OPERATING MANUAL

MODEL 5830B

DIGITAL SIGNAL ANALYZER

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Manual Part Number: 800.6132

2nd Edition

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CHAPTER I

GENERAL INFORMATION

1-1. INTRODUCTION

This Operator's Reference Manual for the WAVETEK 5830A Digital Signal Analyzer, like the 5830A 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 signal processing and spectrum analysis or how to use the 5830A 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 5830A. It is a reference volume of specifications and procedures. But it is more than just a book of facts about operating the 5830A Digital Signal Analyzer. Since it is organized as a tutorial, it provides "hands on" exercises on the 5830A to help you learn to use the instrument as quickly and efficiently as possible -- whether you are already familiar with other analyzers or a new-comer to this technology.. Once you become proficient with the basics of the 5830A, 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 5830A. 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 Engineering Staff. That document contains useful theoretical material about spectra, Fourier Transform mathematics, and the overall architecture of an ideal modern FFT Digital Signal Analyzer - like the WAVETEK 5830A.

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

WAVETEK CORP.
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 5830A to your WAVETEK 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 5830A 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 5830A is a high- accuracy dual channel FFT signal 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
* Total Power within a Frequency Span
* Correlation
* Impulse Response
* Probability Histogram
* Time-History "Waterfall"
* Group Delay
* Input Integrate/Differentiate

You specify the analysis tasks for the 5830A via easy-to-use keys and interactive "menus" you can call up on the CRT.

The 5830A 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 5830A can perform its analysis over the frequency range of 0 Hz to 50KHz in cross-channel and 0 to 100KHz in single channel mode. 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 5 millihertz resolution at low frequencies.

The 5830A has a full-scale amplitude sensitivity of from -70dBV to a maximum of +20dBV with an overall range exceeding 80 dB.

The range of 5830A'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
* Multiple cursors
* Force window

1-4. SPECIFICATIONS

FREQUENCY

FREQUENCY MODES

Span:
Sets frequency band over which analysis is performed.

Position:
Controls start or center of span; in 1-ch, 100KHz span is always 0-Hz start: in 2-ch, 50KHz span is always 0-Hz start.

About Start:
Position controls vary span start (Fmin) which remains fixed as span is changed.

About Center:
Position controls vary span center which remains fixed as span is changed.

Center at Cursor:
Cursor varies position of Span center frequency.

Use keyboard:
Keyboard sets position of span - center frequency or start frequency.

Ext. sampling:
Span is determined by external synch. rate (TTL): calibration is in ORDERS, max. synch. rate is 220KHz, resulting in max. sampling rate of 110KHz.

Frequency Range:
0.005 Hz to 100 KHz in 1-ch, 0.01 Hz to 50KHz in 2-ch.

Display:
Linear or Log frequency axis.

Accuracy:
Center of each line is accurate to ±0.01% of full scale.

Frequency Spans:
(see table below).

TABLE 1-4

SINGLE-CHANNEL			
SPAN (Hz)	MAX FREQ (Hz)	LINE (B) SPACING (Hz)	SETTING RESOLUTION (Hz)
100 K	100 K	250	
50 K	100 K	125	250
25 K	100 K	62.5	250
10 K	100 K	25	50
5 K	100 K	12.5	50
2 K	100 K	5.0	50
1 K	100 K	2.5	50
500	100 K	1.25	50
200	100 K	1.0	50
100	5 K	0.25	2.5
50	5 K	0.125	2.5
20	5 K	0.05	2.5
10	500	0.025	0.25
5	500	0.0125	0.25
2 Hz	500	0.005	0.25

DUAL or CROSS-CHANNEL			
SPAN (Hz)	MAX FREQ (Hz)	LINE ( ) SPACING (Hz)	SETTING RESOLUTION (Hz)
50 K	50 K	250	
25 K	50 K	125	250
10 K	50 K	50	100
5 K	50 K	25	50
2 K	50 K	10	50
1 K	50 K	5	25
500	50 K	2.5	25
200	50 K	1.0	25
100	5 K	0.5	2.5
50	5 K	0.25	2.5
20	5 K	0.10	2.5
10	500	0.05	0.25
5	500	0.025	0.25
2	500	0.01	0.25

INPUT CHANNELS

INPUT IMPEDANCE:
1 Meg, 50pf nom.

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

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

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

COMMON MODE REJECTION:
$>$ 60 dB at 50-60 Hz; max. common mode input is 7.5V for all sensitivity settings except 75V for 0dBV and -10dBV, 200V for +10dBV and +20dBV.

INPUT CHANNEL CROSSTALK:
Less than -150dB.

POWER SPECTRUM AMPLITUDE

FULL SCALE SENSITIVITY RANGE

Log:
Calibrated attenuator range is +20dBV to -70dBV single tone RMS max. input level in 1.0 ± 0.4dB steps.

Linear:
Calibrated attenuator range 10 volts to 320 microvolt single tone RMS max. input level in 12.0 ± 2% steps.

Autorange:
Full scale sensitivity of both channels is automatically adjusted prior to the start of process; data blocks causing overload are not processed.

DISPLAY MODES

Log:

Range	Full Screen	Split Screen
80dB	10dB/div.	20dB/div.
40dB	5dB/div.	10dB/div.
20dB	2.5dB/div.	5dB/div.

Linear:
Constant voltage/division

Reference Level:
Provides added gain and attenuation steps; settable to 1dB on the 80dB range, 0.5dB on the 40dB range and 0.25dB on the 20dB range in log; x1,x2,x5,x10,x20,x50,x100 in linear.

DYNAMIC RANGE

2-Tone Amplitude Linearity:
±0.1dB ±0.001% FS down to 70dB below FS.

Distortion Products:
>70dB below FS.

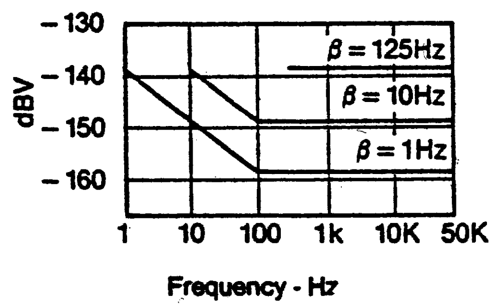
Spurious Responses:
>70dB below FS or -120dBV, whichever is greater.

Typical Equivalent Input Noise:
-155dBV/$\sqrt{Hz}$ (20 nanovolts/$\sqrt{Hz}$) for frequencies greater than 100Hz.

DC Response:
>20dB below FS

Amplitude Resolution:
0.1 dB for log, 0.1% for linear

Noise Floor:



Overload Indicators:
Individual for each channel; overload occurs when input approaches FS. Spurious products are never displayed; except when N=NONE. Occasional overload prevents processing of data block which causes overload only (others 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

MEASUREMENT RANGE

Magnitude:
+170dB FS to -90dB FS for log; $3x10^8$ FS to $3x10^{-5}$ FS for lin.

Phase:
+180 degrees to -180 degrees.

ACCURACY
Magnitude: Better than ± 0.5dB
Phase: Better than ± 1 degree

RESOLUTION
Magnitude:0.1dB log; 0.1% lin.
Phase: 0.1 degree.

EDITED TRANSFER FUNCTION:
Portions of the Transfer Function where coherence is below a preset level are decreased in intensity.

OTHER MEASUREMENTS

TIME FUNCTION
Time-domain waveform displayed ; valid amplitude and time measurements in 50KHz dual or 100KHz single channel.

COHERENCE FUNCTION
Displayed over a range of 0.0 (bottom line) to 1.00 (top line); 0.125/div. full-screen, 0.25/div. split screen; cursor reads to 0.01.

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

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

RATIO & DIFFERENCE
Measures and displays ratio or difference between present function and stored function; in 2-ch, ratio is complex equalization i.e. ratio of amplitude, diff. of phase.

CORRELATION
Calculation is direct at sampling rate (Fs) and $\Delta\psi$=1/Fs. Auto-correlation for ch A and B; cross-correlation AB with zero time in center of display.

HISTOGRAM
Amplitude probability density at ±64 levels for ch A and B processed at sampling rate of range set. Integrating probability density yields cumulative distribution.

INTEGRATE/DIFFERENTIATE
Equivalent of single or double integration or differentiation of either input; carried thru all subsequent processing.

SERVO
Converts closed-loop transfer function measurements to open-loop [TF/(1-TF)].

IMPULSE RESPONSE
Displays the inverse transform of transfer function.

PHASE INVERSION
Multiplies phase of either input by -1 (180 degrees phase shift).

DERIVATIVE OF PHASE
Rate of phase changes vs F.

TF RECIPROCAL
Inverts complex transfer function
[1/MAG(TF),-TF phase]

AVERAGING

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

CONTROLS:
START, STOP, RESUME AND STORE; START erases memory.

MODES
Spectrum and Time (single channel only).

TYPES
Exponential in free-run, otherwise linear. In exponential, normalized linear averaging until preset number is reached; then exponential. Peak stores maximum value at each frequency.

TRANSIENT CAPTURE

TRANSIENT CAPTURE MODES

Free Run:
New measurement is automatically initiated at the completion of the previous one.

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

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

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

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

TRANSIENT CONTROLS
Threshold:
Capture level can be selected by continuous vernier; positive or negative going transition can be selected.

Auto/Single:
Automatic re-arm after each transient is captured in AUTO. In SINGLE, re-arms each time button is pressed.

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

DISPLAY

FORMAT

Full Screen (Front/Back):
One or two traces fill entire screen of 8x10 divisions.

Split Screen (Top/Bottom):
Two traces are displayed one over the other, each in its 4x10 division grid.

Waterfall:
Most recent 8 traces of 200 lines or 4 of 400 lines (ch A or B only) each are displayed one under the other until averaging is stopped. Any frequency function can be displayed.

Nyquist:
TF real is displayed against imaginary in the full display.

DUAL DISPLAYS

Any pair of the following: PS A or B, phase A or B, time A or B, TF magnitude or phase, Coherence, COP, Impulse Response, Auto-correlation of A and B, Cross-correlation; Histogram A and B, TF Real and Imaginary are only displayed in pairs.

For single-channel measurements, the full spectrum (100 KHz, 0-5KHz or 0-500KHz) <u>and</u> the selected zoom span may be simultaneously displayed; the zoom span portion of the full spectrum is intensified.

MENUS

Measurement Mode, Display Format, Readout, Display Modifier, Transient Mode, Tracking Signal, Recording and Stored Settings; View Setup summarizes settings.

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

CURSOR MEASUREMENTS

CURSOR TYPES

Main:
Single line in display reads vertical and horizontal units in annotation, independent of Harmonic or Sideband cursors. Readout can be independent of display scale.

Single:
One line only in display, used as reference for HARMONIC and SIDEBAND markers.

Harmonic:
A dot illuminates each line in the display at multiples of the SINGLE line; vernier adjust provides setting resolution finer than one resolution line to align higher harmonics.

Sideband:
Pairs of dots are placed symmetrically about the SINGLE cursor line vernier alignment.

MAIN CURSOR ACCURACY

Frequency:
Normally limited by line spacing; worst case + 0.5% or ±0.25% of span, depending upon span and processing mode; in HIGH ACCURACY mode, resolution on discrete spectrum peaks improves by 10 x, for worst case error of ±0.05% of span.

AMPLITUDE

	NORMAL	HIGH ACCUR.
Accuracy at line center	±0.5dB	±0.5dB
Hanning Weight	+0, -1.5dB	±0.1dB
Flat Weight	+0, -4.0dB	±0.1dB
Overall max. with Hanning	+0.5 to -2.0dB	±0.6dB

CALIBRATION

Normal units:
dBV, V RMS, VSQ vert.; Hz horiz., absolute or relative.

Engineering units:
Arbitrary setting of V/EU using keyboard or cursor value; CPM or orders.

Power spectral density:
Noise power per unit bandwidth (1Hz); in dBV/$\sqrt{Hz}$, VRMS/$\sqrt{Hz}$, VSQ/Hz or EU/$\sqrt{Hz}$.

STORAGE

Type:
Non-volatile

Data:
Two 400-line single channel spectra (total span and zoom) or one complete set of dual channel data (four 200-line spectra - PSA, PSB, Cross-spectrum real and imaginary) sufficient to recall TF, Coherence, COP, NYQUIST, REAL & IMAGINARY in any format: includes frequency and amplitude information to restore calibration.

Panel Setups:
5 complete sets of panel settings including all control and menu settings (except rotary controls and toggle switch settings); includes cursor type and position, tracking signal type and step attenuator settings.

BUILT-IN SIGNAL SOURCES

Noise:
"White" or periodic; spectrum bandlimited and translated to track the selected frequency span.

Pulse:
Sinewave burst at a frequency equal to the center of the span.

Sinewave:
Matches MAIN cursor frequency settable to cursor resolution; .001% accurate; 3V PTP nominal.

Multiple Sinewave:
10 contiguous sinewaves around MAIN cursor, phase staggered to simulate flat noise 10 lines wide.

Sweep:
Single sinewave steps one line per 1/beta period (as determined by the span setting), frequency changes are phase coherent; multiple sinewave steps 10 lines per 1/beta period; single or multiple frequencies only are analyzed at each step.

ANALOG OUTPUT/INPUT

Plotter:
0-1.5V FS vertical, 0-1V FS horizontal, pen lift 30V max. open collector.

CRT Output or Direct Input:
0-1.5V FS vertical, 0-1.0V horizontal; intensity -1.0V max. to -5.0V min.

External Sampling:
An external TTL signal may be used as the sampling clock for digitizing input signals. Frequency calibration in ORDERS; max. frequency of external signal is 220 KHz, resulting in internal sampling rate of 110 KHz.

DIGITAL INTERFACE

Digital Data In:
12-bit serial digital data may be input directly to the FFT processor, bypassing input signal conditioners and A/D converter.

IEEE 488-1978 INTERFACE(GPIB)

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 a four-color plotter; an external calculator or controller is <u>not</u> required.

TEST SIGNALS

Self-Calibration:
Automatically performed periodically to recalibrate amplitude and phase (does not interrupt processing) for cross channel measurements.

Manual:
Standard test signals for amplitude and phase of both channels.

Diagnostics:
Operator-initiated routine indicates faults to board level; counts up to 10 intermittent failures.

Reset:
Resets front panel to turn-on state.

GENERAL

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

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

STORAGE TEMPERATURE:
-20° to 70° 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.

CHAPTER II

INSTALLATION

2-1. INTRODUCTION

This chapter describes how to properly and safely install your WAVETEK Model 5830A Digital Signal Analyzer. Remember at all times that, as well designed and constructed as it is, the 5830A has certain requirements you must adhere to in order to keep it working for you.

2-2. INSPECTION

If your 5830A 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 5830A 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 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 5830A, 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 5830A is 0 to 45 degrees Celsius.

2-3-1. Surface-mounted Installations

The plastic feet on the bottom of the 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 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 5830A 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 5830A 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 5830A remotely - for example, by a computer. The objective of this manual is to help you begin applying the 5830A 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 5830A 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 operator's front panel of the spectrum analyzer. After you've started using the 5830A, 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 5830A 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 5830A 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 5830A itself as source signals for the exercises. Since the 5830A is a cross-channel spectrum analyzer, you'll want two different signals for comparative purposes. Your 5830A 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 picture of the front panel of the 5830A (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.

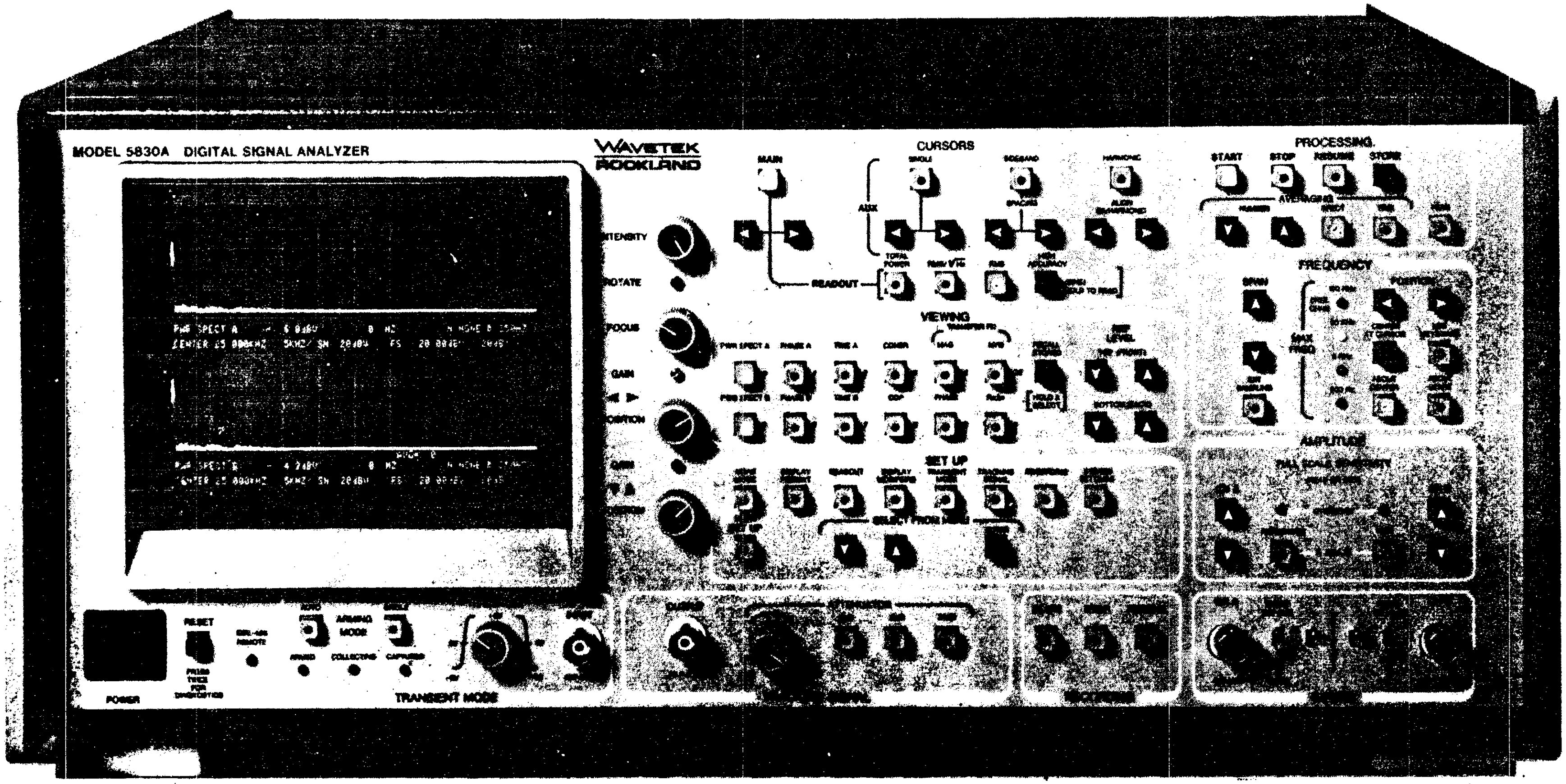


Fig. 3-2 Model 5830A Front Panel

3-3. POWERING-UP

Taking all precautions described in the Power Requirements section of CHAPTER II (Section 2-4), connect the 5830A 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 5830A started up.

2 - The unit can power up in a preset state (see Section 3-4-2). If the preset state is at DEFAULT (which can also be achieved by setting the rear panel AUXILIARY FUNCTION SWITCH F4 to OFF), then 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 MAIN & RMS, PROCESSING START & SPECT, VIEWING POWER SPECT A & POWER SPECT B, FREQUENCY ABOUT CENTER.

c- the 50 KHz green LED under FREQUENCY MAX FREQ should be lit.

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 5830A is performing an autocalibration operation). Then the split-screen display should reappear. The 5830A 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 5830A 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.

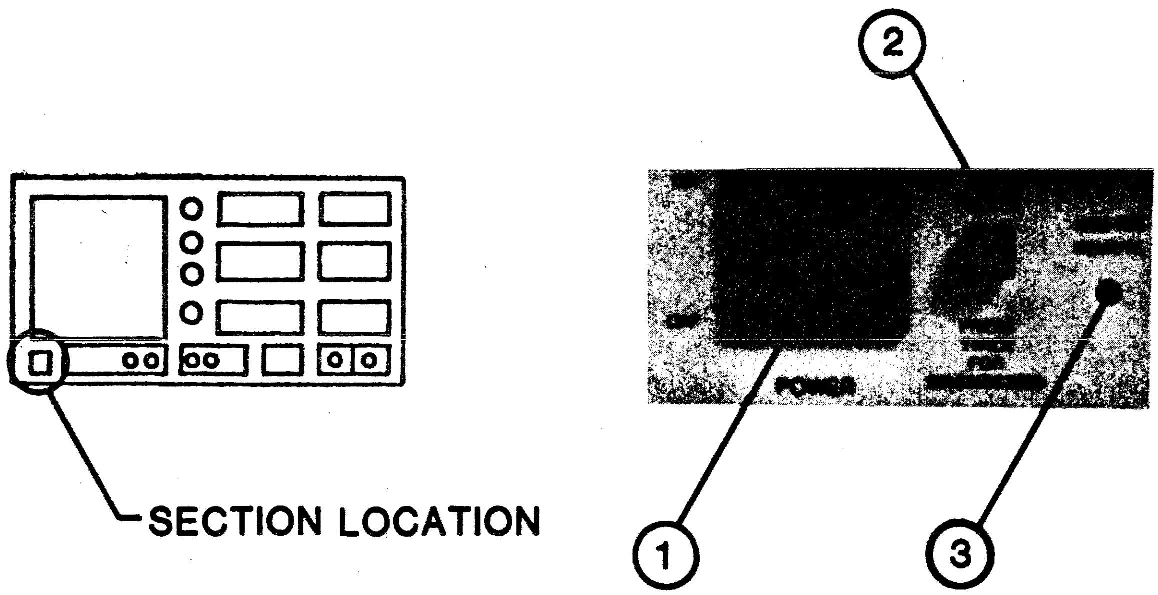


Fig. 3-3A Power-Up Section

(1) Applies power to the instrument when the top is pushed in; at this point the instrument goes through a pre-determined power-up 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 there is activity on the GPIB interface. The 5830A will become under remote control when the proper statements are sent to the instrument (See Section 4-4-1a).

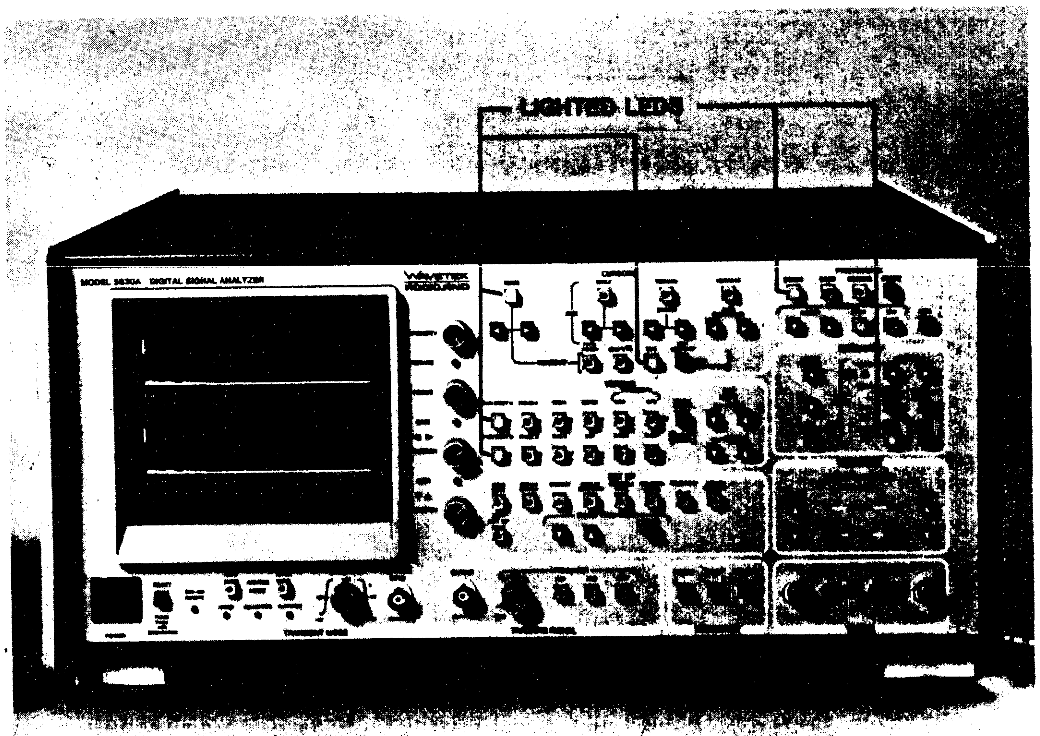


Fig. 3-3B Front Panel After Power-Up in DEFAULT state

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

There are two types of display formats, NORMAL and WATERFALL. The mode can be selected from the display format menu (see Section 3-5-3).

3-4-1-1. NORMAL Display

When you have a well-defined display on the screen, study it for a few moments. Note that there are two graphs displayed. The readout consists of two blocks of two lines, one block below each trace, and a status line written above the lower readout block. The status line contains information on input modifiers, number of averages performed, and pending IEEE requests. 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-la,b & c 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.

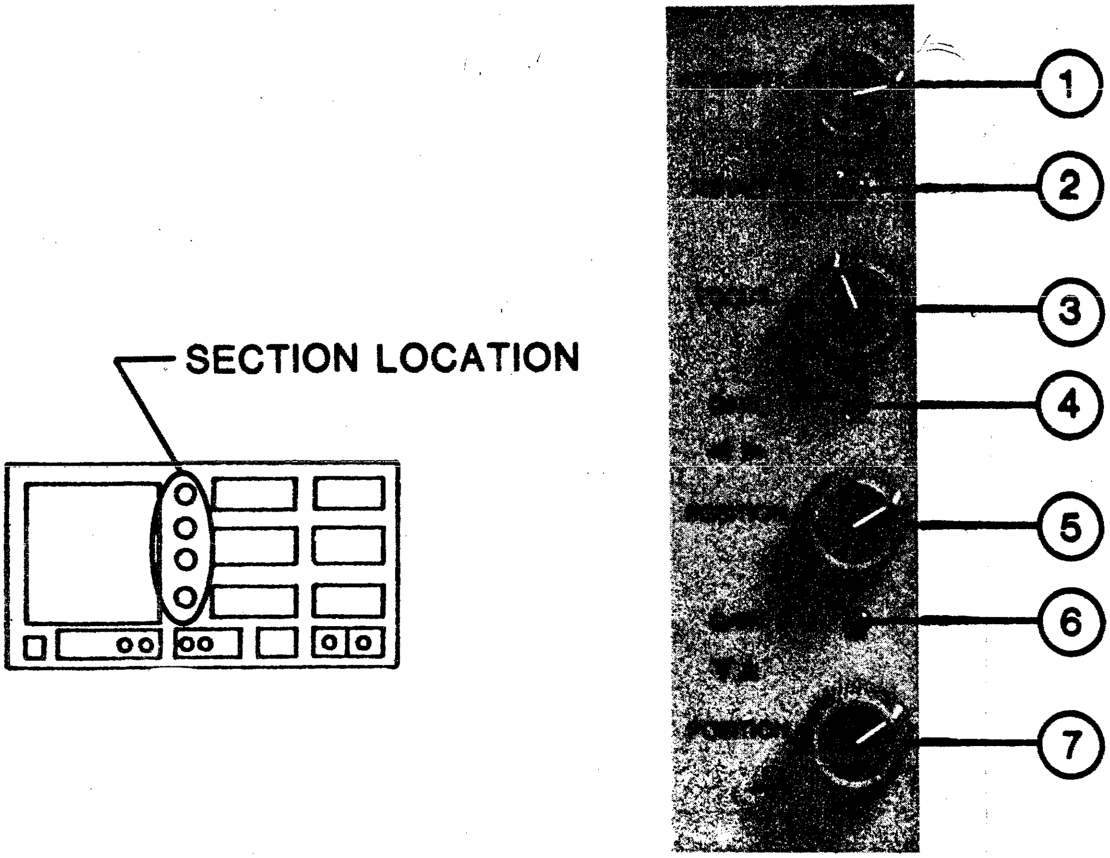


Fig. 3-4 CRT Controls

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

(2) Rotates entire display clockwise, or counterclockwise.

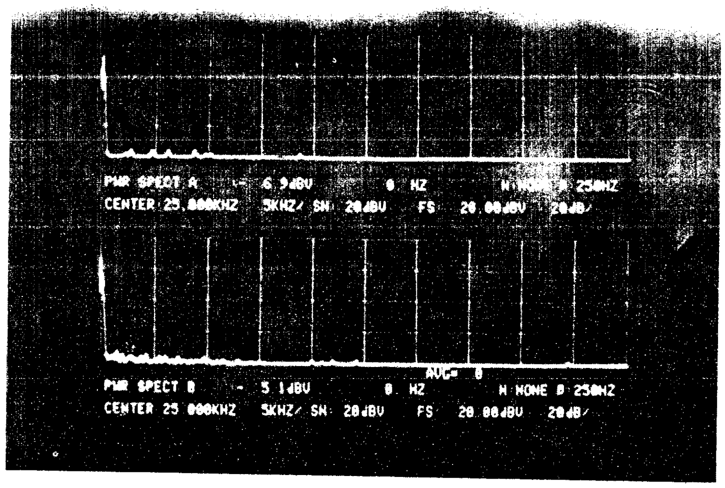
(3) Adjusts the focus, or sharpness of the display.

(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.



(Label) (Cursor Y) (Cursor X) Time/div
N:(Avg) B: (Beta)

— LINE 1

SPAN: (Freq. Range)
or
CENTER: (Center Frequency KHz/Div)

SN: (Sensitivity) FS: (Full Scale) (units/div)

— LINE 2

Input Modifiers, Computed Averages,

Pending IEEE Service Requests.

— STATUS LINE

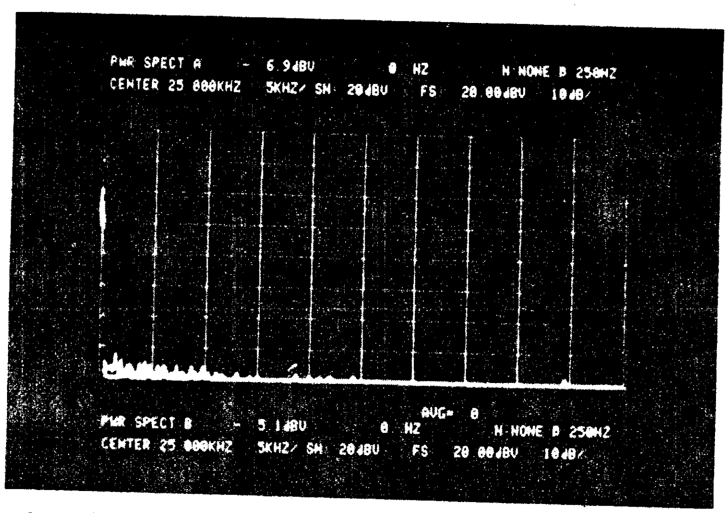
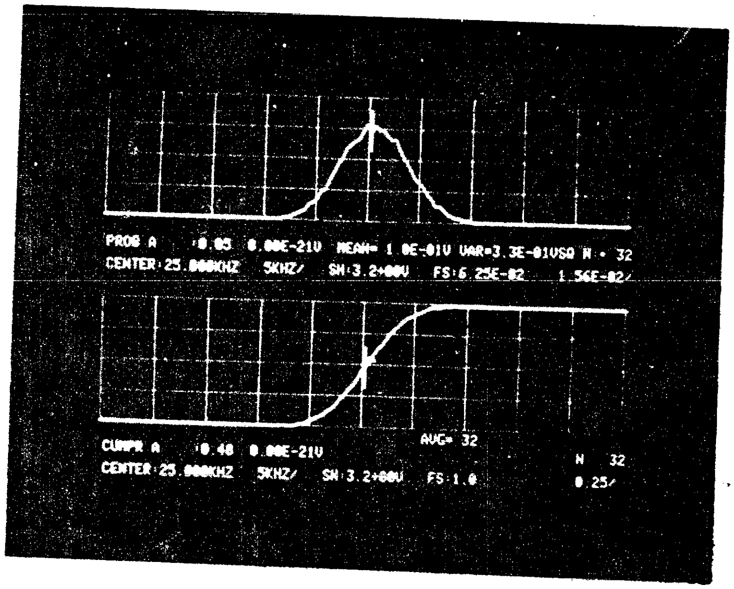


Fig. 3-4-1a Readout and Display Formats

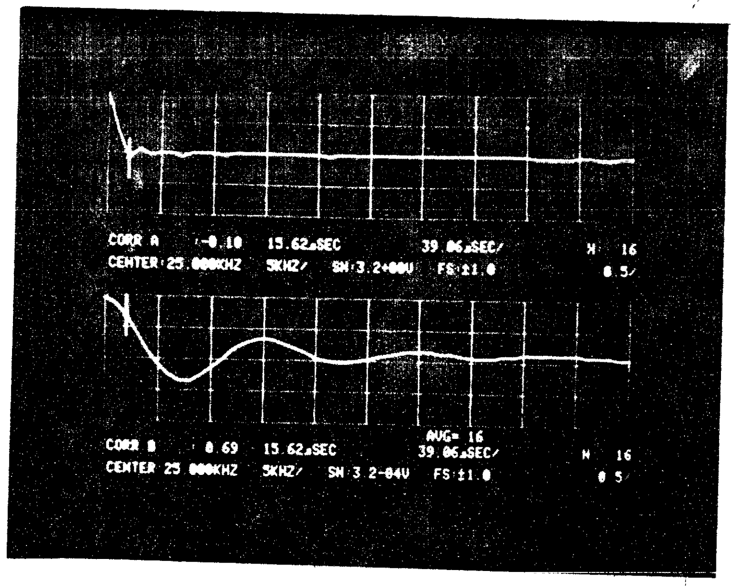


PROB: MEAN: VAR: N:
SPAN (or CENTER): SN: FS:
} TOP

CUMPR: N:
SPAN (or CENTER): SN: FS:
} BOTTOM

Computed Averages
Pending IEEE Service Requests
} LINE 3

Fig. 3-4-1b Readout and Display Formats



CORR A | N: | TOP
SPAN (or CENTER): | SN: | FS:

CORR B: | N: | BOTTOM
SPAN (or CENTER): | SN: | FS:

Computed Averages | STATUS LINE
Pending IEEE Service Requests

Fig. 3-4-1c Readout and Display Formats

Key to Figure 3-4-1 a,b,c 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, Volts squared 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, Volts rms, Volts Sq. or Eng Units.
PHASE	Degrees
TIME	Volts
XFR FN MAG	dB or dimensionless
XFR FN PHASE	Degrees
COHER	dimensionless
COH OUT PWR	dBV, Volt rms, Volts sq. or Eng Units.
NYQUIST	dB or dimensionless, degrees.
Real/Imaginary	dB or dimensionless.
AUTOCORRELATION A & B	dimensionless
CROSS-CORRELATION	dimensionless
HISTOGRAM A & B	dimensionless (each one gives probability and cumulative probability).

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) for spectrum measurement mode. In units of seconds for correlation mode, in units of volts for histogram mode.

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, CORRELATION A & B and CROSS CORRELATION function displays.

Avg. = number of samples averaged together in the AVERAGING modes. N is averaging setting; "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 =
a) If About Start= starting (low) frequency to ending (high) frequency of SPAN under analysis.
b) If About Center = center frequency & Hz/div.

Sensitivity = maximum signal input level acceptable without overload. Initially set by 5830A at +20 dBV at POWER-UP or RESET in DEFAULT state. Then user sets desired sensitivity via the AMPLITUDE SENSITIVITY Section keys (section 3-9). In units of dBV, Volts. Not displayed for XFR FN MAG, XFR FN PHASE, COHER, NYQ or Re,Im.

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.

<u>Exercise #1</u>

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 5830A 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 5830A set up really isn't the issue at this moment. These are exercises to raise your awareness of the 5830A's operating features.

3-4-1-2. WATERFALL Display

The waterfall display provides a way of presenting three dimensional data on a two dimensional display. The two dimensions are the X and Y values described in Section 3-4-1-1, and the third dimension is time. The third dimension is indicated by the display of a number of traces (8 or 4) corresponding to consecutive measurements. The following functions can be diplayed in WATERFALL format.

PWR SPECT
PHASE SPECT
COHER
COH OUT PWR
TRANSFER FN MAG
TRANSFER FN PHASE

The readout corresponds to the top (most recent) trace and has the format described in Section 3-4-1-1.

3-4-2. RESET to 5830A 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 5830A will assume this same preset status. We'll examine that in more detail in a few paragraphs. For reference, the DEFAULT Preset State (see Section 3-15) into which the 5830A is placed by either initial powering-up or RESET is given in the table below:

Instrument DEFAULT Preset State

Section	Preset Setting
Amplitude	20 dBV full-scale sensitivity autorange off, test signal off.
Frequency	50 KHz span, centered at 25 KHz.
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 into the information the 5830A produces about the input signal(s). It is 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 nine 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 5830A'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 occurrence 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
STORED SETTINGS

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

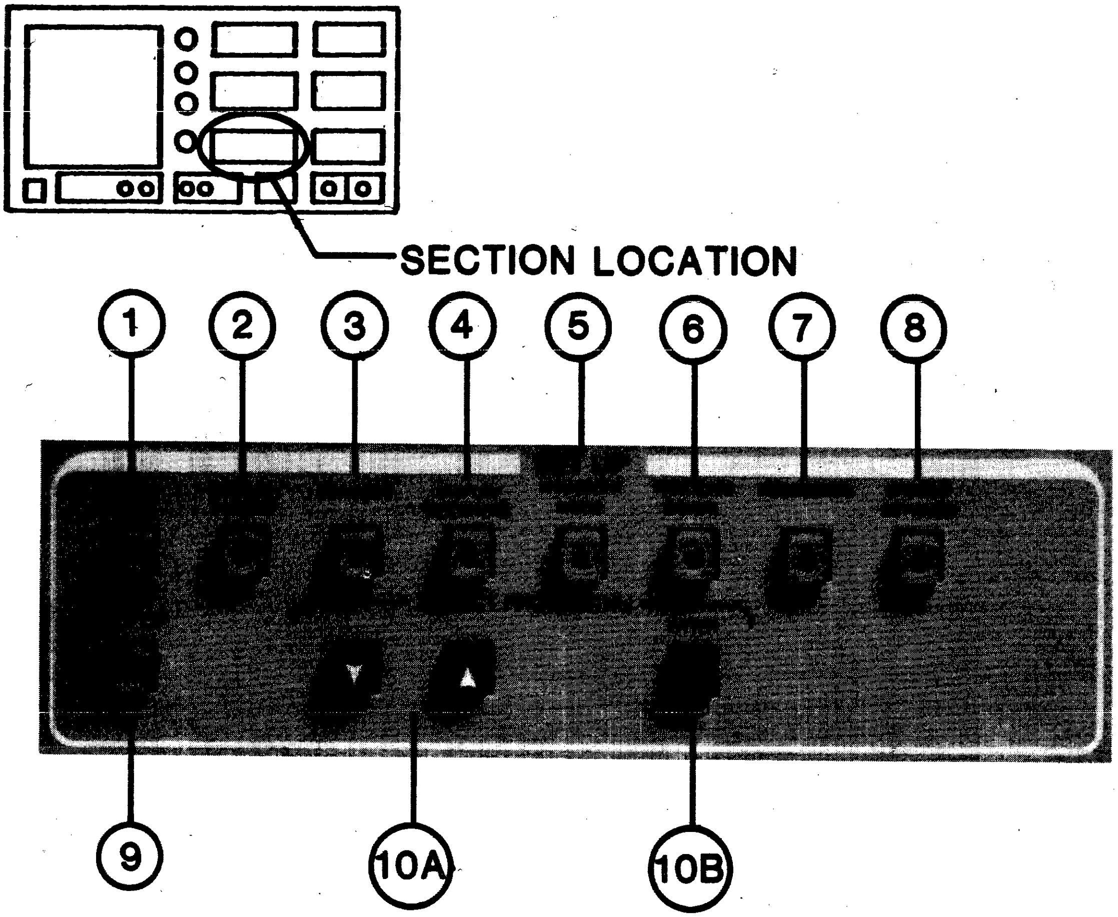


Fig. 3-5 SET UP Section

(1) Measurement Mode
Determines whether input samples are taken from CH A, CH B, or both, and type of processing, i.e. spectrum analysis, correlation or histogram. Also specifies the choice of weighting function

(2) Display Format
Provides choice of full or split screen in normal display, or waterfall display; linear or log frequency axis, linear or log amplitude axis, and full-scale vertical range. In waterfall display, successive displays are shown one beneath the other.

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

(4) Display Modifiers
Spectrum, transfer function and input signal can be processed further to provide additional information without affecting the processed data

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

(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) Stored Settings.
Stores 5 complete sets of front panel settings into a nonvolatile memory, as well as a complete set of spectral calculations corresponding to a measurement that can be recalled at any time, including power up.

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

(10A) 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.

(10A) Moves menu cursor up Δ , 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.

(10B) Enters the menu selection on line next to cursor. Selection entered indicated by asterisk (*).

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 5830A. 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 5830A's set up.

Earlier, you saw that the RESET key put the 5830A 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  [V/R]:1.0E+00
  CH.B SN: 20 dBV  [V/R]:1.0E+00
  MEAS MODE:CROSS CH,SPECT,INT SMP
  CENTER:25.000KHZ    5KHZ/
  WEIGHTING FN: HANNING
  FREE RUN
  SPECT AVG,N:NONE
  TSG: OFF
  DISPLAY MODIFIERS:
     SPECT    INPUT      XFR FN
   >         >          >
   >         >          >
   >         >          >
---------------------------------------
```

FIGURE 3-5-1A

On your 5830A 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, press ABOUT START in FREQUENCY section which will bring you from CENTER to SPAN mode. Press one of the two SPAN settings. Every time you press it, setting will change and eventually the green light, indicating the maximum frequency, will go on.

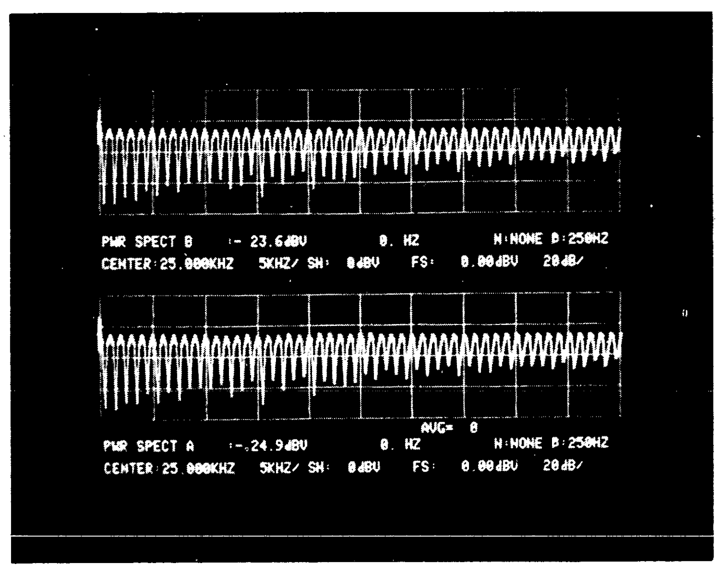
As we proceed, all the entries on the list will take on meaning. For now, note that the "MEASUREMENT MODE" entry indicates a "CROSS CHANNEL" setting. Press and release the VIEW SET UP key. Its LED will go out; the SET UP summary will be replaced by a split-screen display modified by your experimentation 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 5830A - and there's not much of that.

<u>Exercise #1</u>

Just to assure yourself that the 5830A is working, while viewing the VIEW SET UP, press SPAN key and then, looking at the CRT, keep pressing until SPAN equals 0-50KHz or, if in CENTER, it equals 25KHz and 5KHz/. Then, exit the VIEW SET UP by pressing the key and 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, and type of processing.

<u>Exercise #1</u> - 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 5830A 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.

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

[*] SPECTRUM
[ ] CORRELATION          [ ] HISTOGRAM

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

WEIGHTING FUNCTION:
[*] AUTO
[ ] HANNING              [ ] UNIFORM
[ ] FORCE CHN A
    UNIFORM CHN B
   [ ] SET WINDOW EDGE AT TIME CURSOR
```

FIGURE 3-5-2

This particular menu has three groupings: Type of Processing, 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.

Processing Modes

SPECTRUM allows you to perform power spectrum and transfer function measurements.

CORRELATION mode allows you to either compute the autocorrelation of the signal or the cross-correlation between two channels.

HISTOGRAM mode allows you to compute the probability density and distribution of the two input signals.

Exercise #2 - 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 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.

Exercise #3

You may want to experiment a little here by pressing the SPAN key in the FREQUENCY section one step at a time (give the 5830A a moment to change the CRT display).

As you press the FREQUENCY SPAN key, 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 will 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 5830A show and do what you want. You will work with the other SET UP Section menus in the same way you have done here.

Weighting Functions

The third 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 and for periodic random noise and multi-sine.

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

The FORCE window (Cross Channel spectrum measurement mode) is sometimes used in analysis of transients, particularly if impulse testing is performed. If this window is selected, uniform weighting is applied to Channel B and a Force window to Channel A. The force window is flat from time t = 0 to a point that can be selected through the time cursor. It then consists of a very sharp exponential section which decays to 0 in approximately 10 samples.

The EDGE of the window is selected in the measurement mode of the menu using the current value of the time cursor.

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 normal (full or split screen) or waterfall 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
[ ]  WATERFALL       [ ] NORMAL
----------------------------------------
```

FIGURE 3-5-3

The 5830A 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).

Referring to the CRT display illustrations in Figures 3-4-1a, b and c, 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.

When WATERFALL is selected, successive displays can be shown, one beneath the other, starting from the top. Up to eight spectra can be displayed. Enter NORMAL to revert to one spectrum (signal). The following functions can be displayed in WATERFALL:

a) <u>Single Channel</u> (4 traces)

PWR SPECT A or B
PHASE A or B

b) <u>Cross Channel</u> (8 traces)

PWR SPECT A or B
PHASE A or B
COHER
COP
TRANSFER FN MAG
TRANSFER FN PHASE

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 most of 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 5830A, 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 PSI. 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 5830A (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 the units of the readout as well as normal or special calibration:

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

              VERTICAL AXIS

  CALIBRATION:
   [*] WRT REFERENCE
   [ ] WRT 1.0 VRMS


   READOUT:
   [*] SAME AS DISPLAY SCALE
   [ ] dB
   [ ] LINEAR
   [ ] POWER


[ ] 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.)

READOUT will also be in the form that you have initially selected from DISPLAY format, or independent of the display, in which case you can select dB, linear or power.

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 5830A 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 5830A 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=2.0E+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 ZERO
?

[ ] 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 5830A 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 = <u>00.00</u> 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:

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

        SPECTRAL DISPLAY MODIFIERS      [*] OFF

SPECT/XFR FN:
    [ ] EQUALIZE WITH STORED FN [RATIO]
    [ ] COMPARE WITH STORED FN [DIFFERENCE]
    [ ] PHASE DERIVATIVE
    [ ] INTENSIFY AT CURSOR
    [ ] EDIT XFR  FN
    [ ] 1/XFR FN
    [ ] CLOSED TO OPEN LOOP XFR FN
    [ ] XFR FN TO IMPULSE RESPONSE


[ ] CONTINUE

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

FIGURE 3-5-5

Position cursor at CONTINUE to obtain the rest of the menu:

MODIFIERS CONTINUED

PSEUDO INPUT MODIFIERS:

	CH.A	CH.B
1ST DERIVATIVE	[ ]	[ ]
INTEGRAL	[ ]	[ ]
2ND DERIVATIVE	[ ]	[ ]
DOUBLE INTEGRAL	[ ]	[ ]
MULTIPLY BY -1	[ ]	[ ]

[ ] CONTINUE

FIGURE 3-5-5A

(Note: positioning the cursor at CONTINUE in Fig. 3-5-5A will merely bring you back to Fig. 3-5-5).

Equalization, EQUALIZE, works with Power Spectrum A and B, Transfer Function Magnitude and Phase, Coherent, Nyquist, Re-Im. Output Power. This causes the ratio, on a frequency by frequency 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 frequency point-by-point basis and displayed. Difference can be used to remove specific effects such as background noise.

PHASE DERIVATIVE, works on PHASE A & B and TRANSFER FN PHASE. It approximates the derivative of phase with respect to frequency and is useful in computing delays at different frequencies.

INTENSIFY AT CURSOR, makes the cursor(s) look brighter with respect to the rest of the traces.

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
[ ] SINE AT CURSOR
[ ] SINE SWEEP
[ ] MULTI-SINE AT CURSOR [CROSS CH ONLY]
[ ] MULTI-SINE SWEEP [CROSS CH ONLY]

FIGURE 3-5-8

The menu is used to select the type of signal to be output by the 5830A's built-in Tracking Signal

Generator. The tracking signal generator in the 5830A operates in the following modes:

NOISE: random signal whose spectrum is flat and concentrated over the analysis span.

PERIODIC NOISE: pseudo-random signal with a period equal to the data window. 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.

PULSE, TRANSIENT MODE ONLY: pulsed sinewave whose frequency corresponds to the center of the analysis span, permits transfer function measurements anywhere in the span, thus overcoming the restriction of limiting impulse testing to near or at the baseband frequency range.

SINE AT CURSOR: sinewave at frequency equal to the one where cursor frequency happens to be at that time.

SINE SWEEP: One sinewave is generated and made to sweep across the span. One sweep can be used or a number of sweeps may be averaged.

MULTI-SINE AT CURSOR: 10 sinewaves are simultaneously generated, with each sinewave spaced a resolution cell apart, and falling in the center of each DFT filter. These sinewaves are all phased with respect to each other so that the crest factor is minimized. They can be placed anywhere in the analysis span, centered around the cursor.

MULTI-SINE SWEEP: The 10 previously described sinewaves can be made to sweep, actually hop, across the span. One sweep can be used, or a number of sweeps may be averaged.

Note: Multi-sine modes can be selected only in Cross Channel measurement mode. Each sweep mode causes the display to be updated only at those frequencies which are actually being generated to improve the dynamic range of the measurement.

The spectrum of all signal sources is 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.

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.

3-5-9. STORED SETTINGS Menu

This menu stores five complete sets of front panel settings into a nonvolatile memory that can be recalled at any time, including power up. Two 400-line single channel spectra (total span and zoom) or one complete set of cross channel data consisting of four 200-line spectra: power spectrum A and B, cross-spectrum, real and imaginary along with their calibration information, may be stored in the nonvolatile memory and later recalled. The stored information is also sufficient to recall transfer function, coherence and coherent output power, Nyquist, and real vs. imaginary.

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

            NONVOLATILE MEMORY CONTROL

[ ] STORE STATE IN LOCATION [1-5]

[ ] RECALL STATE FROM LOCATION [1-5]


SET POWER UP STATE TO
    [*] DEFAULT
    [ ] ON LOCATION

[ ] SAVE STORED SPECTRUM
[ ] RECALL SPECTRUM

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

FIGURE 3-5-9

The STORED SETTINGS mode enables you to do the following:

1) Store a state and recall it in 5 locations (5 different preset settings). See Appendix G for a description of State.

2) Select Power Up state to be at DEFAULT or at one of the five locations. It will be at DEFAULT in one of the following cases:

a) Default selected;
b) Nothing was ever stored in the specified location;
c) Switch F-4 of rear panel was set to OFF.

3) You can save and later recall a stored spectrum (see Section 3-15) and the corresponding instrument state in a non-volatile memory. Note that when you recall, you destroy any spectrum that might have been stored in the volatile memory.

3-6. Signal INPUTS

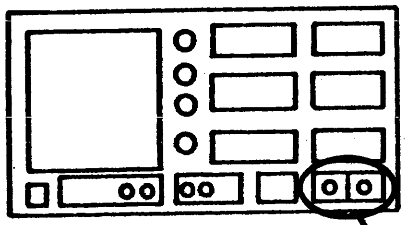
The signal INPUT section provides for connection of input signals and determines what type of coupling is to be used. Read over the description of each INPUT section item depicted in Figure 3-6.

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 5830A's power supply cord must be properly grounded to avoid an unsafe operating condition.



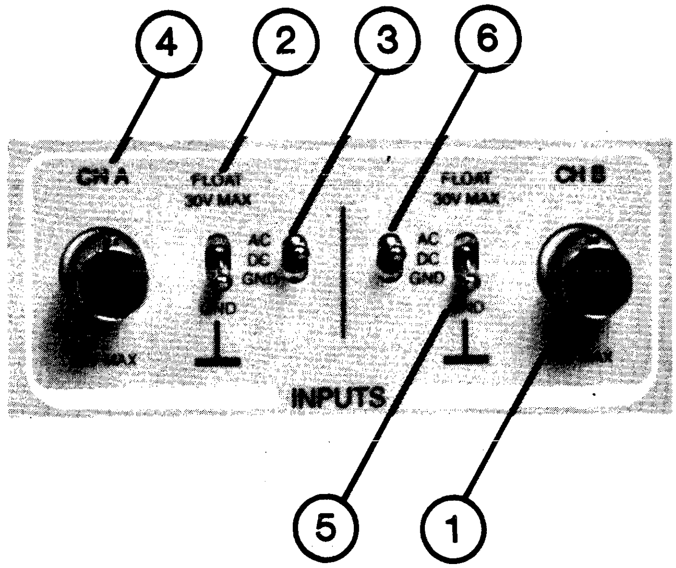


Fig. 3-6 Input Section

(1) Input BNC Connector for Channel B.

(2) Selects whether Channel A input low terminal (BNC shell) is floating in a true differential mode (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).

(4) Input BNC Connector for Channel A.

(5) Selects whether Channel B input low terminal (BNC shell) is floating in a true differential mode (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, -60 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.

The attenuators may be used before the tracking signal is activated to prevent any damage from occuring due to a large signal source.

One of several types of tracking signals 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.

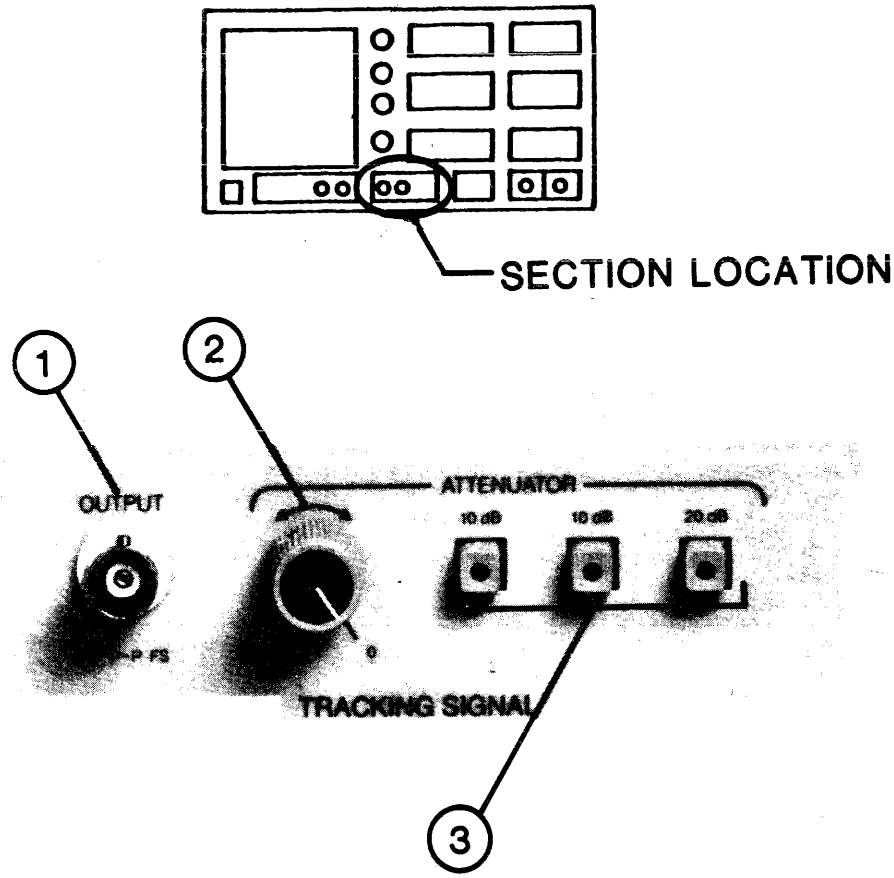


Fig. 3-7 Tracking Signal Generator

(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.

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- Select DEFAULT POWER STATE either through the Stored Settings menu in SET UP Section or by using Switch #F-4 on rear panel. RESET the 5830A. 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.

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- For efficiency's sake, set the FREQUENCY SPAN to 1K (1KHz) or larger. Smaller values can take a while to produce a display - something we'll explain in the FREQUENCY Section.

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 5830A. The 5830A 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.

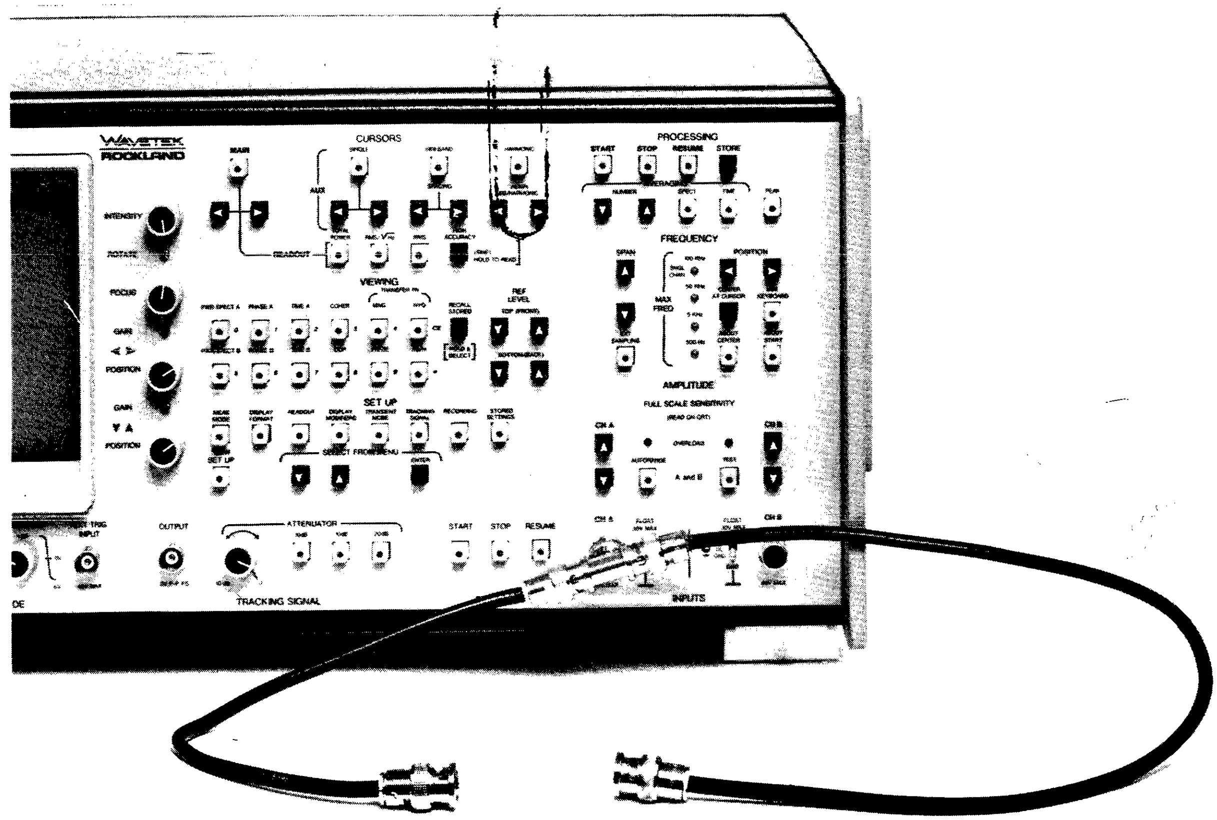


Fig. 3-7-1A

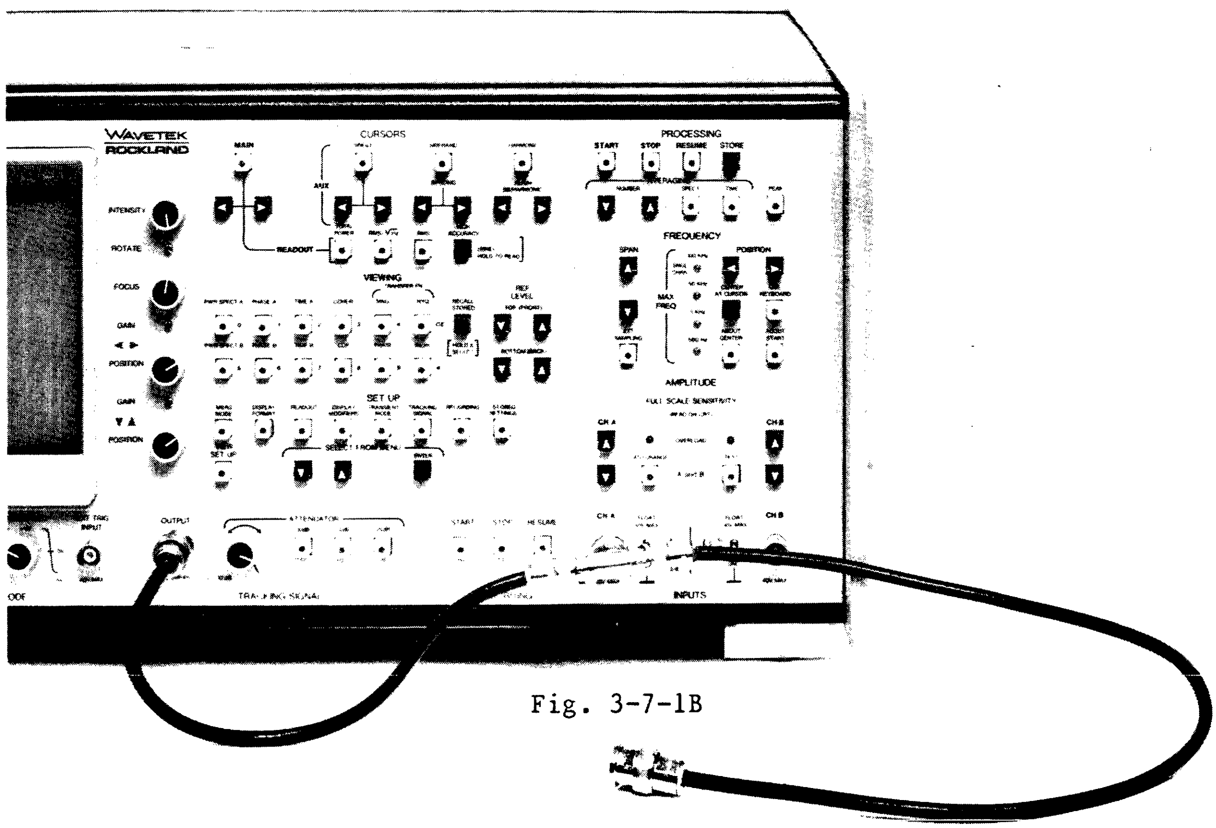


Fig. 3-7-1B

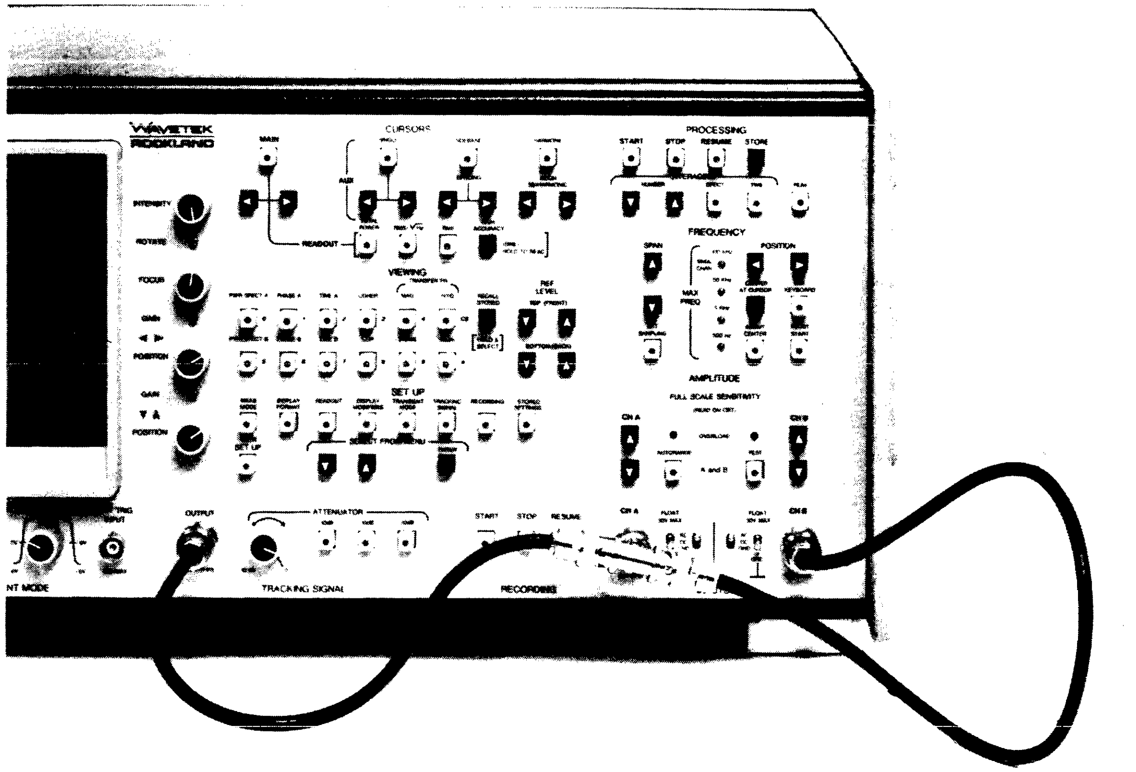


Fig. 3-7-1C

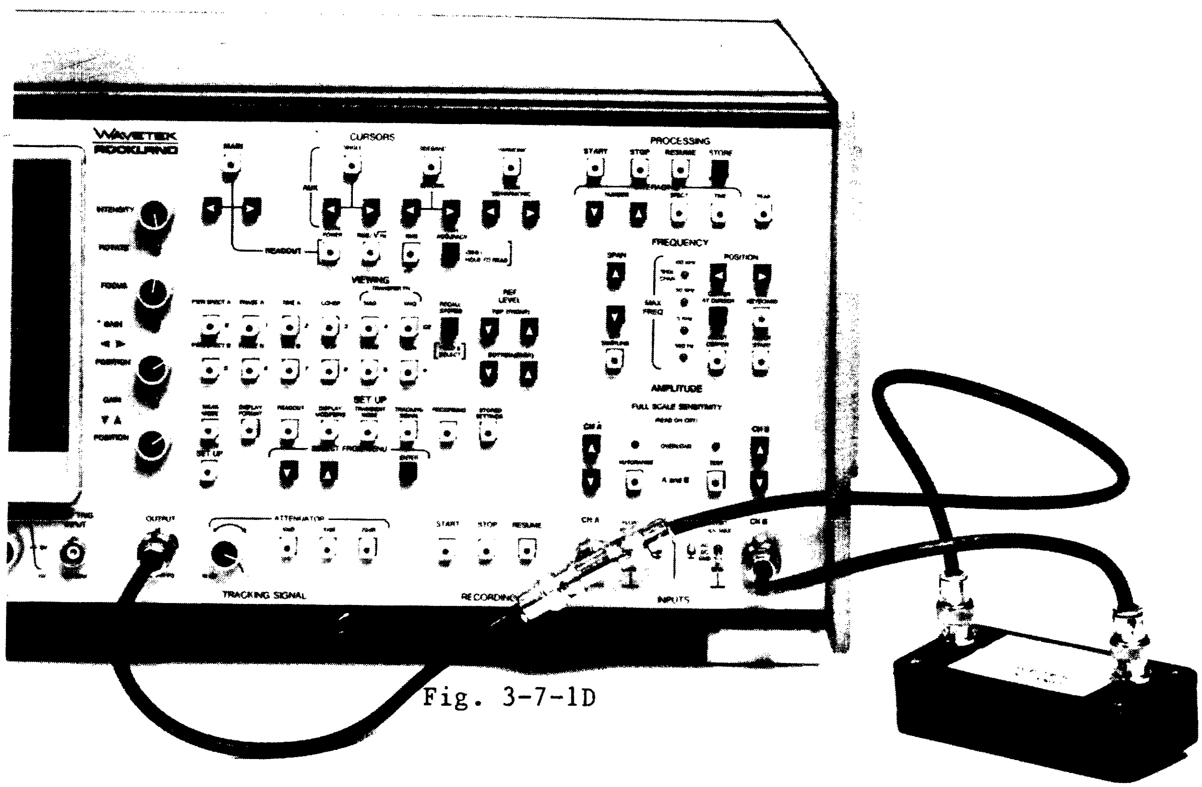


Fig. 3-7-1D

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

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 5830A, including the TRACKING SIGNAL generated by the 5830A 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 5830A to be driven from an external sampling clock.

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

The 5830A implements 201 or 401 digital filters to analyze whatever signal(s) are presented to it. They are used 201 per channel when the 5830A 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 100 KHz span. Each filter's B would be 250 Hz wide (100,000 Hz/400 = 250 Hz per filter).

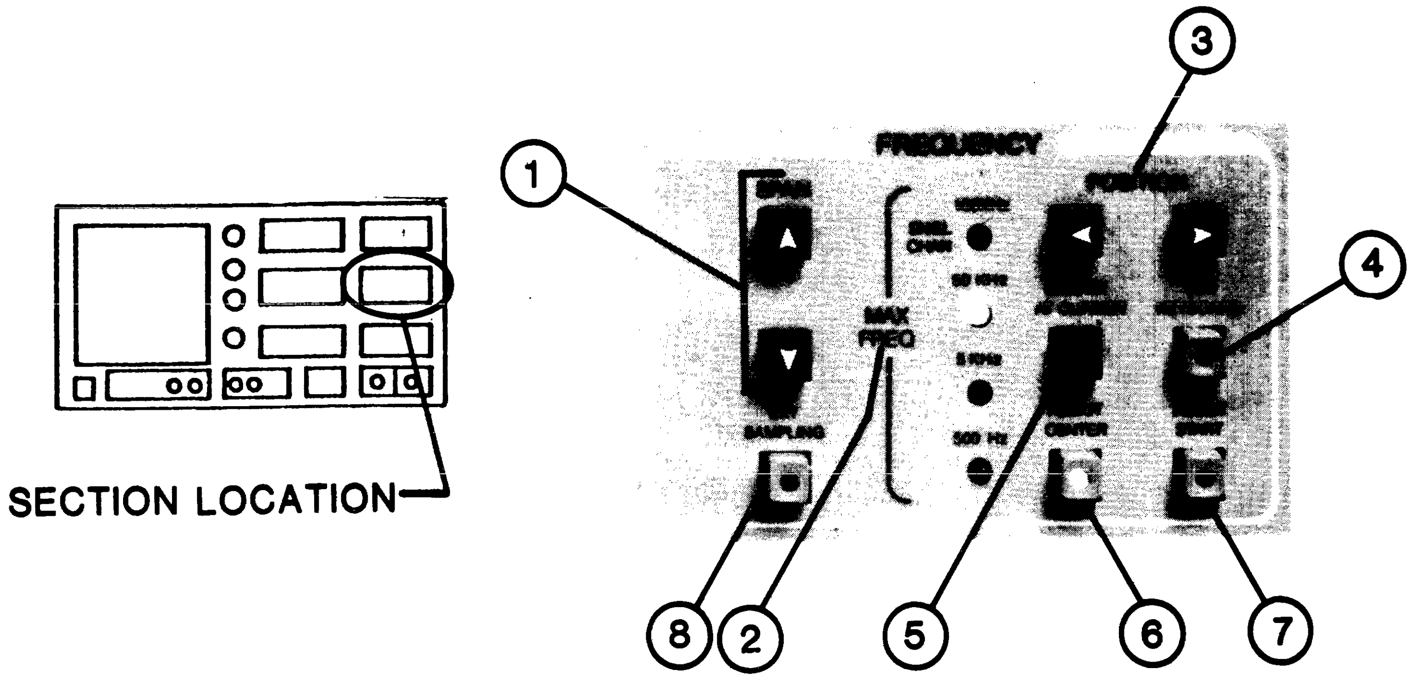


Fig. 3-8 Frequency Section

(1) The SPAN control specifies which portion of the input spectrum will be analyzed. Moves the selected SPAN down ▽ or up △ , thus selecting its width. 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 activated use the keyboard in VIEWING section to enter on the CRT, the position of the span. Press again to return to processing mode.

(5) When momentarily pressed, the selected span centers about the main cursor's position.

(6) When activated, the portion of the spectrum being viewed stays at the same center frequency as the span width is changed.

(7) When activated, the portion of the spectrum being viewed stays at the same start frequency as the span width is changed.

(8) 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. 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 four 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
100 KHz	250 Hz	-	-	-
50 KHz	125 Hz	250 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	0.25 Hz	2.5 Hz	0.5 Hz	2.5 Hz
50 Hz	0.125 Hz	2.5 Hz	0.25 Hz	2.5 Hz
20 Hz	0.05 Hz	2.5 Hz	0.1 Hz	2.5 Hz
10 Hz	0.025 Hz	2.5 Hz	0.05 Hz	0.25 Hz
5 Hz	0.0125 Hz	2.5 Hz	0.025 Hz	0.25 Hz
2 Hz	0.005 Hz	0.25 Hz	0.01 Hz	0.25 Hz

The 2,5 and 10 Hz 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

If selected ABOUT CENTER, the alphanumeric data associated with each CRT display graph will tell you both the center frequency, number of Hz/div and the B(beta) bandwidth of the filters. If selected ABOUT START, the alphanumeric data associated with each CRT display graph will tell you both the span start (low) and end (high) frequencies and the B(beta) bandwidth of the filters.

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- Press RESET. Set span to 50 KHz. The "ABOUT CENTER" LED should be ON right now.

B- Set up the 5830A 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. (Power Spect B key becomes the MAX SPAN key in the single channel mode.

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- Change span 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 5830A automatically drew a display both for the span you selected (uppermost), and for the full 0 to 100 KHz range. Also, on the upper full screen display, the brighter portion of the trace represents the span being displayed in "close-up" on the lower plot.

Displaying both the selected span and the full range span in single channel mode is a regular feature of the 5830A.

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

1- The lower plot of the selected span always is flat (constant average energy per bandwidth) across the range. However, the 0 to 100KHz plot reveals that the Noise generator output changes considerably across the range with each span change. Generating approximately constant energy output per bandwidth only in the span under observation, while minimizing the energy outside the span, maximizes the dynamic range of the 5830A.

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 SATIA for a more detailed theoretical explanation.

3- The span selected has always stayed centered around 50KHz. That's because the 5830A is in the ABOUT CENTER mode and was started in the 0 to 100 KHz range - whose center is 50KHz.

Exercise #2

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

A- Press About Center and set SPAN to 100K; then to 25K. Notice that the center frequency stays at 50KHz.

B- Press the ABOUT START key in the FREQUENCY Section. Now select different spans. Notice that, down to 100 Hz, they all produce spans which begin at 37.500KHz.

At 100 Hz, Span Start drops to 1.875KHz 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 also use the Use Keyboard key to enter the Start or Center Frequency. Press KEYBOARD and then enter numercial data (0 - 9 keys in VIEWING section). Notice that the display prompts you to enter the correct number of digits. After you have entered your data, press KEYBOARD again to return to normal display. If you have selected About Start, the frequency you can enter is the Start Frequency, and conversely, if you have selected the About Center, the frequency you can enter is the Center Frequency.

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- Press RESET to DEFAULT front panel condition. Set up the 5830A 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 and press ABOUT START key in FREQUENCY section. 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.

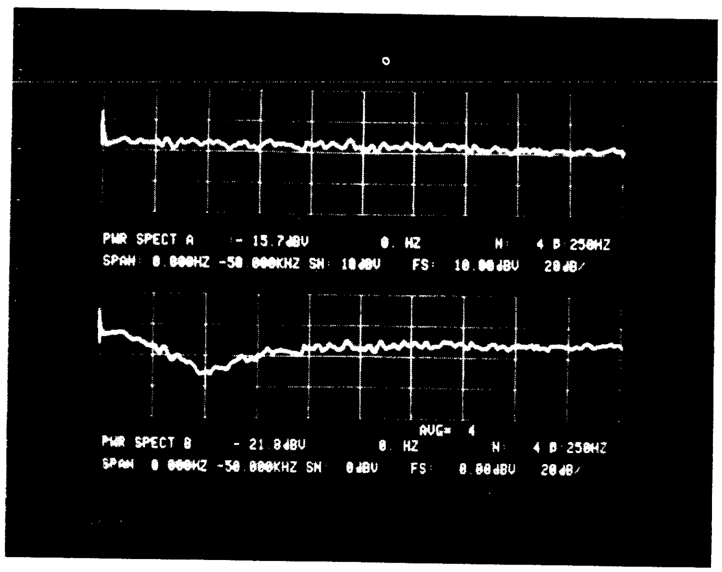


Fig. 3-8-1 Input-Output Power Spectra to IEM

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 MAIN 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 alphanumeri 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 5830A, revealing lower level signal components. For now, one more thing about basic FREQUENCY Section controls - positioning the frequency span.

<u>Exercise #4</u>

A- Leave the 5830A set up exactly as it was in 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- Set span 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 5830A 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 5830A is now in the ABOUT CENTER mode, each time you change the span to a smaller one, it will be centered on 10KHz. Try it.

E- Instead of moving the range using the POSITION keys, the keyboard can be used to directly enter the position of the span. Let's try it.

Set SPAN to 10KHz. Press USE KEYBOARD and enter 11000Hz via the keyboard in the VIEWING section. Press USE KEYBOARD again to resume processing. Note, the notch moved to the left of screen center and the CENTER frequency displayed is now 11.000KHz.

You could repeat Exercise #1, and see the brighter part of the 100K 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 5830A, 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 5830A'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.

In single-channel mode, the external sampling clock is used directly as the sampling signal. In dual-channel mode, every other clock pulse causes simultaneous sampling of both channels so that the effective sample rate is one-half of the external sampling clock frequency. In this case, the A/D conversion takes place once per external clock pulse, alternating between channels A and B.

A useful application 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 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 spans of 50 KHz (dual channel mode) and 100 KHz (single channel mode) correspond 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 span setting. 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 5830A 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. 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.

In dual-channel mode, the 50 KHz lowpass filter present in the input stage of the 5830A 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.

In single-channel mode, the 100KHz lowpass filter will behave in a manner proportional to the 50KHz filter described above.

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

SPAN SETTING	A SPAN IN FR UNITS	B FREQ POINTS	C FREQ RESOLUTION FR UNITS	D 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

100K	400	400	1	220
50K	200	400	0.5	220
25K	100	400	0.25	220
10K	40	400	0.1	220
5K	20	400	0.05	220
2K	8	400	0.02	220
1K	4	400	0.01	220
500	2	400	0.005	220
200	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 5830A can accept without overloading. On LOG scale, the absolute maximum for the 5830A 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 5830A 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 12% 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 whenever a Start of Averaging is performed or whenever the AUTORANGE LED is turned off and on again.

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 5830A in general and the CRT in particular.

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

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 5830A will simply ignore (not process) the overloading data block. Therefore, valid measurements can be made in the presence of overloads when averaging has been selected. With No averaging, the data is processed normally.

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.

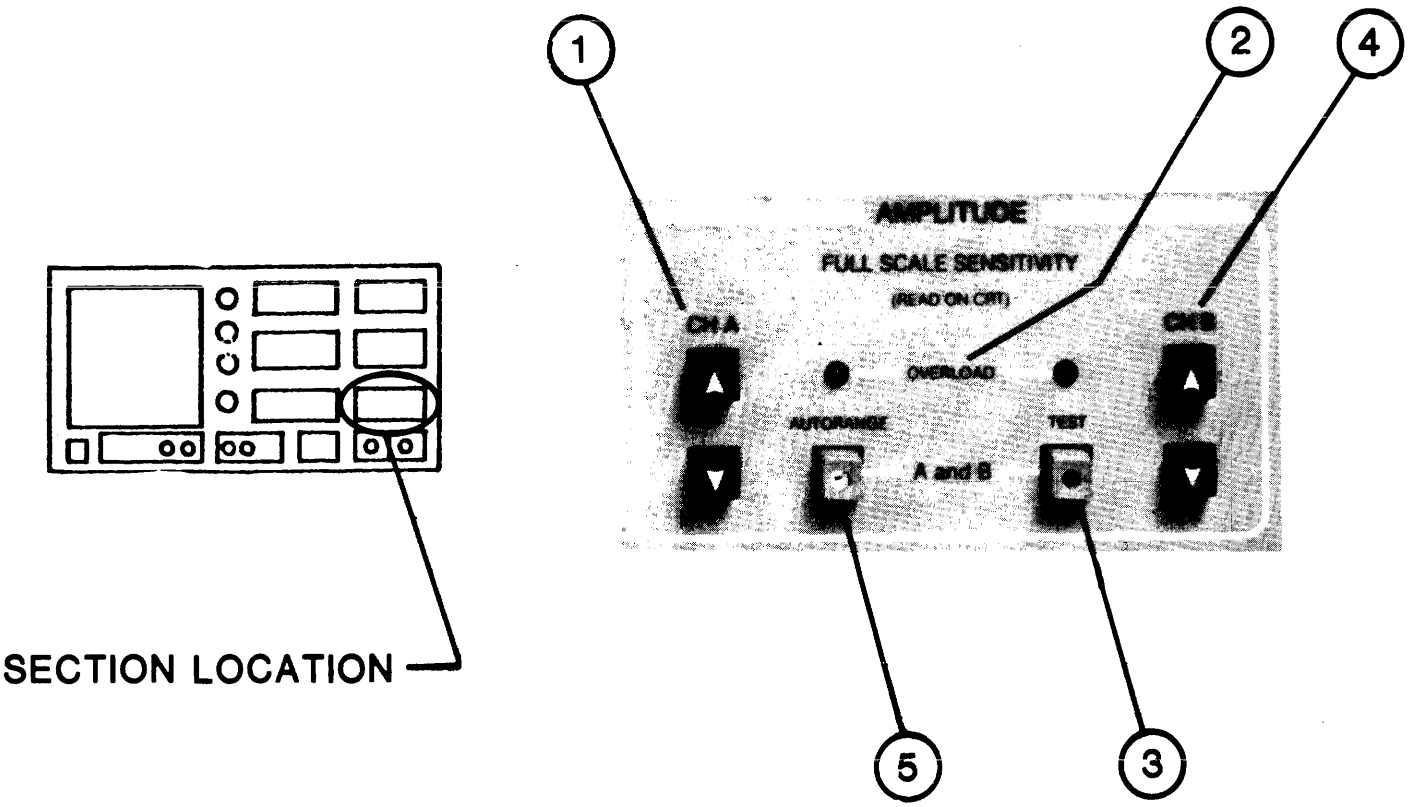


Fig. 3-9 Amplitude Section

(1) Allows for increasing Δ 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 approaches 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. However, if the number of averages (PROCESSING section) is set at NONE, then all data will be processed. 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 Δ 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 5830A 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 5830A (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 120 dB lower.

Experiment with these keys to "move" the displays up and down. Notice what alphanumeric data changes and what stays the same. The Ref Level keys control all displays except the time, phase, and correlation displays.

3-10. The CURSORS

Four cursors or markers are provided. The one marked MAIN is a 1-division high vertical 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.

SINGLE is a 1/2 division high vertical marker which also can be positioned anywhere along the CRT graphic trace(s). SIDEBAND and HARMONIC markers are a series of intensified dots relative to the SINGLE marker and are used to identify sidebands wrt a carrier signal or harmonics wrt a functional signal.

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

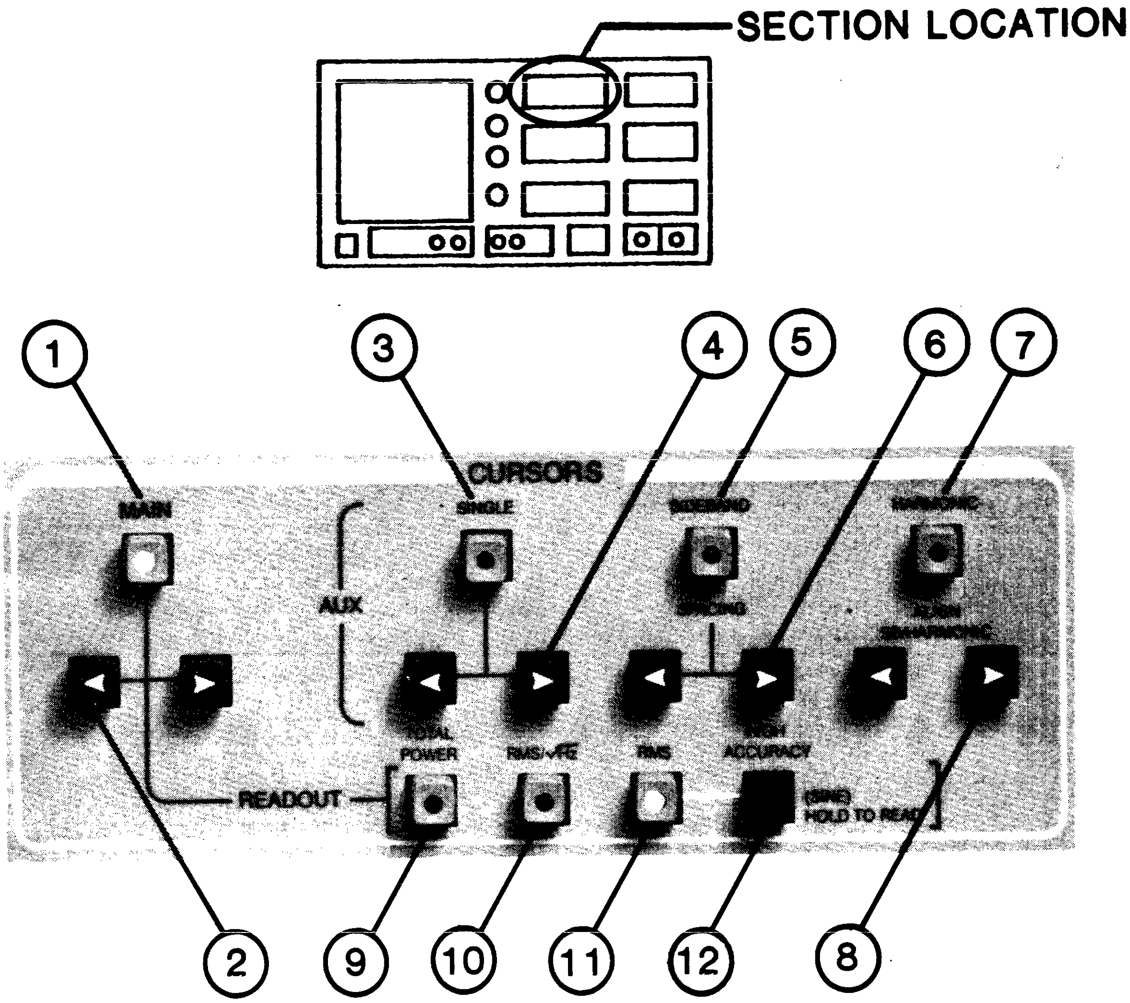


Fig. 3-10 Cursor Section

(1) When activated, it turns on the cursor and its corresponding readouts. All readouts require the main cursor to be on.

(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, it turns on a secondary marker (at the lowest displayed frequency) which is defined as the fundamental frequency when HARMONIC marker is used, and as the carrier when SIDEBAND marker is used.

(4) Allows to move SINGLE marker left ◁ or right ▷ throughout the display.

(5) When activated, turns on a set of secondary markers equally spaced about the SINGLE marker. SINGLE must' be on. (Secondary markers are initially spaced at ΔF=0Hz so they must be opened up first to view-see item 6).

(6) Allows for moving the spacing of the SIDEBAND markers.

(7) When activated, it turns on a set of secondary markers located at multiples of the SINGLE marker. SINGLE must be on.

(8) Allows for small adjustment of the sideband and harmonic markers to account for the discrete signals not falling in the center of a frequency resolution cell.

(9) When activated, with only the MAIN marker on, the amplitude readout is equal to the total power in frequency span being used excluding DC. With the addition of the SINGLE marker, the readout is equal to the total power between the MAIN and SINGLE cursors. With the SIDEBAND marker on, the readout is equal to the power in the identified sidebands. With the HARMONIC marker on, the readout is equal to the power in the displayed harmonics of the fundamental.

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

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

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

Note: In single channel mode, the cursors of the two traces are independent. In order to lock them, set one of them to the left hand of the screen and turn the trace off by pressing the view button. Then, move the other cursor to the left of the screen and return the first trace to the screen.

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 5830A in single channel (CH A), split-screen, maximum span in background. Set SPAN to 10K. Use the SPAN POSITION (or use KEYBOARD) keys to move SPAN center to 50 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 wide trace will be flat (constant power per filter) while the 100K 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 100K trace is the total modified signal.

B- Position the cursor at the center of the screen (50K) 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 100K trace, because the nominal analysis bandwidth in the 100KHz is 250KHz as compared to 25KHz on the 10KHz wide 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 5830A 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 100K span and the narrower span 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.

Exercise #3

Total power in a selected range may be measured using the MAIN and SINGLE cursors.

A- Use the same setup as in Exercise #2 with SPAN to 10KHz.

B- Press TOTAL POWER key with only MAIN cursor on. Record the total power. Turn on SINGLE and adjust the positions of the MAIN and SINGLE cursors so they are nominally a division apart on the 10KHz wide span. You should see the power in the 1KHz wide region is about 10dB lower.

3-10-2. HIGH 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 5830A implements a unique computational process to correct this inaccuracy by better than a factor of 10. You should only use the HIGH ACCURACY key when making PERIODIC signal measurements!

Exercise #4

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 each with a nominal amplitude of -26 dBV. The fundamental of that series is 1001.9569 Hz in dual channel and 2003.9138 in single channel.

A- Set the 5830A into cross channel mode. Set span to 50K. Set the cursor to read in RMS. Activate the TEST key.

B- Use the cursor to measure amplitude of the fundamental at nominally 1.00KHz. Now find the 48th harmonic's peak (spectral line). It should occur at the 48.00 KHz position. Take note of the amplitude.

C- Press the HIGH 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 1001.9569 Hz. Compare the amplitude before and after pressing HIGH ACCURACY. Compare the results with the amplitude of the fundamental signal. The HIGH ACCURACY key function of the 5830A will always improve the accuracy of discrete line spectra measurements: frequency and amplitude.

3-10-3 SINGLE, SIDEBAND and HARMONIC

Many phenomena produce sideband and harmonic signals. For example, amplitude and frequency modulation in communications, runout in gear trains, nonlinearities in amplifiers or structures. Both SIDEBAND and HARMONIC markers help to identify these components relative to SINGLE marker, a useful feature when analyzing complex spectra. In addition, total power in the sidebands or harmonics can be measured.

Exercise #5

A- Use the same setup as in Exercise #4 and set SPAN from 0 to 10KHz.

B- Turn on SINGLE cursor and set it at the fundamental: 1.00KHz. Press HARMONIC key. You should see a dot falling on the peak of each harmonic line.

C- Use the MAIN cursor and measure the RMS amplitude of the fundamental: about -26dBV. Now press TOTAL POWER key. The amplitude readout will corresond to the total power in the 9 harmonics. (By using engineering units, Section 3-5-4, you can define the amplitude of the fundamental to equal 100, so the total harmonic power will equal percent(%) distortion).

D- View the span from 0-25KHz. How many harmonic dots are present? If more were produced, the dots will be too closely spaced and complicate the display. Try the ALIGN button and see what they do.

E- To try the SIDEBAND markers, let us assume that the signal at 12.00KHz represents a carrier. Press SIDEBAND and then hold the SPACING button with the arrow pointing right until the dots are aligned with the spectral peaks adjacent to the "carrier". Count the dots. Try the ALIGN buttons and see their effect.

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.

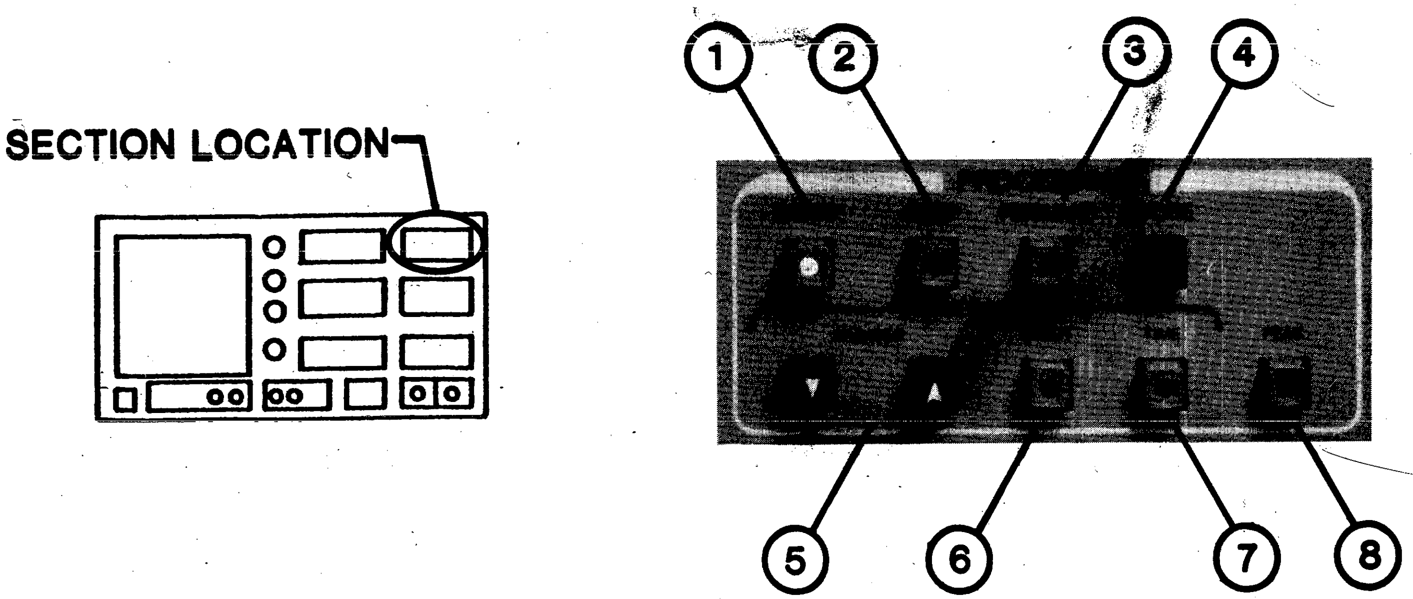


Fig. 3-11 Processing Section

(1) When activated, it clears the memory ana 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 Δ or decreasing ▽ the number of averages from 0 thru 256 in binary steps. The number of averages selected (N) is shown on the CRT as well as number actually performed (AVG=).

(6) When activated, it selects ensemble (RMS) 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 over the ensemble of data blocks being processed.

NOTE:

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

When the START Key is pressed, linear averaging is initiated: START Key light flashes and a count of the number of linear averages per format is indicated on the CRT (AVG=). When the number of averages selected is reached, averaging becomes exponential: START Key stays on and AVG=N on the CRT.

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, Nyquist and real & imaginary 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 5830A 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 and view the spectrum of the averaged time function. Either channel A or B, but not both, can be activated. 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 only, 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. 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:

By selecting the measurement mode through the MEASUREMENT MODE MENU, the keys for this section will take different meanings.

1. <u>Spectrum Mode</u>

The following functions can be displayed:

POWER SPECTRUM on CHANNELS A and B*
POWER SPECTRUM MAX SPAN***
PHASE SPECTRA on CH A and B*
TIME DOMAIN OF CH A and B signals*
COHERENCE FUNCTION**
COHERENT OUTPUT POWER**
TRANSFER FUNCTION MAGNITUDE**
TRANSFER FUNCTION PHASE**
TRANSFER FUNCTION NYQUIST**
TRANSFER FUNCTION Re,Im**

2. <u>Correlation Mode</u>

AUTO CORRELATION on CHANNELS A and B*
CROSS CORRELATION**
TIME DOMAIN of CH A and B signals*

3. <u>Histogram Mode</u>

HISTOGRAM on CHANNELS A and B*
TIME DOMAIN of CH A and B signals*

* Selected channel must be activated via MEASUREMENT MODE menu.
** Both channels must be activated for input.
*** Must be in single channel.

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.

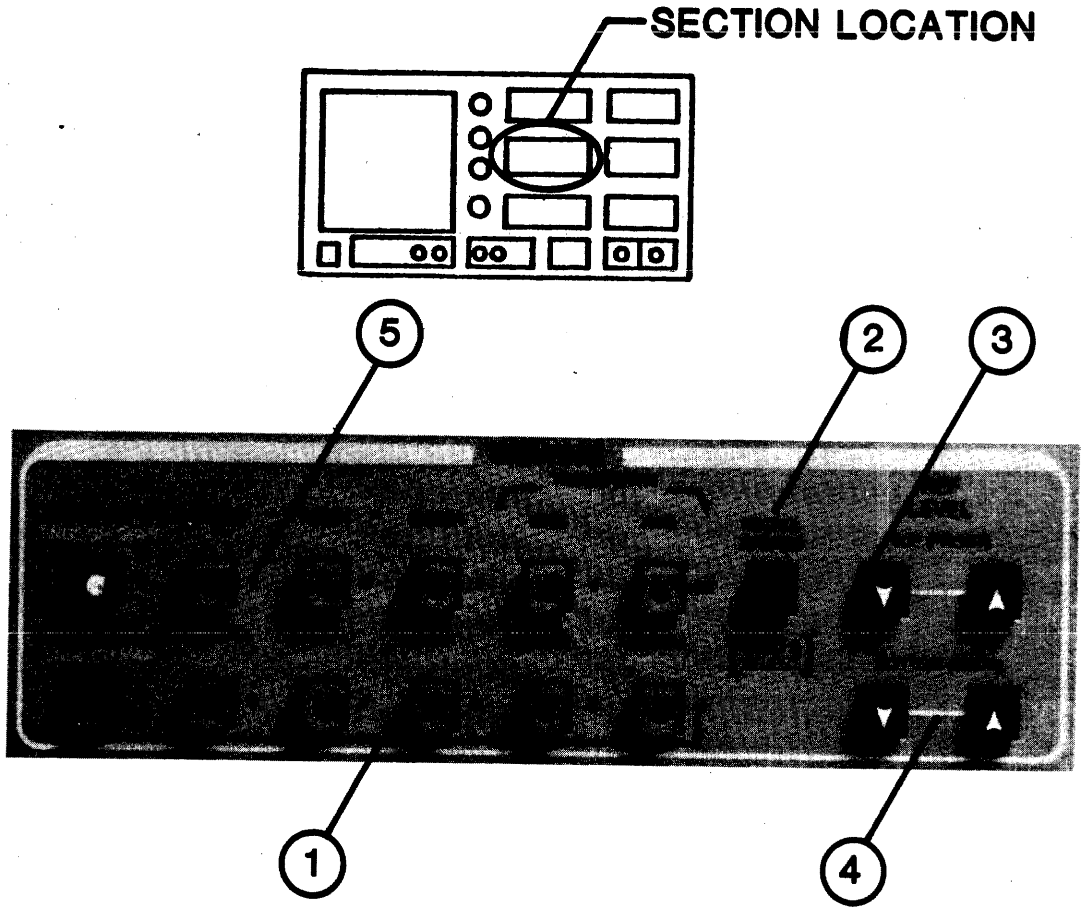


Fig. 3-12 Viewing Section

① Selects the function to be displayed.

When the measurement mode is set to spectrum analysis, then six functions are available in single-channel: power spectrum (Ch.A, Ch.B), phase spectrum (Ch.A, Ch.B) and the time waveform (Ch.A, Ch.B). In cross channel measurements, all of the above are available, plus, transfer function magnitude and phase, Nyquist, i.e., imaginary vs. real part of the transfer funcion, transfer function real and imaginary, coherence and coherent output power.

When the measurement mode is set to Correlation, then the auto and cross correlation functions and the time function of both channels are available.

When the measurement mode is set to Histogram, then the probability and cumulative probability functions and the time function for either channel are available.

(2) 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.

(3) Allows for increasing Δ, 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. (0.25dB for 2.5dB/div scale).

(4) Allows for increasing Δ, 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. (0.25dB for 2.5dB /div scale).

(5) 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. Also, may be used to enter either the starting or center frequency of a FREQUENCY SPAN.

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 six Cross Functions, Transfer Magnitude and Phase, Coherence and Coherent Output Power, and Nyquist and Real/Imaginary 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 5830A computes the power spectrum of Channel A and the cross spectrum between Channels B and A, both the real and imaginary parts. Then, the 5830A calculates the ratio cross-spectrum to power spectrum A. This yields an optimum estimate of the transfer function for the case where no corrupting signals are present at the input, channel A. The result, which is the transfer function of the device under test, in terms of Magnitude and Phase or real and imaginary or imaginary vs. real (NYQUIST plot), is presented on the CRT.

In the process, the 5830A 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 5830A can function as a low-frequency Network Analyzer with real-time measurement speed.

Five different excitation signals are available from the Tracking Signal Generator, each with their own advantages and disadvantages. More on how and where to use these signals will be given in the exercises below.

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 5830A 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 and AVG=64 on the screen. 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 simultaneously. Place the 5830A in full-screen mode (DISPLAY FORMAT key) 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

The transfer function of the notch filter will be measured using the different excitation sources available from the TRACKING SIGNAL GENERATOR.

a) NOISE

A- Set SPAN from 0 to 25KHz, select NOISE as the input to the notch filter and to CH A input. Output of the filter goes to CH B input. Adjust input levels: start with AUTORANGE to get to the nearest 10dB sensitivity setting and then remove AUTORANGE and further adjust the attenuator.

B- With number of averages set at 16, measure the transfer function and display it in its different formats: magnitude and phase vs. frequency, real and imaginary vs. frequency and imaginary vs. real.

C- Using the MAIN cursor, compare the values at the notch. Are they consistent?

b) PERIODIC NOISE

A- Repeat the measurement above, now using PERIODIC NOISE instead of NOISE, and no averaging (N=NONE).

B- Compare the transfer function measured with NOISE when no averaging is used, and when 16N is used. Clearly, using PERIODIC NOISE with no averaging gives the same results as NOISE with averaging.

C- While it may appear that PERIODIC NOISE yields the same transfer function estimate in one-sixteenth the time to use NOISE, it is generally not a preferred excitation signal. Why? The reason lies in experience which shows that many systems that are measured are not perfectly linear. As a result, using a periodic signal, like PERIODIC NOISE, will generate spurious signals which are periodic and will not average towards zero as repeated measurements are made, as in the case of random noise.

To demonstrate the effect of nonlinearities, measure the notch filter's transfer function using PERIODIC NOISE, averaging equal to NONE. Adjust CH B sensitivity until a portion of TIME B display appears to saturate. Examine the magnitude of the transfer function: it is distorted and appears constant in time.

c) PULSE

An exercise using the pulsed sinewave is given in Section 3-13, Exercise #1.

d) SINE SWEEP

With the same sweep, more energy within a resolution cell may be applied to CH A input, without causing overload. Typically, it is 26dB more than random noise. With a higher input, a greater dynamic range can be accurately measured. On the other hand, it takes 12 times longer than noise, where 16 averages is assumed for the noise-type measurement. During the sine sweep, the 5830A is tuned only to the frequency that is exciting the filter. As a result, distortion terms are ignored.

A- Repeat the setup as used for NOISE above, except set the TRACKING SIGNAL GENERATOR at SINE AT CURSOR. Adjust CH A and CH B levels with cursor near DC. (DC region is picked because the notch filter's maximum response occurs there).

B- Change averaging to NONE and select SINE SWEEP. Press START in PROCESSING section. How does the transfer function measurement compare to the one made with noise?

e) MULTI-SINE SWEEP

The ten contiguous sinewaves which will "sweep", actually hop, across the span, allow for measuring a transfer function with an input about 13dB per resolution cell higher than noise and at almost the same speed as with noise. It represents a compromise between the use of a sine sweep and noise.

A- Repeat the setup in A and B above for SINE SWEEP, except substitute MULTI-SINE AT CURSOR for SINE AT CURSOR and MULTI-SINE SWEEP for SINE SWEEP.

B- Repeat A above but use AUTORANGE. What happens to AUTORANGE when MULTI-SINE SWEEP is initiated? The same is true for SINE SWEEP.

Exercise #3 - Coherence Test

A- With 5830A set up as in Exercise #2 using NOISE, set averaging to 8. Display power spectrum B and coherence function. 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.

B- Reduce the output of TRACKING SIGNAL GENERATOR by 30dB without changing the SENSITIVITY settings (AUTORANGE must be off). Note the coherence is less than 1 in the region where power spectrum B dips, indicating not all the observed spectrum is due to the output from the notch filter. For example, if the coherence equals 0.5, then 50% of the signal is due to the filter output and the remaining 50% is due to the noise internal to the 5830A.

Exercise #4 - Other Data Modifiers

Further processing of the measurements can be performed by selecting a function or functions from the DATA MODIFIER menu. Let's try some.

A- Use the same setup as in Exercise #3, A. After displaying transfer function magnitude and phase, select PHASE DERIVATIVE. The transfer function's phase will be replaced by its derivative. It may appear as a horizontal line. Expand its scale by employing the REF LEVEL in the VIEWING section.

B- From the second page of the DISPLAY MODIFIER menu, select the INTEGRAL OF CH.A. Observe the new transfer function magnitude and phase derivative.

C- Cancel PHASE DERIVATIVE and INTEGRAL CH.A and try 1/XFR FN (as in the conversion of impedance to admittance). Compare transfer function magnitude and phase before and after taking the reciprocal. Are the results reasonable?

Now modify the input CH.A by DOUBLE INTEGRAL (as in converting acceleration to displacement). Examine power spectrum A. Compare it to unmodified spectrum. After double integration, it should rolloff at -12dB/Octave. Does it? Examine the modified transfer function.

D- Try some of the other modifiers. Experiment, it cant't hurt.

<u>Exercise #5</u> - Edit XFR Function

A- Set SPAN to 10K. Activate the TEST signal (in the Amplitude section) for Channels A and B. Use a little 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 Transfer FN MAG and PHASE 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).

Exercise #6 - CORRELATION and HISTOGRAM

A- Return to the setup to measure the transfer function from 0-25KHz of the notch filter using noise as the excitation source.

B- Select CORRELATION from the MEASUREMENT menu. View the autocorrelation functions for channels A and B. Because it is symmetric about zero lag, only one half is shown. Autocorrelation A approximates an impulse as expected for "white" noise, while autocorrelation B is the effect of the filter's response on the input signal. Note the vertical scale is limited to +1 because the correlation calculation is normalized by the correlation's value at zero delay, i.e. its variance.

C- Display the cross correlation function which, unlike the autocorrelation function, is not symmetric and is shown for positive and negative lags. Because of the input used, the cross correlation function is proportional to the filter's impulse response. Note its vertical scale is also limited to +1, as a result of normalizing the cross correlation by the square root of the product of the variances of input and output.

D- Return to the MEASUREMENT menu and select HISTOGRAM. Examine the histogram of channel A which is proportional to its probability function, and the cumulative distribution function. The first and second moments, i.e. mean and variance, are listed on the display.

E- Display HISTOGRAM for channel B. How does it compare to channel A?

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 "freerun" 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 5830A 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.

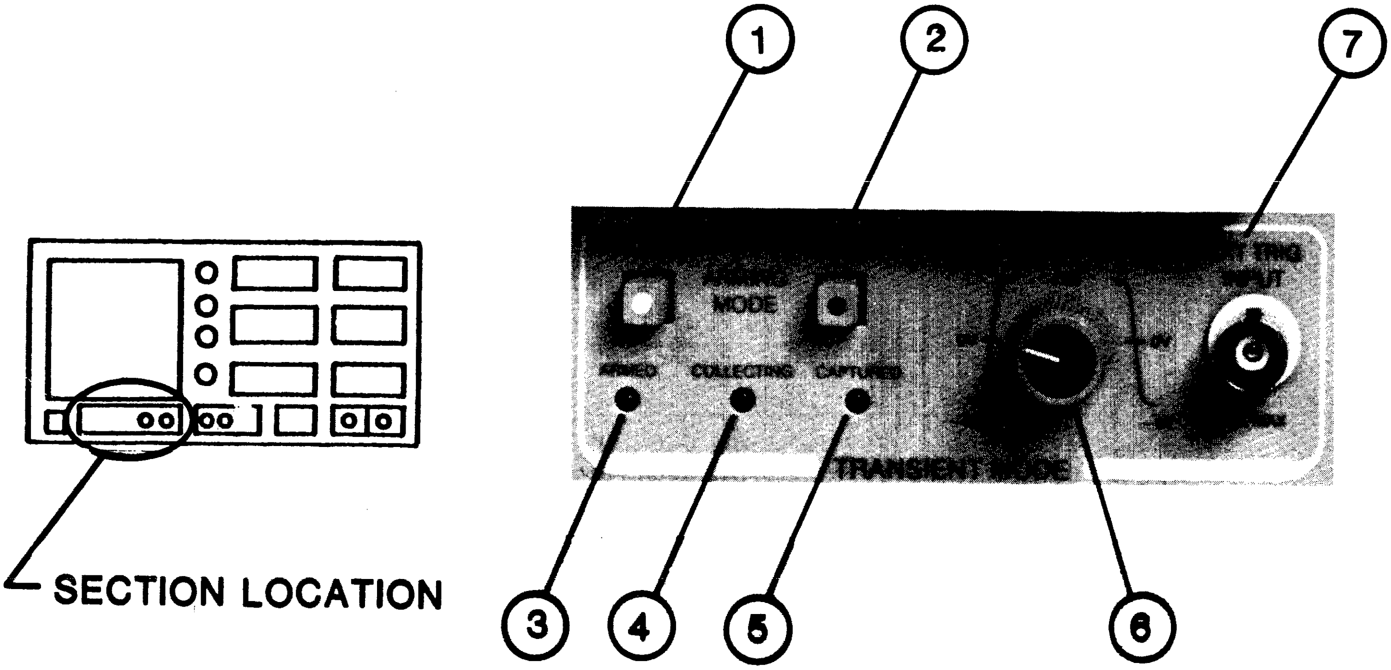


Fig. 3-13 Transient mode controls

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

(2) When activated, transient capture is armed to capture only one transient. Pressing again manually rearms triggering circuitry.

(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 5830A, 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 Transfer Function - Impulse Testing

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

B- Place the 5830A 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 and allow processing even when an overload occurs), ARM the 5830A'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.

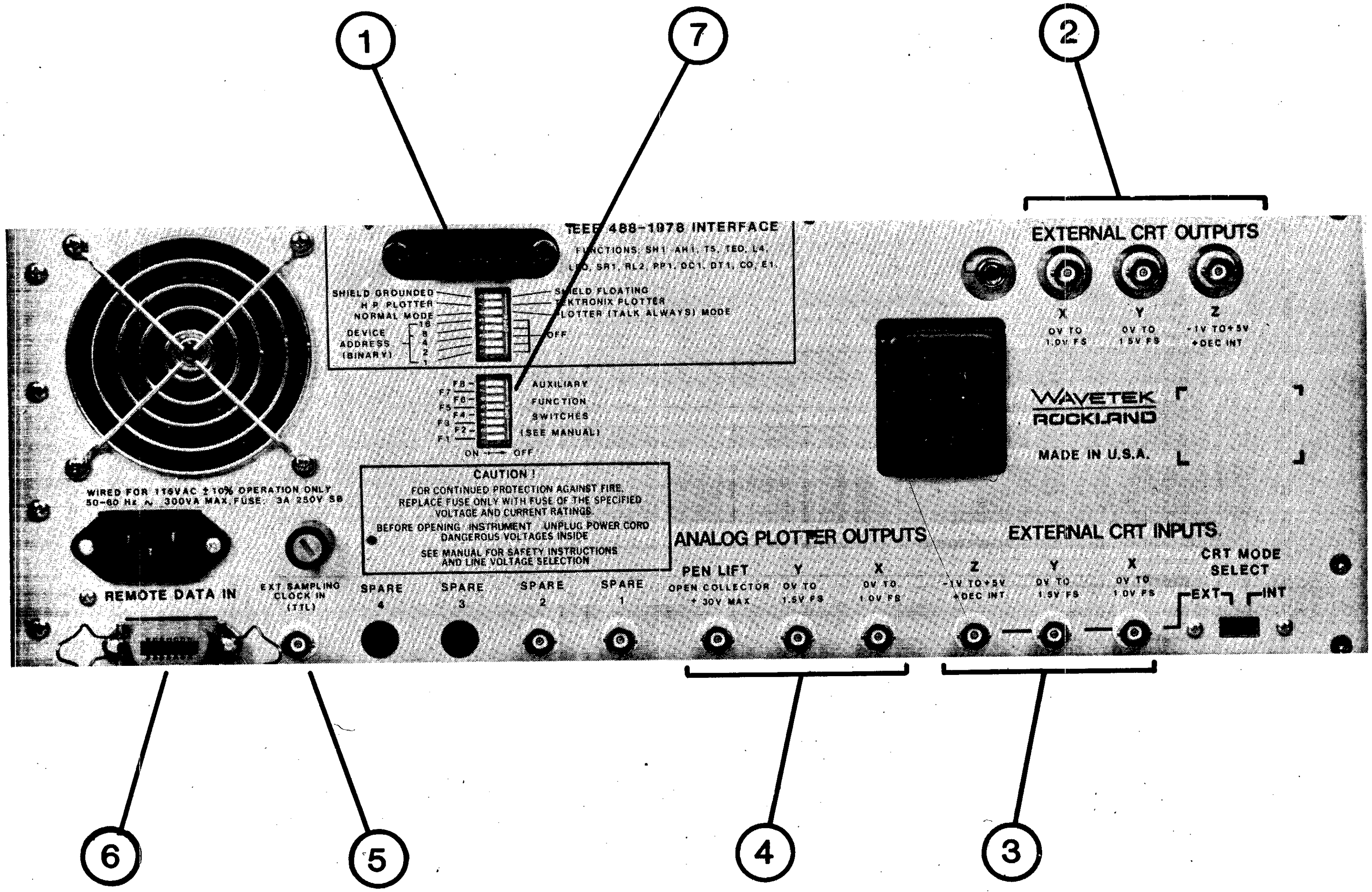
Exercise #2 - Waterfall

Waterfall display is useful for observing a spectrum with time varying components. Since no such test signal is available, we will resort to a more mundane exercise.

A- Return setup to one used in Exercise #1. With averaging N set at NONE, select the WATERFALL display from the MEASUREMENT menu. Eight successive displays will appear, representing the latest 8 transients that were analyzed. If flicker is noticeable and annoying, then turn off the MAIN cursor which will remove the readout on the screen and eliminate any possible flicker.

3-14. RECORDING on a Plotter

This section controls the digital plotter, X-Y recorder or strip chart 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).


1
7
2
IEEE 488-1978 INTERFACE
SHIELD GROUNDED
H P PLOTTER
NORMAL MODE
DEVICE ADDRESS (BINARY)
SHIELD FLOATING
TEKTRONIX PLOTTER
PLOTTER (TALK ALWAYS) MODE
OFF
AUXILIARY
FUNCTION
SWITCHES
(SEE MANUAL)
ON OFF
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.
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
ANALOG PLOTTER OUTPUTS
EXTERNAL CRT INPUTS
CRT MODE SELECT
EXT
INT
PEN LIFT
OPEN COLLECTOR + 30V MAX
REMOTE DATA IN
EXT SAMPLING CLOCK IN (TTL)
SPARE 4
SPARE 3
SPARE 2
SPARE 1
6
5
4
3

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:

HP7470A
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.

In strip chart recorder mode, the X BNC provides the voltage proportionate to the amplitude of the point selected by the MAIN cursor. The Y BNC provides the voltage proportionate to the amplitude of the point selected by the SINGLE cursor.

(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. Switch F3 selects the rate that data is output to an analog plotter: ON for normal, OFF for fast.

Switch F4 determines whether power-up state is always at Default or the one that may be selected from the nonvolatile memory: OFF is always Default.

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

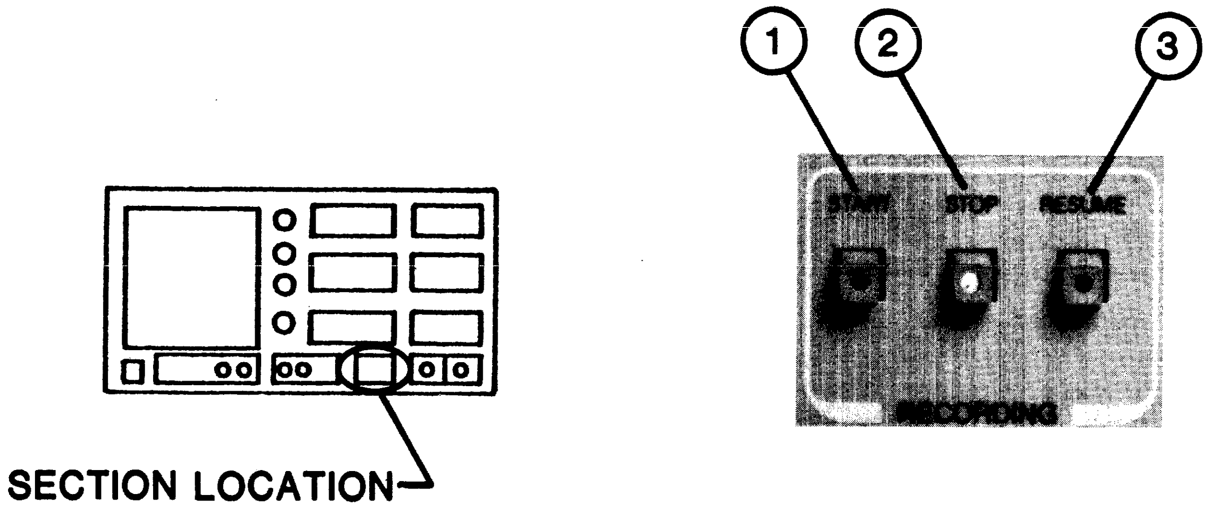


Fig. 3-14b Recording section

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

(2) Stops the plotter.

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

There are four 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- Connect a strip chart recorder to the X-Y recorder BNC. Supply the variations of the signal amplitude at a specified frequency.

d- (Best method) Connect a digital plotter directly to the 5830A (no computing controller is needed). The 5830A 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 plot 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 5830A spectrum analyzer will interface to several different GPIB digital plotters. Some are:

HEWLETT PACKARD

Model HP7470A (HPIB option).
This is a 2-color 8 1/2" x 11" plotter.

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 5830A.

Model HP 9872C/T

These GPIB plotters replaced the HP 9872B/S plotters and provide 8 colors, on 11"x17" paper of which 3 are used.

(The HP 9872A cannot be used since it does not have the "listen only" feature needed to operate with the 5830A 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 5830A.

Model 4663

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

These steps are required to generate a digital plot:

1. 5830A configuration:

   a. Put 5830A 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).
   (device #31 fpr HP7470A)
   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 5830A 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 5830A 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.

b. 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. Exit calibration by entering cursor at X-Y plotter.

d. Select desired speed rate by setting F3.

e. Press START in RECORDING section to initiate plot.

3-14-3. RECORDING on a Strip Chart Recorder

Two signals are provided from the rear panel to drive the strip chart recorder. The signals are present in the X-Y BNC's as follows:

X BNC	0 to 1.0 V FS
Y BNC	0 to 1.5 V FS

Calibration of signal can be generated in the way described in Section 3-14-2.

3-15. STORED SETTING Operations

If F4 of the AUXILIARY switch on the rear panel is set to ON, then a nonvolatile memory is available for storing and recalling front panel settings and spectra at any time, including power up.

Exercise #1

A- Over the FREQUENCY SPAN 0-25KHz, measure the power spectrum of the TEST signal.

B- Select the HARMONIC cursor with the fundamental (SINGLE CURSOR) defined as the peak at nominally 1KHz.

C- Use the READOUT menu to define the fundamental as 0dBR.

D- Now use the STORE SETTING menu and store front panel state into location 5 and select power up state to location 5.

E- Turn power off and then on again. Did it recall the previous state? Press RESET button once. What state is it on now?

Exercise #2

A- Measure the transfer function of the notch filter over the SPAN 0-25KHz using noise as the excitation state. Store the measurements using STORED key.

B- Transfer STORED data into nonvolatile memory using STORED SETTINGS menu. Also store front panel settings into location 4, while leaving power up to location 5.

C- Turn power off and then on again. Which front panel conditions are active?

D- Recall spectra from nonvolatile memory and view STORED transfer function magnitude and phase. Is it the same that was stored prior to power off? If it looks different, perhaps the front panel settings are incorrect. Try to restore front panel state when spectra was stored into nonvolatile memory (remember, the state is stored in location 4).

3-16. 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.	

3-17. 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.

3-17-1. 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 5830 should be driven by buffer gates such as type 7437 or equivalent. Signals driven by the 5830 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 5830	READY FOR DATA - When the 5830 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 5830 sends READY high (true).
CONVERT	FROM 5830	CONVERT -The CONVERT signal is sent low (true) by the 5830 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 5830 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. Each input sample block consists of three segments:

1) Initial Zero Samples
2) Data Samples
3) Terminal Dummy Samples

Initial Zero Samples

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 5830 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.

Table 3-17 shows the number of initial zero samples required for all conditions.

Data Samples

The table shows both the total number of actual data samples required as well as the order of samples within data segment.

Terminal Dummy Samples

In order to satisfy internal timing requirements, either 0, 1 or 2 dummy samples are required immediately following the data samples. Table 3-17 shows the number of dummy samples for each case. The value of these samples is irrelevant.

General Considerations

Each input block sequence will consist of a burst train of equally-spaced CONVERT pulses. Prior to each CONVERT pulse, it is assumed that the input sample word has been serially clocked into the unit. The number of CONVERT pulses is equal to the sum of the initial zero pulses, the data pulses, and the terminal dummy pulses.

For example, in the case of a 5KHz span setting in dual-channel mode with the initial zero samples enabled, the user would first send 120 zero samples, followed by 10240 data samples (B0,A0,B1,A1,B2,A2,......B5119,A5119), and ending with two dummy samples. The total number of samples would be:

$$120 + 10240 + 2 = 10362$$

In this case, the user would see a burst of 10362 CONVERT pulses for each input block. Note that the two dummy samples do not actually have to be sent in serially since their value is ignored; in this case, the A5119 sample loaded last would be utilized for these dummy samples.

Max Span Background

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: the first for the selected span and the next for the max span. The sequence for the max span block is identical to the sequence for the single-channel 100 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 F1 switch.

MODE	SPAN(HZ)	TIME WINDOW (mS)	ACTUAL INPUT SAMPLES PER CHANNEL	SAMPLE SEQUENCE FOR EACH PROCESSING CYCLE								
				ZERO INITIAL SAMPLES*	TOTAL DATA SAMPLES	SEQUENCE FOR DATA SAMPLES T0	T1	T2	T3	T4	T5	DUMMY TERMINAL SAMPLES
	50K	4	512	12	1024	A0	B0	A1	B1	A2	B2	0
	25K	8	1024	24	2048	B0	A0	B1	A1	B2	A2	2
D	10K	20	2560	60	5120	B0	A0	B1	A1	B2	A2	2
U	5K	40	5120	120	10240	B0	A0	B1	A1	B2	A2	2
A	2K	100	12800	300	25600	B0	A0	B1	A1	B2	A2	2
L	1K	200	25600	600	51200	B0	A0	B1	A1	B2	A2	2
	500	400	51200	1200	102400	B0	A0	B1	A1	B2	A2	2
	200	1000	128000	1500	256000	B0	A0	B1	A1	B2	A2	2
	100K	4	1024	6	1024	S0	S1	S2	S3	S4	S5	0
S	50K	8	2048	12	2048	S0	S1	S2	S3	S4	S5	1
I	25K	16	4096	24	4096	S0	S1	S2	S3	S4	S5	1
N	10K	40	10240	60	10240	S0	S1	S2	S3	S4	S5	1
G	5K	80	20480	120	20480	S0	S1	S2	S3	S4	S5	1
L	2K	200	51200	300	51200	S0	S1	S2	S3	S4	S5	1
E	1K	400	102400	600	102400	S0	S1	S2	S3	S4	S5	1
	500	800	204800	1200	204800	S0	S1	S2	S3	S4	S5	1
	200	1000	256000	1500	256000	S0	S1	S2	S3	S4	S5	1

* PRESENT FOR NON-CONTIGUOUS DATA BLOCKS. F1 SWITCH IS 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

Table 3-17. 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 5830A 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 5830A in the manual mode. If necessary, please turn directly to Chapter III for a full course of instruction and information.

2- the 5830A 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 5830A. You will use this command language to speak to the 5830A 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 3-14A shows the rear panel of the 5830A (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.

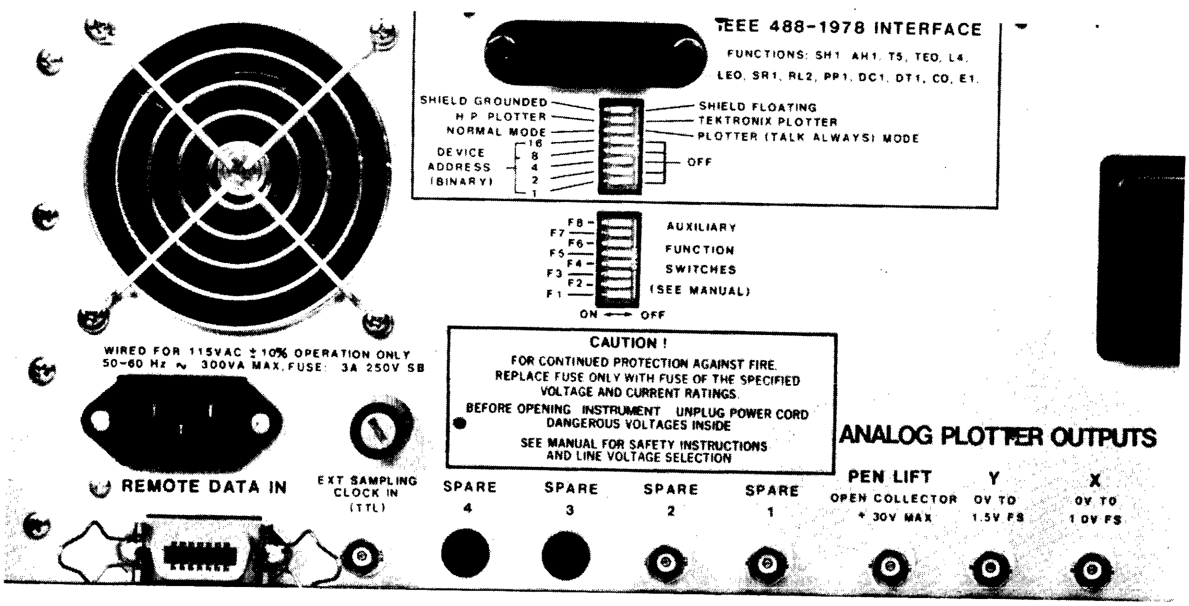


Fig. 4-2-1 IEEE 488-1978

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 5830A 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 5830A Instruction Language

The 5830A 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 5830A 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 buttons on the front panel.

4-3-1. Instruction Format

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

An instruction to the 5830A has the general format:

COMMAND Λ ARGUMENT #1 Λ ARGUMENT #2 Λ 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 47 Command words in the 5830A 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 at least send the part of a Command or Argument word which precedes the dash (-) in this manual. The dash is used to delineate the required portion of the instruction and is not to be used in the program. You can send subsequent letters of the word, but they must be exactly as written in the list below.

5830A GPIB COMMAND LIST

AMPL-ITUDE	AUTO-RANGE
BWR-ITE	BRE-AD
CE-NTER AT CURSOR	CO-MPARE
CU-RSOR	DI-SPLAY
DR-AW	ED-IT
EQ-UALIZE	F-REQUENCY
IN-PUT	LINE1
LINE2	LINE3
LINE4	MO-VE
NVR-EAD	NVW-RITE
O-PEN LOOP HIGH	PL-OT
PR-OCESS	REA-D
RECA-LL	RECO-RDING STOP
REL-EASE	RESU-ME
RESET	REV1
REV2	REVS
SAM-PLING	SAV-E
SET	SIN-GLE
SID-EBANDS	SP-ECTRUM
SRQ	STA-RT AVERAGER
STOP- AVERAGER	STOR-E
TEST	TEXT
TR-ANSFER	V-IEW
WRI-TE	

An example of a GPIB Instruction are these three equivalent versions of the instruction you would send to prepare the 5830A 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 5830A GPIB Instruction Language Commands and Arguments

The following list summarizes the commands that may be used to program the Wavetek Model 5830A Digital Signal Analyzer. These notes pertain to the list of commands.

1. Only upper case ASCII characters may be used.

2. Either the characters preceding the dash (-) may be sent or the entire command.

3. If more than the significant 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).

4-4-1. SET Command

ARGUMENTS FOR COMMAND "SET"

AMP-LITUDE READOUT	AR-M
AV-ERAGER MODE	AT-TENUATOR
CE-NTER FREQUENCY	CO-UPLING
CU-RSOR	D-ATA REMOTE
E-DGE	FR-ONT PANEL
H-ORIZONTAL	I-MPROVED ACCURACY
ME-ASUREMENT	N-UMBER OF AVERAGES
O-RDERS	PL-OTTER
POS-ITION	POW-ERUP
REA-DOUT	REF-ERENCE
SC-REEN	SE-NSITIVITY
SI-GNAL GENERATOR	SP-AN
ST-ART FREQUENCY	T-RIGGER
V-ERTICAL SCALE	W-EIGHTING
Z-ERO FREQUENCY	

a.
```
SET ---- FR-ONT PANEL ----+--- R-EMOTE ---+----
                          |               |
                          +--- L-OCAL ----+
```

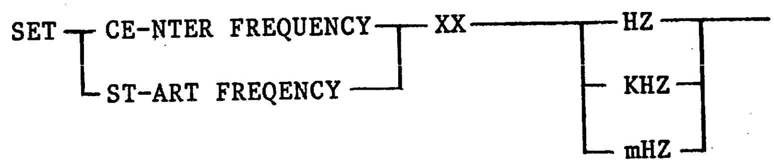
Note: This command must precede any remote programming of front panel functions

b.
```
SET ---- SP-AN ------+--- XX -------+------
                     |              |
                     +--- U-P ------+
                     |              |
                     +--- D-OWN ----+
```

Where XX = 100K-HZ, 50K-HZ, 25K-HZ, 10K-HZ, 5K-HZ, 2K-HZ, 1K-HZ, 500H-Z, 200H-Z, 100H-Z, 50H-Z, 20H-Z, 10H-Z, 5H-Z, 2H-Z

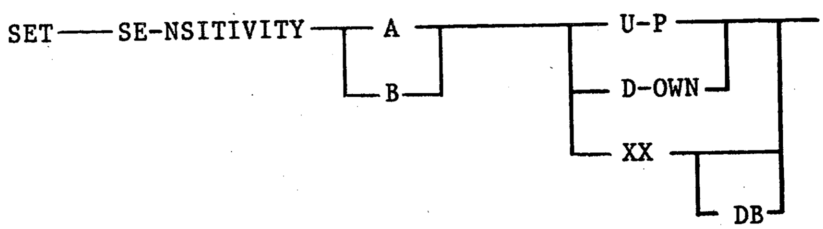
Note: Processor (Averager) must be restarted if span changed.

Example:
"STOP AVERAGER"
"SET SPAN 50KHZ"
"START AVERAGER"

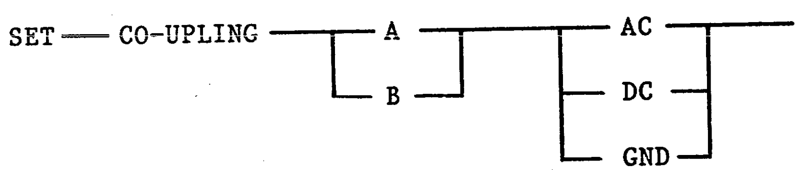
c. 

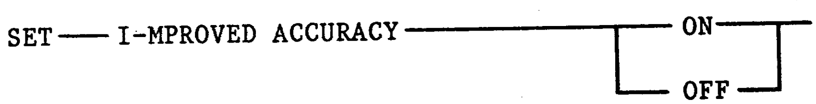
Where K = Kilo   m = milli

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

d. 

UP/DOWN changes sensitivity 1 dB respectively.
XX: integer between -70 & +20

e. 

f. 

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

g. SET —— A-MPLITUDE READOUT —— S-INE | N-OISE | P-OWER

```
g. SET —— A-MPLITUDE READOUT ——┬— S-INE ——┬——
                               ├— N-OISE —┤
                               └— P-OWER —┘
```

Notes: S-INE:= RMS readout (Volts, DBV)
N-OISE: = PSD readout in 1 Hz bandwidth
P-OWER: = Total power over entire selected span or as selected by auxilliary cursors

```
h. SET ——CU-RSOR ——┬— M-AIN ———————┬┬— ON ——┬——
                   ├— SIN-GLE —————┤└— OFF —┘
                   ├— SID-EBANDS ——┤
                   └— H-ARMONICS ——┘
```

Note: To turn on either sidebands or harmonics, single cursor has to be on.

Example:

For HP9825A, D = Device Code
WRT 700+D, "SET SINGLE ON"
WRT 700+D, "SET SIDEBANDS ON"
WRT 700+D, "SET SINGLE ON"
WRT 700+D, "SET HARMONICS ON"

```
i. SET —— AV-ERAGER MODE ——┬— S-PECTRUM ——┬——
                           ├— T-IME ——————┤
                           └— P-EAK ——————┘
```

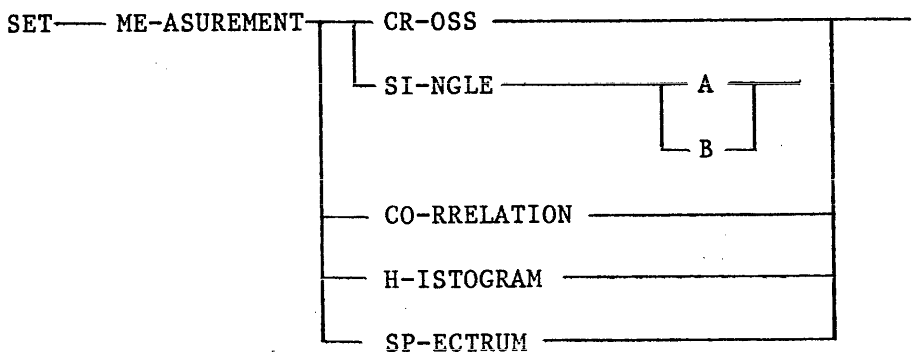
Note: TIME - single channel mode only

```
j. SET —— N-UMBER OF AVERAGES ———————— XX ———
```

Notes:

XX is the power of 2 (2^P)
where P: = 0 to 8.
If P is not an integer, then number of averages correspond to NONE (= 2).

K.

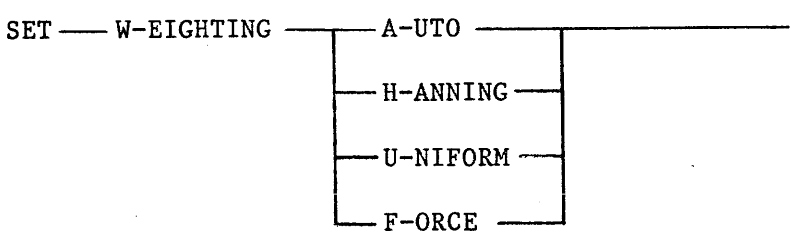


Note: Processor (Averager) must be restarted if measurement mode changed.

Example:

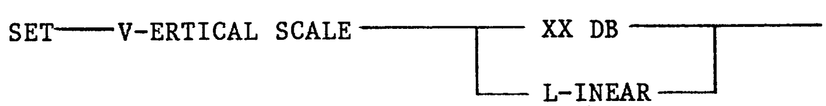
```
For HP9825A, D = DEVICE CODE---
WRT 700+D, "STOP AVERAGER"
WRT 700+D, "SET MEASUREMENT CROSS"
WRT 700+D, "START AVERAGER"

WRT 700+D, "STOP AVERAGER"
WRT 700+D, "SET MEASUREMENT HISTOGRAM"
WRT 700+D, "START AVERAGER"
```

l.



Note: When FORCE is selected, time cursor is set to 0 position.

m.



Note: Selects and sets the display range.
XX= 20, 40 or 80 dB range.

```
n. SET —— H-ORIZONTAL SCALE ─┬─ LI-NEAR ─┬──────────
                             └─ LO-G ────┘
```

```
o. SET —— SC-REEN ──┬── F-ULL ──────┬──────
                    ├── S-PLIT ─────┤
                    ├── W-ATERFALL ─┤
                    └── N-ORMAL ────┘
```

Note: FULL and SPLIT applies to dual displays.

```
p. SET —— E-DGE ──────────────────────────
```

Note: Uses current time cursor to set edge of FORCE window. Cursor in the display of the time function is set to desired position by moving cursor with UP/DOWN commands.

Example:

```
"SET WEIGHTING FORCE"
"VIEW TIME A"
FOR I=1 TO K
"CURSOR UP"
NEXT I
"SET EDGE"
```

```
q. SET —— T-RIGGER ──┬── F-REE RUN ──────────────────┬──
                     ├── E-XTERNAL ──────────────────┤
                     ├── A ──────────────────────────┤
                     ├── B ──────────────────────────┤
                     ├── T-RACKING SIGNAL GENERATOR ─┤
                     └── I-EEE ──────────────────────┘
```

Notes:

EXTERNAL:	=	EXT TRIG INPUT BNC
A :	=	Channel A
B :	=	Channel B
Tracking:	=	internal signal source.

Processor (averager) must be restarted if
trigger mode changed.

```
r.  SET—— SI-GNAL GENERATOR ┬─ O-FF
                            ├─ N-OISE
                            ├─ PU-LSE
                            ├─ PE-RIODIC RANDOM NOISE
                            ├─ SI-NE
                            ├─ M-ULTI SINE
                            └─ SW-EPT ┬─ S-INE
                                      └─ M-ULTI
```

Notes:

PULSE requires Transient Mode.
Processor (Averager) must be restarted if
Signal Generator changed.

Example:

"STOP AVERAGER"
"SET SI N"
"START AVERAGER"

```
s.  SET —— AT-TENUATOR —— XX DB
```

Notes:

Adjust attenuator of internal signal source.
XX = 0, 10, 20, 30, 40

```
t.  SET——REA-DOUT——┬—— R-EMOTE ——┬——————————
                   ├—— LO-CAL ———┤
                   ├—— S-AME ————┤
                   ├—— D-B ——————┤
                   ├—— LI-NEAR ——┤
                   └—— P-OWER ———┘
```

Notes: Selects units of readout.
READOUT REMOTE enables remote writing of alphanumerics on the CRT. Use this command before TEXT command (Section 4.4.40).
SAME makes readout units equal the selected vertical scale.

```
u.  SET——D-ATA REMOTE ——————————————————————
```

Note: Must precede digital input via the GPIB. Set SPAN after sending this command.

```
v.  SET——REF-ERENCE ——┬—— A ——┬——————— X.XE+ XX ————
                      └—— B ——┘
```

Note: Refers to setting volts/REF LEVEL.
Must send all digits in X.XE+XX field.

```
w.  SET—— O-RDERS ——————— XX.XX ————————————
```

Note: Must send all digits in XX.XX field.

```
x.  SET—— Z-ERO FREQUENCY ——————————————————
```

Note: Current cursor location is set to zero.

y. SET — AR-M — A-UTO | S-INGLE

Note: Must be in Transient Capture Mode and must send after entering transient mode.

z. SET — POS-ITION — ST-ART | C-ENTER

Note: Refers to SPAN controls.

aa. SET — POW-ERUP — X

Notes:

X = 0,1,2,3,4,5
0 = Default State, 1,2,3,4,5 refers to stored front panel states held in nonvolatile memory.

bb. SET — PL-OTTER — D-IGITAL | A-NALOG | S-TRIP CHART

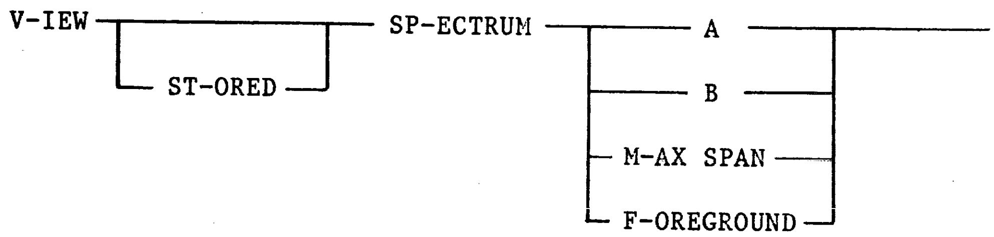
4-4-2. VIEW Command

ARGUMENTS FOR COMMAND "V-IEW"

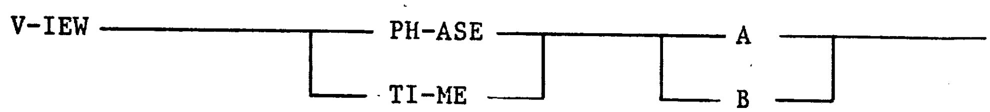
COH-ERENCE	COR-RELATION	D-UAL
F-OREGROUND	H-ISTOGRAM	M-AX SPAN
NY-QUIST	PH-ASE	PO-WER COHERENT
RE-AL-IMAGINARY		SI-NGLE
SP-ECTRUM	ST-ORED	TI-ME
TR-ANSFER FUNCTION		

a. V-IEW — SI-NGLE | D-UAL

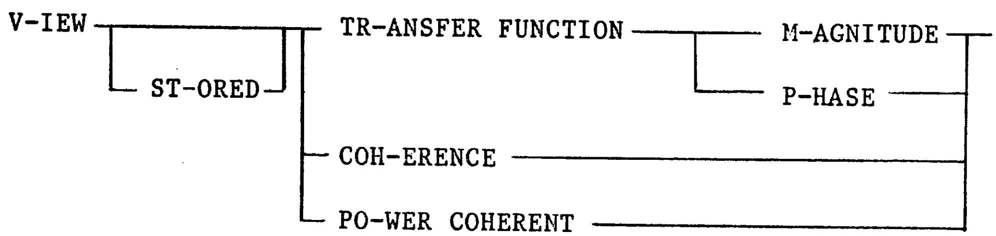
b.



c.

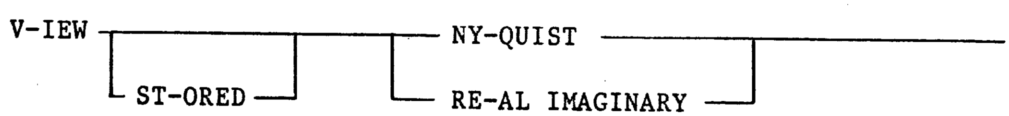


d.



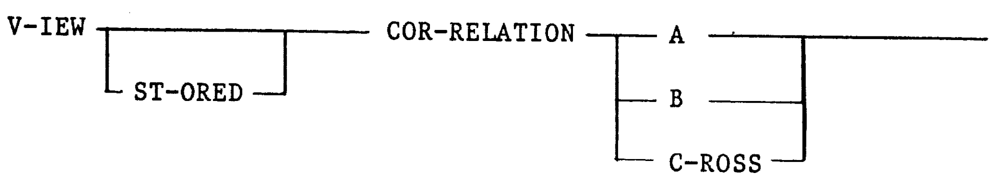
Note: for cross-channel measurements only.

e.

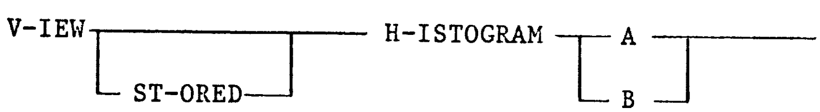


Note: For cross-channel measurements only.

f.



g.



4-4-3. READ COMMAND

ARGUMENTS FOR COMMAND "READ"

COH-ERENCE	COR-RELATION
CR-OSS	CU-RSOR
I-NPUT	H-ISTOGRAM
L-AST	PH-ASE
PO-WER COHERENT	NY-QUIST
RE-AL-IMAGINARY	
SE-TUP	SP-ECTRUM
ST-ATE	TR-ANSFER FUNCTION

```
a. REA-D ── I-NPUT ──┬── A ────────────┬──────
                     ├── B ────────────┤
                     ├── F-OREGROUND ──┤
                     └── M-AX SPAN ────┘
```

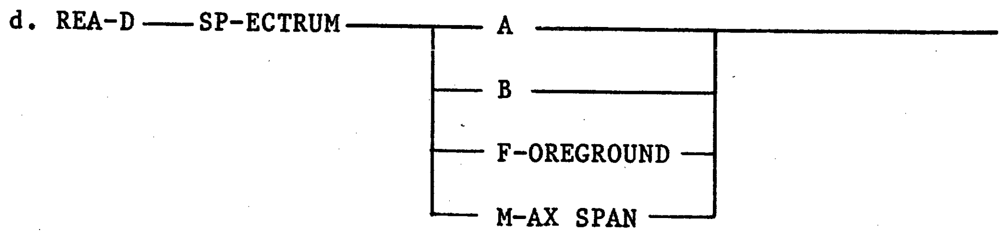
Notes: 1. A and B refer to cross channel inputs.
2. FOREGROUND and MAX SPAN refer to single channel input.
3. Data is transferred as integer real and imaginary parts :
32767 > (-)XXXXX > -32768
4. The number of input samples equals 1024 in all SPANS in single channel mode and on the 20 Hz and 2 Hz in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

```
b. REA-D ──── CR-OSS ──────────────────────
```

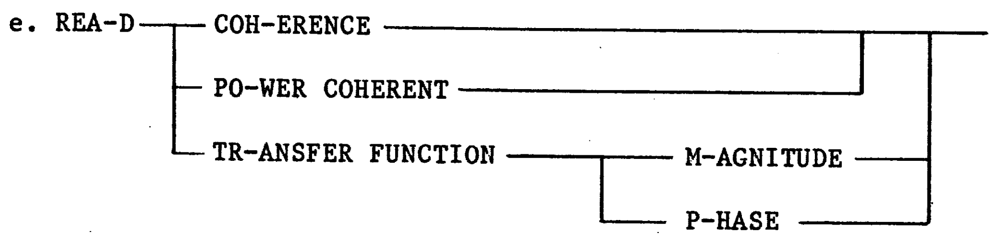
Note : Values read as real and imaginary numbers expressed in scientific notation (201 complex points). (-)X.XXXE±XX

```
c. REA-D ──── PH-ASE ──┬── A ────────────┬──────
                       ├── B ────────────┤
                       └── F-OREGROUND ──┘
```

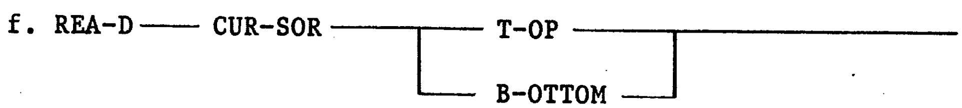
Nctes: A and B - cross channel mode
FOREGROUND - corresponds to zoom Spectrum of single channel.
Cursor values transferred after spectrum is displayed.



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



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



Notes: 1. Corresponds to amplitude and frequency as on CRT (frequency read in Hz).
2. TOP is required for single display.
3. TOP/BOTTOM is used for dual displays.

g. REA-D ——— SE-TUP ———

Notes: 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. REA-D ——— ST-ATE ———
└— X1 ——— X2 —┘

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).

i. REA-D ——— NY-QUIST ———
└— RE-AL IMAGINARY —┘

Note: Cross Channel only.

j. REA-D ——— COR-RELATION ——— A ———
├— B —┤
└— C-ROSS —┘

k. REA-D ——— H-ISTOGRAM ——— A ———
└— B —┘

1. REA-D ——— L-AST ———

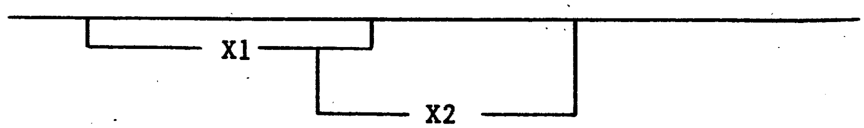
Note: Recalls last instruction issued by controller used in debugging.

4-4-4. AMPLITUDE ——— A-BSOLUTE ———
└— R-ELATIVE —┘

4-4-5. AUTO-RANGE

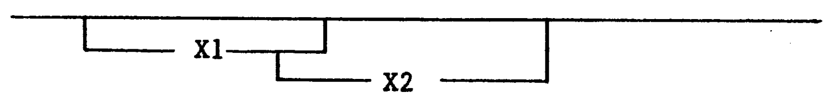
Note: Set Sensitivity automatically in 10dB steps.

4-4-6. BRE-AD



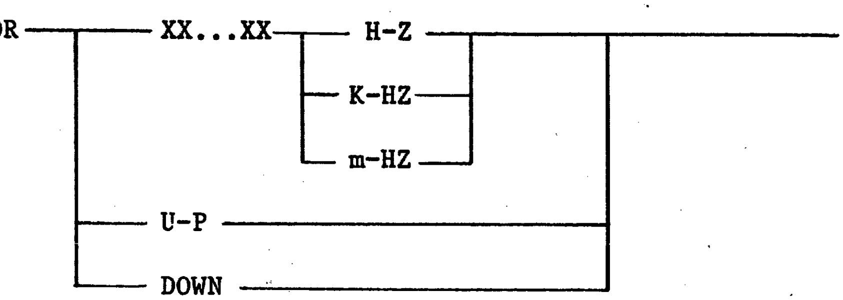
Notes: 1. no arguments will transfer the entire memory
2. X1 & X2 give starting and ending addresses in decimal format (see appendix H for memory map).
3. if X2 is not given, only address X1 is read
4. reads memory into binary format (eight bit byte)
5. the first byte read is always a space (20H) and should be ignored.

4-4-7. BWR-ITE



Note: Same as BREAD.

4-4-8. CU-RSOR



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 cannot be used, the next higher allowable value is used for cursor position.

4-4-9. CE-NTER AT CURSOR

4-4-10. DI-SPLAY

Note: Sets up Graphic Display Mode.

4-4-11. DR-AW X Y

Note: $0 \leq X \leq 255$, $0 \leq Y \leq 127$.
Draws a line on the CRT from its present position to X.Y with beam on.

4-4-12. EDI-T / EQU-ALIZE / CO-MPARE — ON / OFF

- EDI-T
- EQU-ALIZE
- CO-MPARE

- ON
- OFF

Note: EQUALIZE and COMPARE functions operate on the stored data.
EDIT operates on Transfer Function.

4-4-13. F-REQUENCY

- A-BSOLUTE
- R-ELATIVE
- O-RDERS
- H-Z
- C-PM

4-4-14. IN-PUT

- FIR-ST DERIVATIVE
- INT-EGRAL
- SEC-OND DERIVATIVE
- DOU-BLE INTEGRAL
- MUL-TIPLY BY -1

- A
- B

- ON
- OFF

4-4-15. LINE1

LINE2

LINE3

LINE4

Note: Permits writing a line of up to 64 ASC characters on the screen. The ASC string follows the LINEX command. 1,2,3,4 refer to the position of the line on the CRT, where 1 is near the top and 4 at the bottom.

4-4-16. MO-VE X Y

Note: Same as DRAW(4-4-14) except with beam off.

4-4-17. NVR-EAD

X1

X2

Note: Sets up mode to read nonvolative memory between bytes X1 and X2, where $0 \leq X1, X2 \leq 2047$. Memory map of the nonvolatile memory is given in APPENDIX I . (First data byte sent contains a space (20H).

4-4-18. NRW-RITE

X1

X2

Note: Same as NVREAD except controller can now load bytes into nonvolatile memory.

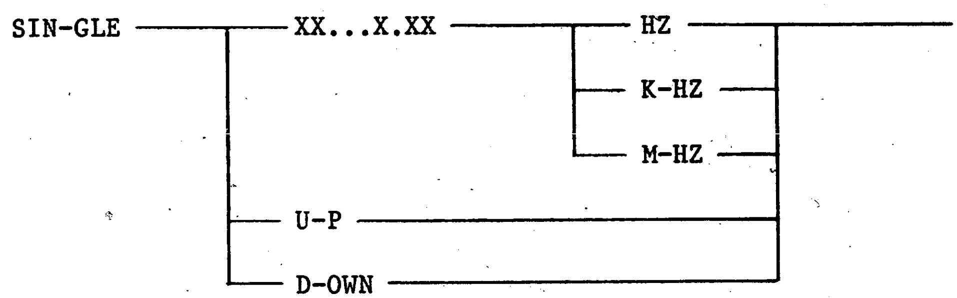
4-4-19. O-PEN LOOP HIGH

Note: Converts a closed loop transfer function to open loop using high precision. For standard precision and faster calculation, see Section 4-4-41.

Example:

For HP9825A, D = DEVICE CODE ---
WRT 700+D, "SET CURSOR SINGLE ON"
WRT 700+D, "SIDEBANDS UP"

4-4-33.



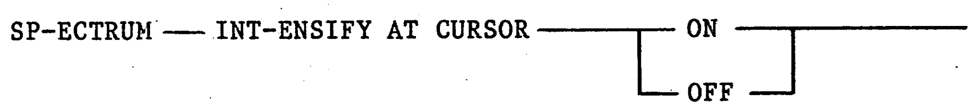
Notes:

1. M-Hz = milli Hz.
2. SINGLE cursor has to be on.

Example:

For HP9825A, D = DEVICE CODE ---
WRT 700+D, "SET CURSOR SINGLE ON"
WRT 700+D, "SINGLE 25KHZ"

4.4.34.



4-4-35. STA-RT AVERAGER

Note: Clears Averager memory and restarts processor if it was previously stopped. If processor is active, then a STOP must be sent before the START.

4-4-36. STOP-AVERAGER

Halts all processing.

4-4-37. STOR-E

Note: Stores all spectrum data: power and cross spectra and control settings.

4-4-38. SRQ

- A-UTORANGE
- CHA- OVLD
- CHB- OVLD
- E-ND OF AVERAGING
- R-ESET

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

4-4-39. TEST

Toggles test signal either on or off.

4-4-40. 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 (EOT) will terminate TEXT mode.
6. "SET READOUT LOCAL" command returns screen to normal spectrum display

4-4-41. TR-ANSFER — DER-IVATIVE OF PHASE / REC-IPROCAL / O-PEN LOOP / I-MPULSE — ON / OFF

Note: Selects further processing of transfer function.

4-4-42. WRI-TE — A / B / S-INGLE

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.

4-5. DATA TRANSFERS

There are two ways of transferring data between the 5830A 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 5830A 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 5830A before a readout is generated. If data is read directly from memory, the user would have to apply these correction factors as given in Appendix H.

There are four commands that perform binary transfers: the BREAD and BWRITE, NVREAD and NVWRITE 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 5830 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A 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 5830A, if it had been stopped to perform Data Transfers.

4-10-3. Parallel Polling

The 5830A 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 5830A 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 5830A 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 5830A 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 HSP 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 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 HIGH 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 -29dBV and the input sensitivity to -23dBV. 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 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 High 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 High Accuracy mode.

5-7. EQUIVALENT INPUT NOISE VERIFICATON

This test verifies that the typical equivalent input noise is less than -155dBV/ 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/ 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 before 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 5830A

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 0.4dB.

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.

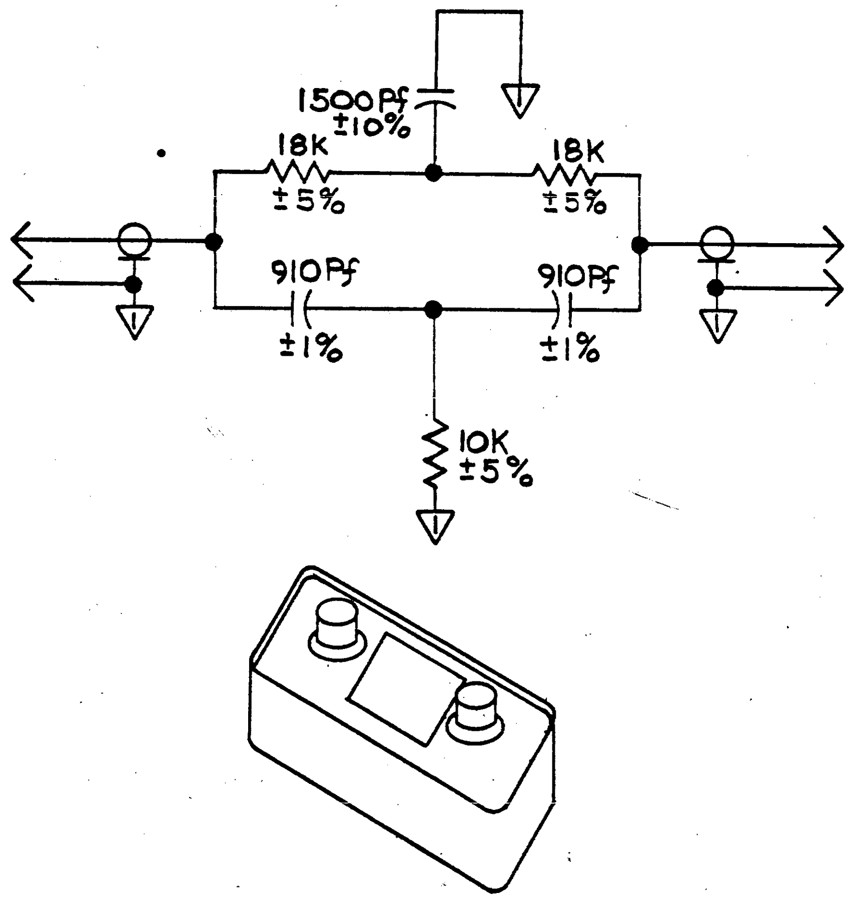


FIG. A-1 SCHEMATIC OF THE NOTCH FILTER

APPENDIX B

SUMMARY OF 5830A 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.

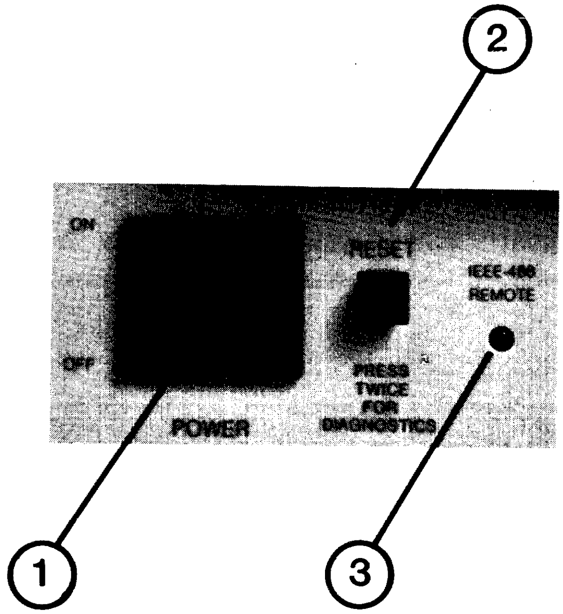
POWER
The Model 5830A will operate from either 115 or 230 VAC. Before connecting power, make sure that the instrument is compatible with the nominal line voltage and that a fuse with the proper rating is installed.

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

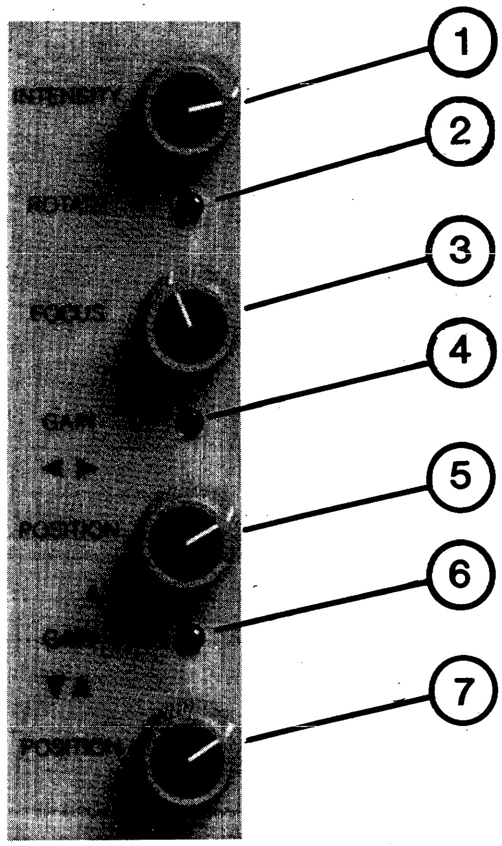


(1) Applies power to the instrument when the top is pushed in; at this point the instrument goes through a pre-determined power-up procedure; following this, the instrument comes up in a pre-determined or preset state, which may be seen by pressing the VIEW SET UP Key (see Section B-4).

(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.

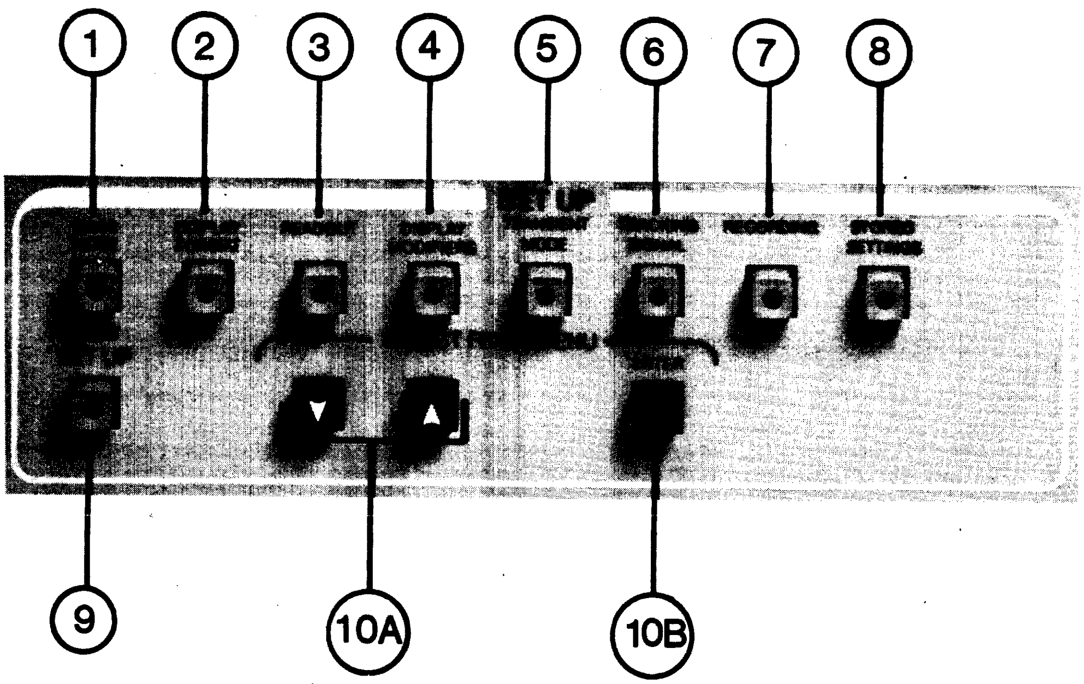
4. Clockwise rotation increases horizontal size of the display.

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

6. Clockwise rotation increases vertical size of the display.

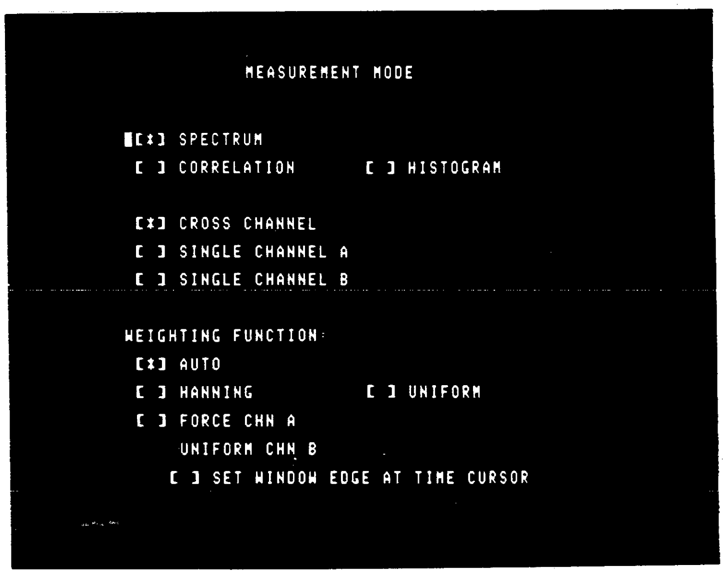
7. Moves display up or down, without changing its size.

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.



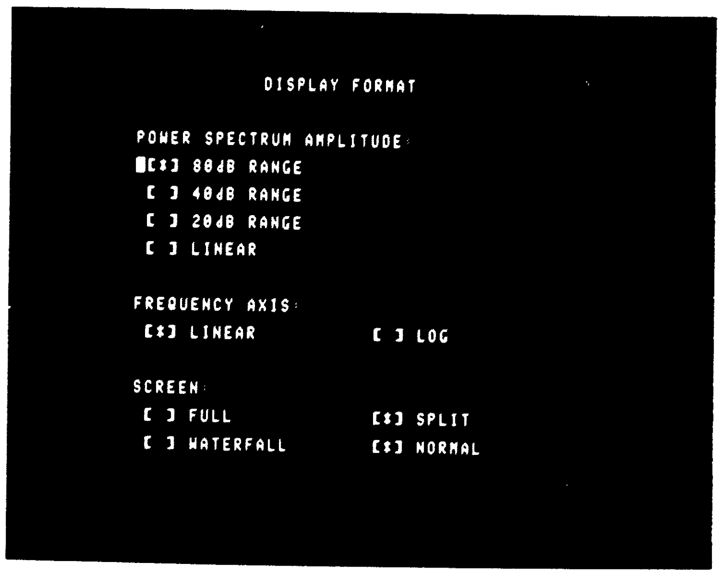
(1) Measurement Mode

Determines whether input samples are taken from CH A, CH B, or both and type of processing, i.e., spectrum analysis, correlation or histogram. Also specifies the choice of weighting function. The FORCE weighting is used in transient mode to window the input when it is an impulse.



② Display Format

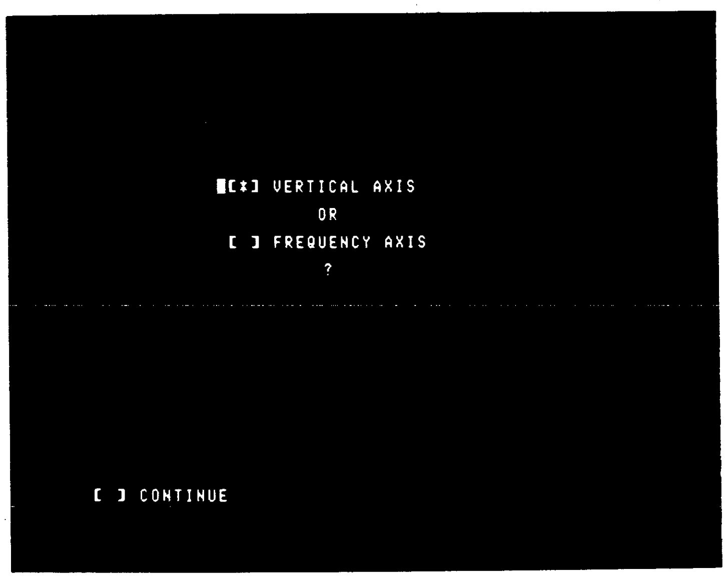
For spectrum displays, provides choice of linear or log frequency axis, linear or log amplitude axis, and full-scale vertical range. Dual displays can be selected to overlap, FULL, or be separated, SPLIT. In WATERFALL, successive displays are shown, one beneath the other.



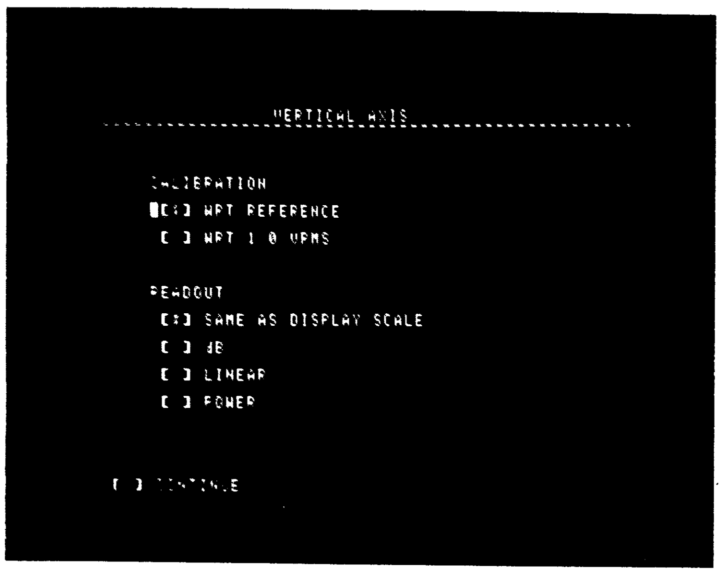
③ Readout

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

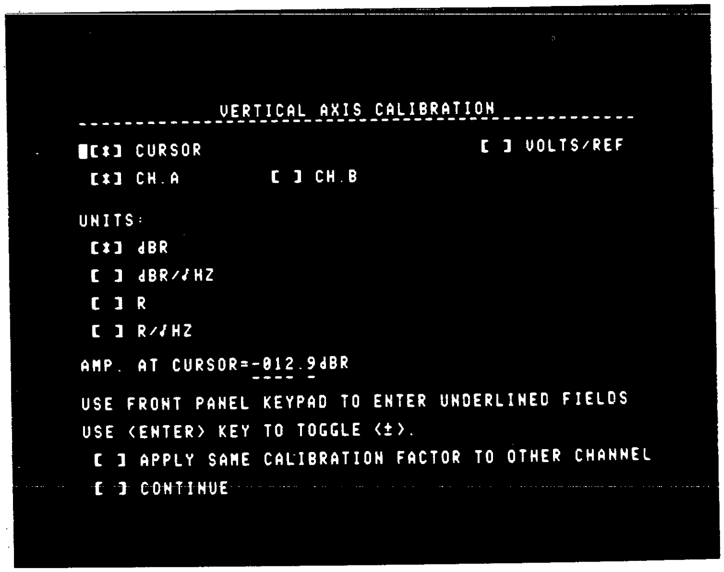
a) Select axis to be calibrated.



b) If the vertical axis is selected, then choose either engineering units, i.e. "WRT REFERENCE" or the default condition 1.0 VRMS. In either case, choose units of cursor readout. User can select either readout to independent of display or leave it to default state where readout corresponds to display scale.



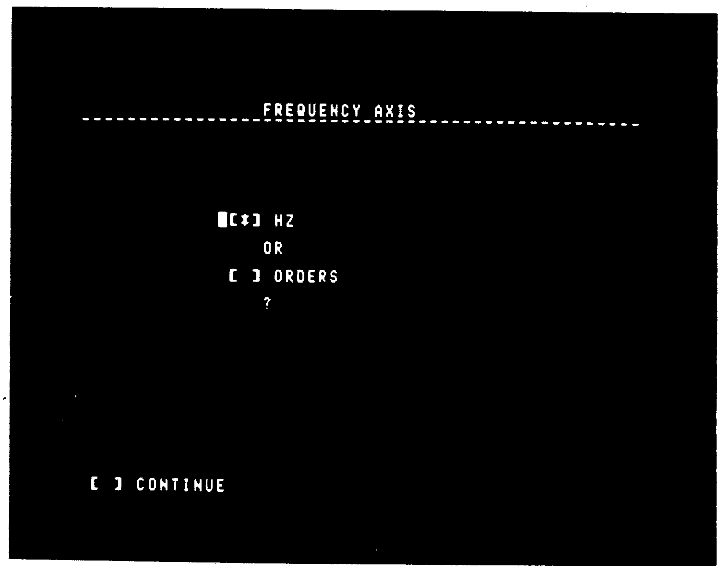
c) Details for Vertical Axis calibration on Engineering units.



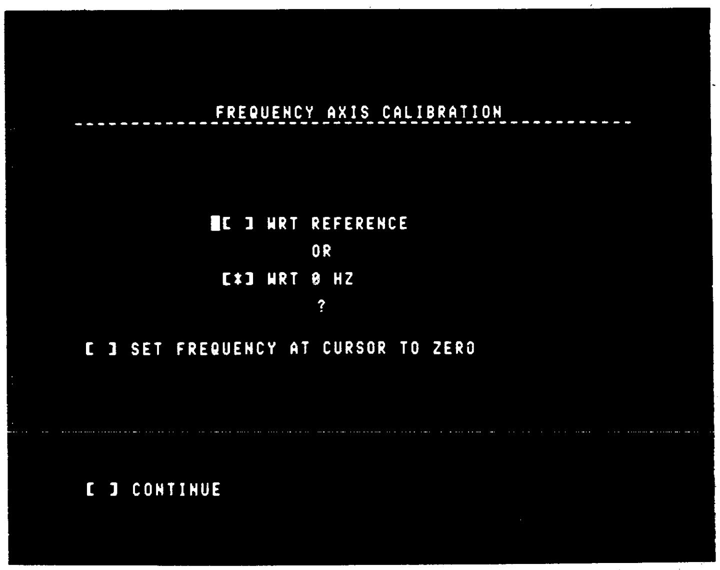
i. Define amplitude at the cursor as the reference signal or transducer's intensity.

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.

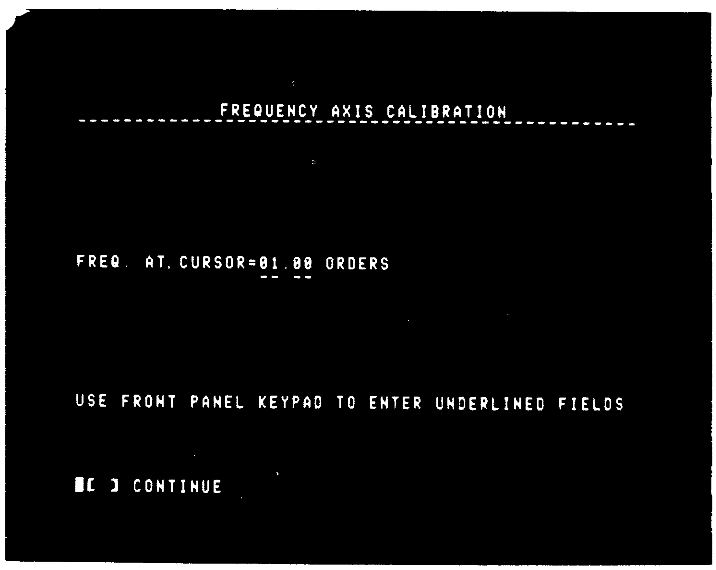


e) If Hz is selected, then select if readout is referenced to DC (0 Hz) or a reference.



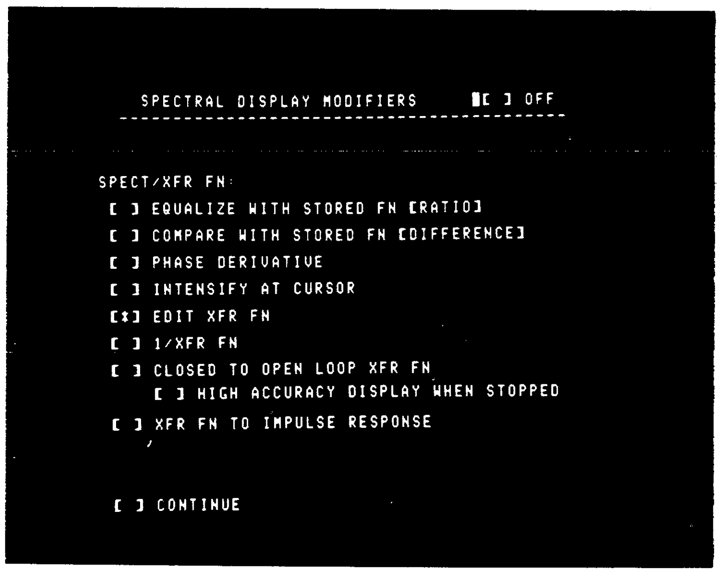
i) If reference is selected then define frequency at the cursor as 0 Hz.

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



(4) Display Modifiers of Spectra

Without affecting the processed data, spectrum and transfer function measurements may be modified in a number of ways: equalizing (ratio) or comparing (difference) with a previously stored measurement; derivative of phase spectrum to obtain "group delay"; dimming spectral displays except at cursor locations; dimming transfer function (EDIT) where it may be in error; calculating the reciprocal or inverse of the transfer function; converting a transfer function to an impulse response by calculating the inverse Fourier transform; computing the open loop response from the measured closed loop; modifying any spectrum measurement by the equivalent of differentiating or integrating the input signal.



MODIFIERS CONTINUED

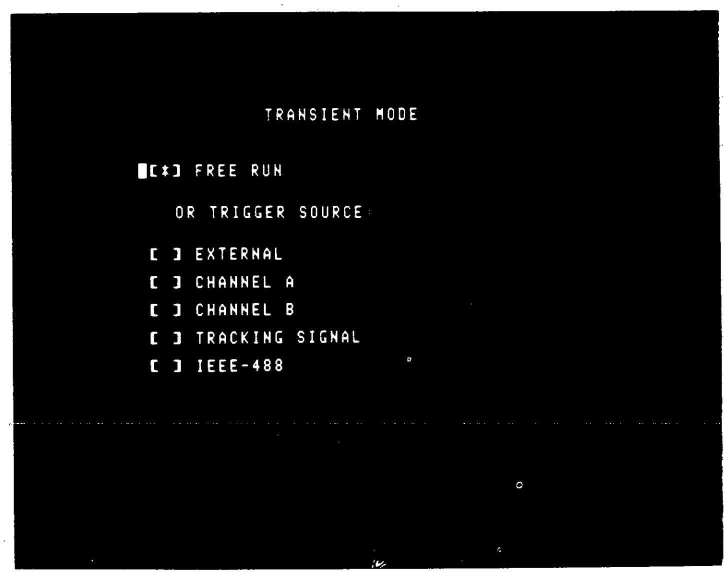
PSEUDO INPUT MODIFIERS:

	CH.A	CH.B
1ST DERIVATIVE	[ ]	[ ]
INTEGRAL	[ ]	[ ]
2ND DERIVATIVE	[ ]	[ ]
DOUBLE INTEGRAL	[ ]	[ ]
MULTIPLY BY -1	[ ]	[ ]

[ ] CONTINUE

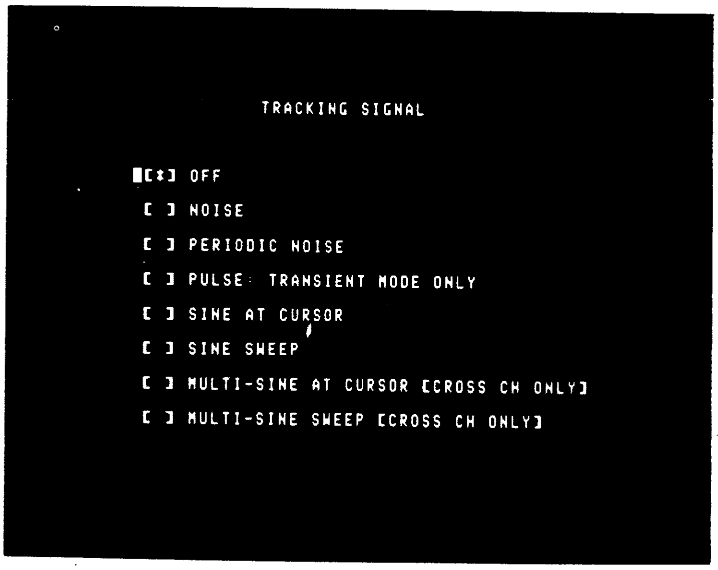
(5) Transient Mode

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.



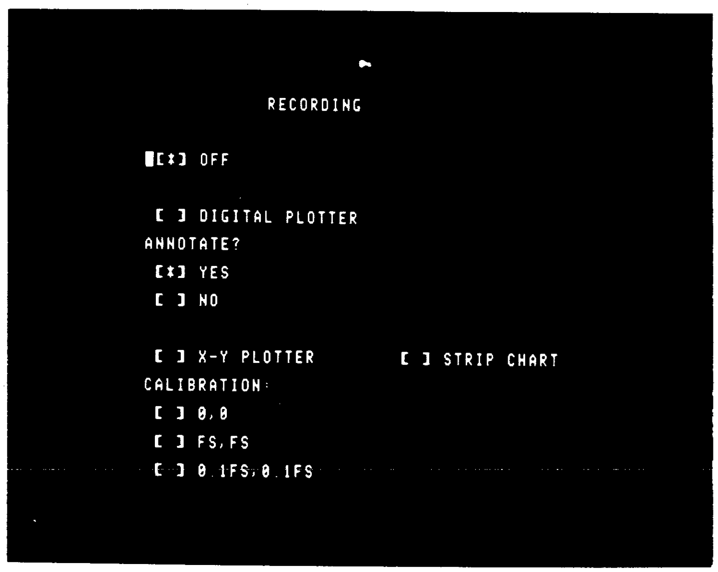
(6) Tracking Signal

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



(7) Recording

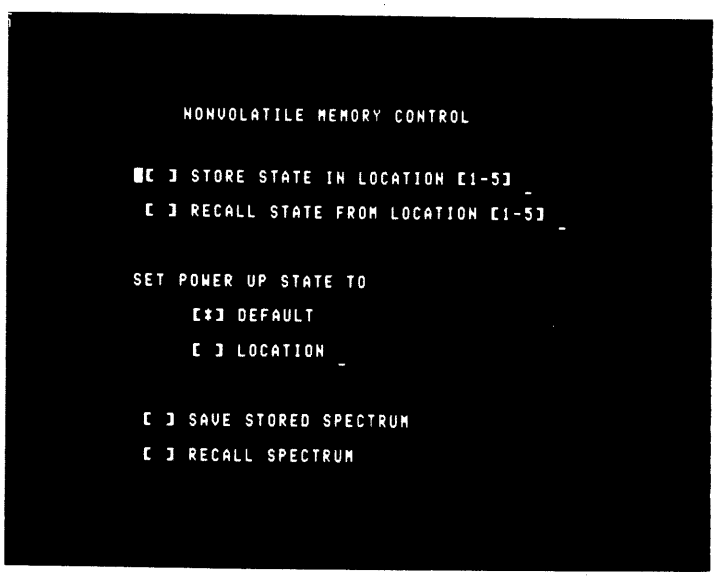
Determines the type of hard copy output to be obtained; also provides calibration of X-Y recorder.



(8) Stored Settings

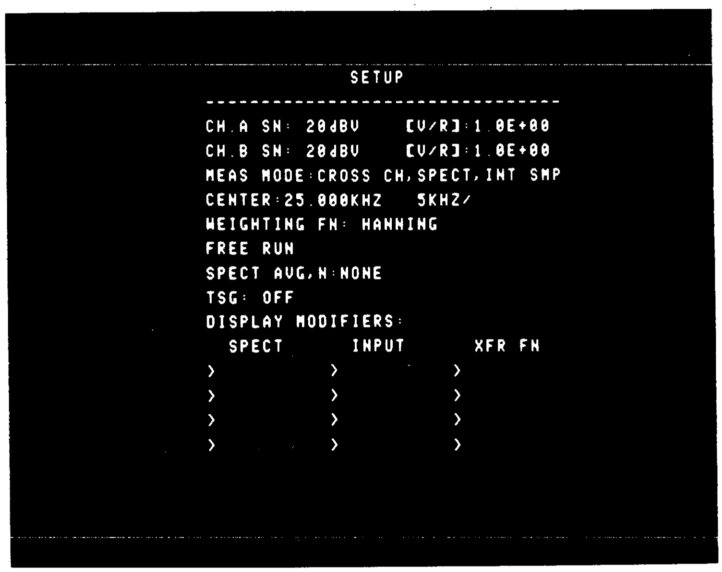
Five complete sets of front panel settings, including all control and menu functions, (except rotary controls and toggle settings) cursor type and position, tracking signal output and step attenuator settings may be stored in a nonvolatile memory and recalled at anytime, including power up.

Two 400-line single channel spectra (total span and zoom) or one complete set of cross channel data consisting of four 200-line spectra:power spectrum A and B, cross-spectrum, real and imaginary along with their calibration information, may be stored in the nonvolatile memory and later recalled. The stored information is also sufficient to recall transfer function, coherence and coherent output power.



⑨ View Set Up

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



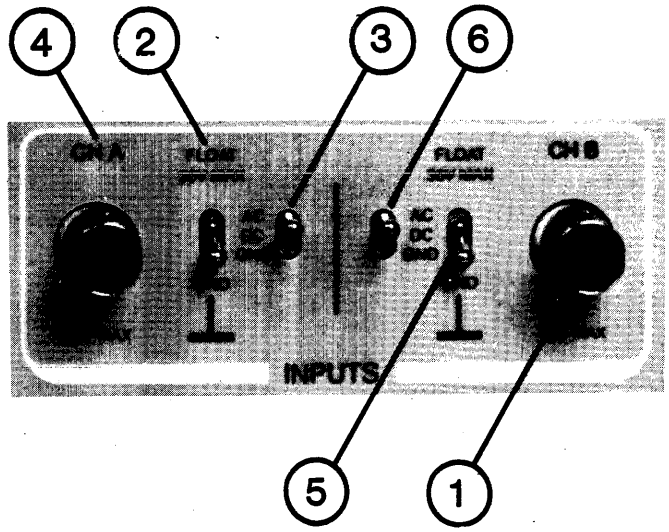
(10A) Moves menu cursor down ∇ , one line per keystroke. When the last line is reached, pressing the key again will position the cursor next to the top line of the menu.

Moves menu cursor up Δ , 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.

(10B) 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 low terminal (BNC shell) is floating in true differential mode (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).

④ Input BNC Connector for Channel A.

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

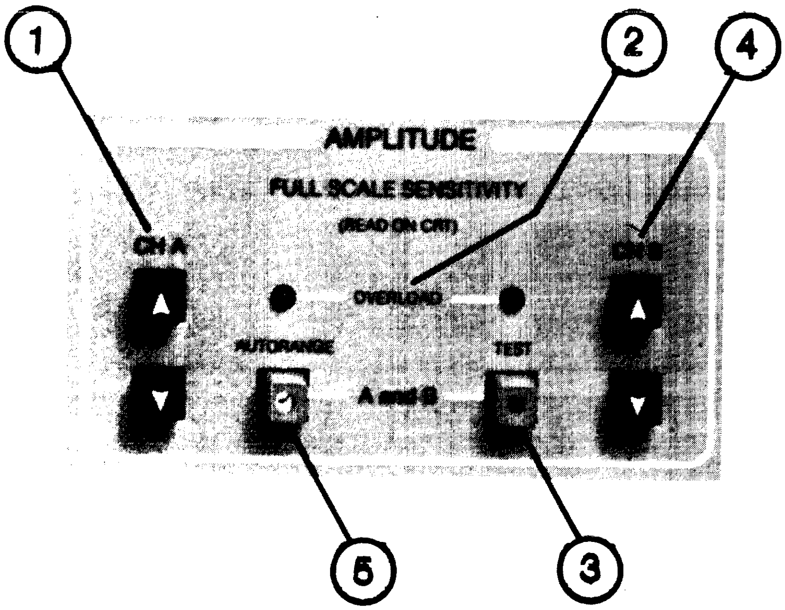
⑥ Selects whether Channel B input circuit is AC coupled, DC coupled, or grounded (When grounded, it will not short-circuit the external signal source).

<u>Note</u>:

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 Δ 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 approaches 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. However, if the number of averages (PROCESSING section) is set at NONE, then al data is processed. 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. Processing occurs whenever a data block is free of overload.

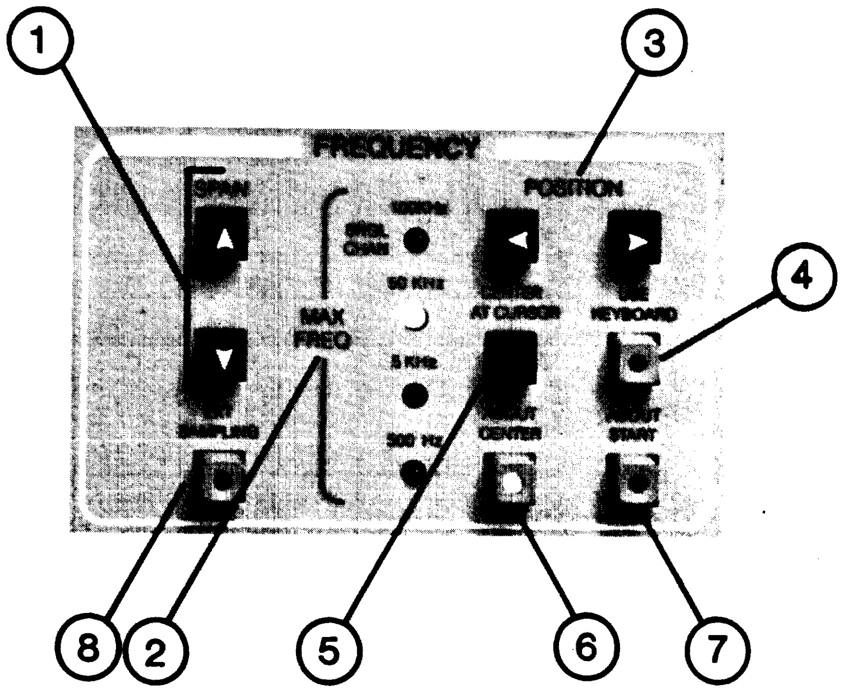
(3) When activated, an internally generated test signal is applied to both channels, to provide a quick indication of proper instrument operation.

(4) Allows for increasing Δ 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. 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 activated use the keyboard in VIEWING section to enter on the CRT, the position of the span. Press again to return to processing mode.

(5) When momentarily pressed, the selected span centers about the main cursor's position.

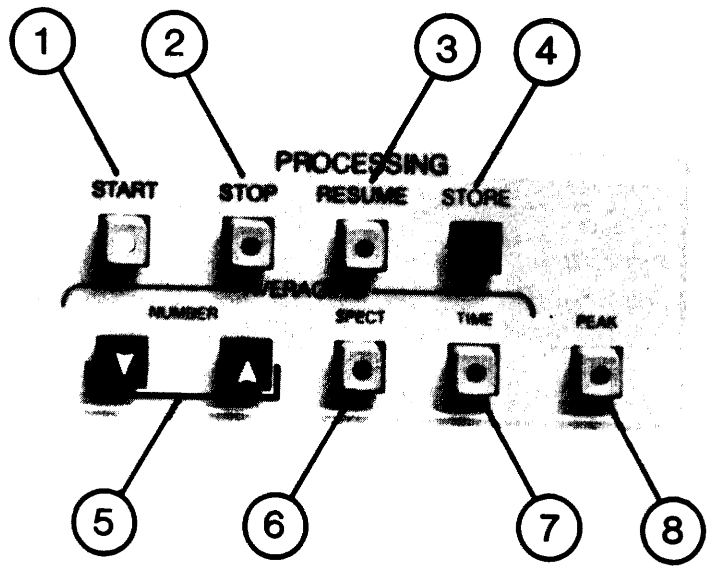
(6) When activated, the portion of the spectrum being viewed stays at the same center frequency as the span width is changed.

(7) When activated, the portion of the spectrum being viewed stays at the same start frequency as the span width is changed.

(8) 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 Δ or decreasing ∇ the number of averages from 0 thru 256 in binary steps. The selected number of averages (N=) is shown on the CRT as well as the actual number performed (AVG =).

(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.

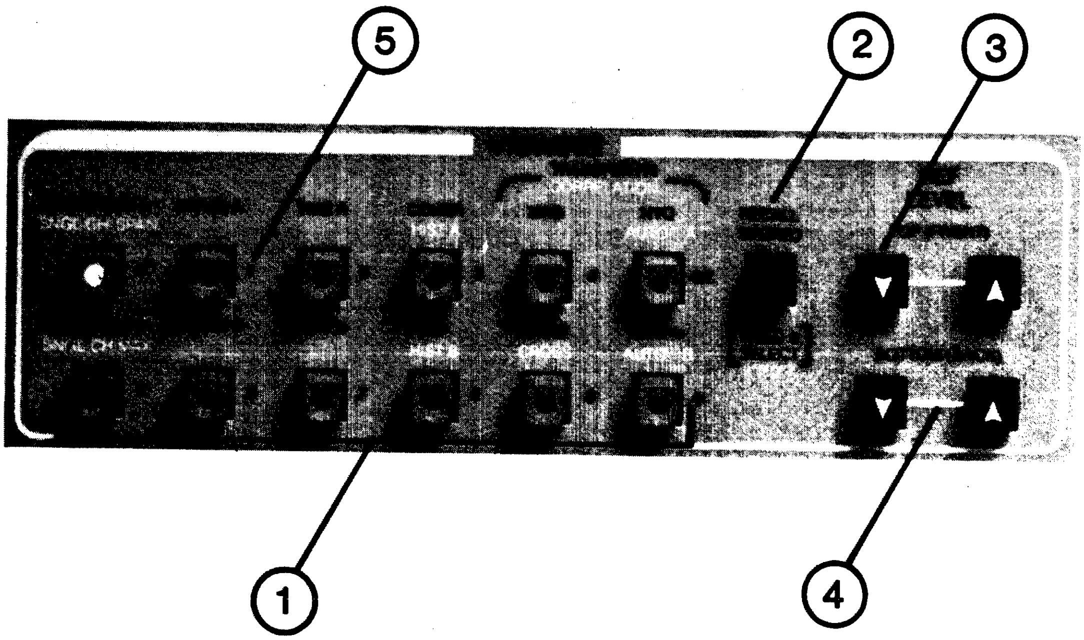
NOTE:

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 and a count of the number of linear averages performed is indicated on the CRT (AVG=). When the number of averages selected is reached, averaging becomes exponential: START Key stays on and AVG=N on the CRT.

B-9 VIEWING

Selects the measurements to be displayed (present or previously stored) and provides for display gain or attenuation. Any two functions 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) Selects the function to be displayed.

When the measurement mode is set to spectrum analysis, then six functions are available in single-channel: power spectrum (Ch.A, Ch.B), phase spectrum (Ch.A, Ch.B) and the time waveform (Ch.A, Ch.B). In cross channel measurements, all of the above are available, plus, transfer function magnitude and phase, Nyquist, i.e., imaginary vs. real part of the transfer function, transfer function real and imaginary, coherence and coherent output power.

When the measurement mode is set to Correlation, then the auto and cross correlation functions, and the time function of both channels are available.

When the measurement mode is set to Histogram, then the probability and cumulative probability functions and the time function for either channel are available.

(2) 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.

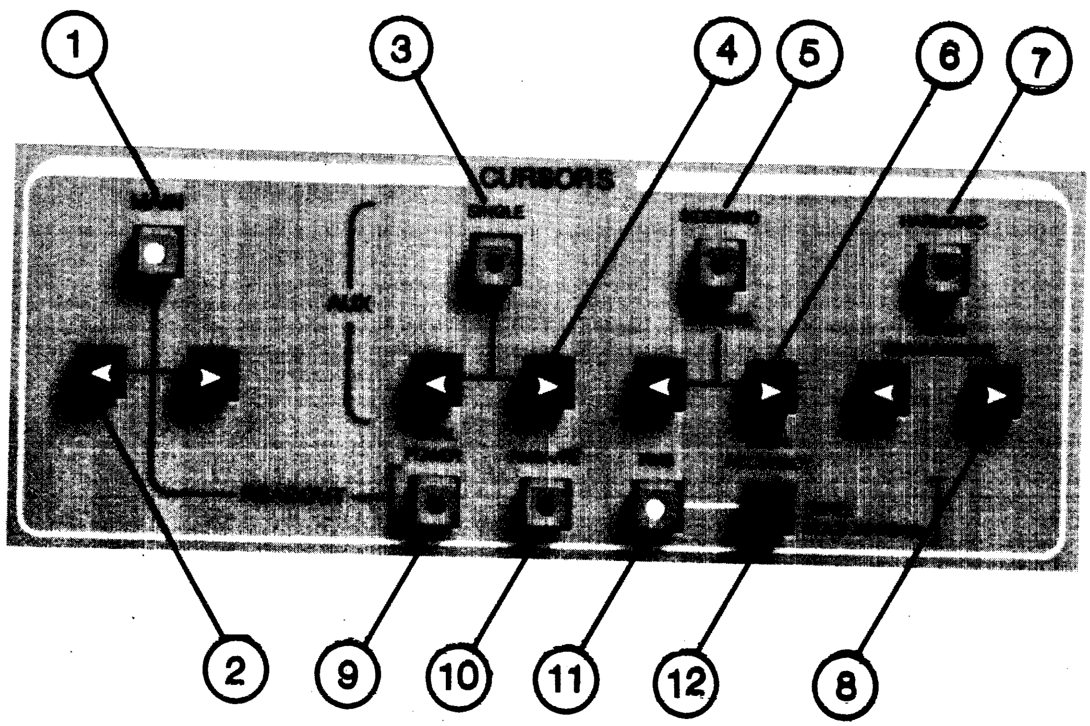
(3) Allows for increasing Δ , or decreasing ∇ display gain of the top trace in split-screen display, or the front trace in full-screen display. When pressed and held, display gain will change in steps of 10 dB; otherwise, display gain will change in steps of 1 dB per keystroke.

(4) Allows for increasing Δ , 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.

(5) 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. Also, may be used to enter either the starting or center frequency of the selected FREQUENCY SPAN.

B-10 CURSOR

Allows for positioning a number of intensified markers on the trace for measurement of vertical and horizontal parameters and for identification of harmonically-related and equally spaced frequency components.



(1) When activated, it turns on the main cursor and its corresponding readouts. <u>All readouts require the main cursor to be on.</u>

(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, it turns on a secondary marker which is defined as the fundamental frequency when HARMONIC marker is used, and as the carrier when SIDERAND marker is used.

(4) Allows to move SINGLE marker left ◁ or right ▷ throughout the display.

(5) When activated, turns on a set of secondary markers equally spaced about the SINGLE marker.

(6) Allows for moving the spacing of the SIDEBAND markers.

(7) When activated, it turns on a set of secondary markers located at multiples of the SINGLE marker.

(8) Allows for small adjustment of the sideband and harmonic markers to account for the discrete signals not falling in the center of a frequency resolution cell.

(9) When activated, with only the MAIN marker on, the amplitude readout is equal to the total power in frequency span being used excluding DC. With the addition of the SINGLE marker, the readout is equal to the total power between the MAIN and SINGLE cursors. With the SIDEBAND marker on, the readout is equal to the power in the identified sidebands. With the HARMONIC marker on, the readout is equal to the power in the harmonics or the fundamental.

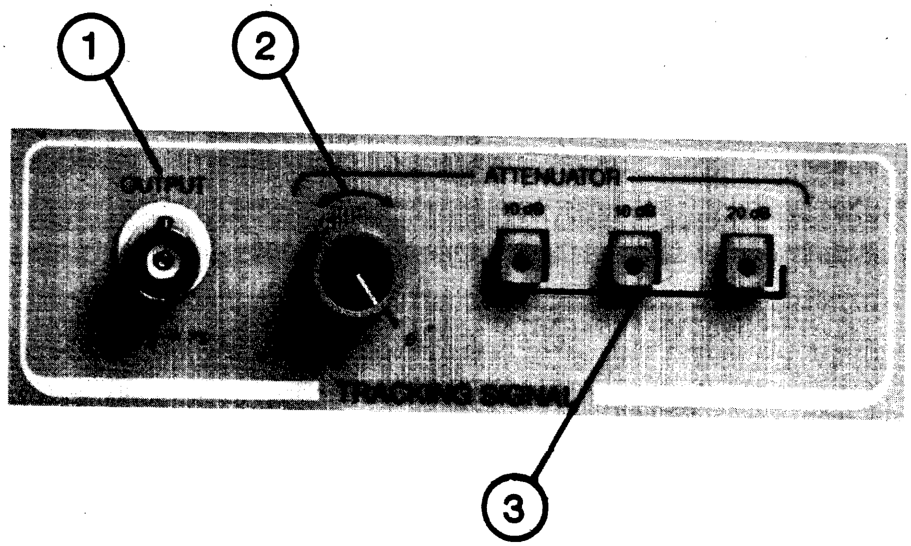
(10) When activated, the cursor amplitude readout is power spectral density (RMS value per unit bandwidth). Use this for measuring noise spectra.

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

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

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.

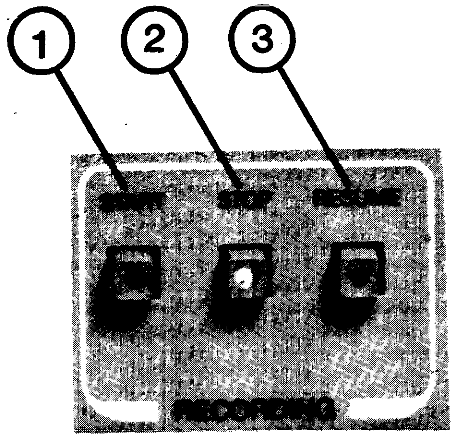


(1) Output BNC connector for connecting the tracking signal to the device under test. Max. output voltage is 3V, p-p.

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

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

Controls the digital plotter, X-Y recorder, or strip chart connected to the appropriate connectors on the rear panel. Recorder selection and calibration is made in the SET UP section.



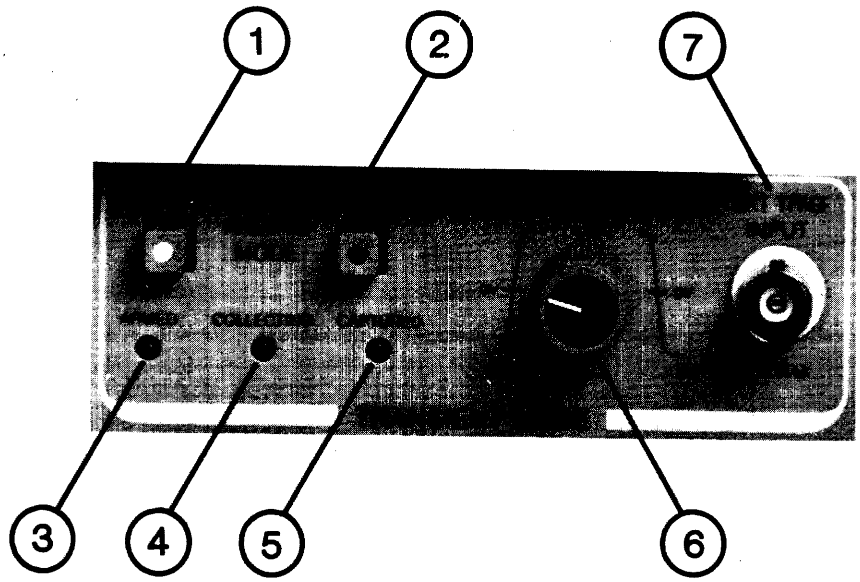
(1) Starts the plotter in the "0" position.

(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. It can only be rearmed by pressing key.

(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.

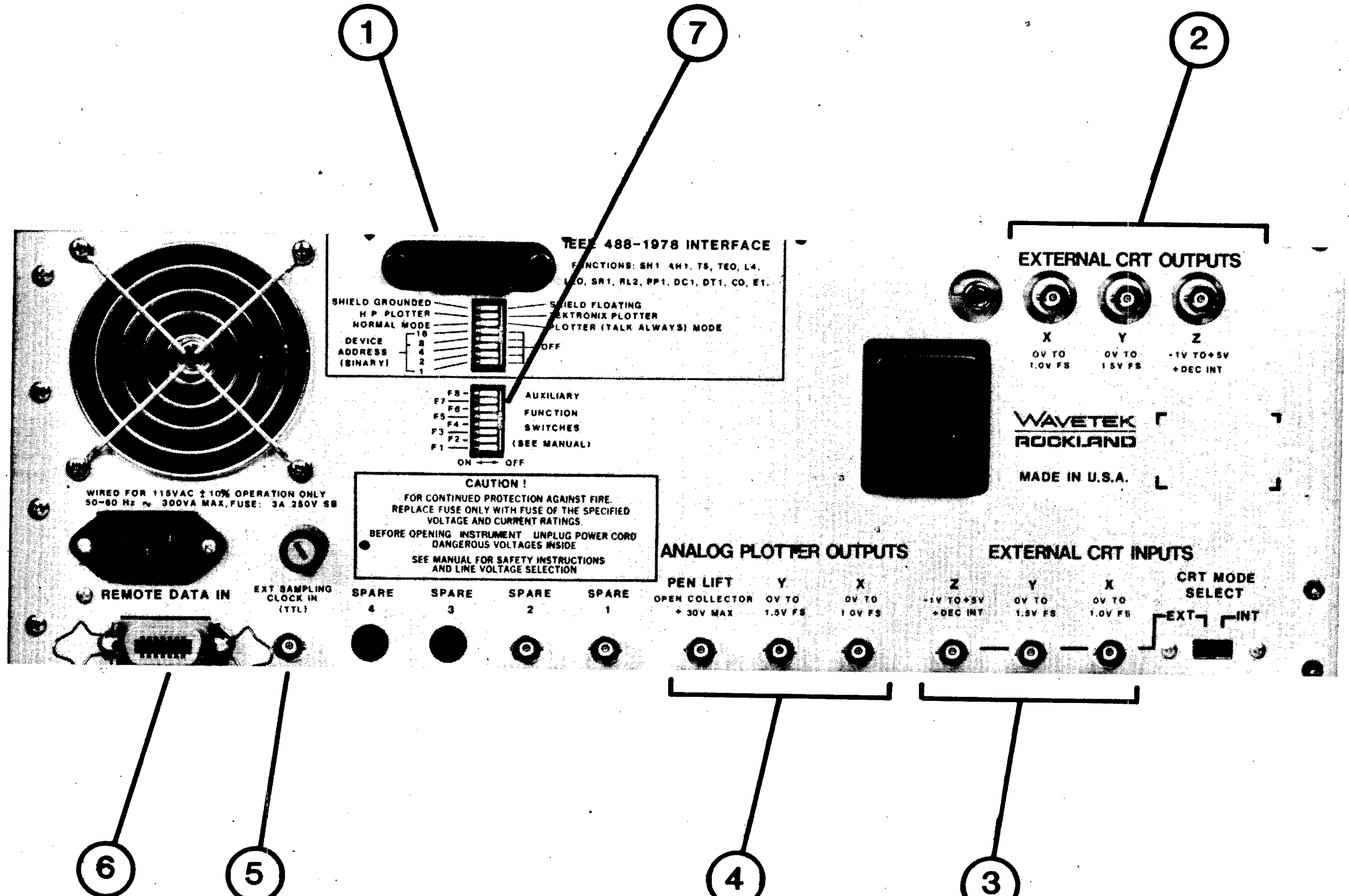
(7) BNC connector for connecting an external trigger signal.

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.



1
7
2
IEEE 488-1978 INTERFACE
SHIELD GROUNDED
H P PLOTTER
NORMAL MODE
DEVICE ADDRESS (BINARY)
16
8
4
2
1
OFF
AUXILIARY
FUNCTION
SWITCHES
(SEE MANUAL)
ON OFF
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.
WIRED FOR 115VAC ±10% OPERATION ONLY
50-60 Hz ~ 300VA MAX, FUSE: 3A 250V SB
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
REMOTE DATA IN
EXT SAMPLING CLOCK IN (TTL)
SPARE 4
SPARE 3
SPARE 2
SPARE 1
ANALOG PLOTTER OUTPUTS
PEN LIFT
OPEN COLLECTOR + 30V MAX
Y
0V TO 1.5V FS
X
0V TO 1.0V FS
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
6
5
4
3

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 7470A
HP 7225A/B
HP 9872B/S
HP 9872C/T
TEK 4662
(usable as a single color plotter only).
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 for faster. If strip/chart mode is selected, the X-BNC corresponds to the y-amplitude of the MAIN cursor, and the Y-BNC corresponds to the y-amplitude of the SINGLE cursor.

(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. Position F3 selects the rate that data is output to an analog plotter. ON corresponds to normal rate and OFF to faster. Position F4 must be in the ON position in order to power-up to the settings stored in the nonvolatile memory; otherwise, it will always power up to the default condition.

APPENDIX C

BASIC TROUBLESHOOTING PROCEDURE

C-1. WHAT TO DO IF.....

The 5830A 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 5830A 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 5830A 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

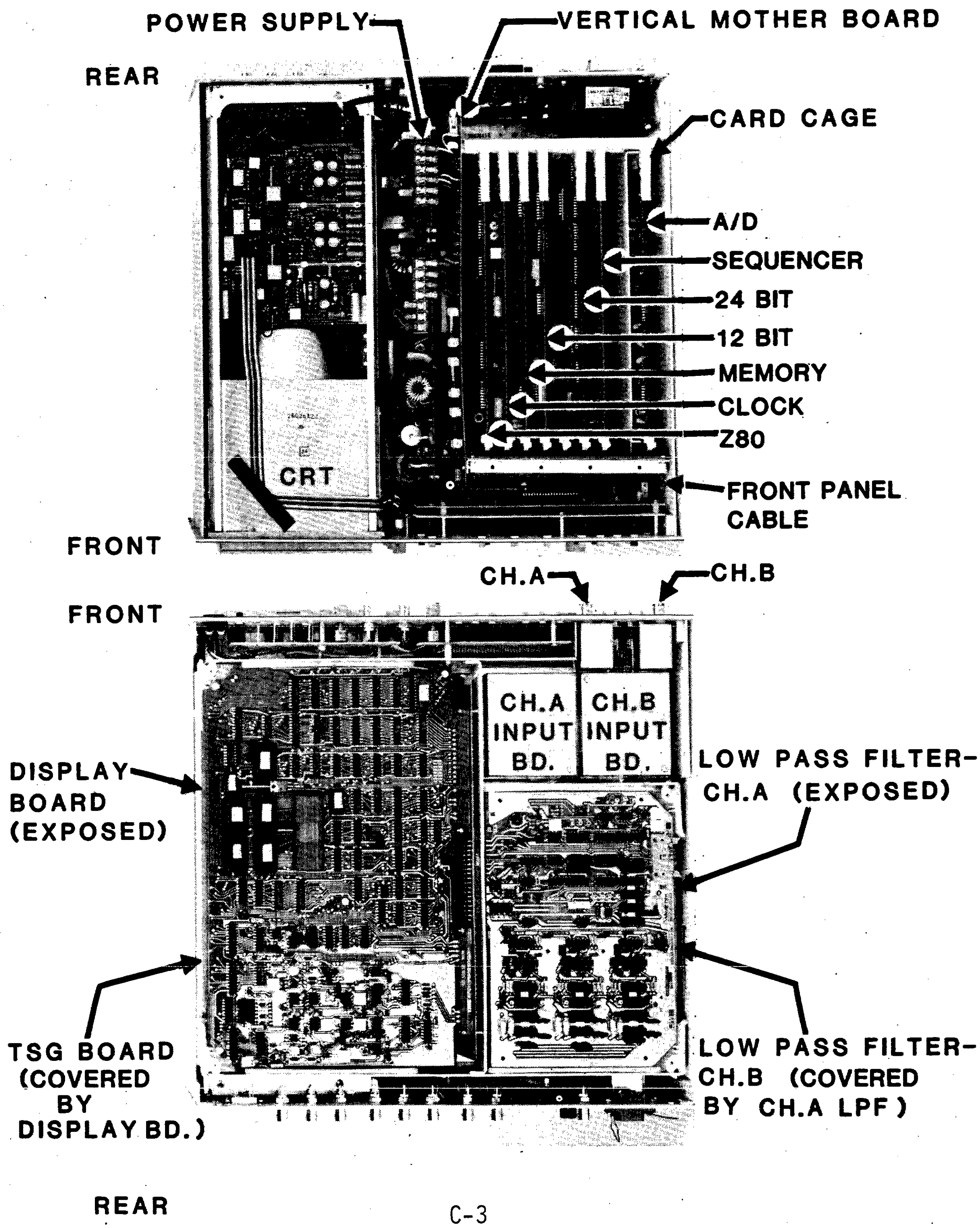
If the instrument's behavior is erratic, or not cured by the steps in C-1-3 or C-1-4, then perform the diagnostic tests.

C-2. DIAGNOSTIC PROCEDURE.

Built-in to the Model 5830A 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.

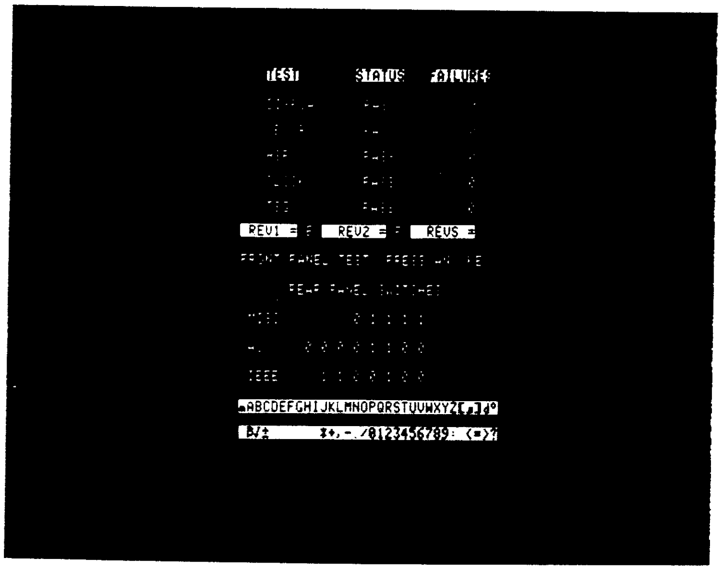


Fig. C-2-1a Typical Diagnostic Pattern

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

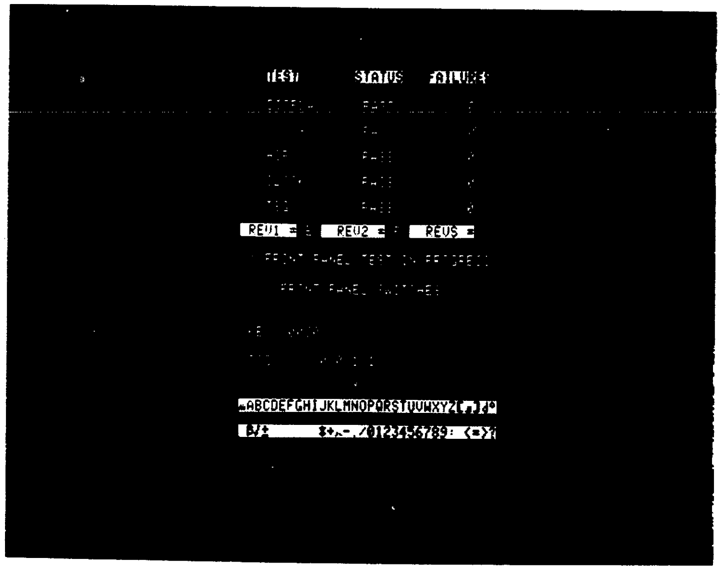


Fig. C-2-2a.

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 / CH B	AC	DC	GND
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.

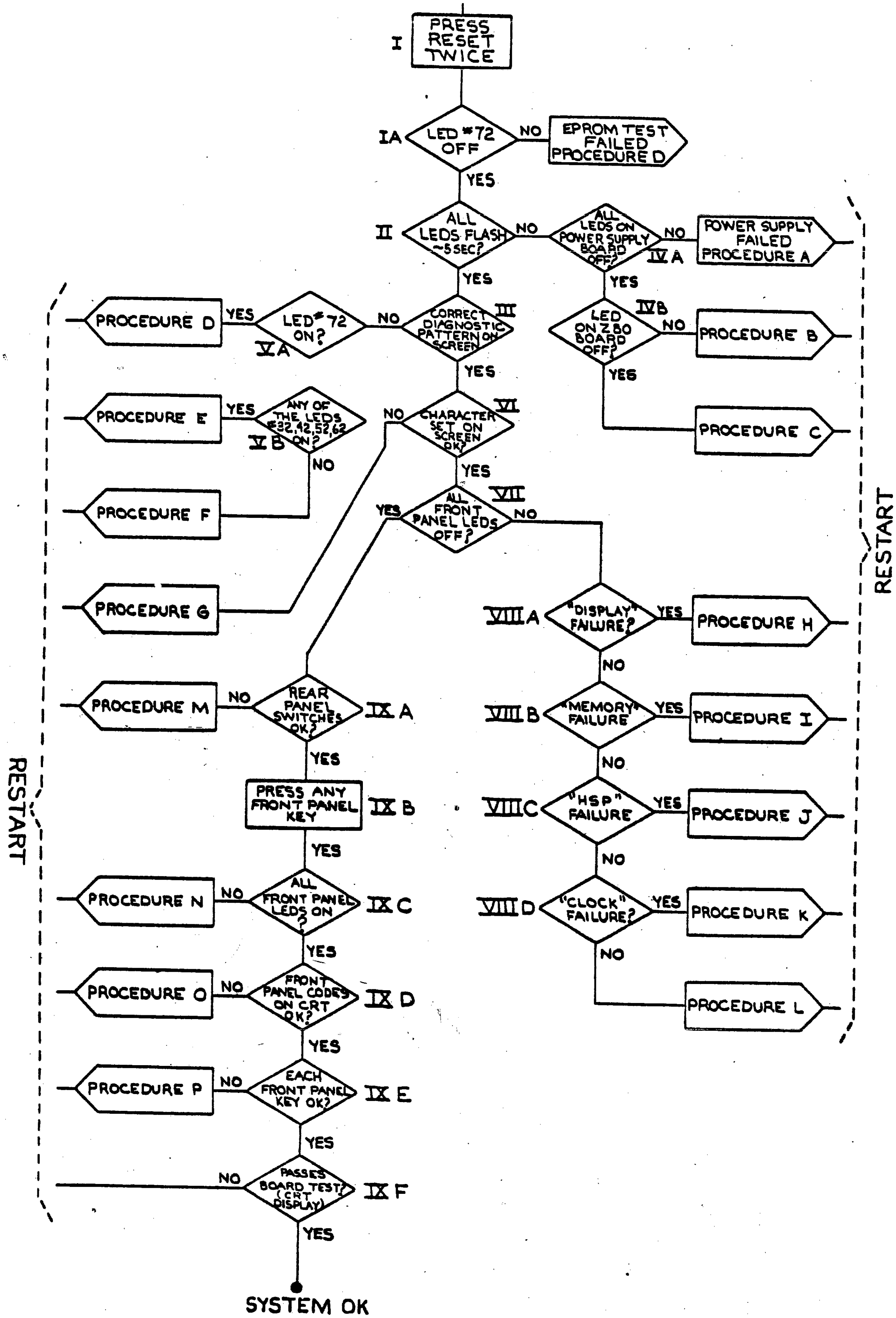


FIG. C-2-4A FLOWCHART FOR DIAGNOSTIC PROCEDURE

STEPS:

Step I

Press RESET key twice to get into the diagnostic mode.

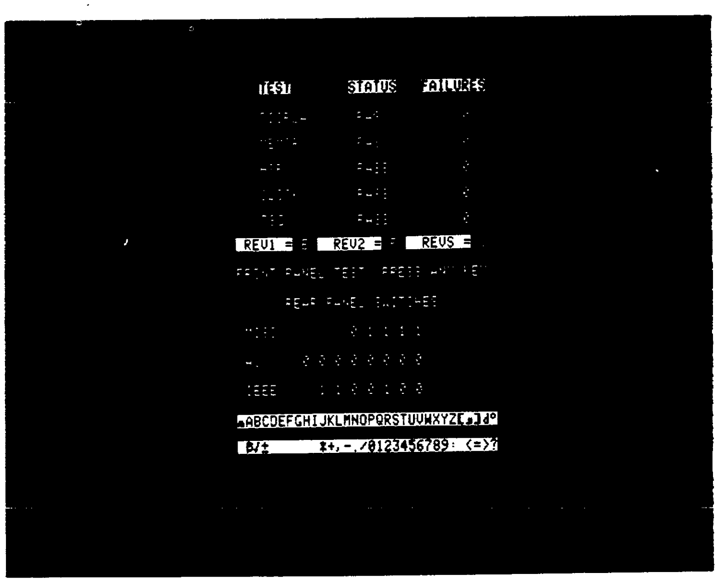
Proceed to procedure (D) if the EPROM error indicating LED is on (Front Panel Key 72,Fig.C-2-1b), otherwise go to Step II.

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 (O) 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

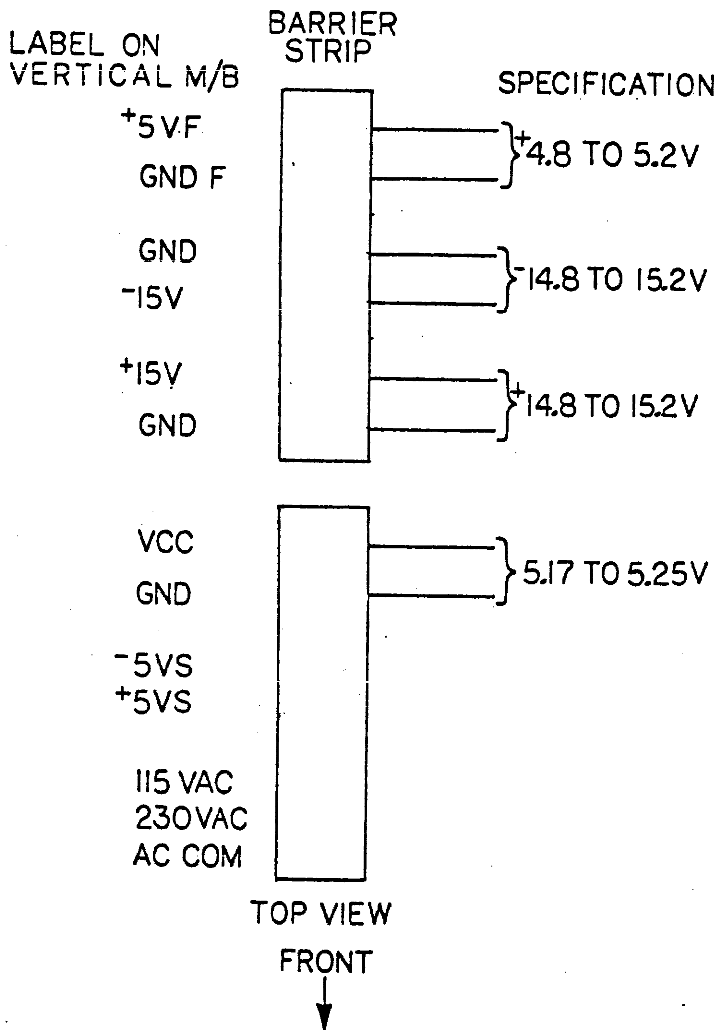


Fig. C-2-5-1 Barrier Strip Voltages on Power Supply

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

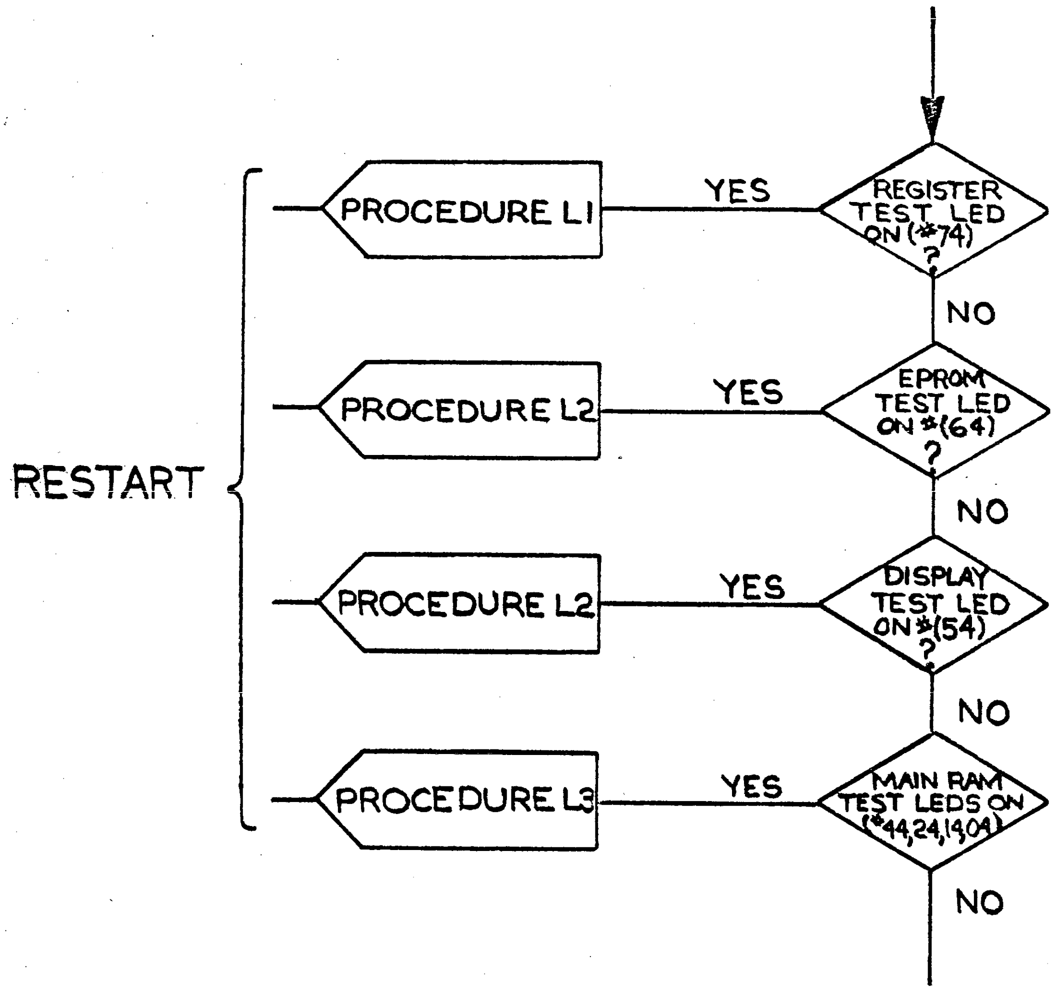
MC: Z-80, CLOCK, FP SCANNER, FP CABLE, DISPLAY, MEMORY.

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 5830 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 0DB"          Select Sensitivities
5:wrt "rta","SET
  SENSITIVITY B 0DB"
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 5830A 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 5830 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

```
 10 ! **************************
 20 !
 30 ! HP85F SAMPLE PROGRAM FOR
 40 ! READING THE DISPLAY ON
 50 ! THE MODEL 5830A ANALYZER
 60 ! USING THE TRANSFER MODE
 70 !
 80 ! **************************
 90 !
100 DIM S(200),Z$[1817]
110 IOBUFFER Z$
120 D=704 ! device address
130 OUTPUT D ;"RESET"
140 WAIT 4000
150 OUTPUT D ;"SET FRONT PANEL R
    EMOTE"
160 OUTPUT D ;"SET VERT LINEAR"
170 OUTPUT D ;"READ SPECT A"
180 !
190 !   "#" - Image modifier
200 !         used to remove the
210 !         need for the line
220 !         feed as a
230 !         terminator
240 !
250 TRANSFER D TO Z$ INTR
260 STATUS Z$,2 ; Z
270 IF Z#0 THEN 260
280 FOR I=0 TO 200
290 ENTER Z$ USING "#,K" ; S(I)
300 NEXT I
310 END
```

```
 10 ! *************************
 20 !
 30 ! HP85F SAMPLE PROGRAM FOR
 40 ! CONTROLLING THE WAVETEK
 50 ! MODEL 5830A ANALYZER
 60 !
 70 ! *************************
 80 !
 90 CLEAR
100 D=704 ! device address
110 OUTPUT D ;"SET FRO REM"
120 OUTPUT D ;"SET VERT 80"
130 OUTPUT D ;"VIEW DUAL"
140 OUTPUT D ;"VIEW SPEC A"
150 OUTPUT D ;"VIEW TIME A"
160 ! -----------------------
170 ! READ CURSOR AT 10.25KHz
180 ! -----------------------
190 C=10250
200 OUTPUT D USING "K,K" ; "CURS
     ",C
210 OUTPUT D ;"READ CURS BOTTOM"
220 ENTER D USING "#,K" ; A,F
230 DISP USING "6/,K,K,K" ; "FRE
    QUENCY OF CURSOR = ",F," HZ"
240 DISP USING "K,K,K" ; "AMPLIT
    UDE AT CURSOR = ",A," dBV"
250 OUTPUT D ;"SET FR L"
260 END
270 FOR I=0 TO 200
280 ENTER Z$ USING "#,K" ; S(I)
290 NEXT I
300 END
```

```
 10 ! ************************
 20 !
 30 ! READ DISPLAY IN ASCII FOR
 40 ! MODEL 5830A
 50 !
 60 ! ************************
 70 !
 80 DIM S(200)
 90 D=704 ! device address
100 OUTPUT D ;"SET FRONT PANEL R
    EMOTE"
110 OUTPUT D ;"SET VERT 40"
120 OUTPUT D ;"READ TRANSFER FUN
    C MAG"
130 !
140 ! "#" - Image modifier used
150 !       to remove the need
160 !       for line feed as a
170 !       terminator
180 !
190 FOR I=0 TO 200
200 ENTER D USING "#,K" ; S(I)
210 NEXT I
220 END
```

E.5 EXAMPLE OF BINARY TRANSFER MODE

An example of a program which transfers the averager buffer in binary format and applies corrections is given. First, it is presented in pseudocode so the user sees an outline of the procedure. Second, a program for the HP-85, following the logic of the pseudocode is given.

The filter's correction factor used for this program is presented in DATA statements. However, in a more general form, a table may be used. The input information for the table is given in Appendix H.

****

```
procedure getaverage

* read power averager buffer from 5830 in binary and
correct for input sensitivity and digital filter
shape*
*Note:In all binary transfers the first byte is a
      dummy space*

byte array averager; real array avg,correction;
begin
      read sensitivities from 5830
      *"READ STATE 25 26" for Sens A*
      *"READ STATE 28 29" for Sens B*
      *Convert as shown in Note 3,App G of Manual*
      read span from 5830;
      *"READ STATE 21" and look at App G*
      read mode from 5830;
      *"READ STATE 12" and look at App G*
      determine channel;
      determine memory starting address A;
      *see Appendix H*
      determine number of points N from mode;
      *see Table 3-8-2*
      for i=0 to N read correction(i) from file;
      set 5830in binary transfer mode;
      *"BREAD "A,A+2*N+1*
      for i=0 to 2*N+1 read averager(i) from 5830;
      *for format see Appendix H*
      for i=0 step 2 until 2*N+1
```

```
         begin
              exponent:=(integer(averager(i+1)/8))-1;
              *extract exponent*
              mantissa:=averager(i)+(averager(i+1) and 7)*256;
              *extract mantissa*
              avg(i):=(mantissa*2 (-exponent))/1024;
              avg(i):=10*log(avg(i))+sensitivity;
              *averager in dB and appropriate sensitivity correction*
              if (mode=cross and span=50K)
                or (mode=single and span=100K)
                  then avg(i):=avg(i)+correction(i);
              end
end
```

```
 20 ! **************************
 40 ! program - AVERGR
 60 !
 80 !   PROGRAM READS AVERAGER
100 !   IN BINARY & CALIBRATES
120 !   RESULTS
140 !
160 !       variables:
180 !  A1$[]- averager memory
200 !  A     - address used
220 !  E     - exponent term
240 !  M     - mantissa term
260 !  D0() - dft corrections
280 !  A0() - address array
300 !  C     - =1 for cross
320 !  S     - span(0=50k...)
340 !  P     - address pointer
360 !
380 !            written by:
400 !            phil feinberg
420 !            4/18/83
440 !            5820A/5830A
460 ! *************************
480 !
500 D=704 ! analyzer address
520 CLEAR
540 INTEGER D0(201),A0(1)
560 SHORT A1(401)
580 COM A$[1],A1$[802],Z$[810]
600 IOBUFFER Z$
620 ! -----------------------
640 ! 5820A or 5830A ????
660 ! -----------------------
680 D8=0
700 OUTPUT D ;"SET READ REM"
720 OUTPUT D ;"BWRITE 53251"
740 OUTPUT D USING "#,B" ; 248
760 OUTPUT D ;"BREAD 53251"
780 ENTER D USING "#,B" ; D9,D9
800 IF D9#248 THEN S3=0 @ GOTO 9
    20
820 IF D8=1 THEN 880
840 D8=1
860 GOTO 720
880 S3=1
900 OUTPUT D ;"SET READ LOC"
920 ! -----------------------
940 !  GENERATE ADDRESS TABLES
960 ! CROSS CHANNEL:
980 ! addresses given for ch A
1000 ! reverse for ch B
1020 ! SINGLE CHANNEL:
1040 ! max span always A0(0)
1060 ! if zoom use A0(1)
1080 ! ------------------------
1100 A0(0)=38912 ! 50k range or
1120 !                or max span
1140 A0(1)=39776 ! all others
1160 ! -----------------------
1180 ! GENERATE DFT CORRCTNS-D0
```

```
1200 ! -----------------------
1220 DATA 0,0,0,0,0,0,0,0,0,0
1240 DATA 12,12,12,12,12,12,18,2
     4,24,24
1260 DATA 24,30,35,35,35,41,47,4
     7,53,59
1280 DATA 59,65,71,77,77,82,88,8
     8,100,100
1300 DATA 112,112,124,124,135,13
     5,147,147,159,159
1320 DATA 171,177,182,188,200,20
     6,212,224,224,235
1340 DATA 247,247,253,271,277,28
     2,294,306,312,323
1360 DATA 335,341,347,359,371,38
     2,394,400,412,423
1380 DATA 435,447,459,471,482,48
     8,500,512,523,535
1400 DATA 547,559,571,582,594,61
     2,623,635,653,665
1420 DATA 676,694,706,717,729,74
     7,759,776,794,806
1440 DATA 817,835,852,864,882,89
     4,911,929,941,964
1460 DATA 976,994,1011,1029,1041
     ,1064,1076,1094,1111,1129
1480 DATA 1146,1164,1188,1200,12
     23,1241,1258,1276,1300,1311
1500 DATA 1335,1353,1370,1388,14
     12,1429,1447,1470,1488,1511
1520 DATA 1535,1552,1570,1594,16
     11,1635,1658,1682,1699,1723
1540 DATA 1746,1770,1787,1811,18
     34,1858,1882,1905,1923,1946
1560 DATA 1970,1993,2017,2040,20
     64,2093,2117,2140,2164,2187
1580 DATA 2217,2240,2264,2287,23
     17,2340,2364,2387,2417,2440
1600 DATA 2464,2499,2523,2552,25
     76,2599,2628,2658,2687,2711
1620 DATA 2740
1640 RESTORE 1220
1660 FOR I=0 TO 200
1680 READ D0(I)
1700 NEXT I
1720 ! -----------------------
1740 ! READ STATE : F-S SENS A
1760 ! -----------------------
1780 OUTPUT D ;"READ STATE 25 26
     "
1800 ENTER D USING "#,B" ; D9,C0
     ,F0
1820 IF BIT(C0,7) THEN C0=C0-256
1840 F0=10*C0+F0
1860 ! -----------------------
1880 ! READ STATE : F-S SENS B
1900 ! -----------------------
1920 OUTPUT D ;"READ STATE 28 29
     "
1940 ENTER D USING "#,B" ; D9,C1
     ,F1
```

```
1960 IF BIT(C1,7) THEN C1=C1-256
1980 F1=10*C1+F1
2000 ! -------------------------
2020 ! READ SPAN SETTING
2040 ! -------------------------
2060 IF S3 THEN S2=21 ELSE S2=2
2080 OUTPUT D USING "K,K" ; "REA
     D STATE ",S2
2100 ENTER D USING "#,B,B" ; D9,
     S
2120 S=BINAND(S,15)
2140 ! -------------------------
2160 ! CHECK FOR # OF CHANNELS
2180 ! -------------------------
2200 OUTPUT D ;"READ STATE 12"
2220 ENTER D USING "#,B,B" ; D9,
     C
2240 C=BINAND(C,6)
2260 IF C=0 THEN C=1 @ GOTO 2360
2280 IF BIT(C,2) THEN F=F1 ELSE
     F=F0
2300 C=0
2320 ! -------------------------
2340 ! SELECT WHICH MEMORY
2360 ! -------------------------
2380 DISP USING "/,K" ; "SELECT
     A or B (A,B) for CROSS   S
     for span & M for max span"
2400 BEEP
2420 INPUT A$
2440 IF A$="A" OR A$="B" OR A$="
     S" OR A$="M" THEN 2560
2460 DISP "  TRY AGAIN!!"
2480 BEEP
2500 GOTO 2380
2520 ! -------------------------
2540 ! READ AVERAGER
2560 ! -------------------------
2580 IF C=1 AND (A$="S" OR A$="M
     ") THEN GOTO 2380
2600 IF C=0 AND (A$="A" OR A$="B
     ") THEN GOTO 2380
2620 A=A0(ABS(C-(S#0)-(A$="A")+(
     A$="M")*(C#0)+(A$="S")*(C=0
     )*(S#0)))
2640 IF C=0 THEN N=801 ELSE N=40
     1
2660 IF C=0 AND (S=7+S3 OR S=8 O
     R S=10+S3 OR S=13+S3) THEN
     N=401
2680 OUTPUT D USING "K,K,X,K" ;
     "BRE ",A,A+N
2700 ENTER D USING "#,B" ; D9
2720 TRANSFER D TO Z$ INTR ; COU
     NT N+1
2740 ENTER Z$ USING "#,#K" ; A1$
2760 BEEP
2780 ! -------------------------
2800 ! CALIBRATE FOR DISPLAY
2820 ! -------------------------
```

```
2840 IF A$="A" THEN F=F0
2860 IF A$="B" THEN F=F1
2880 FOR I=0 TO 38 STEP 2
2900 IF S=7+S3 OR S=10+S3 OR S=1
     3+S3 THEN K=ABS(100-I/2) EL
     SE K=ABS(200-I/(1+(C=0)))
2920 IF C=0 AND S=8 THEN K=ABS(1
     00-I/2)
2940 E=INT(NUM(A1$[I+2])/8)
2960 J=I/2
2980 E=E-1
3000 M=NUM(A1$[I+1])+BINAND(NUM(
     A1$[I+2]),7)*256
3020 IF BIT(M,10) THEN M=M-2048
3040 A1(J)=M*2^(-E)
3060 A1(J)=A1(J)/1024
3080 IF A1(J)=0 THEN A1(J)=-93.3
      ELSE A1(J)=10*LGT(A1(J))
3100 IF A1(J)>-90.3 THEN 3160
3120 A1(J)=A1(J)+F
3140 GOTO 3180
3160 A1(J)=A1(J)+F+D0(K)/1000*(S
     #0)*(1-(A$="M"))
3180 DISP USING "SDDD.D,X,DDD.D,
     X,DDD" ; A1(J),J,K
3200 NEXT I
3220 END
```

APPENDIX F

SUMMARY OF THE IEEE INSTRUCTIONS FOR THE WAVETEK 5830A SPECTRUM ANALYZER

NOTES:

1. A dash (-) indicates the end of the required portion of each command or argument.

2. If the optional part is transmitted, it must be exactly as shown in the Table.

3. ( ) denotes optional arguments or modifiers.

4. The fields of each instruction must be separated by one or more spaces.

5. Each complete instruction must be terminated with a CR/LF.

6. Must send "SET FRONT PANEL REMOTE" before most commands.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
AMPL-ITUDE	A-BSOLUTE R-ELATIVE			
AUTO-RANGE				Toggles Autorange function on and off.
BRE-AD	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. Always read an extra byte (first byte is always a space).
BWR-ITE	i_1	i_2		i_1 and i_2 are defined in BREAD; write in binary
CE-NTER AT CURSOR				
CO-MPARE		ON OFF		
CU-RSOR	XX...XXX U-P D-OWN	H-Z K-HZ m-HZ		
DI-SPLAY				Enter remote display mode. First send Set Readout Remote.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
DR-AW	X	Y		0 X 255; 0 Y 127. Draw line from current location to (X,Y). (remote display mode).
EDI-T	ON OFF			
EQU-ALIZE	ON OFF			
F-REQUENCY	A-BSOLUTE R-ELATIVE O-RDERS H-Z C-PM			
IN-PUT	FIR-ST DERIVATIVE INT-EGRAL SEC-OND DERIVATIVE DOU-BLE INTEGRAL MUL-TIPLY BY -1	A B	ON OFF	
LINE1 LINE2 LINE3 LINE4				Overwrite the corresponding readout line with ASCII string that follows.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
MO-VE	X	Y		0 X 255, 0 Y 127. Move to location (X,Y). (remote display mode).
NVR-EAD	X1	X2		X1, X2 decimal integers. 0 X1 X2 2047 Read from nonvolatile memory in binary form.
NVW-RITE	X1	X2		Same with NVREAD but writing instead of reading
O-PEN LOOP HIGH				Compute Open Loop, using high accuracy method.
PL-OT				Start the activated plotter.
PR-OCESS				Perform one FFT and averaging. Used with DATA REMOTE Command.
READ	I-NPUT	A B F-OREGROUND M-AX SPAN		Real part, Imaginary part (+XXXXX) 32767 XXXXX -32768 512 or 1024 points.
	CR-OSS			Real part, Imaginary part (+X.XXE+XX). 201 complex points. Uncalibrated.
	PH-ASE	A B F-OREGROUND		Get cursor readout (no frequency information) by sweeping the cursor across the trace.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
READ	SP-ECTRUM	A B F-OREGROUND M-AX SPAN		
	COH-ERENCE PO-WER COHERENT			
	TR-ANSFER FUNCTION	MAGNITUDE P-HASE		
	CUR-SOR	T-OP B-OTTOM		Amplitude as on CRT, Frequency in scientific notation.
	SE-TUP			Text from VIEW SETUP as ASCII string (approx. 450 characters).
	ST-ATE	X1	X2	State consists of 70 bytes. Read byte i_1 through i_2 i_1,i_2:decimal integers.
	NY-QUIST RE-AL IMAGINARY COR-RELATION	A B C-ROSS		Read by sweeping cursor across the trace.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
READ	H-ISTOGRAM	A B		
	LAST			Read previous IEEE command. A "?" indicates possible error.
RECA-LL	SP-ECTRUM ST-ATE	X		Recall from Nonvolatile Memory. X is an integer between 1 and 5.
RECO-RDING STOP				
REL-EASE				Return to DATA LOCAL.
RESET				
RESU-ME				
REV1				Revision level of Main Z80 software.
REV2				Revision level of IEEE/TSG software.
REVS				Revision level of shared software.
SAM-PLING	I-NTERNAL EXTERNAL			
SAV-E	SP-ECTRUM ST-ATE	X		Transfer stored spectrum or current state to nonvolatile memory.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
SET	FR-ONT PANEL	R-EMOTE L-OCAL		
	SP-AN	XX U-P D-OWN		XX corresponds to any legal span setting (e.g. 50KHz,100Hz).
	CE-NTER FREQUENCY ST-ART FREQUENCY	X...X.X...X	HZ KHZ mHZ	
	SE-NSITIVITY	A B	U-P D-OWN (-) XX DB	
	CO-UPLING	A B	AC DC GND	
	I-MPROVED ACCURACY	ON OFF		
	A-MPLITUDE READOUT	SINE N-OISE P-OWER		

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
SET	CU-RSOR	M-AIN	ON	
		SIN-GLE	OFF	
		SID-EBANDS		
		H-ARMONICS		
	AV-ERAGER MODE	S-PECTRUM		
		T-IME		
		P-EAK		
	N-UMBER OF AVERAGES	N		
	ME-ASUREMENT	CR-OSS		
		SI-NGLE	A	
			B	
		CO-RRELATION		
		H-ISTOGRAM		
		SP-ECTRUM		
	WE-IGHTING	A-UTO		
		H-ANNING		
		U-NIFORM		
		F-ORCE		
	V-ERTICAL SCALE	XX DB		
		L-INEAR		

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
SET	H-ORIZONTAL SCALE	LINEAR		
		LO-G		
	SC-REEN	F-ULL		
		S-PLIT		
		W-ATERFALL		
		N-ORMAL		
	E-DGE			For force window.
	T-RIGGER	F-REE RUN		
		E-XTERNAL		
		A		
		B		
		TRACKING SIGNAL GENERATOR		
		IEEE		
	SI-GNAL GENERATOR	O-FF		
		N-OISE		
		PU-LSE		
		PE-RIODIC RANDOM NOISE		
		SI-NE		
		M-ULTI SINE		
		SW-EPT	SINE	
			M-ULTI	

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
SET	AT-TENUATOR	XX DB		TSG attenuator.
	REA-DOUT	R-EMOTE LO-CAL		
		S-AME		Same with display selected or independent.
		D-B LI-NEAR P-OWER		
	D-ATA REMOTE			
	REF-ERENCE	A B	X.XE+ XX	
	O-RDERS	XX.XX		
	Z-ERO FREQUENCY			
	AR-M	A-UTO S-INGLE		
	POS-ITION	ST-ART C-ENTER		
	POW-ERUP	X		Select Powerup State (0=Default).

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
SET	PL-OTTER	D-IGITAL A-NALOG S-TRIP CHART		Activate Plotter.
SIN-GLE	XX...X.XX	HZ K-HZ m-HZ		Position single cursor
	U-P D-OWN			
SP-ECTRUM	INT-ENSIFY AT CURSOR	ON OFF		
SRQ	A-UTORANGE CHA- OVLD CHB- OVLD E-ND OF AVERAGING R-ESET			Select condition for the generation of an IEEE Service Request.
STA-RT AVERAGER				
STOP-AVERAGER				
STO-RE				Transfer active spectra to storing memory (volatile).
TEST				Toggle test signal on and off.

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
TEXT				Enter text mode. Terminate with byte 3.
TRANSFER	DER-IVATIVE OF PHASE REC-IPROCAL O-PEN LOOP I-MPULSE	ON OFF		Transfer function modifiers.
VIEW	SI-NGLE D-UAL			Set single or dual trace viewing mode.
	(ST-ORED)	SP-ECTRUM	A B M-AX SPAN F-OREGROUND	
		PH-ASE TI-ME	A B	
	(ST-ORED)	TR-ANSFER FUNCTION	M-AGNITUDE P-HASE	
		COH-ERENCE PO-WER COHERENT NYQUIST RE-AL IMAGINARY		

COMMAND	ARGUMENT #1	ARGUMENT #2	ARGUMENT #3	COMMENTS
V-IEW		COR-RELATION	A B C-ROSS	
		H-ISTOGRAM	A B	
WRI-TE	A B S-INGLE			Real part, Imaginary part. Integers -32768 n 32767. Command SET DATA REMOTE must be given first. See Commands PROCESS and RELEASE.

APPENDIX G

THE 5830A STATE DESCRIPTOR (Section 4-7)

BYTE #	BIT	DESCRIPTION
0	0-2	Unused
	3	External CRT
	4	Remote Serial Data
	5-7	Unused
1	0-1	Unused
	2	Analog Plotter Speed (1=Fast,0=Slow)
	3	1=Default Power Up, 0=Stored Power Up.
	4-7	Unused
2	0-3	Unused
	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 A
	6	Digital Overflow
	7	Armed Light On
4	0	Spectrum Averaging
	1	Unused
	2	Max Frequency=50KHz
	3	Max Frequency=500Hz
	4	Stored Settings Menu
	5	Unused
	6	Autorange
	7	Unused

5	0	Resume Averager
	1	Unused
	2	Max Frequ = 100KHz
	3	Max Frequency = 5KHz
	4	Recording Menu
	5	IEEE Remote
	6	Test Signal On
	7	Tune About Center
6	0	Stop Averager
	1	RMS Amplitude Readout
	2	Nyquist Transfer Function
	3	Re-Im Transfer Function
	4	TSG Menu
	5	Unused
	6	Resume Plotter
	7	Unused
7	0	Start Averager
	1	Power Spectral Density
	2	View Transfer Function Magnitude
	3	View Transfer Function Phase
	4	Transient Mode Menu
	5	External Sampling
	6	Stop Plotter
	7	Tune About Start
8	0	Harmonic Cursor
	1	Total Power
	2	View Coherence
	3	View Coherent Output Power
	4	Display Modifiers Menu
	5	Single Arming
	6	Start Plotter
	7	Unused
9	0	Sidebands
	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	Single Cursor
	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	Power Spectrum Mode
	4	Correlation Mode
	5	Histogram Mode
	6	Phase Derivative
	7	Edit Transfer Function
13	0	Reciprocal of Transfer Function
	1	Equalize
	2	Compare
	3	Transfer Function to Impulse Response
	4	Closed to Open Loop
	5	1= Full Screen, 0= Split Screen
	6-7	Code for Weighting Function 0: Auto 1: Hanning 2: Rectangular 3: Undefined
14	0	1st Derivative Ch A
	1	1st Derivative Ch B
	2	2nd Derivative Ch A
	3	2nd Derivative Ch B
	4	Integral Ch A
	5	Integral Ch B
	6	Double Integral Ch A
	7	Double Integral Ch B

15	0	Multiply Ch A by -1
	1	Multiply CH B by -1
	2-5	Code for Vertical Display 0: 80 dB 1: Undefined 2: 40 dB 3: 20 dB 4-7: Undefined 8-15: Linear
	6	Log Frequency Axis
	7	No Display Modifiers
16	0	Amplitude relative
	1	Frequency Relative
	2	Force Window
	3	Waterfall Display
	4	Intensify at Cursor
	5-7	Unused
17	0-1	Code for Frequency Units 0: Hz 1: Reserved 2: Orders 3: Undefined
	2-7	Unused
18	0-2	Code for TSG Mode 0: Off 1: Noise 2: Sine at Cursor 3: Single Sine Sweep 4: Multi-sine Sweep 5: Pulse 6: Periodic Random Noise 7: Multi-sine at Cursor
	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: Strip Chart Recorder 4-7:Undefined
	6-7	Unused
20	0 1-7	Pending SRQ Unused
21	0-7	Frequency span (0:100KHz,...,14:2Hz)
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 E.U.A. stored (3) E.U.B. stored (3)

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

<u>Format:</u>

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.

<u>Addresses:</u>

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
Max	38912	39776	39314	40178	38912
not Max	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
Max	51712	42204	52114	42606	51712
not Max	42204	51712	52114	42606	Max Span:42204
					Foreground:51712

Note : In 50KHz, -Im GAB is stored.
Max = 50KHz for Cross Channel
=100KHz for Single Channel

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: 0 R/I
1 I/R
Bit 12: Sign of R
Bit 13: Sign of I
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 (3 LSBs)

Starting Addresses:

Single Trace: 53248

Dual Trace:

Top (Front) Trace: 54272
Bottom (Back) Trace: 53248

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
○ :	31
β :	33
√ :	34
± :	35

The MSB is on if the character is displayed in reverse video form.

The Status Line contains 64 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 51392

H-5 TIME AVERAGER BUFFER

Format: same as H-1
Addresses: Real 45056
Imaginary 47104

H-6 CORRELATION AVERAGER BUFFERS

Format: Same as H-1

Addresses:

	GAA	GBB	GAB
Single Channel A	39014	-	-
Single Channel B	-	39014	-
Cross Channel	39116	39014	38912

Note: The mean has not been removed at this point.

For stored functions, add 12800 to the above addresses.

H-7 HISTOGRAM AVERAGER BUFFERS

Format: Same as H-1

Addresses:

	Histogram A	Histogram B
Single Channel A	38912	-
Single Channel B	-	38912
Cross Channel 50KHz	38912	39168
Cross Channel,not 50KHz	39168	38912

For stored functions, add 12800 to the above addresses.

H-8 DIGITAL FILTER CORRECTION TABLES

The following tables are correction tables for the 5830 power spectra. Each table represents 1/2 of a symmetric table. Point #0 corresponds to the center of the span. The units of the tables are dB. The corrections are needed to equalize the digital filter used in the zoom.

1. Cross Channel Mode:

Span	Action
50KHz	No correction required.
25KHz	Use DFTABLE1, even numbered points only.
2Hz,20Hz,200Hz	Use DFTABLE0, points 0 to 100.
Other spans	Use DFTABLE0, even numbered points.

2. Single Channel Mode:

Span	Action
100KHz	No correction required.
50KHz	Use DFTABLE1, every point.
200Hz	Use DFTABLE0, points 0 to 100.
Other spans	Use DFTABLE0, every point.

H-9 ANALOG FILTER CORRECTION TABLES

On power-up and at fixed intervals thereafter, the 5830 goes through an Autocalibration procedure during which the instrument computes and stores the magnitude and phase differences between the input analog filters. The differences are stored and used by the 5830 to correct for all cross measurements. The tables are at:

Active functions:	
Magnitude	44836
Phase	44863
Stored functions:	
Magnitude	44915
Phase	44942

The tables are stored in differential format and the first entry provides the base value. Each table entry corresponds to a frequency and a step in the table corresponds to a frequency step equal to 1/50th of the maximum frequency. Intermediate frequency points can be obtained by linear interpolation. The format of the tables is the following:

<u>Magnitude</u>: log base 2 (Transfer Function Error) is stored.

First Point: 2 bytes; 2nd byte= Integer part,
1st byte= Fractional part.

Rest of the table: stored as nibbles in 2's complement format, multiplied by 16. The nibble corresponding to the LSBs is the correction for the lower frequency.

<u>Phase</u>: tangent of the phase between the channels is stored.

First Point: 2 bytes= 1024*tangent

Rest of the table: 1 byte/point, stored in 2's complement form, 1024*difference.

DFTABLEO

(Units=dB)

Pt.#										
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
20	0.02	0.02	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.06
30	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09
40	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15
50	0.16	0.16	0.18	0.18	0.19	0.20	0.20	0.21	0.21	0.22
60	0.24	0.24	0.25	0.26	0.26	0.27	0.28	0.29	0.29	0.31
70	0.32	0.33	0.33	0.34	0.35	0.36	0.38	0.38	0.39	0.40
80	0.41	0.42	0.44	0.45	0.46	0.46	0.47	0.48	0.49	0.51
90	0.52	0.53	0.54	0.55	0.56	0.58	0.59	0.60	0.62	0.63
100	0.65	0.66	0.67	0.68	0.69	0.71	0.72	0.74	0.75	0.76
110	0.78	0.79	0.81	0.82	0.83	0.85	0.87	0.88	0.89	0.92
120	0.93	0.94	0.96	0.98	0.99	1.01	1.02	1.03	1.06	1.07
130	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.21	1.23	1.25
140	1.27	1.28	1.31	1.32	1.34	1.35	1.38	1.40	1.41	1.43
150	1.46	1.47	1.49	1.52	1.53	1.55	1.58	1.60	1.61	1.63
160	1.66	1.68	1.69	1.72	1.74	1.76	1.79	1.81	1.82	1.85
170	1.87	1.89	1.92	1.94	1.96	1.99	2.01	2.03	2.06	2.08
180	2.10	2.13	2.15	2.18	2.20	2.22	2.25	2.27	2.29	2.32
190	2.34	2.38	2.40	2.42	2.45	2.47	2.49	2.53	2.55	2.58
200	2.60									

DFTABLE1

(Units=dB)

Pt.#										
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
20	0.02	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06
30	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.11	0.11
40	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16
50	0.18	0.19	0.19	0.20	0.21	0.21	0.22	0.24	0.24	0.25
60	0.26	0.26	0.27	0.28	0.29	0.29	0.31	0.32	0.33	0.34
70	0.35	0.35	0.36	0.38	0.39	0.40	0.41	0.42	0.44	0.45
80	0.46	0.47	0.48	0.49	0.51	0.52	0.53	0.54	0.55	0.56
90	0.58	0.59	0.60	0.61	0.62	0.65	0.66	0.67	0.68	0.69
100	0.71	0.73	0.74	0.75	0.76	0.79	0.80	0.81	0.83	0.85
110	0.86	0.88	0.89	0.91	0.93	0.94	0.95	0.98	0.99	1.01
120	1.02	1.05	1.06	1.08	1.09	1.12	1.13	1.15	1.16	1.19
130	1.20	1.22	1.25	1.26	1.28	1.31	1.32	1.34	1.36	1.38
140	1.40	1.42	1.43	1.46	1.48	1.51	1.52	1.54	1.56	1.59
150	1.61	1.63	1.65	1.67	1.69	1.72	1.74	1.76	1.79	1.81
160	1.83	1.86	1.88	1.90	1.93	1.95	1.98	2.00	2.02	2.05
170	2.07	2.09	2.12	2.14	2.16	2.20	2.22	2.25	2.27	2.29
180	2.33	2.35	2.38	2.40	2.43	2.46	2.48	2.50	2.54	2.56
190	2.59	2.62	2.65	2.68	2.70	2.73	2.76	2.79	2.82	2.85
200	2.88									

APPENDIX I

ORGANIZATION OF THE NONVOLATILE MEMORY

Byte	Contents
0-324	Five stored states.
325-2029	Stored functions (spectrum,correlation,histogram)
2030-2045	Reserved
2046	Powerup State (255 for default)
2047	Memory Checksum

For each state

Byte	Contents
0-22	Bytes 4-26 of State from Appendix G.
23-24	Bytes 28-29 from Appendix G.
25-26	Two byte buffer specifying the function viewed.
7-46	Byte 43-62 from Appendix G.
47-51	Frequency Engineering units. If orders was selected, this is the first order in Hz, otherwise it is the reference frequency in Hz. Format: Bits 0-6 Exponent, base 2, excess 64. Bit 7: Sign (1=Negative) Bits (8-31): Mantissa
52-53	Cursor value as display element number.
54-57	Single cursor, units of beta. First three bytes integer part, last byte fractional.

58-61	Sideband spacing, same format as single cursor.
62-63	Pointer to trace buffer (bytes 25-26). The LSB indicates which of the two traces is the top (front) trace.
64	State checksum

For the saved function

Byte	Contents
0-803	Buffer A (see Note)
804-1067	Buffer B (see Note)
1068-1634	Analog filter correction (magnitude)
1635-1686	Analog filter correction (phase) (see Appendix H)
1687-1698	Bytes 31-42 from corresponding state (see Appendix G)
1699-1701	Engineering Units for Channel A (same with bytes 43-45, Appendix G)
1702-1704	Engineering Units for Channel B (same with bytes 53-55, Appendix G)

Note: Buffer A starts at 51712
Buffer B starts at 44205

For the contents, see Appendix H.

Checksums are computed such that the corresponding data adds up to 58H.

WAVETEK

ADDENDUM

MODIFICATION 144

REAR PANEL INPUT - 58XX ANALYZERS

GENERAL DESCRIPTION

The modification 144 provides rear panel BNC inputs for both channels of either Model 5820A/5830A Spectrum Analyzer. The standard front panel BNC input connectors are deleted.

MODEL NUMBER AFFECTED: 5820/5830

SERIAL NUMBER AFFECTED: ALL

SPECIFICATION CHANGES:

1. Slight degradation of the broadband noise and spurious response specifications.
2. All other specifications are identical to standard model.

HARDWARE CHANGES:

Rear panel spare BNC #3 is now labelled Channel A and Spare BNC #4 is labelled Channel B.

Date Initiated: Sept 27, 1983

ADDENDUM TO THE 5820A/5830A OPERATING MANUAL

INTERFACING THE RAYTHEON 1807M TO THE WAVETEK 5820A/5830A

1-1. General

The Raytheon Model 1807M Line Scan Recorder can be driven directly from the Model 5820A/5830A Analog Plotter Outputs. An interconnecting cable is available as P/N 009-9618 or the user may prepare his own cable.

The normal 5820A/5830A X-Y recorder mode is too slow for correct utilization of the 1807M, and the sweep does not automatically repeat as required. To solve these problems, a special line scan recorder mode has been provided. This mode is selected on the 5820A/5830A by setting the rear panel AUXILIARY FUNCTION SWITCH F8 to the ON position.

This line scan recorder capability is available for all 5820A units with software revision JLF or higher, and for all 5830A units with software revision GHD or higher. Contact the factory if you wish to verify or upgrade your software revision level.

2-1. Interconnecting Cable

The two signals required from the 5820A/5830A are the Analog Plotter Y and PEN LIFT signals found on the rear panel. The Plotter Y output is used as the PRINT SIGNAL input to the 1807M. The PEN LIFT is used as the EXT SYNC input to the 1807M. Signals are connected to the 1807M via the 37 pin connector plug, P2.

Because the PEN LIFT signal from the 5820A/5830A is an open collector output, and because the 1807M requires positive current flowing into the EXT SYNC input, one of the unused 1807M input signals with internal pullup resistors was used. The line chosen was EXT PAPER SPEED CLOCK INPUT. The interconnection schematic is shown in Figure 1. (Dwg. 03-009-9618)

The assembly drawing for the required cable is shown in Figure 2. (Dwg. 02-009-9618) The connectors required are two BNC male connectors (Type UG-88/U) plus one Cinch DCM-37S plug and one Cinch DC-24660 hood.

3-1. Operating Instructions

1. Setting Up the Raytheon Model 1807M.

Set the 1807M to the initial configuration shown below:

DISPLAY SECTION:	Display Mode:	Normal
	Markers:	OFF
SYNC SECTION:	Sync Select:	EXT
	Delay Function:	IN
	Delay	0.036 sec
	Trigger Level:	5
STYLUS SECTION:	Scan Speed:	1/4 sec/scan
PAPER SECTION:	Paper Speed:	100 lines/inch
MEMORY SECTION:	Sweep Speed:	00.88 sec/scan
	Direction:	L/R
SIGNAL SECTION:	Gain:	10
	Contrast:	-40
	Threshold:	0
	Filter:	OUT
	FW:	+
	Mode:	NORMAL

2. Setting Up the Model 5820A/5830A

A) Make sure the Auxiliary Function Switch F8 on the rear panel is set to the ON position.

B) Setup the 5820A/5830A to display the desired function to be recorded. It is recommended that a single function be displayed on the screen rather than a dual display. If a dual display is required on the CRT, the top or foreground trace only will be plotted; the other trace will appear greatly disturbed on the screen.

Note: The recommended settings for the 1807M given above are for a 200 point frequency axis trace. If a time trace or a 400 point frequency axis trace is required, the 1807M controls will have to be readjusted for longer scan times and different sync delays.

C) Press the RECORDING button in the SETUP section to enter the recording setup menu. Move the cursor to X-Y Recorder mode and press the ENTER button. Press the RECORDING button again to leave the recorder setup menu.

D) In the RECORDING section of the front panel, the STOP button will now be lit.

4-1. Starting the Operation

1. Turn ON the power switch of the 1807M. The stylus should begin sweeping, but the paper should not be advancing due to the lack of an EXT SYNC pulse from the 5820A/5830A.

2. On the 5820A/5830A, press the START button in the RECORDING section.

3. The 5820A/5830A display will show a small cursor sweeping from left to right, repetitively, approximately once every 0.9 sec.

4. The 1807M should begin recording the display image; paper movement should begin now that the 5820A/5830A is supplying the EXT SYNC signal via the PEN LIFT output.

5-1. Adjusting the Recorder Plot

1. The 1807M SYNC DELAY can be adjusted to position the recording left or right.

2. The 1807M MEMORY SWEEP time can be adjusted to expand or compress the recording.

3. Refer to the Operating Instructions section of the 1807M manual for more details.

DISPLAY REMOVAL PROCEDURE

5820A/5830A

1. Remove the 5820 or 5830 from it's case by removing the four inner screws from the rear panel. Gently push the rear panel forward and the unit will come out of the case.

2. Turn the unit upside down. Remove the bottom perforated cover, by removing the five screws on the side of the unit.

3. Remove the display board (004-6170) from the unit.

4. Locate the screw which holds the front panel to the deck. Looking at the inside of the front panel you will see a plastic spacer 1/2 inch long, between the middle front panel board and deck. Remove this screw while holding the spacer, so you don't lose it.

5. Remove two screws which hold the display unit to the deck. These screws are located on the deck next to the rear panel.

6. Now turn the unit to normal operation position. Find the vertical display to deck brace on both sides of the display unit. Remove the two screws from each side of the unit.

7. Disconnect the multicolored ribbon cable from top of the display unit.

8. Disconnect the three co-ax cables from the rear of the display unit, also unscrew the cable tie.

9. Remove all eight screws from the left side panel and the three rear panel screws which hold the side panel to the rear panel. Remove the side panel and slide the front and rear panel out about one inch.

10. Lift the display unit up a few inches and look underneath. You will see a large gauge gray cable which is plugged into the left side of the display unit. Disconnect this cable and remove the display unit the rest of the way. The cable is not keyed and can be plugged in either way.

    Reverse steps to install new display unit.

March 1983