRIOR TO ACTUAL DATA SAMPLES. (F1 SWITCH = ON).

T0,T1,T2,... = SAMPLE SEQUENCE FOR ACTUAL DATA SAMPLES TRANSMITTED
A0,A1,A2,... = SAMPLE SEQUENCE FOR CHANNEL A
B0,B1,B2,... = SAMPLE SEQUENCE FOR CHANNEL B
S0,S1,S2,... = SAMPLE SEQUENCE FOR SINGLE CHANNEL OPERATION, A OR B
X = DUMMY SAMPLES INSERTED BETWEEN ACTUAL SAMPLES

Table 3-16. Remote Data Input Timing Relationships

CHAPTER IV

REMOTE OPERATION

IEEE-488/1978 STANDARD INTERFACE

4-1. INTRODUCTION

Nearly every operation which you can perform manually from the front panel controls of the 5820A can also be accomplished from a remote location and/or under the control of such devices as a computer. To do so, you'll need to know two things:

1- how to operate the 5820A in the manual mode. If necessary, please turn directly to Chapter III for a full course of instruction and information.

2- the 5820A GPIB (General Purpose Interface Bus) Instruction Language, a relatively simple set of English word commands and instruction syntax relating directly to the controls on the front panel of the 5820A. You will use this command language to speak to the 5820A over the GPIB.

4-2 The GPIB

The General Purpose Interface Bus (GPIB) is a standard IEEE-488/1978 digital data interconnection and interface. The GPIB allows programming or sensing of the Spectrum Analyzer with ASCII commands and data transfers in either ASCII or binary form. In addition, the GPIB can be placed in a Talk Always mode so it can drive a digital plotter without a controller on the bus.

The GPIB satisfies the following functions of the IEEE Standard 488-1978: SH1, AH1, T5, TE0, L4, LE0, SR1, RL2, PP1, DC1, DT1, C0, E1.

If you are not familiar with the conventions of the IEEE-488/1978 standard digital interface, a detailed description of the bus system and all its parameters may be obtained from:

IEEE Standards

347 East 47th Street

New York, New York 10017

4-2-1. Setting Up the Interface

Figure 3-14-1 shows the rear panel of the 5820A (or you can look at the actual instrument). At the top middle of the panel is a boxed in area labeled IEEE 488-1978 INTERFACE. There you'll find the interface cable connector port and a set of eight switches. The topmost switch is labeled "SHIELD GROUNDED" and "SHIELD FLOATING". See Figure 4-2-1 below.

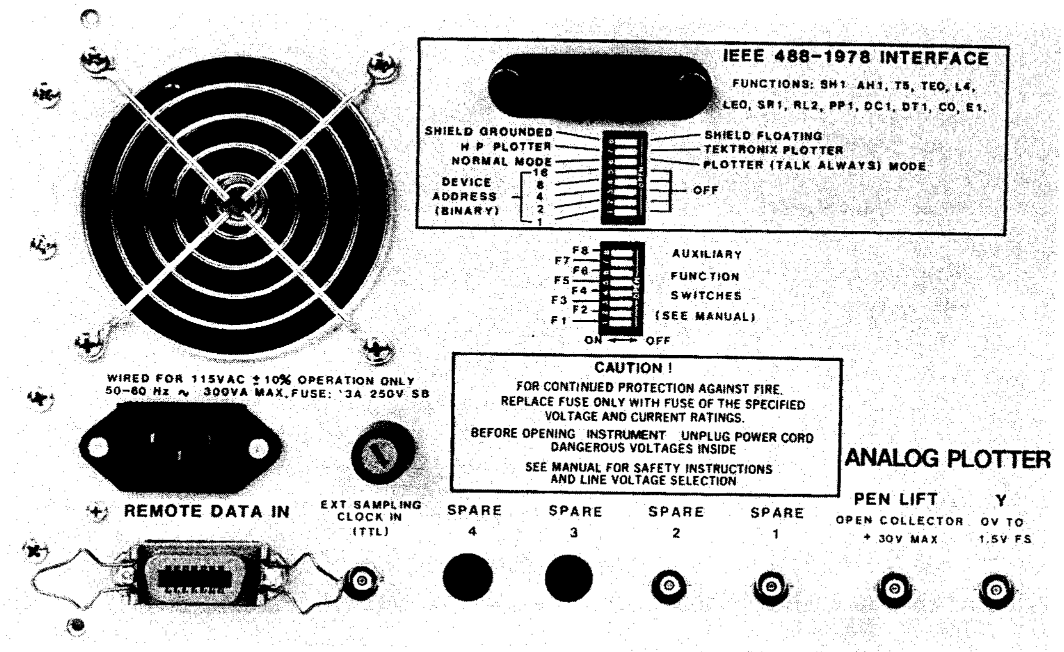


Fig. 4-2-1 IEEE 488-1978

Interface Connector and Switch.

The lower five switches are used to establish the device address code, the address to which the controller will send commands, data, etc. The bottom switch is the LSB (least significant bit); the switches have binary weights. So, in accordance with IEEE 488 specifications, device address numbers between 0 and 30 can be set using switches one to five.

Moving upward to the sixth and seventh switches, you see that they refer to plotter operation, allowing the 5820A to be connected directly to the plotter without needing a separate controller. In the case of such a connection, the switch should be set to the PLOTTER (TALK ALWAYS) MODE position. For remote control via the GPIB, the switch should be set to NORMAL MODE.

When using a plotter, the seventh switch should be set to indicate your use of either a Tektronix 4662-equivalent or an HP 7225-software upwards-compatible plotter. When the interface is set in the TALK ALWAYS mode, normal X-Y plotting is disabled.

The topmost, eighth switch is used to ground the shield of the IEEE cable.

4-3 The 5820A Instruction Language

The 5820A is designed to execute instructions sent to it through the GPIB as ASCII characters. Only CAPITAL (upper case) letters may be used. There are several commands in the 5820A vocabulary. For example, transmitting the SET command (plus some additonal data) allows you to set the Frequency SPAN for any of the values you could set manually using the SPAN dial on the front panel.

4-3-1. Instruction Format

First, a few definitions and conventions: we will use the "^" symbol to denote one or more spaces; CR denotes Carriage Return and LF denotes Line Feed.

An instruction to the 5820A has the general format:

COMMAND ^ ARGUMENT #1 ^ ARGUMENT #2 ^ ARGUMENT #3 CR/LF

"Arguments" are additional data required to specify in detail what a command action should do. All three arguments are not always present in a particular instruction. However, the spaces are used as delimiters of commands and arguments. They must always be used as shown. As we mentioned above, only upper case ASCII characters may be used in instruction transmissions.

4-3-2. The COMMAND List

There are 26 Command words in the 5820A Instruction Language. To speed operations and transmission of the words, you can use certain abbreviated forms. In the list below and in all other cases, you must send the part of a Command or Argument word which is underlined in this manual. You can send subsequent letters of the word, but they must be exactly as written in the list below.

5820A GPIB COMMAND LIST

1. READ	9. STOP	17. PROCESS
2. WRITE	10. RESUME	18. RELEASE
3. BREAD	11. STORE	19. EQUALIZE
4. BWRITE	12. EDIT	20. COMPARE
5. SRQ	13. AUTORANGE	21. TEXT
6. SET	14. TEST	22. AMPLITUDE
7. VIEW	15. REV	23. FREQUENCY
8. START	16. SAMPLING	24. CURSOR
25. PLOT	26. RESET	

An example of a GPIB Instruction are these three equivalent versions of the instruction you would send to prepare the 5820A to accept remote instructions:

SET FRONT PANEL REMOTE

or

SET FRO REM

or

SET FR R

In this example, SET is the Command word, FRONT PANEL is the first Argument word, and REMOTE is the second Argument word.

The first version is the most complete use of the Command and Argument words; the third version uses only the required Command and Argument abbreviations; the second version is one of many possible versions between the two extremes.

4-4 5820A GPIB Instruction Language Commands and Arguments

The following list summarizes the commands that may be used to program the Wavetek Rockland Model 5820 Cross Channel Spectrum Analyzer. These notes pertain to the list of commands.

1. Only upper case ASCII characters may be used.

2. Either the underlined characters may be sent or the entire command.

3. If more than the underlined characters are sent, everything that is sent must be spelled correctly or an SRQ will be generated.

4. Block diagrams will be used to indicate permissible arguments and valid syntax.

5. Any forward path along the diagram indicates a valid statement.

6. The command "SET FRONT PANEL REMOTE" should be sent before any remote programming of the panel may be done. (Some commands do not require it, but it is good practice to do so).

7. The power up state for each command (if applicable) is indicated by an "*".

4-4-1. SET Command

a. SET FRONT PANEL —— REMOTE ——
                    └── LOCAL* ──┘

Note: This command must precede any remote programming of front panel functions.

b. SET SPAN —— XX ——

Where XX = 50KHZ, 25KHZ, 10KHZ, 5KHZ, 2KHZ,
1KHZ, 500HZ, 200HZ, 100HZ, 50HZ,
20HZ, 10HZ, 5HZ, 2HZ

c. SET ┬ CENTER FREQUENCY* ┬ XX...XX ┬ HZ ┬
       └ START FREQENCY ─────┘   ├ KHZ ┤
                                       └ mHZ ┘

Where K = Kilo   m = milli

Note: If desired value cannot be set exactly as transmitted, the next higher allowable value is used.

d. SET POSITION ┬ START ┬
                └ CENTER ┘

e. SET SENSITIVITY ┬ A ┬ ┬ UP ─────┬
                   └ B ┘ ├ DOWN ───┤
                         └ XX ┬────┤
                              └ DB ┘

Where UP increases sensitivity by 1 dB
DOWN decreases sensitivity by 1 dB
XX: integer between -70 & +20*

Note: There is no space between the minus sign and the number.

f. SET COUPLING ┬ A ┬ ┬ AC ┬
                └ B ┘ ├ DC ┤
                      └ GND ┘

g. SET IMPROVED ACCURACY — ON
— OFF*

Note: Cursor readouts will flash momentarily in the reverse video format, and the readouts will remain in the improved accuracy mode until the OFF command is sent.

h. SET AMPLITUDE READOUT — SINE*
— NOISE
— POWER

Where SINE - RMS readout (volts, dBV)

NOISE - power spectral density (PSD) readout: power in a 1 Hz bandwidth.

POWER - total power over entire selected span excluding DC.

i. SET CURSOR — ON*
— OFF

j. SET AVERAGER MODE — SPECTRUM*
— TIME
— PEAK

Note: TIME - single channel mode only

k. SET NUMBER OF AVERAGES — XX

Where XX is power of 2 from 1* to 256, (N=NONE corresponds to N=1).

l. SET MEASUREMENT — CROSS* | SINGLE — A | B

Note: You must STOP & START the Averager to see the effects of the command.

m. SET WEIGHTING — AUTO* | HANNING | UNIFORM

n. SET VERTICAL SCALE — XX DB | LINEAR

Where XX is 20, 40 or 80* for full scale.

o. SET HORIZONTAL SCALE — LINEAR* | LOG

p. SET SCREEN — FULL | SPLIT*

Note: used for dual displays.

q. SET TRIGGER — FREE RUN* | EXTERNAL | A | B | SIGNAL GENERATOR | IEEE

Where EXTERNAL refers to EXT TRIG INPUT BNC on front panel

A - Channel A

B - Channel B

Signal Generator - internal signal source.

IEEE - computer generated software trigger - threshold level knob should be set to Full clockwise or Full counterclockwise.

r. SET SIGNAL GENERATOR — OFF* / NOISE / PULSE / PERIODIC NOISE

Note: PULSE requires use of transient mode for triggered processing.

s. SET ATTENUATOR — XXDB

Where XX = 0*, 10, 20, 30, 40

Note: SIGNAL GENERATOR (item #r) must be activated before adjusting the attenuator.

t. SET READOUT — REMOTE / LOCAL*

Note: Enables and disables remote writing of alphanumerics on the CRT. Use this command before TEXT Command (section 4.4.19).

u. SET DATA REMOTE

Note: Must precede digital input via the IEEE interface.

If other than the 50KHz span is desired, set the span after sending this command.

v. SET REFERENCE — A | B — X.X E± XX

Note: must send all digits in X.XE+XX field.

w. SET ORDERS — XX.XX

Note: Cannot suppress any digit in XX.XX field.

x. SET—ZERO FREQUENCY

Note: Sets current cursor location to 0 Hz reference (0 HR).

y. SET ARM — AUTO | SINGLE

4-4-2. AUTORANGE

Note: Sets amplitude automatically (in 10dB steps).

4-4-3. TEST

Note: Toggles test signal either on or off.

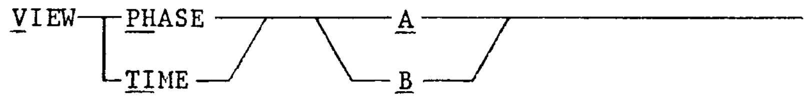
4-4-4. VIEW Command

a. VIEW — SINGLE | DUAL*

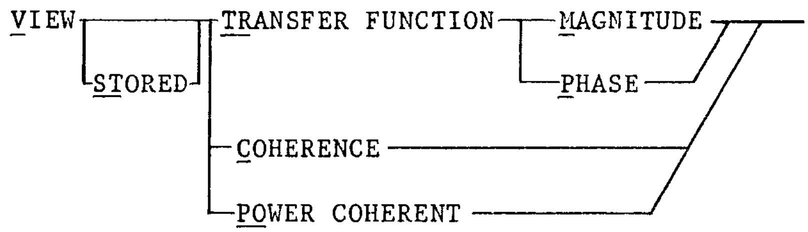
Note: Determines number of traces displayed on screen.

b. VIEW — [STORED] — SPECTRUM — A* | B*

c.



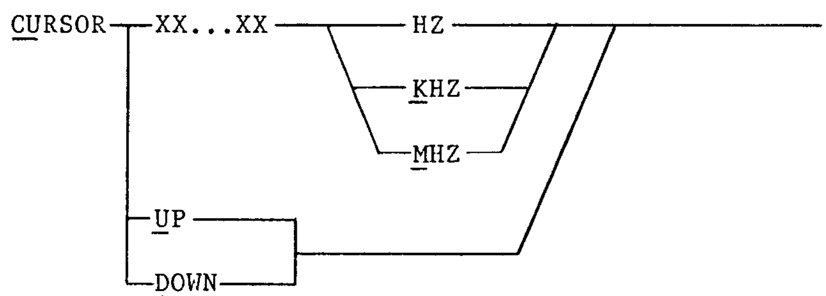
d.



e.

Note : Determines whether Max Span will be always displayed in single channel mode.

4-4-5.



Where : K = kilo
M = milli
default for XX.XX is 0.0Hz

Note : Absolute frequency must be sent even if display shows orders or HR. If the desired value can not be used, the next higher allowable value is used for cursor position.

4-4-6. START

Note : START clears averager memory and restarts the processor if it is stopped. If it is processing, a STOP must be sent before the START.

4-4-7. STOP

Note : STOP halts all processing.

4-4-8. RESUME

Note : RESUME continues averaging without clearing the Averager memory. The processor must be in STOP mode.

4-4-9. STORE

Note : Stores all spectrum data; i.e. power and cross spectra and all functions derived from these spectra.

4-4-10. SAMPLING — INTERNAL / EXTERNAL

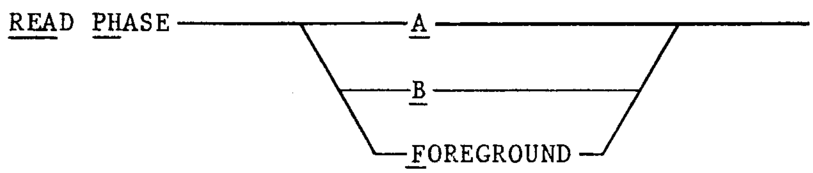
4-4-11. READ COMMAND

a. READ INPUT — A / B / FOREGROUND / MAX SPAN

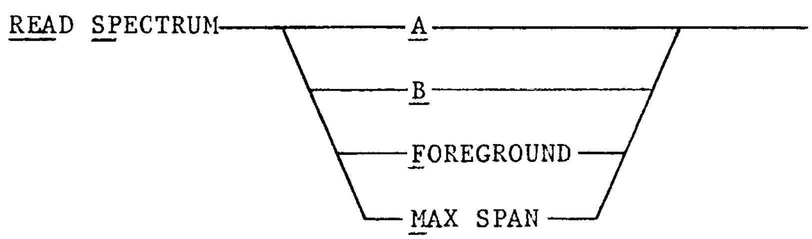
Notes:
1/A and B refer to cross channel inputs.
2/FOREGROUND and MAX SPAN refer to single channel input.
3/Data is transferred as integer real and imaginary parts :
32767 (-)XXXXX -32768
4/The number of input samples equals 1024 in all SPANS in single channel mode and on the 20 Hz and 2 Hz in cross channel.
For all other spans in cross channel it is 512.

b. READ CROSS

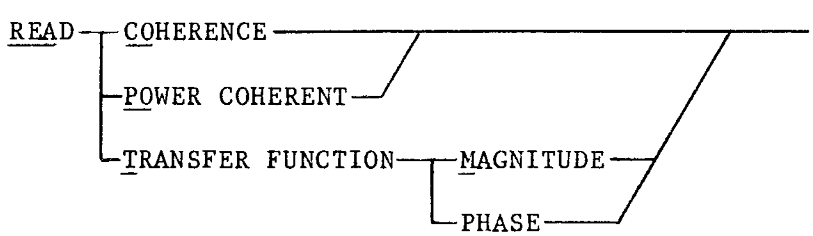
Note : Values read as real and imaginary numbers expressed in scientific notation (201 complex points). (-)X.XXXE±XX

c. 

Note :
A and B - cross channel mode
FOREGROUND - corresponds to zoom Spectrum of single channel.
Cursor values transferred after spectrum is displayed.

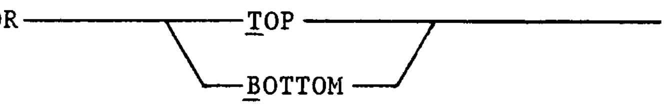
d. 

Note :
A and B - cross channel mode
FOREGROUND and MAX SPAN - single channel
Desired spectrum is displayed and cursor values are transferred (amplitude only).

e. 

Note : Desired spectrum is displayed and cursor values are transferred (201 amplitude points only).

f. READ CURSOR



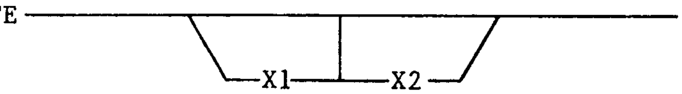
Note :
1/ Corresponds to amplitude and frequency as on CRT
2/ TOP is required for single display.
3/ TOP/BOTTOM is used for dual displays.

g. READ SETUP

Note :
1/ Sends ASCII characters as displayed in VIEW SETUP menu.
Maximum length = 450 characters.

2/ Must be viewing VIEW SETUP if Front Panel is in local control.

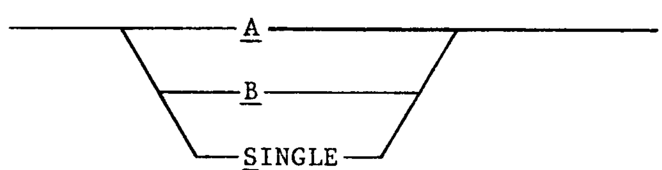
h. READ STATE



Notes :
1/ No arguments causes all 70 bytes of Front Panel configuration and processing state to be read.
2/ X1 = Starting byte number
3/ X2 = Ending byte number.
(see Appendix G for Memory map of state descriptors).

4/ An extra byte (space) is sent first.

4-4-12. WRITE



Notes:
1/ First send command "SET DATA REMOTE"

2/ A & B - cross channel - each 512 pts; except 1024 for 200 Hz, 20 Hz and 2Hz spans.
3/ SINGLE - single channel - 1024 pts.
4/ Send real & imaginary data pairs.
5/ Integers between -32768 and 32767.

4-4-13. EDIT / EQUALIZE / COMPARE — ON / OFF

EDIT
EQUALIZE
COMPARE
ON
OFF

Note: EQUALIZE and COMPARE functions operate on the stored data.

4-4-14. PROCESS

Note: Performs one FFT on remote data.

4-4-15. RELEASE

Note: Returns 5820A to normal local operation.

4-4-16. SRQ Command

a. SRQ

AUTORANGE
CHA OVLD
CHB OVLD
END OF AVERAGING
RESET

Notes:

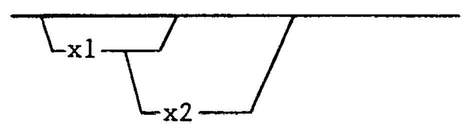
1/ RESET disables all SRQ
2/ More than one SRQ may be enabled.
3/ bit No. 6 = 1 whenever an SRQ is generated
4/ Error conditions exist for syntax (bit #7) or limits exceeded (bit #2).

The SRQ bits in the SPW register are:

Status word

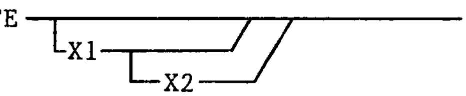
	SYNTAX	SRQ	END OF AVG	B OVLD	A OVLD	ILLEGAL COMM	DIGI- TAL PLOT	END OF AUTORGE
BIT NO.	7	6	5	4	3	2	1	0

4-4-17. BREAD



Notes:
1/ no arguments will transfer the entire memory
2/ X1 & X2 give starting and ending addresses in decimal format (see appendix H for memory map).
3/ if X2 is not given, only address X1 is read
4/ reads memory into binary format (eight bit byte)
5/ an extra byte (space) is sent first.

4-4-18. BWRITE



Note: Same as BREAD

4-4-19. TEXT

Notes:
1/first send "SET READOUT REMOTE"
2/clears screen
3/after TEXT, any ASCII transfer will be written on screen
4/maximum of 32 characters per line (including CR)
5/binary 3 will terminate TEXT mode.
6/"SET READOUT LOCAL" command returns screen to normal spectrum display

4-4-20. AMPLITUDE — ABSOLUTE / RELATIVE

Note: Sets mode

4-4-21. FREQUENCY — ABSOLUTE / RELATIVE / ORDERS

Note: sets mode

4-4-22. REV1

4-4-23. REV2

4-4-24. REVS

Notes: read one character that gives revision level of PROM set 1,2 or S.

1 : main Z80
2 : TSG,GPIB Z80
S : shared EPROMS

4-4-25. PLOT

Notes:
1/ use this command to copy CRT to digital plotter.
2/ must command 5820 as talker and plotter as listener.
3/ bit #1 in Status register is set when digital plotter is completed.

4-4-26. RESET Powers up the 5820

4-5. DATA TRANSFERS

There are two ways of transferring data between the 5820A and a controller. The fast way is the binary transfer mode while the slower way is the ASCII transfer mode.

4-5-1. Binary Transfer Mode

This is the fastest type of transfer but the user must interpret the data appropriately. There are two actions that the user must perform:

a. Format Interpretation

Transfers occur in 8 bit bytes. The data,however, may correspond to 16 bit integers or floating point numbers in 5820A format. The user must, therefore,know the data type and the corresponding format.

b. Application of correction factors.

There is a variety of correction factors, such as corrections for input sensitivity and filter equalization, that are applied by the 5820A before a readout is generated. If data is read directly from memory, the user would have to apply these correction factors.

There are two commands that perform binary transfers: the BREAD and BWRITE commands.

The commands have the format:

```
BREAD    X1    X2
BWRITE   X1    X2
```

X1 and X2 are decimal integers that specify memory addresses. If X1 is only given, the command only refers to address memory X1. If no addresses are given, the entire memory is addreessed. A memory map of the important data blocks is given in Appendix H .

4-5-2. ASCII Transfer Mode

Functions that can be displayed on the 5820 screen are read by sweeping the cursor across the screen and transferring the amplitude readout, as an ASCII string. A comma (2C Hex) is used as a delimiter between points.

The only exception to the above is the transfer of the time functions. For greater accuracy, the time points are transferred as 16 bit signed integers. Every sample has a real part and an imaginary part because the time function is obtained from the output of the digital filter that does the zooming. If no zoom is performed, as, for example, in the 50 KHz span, the imaginary parts will be zero. A comma is used as delimiter.

A function that can be read, although it cannot be displayed on the CRT is the complex cross spectrum. The complex cross spectrum is transferred as floating point numbers less than one. The real part is followed by the imaginary and a comma is used as a delimiter.

Digital input can be provided remotely. The format conventions discused above for the time function must be followed. Furthermore, the user must notify the 5820A that a digital input mode will start by sending the command SET DATA REMOTE. The input must then be transferred. The command PROCESS allows the 5820A to process the data block and get ready to accept another block. To return to the normal input mode, the command RELEASE must be issued. Example E.3 in Appendix E shows the sequence of commands.

The ASCII data transfers are performed by the READ and WRITE commands. A description of the syntax can be found in Section 4.4.

4-6. FRONT PANEL CONTROL

Most of the Front Panel can be remotely controlled. You can select processing modes, span width and position, displayed functions, cursor location, display format and amplitude and frequency units. Any front panel control must be preceded by the Command SET FRONT PANEL REMOTE. This command locks out the Front Panel and allows remote programming. To return to local operation, the commad SET FRONT PANEL LOCAL must be sent. The IEEE commands Device Clear And Go To Local (see Section 4.9) also return the Front Panel to local operation. The syntax of the various commands that can be used to control the 5820A is shown in Section 4.4.

STOP should be issued before any commands that change the measurement parameters. The appropriate parameters should then be selected and a START should be issued to begin processing.

4-7. READING THE STATE

Information about the current condition of the 5820A can be obtained by executing the commands READ SETUP or READ STATE. The command READ SETUP provides exactly the same information with the VIEW SETUP pushbutton. The information is transferred as a string of ASCII characters.

A much more detailed description can be obtained by executing the command READ STATE. The format of the command is

READ STATE X1 X2

where X1 and X2 have the meaning previously described in connection with binary transfers. The complete state can be read by executing READ STATE and reading, in binary format, 70 bytes. If only bytes 10 through 15 are of interest, the command READ STATE 10 15 can be executed. The meaning of each bit of the 70 byte state descriptor is given in Appendix G.

4-8. SERVICE REQUESTS

The 5820A can issue Service Requests if either channel overloads, at the end of the linear portion of Averaging and at the end of Autoranging. The command SRQ with the appropriate argument enables the desired SRQ. The Service Requests are disabled by the command SRQ RESET. It should be noted that a sequence of SRQ commands can be issued to enable more than one Service Request condition.

Aside from these maskable Service Requests, the 5820A will always generate Service Requests when it cannot decode properly an IEEE command. The bits of the Serial Poll register corresponding to the various Service Request conditions have been allocated in the following way:

Bit #	7	6	5	4
	SYNTAX	SRQ	END OF AVG	B OVLD
Bit #	3	2	1	0
	A OVLD	ILLEGAL COMMAND	DIGITAL PLOT	END OF AUTORGE

Whenever a Service Request is pending, the message SRQ is displayed in reverse video on the Status Line (third line from the bottom) of the CRT, if the CRT is not in Remote or Menu mode.

4-9. DISPLAYING MESSAGES

Messages to guide or warn the operator can be displayed on the screen under IEEE control. To enter this mode, the command SET READOUT REMOTE must be sent. This command stops the 5820A processor from updating the screen. The command TEXT clears the screen and formats it as as 16x32 character display. The command SET READOUT LOCAL restarts normal operation. It is also possible to write one line of text with up to 32 characters on the screen without clearing it, thus overlaying the text with the displayed functions. This can only be done by binary transfers. To write in this fashion, follow these steps:

1. SET READOUT REMOTE
2. n = 49160
3. BREAD n
4. If the byte read is different than zero, n=n+8, go to step 3.
5. BWRITE n n+8
6. Send the following 9 bytes:
   a. Byte #1 = 1
   b. Byte #2 = 48
   c. Byte #3 = 0
   d. Byte #4 =207
   e. Byte #5 = x position of the first character
   f. Byte #6 = y position of the line
   g. Byte #7 =256 - Number of characters
   (e.g. for 4 characters = 252)
   h. Byte #8 =128
   i. Byte #9 = 0
7. BWRITE 52992 52991 + (Number of Characters). Send the ASCII characters as sequence of bytes.

It should be noted that in this mode the display is not updating but processing is continuing. The command SET READOUT LOCAL again returns the unit to normal operation.

4-10. IEEE COMMANDS

The 5820A can also respond to some standard IEEE commands. This section describes these commands.

4-10-1. Group Execute Trigger

When a Group Execute Trigger is issued by the controller, the IEEE interface section of the 5820A provides a trigger to the Triggering section. If the unit is in transient mode and the source of the trigger has been specified to be the IEEE (see Section 3-5-7) data collection starts at that point.

4-10-2. Device Clear

A Device Clear command sets the Front Panel to local mode and releases the 5820A, if it had been stopped to perform Data Transfers.

4-10-3. Parallel Polling

The 5820A recognizes the commands:

a. Parallel Poll Configure to allocate the specified bit in the Parallel Poll Register.

b. Parallel Poll Enable to present its bit on the bus.

c. Parallel Poll Unconfigure to deallocate the bit from its Parallel Poll Register.

4-10-4. Serial Poll

The 5820A can be placed in the Serial Poll Active State (SPAS) to present its Serial Poll Register. The contents of the Serial Poll Register were described in Section 4.7.

4-10-5. Remote/Local

The 5820A recognizes the Go To Local, and Remote Commands. The Remote/Local state is shown by the

Front Panel IEEE LED. It should be noted that the 5820A will not accept commands if it is in the Local state.

CHAPTER V

OPERATIONAL VERIFICATION

5.1 INTRODUCTION

Operational verification consists of a number of tests. The first two will verify nearly all the functions of the instrument, while the rest will verify many specifications. This verification should be used by incoming inspection or after a repair has been made.

5-2. DIAGNOSTIC TESTS

The built-in diagnostic tests are selected to verify the operation of most of the digital processing and control operations.

The procedure for using the tests will be described. More details are given in Section C-2.

Fifteen minutes after turn-on, press the RESET button twice to invoke the diagnostic tests. Allow to run for 5 minutes. Correct operation of the digital processing and display sections are verified by indication of 0 (zero) failures under the heading STATUS and FAILURES listed on the CRT (Fig. C2-1a).

Proceed to the front panel test by pressing any front panel key except RESET for a few seconds. At the end of the TSG test, the program will go to the front panel test and change the lower portion of the diagnostic pattern to the form shown in Fig. C-2-2a. Codes for the three kinds of switches will be displayed.

Next to "KEY" is a 4-digit code corresponding to the numbers indicated in Fig. C-2-1b for the front panel key that was most recently pressed.

Press each key and verify the correct code is listed as indicated in Fig. C-2-1b.

Next to "TOG" is a 2-digit code for the 2 toggle switches that select AC, DC or GND. Code is given in

Table C-2-2A. Verify each toggle switch position by comparing the code to the table.

Next to "SPAN" is a 3-digit code corresponding to the selected span. Verify switch by changing position and comparing the code to the front panel markings.

5-3. ANALOG SECTION VERIFICATION

Following the diagnostic tests, press RESET once to return the instrument to its normal preset state.

Set the SPAN dial to 50 KHz and then press the TEST key in the AMPLITUDE section. Verify that the display corresponds to Fig. 3-5-1b. Nominal amplitude of the first peak after DC should be -26 dBV.

By completing the tests in Section 5-2 and 5-3, you have verified most of the functions in the instrument.

5-4 D.C. BALANCE VERIFICATION

Prior to proceeding with any further tests verify that the internal D.C. offset is 20 dB below fullscale.

Set the unit to its preset state and allow at least a 30-minute warm-up.

Set both input coupling switches to DC, the FLOAT-GND switch to GND and short both input BNCs.

Set the SPAN switch to 50 KHz and the cursor to 0 Hz.

Verify that the readout or display at DC is at least 20 dB below full scale sensitivity for SENSITIVITY ranges (dBV):
-20, -21, -22, -23, -24, -26, -29, +10, 0.

Set both input coupling switches to AC and continue the tests for -60 and -70 dBV full scale sensitivity settings.

5-5. SENSITIVITY AND AMPLITUDE ACCURACY VERIFICATION

Equipment required:

Wavetek Rockland Model 5100 Frequency Synthesizer

Fluke 8922A Digital Voltmeter.

Set the instruments to the preset state with both inputs set to AC coupling, the shell of the BNCs to GND and the SPAN to 50 KHz.

Apply a sine wave at -26 dBV, 2.000KHz to each channel, one at a time, with input sensitivity set to -20 dBV. Use the cursor and the IMPROVED Accuracy key to measure the amplitude of the 2.000KHz signal. Verify if amplitude is within 0.6 dB of the input level, -26dBV.

Use the READOUT menu and set the cursor's amplitude to 0.0dB at 2.000KHz.

Change the input level to -23dBV and the input sensitivity to -29dBV. Measure and record any amplitude differences from 0.0dB.

Repeat for the Input Sensitivity set at -22, -23, -24, -25, -26, -29, +10, 0, -40, -60 and -70 dBV while the input signal is always set 6 dB less than the sensitivity. The maximum difference between any two measurements must be less than 0.7 dB, typically 0.4dB.

5-6. FREQUENCY ACCURACY VERIFICATION

Equipment needed:

Wavetek Rockland Model 5100 Frequency Synthesizer.

Set the instrument to the preset state with AC coupling, the shell of the BNC's to GND and the span to 50 KHz.

Apply a 2000.000 Hz signal, with a nominal 1 Volt amplitude to Ch A. Select AUTORANGING. Read cursor's frequency of the peak in Power Spectrum A. Verify its frequency is 2.000 + 125 Hz. Hold Improved Accuracy and verify its frequency is 2000 + 12.5 Hz.

Repeat using the 5 KHz span and the start frequency at 0 Hz. Verify the frequency is 2000 + 12.5 Hz and 2000 + 1.25 Hz in Improved Accuracy mode.

5-7. EQUIVALENT INPUT NOISE VERIFICATON

This test verifies that the typical equivalent input noise is less than -155dBV/ $\sqrt{Hz}$ for frequencies greater than 100 Hz.

Set the instrument to the preset state, both GND/FLOAT switches to GND, coupling to AC and connect two BNC shorts to CH A and B input BNCs.

Set both input sensitivities to -70dBV, cursor readout to RMS/ $\sqrt{Hz}$ and number of averages to 32.

With the cursor at 11.5KHz verify the noise performance. Be careful that the cursor is not setting on a spurious signal.

5-8. DISTORTION LEVEL VERIFICATION

All distortion terms are specified to be 70 dB below full-scale. By using a low distortion oscillator, like the HP239A oscillator, the linearity of the input amplifiers and the A/D converter system may be verified.

Set the instrument to the preset state, span to 50 KHz, number of averages to 32.

Set the 293A to 1.0VRMS at 5 KHz and connect to both channels.

Adjust input sensitivity to 1 dB below onset of overload.

Verify that the distortion at 10 KHz, 15 KHz, 20 KHz, etc. are below 70 dB wrt full scale.

OPERATIONAL VERIFICATION DATA SHEET

Wavetek Rockland Model 5820A

Serial No. ____________

Test Performed by: ____________

Date: ____________

DIAGNOSTIC TESTS: PASS ______ FAIL ______

ANALOG SECTION: PASS ______ FAIL ______

DC BALANCE: -20 dB wrt full scale.

SENS(dBV)	-20	-21	-22	-23	-24	-25	-26	-29	0	+10	-60	-70
dBR - CH A												
dBR - CH B												
	← D.C.									→	← A.C.	→

SENSITIVITY AND AMPLITUDE ACCURACY: 0.6 dB overall amplitude accuracy and 0.7 dB total sensitivity accuracy, typically 0.4 dB.

SENSITIVITY -20 dBV
LEVEL-IN -26 dBV
Level-measured ____________

FREQUENCY ACCURACY:

SPAN=50KHz		with Improved Accuracy
SET-Hz	2000.000	2000.000
MEASURE-Hz	________	________
Spec-Hz	2000 ± 125	2000 ±12.5

SPAN=5KHz		with Improved Accuracy
SET-Hz	2000.000	2000.000
MEASURE-Hz	________	________
Spec-Hz	2000 ± 12.5	2000 ± 1.25

EQUIVALENT INPUT NOISE: Typical performance is -155 dBV/$\sqrt{Hz}$ for frequencies greater than 100Hz.

SPAN = 50 KHz

FREQ = 11.5 KHz

CH A ________ dBV/$\sqrt{Hz}$

CH B ________ dBV/$\sqrt{Hz}$

DISTORTION: specs are 70 dB below full scale.

SPAN = 50 KHz

SENS ≈ + 2 DBV

INPUT= 5 KHz @ 1.0 VRMS

FREQ-KHz	5	10	15	20	25
AMPLITUDE -dBV					
AMPLITUDE wrt FS					

APPENDIX A — TUTORIAL
DEVICE SCHEMATIC

Supplied with this manual is a notch filter to be used with the tutorial given in Section 3-7. The notch is centered about 10 KHz with an attenuation of 25 dB.

A Schematic is shown in Figure A-1.

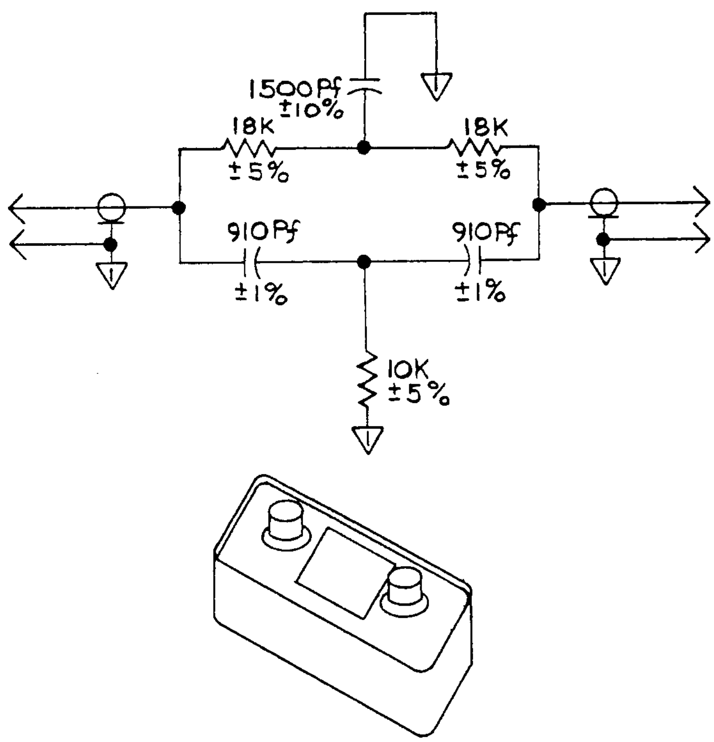


FIG. A-1 SCHEMATIC OF THE NOTCH FILTER

APPENDIX B
SUMMARY OF 5820A
CONTROLS AND OPERATIONS

B-1 INSTALLATION AND POWER REQUIREMENTS

CAUTION:

In keeping with standard safety practice, the case of the instrument is grounded through the power cord. If the instrument must be connected to a two-wire receptacle, use a parallel-ground adapter and connect the short lead securely to ground.

POWER

The Model 5820A will operate from either 115 or 230 VAC. Before connecting power, make sure that the instrument is compatible with the nominal line voltage and that a fuse with the proper rating is installed.

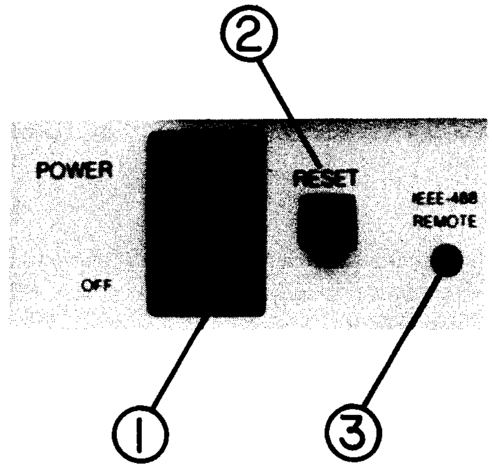
OPERATING PRECAUTIONS

Do not exceed the following limits:

Input Signal level, AC + DC:
200 V peak, -10 dBV to +20 dBV F-S Sensitivity.
40 V peak, -30 dBV to +20 dBV F-S Sensitivity.

Input Low to Chassis, Isolated: 30 V.

B-2 POWER SWITCH, RESET SWITCH & REMOTE INDICATOR

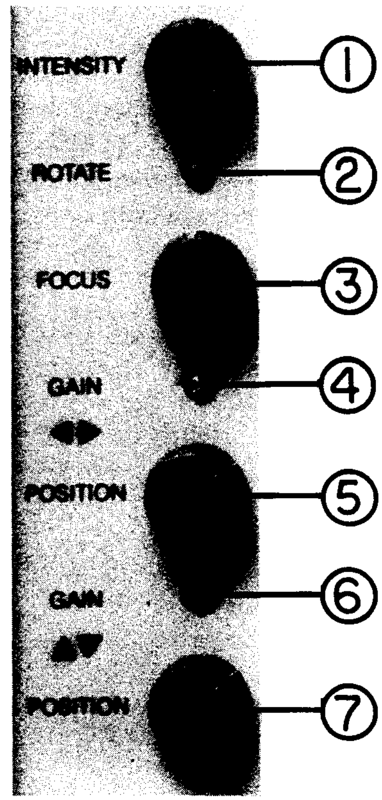


(1) Applies power to the instrument when the top is pushed in; at this point the instrument goes through a pre-determined power-up and self-test procedure; following this, the instrument comes up in a pre-determined or preset state, which may be seen by pressing the VIEW SET UP Key (see Section B-4).

(2) Restores the instrument to the same preset state as when turning power on and clears all memories. Pressing twice in quick succession causes diagnostics to run.

(3) When lit, it indicates that the instrument is under remote control via the GPIB interface.

B-3 CRT CONTROLS



(1) Clockwise rotation increases the intensity of CRT display.

(2) Rotates entire display clockwise, or counterclockwise.

(3) Adjusts the focus, or sharpness of the display.

(4) Clockwise rotation increases horizontal size of the display.

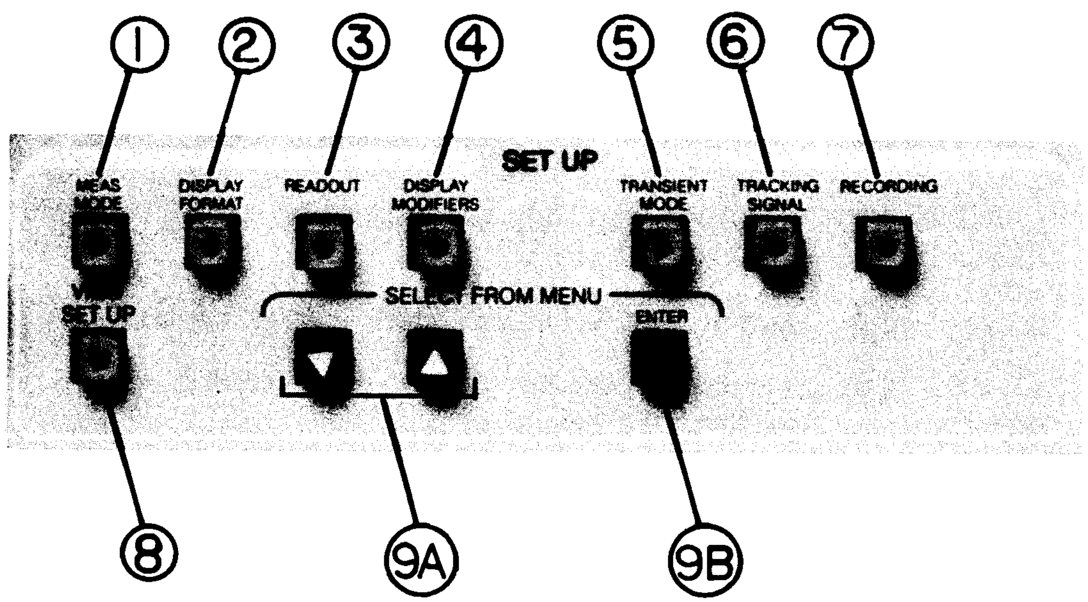
(5) Moves display left or right, without changing its size.

(6) Clockwise rotation increases vertical size of the display.

(7) Moves display up or down, without changing its size.

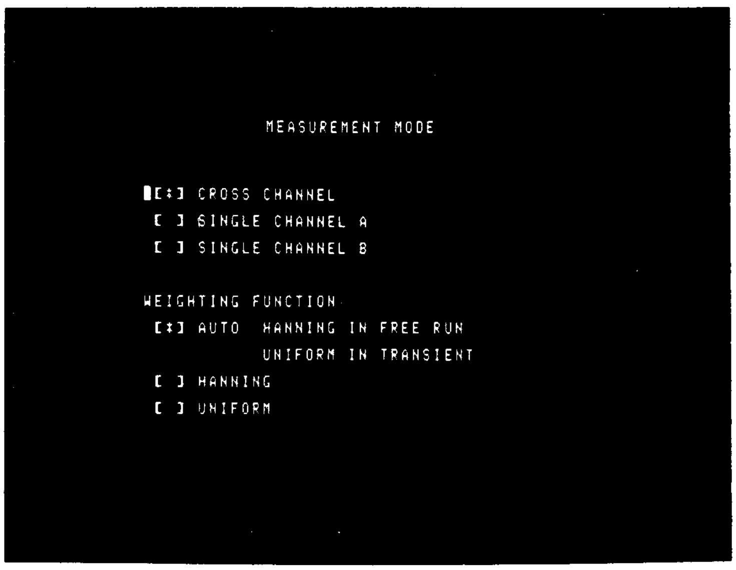
B-4 SET UP

This section provides controls for selecting measurement modes, display calibration, and other functions or measurements. They are all selected from CRT Menus, which appear when any one of the seven keys in the top row is pressed. Pressing the same key again causes the menu to disappear. A flashing cursor may be moved up or down on the menu to select the desired line. Selection is performed by pressing the ENTER key and an asterisk (*) appears next to the selected menu line. When menu selections are completed, a summary of the instrument set up is available for viewing by pressing the VIEW SET UP key.



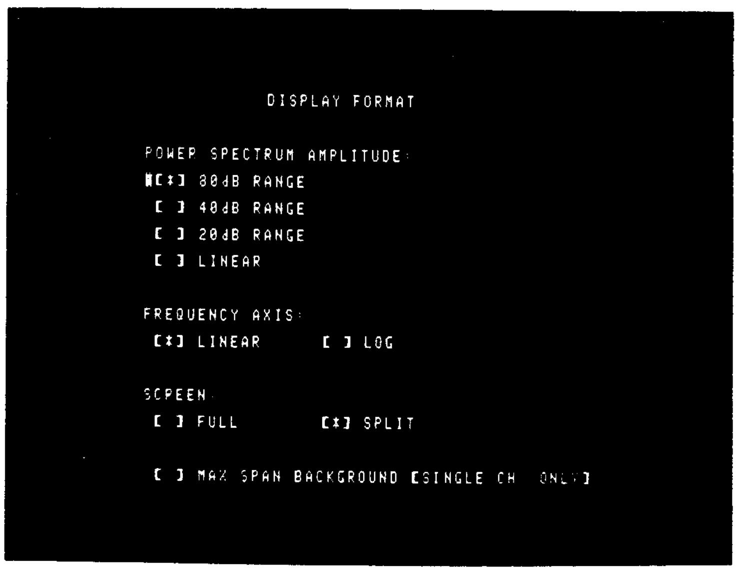
(1) Measurement Mode

Determines whether input samples are taken from CH A, CH B, or both. Also specifies the choice of weighting function.



(2) Display Format

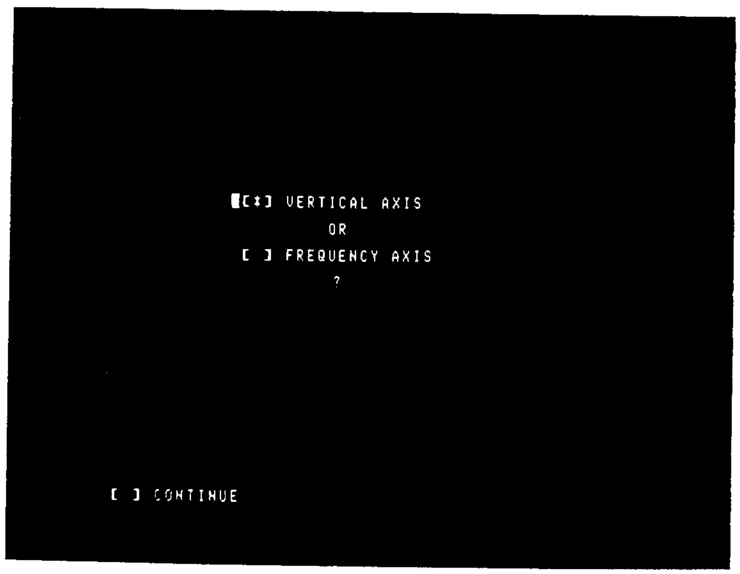
Provides choice of full or split screen display, linear or log frequency axis, linear or log amplitude axis, and full-scale vertical range. Full screen is used when two displays are selected; background is dimmed.



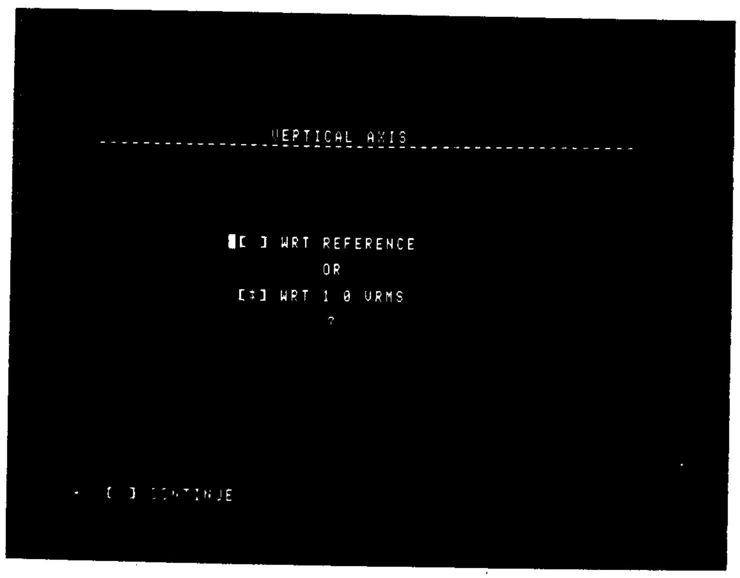
③ Readout

Allows for vertical and horizontal scale calibration, in terms of standard or engineering (arbitrary) units.

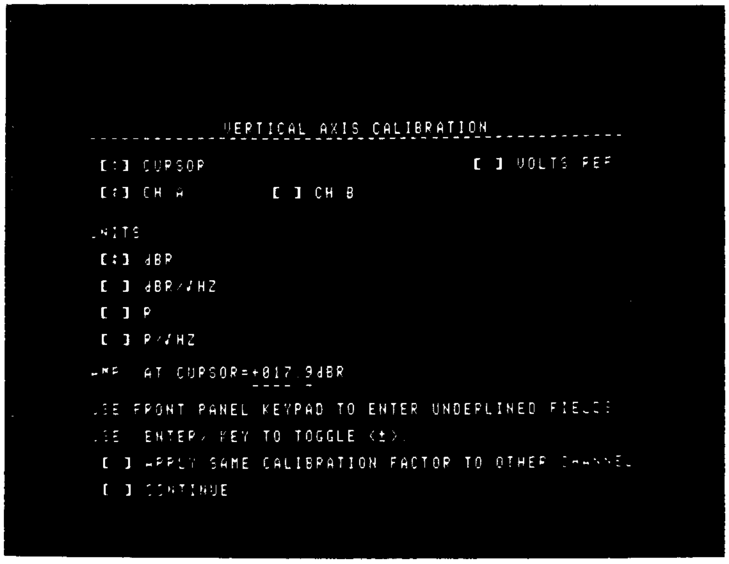
a) Select axis to be calibrated.



b) If the vertical axis is selected, then choose either engineering units, i.e. "WRT REFERENCE" or the default condition 1.0 VRMS.



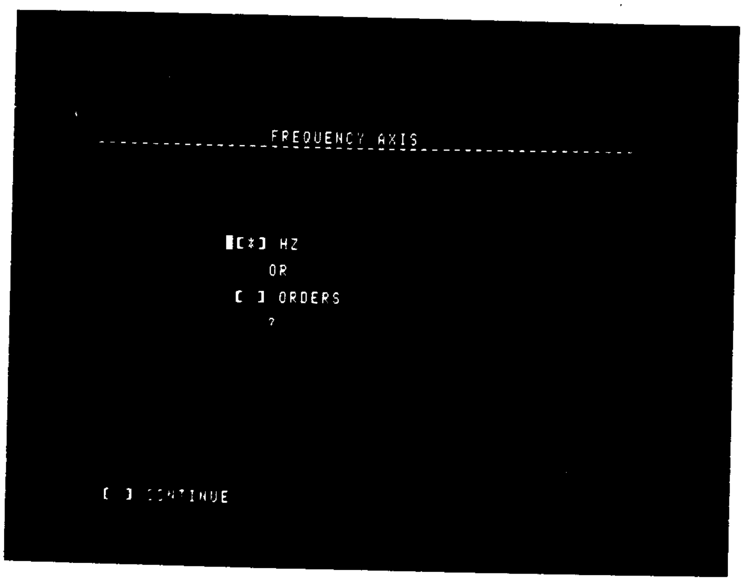
c) Details for Vertical Axis calibration on Engineering units.



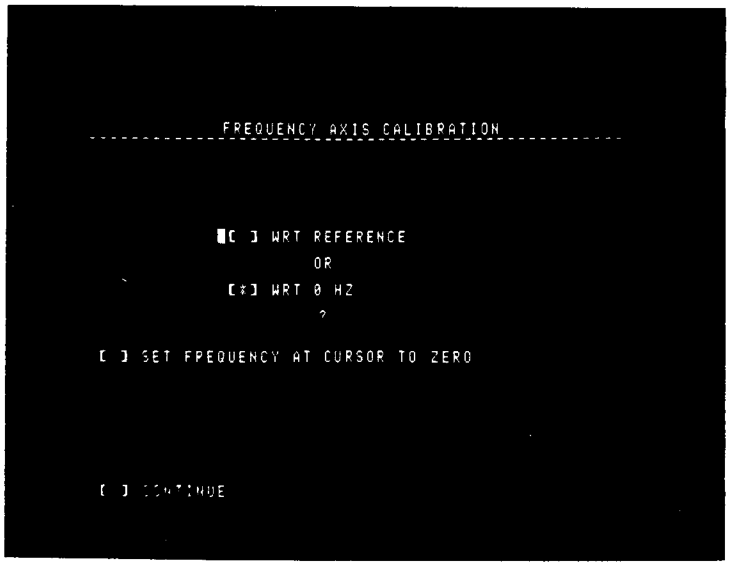
i. Define amplitude at the cursor as the reference signal or transducer's intensity.

ii. If cursor is selected then define its units and amplitude.

d) If Frequency Axis is selected, then choose its units as either Hz or Orders.

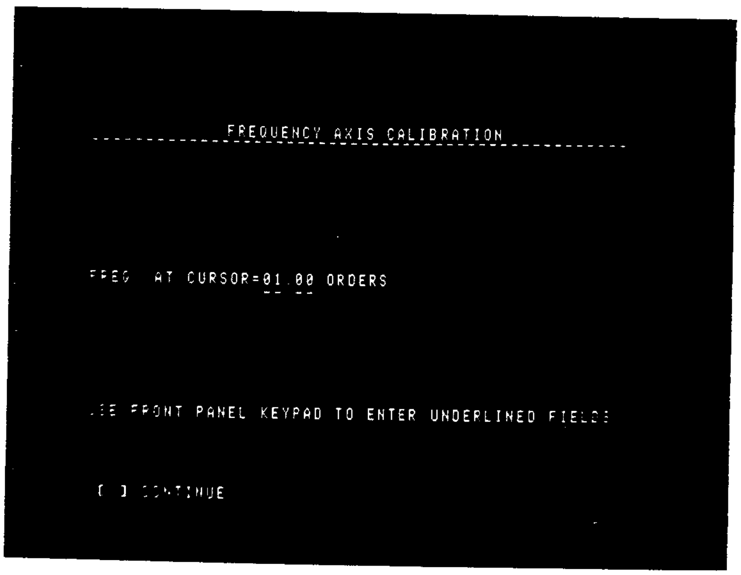


e) If Hz is selected, then select if readout is referenced to DC (0 Hz) or a reference.



i) If reference is selected then define frequency at the cursor as 0 Hz.

f) If ORDERS selected, then define the order number of the cursor location.

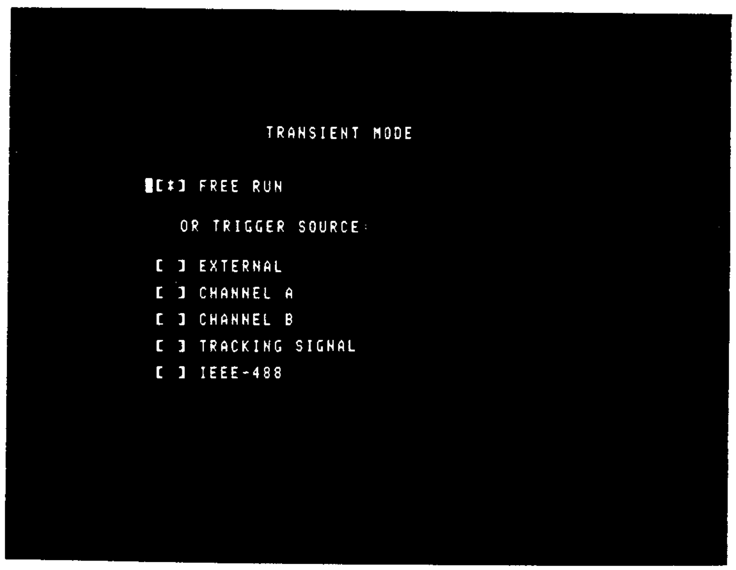


(4.) Display Modifiers

For editing Transfer Function measurements, and for comparing (ratio, difference) a measurement with a previously stored measurement. EDIT XFR FN dims positions of transfer functions that may be in error.

(5.) Transient Mode

Determines Free Run, or Triggered operation and the choice of trigger signal source. IEEE-488 trigger source is derived from a Group Execute Trigger sent by a controller.

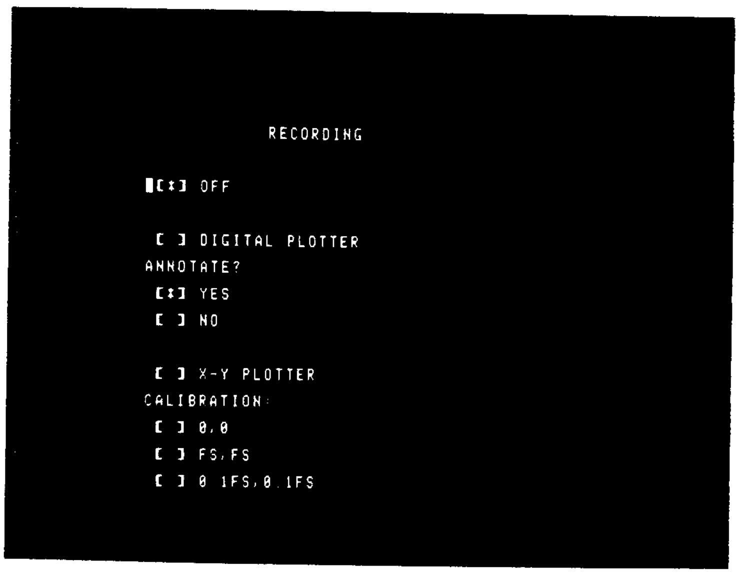


6. Tracking Signal

Determines the type of tracking signal to be connected to the device under test.

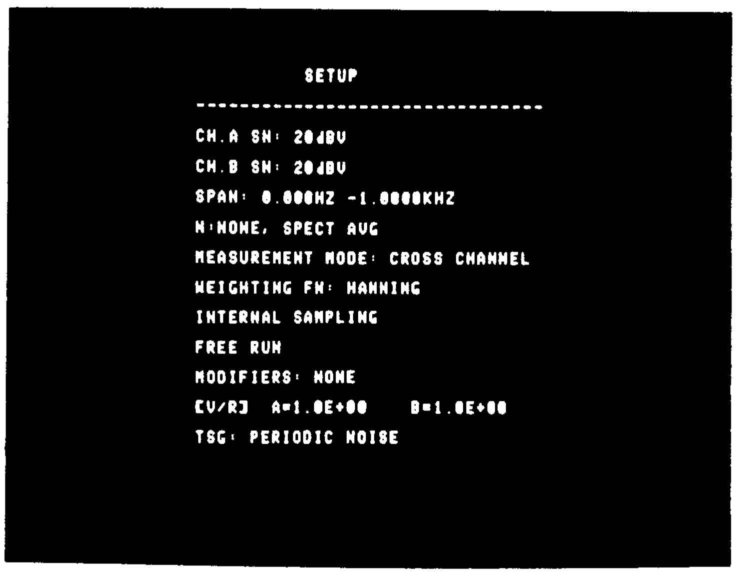
(7.) Recording

Determines the type of hard copy output to be obtained; also provides calibration of X-Y recorder.



(8.) View Set Up

Provides a condensed listing of the set up state of the instrument.



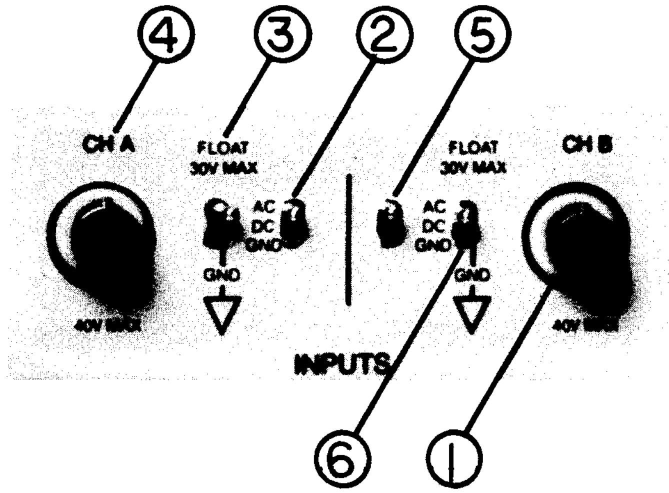
9A. Moves menu cursor down ▼, one line per keystroke. When the last line is reached, pressing the key again will position the cursor next to the top line of the menu.

Moves menu cursor up ▲, one line per keystroke. When the top line is reached, pressing the key again will position the cursor next to the bottom line of the menu.

9B. Enters the menu selection on line next to cursor. Selection entered indicated by asterisk (*).

B-5 INPUTS

Allows for connection of input signals and determines what type of connection is to be used.



(1) Input BNC Connector for Channel B.

(2) Selects whether Channel A input circuit is AC coupled, DC coupled, or grounded. (When grounded it will not short-circuit the external signal source).

(3) Selects whether Channel A input low terminal (BNC shell) is floating (up) or connected to chassis ground (down).

(4) Input BNC Connector for Channel A.

(5) Selects whether Channel B input low terminal (BNC shell) is floating (up) or connected to chassis ground (down).

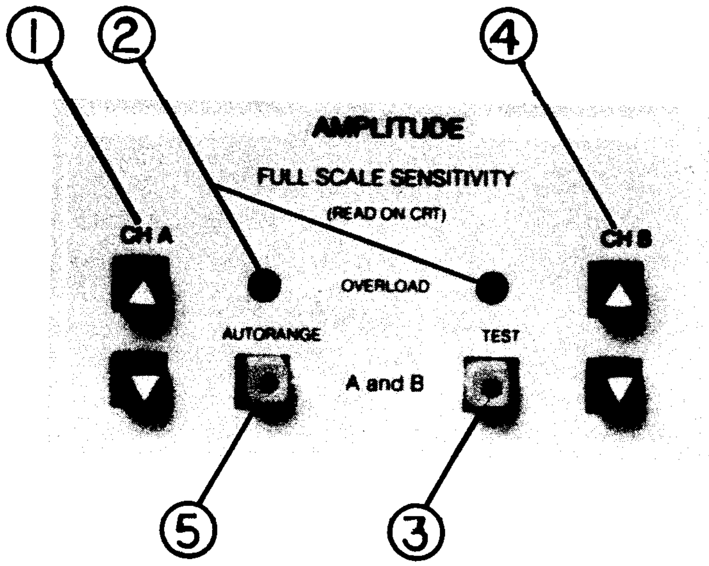
(6) Selects whether Channel B input circuit is AC coupled, DC coupled, or grounded (When grounded, it will not short-circuit the external signal source).

Note:

DC coupling in -50, -60, and -70 dBV full-scale sensitivity settings is not recommended

B-6 AMPLITUDE

Allows for setting full scale sensitivity, either manually or automatically; it also provides for overload indication and for connection and display of an internal test signal.



(1) Allows for increasing ▲ or decreasing ▼ full scale sensitivity of Channel A. When pressed and held sensitivity will advance in steps of 10 dB; otherwise, sensitivity will advance in steps of 1 dB per keystroke. Full-scale sensitivity is indicated on the CRT.

(2) Independent overload indicators for each channel. Overload occurs when input level exceeds full scale. Reduce corresponding channel sensitivity until OVERLOAD light extinguishes, or flashes only occasionally. Occasional overload will only prevent processing of the particular data block which caused the overload; the remaining data blocks will be processed properly. When an overload lasts more than a predetermined length of time, the statement (CONT OVLD) appears on the CRT.It is only a message that a significant number of data blocks were not processed. It does not mean that processing has been stopped.

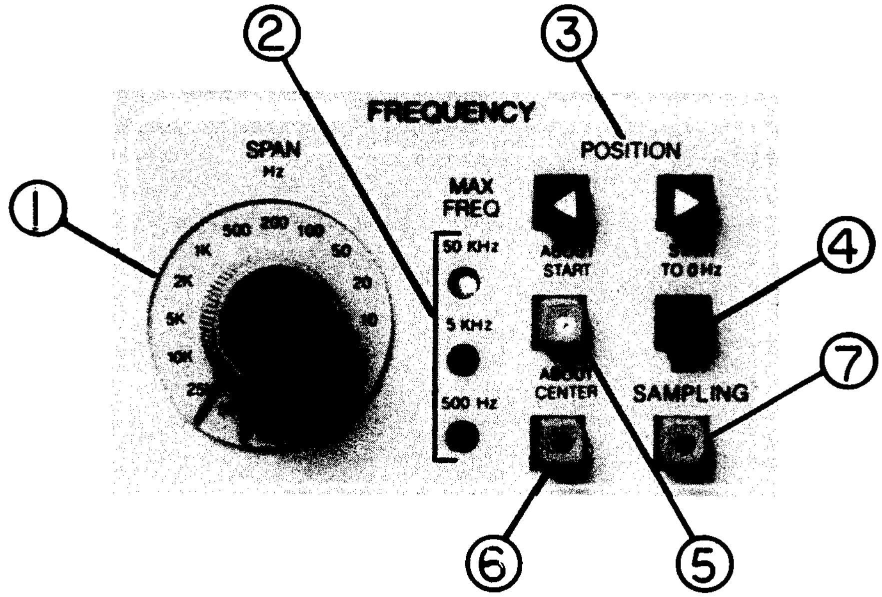
(3) When activated, an internally generated test signal is applied to both channels, to provide a quick indication of proper instrument operation.

(4) Allows for increasing ▲ or decreasing ▼ full scale sensitivity of Channel B. When pressed and held sensitivity will advance in steps of 10 dB; otherwise, sensitivity will advance in steps of 1 dB per keystroke. Full-Scale sensitivity is indicated on the CRT.

(5) When activated, full-scale sensitivity of both channels wil be automatically selected to be at the maximum allowable levels to prevent overloads. Any data block which causes an overload will not be processed. In this mode, full-scale sensitivity is changed in 10 dB steps only.

B-7 FREQUENCY

Allows for setting the frequency range over which measurements will be performed; also provides for driving the instrument from an external sampling clock.



(1) The SPAN control specifies which portion of the input spectrum will be analyzed in all but the 50 KHz position; when set in this position, the entire 0-50 KHz spectrum is analyzed. The SPAN width is indicated on the CRT.

(2) The MAX FREQ indicators show the maximum frequency range that the selected SPAN can be positioned to cover.

(3) Moves the selected SPAN down ◀ or up ▶ throughout the available frequency range. When pressed and held, span position will move continuously; otherwise, position will move one step per keystroke.

(4) When momentarily pressed, it defines the selected SPAN to start at DC.

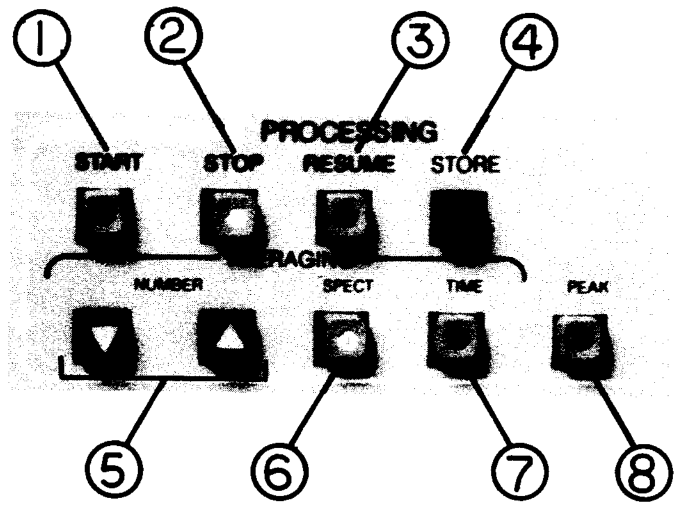
(5) When activated, the portion of the spectrum being viewed begins at a constant start frequency; its width is specified by the SPAN control.

(6) When activated, the portion of the spectrum being viewed is centered at a constant center frequency; its width is specified by the SPAN control.

(7) When activated, it selects external sampling control for digitizing input data. The external (TTL) signal must be applied through the BNC connector on the rear panel.

B-8 PROCESSING

Selects spectrum or time averaging, selects the number of averages and stores spectral calculations for later recall and comparison with subsequent calculations.



(1) When activated, it clears the memory and starts the selected processing.

(2) When activated, it halts the processing.

(3) When activated, it restarts the selected processing without clearing the memory.

(4) When momentarily pressed, it will cause fundamental measurements and associated calibration data to be stored for later recall (see VIEWING) and comparison. The word STORING appears on the CRT.

(5) Allows for increasing ▲ or decreasing ▼ the number of averages from 0 thru 256 in binary steps. The number of averages is shown on the CRT.

(6) When activated, it selects ensemble averaging of spectral measuremens.

(7) When activated, it selects ensemble averaging of the time function in either Channel A or Channel B (not both). Time averaging requires processing to be initiated by a trigger signal (see Transient Mode). The time function that is averaged corresponds to the output of a bandpass filter, whose bandwidth is equal to the SPAN setting, and center or start frequency as set by the POSITION setting (see FREQUENCY section). The spectrum amplitude and phase of the averaged time function is also calculated and it may be displayed, if selected (see VIEWING).

(8) When activated, PEAK causes the averager to store the maximum value at each frequency or time cell over the ensemble of data blocks being processed.

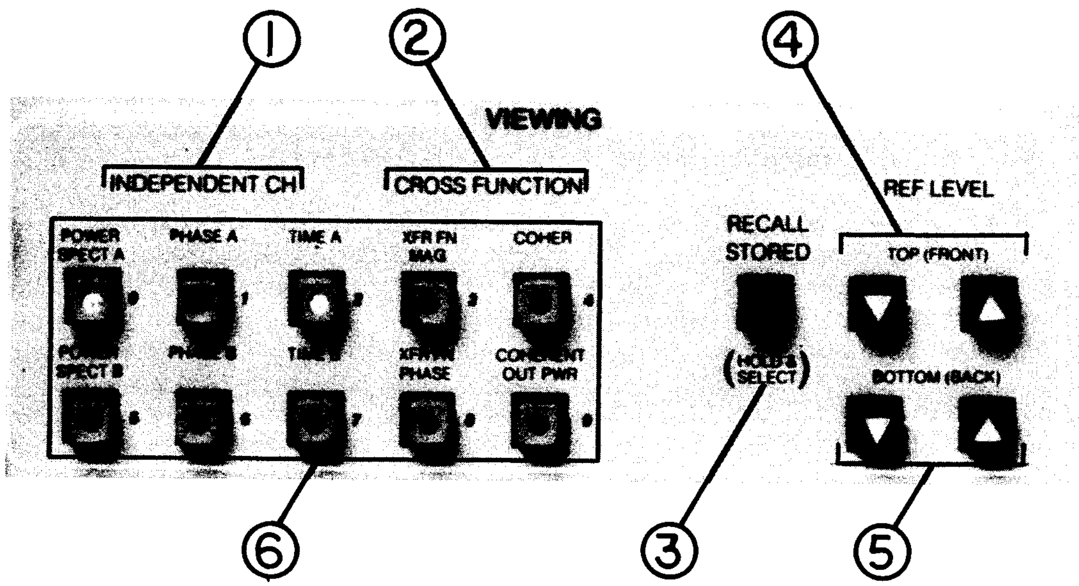
NOTE:

The number of averages selected is equivalent to the time constant of an exponential averager.

When the START Key is pressed, linear averaging is initiated (START Key light flashes). When the number of averages selected is reached, averaging becomes exponential (START Key stays on).

B-9 VIEWING

Selects the measurements to be displayed (present or previously stored) and provides for display gain or attenuation. Any two traces may be displayed simultaneously. Pressing the key activates the corresponding display; press again to erase it, or press the next desired function key. The last entry made defines the top trace in split-screen display, or the front (darker) trace in full-screen display.



(1) Independent Channel: Six functions are available in single-channel measurements: power spectrum (Ch.A, CH B), phase spectrum (Ch A, Ch B) and the time waveform (Ch A, Ch B).

(2) Cross Function: Four functions are available in cross-channel measurements: transfer function magnitude, transfer function phase, coherence, and coherent output power.

(3) To recall a stored function for display, press and hold this key, and then enter the desired function key. Repeat the procedure to remove the stored function from display. Time functions and single-channel phase spectra cannot be stored or recalled.

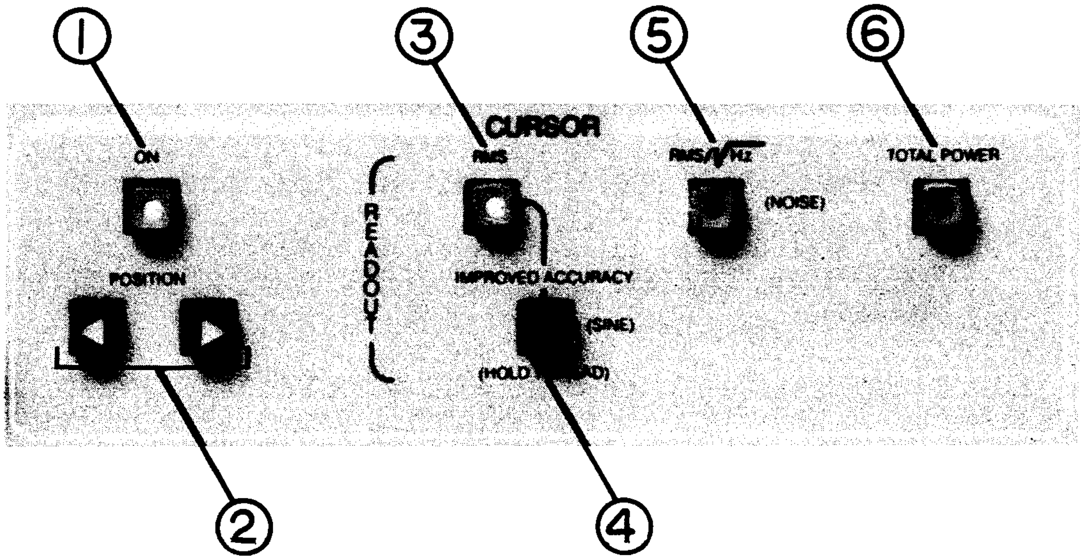
(4) Allows for increasing ▲, or decreasing ▼ display gain of the top trace in split-screen display, or the front trace in full-screen display. When pressed and held, display gain will change in steps of 10 dB; otherwise, display gain will change in steps of 1 dB per keystroke.

(5) Allows for increasing ▲ ,or decreasing ▼ display gain of the bottom trace in split-screen display, or the back trace in full-screen display. When pressed and held, display gain will change in steps of 10 dB; otherwise,display gain will change in steps of 1 dB per keystroke.

(6) Engineering Units: These ten keys revert to a numeric keyboard (0-9) for entering vertical and horizontal scale calibrations in arbitrary units. Engineering unit calibration is selected in the SET UP section.

B-10 CURSOR

Allows for positioning an intensified marker on the trace and measuring the vertical and horizontal parameters at that point.



(1) When activated, it turns on the cursor and its corresponding readouts.

(2) Allows for moving cursor left ◀ or right ▶ throughout the display. Pressing and holding down either key will cause the cursor to move continuously; otherwise, the cursor will move one frequency or time cell per keystroke. When the cursor has been moved to either end of the display, the next keystroke will position it at the opposite end of the display (wrap-around feature).

(3) When activated, the cursor amplitude readout is in RMS units. Use this for measuring discrete line spectra, or time waveforms.

(4) When pressed and held, it increases the accuracy of amplitude and frequency readouts when measuring discret line spectra.

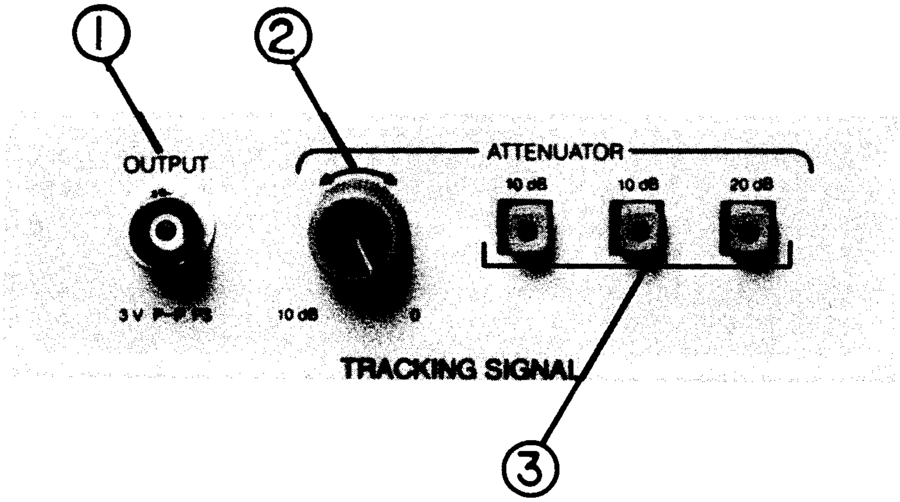
(5) When activated the cursor amplitude readout is power spectral density (RMS value per unit bandwidth).

Use this for measuring noise spectra.

(6) When activated, the cursor amplitude readout is equal to the total power in the frequency span being used except DC.

B-11 TRACKING SIGNAL

Provides the internal tracking signal output connector and defines its amplitude. The type of tracking signal available is selected in the SET UP section.



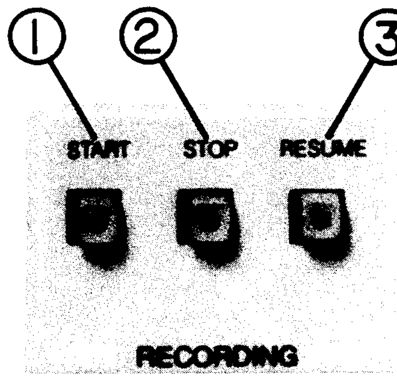
(1) Output BNC connector for connecting the tracking signal to the device under test. Max. output voltage is 3V, p-p.

(2) 0-10 dB vernier attenuator of tracking signal output amplitude.

(3) 40 dB attenuator of tracking signal output amplitude, in 10 dB steps.

B-12 RECORDING

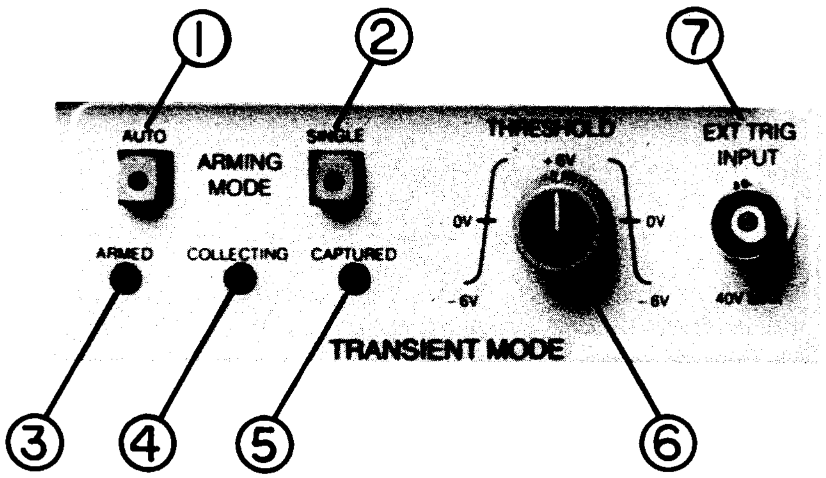
Controls the digital plotter, or X-Y recorder connected to the appropriate connectors on the rear panel. Recorder selection and calibration is made in the SET UP section.



1. Starts the plotter in the "0" position.
2. Stops the plotter.
3. Resumes plotting from position in which it was stopped.

B-13 TRANSIENT MODE

Provides controls for triggered operation, so that transient signals can be captured and analyzed. Transient mode of operation is selected in the SET UP section.



(1) When activated, transient capture is armed and automatically rearmed after a transient is captured.

(2) When activated, transient capture is armed to capture ony one transient.

(3) Indicates transient mode is armed.

(4) Indicates that data is being collected; useful in high resolution modes, when data collection may take many seconds to complete.

(5) Indicates that a block of data has been captured.

(6) Defines amplitude and slope of external trigger signal required to start collection of a data block.

(7) BNC connector for connecting an external trigger signal.

B-14 REVERSE VIDEO

When a control is activated or changed, its corresponding CRT readout appears in reverse video. A moment later, the readout automatically changes to normal.

B-15 AIRFLOW

As with any forced-ventilation instrument, care should be taken not to block normal airflow. The airpath is IN through the rear panel fan and OUT through the slots of the bottom cover. Do not obstruct this airpath.

B-16 REAR PANEL

The rear panel has the following connectors and controls.

(1) GPIB/Digital Plotter Interface.

Standard IEEE-488 Connector and selector switches for remote control or sensing and for connecting the instrument to digital plotters without a separate controller, by placing the instrument in the TALK ALWAYS mode. The spectrum analyzer will interface with the following digital plotters with GPIB:

HP 7225A/B
HP 9872B/S
HP 9872C/T
TEK 4662
TEK 4662-31
TEK 4663

(2) Display Outputs

Signals are provided to drive an external CRT display in parallel with the built-in display. The frequency response of the external display must exceed 3 MHz for X- and Y- axes and exceed 5 MHz for the Z-axis.

(3) Display Inputs

External CRT signals can be connected to the built-in display, so it can be used as a stand-alone display for another signal whose bandwidth is less than 100 KHz on each channel.

(4) Analog Plotter Interface

Signals are available to drive an external X-Y recorder; two speeds with adaptive rate can be selected from CRT menu by setting position F3, Auxiliary switch, to ON for normal rate, OFF to faster.

(5) External Sampling Clock

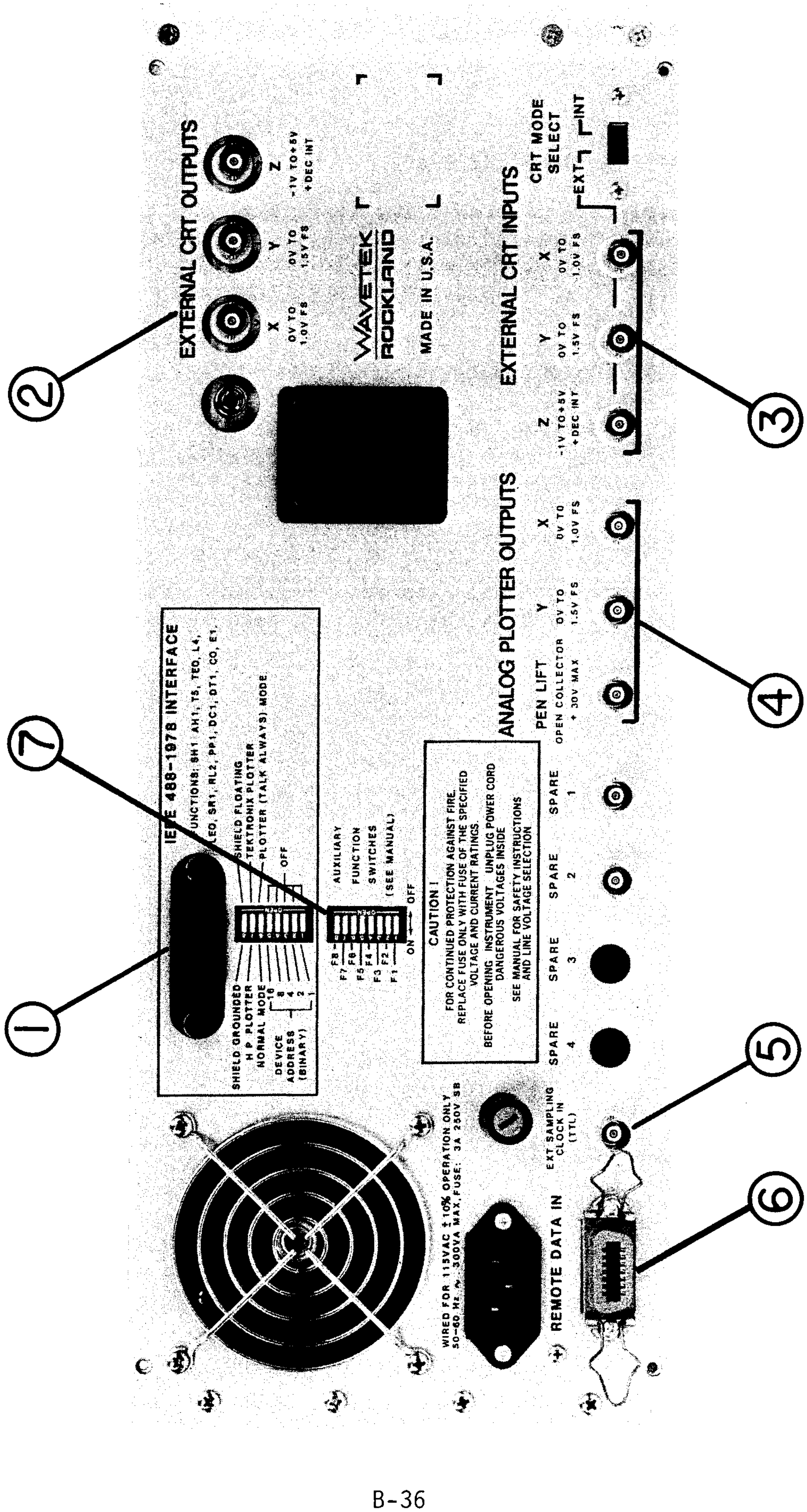
By using an external sampling clock, one can obtain stationary spectra of non-stationary signals. This capability is particularly useful in machine vibration analysis, or removal of tape recording wow and flutter.

(6) Digital Data Input

Serial Data can be directly applied to the FFT processor of the instrument, bypassing its input signal conditioners and A/D converter.

(7) Auxiliary function switch

Provides additional control functions. For example, position F3 selects the rate that data is output to an analog plotter.



EXTERNAL CRT OUTPUTS
X
0V TO 1.0V FS
Y
0V TO 1.5V FS
Z
-1V TO +5V +DEC INT
WAVETEK ROCKLAND
MADE IN U.S.A.
EXTERNAL CRT INPUTS
Z
-1V TO +5V +DEC INT
Y
0V TO 1.5V FS
X
0V TO 1.0V FS
CRT MODE SELECT
EXT
INT
ANALOG PLOTTER OUTPUTS
PEN LIFT
OPEN COLLECTOR + 30V MAX
Y
0V TO 1.5V FS
X
0V TO 1.0V FS
IEEE 488-1978 INTERFACE
FUNCTIONS: SH1, AH1, T5, TE0, L4, LE0, SR1, RL2, PP1, DC1, DT1, C0, E1
SHIELD GROUNDED
H P PLOTTER
NORMAL MODE
DEVICE ADDRESS (BINARY)
16
8
4
2
1
SHIELD FLOATING
TEKTRONIX PLOTTER
PLOTTER (TALK ALWAYS) MODE
OFF
F8
F7
F6
F5
F4
F3
F2
F1
ON
OFF
AUXILIARY FUNCTION SWITCHES (SEE MANUAL)
CAUTION!
FOR CONTINUED PROTECTION AGAINST FIRE, REPLACE FUSE ONLY WITH FUSE OF THE SPECIFIED VOLTAGE AND CURRENT RATINGS.
BEFORE OPENING INSTRUMENT, UNPLUG POWER CORD DANGEROUS VOLTAGES INSIDE
SEE MANUAL FOR SAFETY INSTRUCTIONS AND LINE VOLTAGE SELECTION
SPARE 1
SPARE 2
SPARE 3
SPARE 4
WIRED FOR 115VAC ±10% OPERATION ONLY 50-60 Hz, 300VA MAX. FUSE: 3A 250V SB
EXT SAMPLING CLOCK IN (TTL)
REMOTE DATA IN
1
2
3
4
5
6
7

APPENDIX C

BASIC TROUBLESHOOTING PROCEDURE

C-1. WHAT TO DO IF.....

The 5820A is a reliable instrument which has been carefully adjusted, operated at elevated temperatures for an extended period and totally tested before shipping. Despite these precautions, it may fail to operate properly. Our experience indicates that a few different types of failure modes are common and with a few simple procedures and using the built-in diagnostics, the problem may be cured or isolated.

First, we will discuss steps to resolve if the unit is failing, then how to use the diagnostics and make some basic measurements.

Any servicing or testing must be performed only by a qualified technician. High voltages and currents are present which are clearly hazardous to one's health. Do not go further unless you are qualified!

C-1-1. UNIT FAILED?

It will be obvious that a failure occured in the middle of an otherwise successful test. Suddenly, there will be a noticeable change in the display and/or inability to use the controls in a normal manner. However, on turn-on, there is no point of reference. Therefore, how do we know the unit failed? If it did, the typical manifestations will include some of the following:

- No display
- Nonsensical information on the screen
- "AUTO CALIBRATION" message on the screen does not go away in a few seconds.
- Input OVERLOAD LEDS stays on with both inputs grounded.
- LEDs do not come on in their normal power - up state as described in Section 3-3.

C-1-3. NO DISPLAY

Turn the 5820 on. If no display appears after 1 minute, then proceed as follows:

a. Check CRT controls, in particular, horizontal and vertical position(s) (Section 3-4).

b. Press any switch which has an unlit LED to see if it now lights, e.g., VIEW SET UP. If it does not, it is possible another switch is stuck. Wiggle each one.

c. Check to see if an external CRT connected to rear panel BNC's has a display.

C-1-4. OVERLOAD LED ON CONTINUOUSLY

Turn the 5820 on. If the overload LED stays on continuously with no input signal applied, then proceed to the following:

Set SPAN switch to 50 KHz range and press RESET. If OVERLOAD LED stays on, then reseat filter board (Fig.C-1).

C-1-5. RESETS OFTEN, APPEARS INTERMITTENT OR PROCESSING "LOOKS" WRONG

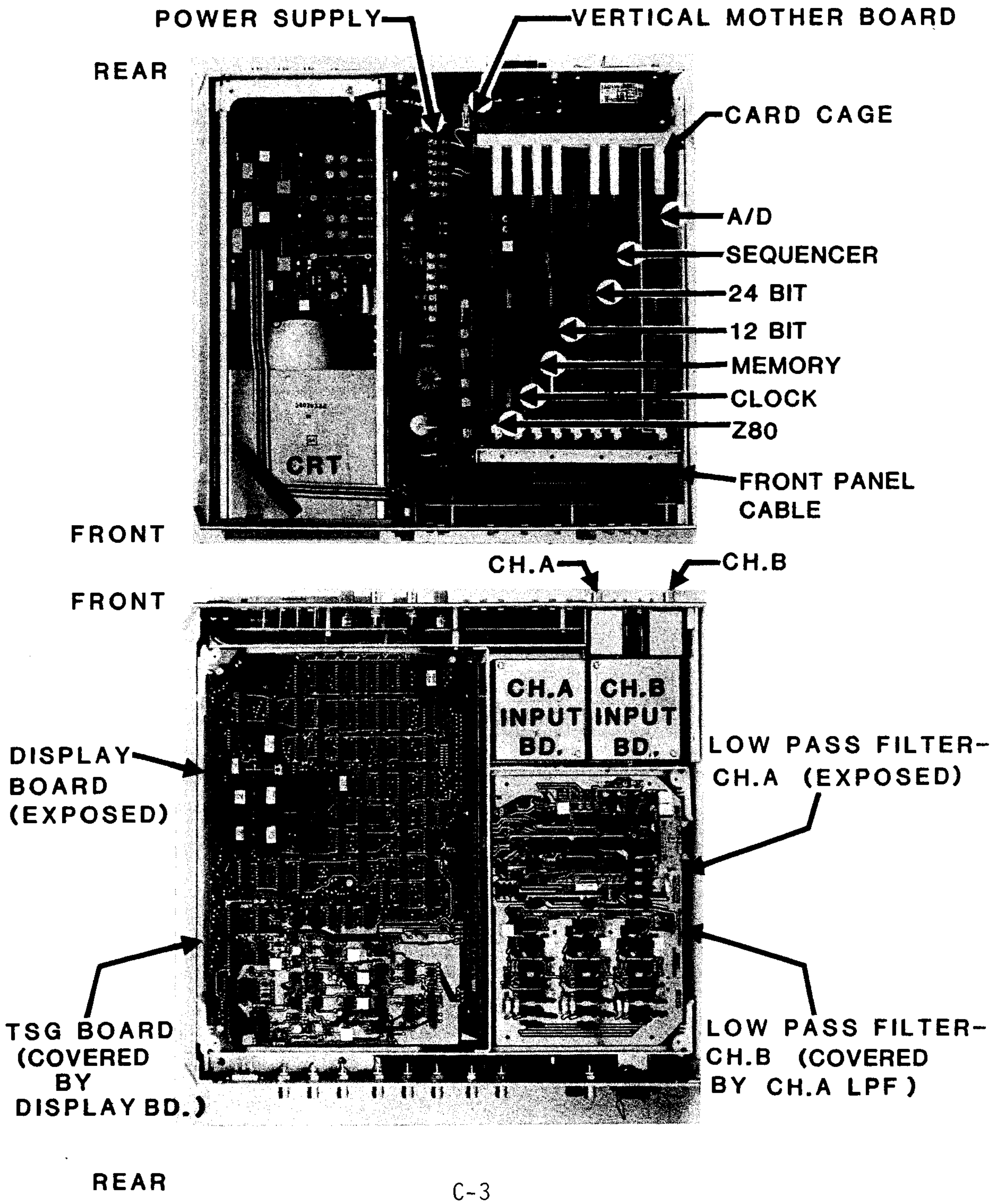
If the instrument's behavior is erratic, or not cured by the steps in C-1-3 or C-1-4, then perform the diagnostic tests.

C-2. DIAGNOSTIC PROCEDURE.

Built-in to the Model 5820A is a diagnostic module which will exercise portions of the processor and help isolate problems to the board level.

The diagnostics proceed by performing basic tests and, if anyone of them fails, instruct the user to follow a specific procedure.

Fig. C-1 Top and Bottom views



C-2-1. Diagnostic Pattern and Codes.

The basic diagnostic procedure is based on using the diagnostic pattern shown in Fig. C-2-1a.

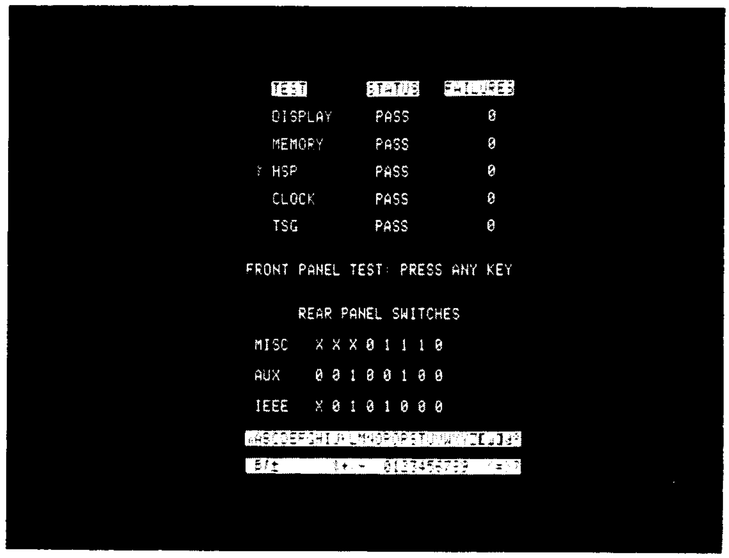


Fig. C-2-1a Typical Diagnostic Pattern

The TEST column indicates the particular board test performed.

i) DISPLAY means display test.
ii) MEMORY means memory test.
iii)HSP means high speed processor test.
iv) CLOCK means clock test.
v) TSG means tracking signal generator test.

The STATUS column shows the real time pass or fail status for each test.

The FAILURES column provides the number of failures accumulated since the diagnostic mode started. These counters will increment up till 9. For failures that are greater than 9, ">9" will appear on the CRT.

The cursor "*" identifies the test that is currently executing by staying on in front of the corresponding test name on the CRT.

The two rows of character strings appearing at the lower part of the pattern show the character set available.

The results of the board tests are also indicated by turning on LED's. All the LEDs are coded and identified in Fig. C-2-1b.The specific error codes corresponding to the boards are given in the table below. In addition, more specific failure modes are indicated by the LED error codes.

C-2-2. FRONT PANEL CODES

The next test verifies that the front panel keys and some switches are functioning properly. The phrase "FRONT PANEL TEST: PRESS ANY KEY" means that in order to enter the test, the operator must press - for a few seconds - any key on the front panel. At the end of the TSG test, the program will go to the front panel test and change the lower portion of the diagnostic pattern to the form shown in Fig. C-2-2a. Codes for three kinds of switches will be displayed.

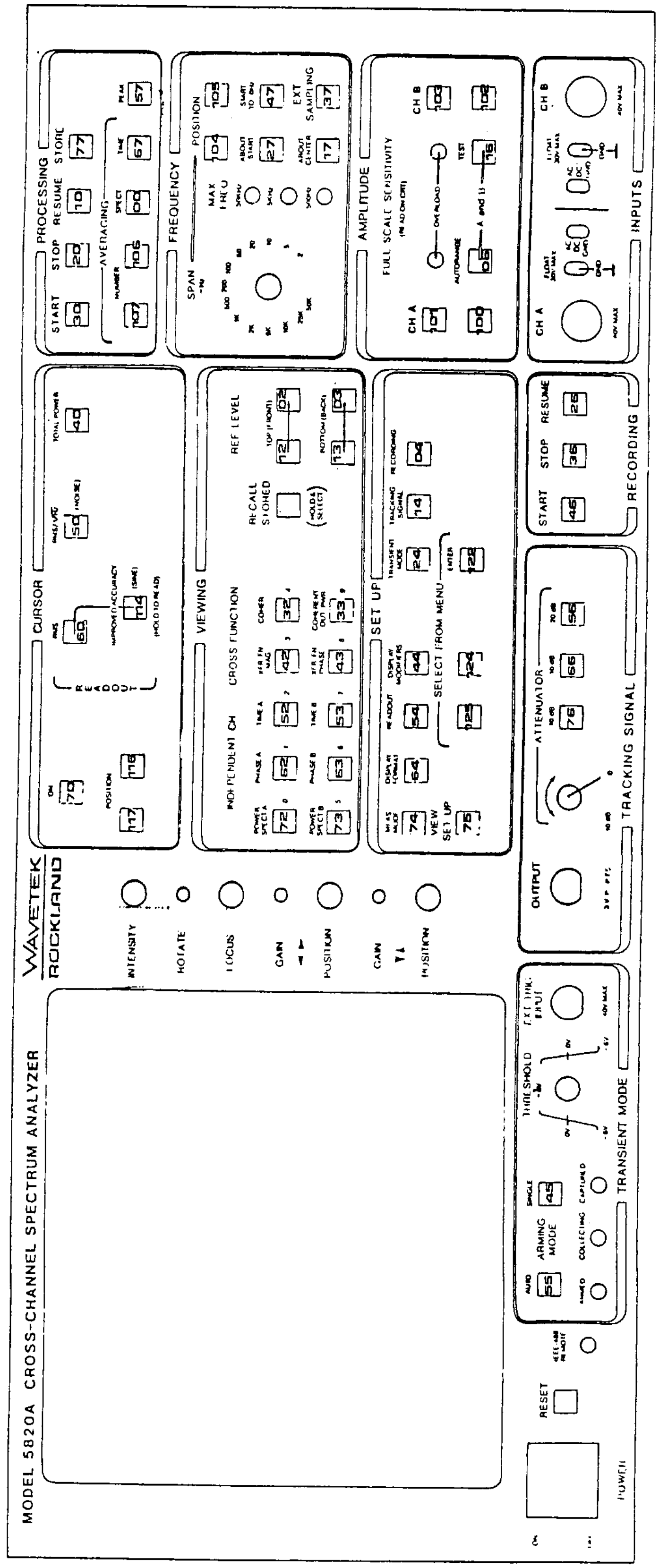


Fig. C-2-1b Front Panel Switch Codes

Next to "Key" is a 4-digit code, corresponding to the numbers indicated in Fig. C-2-1b, for the front panel key that was most recently pressed.

Table C-2-1a

ERROR CODES

TEST	ERROR INDICATING LED	FAILURE MODE
DISPLAY	72	EPROM
	62	DISPLAY RAM DATA LINE
	52	DISPLAY RAM DATA LINE
	42	DISPLAY RAM DATA LINE
	32	DISPLAY RAM ADDRESS LINE
MEMORY	73	MAIN MEMORY DATA LINE
	63	MAIN MEMORY DATA LINE
	53	MAIN MEMORY DATA LINE
	43	MAIN MEMORY ADDRESS LINES
HSP	06	
CLOCK	16	
TSG	74	REGISTER (Z80 #2)
	64	EPROM CHECK SUM
	54	DISPLAY RAM TEST
	44	MAIN MEMORY DATA LINES
	24	MAIN MEMORY DATA LINES
	14	MAIN MEMORY DATA LINES
	04	MAIN MEMORY ADDRESS LINES

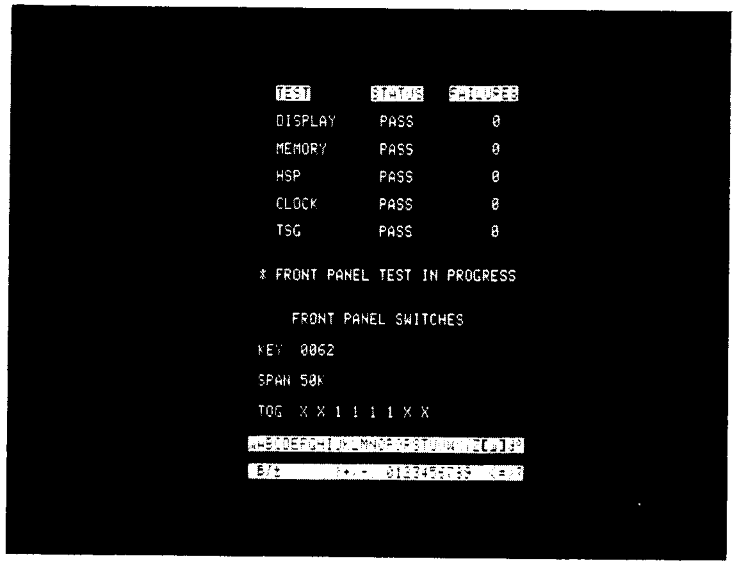


Fig. C-2-2a.

Next to "TOG" is an 8-digit code for the 2 toggle switches that select AC, DC, or GND. Code is given below.

TABLE C-2-2A. TOGGLE SWITCH CODE

CH A	AC	DC	GND
CH B			
AC	XX0011XX	XX1011XX	XX1010XX
DC	XX0111XX	XX1111XX	XX1110XX
GND	XX0101XX	XX1101XX	XX1100XX

Next to "SPAN" is a 3-digit code corresponding to the selected Span.

C-2-3. REAR PANEL CODES

Below "REAR PANEL SWITCHES" are codes for three types of switches on the rear panel. Next to "MISC" is a 8-bit binary code corresponding to description given in Table C-2-3a.

TABLE C-2-3a MISCELLANEOUS SWITCH CODE.

BIT NO.	DESCRIPTION	VALUE
7	(Left-most bit)	x
6		x
5		x
4	REM DATA (pin #3 on Remote Data In connector)	0 or 1
3	CRT INT	0
	CRT EXT	1
2	INIT (pin #4 on Remote Data In connector).	0 OR 1
1	Spare 2 BNC	0 or 1
0	Spare 1 BNC	0 or 1

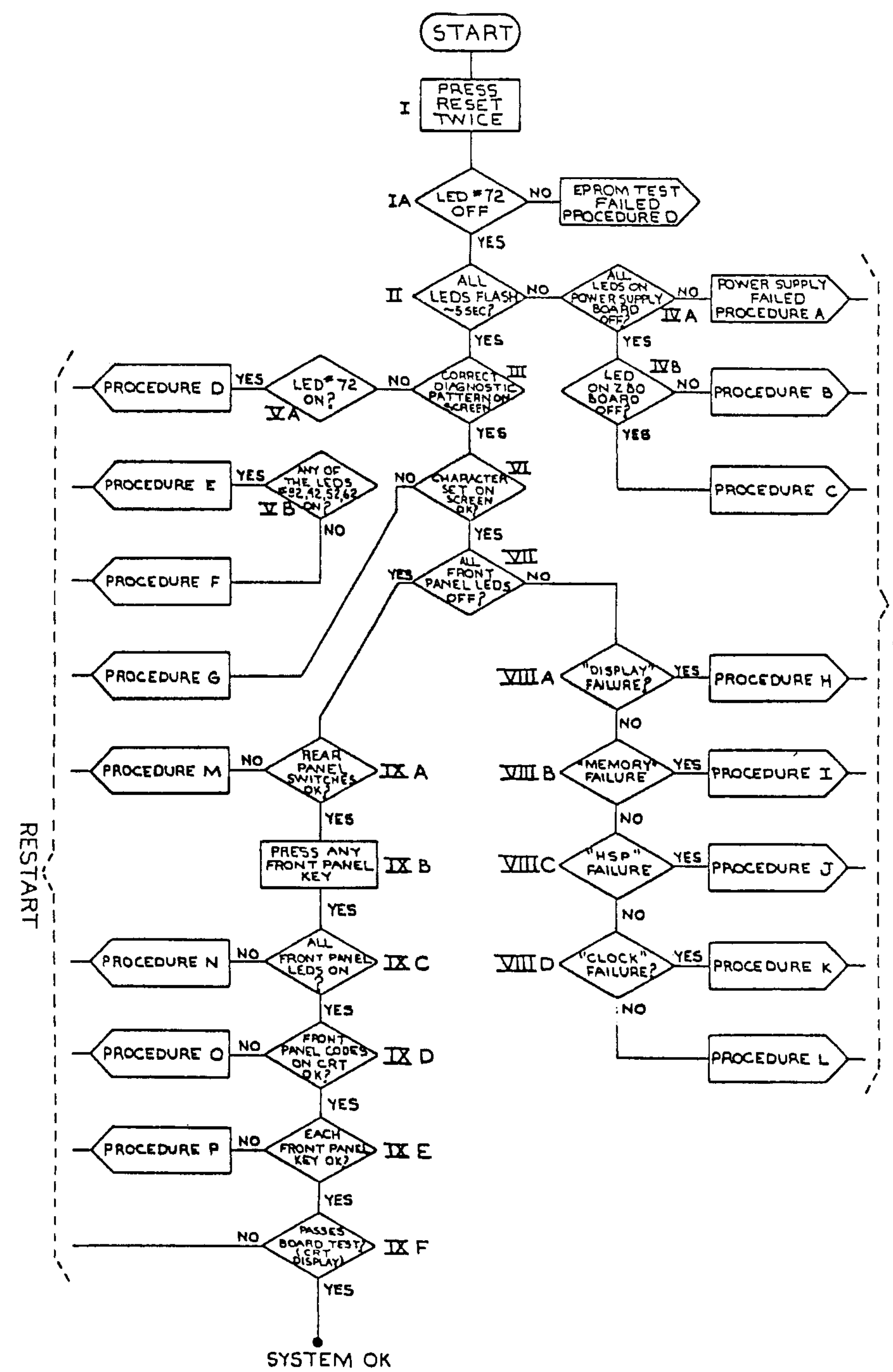
Next to "AUX" is a 8-bit code corresponding to the auxiliary switch code. Left-to-right on the CRT display corresponds to top-to-bottom on the rear panel, where "1" equals ON and "0" equals "OFF".

Next to "IEEE" is a 8-bit code corresponding to the code of the IEEE-488 and digital plotter switch with similar interpretation as the "AUX" code.

C-2-4. DIAGNOSTIC TEST

Tests will follow the flowchart in Fig. C-2-4a. If a failure occurs, the operator will be referred to a procedure in C-2-5.

FIG. C-2-4A FLOWCHART FOR DIAGNOSTIC PROCEDURE



STEPS:

Step I

Press RESET key twice to get into the diagnostic mode.

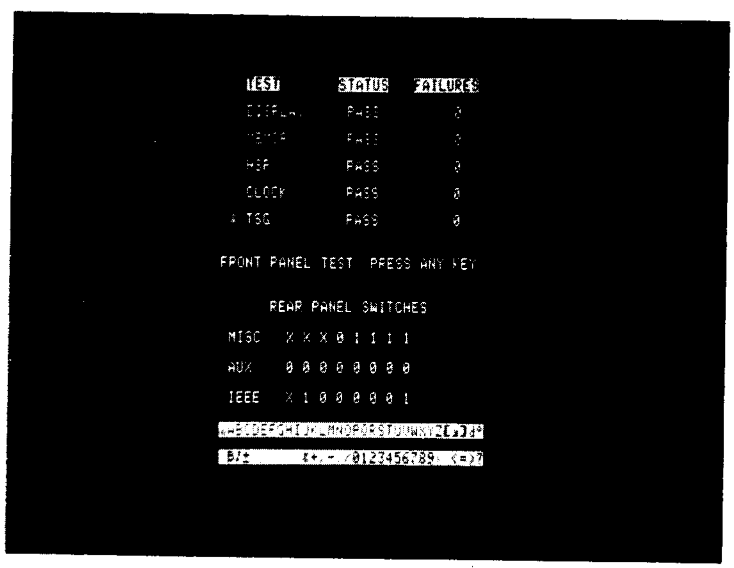
Proceed to procedure (D) if the EPROM error indicating LED is on (Front Panel Key 72,Fig.C-2-1b), otherwise go to Step II.

Step II

Proceed to step III, if all front panel LEDs are on for about 5 seconds and then go off, otherwise go to Step IV.

Step III

The diagnostic pattern as shown below has to be on at this stage, where the codes for the rear panel depend on switch settings :



Proceed to Step VI, if the pattern described above appears and the period for the flow of the cursor is about 10 seconds, otherwise go to step V.

Step IV

Open the top cover of the system and follow the instructions provided below:

a) Proceed to procedure (A) if any of the five power supply LEDs is off, otherwise go to Step (b) below.

b) Proceed to procedure (B), if the LED on the Z-80 board is on, otherwise go to procedure (C).

Step V

a) Proceed to procedure (D) if the EPROM error indicating LED (Key #72) is on, otherwise go to step (b).

b) Proceed to procedure (E), if any of the DISPLAY RAM error indicating LEDs are on (#62, 52, 42, 32), otherwise go to procedure (F).

Step VI

Proceed to procedure (G) if the character set of the diagnostic display pattern is improper, otherwise go to Step VII.

Step VII

Proceed to Step IX if all LEDs on the front panel are off, otherwise go to Step VIII.

Step VIII

At this stage, failures may occur on any of these five tests: Display test, Memory test, HSP test, CLOCK TEST AND TSG test. Two approaches are used to show failures: the front panel LED for a number of sub-tests and the CRT failures counter for the complete test. Steps to locate the failures are described below:

a) Proceed to procedure (H) if the counter for

DISPLAY test is nonzero, or any of the DISPLAY error-indicating LEDs (#72,62,52,42) are on, otherwise go to Step (b) below.

b) Proceed to procedure (I) if the counter for MEMORY test is nonzero, or if any of the MEMORY error-indicating LEDs are on (#73,63,53,43), otherwise go to step (c) below.

c) Proceed to procedure (J) if the counter for HSP is nonzero, or if the HSP error-indicating LED is on (#06), otherwise go to Step (d) below.

d) Proceed to procedure (K) if the counter for CLOCK test is nonzero, or the CLOCK error-indicating LED is on (#16), otherwise go to Step (e) below.

e) Proceed to procedure (L) if the counter for the TSG is nonzero, or the TSG error-indicating LEDs are on (#74,64,54,44,24,14,04).

Step IX

At this point, all LEDs of the front panel will be off, and you can proceed as follows:

a) The codes of the rear panel switches can be checked during the TSG test. Proceed to procedure (M) for any failure on these switches.

b) To enter the front panel test, press any key of the front panel for a few seconds.

c) All LEDs have to be on all the time; proceed to procedure (N) if this condition is not met.

d) The codes of the toggle switches and the span switches can be checked (Section C-2-2) during the FRONT PANEL test. Proceed to procedure (0) for any failure of these switches.

Press any key on the front panel; the code of the key pressed will appear next to "KEY" position. Proceed to procedure (P) if pressed key's code does not match that in Fig. C-2-1b; otherwise go to Step (e).

If the key happens to be an LED, the LED will be turned off once it has been pressed.

Continue pressing the front panel keys and checking the codes. The front panel test will be completed once the operator hits the last front panel LED. Then the cursor will move to the CLOCK test position.

e) If no failures occur during the loop on TESTS, the system is good, otherwise proceed to Step (I) and restart the testing to locate the defective board.

C-2-5. PROCEDURES TO LOCATE FAULTS.

The detailed procedures to locate a faulty board based on the diagnostic tests are presented.

For each procedure, a minimum amount of boards must be retained for testing. We refer to these boards as the MINIMUM CONFIGURATION (MC) of boards required for testing.

If no error occurs within these MC, this implies that the error occured in the omitted boards. Keep the MC and replace the other boards, one at a time, to find the defective boards that reside outside the MC.

If the error occurs within the MC, boards can be replaced and checked in the recommended order.

The lettering (H M and L) indicates the level of probabilities of failures occuring within a particular board as High, Medium and Low respectively.

The boards and assemblies that will be referred to are shown in the top and bottom photos, Figures C-1a and C-1b.

C-2-5-1 Procedure A

1)	Verify all power supply LED are on	
2)	Check P.S. voltage levels-Fig.C-2-5-1	H
3)	Check P.S. fuses (replace if necessary)	H
4)	Locate power line shorts	H
5)	Replace power supply.	

C-2-5-2 Procedure B

MC: Z-80 Board, CLOCK Board

1)	Z-80 Board	H
2)	CLOCK Board	M

C-2-5-3 Procedure C

MC: Z-80 Board, CLOCK Board, Scanner, FP Cable, FP PC Board, DISPLAY Board, MEMORY Board.

1)	Scanner Board	H
2)	Z-80 Board	M
3)	FP PC Board (main)	L
4)	FP PC Board (aux)	L
5)	FP Cable	L

C-2-5-4 Procedure D

MC: Z-80, CLOCK, MEMORY, DISPLAY

1)	DISPLAY Board	H
2)	MEMORY Board	M
3)	Z-80 Board	M
4)	CLOCK Board	L
5)	TSG Board	L
6)	SEQUENCER Board	L
7)	12-bit Board	L

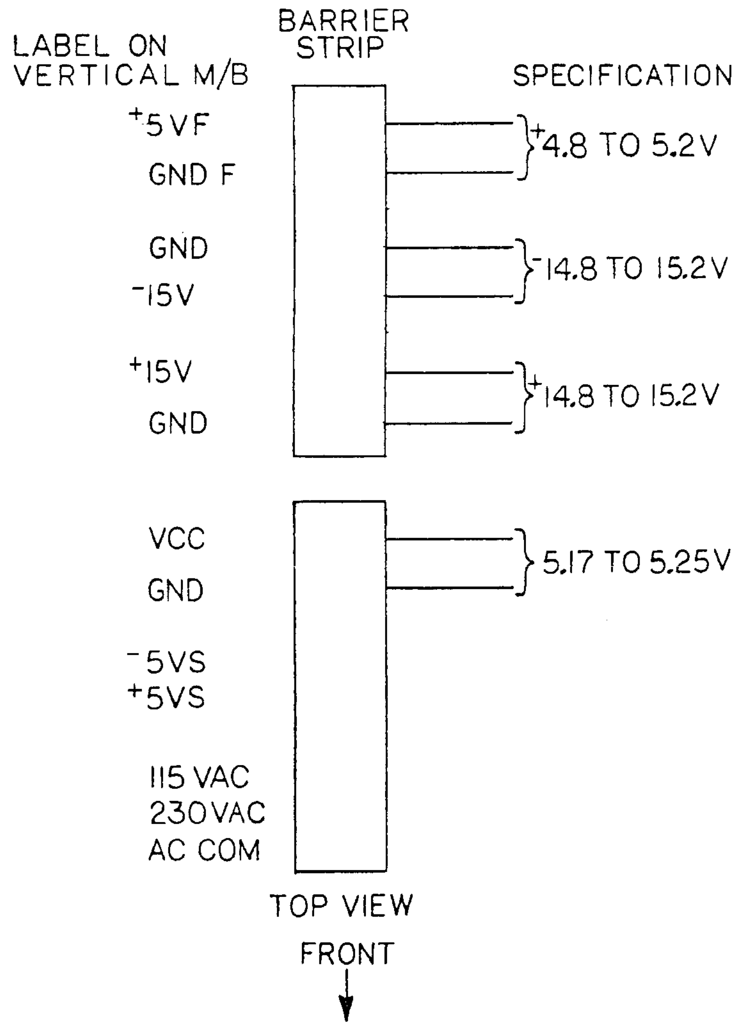


Fig. C-2-5-1 Barrier Strip Voltages on Power Supply

C-2-5-5 Procedure E

MC: Z-80, CLOCK, MEMORY, DISPLAY

1)	DISPLAY Board	H
2)	Z-80 Board	M
3)	TSG Board	L
4)	MEMORY Board	L
5)	CLOCK Board	L
6)	SEQUENCER Board	L
7)	12-bit Board	L

C-2-5-6 Procedure F

MC: Z-80, CLOCK, MEMORY, DISPLAY

a. Use external CRT and verify rear panel CRT outputs:

- not O.K. = bad DISPLAY Board
- O.K. = bad CRT

b. If external scope is not available, then :

1) Check CRT control cable is properly seated.
2) Replace DISPLAY Board M
3) Replace CRT M

C-2-5-7 Procedure G

MC: same as (F).

Boards most likely to have failed: same as (F).

C-2-5-8 Procedure H

MC: same as (E).

Boards most likely to have failed: same as (E).

C-2-5-9 Procedure I

MC: Z-80, CLOCK, MEMORY, DISPLAY

1) MEMORY Board	H
2) Z-80 Board	L
3) DISPLAY Board	L
4) TSG Board	L
5) CLOCK Board	L
6) SEQ Board	L
7) 12-bit Board	L

C-2-5-10 Procedure J

MC: Z-80, CLOCK, MEMORY, SEQ, 12 BIT, 24 BIT, A/D, DISPLAY.

1)	SEQUENCER Board	M
2)	24-bit Board	M
3)	12-bit Board	M
4)	A/D Board	M
5)	MEMORY Board	M
6)	CLOCK Board	L

C-2-5-11 Procedure K

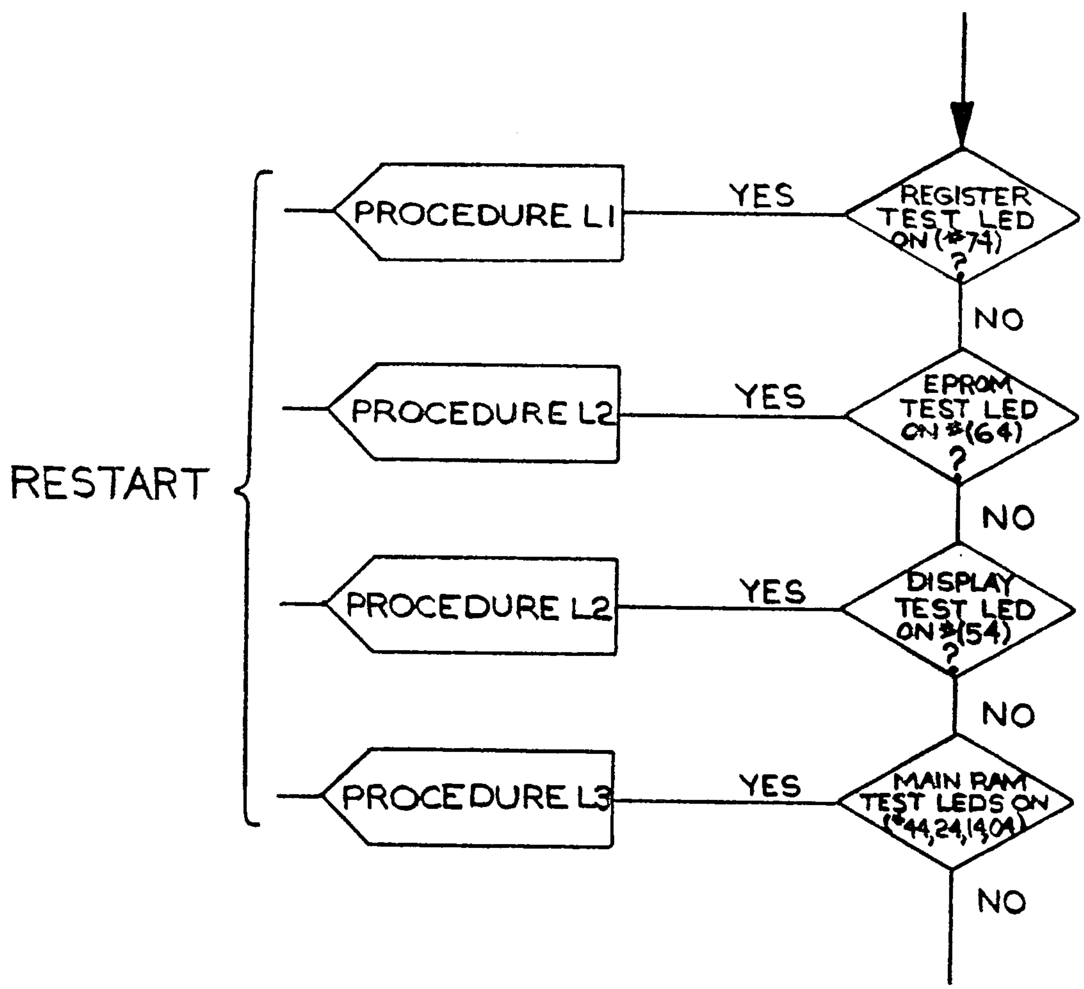
MC: Z-80, CLOCK, FP SCANNER, FP CABLE, DISPLAY, MEMORY.

1)	CLOCK Board	H
2)	SCANNER Board	L

C-2-5-12 Procedure L

MC: Z-80, CLOCK, TSG, MEMORY, DISPLAY.
Seven tests are performed within the TSG test, hence procedure (L) is further divided as follows:

Fig. 2-5-2 Flow Chart Of TSG Test



C-2-5-12a. Procedure L(1)

MC: Z-80, CLOCK, TSG, MEMORY, DISPLAY.

1)	TSG Board	H
2)	Z-80 Board	M
3)	CLOCK Board	M

C-2-5-12b. Procedure L(2)

NC: Z-80, CLOCK, MEMORY, DISPLAY, TSG

1)	TSG Board	H
2)	DISPLAY Board	M
3)	Z-80 Board	M
4)	MEMORY Board	M
5)	CLOCK Board	L
6)	SEQUENCER Board	L
7)	12-bit Board	L

C-2-5-12c Procedure L(3)

MC: Z-80, CLOCK, MEMORY, TSG, DISPLAY

1)	TSG Board	H
2)	MEMORY Board	H
3)	Z-80 Board	L
4)	DISPLAY Board	L
5)	CLOCK Board	L

C-2-5-13 Procedure M

MC: Rear Panel Board plus MC of (L).

1)	IEEE/RP Board	H
2)	TSG Board	M

C-2-5-14 Procedure N

MC: Z-80, CLOCK, FP scanner, cable, DISPLAY, MEMORY

1)	FP Main Board	H
2)	FP Aux Board	H
3)	Scanner Board	M

C-2-5-15 Procedure O

MC: Z-80, CLOCK, FP SCANNER, CABLE, FP (main) Board, DISPLAY, MEMORY.

1)	Scanner Board	M
2)	FP Main Board	M

C-2-5-16 Procedure P

MC: same as (O).

1)	Scanner Board	H
2)	FP Main Board	M
3)	FP Aux Board	L

APPENDIX D
CHANGING AC LINE VOLTAGE

D-1 INTRODUCTION

The unit is wired for either 115 V or 230 V AC as indicated by the label beneath the fan on the rear panel. To change the usable line voltage requires changing the fan assembly to one wired to the desired line voltage.

For 115 V AC the fan assembly is Wavetek Rockland part number 011.0101 and part number 011.0102 for 230 V AC. The assembly is available from the factory or nearest representative. Each fan assembly consists of a fan wired to a Molex connector, the appropriate fuse and a rear panel label indicating the usable line voltage.

D-2 INSTALLATION OF THE FAN ASSEMBLY

1. Remove the four (4) screws on the back panel holding the chassis and then remove chassis from the case.

2. Remove the four (4) screws holding each side panel to the rear panel.

3. Lower the rear panel. Remove the 50-pin flat cable from the IEEE interface PCB on the rear panel to the vertical mother board. Lay the rear panel down with the fan facing up.

4. Note the fan mounting. Remove the four (4) screws holding the fan and fan guard.

5. Disconnect the Molex connector.

6. Install the fan with the desired voltage using the above steps, 1 to 5, in reverse order.

Note, the air flow marking on the fan must be pointing in, i.e., away from the rear panel.

7. Replace the fuse and place the usable line voltage label on the rear panel under the fan guard.

APPENDIX E
PROGRAMMING EXAMPLES FOR THE IEEE INTERFACE

E.1 PROGRAMMING EXAMPLES FOR THE HP9825A

Read the Input Buffer for Channel A.

```
0:dev "rta",704              mnemonic rta-device 704
1:dim R [512], I [512]       set up arrays for the
                             real and imaginary parts
2:wrt "rta","READ
  INPUT A"                   send command to analyzer
3:for J=1 to 512
4:red "rta", R [J],          read input signal
  I [J]
5:next J
6:end
```

Provide input for Channels A and B

```
0:dim A [512], B [512]       two data arrays
1:dev "rta",701              mnemonic rta-device 701
2:wrt "rta","SET DATA
  REMOTE"                    Stop A/D data collection
3:wrt "rta", "START"
4:wrt "rta","WRITE A"        Set up analyzer
                             to receive data for A.
5:for J=1 to 512
6:wrt "rta", A [J] ,0
7:next J
8:wrt "rta", "WRITE B"       Set up analyzer to
                             receive data for B.
9:for J=1 to 512
10:wrt "rta", B   J  ,0
11:next J
12:wrt "rta","PROCESS"       Allow Analyzer
                             to process block.
13:end.
```

Read the 5820 State

```
0:dev "rta",701                  mnemonic rta device 701
1:dim S [70]
2:wrt "rta","READ STATE"
3:for J=1 to 70
4:rdb (701)→S [J]                read state in binary
5:next J
6:end
```

Control of the Front Panel

```
0:dev "rta",701                  mnemonic rta device 701
1:wrt "rta","SET
  FRONT PANEL REMOTE"            FP under remote control
2:wrt "rta","SET SPAN
  1KHZ"                          Select 1KHz Span
3:wrt "rta","SET START
  FREQUENCY 10 KHZ"              Select 10-11KHz Range
4:wrt "rta","SET
  SENSITIVITY A ODB"             Select Sensitivities
5:wrt "rta","SET
  SENSITIVITY B ODB"
6:wrt "rta","VIEW DUAL"          Dual trace mode
7:wrt "rta","VIEW
  TRANSFER FUNCTION M"           View Transfer Function
8:wrt "rta","VIEW
  TRANSFER FUNCTION P"           Magnitude and Phase
9:wrt "rta","SET N 16"           16 Averages
10:wrt "rta","STOP"
11:wrt "rta","START"
12:end
```

Write TEXT

```
0:wrt 720, "SET READOUT
  REMOTE"                        Desired information on
                                 CRT
1:wrt 720, "TEXT"                Repeat for as many times
2:wrt 720,"         "            as needed"
3:wtb 720,  3                    Cancels text mode
4:wrt 720, "SET READOUT
  LOCAL"
```

E-2. PROGRAMMING EXAMPLES FOR THE APPLE.

The IEEE interface was plugged in Slot #3. The device code was 20.

Control of the Front Panel

```
10 D$ = "":REM D$=CTRL-D,DOS COMMAND
20 Z$ = "": REM Z$=CONTROL-Z,GPIB COMMAND
30 PRINT D$;"PR#3": REM SEND OUTPUT TO IEEE CARD
40 PRINT D$;"IN#3": REM GET INPUT FROM IEEE CARD
50 PRINT "RA"": REM ENABLE ALL FOR REMOTE
60 PRINT "DV1": REM APPLE IS DEVICE #1
70 PRINT "LF1": REM SEND AND RECEIVE [LF] AFTER [CR]
80 PRINT "WT4";Z$;"SET FRO R":
90 PRINT "WT4";Z$;"VIEW SINGLE":
100 PRINT "WT4";Z$;"VIEW COH":
110 PRINT D$;"PR#0":REM SEND OUTPUT TO SCREEN
120 PRINT D$;"IN#0":REM GET INPUT FROM KEYBOARD
130 INPUT A$:REM WAIT
140 PRINT D$;"PR#3":REM SEND OUTPUT TO IEEE
150 PRINT D$;"IN#3": REM GET INPUT FROM FILE
160 PRINT "WT4";Z$;"SET FRO L":REM 5820A FP LOCAL
170 PRINT D$;"PR#0": REM SEND OUTPUT TO SCREEN
180 PRINT D$;"IN#0": REM GET INPUT FROM KEYBOARD
190 END
```

Read the Input from Channel A

```
10 D$ = ""
20 Z$ = ""
30 GOSUB 500
40 PRINT "WT4";Z$;"SET FRO R":
50 PRINT "WT4";Z$;"READ SP A":
55 DIM B$(201)
60 FOR I = 1 TO 201
65 B$(I) = ""
80 PRINT "RDT";Z$;:
90 GET A$:PRINT A$;:
100 IF ASC (A$) = 44 THEN 140
105 IF ASC (A$) = 13 THEN 140
110 B$(I) = B$(I) + A$
120 GOTO 90
140 NEXT I
150 PRINT "WT4";Z$;"SET FRO L":
200 GOSUB 600
```

```
220 FOR I = 1 TO 201
230 PRINT B$(I)
240 NEXT I
250 END
500 PRINT D$;"PR#3"
510 PRINT D$;"IN#3"
520 PRINT "RA"
530 PRINT "DV1"
540 PRINT "LF1"
550 RETURN
600 PRINT D$;"PR#0"
610 PRINT D$;"IN#0"
620 RETURN
630 END
```

E-3. PROGRAMMING EXAMPLES FOR THE TEKTRONIX 4051

The 5820 had a device address of 4.

Read the Input Buffer of Channel A.

```
100 INIT
105 REMARK - CLEAR THE INTERFACE AND ANALYZER
110 DIM I(1024)
115 REMARK - SET UP AN ARRAY
120 PRINT @4,32: "READ INPUT A"
130 INPUT @4,32: I
140 END
```

Front Panel Control

```
100  INIT
110  PRINT @4,32: "SET FRO R"
120  PRINT @4,32: "SET SPAN 1KHZ"
130  PRINT @4,32: "SET START FR 10KHZ"
140  PRINT @4,32: "STOP"
160  PRINT @4,32: "START"
170  END
```

Service Requests (SRQ when Channel A Overloads)

```
100  INIT
110  WBYTE @95,25:
115  REMARK - UNTALK, SERIAL POLL DISABLE
120  ON SRQ THEN 150
125  REMARK - SRQ SERVICE ROUTINE AT 150
130  PRINT @4,32: "SRQ CHA"
135  REMARK - ENABLE SRQ
140  GO TO 140
145  REMARK-WAIT FOR INTERRUPT
150  POLL A,B; 4
155  REMARK - DO A SERIAL POLL
160  PRINT A,B
170  RETURN
180  END
```

E-4. PROGRAMMING EXAMPLES FOR THE HP85

```
20  ! ***************************
40  !
60  !  HP85F SAMPLE PROGRAM FOR
80  !        READING THE DISPLAY
100 !       ON THE MODEL 5820A
120 !      using TRANSFER mode
140 !
160 ! ***************************
180 !
200 DIM S(200),Z$[1817]
220 IOBUFFER Z$
240 D=20 ! device address
260 OUTPUT 700+D ;"SET FRONT PAN
    EL REM"
280 OUTPUT 700+D ;"SET VERT LINE
    AR"
300 OUTPUT 700+D ;"READ SPEC A"
320 !
340 ! "#"- Image modifier used
360 !       to remove the line
380 !       feed as a terminator
400 !
420 TRANSFER 700+D TO Z$ INTR
440 STATUS Z$,2 ; Z
460 IF Z#0 THEN 440
480 FOR I=0 TO 200
500 ENTER Z$ USING "#,K" ; S(I)
520 NEXT I
540 END
```

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
SET	FRONT PANEL	REMOTE LOCAL		This command must precede any remote programming of FP functions
	SPAN	50KHZ . . 2HZ		Analysis Span is defined on the Front Panel Rotary switch. Best procedure is to stop averager first, send statements, then ReSTART averager.
	CENTER FREQUENCY	X X.X X	(K) HZ (m) HZ	
	START FREQUENCY	X X.X X	(K) HZ (m) HZ	
	POSITION	START CENTER		
	SENSITIVITY	A B	UP DOWN (-) XX DB	

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
SET	READOUT	REMOTE LOCAL		Enable and disable remote writing of alphanumerics on CRT.
	DATA REMOTE			Must precede digital input via the IEEE interface.
	REFERENCE	A B	X.XE±XX	
	ORDERS	XX.XX		
	ZERO FREQUENCY			Sets cursor value to 0 Hz reference.
	ARM	AUTO SINGLE		Must send to initialize transient mode.

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
SET	SCREEN	FULL SPLIT		
	TRIGGER	A B FREE RUN EXTERNAL IEEE SIGNAL GENERATOR		Signal Generator corresponds to Tracking Signal Generator output. For triggering, it should be set to Pulse mode. Must stop, then restart the averager.
	SIGNAL GENERATOR	OFF NOISE PULSE PERIODIC NOISE		
	ATTENUATOR	0DB . . . 40DB		Tracking signal generator's attenuator settings. 10 dB steps.

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
SET	NUMBER OF AVERAGES	n		n = 1,2,...,256 n=1 corresponds to NONE all non-allowed values cause N = NONE to be set.
	MEASUREMENT	CROSS SINGLE	A or B	Must stop, then Restart the averager.
	WEIGHTING	AUTO UNIFORM HANNING		
	VERTICAL SCALE	20 DB 40 DB 80 DB LINEAR		
	HORIZONTAL SCALE	LINEAR LOG		

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
SET	COUPLING	A B	AC DC GND	
	IMPROVED ACCURACY	ON OFF		After activating, improved accuracy will be in effect until it is turned off.
	AMPLITUDE READOUT	SINE NOISE POWER		
	CURSOR	ON OFF		Turn on or off the cursor readout.
	AVERAGER MODE	PEAK SPECTRUM TIME		

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
AUTORANGE				Toggle on and off.
TEST				Toggle on and off
PLOT				Copies CRT onto external digital plotter. SRQ (bit #1) generated at completion of plot.

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
VIEW	SINGLE DUAL			Set single or dual trace viewing mode but will not change display until next VIEW statement.
	(STORED)	SPECTRUM	A B	
		PHASE	A B	
		TIME	A B	
	(STORED)	TRANSFER FUNCTION	MAGNITUDE PHASE	
		COHERENCE POWER COHERENT		
	(STORED)	MAX SPAN FOREGROUND		Display MAX SPAN in single channel mode.

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
CURSOR	X X.X X UP DOWN	(K)HZ (m)		Set cursor frequency. Default for XX.XX is 0.0 Hz.
START STOP RESUME STORE				Start, Stop and Resume Averaging. Store averaged spectra.
SAMPLING	INTERNAL EXTERNAL			

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
READ	INPUT	A B MAX SPAN FOREGROUND		Real part, Imaginary part (± XXXXX): 32767 ≥ XXXXX ≥ -32768 512 or 1024 points.
	CROSS			Real part, Imaginary part (± X.XXXE±XX), 201 complex points. Uncalibrated.
	SPECTRUM	A B MAX SPAN FOREGROUND		Get cursor readout (amplitude only) by sweeping the cursor across the trace. The Cursor Readout must be ON.
	PHASE	A B FOREGROUND		
	COHERENCE			

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
READ	POWER COHERENT			Only amplitude values are transferred.
	TRANSFER FUNCTION	MAGNITUDE PHASE		
	CURSOR	TOP BOTTOM		Amplitude, Frequency as on CRT. Numbers only. (Top for single display).
	SETUP			Text from VIEW SETUP as ASCII string. Should send Front panel remote first.
	STATE	i_1	i_2	State consists of 70 bytes. Command allows reading i_1 through i_2 in binary. Default: read all 70 bytes. Must read 1 extra byte first (space).

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
WRITE	A B SINGLE			Real part, Imaginary part Integers $-32768 \le n \le 32767$ A or B: 512 points Single:1024 points Command SET DATA REMOTE must be given first. See Commands PROCESS and RELEASE
EDIT	ON OFF			
EQUALIZE	ON OFF			Operates on stored data.
COMPARE	ON OFF			Operates on stored data.

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
PROCESS				Perform one FFT and averaging. Used with DATA REMOTE command.
RELEASE				Return to DATA LOCAL operation.
SRQ	AUTORANGE CHA OVLD CHB OVLD END OF AVERAGING RESET			More than one SRQ may be enabled The SRQ bits in the SPW register are: MSB : Syntax Error 6 : SRQ 5 : End of Averaging 4 : B Overload 3 : A Overload 2 : Illegal Command 1 : End of plot 0 : End of Autorange
BREAD	i_1	i_2		Read in binary from address i_1 to address i_2. Addresses in decimal. Default values: $i_2 = i_1$ i_1 : Read entire memory Read extra byte first (space).

COMMAND	ARGUMENT # 1	ARGUMENT # 2	ARGUMENT # 3	COMMENTS
BWRITE	i_1	i_2		Same with BREAD but writing instead of reading.
TEXT				TEXT followed by ASCII string displays the string on the CRT. READOUT must be in REMOTE mode. Binary 3 is the string delimiter.
AMPLITUDE	ABSOLUTE RELATIVE			
FREQUENCY	ABSOLUTE RELATIVE ORDERS			
REV1 REV2 REV3				REV 1 - Revision level of main Z80 REV 2 - Revision level of TSG, GPIB Z80 REV S - Revision level of shared PROMS.
RESET				Powers up the 5820A

APPENDIX G

THE 5820A STATE DESCRIPTOR (Section 4-7)

BYTE #	BIT	DESCRIPTION
0	0-2	Unused
	3	External CRT
	4	Remote Serial Data
	5-7	Unused
1	0-7	Unused
2	0-3	Binary code for span (0 for 50KHz,...,13 for 2Hz)
	4	Recall Stored
	5-6	Unused
	7	Momentary Front Panel button sustained.
3	0	Channel A Overload
	1	Channel B Overload
	2	Channel A AC coupling
	3	Channel B AC Coupling
	4	Ground Ch B
	5	Ground Ch
	6	Digital Overflow
	7	Armed Light On
4	0	Spectrum Averaging
	1	Unused
	2	Max Frequency=50KHz
	3	Max Frequency=500Hz
	4	Recording Menu
	5	Unused
	6	Autorange
	7	Unused
5	0	Resume Averager
	1-2	Unused
	3	Max Frequency = 5KHz

	4	TSG Menu
	5	IEEE Remote
	6	Test Signal On
	7	Tune About Center
6	0	Stop Averager
	1-2	Unused
	4	Transient Mode Menu
	5	Unused
	6	Resume Plotter
	7	Tune About Start
7	0	Start Averager
	1	Unused
	2	View Coherence
	3	View Coherent Output Power
	4-5	Unused
	6	Stop Plotter
	7	External Sampling
8	0	Total Power
	1	Unused
	2	View Transfer Function Magnitude
	3	View Transfer Function Phase
	4	Display Modifiers Menu
	5	Single Arming
	6	Start Plotter
	7	Unused
9	0	RMS/ HZ Amplitude Readout
	1	Unused
	2	View Time A
	3	View Time B
	4	Readout Menu
	5	Auto Arming
	6	TSG Attenuator 20 db button
	7	Peak Averaging
10	0	RMS Amplitude Readout
	1	Unused
	2	View Phase A
	3	View Phase B
	4	Display Format Menu
	5	Unused
	6	TSG Attenuator 10db button(2nd one)
	7	Time Averaging
11	0	Cursor On
	1	Unused
	2	View Power Spectrum A

	3	View Power Spectrum B
	4	Measurement Mode Menu
	5	View Setup Menu
	6	TSG Attenuator 10 db button(1st one)
	7	Unused
12	0	Improved Accuracy
	1	1=Single Channel, 0= Cross
	2	0=Single Ch A,1= Single Ch B
	3-6	Unused
	7	Edit Transfer Function
13	0	Unused
	1	Equalize
	2	Compare
	3-4	Unused
	5	1= Full Screen, 0= Split Screen
	6-7	Code for Weighting Function 0: Auto 1: Hanning 2: Rectangular 3: Undefined
14	0-7	Unused
15	0-1	Unused
	2-5	Code for Vertical Display 0: 80 dB 1: Undefined 2: 40 dB 3: 20 dB 4-7: Undefined 8-15: Linear
16	0	Amplitude relative
	1	Frequency Relative
	2	Max Span On (Single Chn)
	3-7	Unused
17	0-1	Code for Frequency Units 0: Hz 1: Undefined 2: Orders 3: Undefined
	2-7	Unused
18	0-2	Code for TSG Mode 0: Off 1: Noise 2-4:Undefined

		5: Pulse
		6: Periodic
		7: Undefined
	3-4	Unused
	5	Anotate Plot
	6-7	Code for Analog Plotter Calibration
		0: Off
		1: (0,0)
		2: (Full Scale, Full Scale)
		3: (FS/10, FS/10)
19	0-2	Code for Transient Mode
		0: Free Run
		1: Trigger on Ch A
		2: External Trigger
		3: Trigger on TSG
		4: Trigger on IEEE
		5: Trigger on Ch B
		6-7:Undefined
	3-5	Code for Recording
		0: Off
		1: Digital Plotter
		2: X-Y Plotter
		3-7:Undefined
	6-7	Unused
20	0	Pending SRQ
	1-7	Unused
21	0-7	Reserved
22-23	0-15	Center frequency (see Note 1)
24	0-7	log (# of Averages)
25	0-7	Coarse Sensitivity Ch A (See Note 2)
26	0-7	Fine Sensitivity Ch A (Positive Integer 0-9)
27	0-7	Reserved for system
28-29		Same as 25-26 but for Channel B
30	0-7	Reserved for system
31-40		Same as 21-30 but refers to stored spectrum (see Note 3)

41-42		Reserved
43-45	0-23	Ch A Eng Units, floating point. Format:0-6 Exponent,base 2,excess 64 7: Sign (1= Negative) 8-23: Mantissa
46-52		Ch A Eng Units. Valid if second byte = 47. ASCII string X.XE+XX.
53-62		Same as 43-52,for Channel B
63-67	0-31	If orders,then = Hz/order in floating point. Format: 0-6: Exponent,Base 2,Excess 64 7: Sign (1 Negative) 8-31:Mantissa If Relative Hz then # = Frequency defined as zero in units of Hz, integer format
68	0-7	ASCII character=Revision Level
69	0-7	Reserved

Notes

1. The center frequency is an integer whose units depend on the measurement mode (single or cross) and the span according to the following Table:

Single Channel		Cross Channel	
Span	Units	Span	Units
200Hz - 50KHz	50Hz	200Hz -50KHz	25Hz
100Hz	25Hz	20Hz -100Hz	2.5Hz
50Hz	2.5Hz	2Hz -10Hz	.25Hz
20Hz	5Hz		
2Hz - 10Hz	.5Hz		

2. The Sensitivity is given by:

Sensitivity = Coarse * 10 + Fine

Remember that Fine is always positive. Thus, for example, a sensitivity of -27db would be represented by a -3 in the Coarse loction and a 3 in the Fine.

3. The MSB of the # of Averages for the stored spectrum indicates Peak, when equal to 1, Exponential otherwise.

4. 1 in all of the above means that the function is active.

5. The LSB is bit 0.

6. Remember that a six bit ASCII set is used. Thus, the character E is represented by a code of 5.

APPENDIX H
MEMORY MAP AND FORMATS
(Sections 4-4-18 and 4-4-19)

H-1 SPECTRUM AVERAGER BUFFERS

Format:

Two bytes for each averager point. The first byte represents the LSB's and the second byte the MSB's. The top 5 bits are the magnitude of the exponent plus one. The sign of the exponent is always minus. The bottom eleven bits are the mantissa in 2's complement form.

Addresses:

The starting addresses of the averager buffers are given in the following table:

Cross Channel					Single Channel
SPAN	GAA	GBB	ReGAB	Im GAB	GAA or GBB
50KHz	38912	39776	39314	40178	38912
Not 50K	39776	38912	39314	40178	Max Span:39776 Foreground:38912

For stored spectra:

Cross Channel					Single Channel
SPAN	GAA	GBB	ReGab	Im GAB	GAA or GBB
50KHz	51712	42204	52114	42606	51712
not 50KHz	42204	51712	52114	42606	Max Span:42204 Foreground:51712

Note : In 50KHz, -Im GAB is stored.

H-2. PHASE BUFFERS

Format

Two bytes for each point, first byte has the LSBs.

Bits (0-10)(LSBs): Ratio of I/R or R/I.
(I = Imaginary)
(R = Real)
Bit 11: 1⟶R/I
0⟶I/R
Bit 12: Sign of I
Bit 13: Sign of R
Bits 14-15: Unused

Addresses

	Phase A	Phase B	Phase of Foreground
50K	44434	44032	44032
Not 50K	44032	44434	44032

H-3. DISPLAY BUFFERS

Format

Two bytes for each output point.
The first byte has the y amplitude information.
The second byte has intensity information (top two bits) and cursor information (second LSB).

Starting Addresses:

Single Trace: 49408

Dual Trace:

Top (Front) Trace: 50432
Bottom (Back) Trace: 49408

H-4 READOUT BUFFERS

Format

The six LSBs are the ASCII code of the character. The codes of special characters are:

m :	0
μ :	28
d :	30
o :	31
β :	33
√ :	34
± :	35

The MSB is on if the character is displayed in reverse video form.

The Status Line contains 32 characters.

The other readout lines contain 64 characters.

Starting Addresses

Single Trace

Top Line: 51584
Bottom Line: 51648

Dual Trace

Top (Front):
Top Line: 51584
Bottom Line: 51648
Bottom (Back)
Top Line: 51456
Bottom Line: 51520

Status Line 52006

H-5 TIME AVERAGER BUFFER

Format: same as H-1
Addresses: Real 45056
Imaginary 47104