Errata

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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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SECTION III PART I
MANUAL OPERATION

3-1. INTRODUCTION.

3-2. This section contains the complete operating instructions as they relate to manual operation. Remote operating instructions, such as those from the HP-IB, are contained in Section III, Part II. Included in this section are the turn-on procedure, a description of the 3582A, a familiarization exercise, and specific operating data.

3-3. CONTROLS, CONNECTORS, AND INDICATORS.

3-4. On the foldout at the end of Section III is an illustration of all front and rear panel controls, connectors and indicators. The description of each item is keyed to the drawing within the figure.

NOTE

To permit maximum CRT life, always turn the instrument power LINE switch or the intensity control to OFF when the instrument is not in use for extended periods.

3-5. TURN-ON PROCEDURE.

3-6. If you have never used the 3582A, you are probably anxious to get started. Notice that the 3582A front panel switches are arranged in functional groups. The pushbuttons in each group are either momentary contact or push to turn on and push to turn off. Framed functions in some groups may be placed in the ON position to establish a basic turn-on mode of operation. If an apparent operating difficulty arises due to the inadvertant setting of switches or power line fluctuations, resetting the instrument to the basic turn-on mode and pressing the RESET button (colored orange) will often solve the problem (see the instrument pullout card). Preset the front panel switches for turn-on as follows:

Button Positions: ON OFF

Set both framed buttons	ON
Set AMPLITUDE A	ON
Set SCALE 10 dB/DIV	ON
Set AVERAGE NUMBER 4	ON
Set PASSBAND SHAPE	FLAT TOP
Set all other buttons	OFF
AMPLITUDE REFERENCE LEVEL	NORM
FREQUENCY MODE	0-25 kHz
TRIGGER LEVEL	FREE RUN
INPUT CHANNEL A SENSITIVITY	30 dBV
VERNIER	CAL
INPUT CHANNEL B SENSITIVITY	30 dBV
VERNIER	CAL
INPUT MODE	A

3-7. Connect the 3582A to a suitable power source (see Section II, Installation). Set the LINE switch to the ON position. While the instrument is warming up (allow 1 or 2 minutes),read the following information about spectrum analyzers and the description of the 3582A.

3-8. ABOUT SPECTRUM ANALYZERS.

3-9. The first spectrum analyzers were introduced during World War II for use in the development of pulse radar systems. Early spectrum analyzers were difficult to operate and interpret since they lacked such refinements as calibrated controls. They were, however, adequate tools which enabled scientists to observe the spectra of radar pulses and subsequently optimize the gain and bandwidth of radar receivers. Since that time, spectrum analyzers have evolved into general purpose instruments with unlimited applications. The 3582A is a low frequency spectrum analyzer designed for use below 25 kHz.

3-10. A COMPARISON.

3-11. Most low frequency spectrum analyzers use analog circuits to sweep the frequency band of interest and display the spectral components. This may require complex analog circuits with many associated adjustments to assure good signal analysis. Also, High Q circuits required for narrow bandwidths have long settling times resulting in slow operation.

3-12. In contrast, the 3582A converts the analog input signal into discrete digital data through a sampling process. This data is then processed by a unique "digital filter" to obtain the frequency band of interest before it is stored in memory for analysis. A "computer-like" processor performs a Discrete Fast Fourier Transform and other mathematical operations on the stored data allowing the 3582A to display a great variety of information in a timely manner. For example, the 3582A will provide spectral data at greater than 100 times the speed of the -hp- 3580A Spectrum Analyzer (using conventional swept L.O. techniques) for narrow bandwidths.

3-13. FEATURES.

3-14. The 3582A, because of its digital design, offers many operating features not found in "conventional" spectrum analyzers. Some of the more prominent features are listed in Operating Features on the following page.

3-15. THE DISPLAY.

3-16. The display on the 3582A contains both alphanumeric and graphical data. The graphical display of spectra is discrete in nature and is presented as a series of line segments connecting discrete data points.

3-17. There are many problems associated with changing continuous waveforms into discrete data. Sampling processes and finite measurement times generate some extraneous information which effect frequency analysis operations and may appear as undesirable display data. These display aberrations become more pronounced when a narrow passband is used and the frequency is shifted slightly. The effects of discrete measurements are explained in more detail in Simplification of Discrete Data Analysis.

OPERATING FEATURES

Frequency Range:
.02 Hz to 25 khz
Amplitude Range:
3 mV to 30 V maximum input
Display Range:
80 dB (dynamic range > 70 dB)
Display:
Two channel input and capability of displaying or storing two traces simultaneously. The traces may contain the following information.

1. Phase: either or both channels
2. Amplitude: either or both channels
3. Phase Transfer Function
4. Amplitude Transfer Function
5. Coherence
6. Time Function: either channel can be displayed but not stored

Zoom:
Zoom can expand any portion of the display to a maximum of .5 Hz/cm
Marker:
Manually moveable marker can be used for determining frequency, amplitude, and phase on any point of the selected spectrum. The marker is not usable on stored traces.
Averaging:
RMS and Time averaging functions and selectable averaging cycles. Also there is a Peak hold mode.
Noise Source:
Amplitude adjustable (periodic or random)

NOTE

Random noise source is not available on instruments with serial numbers prefixed 1747A.

Noise Measurement:
Volts/$\sqrt{Hz}$ can be measured directly
Filter Shapes:
Three selectable filter (PASSBAND) shapes:

1. Flat Topped: Best for measuring accurate amplitude of discrete spectra.
2. Hanning: More selective than Flat Topped filter (narrower 3 dB passband) but less accurate. Better for frequency measurements where spectral amplitudes are relatively equal (within 50 dB).
3. Uniform: Useful for analyzing transients. Also the 3582A's Periodic Noise Source is optimized for this filter to improve analysis.

Filter Bandwidth:
Automatically selected
HP-IB:
The Hewlett-Packard Interface Bus permits interconnection to a controller (such as the -hp- 9825A Calculator) and affords programmability plus data transfer capabilities.

3-18. The discrete display may appear somewhat different from conventional spectrum analyzers, however, the locus of all points represented by the graphical display will be accurate within the specifications for the mode of operation selected.

3-19. FAMILIARIZATION EXERCISE.

3-20. Introduction.

3-21. The familiarization exercise is intended to give the user a general introduction to the instrument controls and their functions. The exercise will begin with simplified displays of data and proceed to the more complex modes of operation and data display. To help facilitate making sample measurements, a 10 kΩ resistor, a 3000 pF capacitor, and a function generator will be required (suggestion: a Hewlett-Packard 3312A Function Generator will provide all the necessary output signals). To avoid confusion, follow the procedures and switch settings in the order given.

3-22. Adjusting the Display.

3-23. The 3582A should already be set up in the basic turn-on mode as indicated in the Turn-On Procedure. Press the SCALE 2 dB/DIV button and set CHANNEL A and B SENSITIVITY to CAL. Adjust the INTENSITY and FOCUS to obtain a well defined trace. An ASTIG (astigmatism) control is provided, but adjustment is only necessary if the FOCUS control cannot produce a clear display. The trace being displayed is the channel A calibration signal.

3-24. The CAL Signal.

3-25. An internal calibration signal is provided to check instrument operation and is switched into the input circuits whenever the CHANNEL A or CHANNEL B SENSITIVITY control is placed in the CAL position. A display of spectral lines, which have an amplitude of 22 dBm (or 20 V in LINEAR mode) and are 1 kHz apart, serve as a quick reference for verifying the amplitude and frequency calibration of the instrument (see Figure 3-1). These non-equivalent levels result in displays of exactly half full scale for LINEAR and 2 dB/DIV display settings. To display the channel B CAL signal, make the following switch changes:

DISPLAY AMPLITUDE A.............................OFF
DISPLAY AMPLITUDE B.............................ON

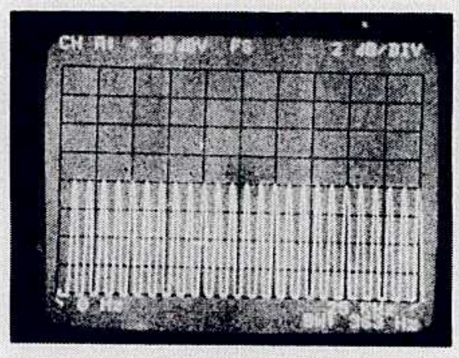


Figure 3-1. The Channel A CAL Signal.

3-26. Notice that the display message indicates that an invalid condition exists. This is one of several messages that help to insure proper instrument operation. To continue though, place the INPUT MODE switch to the B position to obtain the correct display.

3-27. The Input Mode Switch.

3-28. The INPUT MODE switch position establishes one or two channel operation. Because the display and analysis techniques are discrete and the amount of memory space limited, the number of displayed data points are divided in half for two channel operation. As a result of this division, the instrument doubles the bandwidth even though the SPAN setting remains the same. To observe this condition on the display, slowly alternate the INPUT MODE switch between B and BOTH. Reset the following switches:

DISPLAY AMPLITUDE B.............................OFF
DISPLAY AMPLITUDE A.............................ON
INPUT MODE...A

3-29. Input Considerations.

3-30. Voltage Limitations. Before connecting any device to the input terminals, be aware of the maximum voltages which are marked on the Front Panel and listed as follows:

MAXIMUM INPUT VOLTAGE.........100 V rms or ± 100 Vdc
MAXIMUM ISOLATION VOLTAGE..............30 V MAX

3-31. AC-DC Coupling. A front panel slide switch selects ac or dc coupling. AC coupling is useful for analyzing signals which have a high dc offset. Note that the absolute value of the dc offset plus the absolute value of the peak voltage of the signal must be less than 100 V dc. This capacitive type of coupling acts like a high pass filter which has a − 3 dB point at .5 Hz. DC coupling has the widest area of applications and the 0 Hz frequency spectral component is presented on the display when the range of frequencies selected include 0 Hz but do not use the dc component to measure dc as some inaccuracies may result. Set the following switches:

A COUPLING....................................⎓(dc)
B COUPLING....................................⎓(dc)

3-32. Input Isolation. The input section of the 3582A can be isolated to permit measurements where ground loops may be present. When the ISOL-CHAS switch is in the CHAS position, the lower (black)-input terminal is connected to the chassis which in turn is connected to the power system ground through the offset pin on the power plug. It is not advisable to isolate the chassis through a power plug adapter which would, in effect, render the instrument in an unsafe condition. When the ISOL-CHAS switch is set to ISOL, it disconnects the input low from chassis ground; the maximum isolation voltage must not be greater than 30 V max above the chassis potential (0 V). Set the following switch:

ISOL-CHAS .... CHAS

3-33. Balance Adjustments. Balance adjustments (BAL) are provided for each channel and may be used to change the dc offset voltage output of the input amplifiers. Under normal operating conditions, no change in the BAL setting is required. However, the BAL adjustment may be made for each setting of the INPUT SENSITIVITY switches. Specific instructions for setting the BAL adjustment are given under Front Panel Screwdriver Adjustment.

NOTE

The dc balance, if it is far out of adjustment, may cause a premature overload condition.

3-34. Analyzing an Input Signal.

3-35. Connecting the Input. Set the controls on the function generator for a 1 kHz square wave output. Connect this output to the channel A input of the 3582A (a shielded cable with suitable connectors is recommended, but not mandatory). Make the following switch changes:

CHANNEL A SENSITIVITY .... 30 dBV
DISPLAY SCALE .... 10 dB/DIV

3-36. Setting the Input Sensitivity. Adjust CHANNEL A SENSITIVITY to achieve an approximately full scale display without overloading the input. The input amplitude will be referenced to a calibrated full scale amplitude on the display (see Figure 3-2). Each INPUT SENSITIVITY switch has a concentric control which is an 11 dB attenuator. This may be used to decrease the signal amplitude between INPUT SENSITIVITY ranges, however, the displayed amplitude will not be referenced to a calibrated full scale amplitude. It is always a good operating procedure to set the INPUT SENSITIVITY switch to its least sensitive position and then increase the sensitivity to obtain an adequate display amplitude. The OVERLOAD light will indicate if the input magnitude is too large. An indication on the alphanumeric portion of the display will appear if an overload condition occurs during the period when data is being taken. (There could be a possible overload in the data.)

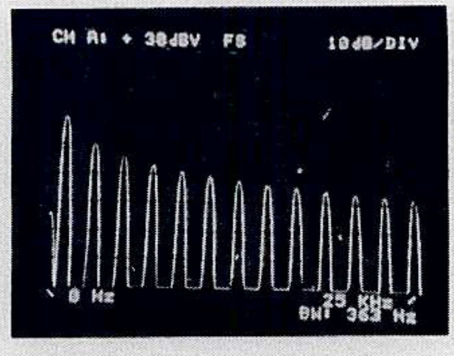


Figure 3-2. Spectrum of a 1 kHz Square Wave.

3-37. The Triggering Controls. The triggering controls determine when the input signal will start to be sampled for analysis. The input trigger is derived from one of the following sources:

a. A signal level on channel A input.

b. An external TTL level input on the rear panel.

3-38. When data is being taken, the DATA LOADING annunciator will be on. The LEVEL control in combination with the SLOPE switch determine the portion of the wave shape which will initiate a trigger. When the LEVEL control is in the FREE RUN position, data will be taken as fast as it can be processed. The REPETITIVE switch, when placed in the off position, places the instrument in a single scan mode of operation. In this mode a trigger can be generated as described above, but only after the trigger circuits are enabled by an arm command generated by pressing the ARM button. An annunciator light, located adjacent to the ARM button, indicates when an arm command has been initiated. Try the following procedure:

a. Move the LEVEL control out of FREE RUN to the approximate center position. A trigger initiated by the input signal will continue the scan operation.

b. Set REPETITIVE to OFF for single scan operation.

c. To initiate a scan, press the ARM button. A single scan will take place almost immediately.

d. Make the following switch changes:

LEVEL .... FREE RUN
REPETITIVE .... ON

NOTE

The FREE RUN position is framed to draw attention to it. If the TRIGGER LEVEL is inadvertantly left on and an appropriate input signal is not available, the instrument will stop taking data and appear to be "hung up".

3-39. Marker Controls. The 3582A has a unique movable marker which is set by the POSITION control. The marker frequency is displayed in addition to three amplitude functions:

a. Normal marker amplitude.

b. Amplitude of noise in the equivalent noise bandwidth ($\div\sqrt{BW}$).

c. Relative amplitude (the frequency is also relative (REL).

3-40. Normal Marker Amplitude. Set the MARKER ON switch to ON. A bright dot will appear on the trace. Rotate the POSITION control to place the marker at a point of interest. In Figure 3-3 the marker has been set on the 1 kHz spectral line.

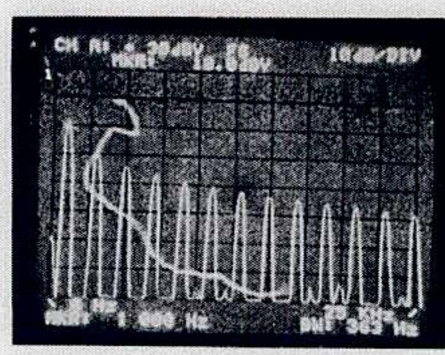


Figure 3-3. Setting the Marker Position.

3-41. Equivalent Noise Bandwidth. The $\sqrt{BW}$ button is used for making measurements of random noise. Normally the noise level measured at any point with the analyzer is a function of the filter bandwidth and the actual noise density. Since different filter bandwidths will give different answers, the comparison of results is difficult. In order to eliminate this problem, it is customary to normalize out the bandwidth factor by dividing the reading by the square root of the "equivalent noise bandwidth". This is the width of an ideal rectangular filter with the same power response as the actual filter used. The $\sqrt{BW}$ function performs this normalization automatically and presents the results directly in dBV/$\sqrt{Hz}$ or voltage /$\sqrt{Hz}$. To observe this function set the $\sqrt{BW}$ button to ON; when finished, set the button to OFF.

3-42. Relative Amplitude. The SET REF button enters a reference amplitude and frequency into memory of comparison to the present marker reading (see Note). This reference remains in memory until the SET REF button is pressed again establishing a new reference. Press the SET REF button.

NOTE

The relative marker reading is the ratio of the present amplitude reading to the previous amplitude reading. Units for the various marker functions will be displayed accordingly. In the relative mode, an error will result if the SCALE is changed between LINEAR and LOG.

3-43. To read a relative amplitude and frequency, set the REL button to the ON position. The display will now present the relative frequency and amplitude of the present marker position. Move the MARKER POSITION to observe a new relative reading. Set the REL button to OFF.

3-44. Switching the Marker to a Different Trace. When two traces are being displayed, the TRACE button causes the marker to be moved from one trace to another. Note that if the REL button is on, relative comparisons between the two traces can be made. Dual trace operation and examples of marker functions will be given later.

3-45. Setting a Frequency Reference for Band Analysis Modes. Move the marker to the 1 kHz spectral line as in Figure 3-3. Press SET FREQ to load the marker frequency, as a reference, into memory for a new start or center frequency in the band analysis modes.

3-46. The Frequency Span Controls.

3-47. The Mode Switch. The Mode switch can select one of four different types of frequency displays. Two of the types of displays will be referred to as the base band mode because the frequencies displayed begin at 0 Hz and end at some upper frequency. The 0-25 kHz position permits an overall view of the frequency spectrum and provides a quick reference to return to if a spectral line is lost while searching at narrow bandwidths in other modes. The 0 START position provides for high resolution near the 0 Hz frequency point using the span selector to set the upper frequency limit.

3-48. The other two types of displays will be referred to as the band analysis modes because a segment or band of frequencies within the 0–25 kHz range may be observed. Switching to either SET START or SET CENTER, allows for the use of a variable frequency control which tunes the digital local oscillator. Rotating the control changes the starting frequency or the center frequency so that spectral lines may be placed at any horizontal position on the display. START or CENTER frequency may also be selected using the MARKER SET FREQ button. Set the following switch:

MODE. . . . . SET CENTER

3-49. The 1 kHz spectral line should now be in the center of the display. Rotate the ADJUST control to see how the center frequency is changed. For more detailed analysis, the SPAN may be reduced thereby expanding (or zooming in) on the frequencies of interest.

3-50. The SPAN Control. The SPAN switch controls the displayed span. The bandwidth is adjusted automatically and is also dependent upon the position of the DISPLAY MODE switch. The narrowest bandwidths are available in the 0 START mode and single channel mode for any PASSBAND SHAPE selected. When using SET START or SET CENTER, all span settings are available for use except the two narrowest spans (1 Hz and 2.5 Hz). Set the following switch:

SPAN	250 Hz

3-51. In the example presented by Figure 3-4, reducing the span permitted two sidebands to be resolved which were formerly included in the wider 25 kHz span. The use of the MARKER controls showed that the sidebands were 40 Hz away from the center frequency with a relative amplitude of −20.0 dB.

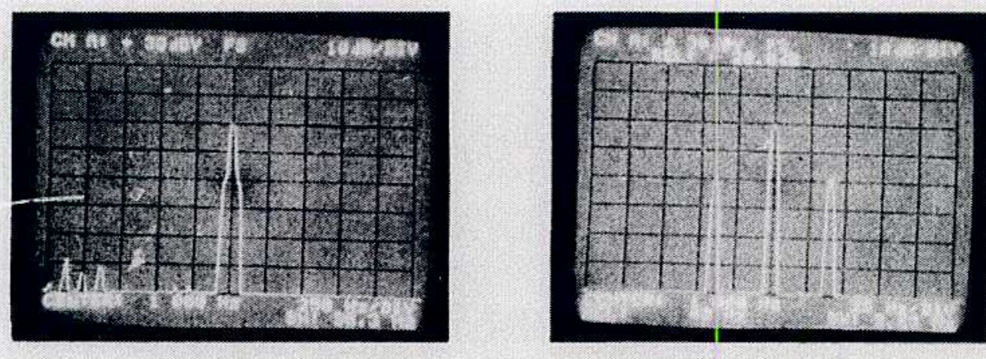


Figure 3-4. Using the SPAN Control to Resolve Sidebands.

3-52. If the function generator has modulating capabilities, pause to experiment with different modulating frequencies and amplitudes using the 3582A and the control information thus far presented to derive spectral data. When finished, reset the following switches (except the LINE switch):

Set both framed functions	ON
Set SCALE 10 dB/DIV	ON
Set AVERAGE NUMBER 4	ON
Set PASSBAND SHAPE	FLAT TOP
Set AMPLITUDE A	ON
Set all other buttons	OFF
AMPLITUDE REF LEVEL	NORMAL
FREQ SPAN MODE	0-25 kHz
TRIGGER LEVEL (framed)	FREE RUN
INPUT CHANNEL A	30dBV
VERNIER	CAL
INPUT CHANNEL B	30dBV
VERNIER	CAL
INPUT MODE	A

3-53. Scales.

3-54. One of three scales may be selected to represent display spectral amplitudes. Each scale may be used in combination with the channel SENSITIVITY switches and the

AMPLITUDE REFERENCE LEVEL switch to offset (log modes) or expand (linear mode) the display relative to full scale. There are three basic scale settings:

a. 10 dB/DIV. The 10 dB/DIV scale is a logarithmic type of display which has a range of 80 dB.

b. 2 dB/DIV. The 2 dB/DIV scale is a logarithmic type of display which has a range of 16 dB.

c. LINEAR. The LINEAR scale has a range from the full scale indicated voltage to zero volts. Therefore, the volts per division decreases as the full scale amplitude is reduced. The SENSITIVITY switch indicates the maximum rms voltage level which does not exceed overload. The voltage level displayed is a calibrated voltage which can be easily divided among the eight graticule divisions. Because of this, some SENSITIVITY switch positions will give a displayed full scale voltage which will require the use of the AMPLITUDE REFERENCE LEVEL switch to give a full scale display.

3-55. Amplitude Reference Level.

3-56. The AMPLITUDE REFERENCE LEVEL switch has nine positions. In the NORM position, the amplitude reference level function is off. If the switch is turned clockwise, the following changes will take place on the display (NORM is position 1):

a. Log Modes: The display is offset by an additional 10 dB/DIV for each position which can accumulate to a total of 80 dB.

b. Linear Mode: Since the zero volts line is always at the bottom of the display, the full scale reference level will decrease thereby expanding or amplifying lower signal levels.

3-57. To observe the different SCALES and effects of the AMPLITUDE REFERENCE LEVEL switch, try the following exercise:

a. Set the function generator for a 1 kHz square wave output. Adjust the amplitude to 3 V rms or less.

b. Set the CHANNEL A SENSITIVITY for 10 dB.

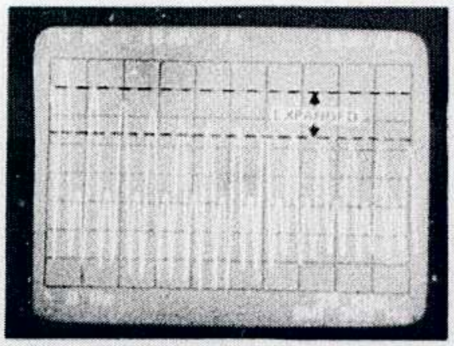
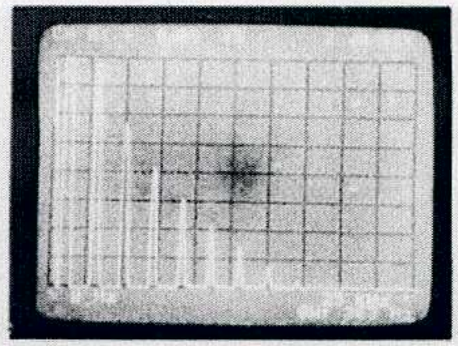
c. Readjust the amplitude of the function generator to achieve a full scale display without an overload indication.

d. Rotate the AMPLITUDE REFERENCE LEVEL switch and observe how the display is shifted up in 10 dB increments.

e. To expand a portion of the display, use the AMPLITUDE REFERENCE LEVEL switch to place that part of the display at or near the full scale graticule.

f. Placing the 2 dB/DIV button to the ON position will expand the spectra within − 16 dB from the reference setting to a full scale display (see Figure 3-5).

g. Return the AMPLITUDE REFERENCE LEVEL switch to NORM.

BEFORE OFFSET AND EXPANSION AFTER OFFSET AND EXPANSION

Figure 3-5. Expanding a Portion of the Display.

h. Press the LINEAR scale button and observe that the maximum allowable input signal on the 3 V range does not produce a full scale display. Notice that the calibrated reference level is 4 V (see Figure 3-6).

i. To observe the associated lower amplitude spectra, rotate the AMPLITUDE REFERENCE LEVEL switch. Notice that the volts/div decreases at each new reference level, thus expanding the amplitude of the spectra on the display.

j. Set the following switches:

10 dB/DIV..ON
AMPLITUDE REFERENCE LEVEL..................NORM

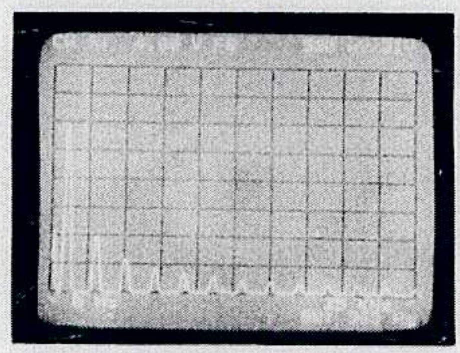


Figure 3-6. Full Scale Reference in the LINEAR Mode.

3-58. The Passband Shape Controls.

3-59. One of three passband shapes may be selected to characterize the signal data. Careful consideration should be given to the choice of PASSBAND SHAPE in order to maximize the spectral information displayed for a particular type of measuring application. The PASSBAND SHAPEs are unique and are explained as follows:

a. FLAT TOP. The FLAT TOP passband is similar to those found in wave analyzers such as the -hp- 312D and the -hp- 310A. Its high shape factor and broad response make it ideal for measuring the amplitude of individual spectra, such as that found in the output from an oscillator. Therefore it is the most accurate passband for measuring amplitude.

b. HANNING. The HANNING passband is similar to those found in swept frequency spectrum analyzers such as the -hp- 3580A. The HANNING passband is derived from a raised cosine shape which helps to give better resolution for isolating one spectral line in a closely spaced group of spectral lines, particularly when the amplitudes of the spectra are within 50 dB of each other. A good example of the use of this passband would be in deriving the spectrum for a notch filter. The HANNING passband should be selected when using the RANDOM NOISE SOURCE and when measuring discrete spectrum components. It is slightly less accurate (approximately − 1 dB) than the FLAT TOP passband.

c. UNIFORM. The UNIFORM passband has a very narrow 3 dB bandwidth and should be used for measuring transient signals. The 3582A's PERIODIC NOISE SOURCE is optimized for this passband which aids in analyzing transfer characteristics of networks. The display aberrations are greatest when using this passband so caution should be used when measuring the amplitudes of individual spectra.

3-60. To observe the effects of using the different passband shapes on a spectral display, try the following exercise:

a. The 3582A should have the switches already set up from the last exercise. But if you are beginning here, set the switches to the basic turn-on mode as indicated in the Turn-On Procedure.

b. Set CHANNEL A SENSITIVITY to + 10 dB.

c. Adjust the function generator for a 10 kHz sine wave and a full scale display on the 3582A (approximately 3 V). The spectrum should appear as in Figure 3-7.

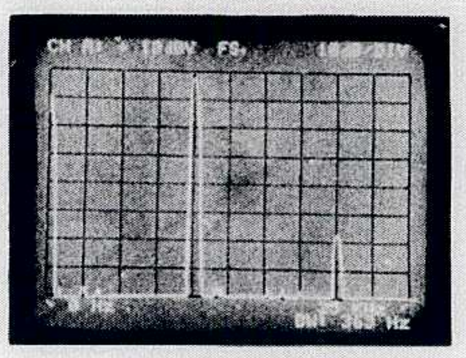


Figure 3-7. A Sine Wave Spect m using the FLAT TOP Passband.

d. Change the frequency of the oscillator very slowly and notice that the spectral display retains its shape as it shifts across the screen.

e. Now set the HANNING passband button to ON. The spectrum should appear as in Figure 3-8.

f. Slowly change the frequency of the oscillator and observe how the spectral shape slightly changes proportions. Also notice that the bandwidth has decreased to less than one

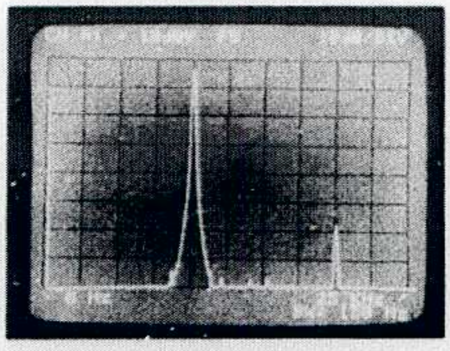


Figure 3-8. Sine Wave Spectrum using the HANNING Passband.

half its previous value. The smaller bandwidth allows for greater selectivity, while the slightly changing shape is due to the discrete sampling and display technique.

g. Set the UNIFORM passband button to ON. The spectrum may appear as in Figure 3-9.

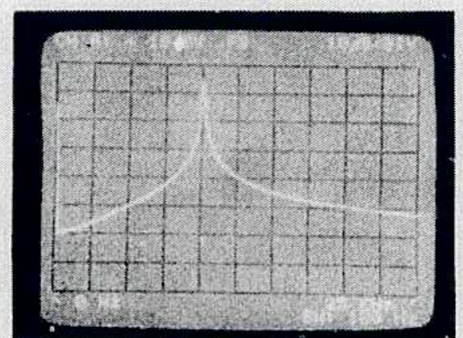


Figure 3-9. Sine Wave Spectrum Using the UNIFORM Passband.

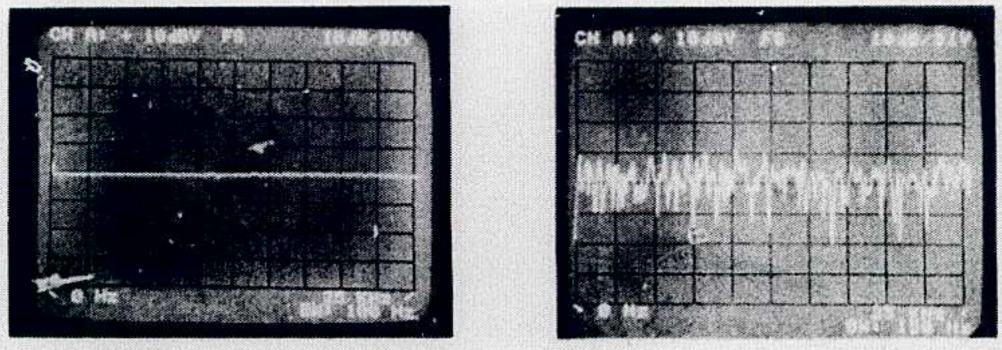
h. Slowly change the frequency of the oscillator. The radically changing shape is due to a bandwidth which is now less than a third that of the FLAT TOP passband. This reveals that the UNIFORM passband should generally not be used except for measuring transfer functions using the PERIODIC NOISE OUTPUT as a source.

3-61. The NOISE SOURCE.

3-62. The NOISE SOURCE is a broadband periodic pseudo random signal. When "PERIODIC" is selected, the period is automatically adjusted so that one period covers one SPAN setting and, therefore, the periodicity does not effect the spectrum analysis. When "RANDOM" is selected, the periodicity of the noise source signal is extended to as much as 14 minutes. In this mode, the 3582A interprets the pseudo random signal as a band limited white noise source. The NOISE SOURCE output may be adjusted through the use of the LEVEL control located adjacent to it. The low impedance output (< 1 ohm) may be used as a source signal for analyzing two port networks.

3-63. To see the spectral output of the NOISE SOURCE, connect the NOISE SOURCE output to the channel A input connector via a shielded cable with suitable adapters. Set the

CHANNEL A COUPLING and the CHANNEL B COUPLING to AC. Adjust the CHANNEL A SENSITIVITY control for an on-scale display. The displayed spectrum is nearly a uniform amplitude across the frequency axis (see Figure 3-10[a]). It is important to note that there is energy at each spectral point, but none in between. If a phase spectrum is observed, the phase will be consistent for corresponding frequencies for each time record taken. Do not use SET START or SET CENTER for making measurements using the Periodic Noise Source within one SPAN width of 0 Hz. Instead, use the 0-START mode as this does not use the Digital Local Oscillator and will avoid L.O. translated noise aliasing around 0 Hz.



(a) PERIODIC NOISE SOURCE (b) RANDOM NOISE SOURCE

Figure 3-10. Noise Source Spectrums.

3-64. To see the spectral output of the RANDOM noise source, set the PASSBAND SHAPE to HANNING and turn the concentric control of the level switch to RANDOM. The spectrum will appear similar to that in Figure 3-10(b). A smoother display may be obtained by RMS averaging.

3-65. IMPULSE OUTPUT.

3-66. The IMPULSE output signal is a pulse which has an amplitude of +5 V. The period of the pulse is determined by the SPAN control settings (see Table 3-1). The repetition period is the same as the length of the time record. The UNIFORM window should be used

Table 3-1. Impulse Output Pulse Period.

SPAN	0-25 kHz 0-Start	SET START SET CENTER
25 kHz	1.211 μsec	2.441 μsec
10 kHz	2.441 μsec	6.104 μsec
5 kHz	6.104 μsec	12.207 μsec
2.5 kHz	12.207 μsec	24.414 μsec
1 kHz	30.518 μsec	61.035 μsec
500 Hz	61.035 μsec	.12207 msec
250 Hz	.12207 msec	.24414 msec
100 Hz	.24414 msec	.6105 msec
50 Hz	.6105 msec	1.221 msec
25 Hz	1.221 msec	2.441 msec
10 Hz	2.441 msec	6.101 msec
5 Hz	6.101 msec	— — —
1 Hz	30.667 msec	— — —

when making measurements using the IMPULSE output as a source. The resulting spectrum has a constant amplitude and phase-frequency relationship.

3-67. To observe the IMPULSE spectrum, remove the NOISE SOURCE output from CHANNEL A and connect the IMPULSE output to CHANNEL A. Adjust the SENSITIVITY for an on-scale display. The spectrum will appear similar to that in Figure 3-10(a).

3-68. Dual Channel Measurements.

3-69. The dual channel capability makes the 3582A a very versatile instrument. With two channels, many measuring applications are possible including the measurement of the transfer characteristics of two port networks. One type of two port network is a single pole low pass filter, consisting of a series resistor and a parallel capacitor (see Figure 3-11).

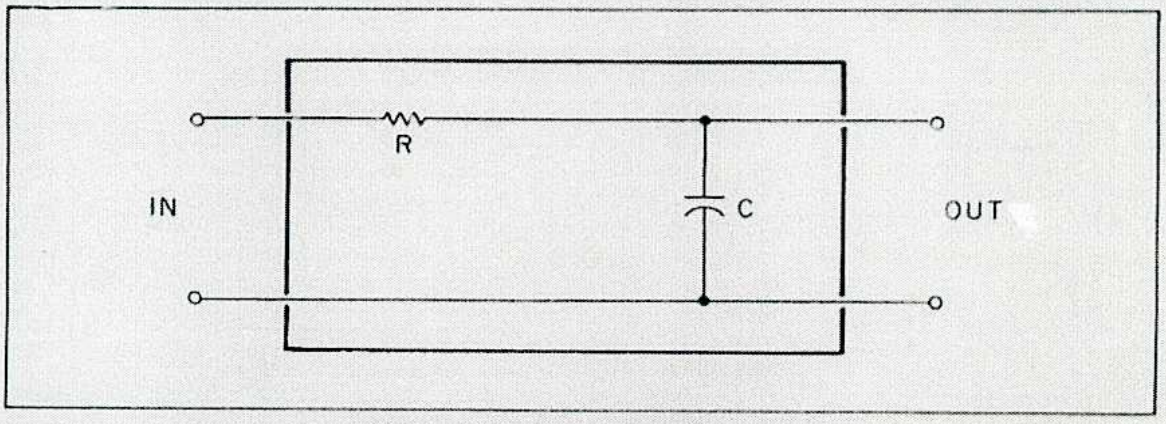


Figure 3-11. A Two Port Network.

3-70. A two port network such as this will be used to illustrate the amplitude and phase transfer measuring functions of the 3582A. To connect the filter:

a. Remove the IMPULSE source from channel A.

b. Connect a 10 kΩ resistor and a 3000 pF capacitor between the inputs of channels A and B as shown in Figure 3-12.

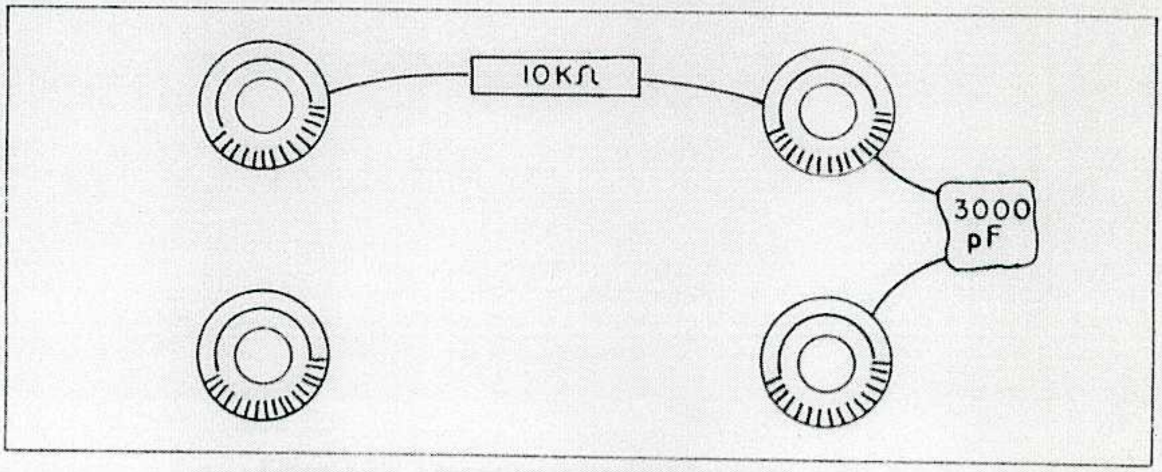


Figure 3-12. Connecting a Single Pole Low Pass Filter.

3-71. To observe both input A and input B, try the following exercise:

a. Reconnect the NOISE SOURCE OUTPUT to channel A INPUT.

b. Verify that CHANNEL A and CHANNEL B COUPLING switches are set to AC and that the INPUT MODE switch is set to BOTH.

c. Set CHANNEL A and CHANNEL B SENSITIVITY switches for + 10 dB.

d. Verify that the UNIFORM PASSBAND button is set to on and "PERIODIC" is selected.

e. Press channel A and channel B AMPLITUDE buttons to ON.

f. Adjust the AMPLITUDE REFERENCE LEVEL for a centered display.

g. The input and output of the low pass filter is described by the two traces and should appear similar to Figure 3-13.

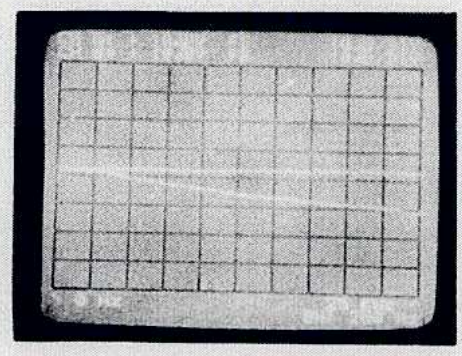


Figure 3-13. Input and Output Spectrum of a Low Pass Filter.

h. Comparisons between the two traces can be made with the use of the MARKER functions.

i. Set the MARKER ON button to ON.

j. Set the MARKER to a desired reference point on the top trace using the POSITION control.

k. Press the MARKER REL button to ON.

l. Press the MARKER SET REF to load a relative reference into memory.

m. Pressing the MARKER TRACE button will now give relative amplitude information between the two traces.

3-72. Amplitude Transfer (XFR) Function. As already illustrated, comparative measurements can be used to determine the differences between channel A and channel B. If enough of these measurements are made, a graph may be constructed which would indicate the amplitude transfer characteristics of the network under analysis. The AMPLITUDE

XFR FCTN is a graphical display which is the result of dividing the spectrum of channel B by the spectrum of channel A. It is a continuous function which describes the gain or attenuation, as referenced to frequency, of a two port network. To observe the AMPLITUDE XFR FCTN, try the following exercise:

a. Set MARKER REL OFF.

b. Set AMPLITUDE A and AMPLITUDE B OFF.

c. Set AMPLITUDE XFR FCTN to ON.

d. Set AMPLITUDE REFERENCE LEVEL for a centered display.

e. The MARKER functions may be used to provide amplitude and frequency information at a point of interest.

f. For example, turn the MARKER POSITION control so that the marker is in the vicinity of 5300 Hz. This is the approximate −3 dB point of the transfer function (see Figure 3-14).

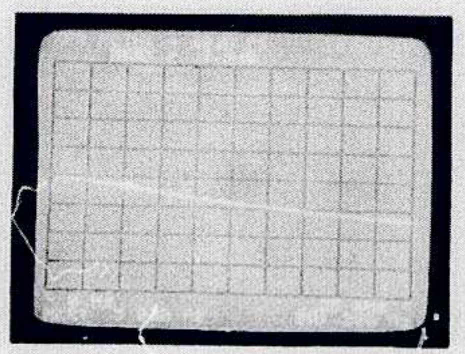


Figure 3-14. Transfer Function for a Two Port Network.

3-73. Phase Measurements. Complete analysis of a waveform requires that phase as well as amplitude be known. Phase data must be relative to a fixed point in time. It is best to use a trigger signal when single channel measurements are made to establish relative phase data. A trigger signal is not required for some dual channel displays since phase data is simply relative between the two channels.

3-74. The phase display uses the central horizontal graticule to indicate zero degrees each division vertically represents 50 degrees. The phase display is dependent on the triggering of the time record, but the phase reference is at the middle of the screen so there is no simple relationship between the phase spectrum and the trigger point. However, the phase reference is at the beginning of the time record if the UNIFORM window is used.

3-75. Since the instrument is already set up to display a transfer function, the phase transfer function of the low pass filter may be observed by setting the following switches:

AMPLITUDE XFR FCTN................................OFF
PHASE XFR FCTN..ON
AMPLITUDE REFERENCE LEVEL...................NORM

3-76. The MARKER controls may be used to indicate the phase reading at a particular frequency of interest. Notice that at low frequencies the relative phase is approximately 0 degrees and at 5300 Hz the phase is approximately 45 degrees (see Figure 3-15).

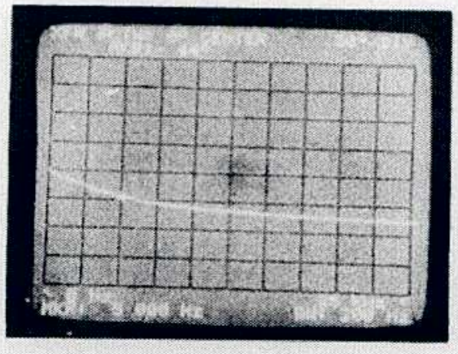


Figure 3-15. Phase Transfer Function of a Low Pass Filter.

3-77. Single channel phase measurements will be illustrated with the use of a function generator. To observe a single channel measurement, try the following exercise:

a. Set the following switches:

PHASE XFR FCTN..OFF
AMPLITUDE A...ON
PASSBAND SHAPE FLAT TOP.............................ON
INPUT CHANNEL A SENSITIVITY.........................30 V
INPUT MODE..A

b. Set the function generator for a 1 kHz triangle wave output. Disconnect the NOISE SOURCE OUTPUT and connect the output of the function generator to the input of the 3582A via suitable cables. Adjust the output of the function generator and/or the INPUT SENSITIVITY of the 3582A to achieve a full scale display without overloading the 3582A. Now set the 3582A switches as follows:

AMPLITUDE A...OFF
PHASE A...ON

3-78. Notice that the phase readings change randomly. This is caused by the TRIGGER LEVEL control being in the FREE RUN position. To stabilize the readings and establish a phase reference, turn the TRIGGER LEVEL control until the desired display is shown. An example display is shown in Figure 3-16.

3-79. There are two important criteria about the phase display that should be noted.

a. Threshold: Except for the phase transfer function, the phase is displayed if the signal is above a certain threshold. If it is below the threshold, 0 degree is displayed and the marker will indicate that it is undefined. This eliminates phase readings resulting from low signal levels (i.e., noise).

b. Slope: There is a phase slope which corresponds to a phase shift across the passband

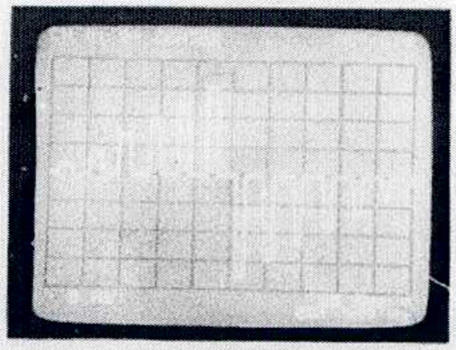


Figure 3-16. Phase Spectrum of a Triangle Wave.

filters. The correct reading is obtained at the center of the sloping segment which is the peak of the amplitude response at that frequency.

3-80. If desired, the MARKER functions and/or the amplitude spectrum may be shown for reference purposes by pressing the appropriate buttons.

3-81. External Trigger Input. Another method of establishing a phase reference is through the use of the rear panel TRIGGER INPUT. This is TTL compatible input which is enabled when the TRIGGER switch is set to EXT. Another condition is that the front panel TRIGGER LEVEL control must not be in the FREE RUN position. If your function generator has a TTL pulse output (0 V to 5 V), connect this output to the rear panel TRIGGER INPUT and set the adjacent TRIGGER switch to EXT. Notice that the TRIGGER LEVEL control is now non-functional except in the FREE RUN position. When finished, disconnect the external TRIGGER INPUT and return the TRIGGER switch to INT. It is good to mention at this point that some apparent trigger problems may be due to the inadvertant setting of the rear panel TRIGGER switch. Always verify that this switch is in the proper position for the desired mode of operation of the instrument.

3-82. The Averaging Functions. The AVERAGE controls are used to average the spectra displayed on the CRT. Operationally, it replaces the video filtering or display smoothing usually found on spectrum analyzers. The TIME average does offer a unique capability of actually enhancing the signal-to-noise ratio.

3-83. RMS Average. The RMS average mode combines a new spectrum with a partial result on a point-by-point basis using an RMS calculation. At any point (m) in the cycle, the amplitude and phase at some frequency (f) are given as:

Amplitude: $$\sqrt{\frac{1}{m} \sum_{i=1}^{m} A_i^2}$$

Phase: $$\frac{1}{m} \sum_{i=1}^{m} \Theta_i$$

This averaging results in smoothing of the noise variations but does not reduce the level of the noise. RMS averaging must be used when making coherence measurements.

3-84. TIME Average. The TIME Average mode involves time domain averaging. When a synchronizing trigger is available, successive time records are averaged point-by-point. Time variations that are coherent with the trigger will average to some value while those that are not coherent will average to zero. This reduces the noise prior to the transformation to the frequency domain. Time averaging is unique in that it does result in an enhancement of the signal-to-noise ratio. It is also by far the fastest averaging mode for wide frequency spans and should be used any time a synchronizing trigger is available.

3-85. PEAK Mode. The PEAK mode is not truly an averaging mode, but rather is the result of keeping the maximum input at each frequency point. The phase point retained is the phase of the retained point at each frequency. PEAK averaging is useful for measurements such as monitoring signal drift, etc.

3-86. Selecting the Number of Averages. The NUMBER of averages is selectable between 4 and 256 in a binary sequence. The SHIFT key selects whether the lower case black numbers or the upper case blue numbers are active.

3-87. EXP Mode. The EXP mode is a continuous averaging process where the new spectrum is weighted ¼ and the previous average is weighted ¾. This causes the most recent data to be most important while the older data dies out in importance at a decaying exponential rate. The exponential accumulation mode works with the RMS average but in the PEAK mode provides unlimited peak hold. It is most useful when the process under consideration exhibits relatively slow term variations and yet some averaging is still desired. The time constant of the exponential weighting is such that it averages out short term variations, yet follows longer term variations.

3-88. Running an Averaging Sequence. In all of the averaging modes except exponential, the instrument stops taking new data when the selected number of averages are completed. When this occurs, the 3582A may appear to be "hung up" when actually it is waiting for further instructions. This is the reason the AVERAGE OFF button is framed. Any time the 3582A appears to be stopped, this button and other framed functions should be checked. When the instrument has taken the selected number of averages, the RESTART button is used to start the next averaging sequence. When the averaging mode is changed, a restart is automatically executed. When the number of averages is changed from one number to a larger number, a restart is also not required; the instrument continues from where it stopped to the new number of averages.

3-89. The following exercise will illustrate the use of the RMS and TIME averaging controls. It requires that the function generator have external modulating capability.

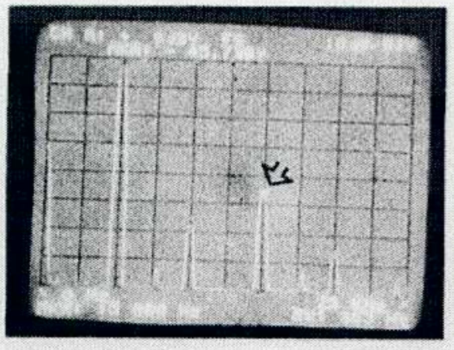
a. Set the controls of the function generator so that a 5 kHz sine wave can be AM modulated by an external source.

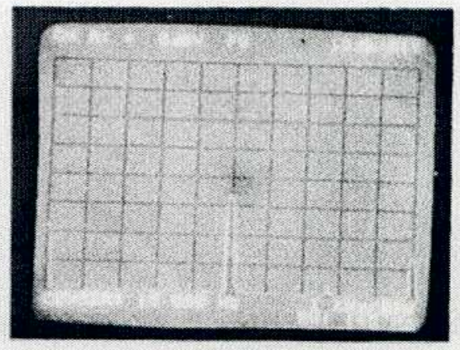
b. Connect the output of the function generator to the CHANNEL A input of the 3582A.

c. Using the control information thus far presented, adjust the function generator output and the 3582A controls for a full scale amplitude display using the trigger mode and FLAT TOP PASSBAND.

d. Select a harmonic of low amplitude and place it in the center of the screen using either SET START or SET CENTER frequency mode (see Figure 3-17).

e. Connect the NOISE SOURCE OUTPUT of the 3582A to the external modulation input of the function generator.





SELECTED HARMONIC PLACED IN CENTER OF SCREEN

Figure 3-17. Selecting the Correct Harmonic.

f. Adjust the modulation and NOISE SOURCE LEVEL such that the harmonic spectral line is indistinguishable from the noise spectrum (see Figure 3-18). The noise level peaks should be a little lower than the harmonic.

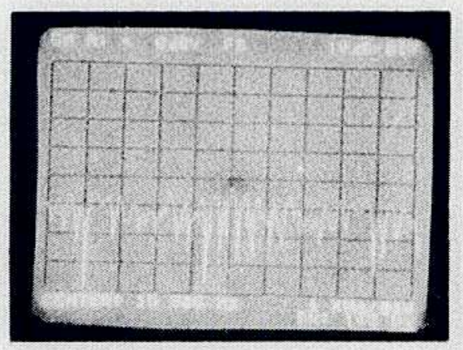


Figure 3-18. Modulating a Spectral Line with Noise.

g. Set the AVERAGE controls for a 256 RMS average function. When the average is completed, the spectrum may appear as in Figure 3-19. Notice that the value of the noise has averaged out to an RMS amplitude which is less than its peak value and that the spectra of the harmonic retains the same RMS amplitude throughout the averaging process.

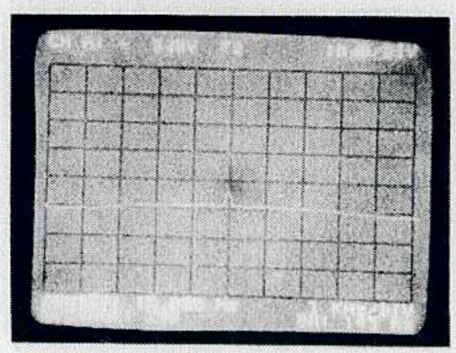


Figure 3-19. RMS Averaged Signals.

h. Set the TIME average button to ON and trigger properly. When the average is completed, notice that a signal-to-noise ratio enhancement has taken place (see Figure 3-20).

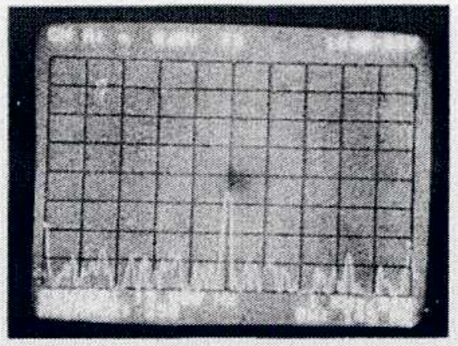


Figure 3-20. TIME Averaged Signals.

This is due to the principle that random noise averages in time to a lower value than a periodic waveform averages in time. Thus, if successive time records (relative to a fixed point in time) were superimposed upon one another, the signal waveform components would coincide while the noise waveform components would not.

i. Disconnect the NOISE SOURCE from the function generator and set the AVERAGE OFF button to OFF.

3-90. The following exercise illustrates the PEAK average mode and requires the function generator to have FM modulating capabilities.

a. Adjust the function generator for a 10 kHz sine wave modulated by a 1 Hz sine wave.

b. Adjust the controls of the 3582A for a center frequency of 10 kHz and a SPAN of 2.5 kHz.

c. The sine wave spectral line should be oscillating in frequency as indicated in Figure 3-21.

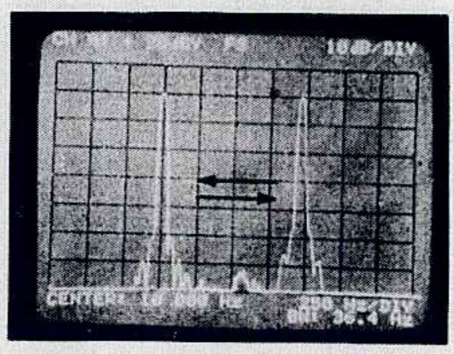


Figure 3-21. Oscillating Frequency Spectrum.

d. Press the PEAK average button to ON. At the end of 256 averages, the FM passband should appear as in Figure 3-22. This shape describes the maximum amplitude of the spectral line as it sweeps between maximum and minimum frequency.

3-91. Time Functions. The TIME display buttons supersede the other display controls. Only one time display can be selected at a time and all other displays are suspended. The TIME display is active only as long as the pushbutton is held in. It is important to note that the

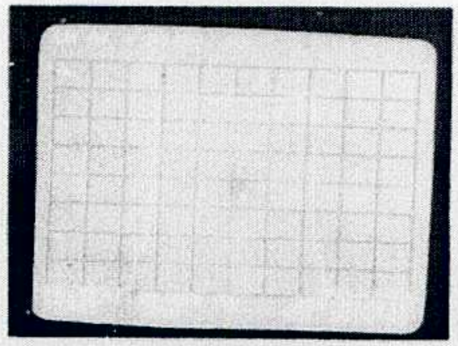
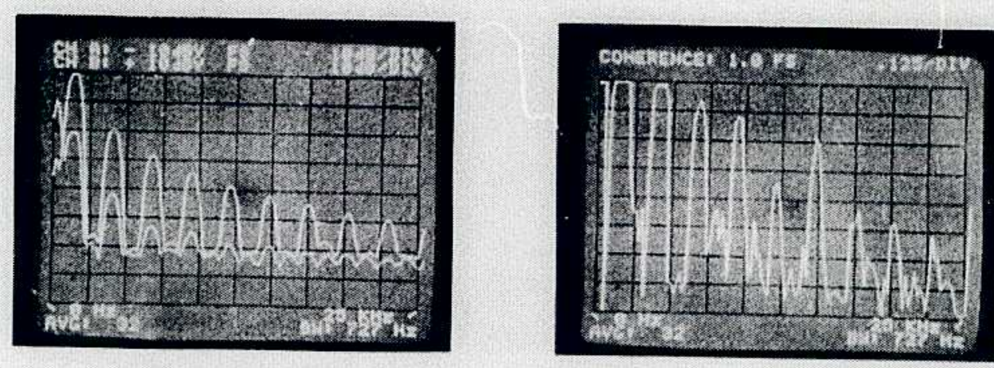


Figure 3-22. Spectrum of an FM Passband.

TIME display is used mainly for setting input sensitivities and for determining when a time record is complete; it does not replace an oscilloscope. The information displayed consists of alternate samples of the input time record in the baseband modes. In the band analysis modes, the time record may not be representative of the input signal since it is mixed with the Digital Local Oscillator before being stored.

3-92. Coherence. The coherence display is activated when the instrument is in the two channel RMS average mode and the COHER button is set to the ON position. The most common use of this display is as a check on the validity of a transfer function measurement. The coherence function is also a measure of the proportion of power in an output signal caused by an input signal. A coherence value of 1.0 would indicate that the cause/effect relationship is ideal and the transfer function ratio at that frequency is valid. Figure 3-23 shows two signals derived from the same source and their coherence relationship.



AVERAGED INPUT SIGNALS

COHERENCE RELATIONSHIP

Figure 3-23. The Coherence Relationship Between Two Signals.

Notice that the coherence function shows unreliable data in the higher frequencies. This is largely due to the signal-to-noise ratio of the smaller signal which becomes less as the frequency increases. Also note that when the signal-to-noise ratio of either signal is low, the coherence is also low.

3-93. To observe the TIME and COHER functions, try the following exercise.

a. Connect the function generator output to the 3582A's channels A and B input via suitable cables and connectors.

b. Set the function generator for a 2 kHz triangle wave output.

c. Set the 3582A for normal dual channel amplitude measurement (in case of difficulty, see Turn-On Procedure).

d. Set SCALE to 10 dB/DIV and the INPUT MODE to BOTH.

e. With CHANNEL A and CHANNEL B INPUT SENSITIVITY controls set to +30 dBV, adjust the function generator for a half scale (approximately −10 dBV) display.

f. To observe the channel A TIME function, depress the TIME A button and hold it in while varying the channel A INPUT SENSITIVITY. This will show the effect of the INPUT SENSITIVITY switch on the TIME amplitude. Set the AMPLITUDE A and B buttons to OFF.

g. To observe the coherence function, set the COHER button to ON, RMS AVERAGE button to ON, and AVERAGE NUMBER 64 to ON. The RMS averaging sequence should begin immediately with the coherence display becoming valid at the end of the sequence.

h. Experiment with the coherence function by varying the INPUT SENSITIVITY controls, pressing RESTART, and noting the result on the display when the averaging sequence is completed.

i. When finished, press the AVERAGE OFF button and set the COHER button to OFF.

3-94. Storing Traces.

3-95. The graphics portion of a single trace being displayed may be stored in TRACE 1 and/or TRACE 2, but either or both may be recalled using the dual channel mode of operation. The MARKER functions do not work on the recalled traces and the stored traces are not affected by any front panel operations except POWER OFF.

3-96. The following exercise illustrates the use of the trace STORE and RECALL functions.

a. Connect the NOISE SOURCE OUTPUT to the channel A INPUT.

b. Set the controls of the 3582A for a dual channel amplitude measurement. (In case of difficulty, see the Turn-On Procedure.)

c. Set the SCALE 10 dB/DIV to ON, the INPUT MODE switch to BOTH, and AMPLITUDE A to ON.

d. Set the INPUT SENSITIVITY switches as follows:

CHANNEL A .... +20 dBV
CHANNEL B .... CAL

e. With channel A only being displayed, press the TRACE 1 STORE button.

f. Change the AMPLITUDE buttons to display channel B only and press the TRACE 2 STORE button.

g. Keeping in mind that only two traces may be displayed at one time, experiment with the TRACE RECALL buttons, INPUT MODE switch, and the DISPLAY AMPLITUDE buttons to get different combinations of recalled traces and amplitude functions.

3-97. Conclusion.

3-98. Storing Traces marks the end of the Familiarization Exercise. It must be reiterated that only the most fundamental concepts were covered and that expertise acquired through continued use of the instrument will lead to discoveries of many applications for measuring spectra using the variety of unique capabilities of the 3582A.

NOTE

See Application Notes in Appendix D for additional information.

3-99. OPERATING ON SIGNAL DATA.

3-100. Introduction.

3-101. The following information is presented in order to maximize the user's efficiency in the operation of the 3582A. The two main functions involving the use of the instrument controls are:

a. Acquiring a time record.
b. Operating on stored time data.

3-102. Acquiring a Time Record.

3-103. Because the time record is stored in digital form, the 3582A is a versatile instrument for doing transient analysis. The irregular nature of transient signals, however, dictate that the time record of the captured event must remain unaltered until all applicable analysis is completed. The 3582A has many functions, therefore, great care must be exercised to avoid destroying a time record through the inadvertent setting of a control. To acquire a time record, the following conditions should prevail:

a. INPUT, TRIGGER, and FREQUENCY controls should be set prior to the initiation of a trigger.

b. If more than one time record is needed and the AVERAGE functions are used, the PASSBAND SHAPE must be established prior to the initiation of the trigger signals.

Once a time record is established, several operations may be carried out on the data.

3-104. Operating on Stored Time Data.

3-105. Data may be displayed without destroying the time record under the following conditions:

a. The display of transformed time data may be made in any of the formats indicated by the switches in the DISPLAY group. Note, however, that some DISPLAY functions may require certain setups in the INPUT and TRIGGER switch groups.

b. Once a trace is displayed, the MARKER functions may be used to obtain information at a particular point of interest.

c. Traces may also be stored, recalled, or plotted by an external plotting instrument.

d. The PASSBAND SHAPE may be changed but only if the AVERAGE functions are not used.

NOTE

Pressing the RESET button will clear the time record, but it will not clear traces which are stored using the TRACE 1 and/or TRACE 2 storage functions.

3-106. Using the Recorder Output.

3-107. An X–Y analog recorder (such as the -hp- Model 7004B) may be used to plot the graphics portion of the display. Three controls on the 3582A front panel allow the processor to operate the X–Y analog outputs and the PEN LIFT control output located on the rear panel.

3-108. To initiate a plot, the following steps should be taken:

a. All 3582A and recorder interface lines should be connected and both instruments turned on.

b. Next press the LL↓← (RESET) button in order to set the lower left-hand corner minimum scale pen position using the recorder offsets.

c. The UR →↑ button on the 3582A may be pressed in order to set the upper right-hand corner full scale pen position using the recorder gain.

d. When the desired spectrum is present on the display and you are ready to plot, press the PLOT button. The 3582A will automatically control the pen lift line throughout the entire plot and return the recorder pen to its initial position when the plot is finished or terminated. If desired, choose another trace and plot again (see Figure 3-24).

e. To terminate a plot, press the LL↓← (RESET) button to cause the recorder pen to return to its initial position.

NOTE

No other operations on the 3582A may be initiated during a plotting sequence except RESET or HP-IB inputs.

3-109. USING PROBES.

3-110. The -hp- Model 10001A Voltage Divider Probe is recommended for use with the 3582A. The probe has a tip impedance of 10 megohms shunted by 10 pF and a 10:1 division ratio. The probe is especially valuable for use in analyzing high impedance circuits. Note, however, that most high impedance probes such as the -hp- 10001A have capacitive compen-

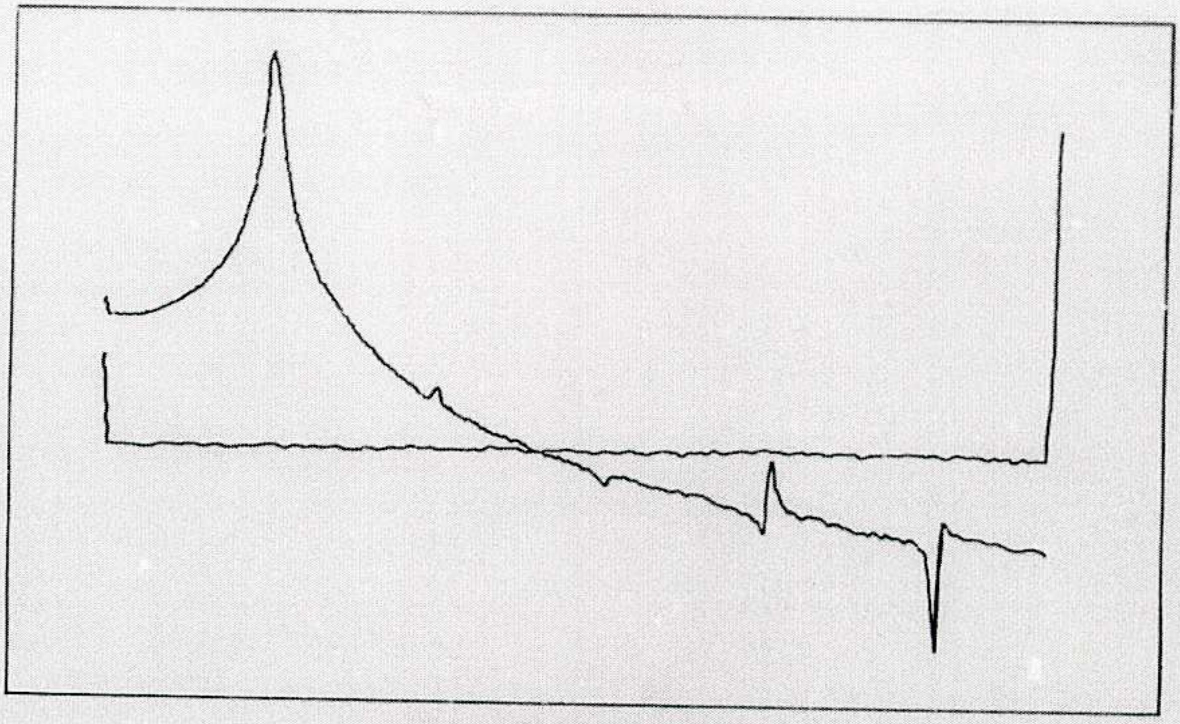


Figure 3-24. A Two Trace Plot.

sating adjustments which effect their frequency response. Before using the -hp- 10001A probe in a measuring application, the probe should be compensated to match the input impedance of the 3582A. Once the probe is properly adjusted, it should not require further attention. It is a good practice, however, to perform periodic verification tests to assure that optimum adjustment is maintained.

3-111. Probes Are Delicate.

3-112. If you have ever tried to use a probe that does not work because it has been abused, you will appreciate the exerpt from -hp- *Bench Briefs* given in Figure 3-25.

3-113. Probe Compensation Procedure.

3-114. The Probe Compensation Procedure uses the Amplitude Transfer Function measuring mode and the PERIODIC NOISE SOURCE OUTPUT of the 3582A.

a. Turn on the 3582A and/or set the switches as indicated in the Turn-On Procedure.

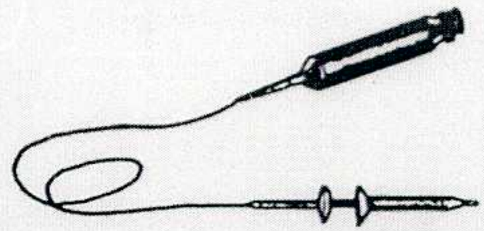
b. Set the CHANNEL A SENSITIVITY for 3 V.

c. Set the INPUT MODE switch to BOTH.

d. Set the CHANNEL B SENSITIVITY for .3 V.

e. Connect the NOISE SOURCE OUTPUT to channel A INPUT via suitable cable and connectors.

f. Connect the cable from the probe to channel B using a BNC adapter (-hp- Part No. 1251-2277).



Although oscilloscope probes are as common as pocket screwdrivers, they need to be handled with much more care than the normal screwdriver. Probes are often dropped on the floor, stepped on, rolled over with carts or even used as tow ropes to pull systems around on carts.

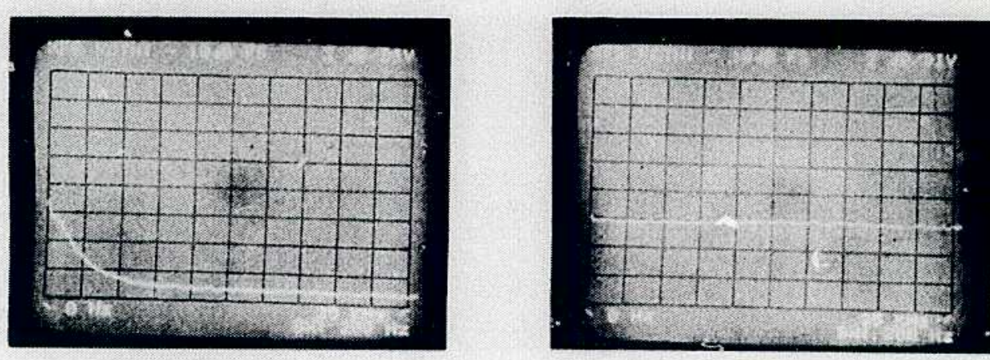
Probes are designed to be as rugged as possible, but many times they are abused. It turns out that a high-frequency passive probe is a fairly sophisticated piece of electronic equipment, even if it doesn't sound or look exciting. Electrically, there is a complex termination and compensation network at the base of the probe. The probe tip has the divider resistor (usually about 9 megohms) and another compensating capacitor. One of the toughest things to design and build well is the probe cable. To keep the input capacitance at the probe tip as low as possible, the cable must be very low capacitance. To accomplish this, a very small center conductor must be used. The smaller the center conductor, the lower the capacitance, but also, the easier it is to break the center conductor. The typical diameter of a probe cable center conductor is 4 mils (about the size of a hair!). The point is that a probe should be handled with care, just as any precision measuring tool should be.

Figure 3-25. About Scope Probes.

g. Attach the probe tip to the signal input on channel A and the ground lead to channel A ground.

h. Place the DISPLAY AMPLITUDE XFR FCTN to the ON position. Adjust the AMPLITUDE REFERENCE LEVEL for a centered display.

i. Adjust the probe so the response is flat over the entire frequency range (see Figure 3-26).



UNCOMPENSATED PROPERLY COMPENSATED

Figure 3-26. Probe Compensation.

3-115. FRONT PANEL SCREWDRIVER ADJUSTMENTS.

3-116. Front panel screwdriver adjustments are provided for periodic fine tuning of the instrument. Under most normal operating conditions, there is no need to change the setting of these adjustments, however, it is a good practice to verify that the instrument is tuned for optimum accuracy before a critical measurement is made.

3-117. ASTIG (Astigmatism) Adjustment.

3-118. The ASTIG adjustment is an analog control which works in combination with the FOCUS control to provide well defined traces and characters on the display. The adjustment of this control may be made anytime the instrument is turned on and there is a display on the CRT. It is often necessary to alternate adjusting the ASTIG control and the FOCUS control to provide a sharp, clear display.

3-119. BAL (Balance) Adjustments.

3-120. The BAL adjustment effects the dc offset of the Input Amplifiers and balances offsets even though ac COUPLING is selected. The BAL adjustment is usually made on the most sensitive input range of the instrument, however, when making a critical measurement, the adjustment should be made on the particular range in use.

3-121. The following procedure is given for adjusting the BAL control on the most sensitive input range, but the same principal procedure applies for adjusting the BAL control on any of the INPUT SENSITIVITY ranges in channel A or channel B.

a. Set the switches on the 3582A as indicated in the Turn-On Procedure.

b. Set the DISPLAY AMPLITUDE to A.

c. Set the SCALE to LINEAR.

d. Connect a short across the input terminals of channel A.

e. Set the channel A COUPLING to DC(⎓).

f. Set the CHANNEL A SENSITIVITY to 3 mV.

g. Adjust the BAL control for a minimum amplitude at the 0 Hz frequency point (see Figure 3-27).

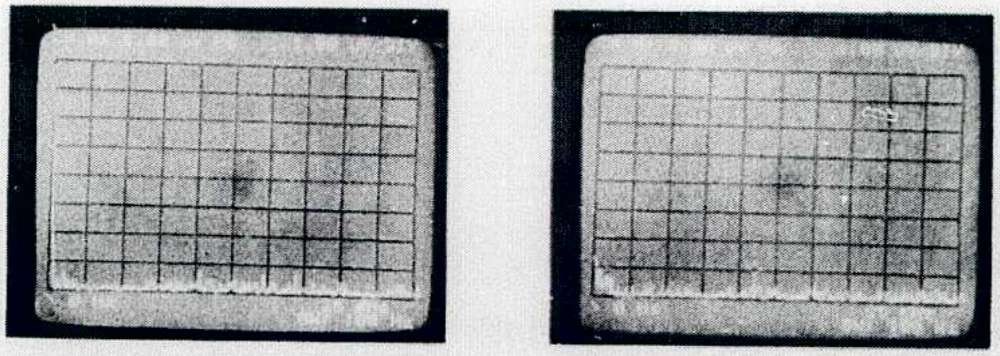
h. Rotate the AMPLITUDE REFERENCE LEVEL control fully clockwise and repeat Step g. This completes the BAL adjustment.

i. A quicker but less accurate method is to press the TIME function button for the appropriate channel and adjust the time trace for zero volts by centering it on the middle horizontal graticule.

3-122. IN CASE OF TROUBLE.

3-123. Introduction.

3-124. The 3582A, because of its high degree of flexibility, has many operating modes requiring some fundamental knowledge of the operating controls. Under some circumstances, the instrument may appear to be operating incorrectly, when all that is really



INCORRECT ADJUSTMENT PROPER ADJUSTMENT

Figure 3-27. Adjusting the BAL Control.

needed is correct operator interpretation and input. The following information will aid the operator in interpreting situations which may arise during measurement sequences. It is intended only as a supplement to the information presented in the Familiarization Exercise. The Familiarization Exercise should be read (and performed) before any (other) operation of the instrument is attempted.

3-125. "Hung Up" (Instrument does not appear to respond).

3-126. If the instrument does not appear to respond to front panel controls, check the following list of possibilities:

a. Instrument under REMOTE Local Lockout.

b. No trigger signal available:

1. Trigger REPETITIVE is OFF.
2. No INPUT on channel A.
3. Incorrect TRIGGER LEVEL setting.
4. Rear panel switch set to EXT without an input connected.
5. Improper EXT input level.

c. An average has been completed and the instrument is awaiting further averaging instructions. (Suggestion: turn AVERAGE to OFF.)

d. A Plotting operation has been initiated and the instrument is awaiting completion of the plot. Note that the display will remain active during this time.

3-127. Overload.

3-128. Data displayed under OVERLOAD conditions may involve the following peculiarities:

a. Overload occurs at 100% of full scale input and may produce spurious responses in spectral display data.

b. The TIME display is shown as alternate time record points; therefore it is possible to have an overload indication which does not appear in the TIME record display.

c. Signals are clipped at full scale and as a result, displayed spectra may be misrepresented in amplitude.

d. To avoid a possible overload when using TIME AVERAGE, be sure that input signals are at least 2 dB below full scale.

3-129. Unrelated Spectral Displays.

3-130. The 3582A may display spectra which are unrelated to the input signal under the following circumstances:

a. If using either SET START or SET CENTER, several spectral lines may appear above 26 kHz. These spectra are derived from the switching power supplies and from an analog to digital exercising signal.

b. If the PERIODIC NOISE SOURCE is used in combination with either the SET START or SET CENTER frequency modes, the spectral data within one SPAN width of 0 Hz may be inaccurate due to local oscillator translated noise aliasing around 0 Hz and adding to the desired spectral data. To avoid this problem, use the 0 START frequency mode.

c. Unrelated spectral displays may be caused by data analyzed under OVERLOAD conditions.

d. Stray signals present in both input channels may result in an abnormally high COHERENCE level even though there is no cause and effect relationship, merely the presence of a common signal. (Suggestion: use well shielded input cables.)

3-131. Noise Source Output.

3-132. The 3582A has two types of noise sources available. There are measurement situations where the use and choice of a noise source may be critical in achieving correct results. The Noise Source Output has the following peculiarities:

a. The PERIODIC noise source will cause uneven or noisy transfer function measurements on non-linear systems. (Suggestion: Use the RANDOM source and AVERAGING.)

b. Use an external source resistor when driving low impedance filters. For example, use a 50 ohm external series resistor when driving a 50 ohm filter. This is necessary because of the low output impedance (< 2 ohms) of the Noise Source Output.

3-133. SIMPLIFICATION OF DISCRETE DATA ANALYSIS.

3-134. Introduction.

3-135. The following description is presented in order to provide the user with a feel for what is taking place in the 3582A as data is converted from the time domain to the frequency domain. While this is entirely a mathematical process, the main vehicle for explanation will be graphical with many math operations assumed for simplification.

3-136. Time Domain Considerations.

3-137. The sampling function is carried out by hardware while the conversion to the frequency domain is handled by firmware. Sampling is accomplished in the Analog-to-Digital Converter at a 102.4 kHz rate and involves the multiplication of the normalized input waveform by an impulse train of unity amplitude. This results in the waveform being broken down into a series of amplitude pulses separated by the period of the sampling impulses (see Figure 3-28).

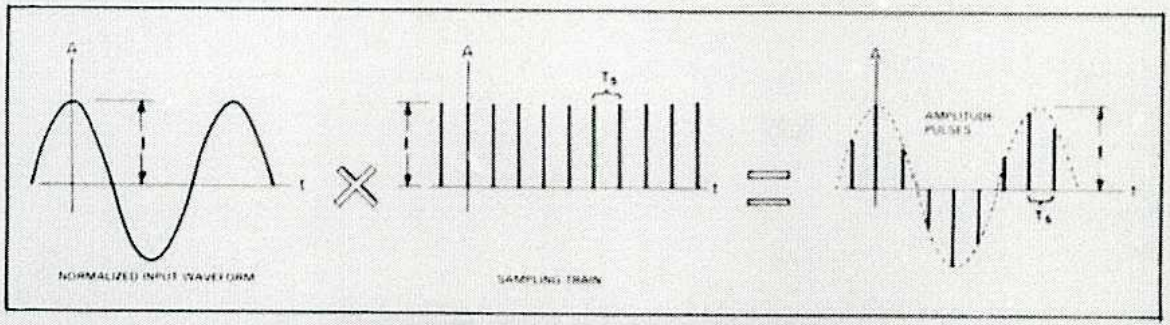


Figure 3-28. Sampling an Input Waveform.

3-138. Because of limited memory and other processing requirements, sampled data cannot be taken indefinitely and therefore must be restricted to a period of time called a window. A window in this particular sense is defined as a square pulse of unity amplitude which, when the sampled data is multiplied by the window, confines it to a particular time interval (see Figure 3-29).

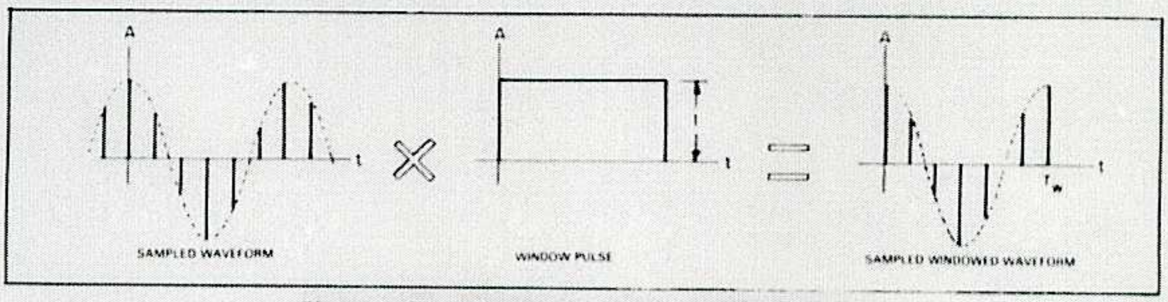


Figure 3-29. Windowing a Sampled Waveform.

3-139. Frequency Domain Considerations.

3-140. So far, three waveforms and two processes have been given in the time domain. Each waveform and process has an equivalent representation in the frequency domain which is carried through by Fourier Analysis. For example, assume the input is a cosine waveform which has a discrete line spectrum in the frequency domain. Its representation in the frequency domain is indicated in Figure 3-30.

3-141. Notice that as a result of the transform, half of the energy is represented in the negative frequency region of the spectrum. This situation is eliminated by scaling the amplitude data by a factor of two before it is displayed.

3-142. The sampling train is composed of impulses of theoretically zero width. An impulse train transforms into a discrete line spectrum with lines spaced at $1/T_s$ intervals. Its representation in the frequency domain is indicated in Figure 3-31.

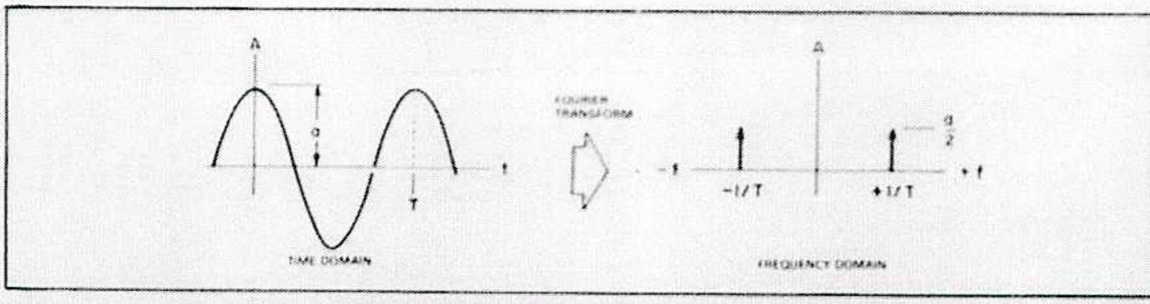


Figure 3-30. Frequency Representation of a Cosine Wave.

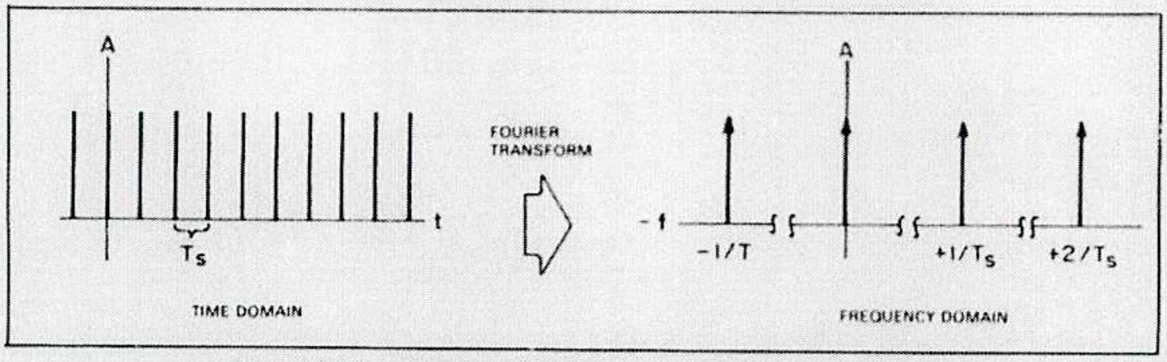


Figure 3-31. Frequency Representation of an Impulse Train.

3-143. The square pulse has a unique frequency domain representation which is not discrete but a continuous function and is composed of all frequencies. This function is represented by the formula Y = SIN X/X (see Figure 3-32).

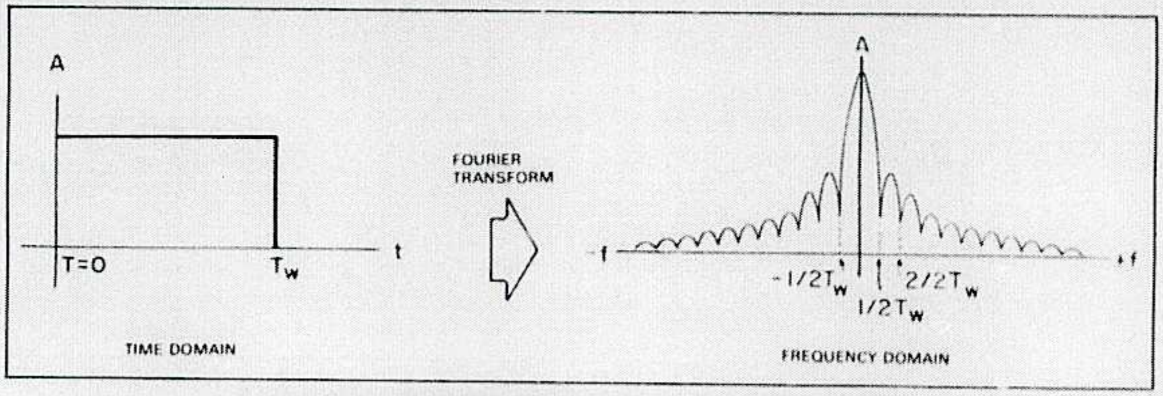


Figure 3-32. Frequency Representation of a Square Pulse.

3-144. In the time domain, different waveforms were multiplied resulting in a new modified waveform, i.e., the sampled windowed cosine wave. This multiplication process is represented in the frequency domain by another process called convolution. In a mathematical context, the operation involves the use of the Convolution Integral, sometimes known by its other name, the Superposition Integral. The convolution of the cosine spectrum with a sampling spectrum is shown in Figure 3-33.

3-145. Notice that the impulse spectrum has been combined into the new cosine and impulse spectrum. Another convolution operation is necessary involving the sampled cosine spectrum and the window spectrum (see Figure 3-34).

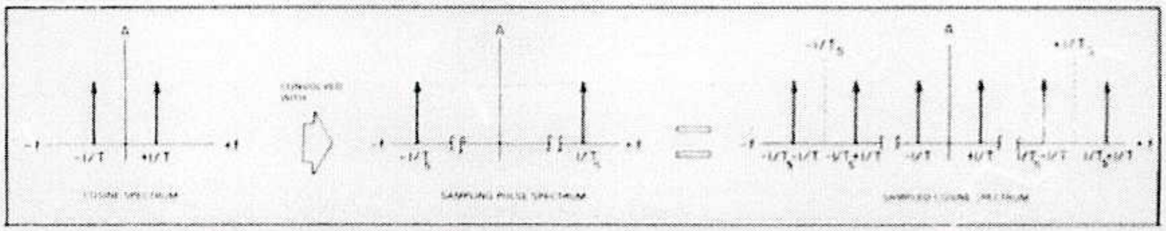


Figure 3-33. Convolving the Cosine Spectrum with the Sampling Pulse Spectrum.

3-146. Although there appear to be three sets of SIN X/X shapes, each set is replicated at intervals of 1/Ts (sampling frequency) out to infinity in both positive and negative frequency domains. A seeming paradox is that all the information needed by the 3582A is contained in one-half of any one set or one SIN X/X shape and its relationship to the origin or zero Hz mark. The other sets cannot be forgotten and may impair desirable data due to a characteristic of sampling systems called aliasing.

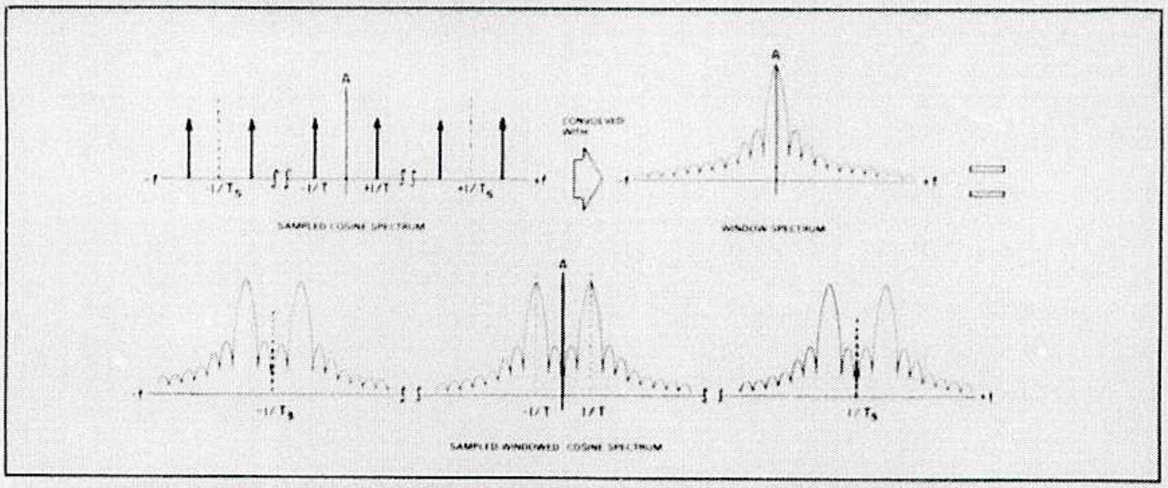


Figure 3-34. Convolving a Sampled Cosine Spectrum with a Window Spectrum.

3-147. Aliasing.

3-148. Consider what would happen if the frequency of the cosine wave were to increase. Each SIN X/X shape in a pair would separate (see Figure 3-35).

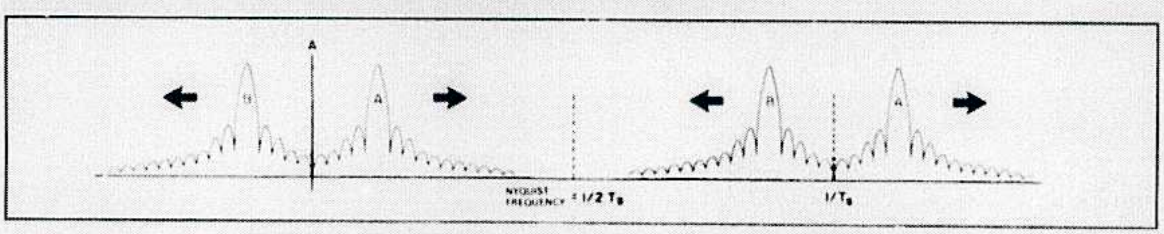


Figure 3-35. Increasing the Frequency of a Cosine Wave.

Remembering that the sampling frequency (1/Ts) is constant, it can be visualized that as the cosine wave continues to increase in frequency, the SIN X/X shapes will meet at a point half-way between the sampling frequency and the origin. This point is called the Nyquist Frequency and defines the maximum frequency of a sampled waveform. Any further increase in the waveform frequency above the Nyquist point will result in an overlapping of spectrums and contamination of data in the desirable region of the spectrum under analysis. This is called aliasing (see Figure 3-36).

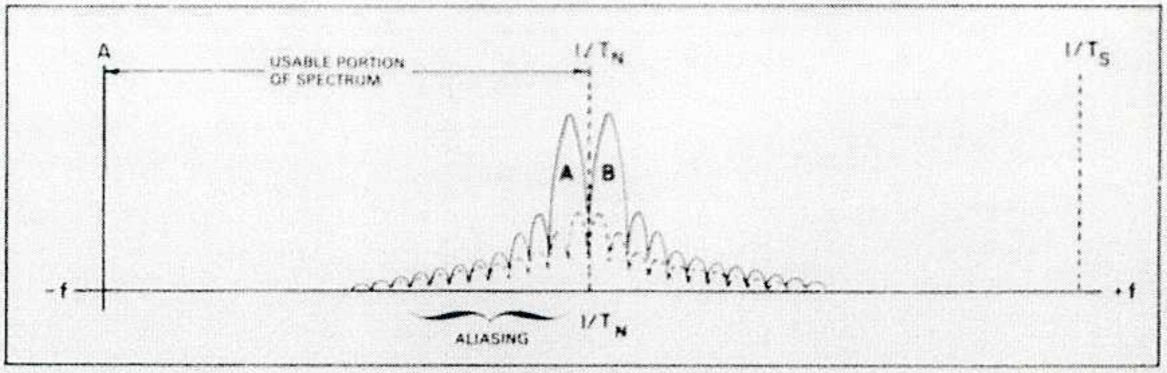


Figure 3-36. Aliasing.

3-149. Aliasing may be minimized by increasing the sampling frequency or filtering the input waveform so that frequency components above the Nyquist point are reduced to acceptable levels. The 3582A does the latter of the two and has an antialiasing filter in the input section which is flat to 25 kHz and then rolls off to approximately − 80 dB at 70 kHz. Since the sampling frequency is 102.4 kHz and the Nyquist Frequency is at 50 kHz, data within the dynamic range of the instrument should be free from alias contamination (see Figure 3-37).

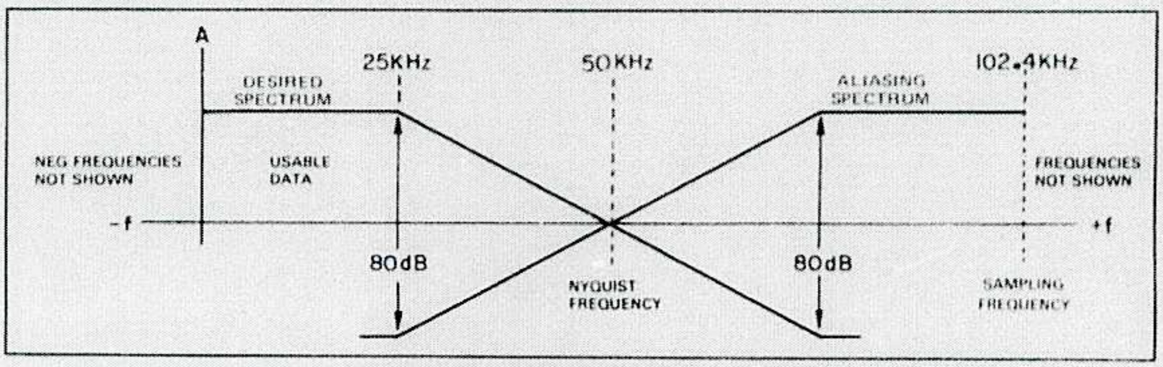


Figure 3-37. 3582A Antialiasing Filter.

3-150. Data in Memory.

3-151. Refer again to the SIN X/X shape (see Figure 3-38).

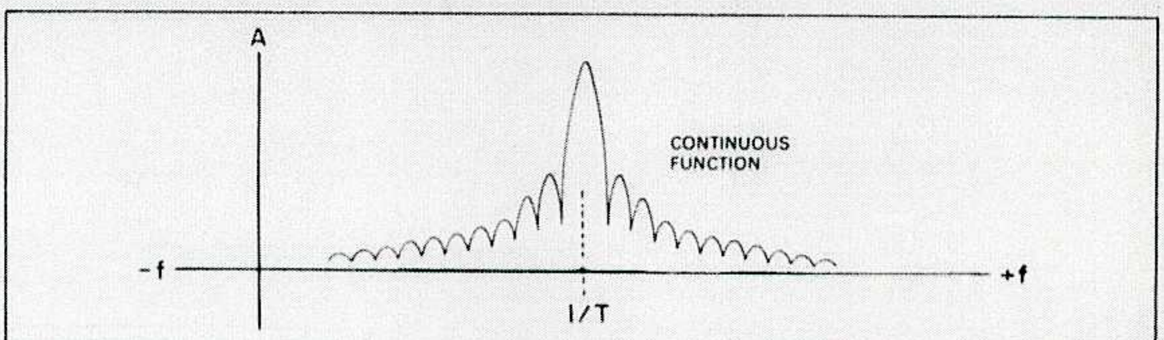


Figure 3-38. The Continuous Function.

3-152. What has been presented to this point is a graphical analogy of the continuous function resulting from the Fourier Transform of a cosine wave. But the 3582A uses an implementation of the Discrete Fourier Transform called the Fast Fourier Transform. The key here is the word discrete. Instead of the transform being evaluated for all frequencies, the discrete transform is evaluated at selected frequency intervals. Therefore, the discrete transform is an approximation of the continuous transform and the resemblance to the latter depends upon the number of frequency evaluation points. How many points are needed? Naturally, the more points evaluated, the more defined the function becomes. The 3582A has 256 display points on single trace and 128 display points on double trace stored in memory. These points are derived from a 1024 point or 512 point time record (the result of sampling) which also resides in memory. These combination of points are a compromise among filter design, memory allocation, and display information. A way of visualizing the spectrum points in memory is to think of the continuous function masked by a slotted overlay (see Figure 3-39).

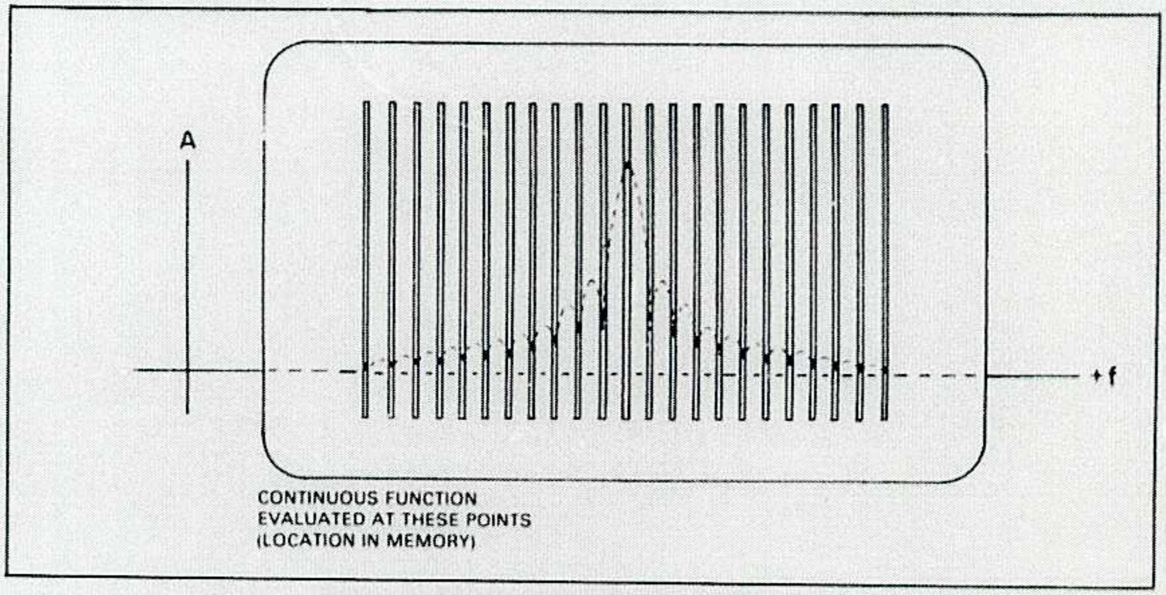


Figure 3-39. Spectrum Points in Memory.

3-153. Interpreting the Display.

3-154. It is now easy to understand that each location in memory is a frequency point (commonly referred to as a frequency bin) and that the digital word in that location (bin) represents the amplitude and phase at that point. The Display Section contains the hardware and firmware which allows the display to be shown as the data points connected by straight line segments (see Figure 3-40).

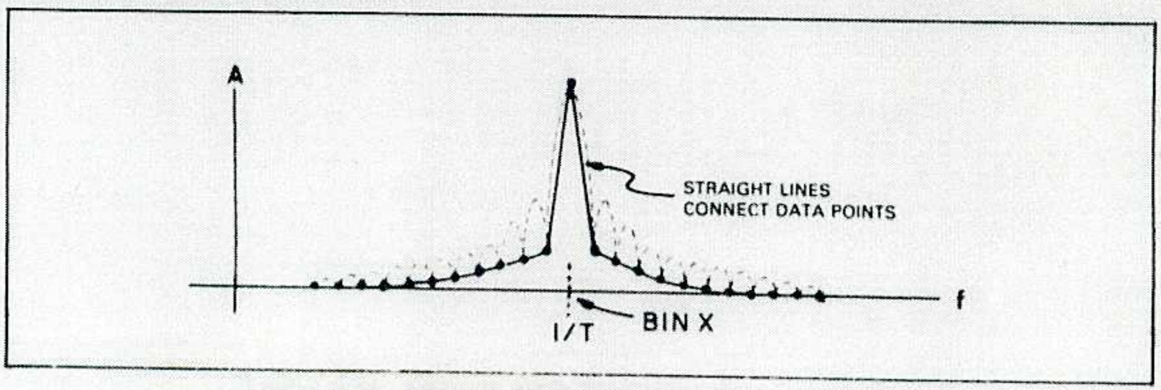


Figure 3-40. Memory Data Points Displayed on CRT.

3-155. Notice that many of the spectrum points occur in the valleys (nulls) of the SIN X/X shape. Remembering that the frequency bins are fixed relative to the frequency scale, what would happen if the cosine wave input were to change slightly in frequency? Spectrum points will now be determined at other parts of the SIN X/X shape (see Figure 3-41). This distorted spectrum is the result of leakage.

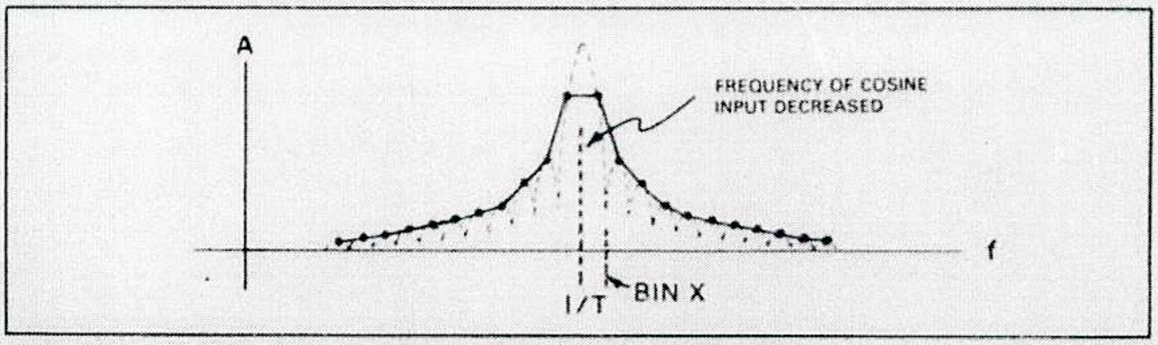


Figure 3-41. Leakage of Energy.

3-156. Leakage.

3-157. A property of the SIN X/X shape is that the nulls (valleys) line up with the bin frequencies whenever the center frequency of the waveshape under examination occurs at a bin frequency. Thus, changes result only when the frequency of the input is varied and the worst case occurs when the center frequency of the signal being analyzed is shifted between two adjacent bin frequencies. Because energy is related to amplitude, the undesirable changes in amplitude between adjacent bins is called leakage. The energy is said to have leaked from one bin to another. One method for reducing leakage is to modify the window function which operates on the time record.

3-158. Windowing.

3-159. As previously described, windowing involved the limiting of the number of samples of the input waveform to a particular interval of time. Therefore, windowing may be thought of as performing some operation on data as it passes through. Additional time domain windows may be added in series to manipulate frequency domain data through the convolution process (multiplication of data in the time domain).

3-160. The SIN X/X shape in the frequency domain was the result of time domain sampling with no further windowing operations applied. The frequency domain function produced inaccuracies when evaluated in a discrete manner. These inaccuracies were primarily due to the excessive relative amplitude of the sidelobes of the function (see Figure 3-42).

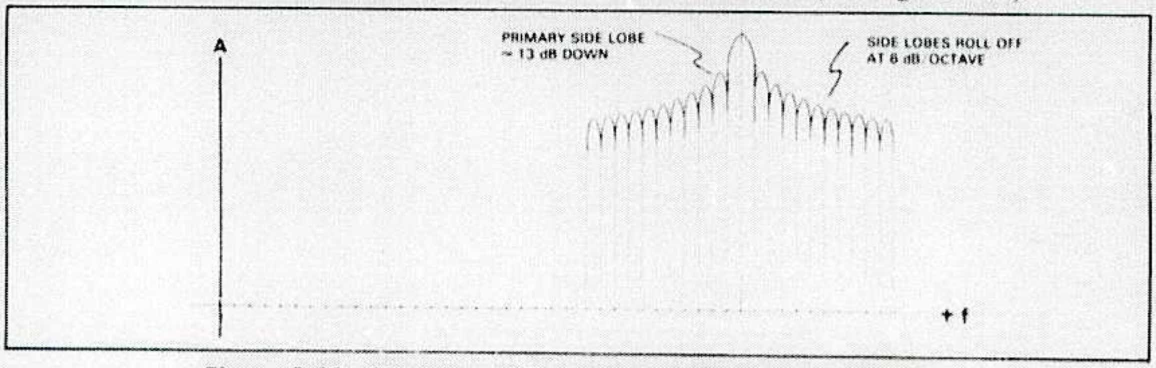


Figure 3-42. Sidelobes of Transformed Rectangular Window.

3-161. Notice that the primary sidelobes are only 13 dB down and that successive sidelobes roll off at 6 dB/octave. The sidelobe amplitude may be reduced through the use of additional windowing operations, but this occurs only at the expense of increased bandwidth. This sidelobe-bandwidth tradeoff translates into an amplitude accuracy versus frequency resolution tradeoff when the choice of passbands needs to be considered.

3-162. The additional windowing functions are accomplished when time domain data is shifted from the accumulated time record buffer in memory to another buffer in memory where the Fast Fourier Transform is performed (see Figure 3-43).

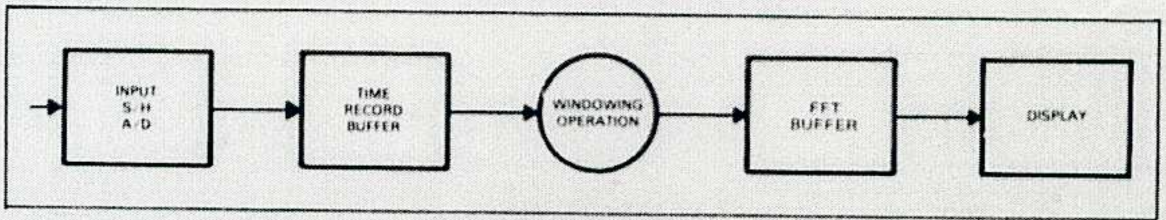


Figure 3-43. Data Flow.

3-163. Window Functions.

3-164. The window functions, including additional notes are presented as follows:

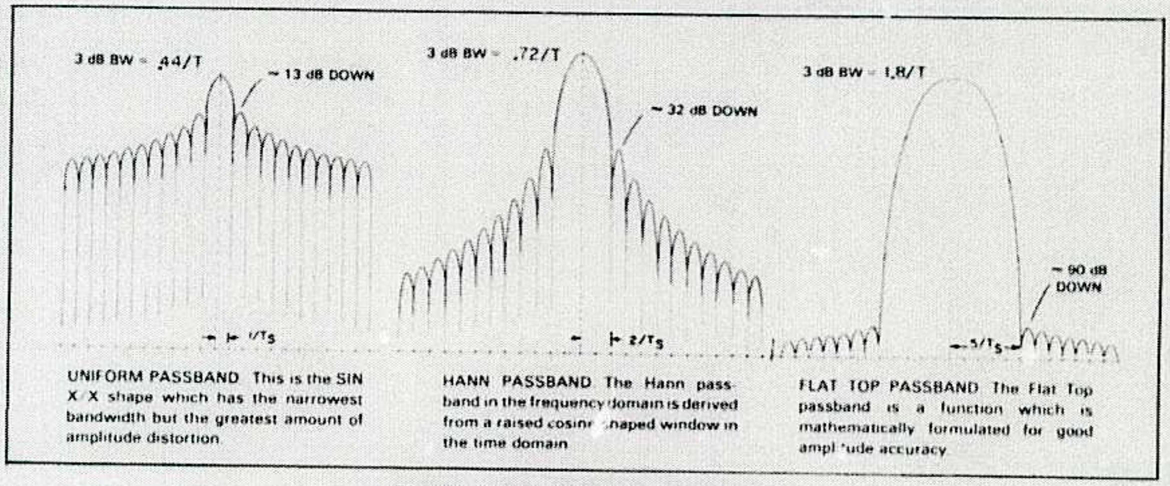


Figure 3-44. Window Functions.

NOTE

The Hann window, commonly referred to as the Hanning window, was discovered by Julius von Hann. Hanning refers to the operation of applying a Hann window.

SECTION III PART II
REMOTE OPERATION

3-165. REMOTE OPERATION.

NOTE

The 3582A may be remotely controlled in much the same manner as it is controlled manually. Therefore, it is recommended that the manual operation of the instrument be learned before remote operation is attempted.

3-166. INTRODUCTION.

3-167. The following information concerning remote operation of the 3582A via the Hewlett-Packard Interface Bus (HP-IB) will be supplemented with examples using the -hp- 9825A Calculator and -hp- 1000 computer (controllers) with equivalent examples incorporating the Meta Message concept. For a condensed description of the HP-IB, see Appendix B. For a condensed description of the Meta Message concept, see Appendix C.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1975, "Standard Digital Interface for Programmable Instrumentation".

3-168. While the -hp- 9825A and -hp- 1000 are specific controllers, fully capable of implementing all the HP-IB functions used with the 3582A, the Meta Message equivalent may be referenced to by any controller which is HP-IB compatible.

NOTE

Not all HP-IB compatible controllers may possess the sophistication necessary to utilize the complete remote capabilities of the 3582A.

3-169. 3582A REMOTE FUNCTIONS.

3-170. General Description.

3-171. In remote operation, the 3582A has even greater flexibility than in manual operation. The following functions describe how the 3582A may be controlled through the HP-IB:

Remote Front-Panel Programming
: In addition to the normal front panel switch controls, the operation of the 3582A can be controlled by remote commands sent on the HP-IB.

Instrument Data Output

Display data, alphanumerics, switch settings and other useful data can be output from the instrument for the purpose of making plots, additional processing, etc.

Instrument Data Input

Time record data obtained by external means can be input to the instrument for analysis. Also, any of the instrument data output may be reentered into the instrument at a later time.

Instrument Signal Processing Control and Status

Additional special HP-IB commands allow limited control of the signal processing. An 8 bit status word is available to indicate various states of the signal processing.

3-172. REMOTE FRONT PANEL PROGRAMMING.

3-173. The Command List specifies all of the functions which may be activated by the 3582A via the HP-IB. Note that many of the functions are the remote equivalent of setting a front panel switch manually and may be executed in similar sequences. For example, the arm command (AR) would not be given until all other applicable functions are set for a measurement operation. The Command List is given in Appendix A.

3-174. The HP-IB status light "REMOTE", located at the lower left of the front panel, indicates whether the instrument is currently operating under local (front panel switches) or remote control. Remote operation is accomplished only via commands sent on the HP-IB.

3-175. When the instrument is in local, the operation is determined solely by the front panel settings. At the time that the instrument is programmed to remote, the operation remains exactly the same as it was in local. Additional commands sent on the HP-IB can change the mode of operation. Returning to local, either by pushing the LOCAL button or by an HP-IB command, causes the instrument to return to front panel switch control.

3-176. Syntax.

3-177. The Command List (actually sent as DATA) is divided into groups of related operations. Each command in a group is divided into a function and a setting (some groups do not have settings). If the function is a front panel switch, the letters will correspond to the underlined letters of the name of that switch on the front panel. The setting indicates a switch position. A zero setting will indicate that the switch is out (OFF) and numbers greater than zero indicate that the switch is in (ON) or set at some other position (rotary switches and slide switches). On rotary and slide switches, a one (1) will indicate a counterclockwise or left most position (COUPLING switches excepted, a one indicates ac).

3-178. Adjust Frequency. For Adjust Frequency (AD Ø-24999), the setting is a number which corresponds to the CENTER or START frequency in the band analysis modes.

3-179. Marker Position. The marker position setting corresponds to a position on the display. For single trace modes of operation, the marker may be programmed to one of 256 horizontal positions. For dual trace operation, the marker may be programmed to one of 128 horizontal positions on the selected trace.

3-180. Delimiters.

3-181. Delimiters are not needed, but if desired, commas, spaces, upper or lower case alphanumerics can be used.

NOTE

The last character needs to be followed by a CRLF, space, or a comma. For example, the 9825A automatically sends this information if the **wrt** *statement is used. If the* **cmd** *statement is used, these additional characters must be supplied. The PRINT statement on the -hp- 1000 automatically defaults to CRLF if these characters are forgotten. Spaces following characters will not effect the messages sent, except for the write alphanumerics (WTA) command which requires the output string of characters to have a fixed number of characters (32) and may consist of spaces and/or alphanumeric characters.*

	-hp- 9825A	-hp- 1000
Example:	wrt711,"prs, ad442,ac1"	10 PRINT#11;"prs,ad442,ac1"
	wrt711,"PRSAD442AC1"	10 PRINT #11; "PRSAD422AC1"

3-182. SPECIAL FRONT PANEL COMMANDS.

3-183. Special commands are useful when it is desirable to set the front panel controls for a particular mode of operation. Special sequences are useful when data is being transferred between the 3582A and a controller.

3-184. Using Preset.

3-185. The preset (PRS) command places the 3582A front panel controls in a mode which is equivalent to that in the Turn-On Procedure. If the 3582A instrument appears to be "hung up" due to an inadvertant programming error, sending the PRS command will often return the instrument to an operating status. Furthermore, it is a good programming practice to "initialize" the front panel controls of the 3582A using the PRS command before entering an extensive programming sequence. See the Command List in Appendix A for the PRS switch settings.

3-186. Setting the Marker.

3-187. The marker position command (MP) combined with a marker position number (0–255 or 0–127) sets the marker horizontal position on the display. The marker position may be determined by the following equations:

$$\text{MARKER POSITION} = \frac{250 \text{ (or } 125^*)}{\text{SPAN}} \times (\text{fm} - \text{fs})$$

Where: fm = Desired marker frequency

fs = START FREQUENCY or $\left(\text{CENTER FREQUENCY} - \left(\frac{\text{SPAN}}{2}\right)\right)$

***NOTE**

The marker has 128 positions for each trace in dual mode.

3-188. Note that on larger spans and dual trace operation, the marker position (derived from the equation) will not be an integer for some frequencies. In this case, round the marker position to the nearest integer number.

3-189. INSTRUMENT DATA OUTPUT.

3-190. The listing commands are used to read control or display data from the 3582A. The general form for initiating a list command requires that the list command be given by the controller which sets the 3582A in a "talk" mode. The 3582A will then output data, as specified by the list command, to the controller which must then be programmed to the "listen" mode.

3-191. Listing Control Settings.

3-192. The position of some front panel control settings, in decimal or exponential format, may be read by the controller through the following list commands:

Command	Description	
LAD	List frequency adjust value NNNNN.NN CRLF	
LMK	List marker amplitude and frequency ± NNNNE ± NN, NNNNN.NNN CRLF	
LSP	List span (Hz) NNNNN CRLF	
LAS	List channel A sensitivity	± N.NNE ± NN CRLF
LBS	List channel B sensitivity	± N.NNE ± NN CRLF
LXS	List Transfer Function sensitivity	± N.NNE ± NN CRLF

3-193. Notice that all of the list commands above, except LMK, require one variable in which to store the data in the controller. The LMK instruction requires two variables in which to store data, and both must be available when the LMK command is given. (See the HP-IB section of your controller manual for information on how to read from the HP-IB into multiple variables.) The sensitivities obtained by the LAS, LBS, and LXS commands are the same as those indicated on the display and are the total of the SENSITIVITY switch setting and the AMPLITUDE REFERENCE LEVEL switch setting. The units are either volts or dBV as determined by the LOG/LINEAR switches.

3-194. Program Examples.

-hp- 9825A	META Equivalent
0: "program to demo LAD comman d":	REMOTE
1: fxd 1;wrt 711,"LAD"	DATA: LAD
2: red 711,A; prt A;dsp "FREQ =",A	DATA: NNNNN.NN CRLF
3: lcl 711;end	LOCAL
*6446	

-HP - 1000- META Equivalent

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

10 CALL RMOTE(7)                                   REMOTE
20 PRINT #7; "LAD"                                 DATA: LAD
30 READ  #7;A                                      DATA: NNNNN.NN CRLF
40 PRINT "FREQUENCY ADJUST "A" HZ"
50 CALL GTL(7)                                     LOCAL
60 END
```

-hp- 9825A META Equivalent

```
0: "program to
 demo LMK comman                 REMOTE
 d":wrt 711,"LMK                 DATA: LMK
 ";red 711,A,B                   DATA: + NNNNE + NN, + NNNNN.NNN CRLF
1: flt 2;prt A,
 B;dsp "A=",A,
 "B=",B
2: lcl 711;end                   LOCAL
*17489
```

-HP- 1000 META Equivalent

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

10 CALL RMOTE(7)                                   REMOTE
20 PRINT #7;"LMK"                                  DATA: LMK
30 READ #7;B,C                                     DATA: + N.NNN E + NN,NNNNN.NNN CRLF

40 PRINT "MARKER AMPLITUDE ="B" DBV"
45 PRINT "MARKER FREQUENCY ="C" HZ"
50 CALL GTL(7)                                     LOCAL
60 END
```

-hp- 9825A META Equivalent

```
0: "program to
 demo LSP comman
 d":
1: fxd 1;wrt                     REMOTE
 711,"LSP"                       DATA: LSP
2: red 711,A;                    DATA: NNNNN CRLF
 prt A;dsp "SPAN
 =",A
3: lcl 711;end                   LOCAL
*323
```

```
-HP - 1000-                              META Equivalent

-----------

10 CALL RMOTE(7)                         REMOTE
20 PRINT #7; "LSP"                       DATA: LSP
30 READ  #7;A                            DATA: NNNNN CRLF
40 PRINT "SPAN "A" HZ"
50 CALL GTL(7)                           LOCAL
60 END
```

```
-hp- 9825A                               META Equivalent

0: "program to
 demo LAS comman
 d":
1: flt 2;wrt                             REMOTE
 711,"LAS"                               DATA: LAS
2: red 711,A;                            DATA: ±N.NNE±NN CRLF
 prt A;dsp "ASEN
 S=",A
3: lcl 711;end                           LOCAL
*29531
```

```
-HP - 1000-                              META Equivalent

-----------

10 CALL RMOTE(7)                         REMOTE
20 PRINT #7; "LAS"                       DATA: LAS
30 READ  #7;A                            DATA: ±N.NNE±NN CRLF
40 PRINT "CH. A SENSIVITY (DBV/V):"A
50 CALL GTL(7)                           LOCAL
60 END
```

3-195. Listing Display Data. The display graphics or the display alphanumerics may be listed using the following instructions:

Command	Description
LDS	List display (128, 256, or 512 points in corresponding units) each point ±N.NNE±NN separated by commas; CRLF
LAN	List alphanumerics (128 ASCII characters, CRLF;representing the four 32 character lines)

3-196. The LDS instruction causes the 3582A to output data from the display in three different quantities. The number of points which are outputted depends upon the particular mode of operation the instrument is in when the LDS command is received (see Table 3-2).

Table 3-2. LDS Points Returned.

No. of Points	Mode of Operation
128	Single trace in dual channel mode
256	1. Single trace in single channel mode 2. Dual trace in dual channel mode (128 points for channel A followed by 128 points for channel B) 3. Single time trace in dual channel mode
512	Single trace time in single channel mode

3-197. The points are outputted in corresponding units. That is, the SCALE and SENSITIVITY will determine the type of units and the relative magnitude. However, the magnitude of the time points are determined by the SENSITIVITY setting alone. Each group of ASCII coded characters is separated by commas with the CRLF sent after the last point.

NOTE

It is important to note that some controllers may not accept a comma as a delimiter and therefore may require special programming steps in order to receive and retain the number representing each point sent.

3-198. Note that if the display is listed when the instrument is in the UNCAL (uncalibrated) mode, the units which are output will be different than when the instrument is in the CAL mode (see Table 3-3).

Table 3-3. Output Units.

Function	CAL		UNCAL
Amplitude	dBV (log)	Volts (lin)	0 to 1
Time	−1 to +1		0 to 1
Phase	−200 to +200		0 to 1
Transfer Function	dB		dB

3-199. Program Example.

-hp- 9825A	META Equivalent
0: "program to demo LDS command":	
1: fmt 1,f4.0,2x,e10.2;wrt 711,"LDS"	REMOTE DATA: LDS
2: red 711	
3: for I=0 to 9	
4: red 731,A;wrt 16.1,I,A	DATA: Each point +N.NNE+NN separated by commas; CRLF sent last
5: next I	
6: spc 2;lcl 711;end	LOCAL
*23532	

3-200. The LAN (list alphanumerics) instruction causes the 3582A to output 128 ASCII coded characters which represent the four alphanumeric display lines. Note that some symbols such as √ (square root) do not have an ASCII equivalent and may require conversion to another code form. Table 3-4 gives the displayed character and the ASCII equivalent which is sent or received over the HP-IB.

Table 3-4. Display-ASCII Equivalents.

LISTEN					TALK		LISTEN					TALK	
OCT	DEC	CHAR SENT	CHAR DISP	CHAR RETN	OCT	DEC	OCT	DEC	CHAR SENT	CHAR DISP	CHAR RETN	OCT	DEC
41	33	!	!	!	41	33	104	68	D	D	D	104	68
42	34	[illegible]	µ	µ	165	117	105	69	E	E	E	105	69
43	35	#	[illegible]	[illegible]	141	97	106	70	F	F	F	106	70
44	36	$	[illegible]	[illegible]	155	109	107	71	G	G	G	107	71
45	37	%	[illegible]	[illegible]	172	122	110	72	H	H	H	110	72
46	38	&	[illegible]	[illegible]	170	120	111	73	I	I	I	111	73
50	40	(	[illegible]	[illegible]	57	47	112	74	J	J	J	112	74
51	41	)	[illegible]	[illegible]	134	92	113	75	K	K	K	113	75
52	42	*	*	*	52	42	114	76	L	L	L	114	76
53	43	+	+	+	53	43	115	77	M	M	M	115	77
55	45	-	-	-	55	45	116	78	N	N	N	116	78
56	46	.	.	.	56	46	117	79	O	O	O	117	79
57	47	/	/	/	57	47	120	80	P	P	P	120	80
60	48	0	0	0	60	48	121	81	Q	Q	Q	121	81
61	49	1	1	1	61	49	122	82	R	R	R	122	82
62	50	2	2	2	62	50	123	83	S	S	S	123	83
63	51	3	3	3	63	51	124	84	T	T	T	124	84
64	52	4	4	4	64	52	125	85	U	U	U	125	85
65	53	5	5	5	65	53	126	86	V	V	V	126	86
66	54	6	6	6	66	54	127	87	W	W	W	127	87
67	55	7	7	7	67	55	130	88	X	X	X	130	88
70	56	8	8	8	70	56	131	89	Y	Y	Y	131	89
71	57	9	9	9	71	57	132	90	Z	Z	Z	132	90
72	58	:	:	:	72	58	134	92	\	[illegible]	[illegible]	134	92
74	60	[illegible]	[illegible]	[illegible]	74	60	144	100	d	d	d	144	100
76	62	[illegible]	[illegible]	[illegible]	162	114	155	109	m	m	m	155	109
77	63	?	[illegible]	[illegible]	77	63	162	114	r	r	r	162	114
101	65	A	A	A	101	65	165	117	u	u	u	165	117
102	66	B	B	B	102	66	170	120	[illegible]	[illegible]	[illegible]	170	120
103	67	C	C	C	103	67	172	122	z	z	z	172	122

3-201. Program Example.

```
-hp- 9825A

0: "program to
 demo LAN comman
 d":
1: dim A$[130];
 fxd 0
2: wrt 711,"LAN"
3: red 711,A$
4: wrt 16,A$[1,
 32]
5: wrt 16,A$[33,
 64]
6: wrt 16,A$[65,
 96]
7: wrt 16,A$[97,
 128]
```

META Equivalent

REMOTE
DATA: LAN
DATA: 128 ASCII characters, CRLF

```
8: wrt 0,A$[1,
 32];stp
9: wrt 0,A$[33,
 64];stp
10: wrt 0,A$[65,
 96];stp
11: wrt 0,A$[97,
 128];stp
12: lcl 711;end                    LOCAL
*5323
```

```
    -HP - 1000-                    META Equivalent
    -----------

  1 DIM A$(140)
  2 FOR I = 1 TO 130
  3 A$(I) = "X"
  4 NEXT I
 10 CALL RMOTE(7)                  REMOTE
 20 PRINT #7;"LAN"                 DATA: LAN
 30 READ #7;A$                     DATA: 128 ASCII CHARACTERS,
                                         CRLF
 40 PRINT A$(1,32)
 50 PRINT
 60 PRINT A$(33,64)
 70 PRINT
 80 PRINT A$(65,96)
 90 PRINT
100PRINT A$(97,128)
110CALL GTL(7)                     LOCAL
120END
```

3-202. INSTRUMENT DATA INPUT.

3-203. Writing Alphanumeric Messages.

3-204. Alphanumeric messages may be written into any of the four alphanumeric lines on the display through the use of the following instruction:

WTA 1-4, 32 ASCII Characters

select line 1,2,3, or 4 *Use blanks to fill up remaining spaces to total 32.*

The first part of the instruction (WTA) should be followed immediately by a line number and a comma. The next 32 characters are reserved for the text of the message. For example, to write "A COSINE SPECTRUM" on line 1 of the display, the command and message would appear as follows (Δ means space):

"WTA1,ΔΔΔΔΔΔΔAΔCOSINEΔSPECTRUMΔΔΔΔΔΔΔΔ"

NOTE

The text of the message must have at least 32 characters or the 3582A will not display the message and will appear to be "hung up" while waiting for the completion of the message.

3-205. Program Example.

```
-hp- 9825A                         META Equivalent

0: "program to
 demo WTA comman
 d":
1: dim B$[37]
2: "WTA1,"→B$[1,
 5];dsp "Write
 a 32 character
 message";wait
 5000;ent B$[6,
 37]
3: prt B$[6,37];                   REMOTE
 wrt 711,B$                        DATA: WTA1, 32 ASCII characters
4: lcl 711;end                     LOCAL
*23868
```

3-206. WORKING WITH MEMORY.

3-207. The RAM (Random Access Memory) contents are completely accessible via the HP-IB. Data in memory is stored in a binary format consisting of 16 bit words. But information is transferred over the HP-IB in 8 bit bytes, therefore, two bytes are required to transmit or receive memory word.

3-208. The Binary Format.

3-209. In order to work with memory data directly, it is important that the binary format of words be understood. The words themselves indicate a magnitude for numerics or a particular code for alphanumerics. There are no units indicated in a numeric word and the word is simply a 2's complement binary number with an equivalent decimal range of from −32768 to +32767 (see Figure 3-45).

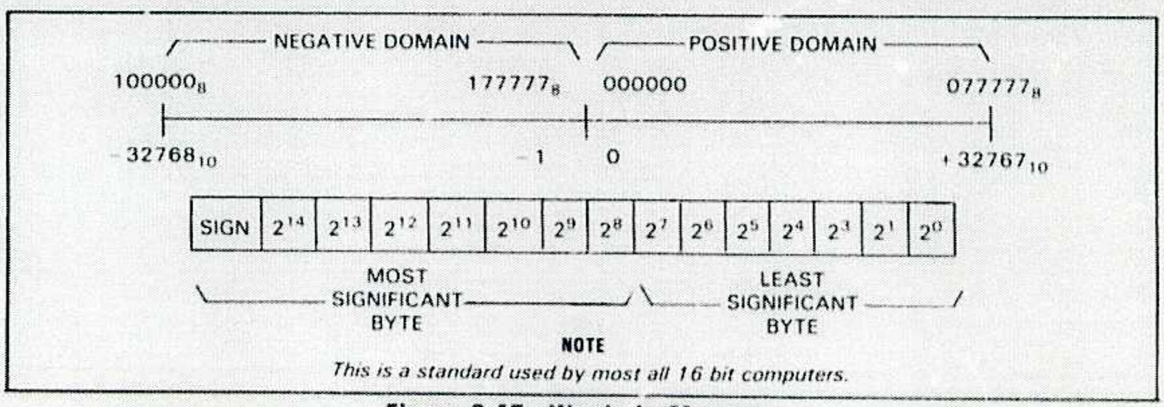


Figure 3-45. Words in Memory.

3-210. In the display section of memory, numerics and alphanumerics are mixed together and require a decoding procedure if they are to be interpreted by a controller program as binary data. This will generally not be necessary since the List Display commands perform the decoding operations and transmit the words in ASCII format.

3-211. When binary data is transmitted over the bus between the controller and the 3582A, the most significant byte of a 16 bit word is sent first followed by the least significant byte.

3-212. Memory Instructions.

3-213. There are two instructions for working with binary memory data. These commands are primarily for the advanced user who wishes to input his own time record or display or to do special processing:

Command	Description
LFM,M,N	List from memory
WTM,M,N	Write to memory

Where: M = Start address (octal)
N = Number of words to be transferred (decimal)
Data is in 2N 8 bit bytes, most significant byte first

3-214. These memory instructions are transmitted via the HP-IB in ASCII format. The controller must be programmed to take the appropriate action directly after the instruction is sent with no intervening messages. Each instruction requires that the memory location (in octal) be specified. For example, if a time record is to be entered into the 3582A for processing, the instruction would appear as follows:

WTM,70000,1024

NOTE

The 3582A starts accepting or sending binary data after the LF character is sent. The CRLF is automatically sent by the 9825A if the **wrt** *command is used and by the -hp- 1000 when the PRINT statement is used. For other commands and controllers, check the order and type of characters used as delimiters. When the LFM or WTM instruction is used, a CR or LF is not sent by the 3582A after the binary string, nor is it looked for after a binary string is received from the controller.*

After the instruction is given, the controller may send the data as a character string or as individual bytes. (Character strings may be composed of 8 bit bytes and are one of the faster methods for transferring data between the controller and the 3582A.) See EXAMPLE FLOWCHARTS AND PROGRAMS.

3-215. Memory Locations.

3-216. The principal memory locations of interest are given as follows:

Description	Start Address (M, octal)	Number of Words (N, decimal)	Binary Format
Time Record	70000	1024	Numeric
Display	74000	512	Alphanumeric
Front Panel Switches	77454	5	Numeric
Stored Trace 2	75400	256	Numeric

3-217. INSTRUMENT SIGNAL PROCESSING CONTROL AND STATUS.

3-218. Service Request.

3-219. Service Request (SRQ) is set only as a result of syntax errors caused by improper HP-IB commands. It is cleared by a DEVICE CLEAR or cleared as the result of a SERIAL POLL. When cleared, the five bit status byte returned will always consist of zeros.

3-220. Status Word.

3-221. The status word may be used to determine what operational state the 3582A is in. The eight bit status word contains the following information:

Bit	Value	Meaning
Ø	1	Diagnostic on screen. Indicates current switch setting is invalid. Set and cleared by 3582A.
1	2	Arm light is on. Set and cleared by 3582A to agree with arm light on front panel.
2*	4	A overload. Set by 3582A when 1. Time record is moved to FFT area or time record is complete 2. and hardware overload has occurred 3. and A or BOTH INPUT MODE
3*	8	B overload. Same as A.
4*	16	Time record complete. Set when 1024 new time points have been taken since last record complete. Set when time complete data has been FFT'D and displayed. Use LST1 to check this flag! It depends on internal flags which are cleared by LSTØ.
6*	64	Average complete.
7*	128	X-Y plot complete. if two traces are plotted, it is set after the final trace.

NOTE

The Status Word is not the same as the HP-IB STATUS BYTE. The STATUS BYTE returned as the result of a serial poll will be zeros since the only reason for an SRQ from the 3582A is incorrect HP-IB commands.

3-222. The two commands for obtaining a status word are:

Command	Description
LST1	Reads status word
~~LSTØ~~	~~Reads status word and then resets*~~

As with many other HP-IB commands, the controller first gives the command and then reads the returning byte into a variable for decoding. The LSTØ command resets the starred bits after they are read so that new information may be entered on the next machine cycle.

3-223. Program Example.

-hp- 9825A	META Equivalent
0: "program to demo LST comman d":	
1: moct;fxd 0; wrt 711,"LST1"	REMOTE DATA: LST1
2: dsp rdb(711); lcl 711;end	DATA: Binary 8 bit word LOCAL
*9201	

3-224. Processor Control Commands.

3-225. There are two processor control commands which can be used to improve data transfer rates when large blocks of data are transmitted.

Command	Description
HLT	Unconditional halt at next HP-IB branch point
RUN	Unconditional run

Without the use of these commands, the processor handles the HP-IB in an interrupt mode of operation. When the HLT command is given, the processor is stopped which allows practically direct memory access without unnecessary time delay. After the data is transferred, the processor may be returned to normal operation by giving the RUN command. However, no momentary buttons are processed when the processor is in the HLT mode.

3-226. EXAMPLE FLOWCHARTS AND PROGRAMS.

3-227. Loading a Time Record Into Memory.

3-228. The following flowchart presents the fundamental steps needed to load a time record into memory in the baseband 0–25 kHz mode. The time record should consist of 1024 data points with each point being a 16 bit 2's complement number (other magnitude ranges will require scaling). The example flowchart (see Figure 3-46) includes scaling for a function which has a range between +1 and −1 and also conversion of the scaled number to an integer.

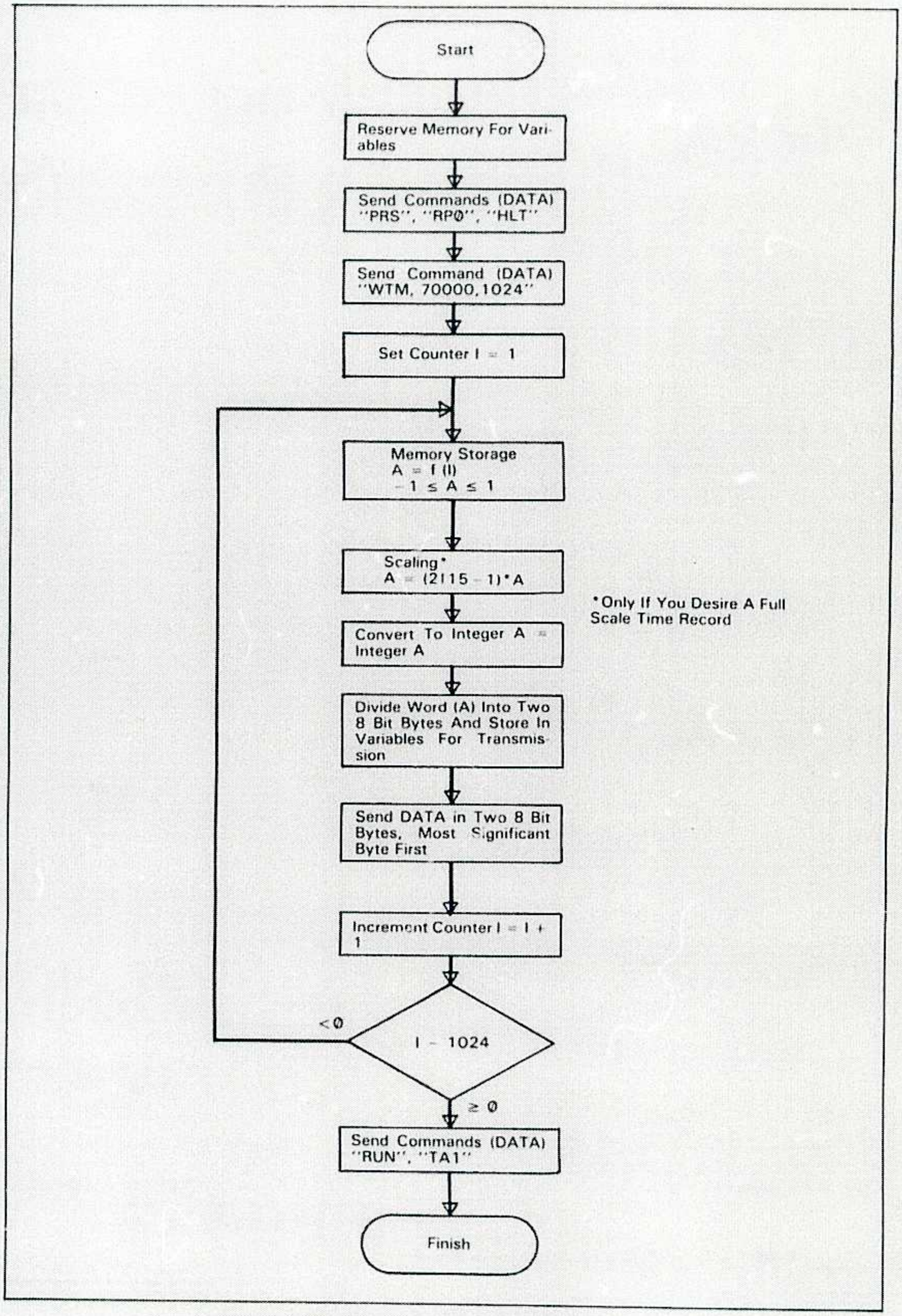


Figure 3-46. Storing a Time Record in Memory.

3-229. Program Example: Writing to Memory.

-hp- 9825A	META Equivalent
`0: "program to demo WTM comman d":`	
`1: rad;wrt 711, "TA1"`	REMOTE DATA: TA1
`2: mdec;dim A[10 24]`	
`3: for I=1 to 1024`	
`4: 20000*cos(2π* (I-1)/256)→A[I]`	
`5: next I`	
`6: fmt 1,"WTM, 70000,1024"`	
`7: wrt 711.1`	DATA: WTM,70000,1024
`8: beep`	
`9: for I=1 to 1024`	
`10: wtb 731,shf( A[I],8)`	DATA: Most significant 8 bit byte
`11: wtb 731,band (255,A[I])`	DATA: Least significant 8 bit byte
`12: next I`	
`13: beep`	
`14: end`	
`*9460`	

3-230. Reading Binary Data From Memory.

3-231. The following flowchart presents the fundamental steps needed to read data from memory. A very useful function, derived from this operation, is the storage of data for long periods of time. Remember that if the 3582A is turned off, all data in RAM is lost. As an example, switch settings, time records, or the entire display may be stored in the controller and then later written back into the 3582A memory (using a technique similar to entering a time record but without the need for scaling since the data itself is merely being stored and not operated on). The example flowchart (see Figure 3-47) includes scaling* but this step may be skipped if the data is only to be stored.

3-232. The Learn Mode.

3-233. One method of programming the instrument is to use the PRS (preset) command and then program the control settings as necessary. Another method involves the Learn Mode. To use this method, the instrument controls are set up manually in the LOCAL mode of operation. The switch settings may then be stored in the controller by accessing the five switch registers using the LFM (list from memory) command. At a later time when it is desirable to duplicate the same switch settings, the controller may write the switch settings back into the five switch registers using the WTM (write to memory) command.

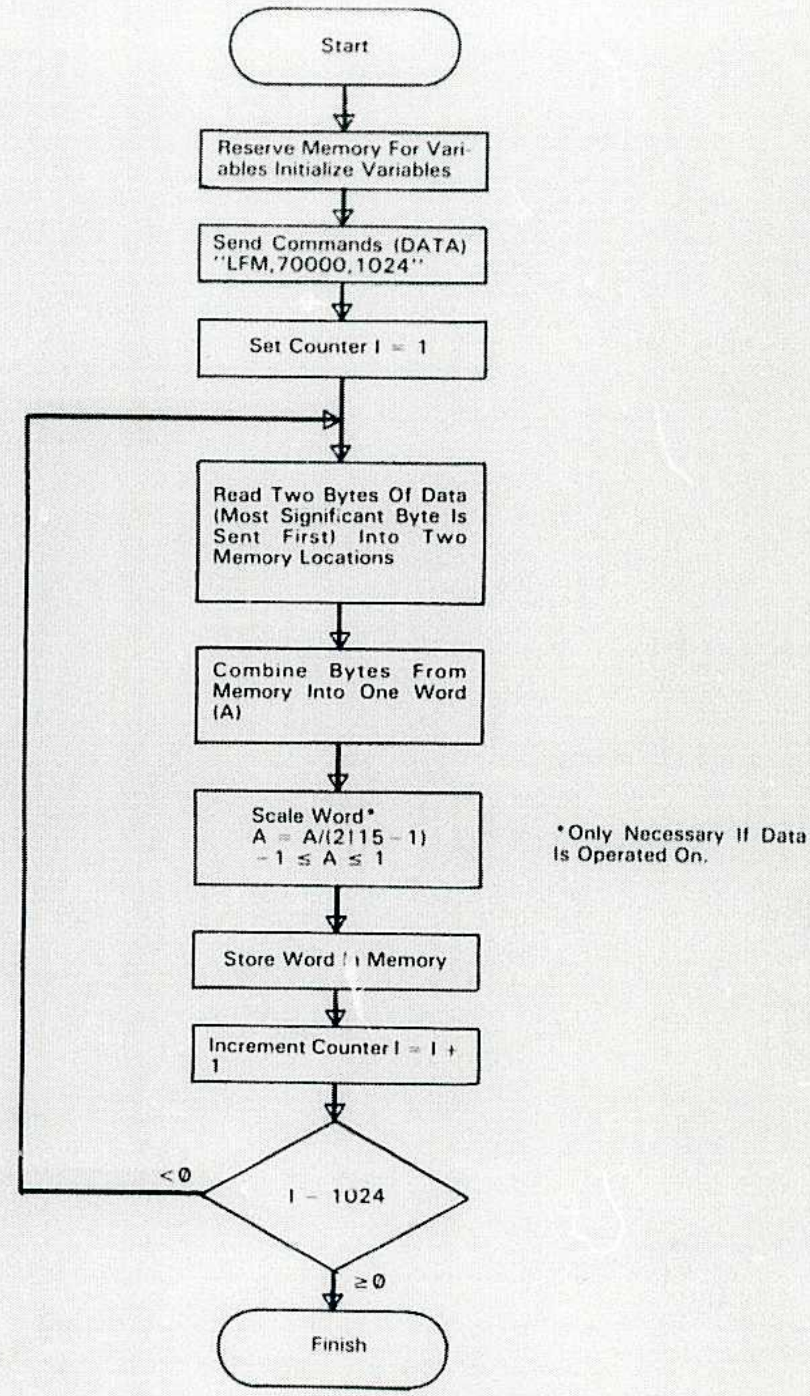


Figure 3-47. Reading Binary Data From Memory.

3-234. Program Example: The Learn Mode (reading and writing to memory).

-hp- 9825A	META Equivalent
0: "program to demo learn mode ":	
1: dim A[10]	
2: dsp "learn mode demonstration"	
3: wrt 711,"LFM, 77454,5"	REMOTE DATA: LFM,77454,5
4: rdb(711)→A[1]	DATA: Most significant 8 bit byte
5: for I=2 to 10	
6: rdb(711)→A[I] ;next I	DATA: Least significant 8 bit byte; remaining input alternates between MSB and LSB (bytes)
7: beep;dsp "switch settings learned"	
8: wait 1000; beep	
9: lcl 711;beep	LOCAL
10: dsp "press cont to reprogram 3582"	
11: stp	
12: wrt 711,"WTM ,77454,5"	REMOTE DATA: WTM,77454,5
13: wtb 711,A[1]	DATA: Most significant 8 bit byte
14: for I=2 to 10	
15: wtb 711,A[I]	DATA: Least significant 8 bit byte; remaining output alternates between MSB and LSB (bytes).
16: next I	
17: beep;end	
*8362	

3-235. Program Example: Plotting the Display.

-hp- 9825A

```
0: "program to
 plot and annota
 te display on
 a 9862 plotter"
 :
1: dim A[512],
 A$[130]
2: wrt 711,"LDS"
3: red 711
4: for I=1 to
 256;red 731,
 A[I]
5: next I
6: ent "Ymax",B,
 "Ymin",C
7: scl 1,256,C,B
8: axe 1,C,25.6,
 (B-C)/8
9: plt 1,C,1
10: for I=1 to
 256
11: plt I,A[I]
12: next I
13: wrt 711,"LAN
 ";red 711,A$
14: .97*(B-C)+
 C→E
15: plt 20,E,1;
 csiz ;lbl A$[1,
 32]
16: plt 147,E,1;
 lbl A$[65,96]
17: .93*(B-C)+
 C→E
18: plt 20,E,1;
 lbl A$[33,64]
19: plt 147,E,1;
 lbl A$[97,128]
20: plt 256,B,1;
 end
*13545
```

META Equivalent

REMOTE
DATA: LDS

DATA: Each point ±N.NNE±NN
separated by commas;
CRLF sent last

DATA: LAN
DATA: 128 ASCII characters, CRLF