Operator's Manual
SD385 NOMAD Portable Signal Analyzer
Part Four

Legacy Manual

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3-3.2 Setup Page 2 - INPUT/PROCESS CONTROL

Most of the Controls on this Setup Page can be accessed directly from the data display and the front panel without accessing Setup Page 2. Figure 3-INP/PROC-1 shows the location of each of the Controls that can be accessed in this manner.

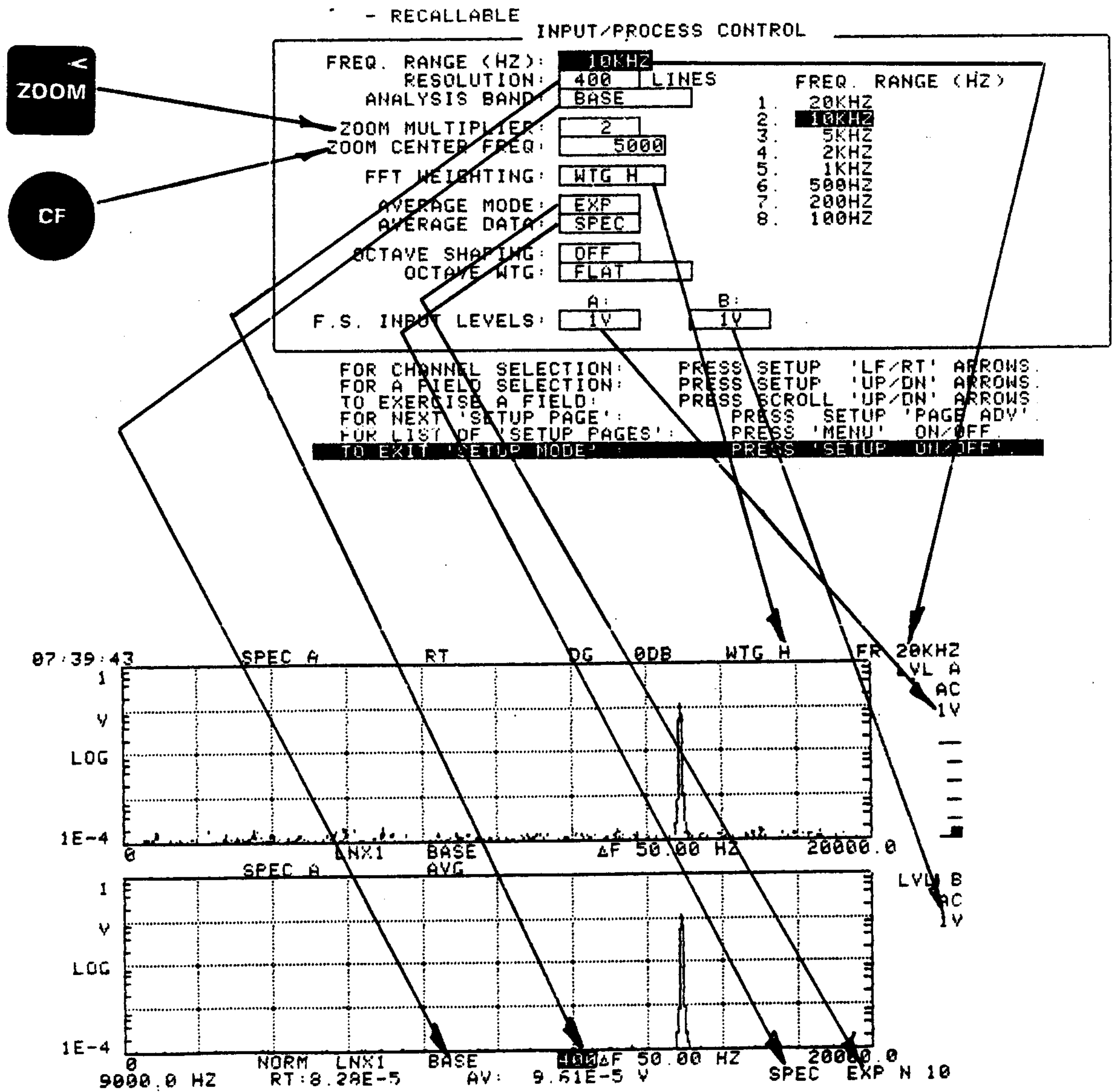


Figure 3-INP/PROC-1. Setup Page 2 Control Fields That Can Be Accessed Directly From the Data Display and Front Panel.

FREQ. RANGE (HZ):

```
         - RECALLABLE
        ______________ INPUT/PROCESS CONTROL ________________
  FREQ. RANGE (HZ): [10KHZ]
        RESOLUTION: [400  ]LINES        FREQ. RANGE (HZ)
     ANALYSIS BAND: [BASE     ]        1.  20KHZ
                                       2.  10KHZ
   ZOOM MULTIPLIER: [  2  ]            3.   5KHZ
  ZOOM CENTER FREQ: [   5000]          4.   2KHZ
                                       5.   1KHZ
     FFT WEIGHTING: [WTG H  ]          6.  500HZ
                                       7.  200HZ
      AVERAGE MODE: [EXP  ]            8.  100HZ
      AVERAGE DATA: [SPEC ]

    OCTAVE SHAPING: [OFF  ]
        OCTAVE WTG: [FLAT     ]
                      A:         B:
 F.S. INPUT LEVELS: [ 1V  ]    [ 1V  ]

 FOR CHANNEL SELECTION:      PRESS SETUP  'LF/RT' ARROWS.
 FOR A FIELD SELECTION:      PRESS SETUP  'UP/DN' ARROWS.
 TO EXERCISE A FIELD:        PRESS SCROLL 'UP/DN' ARROWS.
 FOR NEXT 'SETUP PAGE':          PRESS  SETUP 'PAGE ADV'.
 FOR LIST OF 'SETUP PAGES':      PRESS 'MENU'  ON/OFF.
 TO EXIT 'SETUP MODE'            PRESS 'SETUP  ON/OFF'
```

Control Menu for Selecting the Full Scale Analysis Range.

Menu selection is accomplished using the SCROLL group UP/DOWN buttons, or the ENTRY keypad.

RESOLUTION: - LINES

```
         - RECALLABLE
        ______________ INPUT/PROCESS CONTROL ________________
  FREQ. RANGE (HZ): [10KHZ]
        RESOLUTION: [400  ]LINES        RESOLUTION
     ANALYSIS BAND: [BASE     ]        1. 800
                                       2. 400
   ZOOM MULTIPLIER: [  2  ]            3. 200
  ZOOM CENTER FREQ: [   5000]          4. 100

     FFT WEIGHTING: [WTG H  ]

      AVERAGE MODE: [EXP  ]
      AVERAGE DATA: [SPEC ]

    OCTAVE SHAPING: [OFF  ]
        OCTAVE WTG: [FLAT     ]
                      A:         B:
 F.S. INPUT LEVELS: [ 1V  ]    [ 1V  ]

 FOR CHANNEL SELECTION:      PRESS SETUP  'LF/RT' ARROWS.
 FOR A FIELD SELECTION:      PRESS SETUP  'UP/DN' ARROWS.
 TO EXERCISE A FIELD:        PRESS SCROLL 'UP/DN' ARROWS.
 FOR NEXT 'SETUP PAGE':          PRESS  SETUP 'PAGE ADV'.
 FOR LIST OF 'SETUP PAGES':      PRESS 'MENU'  ON/OFF.
 TO EXIT 'SETUP MODE'            PRESS 'SETUP  ON/OFF'
```

Control Menu for Selecting Number-of-Lines of Resolution.

Selections on this Control Menu are for selecting the number-of-lines of resolution (number of data points in a time segment which determines the number of frequency points output by the FFT). The selections on this Control Menu have a direct affect on processing time. As the number of lines increases, processing time increases.

This Control Menu can be accessed from the data display. However, the annotation is hidden until the RV is positioned one step to the right of the ANALYSIS BAND Control Field. For Example: Press the FIELD LOCATOR group BAND button. Press the SETUP group RIGHT directional button, once. The RV will move to the RESOLUTION Control Field. This is shown in Figure 3-INP/PROC-2.

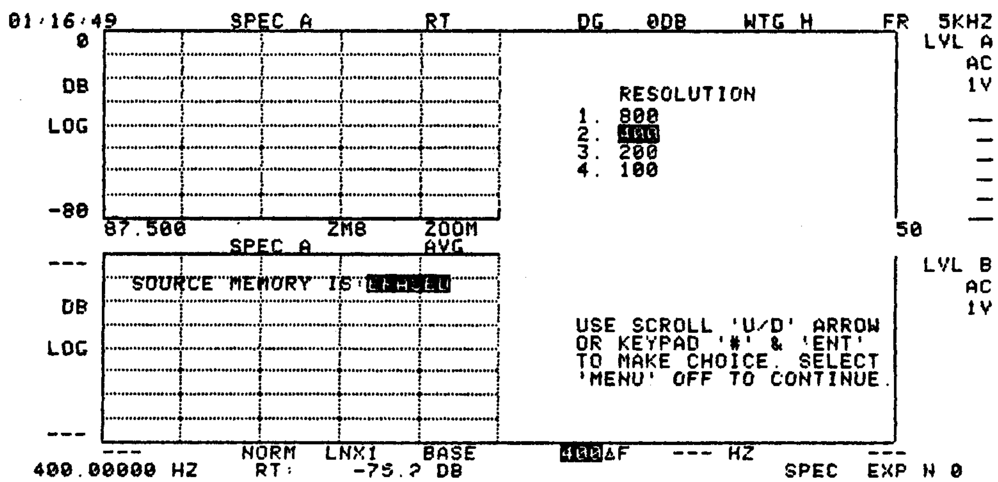


Figure 3-INP/PROC-2. Accessing the RESOLUTION Control Menu from the Data Display

ANALYSIS BAND:

```
- RECALLABLE
                    INPUT/PROCESS CONTROL
FREQ. RANGE (HZ): [10KHZ]
     RESOLUTION: [400  ] LINES            ANALYSIS BAND
  ANALYSIS BAND: [BASE      ]             1. BASE
                                          2. ZOOM
ZOOM MULTIPLIER: [  2  ]                  3. 15 1/3 OCT
ZOOM CENTER FREQ: [   5000]               4.  5 OCTAVE
   FFT WEIGHTING: [WTG H  ]               5. 30 1/3 OCT
                                          6. 10 OCTAVE
    AVERAGE MODE: [EXP  ]
    AVERAGE DATA: [SPEC ]

 OCTAVE SHAPING: [OFF  ]
     OCTAVE WTG: [FLAT      ]
                   A:          B:
F.S. INPUT LEVELS: [ 1V  ]     [ 1V  ]

FOR CHANNEL SELECTION:      PRESS SETUP  'LF/RT' ARROWS.
FOR A FIELD SELECTION:      PRESS SETUP  'UP/DN' ARROWS.
TO EXERCISE A FIELD:        PRESS SCROLL 'UP/DN' ARROWS.
FOR NEXT 'SETUP PAGE':          PRESS  SETUP 'PAGE ADV'.
FOR LIST OF 'SETUP PAGES':      PRESS 'MENU'  ON/OFF.
TO EXIT 'SETUP MODE':           PRESS 'SETUP  ON/OFF'.
```

Control Menu for Selecting the Analyzer's Basic Analysis Bandwidth.

1. BASE — Standard baseband analysis selection. Displayed range is from zero to selected full scale analysis range.

2. ZOOM — This selection enables the Zoom feature. This feature increases baseband resolution by a factor of 2 to 128 as selected on the ZOOM MULTIPLIER Control Menu or the front-panel ZOOM button. ZOOM Center Frequency is entered via the ZOOM CENTER FREQ Numerical Entry Field.

3. 15 1/3 OCT — 1/3 octave analysis. Total of 15 filters (per channel if the 2 channel Option is installed) and the overall signal will be displayed.

4. 5 OCTAVE — Full 1/1 octave analysis. Total of 5 filters (per channel) and the overall signal will be displayed.

5. 30 1/3 OCT — 1/3 octave analysis. Total of 30 filters per channel and the overall signal is displayed.

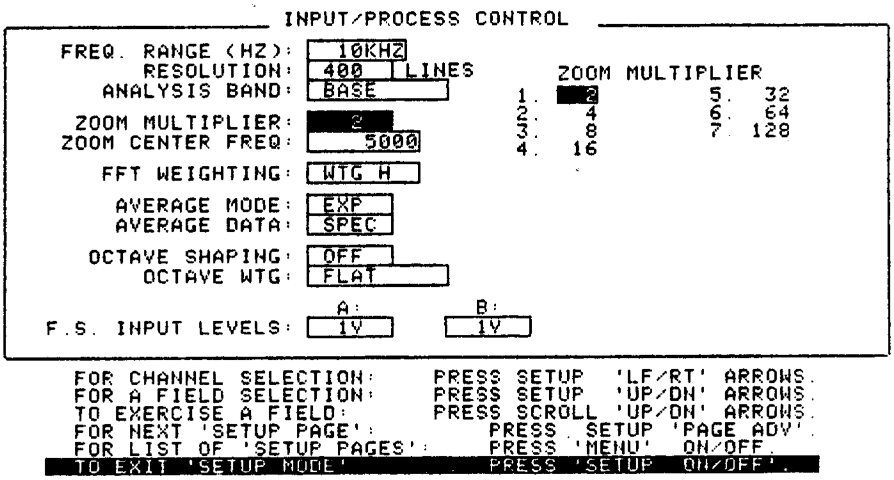
6. 10 OCTAVE — Full 1/1 octave analysis. Total of 10 filters per channel and the overall signal is displayed.

NOTE

When the selected Analysis Band is any of the Octave Bands (15 1/3, 5, 30 1/3, or 10), a digital plot of the Octave List may be obtained by selecting menu item 2, HRMNC, on the PLOT LIST SELECT menu located on Setup Page 8.

A more detailed description of the Octave Band selections can be found in subsection 3-3.2.1.

ZOOM MULTIPLIER:



Control Menu for Selecting the Zoom Multiplier.

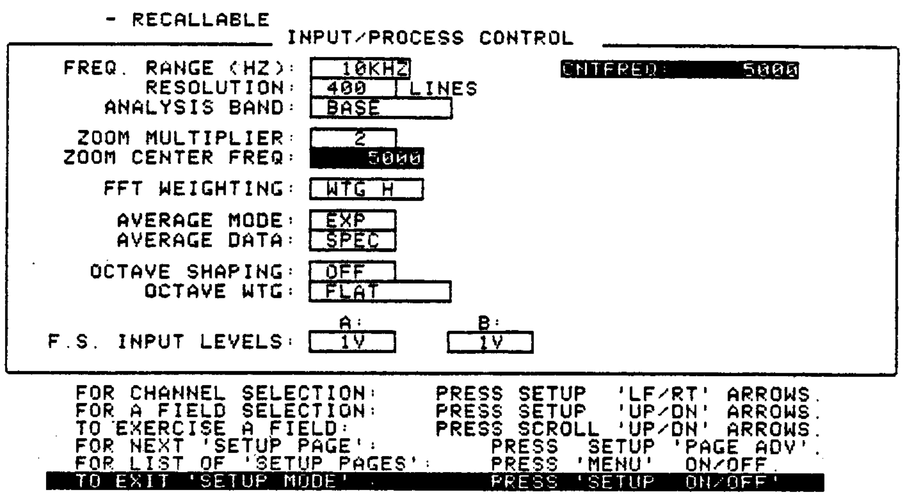
Selections are in binary powers of two. Baseband resolution (ΔF) is multiplied by the reciprocal of the selected Zoom Multiplier resulting in 2 to 128 times the normal baseband resolution. In addition, the selected frequency range is divided by the selected Zoom Multiplier resulting in a display window proportional to the zoomed ΔF (1/2, 1/4, 1/8,... 1/128 of the selected frequency range). However, available Zoom factors are frequency range dependent.

Freq Range	Sample Rate	LPF Cutoff	Zoom Factors
20kHz	51.2kHz	20kHz	(see following paragraph)
10kHz	25.6kHz	10kHz	2,4,8,16,32,64,128
5kHz	25.6kHz	10kHz	2,4,8,16,32,64
2kHz	10.24kHz	2.81kHz	2,4,8,16,32,64
1kHz	10.24kHz	2.81kHz	2,4,8,16,32
500 Hz	2.56kHz	663 Hz	2,4,8,16,32,64
200 Hz	2.048kHz	663 Hz	2,4,8,16,32
100 Hz	2.048kHz	663 Hz	2,4,8,16

When the 20kHz range is selected, narrow band data can be analyzed in the Zoom band only if the Input Memory is in HOLD. Limit is a Zoom of 16, or that imposed by the scroll limits established by entry of SET-1, SET-2. This will allow Zoom analysis of "held" 20kHz data.

The contents of this Control Menu can be exercised directly from the front panel (without displaying the Control Menu) via the SCROLL group ZOOM button. With the LED lit on the ZOOM button, the SCROLL group UP/DOWN buttons will increase/decrease the ZOOM MULTIPLIER (see the front panel description of the SCROLL group).

ZOOM CENTER FREQ:



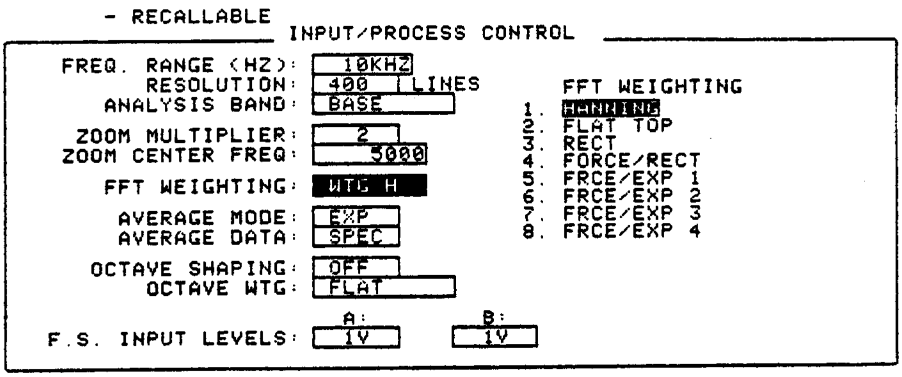
Numerical Entry Field for Entering the Center Frequency of the ZOOM Window.

ZOOM CENTER FREQ is a user-entered value that designates the Center Frequency of the ZOOM window. Values are entered by selecting the desired center frequency on the ENTRY keypad, and then pressing the ENT button. ZOOM Center Frequency can also be assigned from the front panel using the ENTRY group CF button. If the front-panel method is used, center frequency can be set by cursor location (when cursor has Hz readout) or by entering the desired numerical value as previously described.

The selected Center Frequency must be within the narrowband window. The entered value will be clamped to keep highest frequency of the resultant data from exceeding the full-scale frequency of the selected narrowband analysis range, and to keep lowest frequency above 0 Hz.

Zoom frequency accuracy is +/- .0025% of the center frequency.

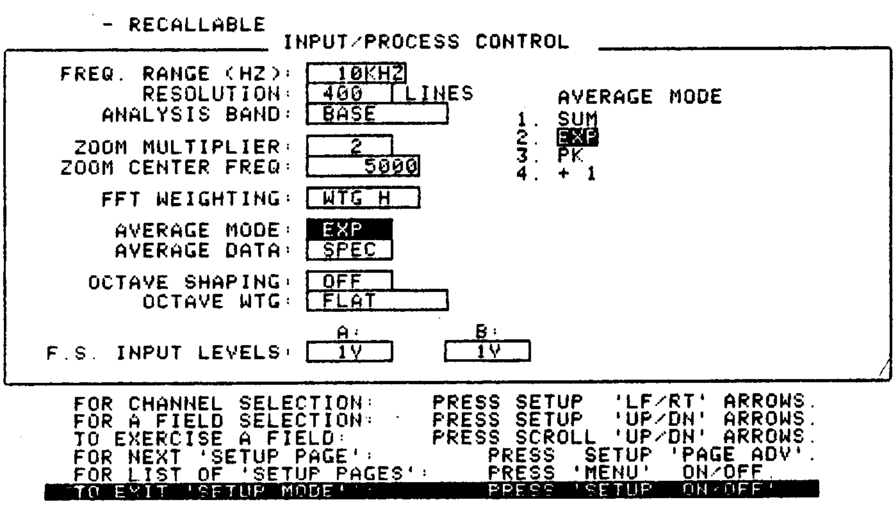
FFT WEIGHTING:



Control Menu for Selecting the FFT Weighting Function.

Weighting is the technique for treating the data in the time domain, before the FFT, in order to reduce the effect of side lobes and other variables, as the FFT is performed on a finite sample of Time Domain data. A more detailed description of weighting can be found in subsection 3-3.2.2. The selected weighting function will be applied to the input data immediately upon making the selection.

AVERAGE MODE:



Control Menu for Selecting the Average Mode.

The Average Mode tells the analyzer <u>how</u> to accumulate data in the Averager Memory.

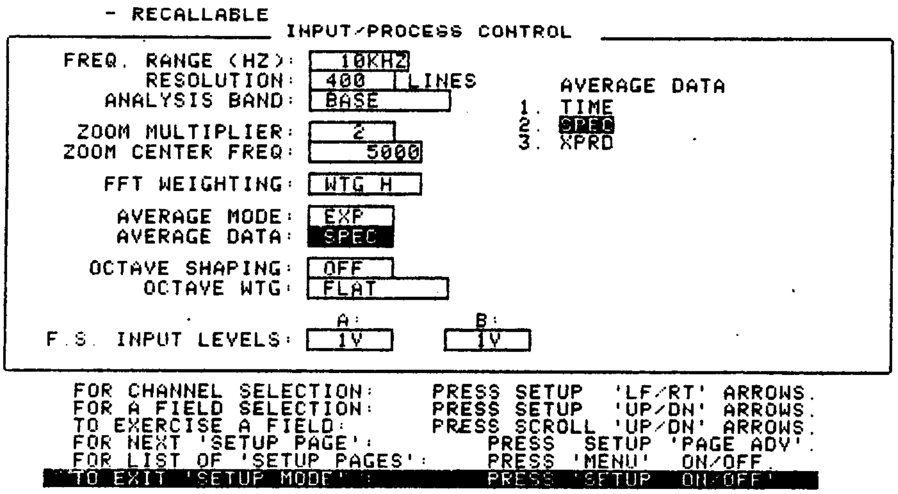
1. SUM — In SUM averaging, the analyzer sums the measured signal levels over N ensembles (N being the number of operator selected ensembles to be averaged) and divides by N when the data is read and used for display in a AVG display mode. The average will automatically stop when either the number of ensembles taken matches the AVG TARGET COUNT number, or the elapsed time matches the AVG TARGET TIME entry. Both of these fields are located on the ACQUISITION PAGE.

2. EXP — In EXP (Exponential averaging, the analyzer treats each new ensemble of data as the Nth ensemble and the current contents of the Averager memory as the summation of N to N-1. The result is rise and decay time on data changes; e.g., a "time constant integrator". The time constant is determined by the selected N.

3. PEAK — In PEAK averaging, the analyzer compares the amplitude of new signal data, at each cell location, with old data (in the AVG Memory). The larger value is kept in the Averager Memory, the smaller value is discarded. This is done for each individual cell.

4. +1 — During the averaging process, each new ensemble of data is automatically processed every memory period. However in +1, ensembles can be processed manually. The +1 averaging process is initiated by first selecting the +1 Average Mode, then by pressing the AVERAGE group START button each time an average is desired. Each time the AVERAGE group START button is pressed, a new ensemble will be processed, up to the numbers of averages selected. This is always a SUM average. The analyzer will not process new data beyond the count selected on the AVG TARGET COUNT field, or the time selected on the AVG TARGET TIME field on the ACQUISITION PAGE.

AVERAGE DATA:



Control Menu to Select the <u>Type</u> of Data to be Averaged.

1. **TIME** — **Averaging performed on digitized time-domain data from the Input Memory.**

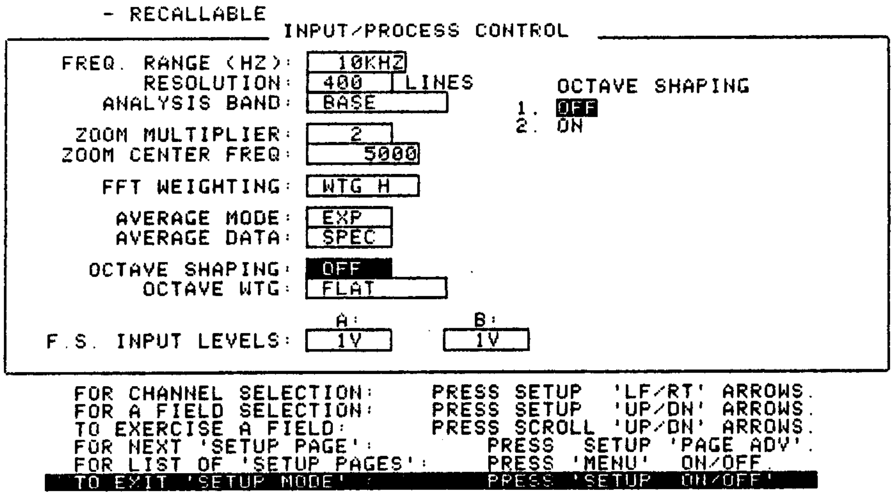
2. **SPEC** — **Averaging performed on FFT'd (spectrum) data from the Input Memory.**

NOTE

When the selected Function Group is Statistics, (STAT on the FUNCTION GROUP menu), or if TIME & PDH is selected on the TIME FUNCTION menu, selection 2 on this menu will be AMP instead of SPEC. This indicates the type of data to be averaged is Amplitude Domain Data.

3. **XPRD** — **Averaging performed on Spectrum and the Complex Cross Product data (requires two channels) required for Transfer Function and Phase, etc.**

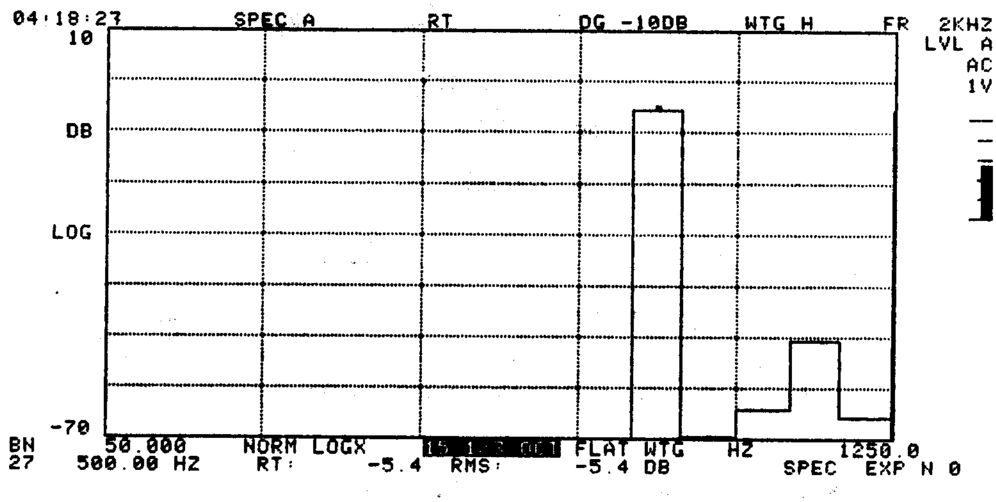
OCTAVE SHAPING



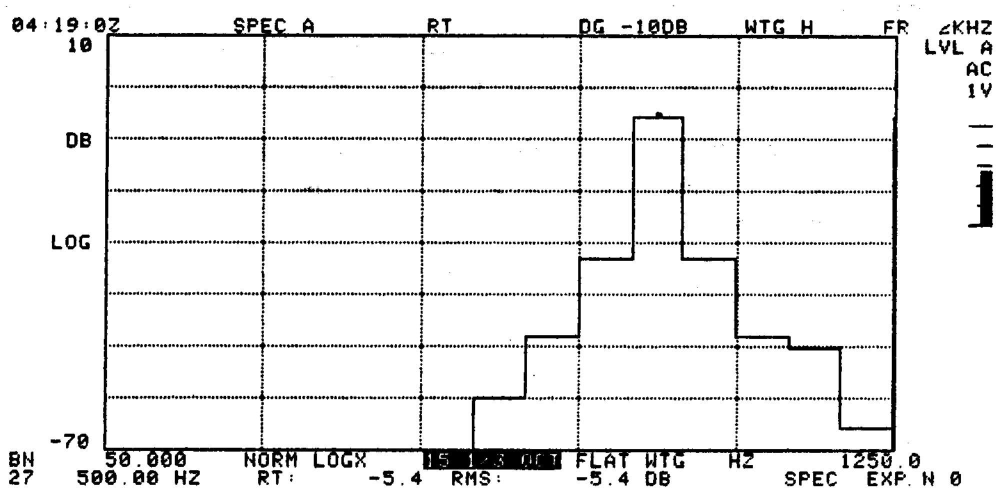
Control Menu for Applying Octave Shaping to 1/3 Octave Filters

Since the 1/3 octave bands are developed from digital narrow band filters, a given input signal may not produce any power in adjacent cells as with analog 1/3 octave band filters. As a result, the display of a single tonal may not have the familiar conventional shape. The OCTAVE SHAPING feature allows the operator to select either the standard SD385 shape or the conventional shape as shown in Figure 3-INP/PROC-3. The OFF menu selection is the standard SD385 shape and the ON menu selection is the conventional shape. Both of these shapes conform to applicable ANSI standards.

Figure 3-INP/PROC-3 shows two examples of the same 500 Hz square wave, one with shaping turned off, the other with shaping turned on.



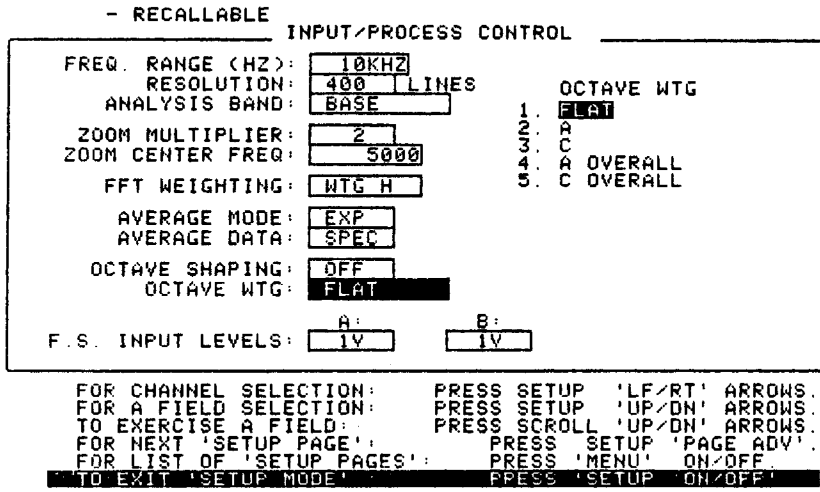
Shaping Turned OFF



Shaping Turned ON

Figure 3-INP/PROC-3. 1/3 Octave Shaping Examples

OCTAVE WTG:



Control Menu for Selecting Octave Acoustical Weighting.

This menu provides selection of either "A" or "C" acoustical weighting. The selected weighting factor is applied only to the display of the octave data. This allows the operator to select the type of weighting applied after averaging has been performed.

1. FLAT — When this selection is made, there is no weighting factor applied to the displayed signal.

2. A — When this selection is made, a Type A weighting factor is applied to the displayed signal over the dynamic range of the instrument (Refer to Table 3-INP/PROC-1, the column titled "Curve A, dB" and Figure 3-INP/PROC-4).

3. C — When this selection is made, a Type C weighting factor is applied to the displayed signal over the dynamic range of the instrument (Refer to Table 3-INP/PROC-1, the column titled "Curve C, dB" and Figure 3-INP/PROC-5).

4. A OVERALL — When this selection is made, a Type A weighting factor is applied **only** to calculate the overall bar (rms spectrum level) located on the right side of the display grid.

5. C OVERALL When this selection is made, **a Type** C **weighting** factor is **applied** **only** to **calculate** the overall **bar** (**rms** spectrum level) located on the right side of the display grid.

Table 3-INP/PROC-1. "A" and "C" Acoustic Weighting Factors

BAND	CENTER FREQUENCY		Curve A	Curve C
NUMBER	1/1	1/3	dB	dB
40		10 kHz	- 2.5	- 4.4
39	->	8 kHz	- 1.1	- 3.0
38		6.3 kHz	- 0.1	- 2.0
37		5 kHz	0.5	- 1.3
36	->	4 kHz	1.0	- 0.8
35		3.15 kHz	1.2	- 0.5
34		2.5 kHz	1.3	- 0.3
33	->	2 kHz	1.2	- 0.2
32		1.6 kHz	1.0	- 0.1
31		1.25 kHz	0.6	0.0
30	->	1 kHz	0.0	0.0
29		800 Hz	- 0.8	0.0
28		630 Hz	- 1.9	0.0
27	->	500 Hz	- 3.2	0.0
26		400 Hz	- 4.8	0.0
25		315 Hz	- 6.6	0.0
24	->	250 Hz	- 8.6	0.0
23		200 Hz	-10.9	0.0
22		160 Hz	-13.4	- 0.1
21	->	125 Hz	-16.1	- 0.2
20		100 Hz	-19.1	- 0.3
19		80 Hz	-22.5	- 0.5
18	->	63 Hz	-26.2	- 0.8
17		50 Hz	-30.2	- 1.3
16		40 Hz	-34.6	- 2.0
15	->	31.5 Hz	-39.4	- 3.0
14		25 Hz	-44.7	- 4.4
13		20 Hz	-50.5	- 6.2
12	->	16 Hz	-56.7	- 8.5
11		12.5 Hz	-63.4	-11.2
10		10 Hz	-70.4	-14.3
9	->	8 Hz	-77.0	-18.5
8		6.3 Hz	-84.0	-22.5
7		5 Hz	-91.0	-26.0
6	->	4 Hz	-97.5	-30.0
5		3.15 Hz	-105.0	-34.2
4		2.5 Hz	-111.5	-38.0
3	->	2.0 Hz	-118.0	-42.0
2		1.6 Hz	-120.0	-45.5

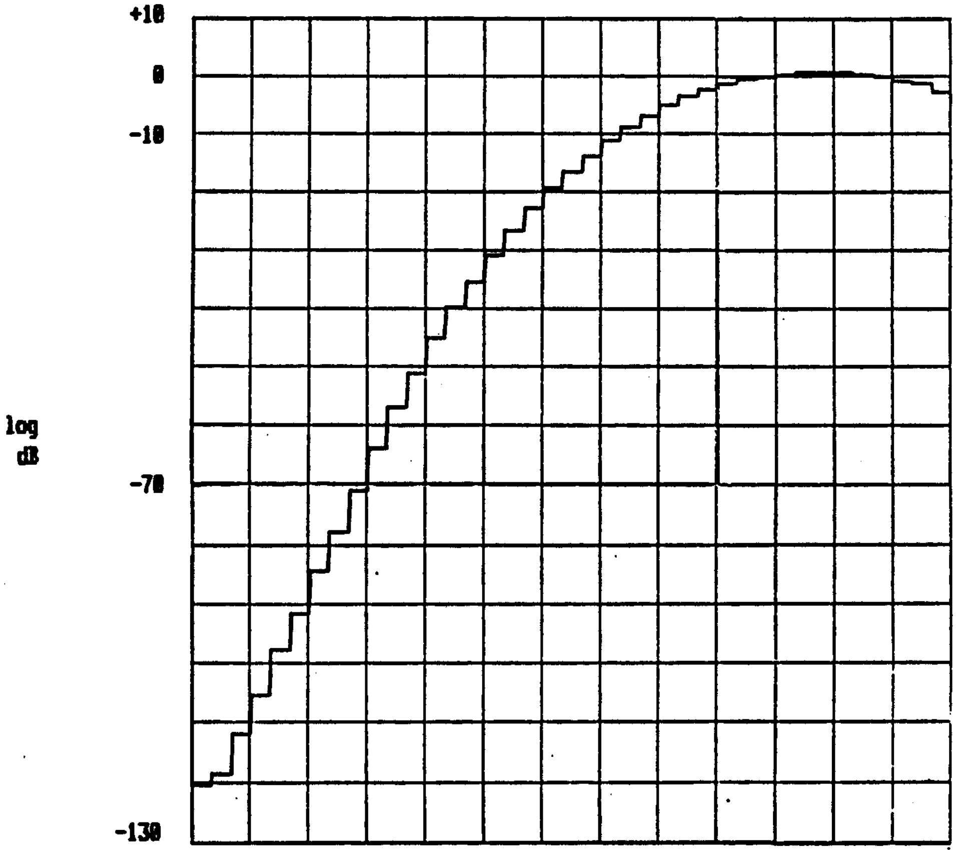


Figure 3-INP/PROC-4. Acoustical Weighting Curve "A" Example

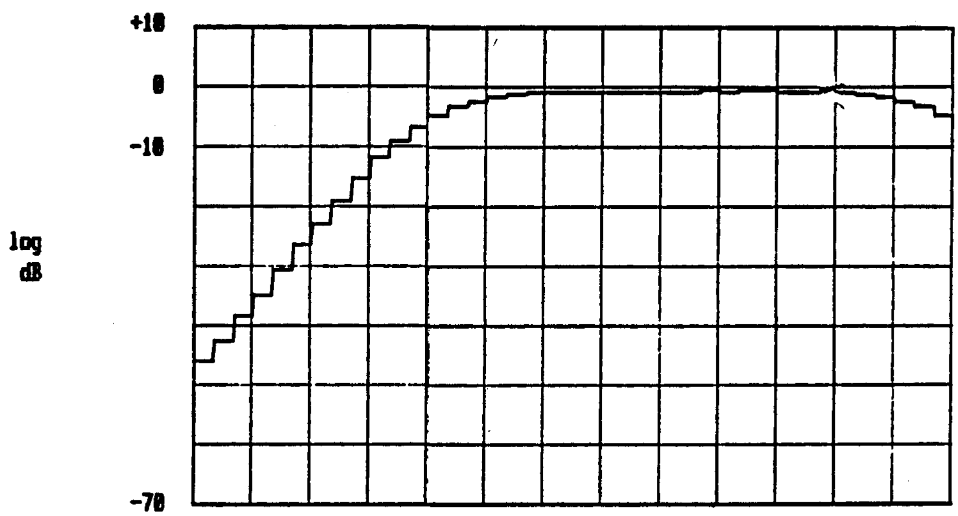
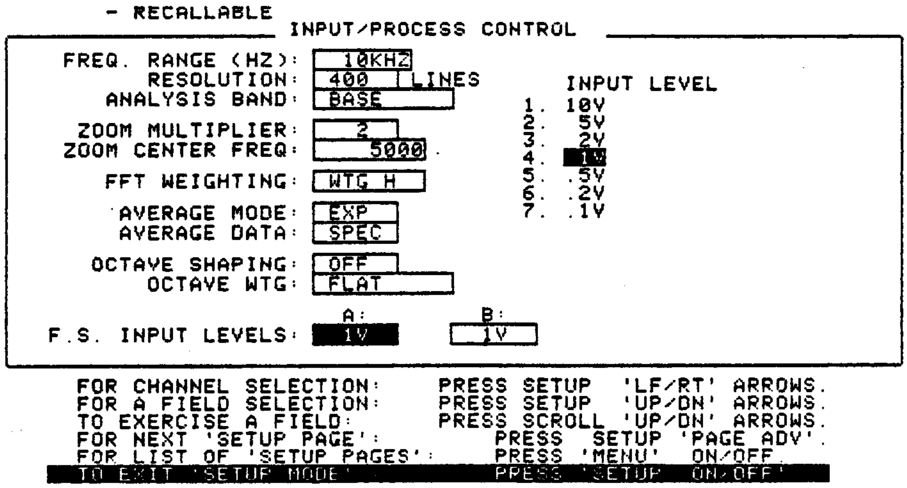


Figure 3-INP/PROC-5. Acoustical Weighting Curve "C" Example

F.S. INPUT LEVELS:



Control Menu for Selecting the RMS Input Signal Level.

Separate Input Level selections must be made for each channel for instruments with the two channel option. This is accomplished as follows:

The RV just opposite the "F.S. INPUT LEVELS:" statement can be moved from one channel to another using the SETUP group LEFT/RIGHT buttons. The SCROLL group UP/DOWN buttons are used to select the Input Level for a specific channel.

3-3.2.1 Octave Band Analysis

Octave Band	5 Octave bands or 15 1/3 Octave bands.
	10 Octave bands or 30 1/3 Octave bands.

Available Ranges

5 Octaves	15 1/3 Octaves
500 Hz to 8kHz	400 Hz to 10kHz
250 Hz to 4kHz	200 Hz to 5kHz
125 Hz to 2kHz	100 Hz to 2.5kHz
63 Hz to 1kHz	50 Hz to 1.25kHz
31.5 Hz to 500 Hz	25 Hz to 630 Hz
16 Hz to 250 Hz	12.5 Hz to 315 Hz
8 Hz to 125 Hz	6.3 Hz to 160 Hz
4 Hz to 63 Hz	3.15 Hz to 80 Hz

10 Octaves	30 1/3 Octaves
16 Hz to 8kHz	12.5 Hz to 10kHz
8 Hz to 4kHz	6.3 Hz to 5kHz
4 Hz to 2kHz	3.15 Hz to 2.5kHz
2 Hz to 1kHz	1.6 Hz to 1.25kHz

Acoustical Weighting	A, C, FLAT, A overall only. C overall only in accordance with IEC 179.
Passband Uniformity	Meets ANSI S1.11-1966 CLASS III for 1/3 Octave filters CLASS II for 1/1 Octave filters (to -70dB from full-scale amplitude)
Linearity	+/- 1dB or +/- 1% of amplitude full scale, whichever is greater.

The Octave Analysis Bands sample the input signal using two different sampling rates to separate the low frequency components from the high frequency components. This increases the resolution at the lower frequencies. The contents of the Input Memory are then transferred to Processor Memory where a spectrum analysis is performed separately on each set of data. The higher frequency spectrum cells from the Input Memory containing the high group are used to generate the octave presentation for those bands designated with an "X" in Tables 3-INP/PROC-2 and 3-INP/PROC-3. The lower frequency spectrum cells from the Input Memory containing the low group are used to generate the octave presentation for those bands designated with a "0" in Table 3-INP/PROC-2.

The 1/1 Octave mode provides 10 bands with the center frequency of each band as listed in Table 3-INP/PROC-2, or 5 bands with the center frequency as listed in Table 3-INP/PROC-3. In the 1/3 Octave mode, 30 bands are provided with center frequencies as listed in Table 3-INP/PROC-2, or 15 bands with center frequencies as listed in Table 3-INP/PROC-3. In all cases, an additional bar containing the overall rms spectrum level appears on the right side of the display.

Table 3-INP/PROC-2. 10 1/1 and 30 1/3 Octave Bands and Center Frequencies

BAND NO.	CENTER FREQUENCY		SELECTED FREQUENCY RANGE (kHz)				
	1/1	1/3	NB 1/1 1/3	20 8 10	10 4 5	5 2 2.5	2 1 1.25
40		10 kHz		X			
39	->	8 kHz		X			
38		6.3 kHz		X			
37		5 kHz		X	X		
36	->	4 kHz		X	X		
35		3.15 kHz		X	X		
34		2.5 kHz		X	X	X	
33	->	2 kHz		X	X	X	
32		1.6 kHz		X	X	X	
31		1.25 kHz		X	X	X	X
30	->	1 kHz		X	X	X	X
29		800 Hz		X	X	X	X
28		630 Hz		X	X	X	X
27	->	500 Hz		X	X	X	X
26		400 Hz		X	X	X	X
25		315 Hz		0	X	X	X
24	->	250 Hz		0	X	X	X
23		200 Hz		0	X	X	X
22		160 Hz		0	0	X	X
21	->	125 Hz		0	0	X	X
20		100 Hz		0	0	X	X
19		80 Hz		0	0	0	X
18	->	63 Hz		0	0	0	X
17		50 Hz		0	0	0	X
16		40 Hz		0	0	0	0
15	->	31.5 Hz		0	0	0	0
14		25 Hz		0	0	0	0
13		20 Hz		0	0	0	0
12	->	16 Hz		0	0	0	0
11		12.5 Hz		0	0	0	0
10		10 Hz			0	0	0
9	->	8 Hz			0	0	0
8		6.3 Hz			0	0	0
7		5 Hz				0	0
6	->	4 Hz				0	0
5		3.15 Hz				0	0
4		2.5 Hz					0
3	->	2.0 Hz					0
2		1.6 Hz					0

Table 3-INP/PROC-3. 5 1/1 and 15 1/3 Octave Bands and Center Frequencies

BAND NO.	CENTER FREQUENCY		SELECTED FREQUENCY RANGE								
	1/1	1/3	NB 1/1 1/3	20K 8K 10K	10K 4K 5K	5K 2k 2.5k	2K 1k 1.25k	1K 500 630	500 250 315	200 125 160	100 63 80
40		10 kHz		X							
39	->	8 kHz		X							
38		6.3 kHz		X							
37		5 kHz		X	X						
36	->	4 kHz		X	X						
35		3.15 kHz		X	X						
34		2.5 kHz		X	X	X					
33	->	2 kHz		X	X	X					
32		1.6 kHz		X	X	X					
31		1.25 kHz		X	X	X	X				
30	->	1 kHz		X	X	X	X				
29		800 Hz		X	X	X	X				
28		630 Hz		X	X	X	X	X			
27	->	500 Hz		X	X	X	X	X			
26		400 Hz		X	X	X	X	X			
25		315 Hz			X	X	X	X	X		
24	->	250 Hz			X	X	X	X	X		
23		200 Hz			X	X	X	X	X		
22		160 Hz				X	X	X	X	X	
21	->	125 Hz				X	X	X	X	X	
20		100 Hz				X	X	X	X	X	
19		80 Hz					X	X	X	X	X
18	->	63 Hz					X	X	X	X	X
17		50 Hz					X	X	X	X	X
16		40 Hz						X	X	X	X
15	->	31.5 Hz						X	X	X	X
14		25 Hz						X	X	X	X
13		20 Hz							X	X	X
12	->	16 Hz							X	X	X
11		12.5 Hz							X	X	X
10		10 Hz								X	X
9	->	8 Hz								X	X
8		6.3 Hz								X	X
7		5 Hz									X
6	->	4 Hz									X
5		3.15 Hz									X

As previously stated, Octave can be enabled in the Spectrum modes only. Octave Analysis is **enabled** by selecting one of the four available Octave Analysis menu items from the ANALYSIS BAND menu.

Selections 3 through 6 on the ANALYSIS BAND menu are the Octave Analysis Band selections. Note that there are two selections for both 1/3 and 1/1 octave analysis. The difference between the Octave-acquisition modes is the number of **displayed** octave bands. For example (refer to Tables 3-INP/PROC-2 and 3-INP/PROC-3), if the 10 kHz frequency range is selected, and the ANALYSIS BAND menu selection is 30 1/3 OCT, then the total number of displayed 1/3 octave bands is 30, ranging from band 8 (6.3 Hz at the low end) to band 37 (5 kHz at the high end). If the ANALYSIS BAND menu selection is changed to 15 1/3 OCT (same frequency range), the total number of displayed 1/3 octave bands is 15, ranging from band 23 (200 Hz at the low end) to band 37 (5 kHz at the high end).

Figures 3-INP/PROC-6 through 3-INP/PROC-9 are single trace display examples of each of the four Octave Analysis-band selections. Each example uses the same 4 kHz signal and the same 10 kHz narrow-band frequency range selection. Note the lower-most and upper-most frequency bands indicated in Figure 3-INP/PROC-6 and the lower-most and upper-most center frequency bands indicated in Figure 3-INP/PROC-7 and compare these values with the corresponding values in the column titled "CENTER FREQUENCY" on Table 3-INP/PROC-2. Figure 3-INP/PROC-6 uses the "1/3" column and Figure 3-INP/PROC-7 uses the "1/1" column. If you look at the column titled "SELECTED FREQUENCY RANGE (kHz)" and then look at the second column of X's and 0's (specifically, the first X and the last 0 in this column), you will notice that the upper-most and lower-most frequencies in the 1/3 column (10 kHz for the first X and 12.5 Hz for the last 0) correspond to the upper-most and lower-most frequencies indicated in Figure 3-INP/PROC-6. The same column of X's and 0's applies to Figure 3-INP/PROC-7 except the corresponding upper-most and lower-most center frequencies are those indicated by the arrows in the 1/1 column (8 kHz for the upper-most center frequency and 16 Hz for the lower-most center frequency). Table 3-INP/PROC-3 is the reference table for Figures 3-INP/PROC-8 and 3-INP/PROC-9. This table is almost the same as Table 3-INP/PROC-2. The only difference is the number of frequency ranges that can be selected (twice as many) and the number of displayed octave bands per selected frequency range (half as many).

Three other Octave-mode display items indicated in Figures 3-INP/PROC-6 through 3-INP/PROC-9 are the selected narrow band (NB) frequency range, present cursor-location band number and the corresponding frequency. If you look at the columns titled "SELECTED FREQUENCY RANGE" on both Tables 3-INP/PROC-2 and 3-INP/PROC-3, it appears that there are separate frequency range selections for the Octave modes. The Octave mode frequency ranges are automatically selected when a corresponding narrow band frequency range is selected with Octave enabled. The corresponding narrow band frequency ranges appear in the row titled "NB" on both Tables 3-INP/PROC-2 and 3-INP/PROC-3. Refer to Figures 3-INP/PROC-6 through 3-INP/PROC-9 and note the present cursor location. Now, refer to Tables 3-INP/PROC-2 and 3-INP/PROC-3 and locate the number 36 in the column titled "BAND NO." If you look at the value in the CENTER FREQUENCY column just opposite band number 36, you will notice that the frequency that corresponds to band number 36 is 4 kHz.

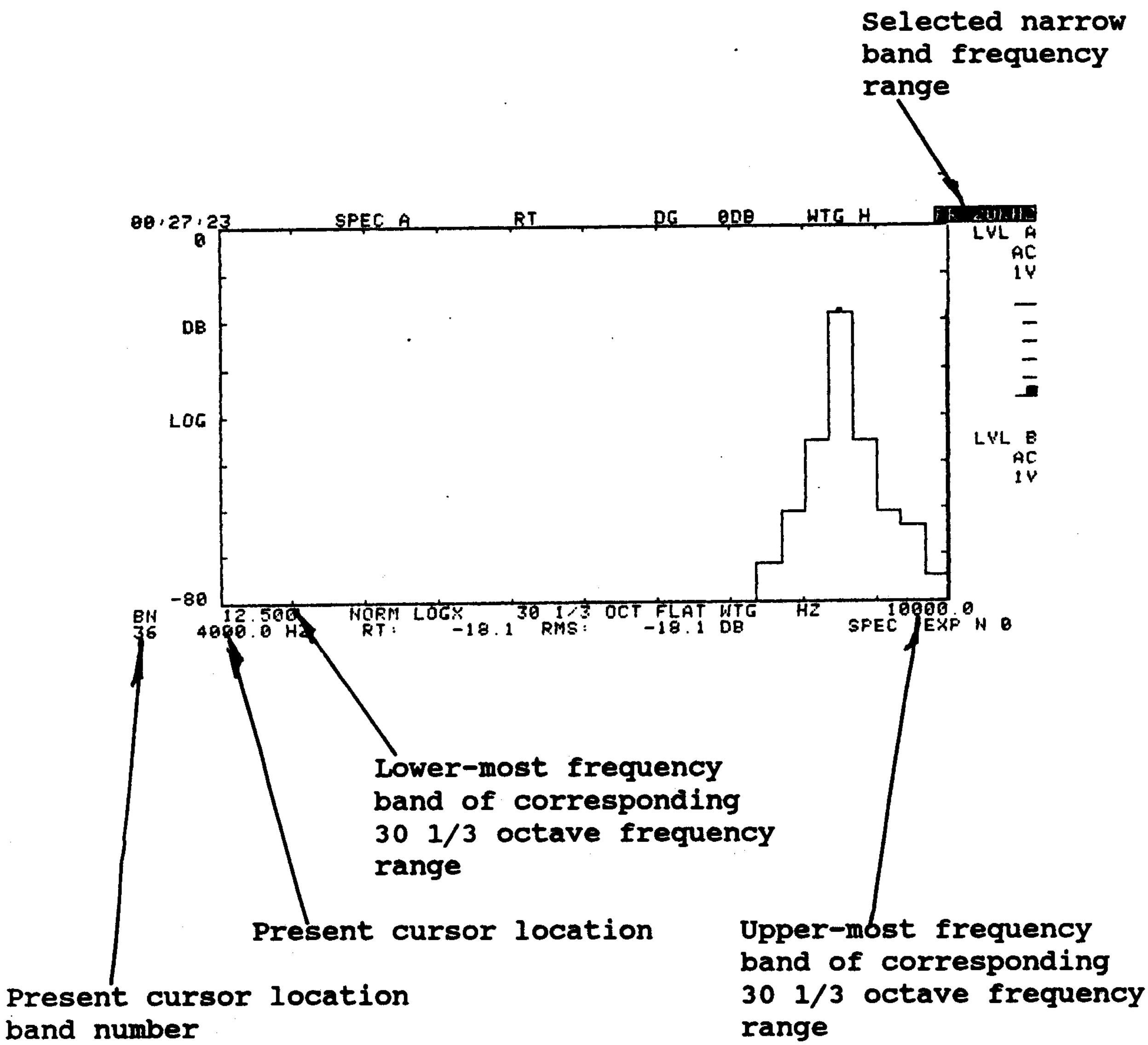


Figure 3-INP/PROC-6. 30 1/3 Octave Display Example

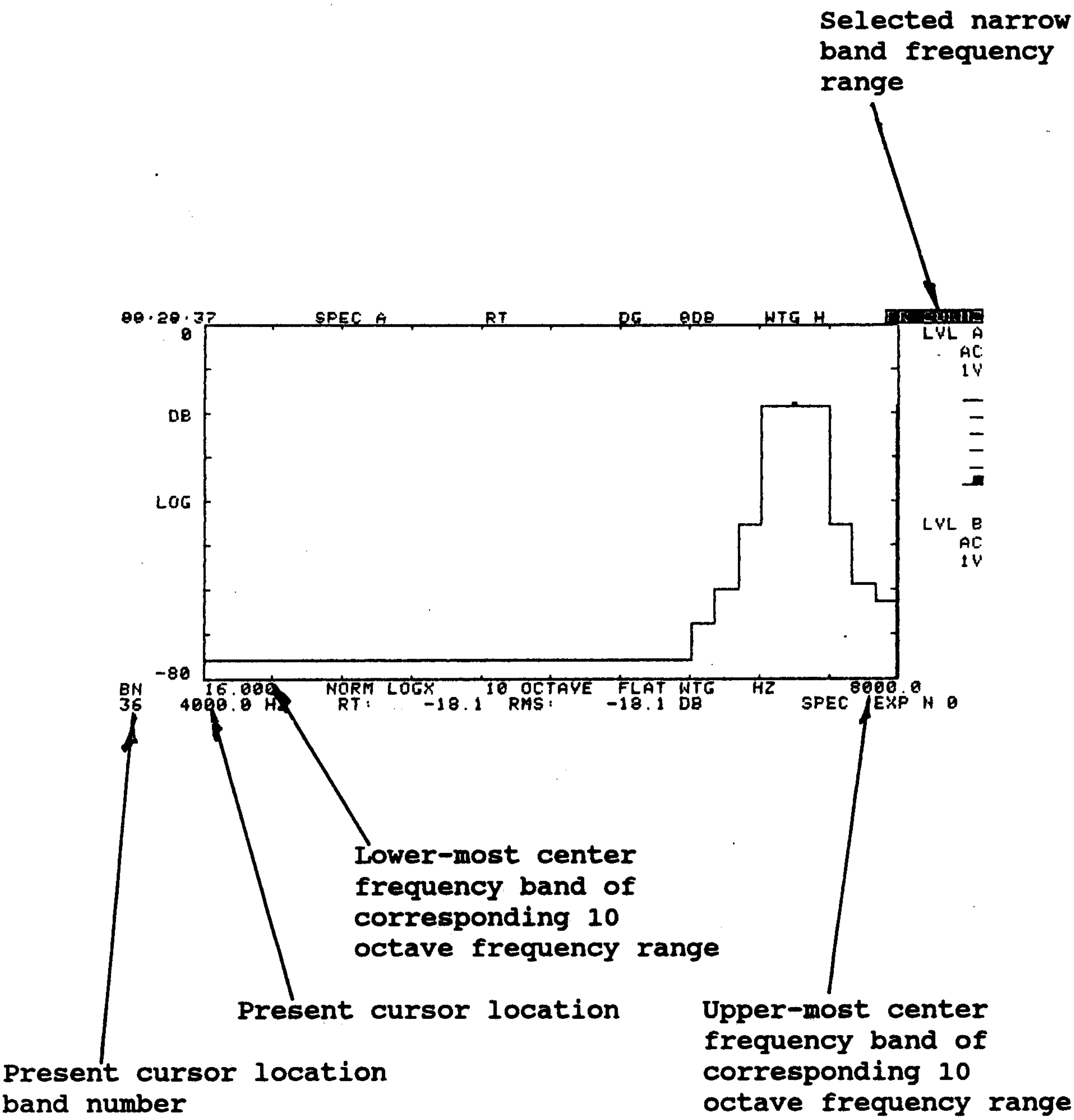


Figure 3-INP/PROC-7. 10 Octave Display Example

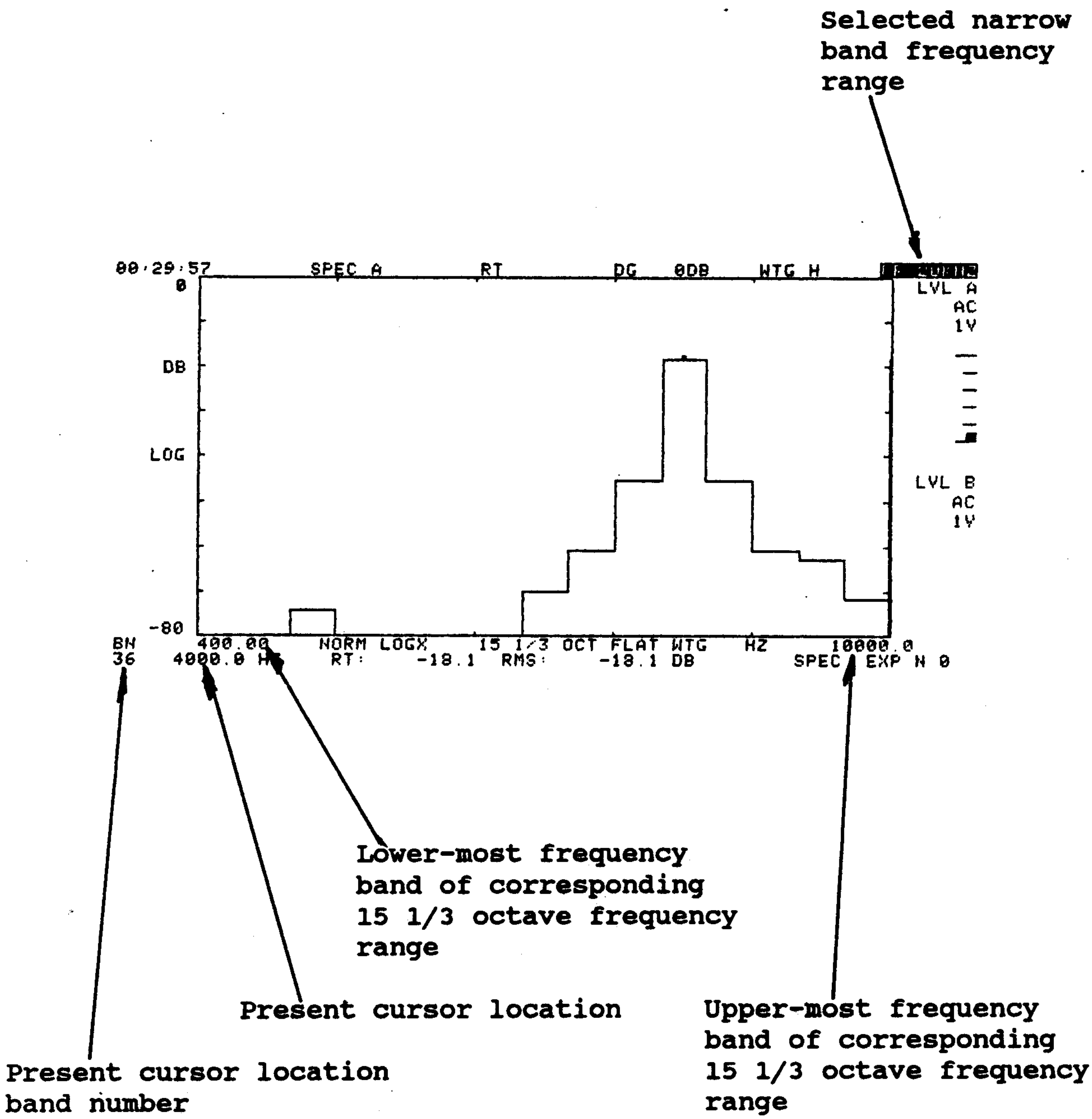


Figure 3-INP/PROC-8. 15 1/3 Octave Display Example

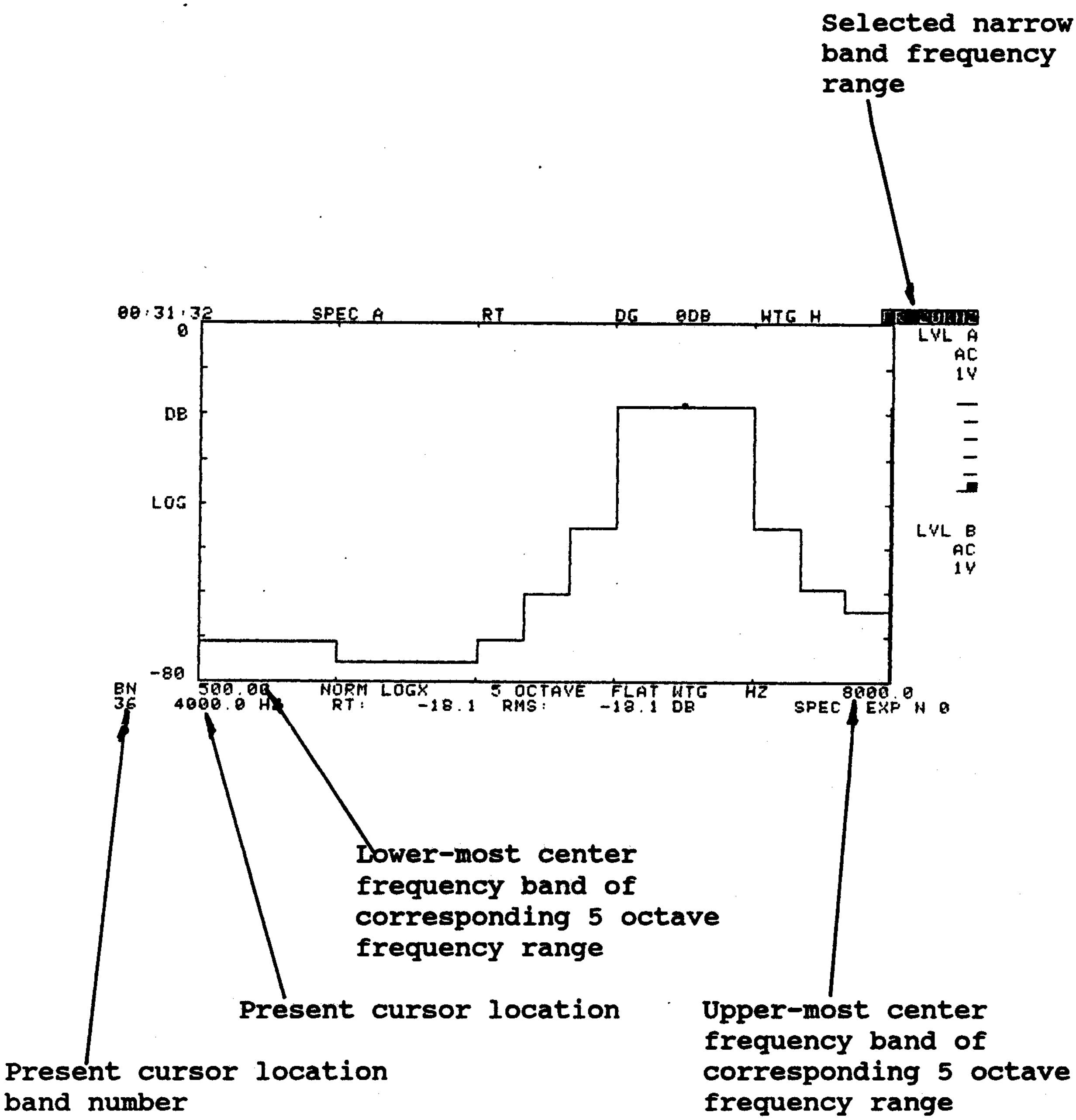


Figure 3-INP/PROC-9. 5 Octave Display Example

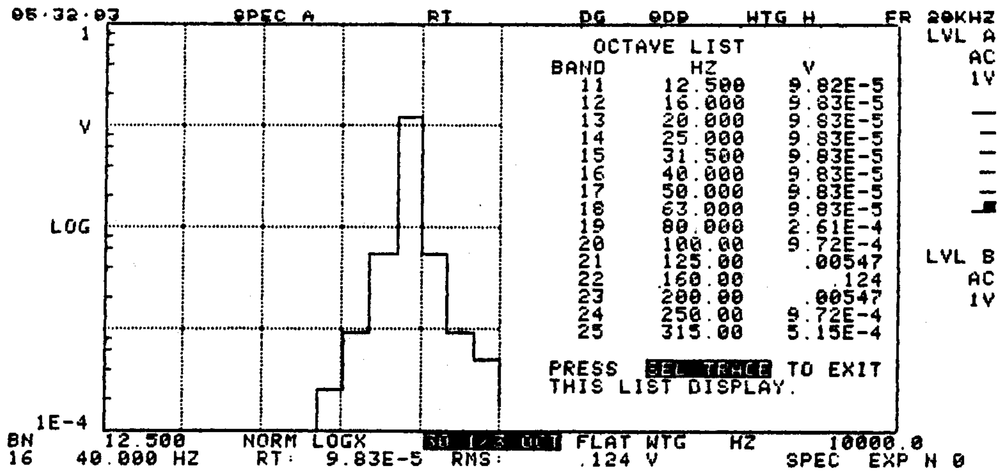
Using Octave List

The Octave List consists of each Octave Band Number and the X and Y-axis values that correspond to each band number. The Octave List feature is enabled as follows:

Select one of the Octave Analysis Bands from the ANALYSIS BAND menu located on Setup Page 2, then press the front-panel LIST button. The grid and the right half of the data display will be blanked and the OCTAVE LIST will appear.

Up to fifteen X and Y-axis values with their corresponding band numbers can appear on the list. The actual amount depends upon the selected Octave Analysis Band (ANALYSIS BAND menu located on Setup Page 2). For example: When the selected ANALYSIS BAND is 5 OCTAVE, five X and Y-axis values will appear on the list. For the 10 OCTAVE selection, ten values will appear on the list and for the 15 1/3 OCT selection, fifteen values will appear on the list. When 30 1/3 OCT is selected, only 15 values will be displayed at a time. Which 15 depends upon whether the data cursor is in the left or right half of the display (upper or lower half of the selected frequency range). Either list can be displayed by placing the Data Cursor in the desired portion of the display and then pressing the LIST button. For example, if a list of the upper fifteen octave bands is being displayed, moving the Data Cursor to the left and then pushing the LIST button will cause a list of the lower fifteen octave bands to be displayed. The two Octave Lists shown in Figure 3-INP/PROC-10 are examples of the Octave List with 30 1/3 OCT as the selected Analysis Band.

Each time the LIST button is pressed (when the octave list is being displayed), the octave list will be updated.



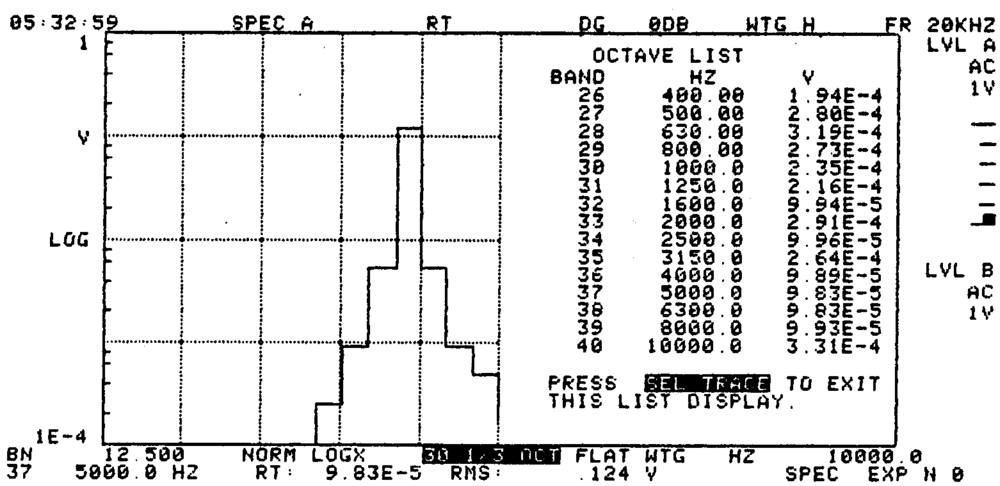


Figure 3-INP/PROC-10. Octave List Examples

3-3.2.2 Weighting

The earliest spectrum (or harmonic) analyzer consisted of tunable, high Q filters with a frequency dial and a standard analog voltmeter connected to the output of the filter. As the operator swept across the frequency band of interest, the meter would "peak" at various frequencies. The operator, typically, would plot (by hand) the frequency and magnitude of the peaks. The plot may have looked like Figure 3-INP/PROC-11.

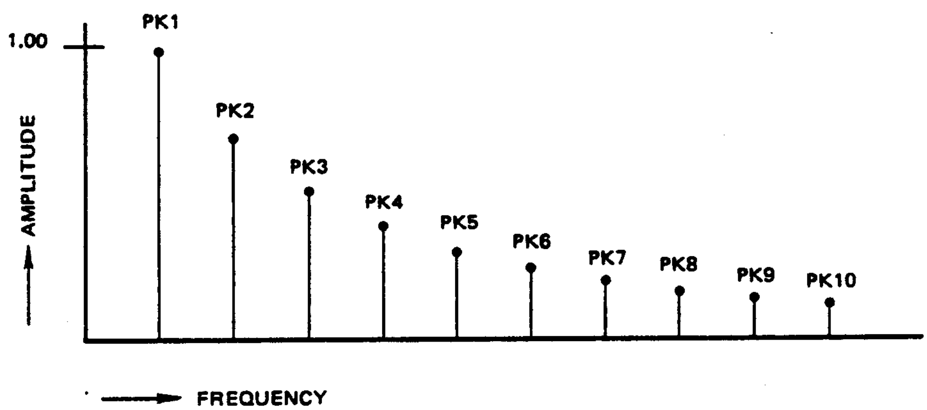


Figure 3-INP/PROC-11. Frequency Spectrum Drawn by Hand

The above plot however, is not a true representation of a spectrum plot. If the frequency dial and voltmeter readings of the analyzer were connected to the X and Y-axis of an X-Y recorder, the plot would resemble Figure 3-INP/PROC-12.

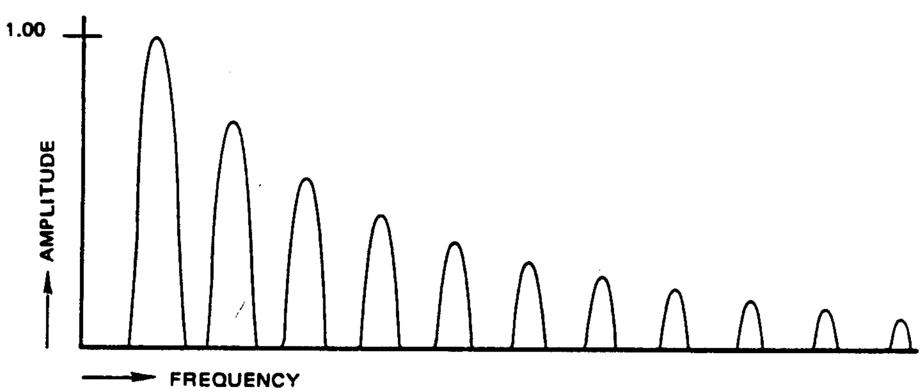


Figure 3-INP/PROC-12. Frequency Spectrum From an X-Y Recorder

The harmonic plot of Figure 3-INP/PROC-12 is the result of tuning a filter past a stationary signal that contains more than one frequency component. If the filter is tuned to a frequency and a swept frequency signal is applied, the resultant filter response would resemble Figure 3-INP/PROC-13.

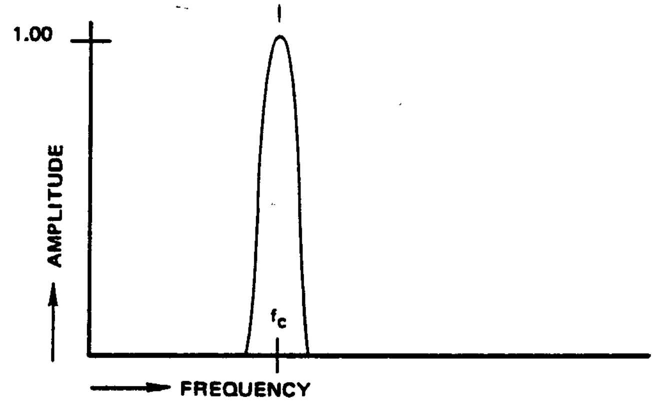


Figure 3-INP/PROC-13. Filter Response of a High Q Filter

A digital spectrum analyzer carries the spectrum analysis concept even farther. It simultaneously displays the output of up to 800 equally spaced, digital filters. This is accomplished by using a high speed discrete Fourier Transform called the Fast Fourier Transform (FFT). FFT analysis allows the rapid transformation of discrete time domain data into frequency domain data. The end result is up to 800 values representing the simultaneous output of each high Q filter.

Since the FFT is performed on a finite sample, incongruities such as side lobes, spurious noise, etc., can cause false data to be acquired. Weighting, also known as windowing, is a technique for treating data in the time domain, before the FFT, to reduce the effect of side lobes, etc. The FFT of the signal shown in Figure 3-INP/PROC-14 is performed on the data in the sample window.

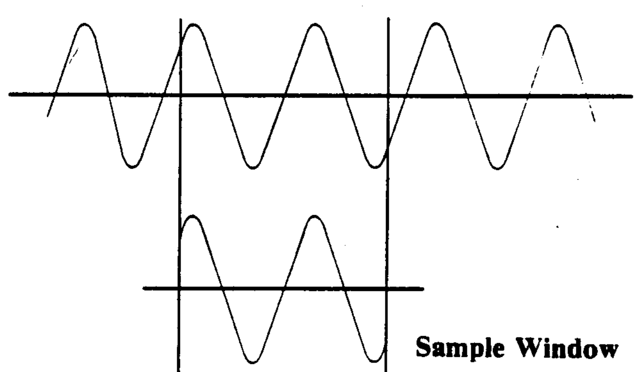


Figure 3-INP/PROC-14. The Sample Window

The following illustrations show the difference between "true" spectrum data and FFT data.

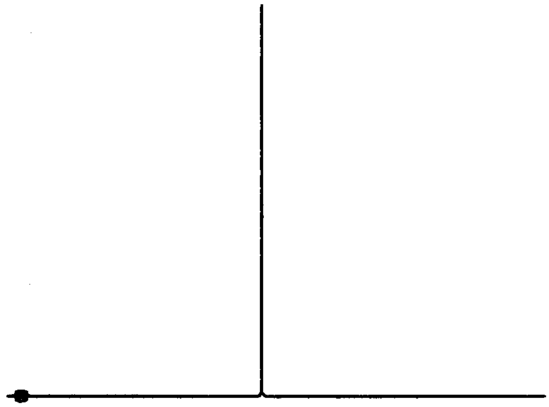


Figure 3-INP/PROC-15. True Spectrum of the Sample Window Data

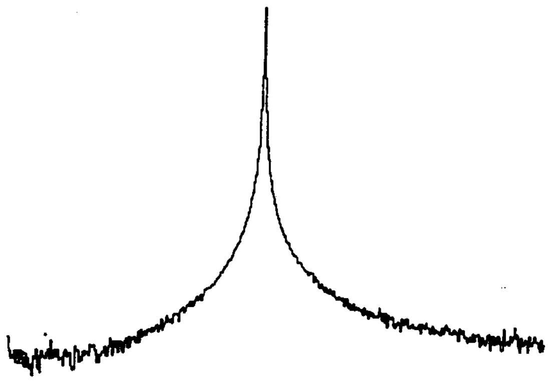


Figure 3-INP/PROC-16. The FFT of the Sample Window Data

This phenomenon is called "flaring" or "skirting" and is frequently referred to as "Rectangular" weighting, although no weighting is applied to the data before the FFT is performed. Weighting eliminates the flaring by smoothing the transitions on each side of the sample window.

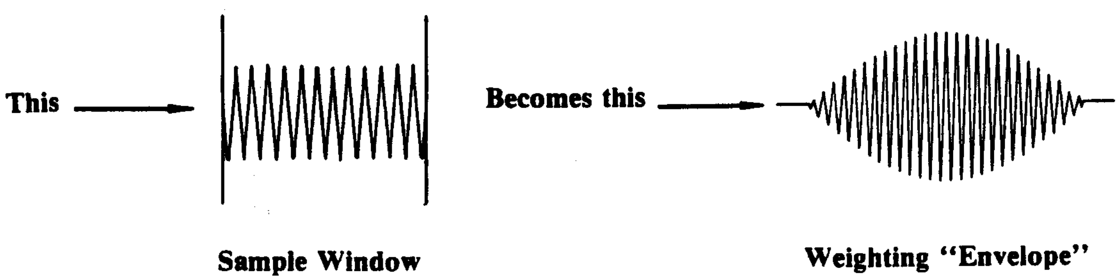


Figure 3-INP/PROC-17. Weighting Effects on the Sample Window Signal

An additional effect weighting has on the data is the effective shape of digital filters that produce the display. This filter shape could be measured by slowly sweeping a signal through the filter and measuring the response. A "swept sine" plot of a single filter would produce the filter shapes as shown in Figure 3-INP/PROC-18 for Rectangular, Hanning, and Flat Top Weighting.

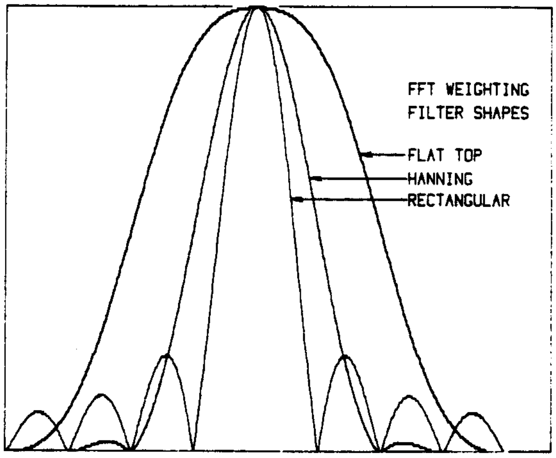


Figure 3-INP/PROC-18. Rectangular, Hanning and Flat Top Filter Shapes

There can be up to 800 filters overlapping each other on the SD385 display (Lines of Resolution Control Menu). The displayed data are actually the vectors between the output data points at the applied frequency. Figure 3-INP/PROC-19 is a simplified description of how the displayed signal is generated from these filters.

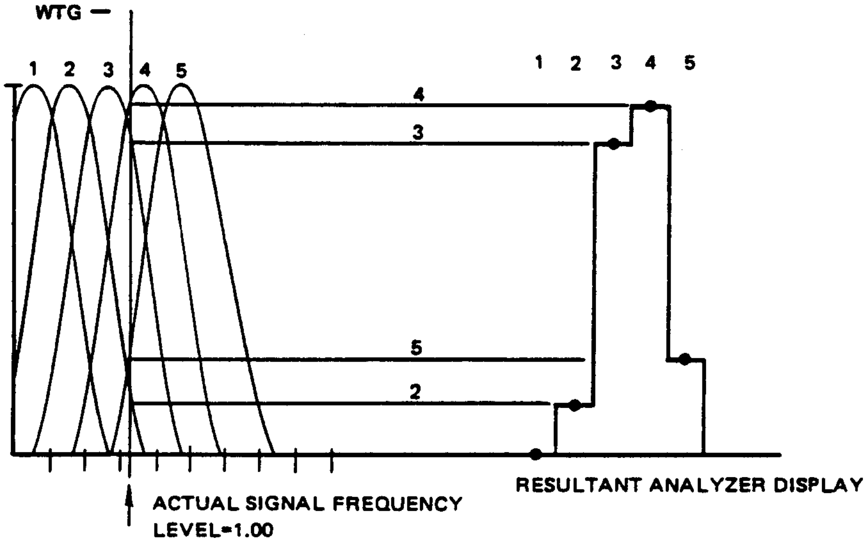


Figure 3-INP/PROC-19. Generation of Weighted Analyzer Display

Figures 3-INP/PROC-20 through 3-INP/PROC-22 are examples of each of the first three weighting functions from the FFT WEIGHTING control menu. The examples were made using "times four" (LNX4) X-axis expansion to emphasize the differences in filter shape. The applied input signal was identical for all three weighting functions. In addition, the actual width of the filters depends upon the selected resolution (number of lines). Each weighting function shown in Figures 3-INP/PROC-20 through 3-INP/PROC-22 illustrates how each resolution selection affects filter width.

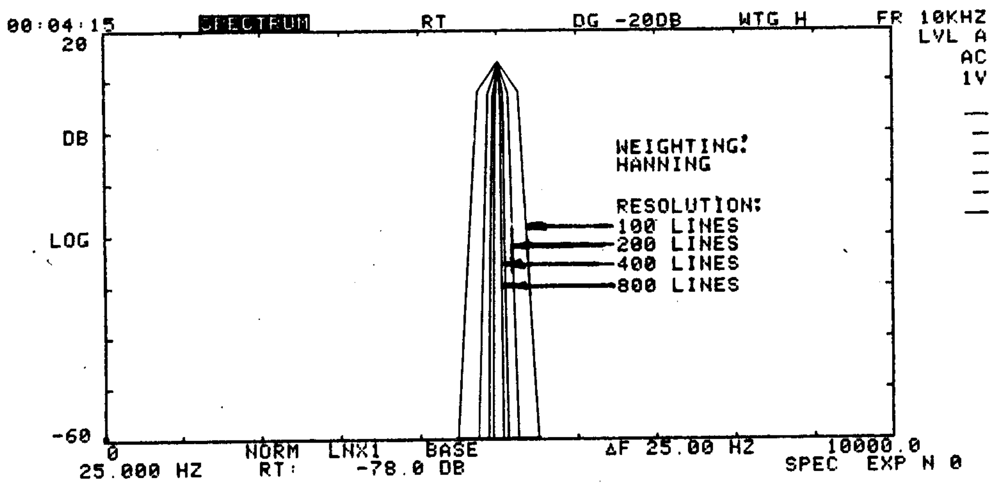


Figure 3-INP/PROC-20. HANNING Weighting Example

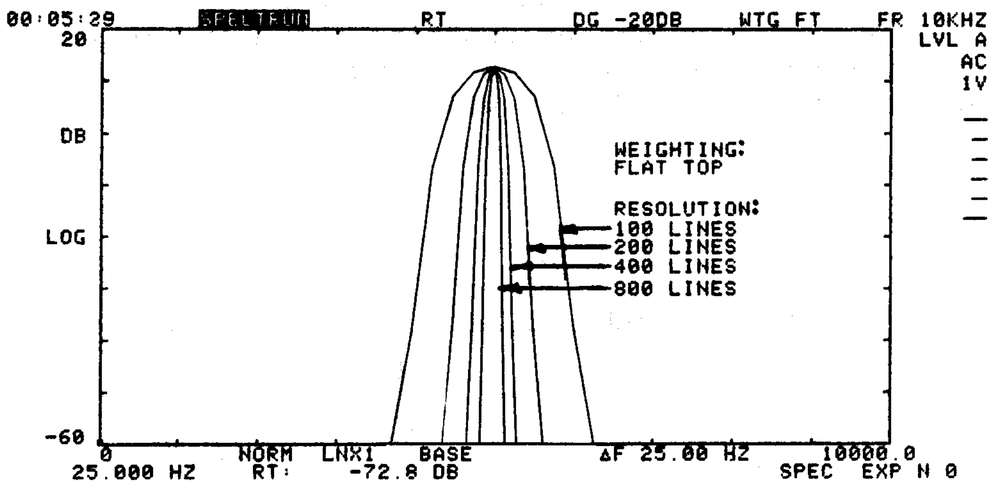


Figure 3-INP/PROC-21. FLAT TOP Weighting Example

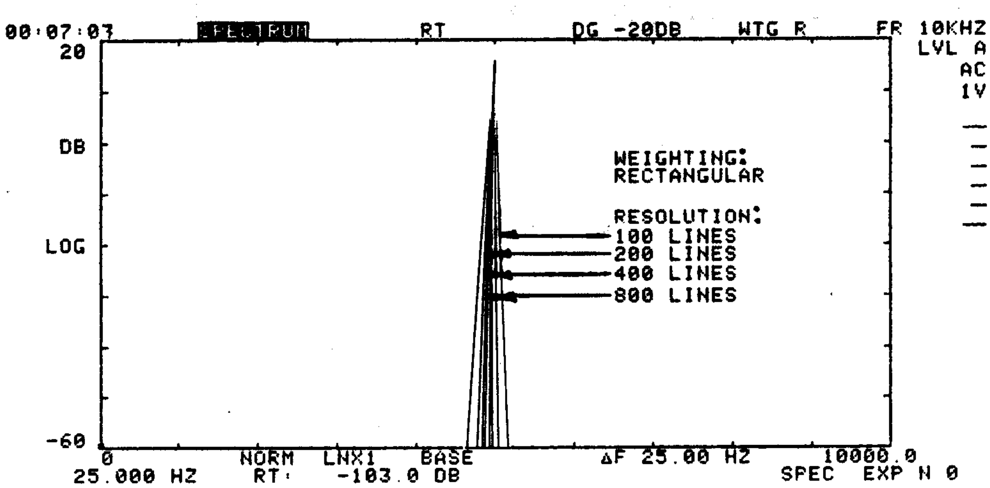


Figure 3-INP/PROC-22. RECTANGULAR Weighting Example

If you were to plot the measured signal peak versus input frequency across the weighting filters, you would notice an effect called "scalloping." It (scalloping) reflects the variation in amplitude of a measured tonal as is passes into and out of the digital filter centers. Examples of this effect are shown in figure 3-INP/PROC-23. Note that as the tonal passes from the center of one filter to the center of the next filter, the amplitude of the tonal will decrease as it passes between the filter centers (the point at which the filters overlap) and then increase as it approaches the next filter center. This variation in amplitude reflects the percentage of scalloping for each weighting-function filter shape.

In an environment where the amplitude of a signal (tonal) is extremely important, Flat Top weighting can insure that filter shape does not affect measured amplitude. For example, if you were to sweep a signal across a particular band, you would notice that the "next filter" would rise to signal strength before the "current filter" started to descend.

Harris Flat Top weighting (the method of Flat Top weighting the SD385 uses) is very efficient since it is only the necessary 3 or so filters wide (as opposed to 5 to 6 filters wide for other methods of Flat Top weighting). This gives you the necessary flat response without sacrificing any more frequency resolution than necessary.

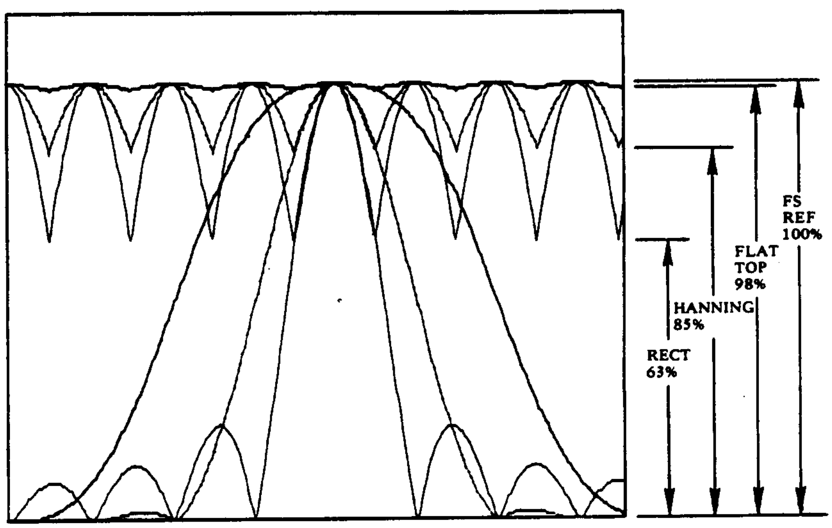


Figure 3-INP/PROC-23. HANNING, FLAT TOP, and RECTANGULAR Scalloping Examples

Summary

The three main weighting functions are RECTANGULAR, HANNING and FLAT TOP.

Rectangular weighting is useful if a signal (tonal) is in the exact center of a bin (as it may be when using the Signature Ratio Option) or, if a Time Domain transient builds up and decays entirely within a single memory period (as in burst random and some transient analysis).

Hanning weighting is a good compromise, expecially for examining two closely space signals which may not be bin-centered.

Flat Top is best for accurately measuring the amplitude of a specific signal that is not bin-centered since the "scallop loss" is very small.

Weighting (other than Rectangular) is accomplished by smoothing the transitions of each side of the sample window. However, this causes some loss of signal, increases noise sensitivity somewhat, and makes the displayed Spectrum signal appear "fatter." If you were to compute an rms summation of all the filter values, the result would be somewhat larger than it should be and, of course, incorrect. When the SD385 performs an rms summation (^P Cursor Mode), this signal loss and increased sensitivity is compensated for in the calibration. However, when performing computations on an external computer and transferring data via the IEEE bus, you may have to know the Equivalent Noise Bandwidth, Gain and Scallop loss.

"Equivalent Noise Bandwidth" is a measure of the width of the filter of each FFT bin. The largest is for Flat Top weighting.

"Gain" is a measure of the data lost by the weighting attenuation process.

"Scallop Loss" is the error in estimating signal amplitude when a sinewave is placed exactly between two FFT bins.

Table 3-INP/PROC-4 provides the numerical values associated with Equivalent Noise Bandwidth, Gain and Scallop Loss.

Table 3-INP/PROC-4. Weighting Table

Selected Weighting Function	Equivalent Noise Bandwidth	Gain	Scallop Loss
RECTANGULAR	1 Filter	1.00	3.92 dB
HANNING	1.5 Filters	0.50	1.42 dB
FLAT TOP	3.087 Filters	0.252	0.20 dB

The five remaining selections on the FFT WEIGHTING menu are Special Weighting Algorithms. These are:

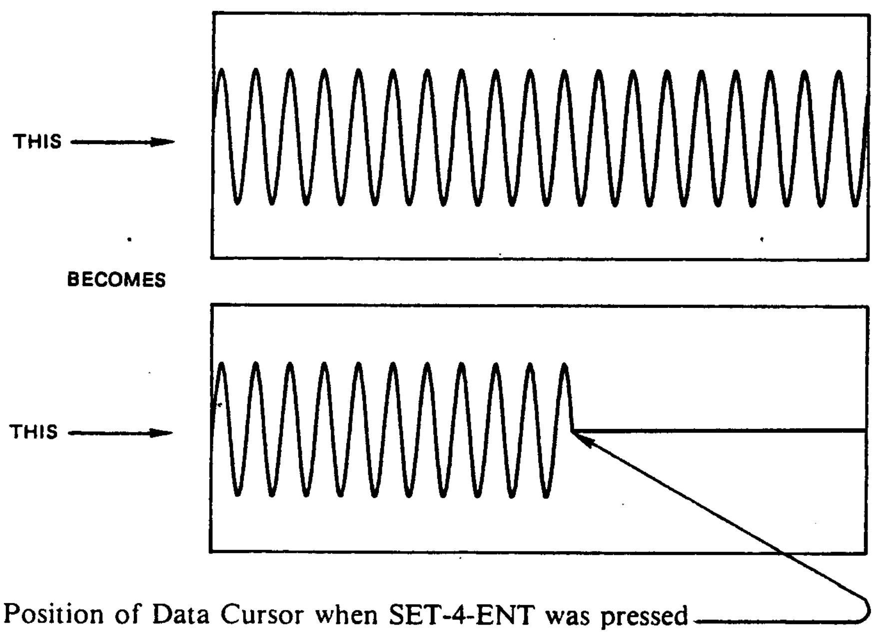
4. FORCE/RECT (Force-Response - Rectangular Weighting)
5. FRCE/EXP 1 (Force-Response - Exponential 1)
6. FRCE/EXP 2 (Force-Response - Exponential 2)
7. FRCE/EXP 3 (Force-Response - Exponential 3)
8. FRCE/EXP 4 (Force-Response - Exponential 4)

These weighting algorithms enhance signal analysis for impact testing and other types of transient response. Hence, the weighting applied to Channel A may be somewhat different from Channel B (see Table 3-INP/PROC-5).

FORCE/RECT Weighting

This weighting applies a zero-fill from a user-defined location (the location is determined by the position of the Data Cursor) to the end of memory. The location is defined by the user placing the Data Cursor at the desired location and then performing a "SET-4-ENT."

As an illustration, the effect on a sine wave is shown, although the feature is useful only for narrow-width impulse data.



If SET-4-ENT has not been entered or cleared, no data points are zeroed and FORCE/RECT Weighting will look just like default weighting (again, see Table 3-INP/PROC-5).

FRCE/EXP (1, 2, 3 and 4) Weighting

This weighting applies an exponential damping envelope to the data. The numbers 1, 2, 3 and 4 that accompany the FRCE/EXP selections allow for choosing different amounts of damping. This is shown in Figures 3-INP/PROC-24 through 3-INP/PROC-28 as follows:

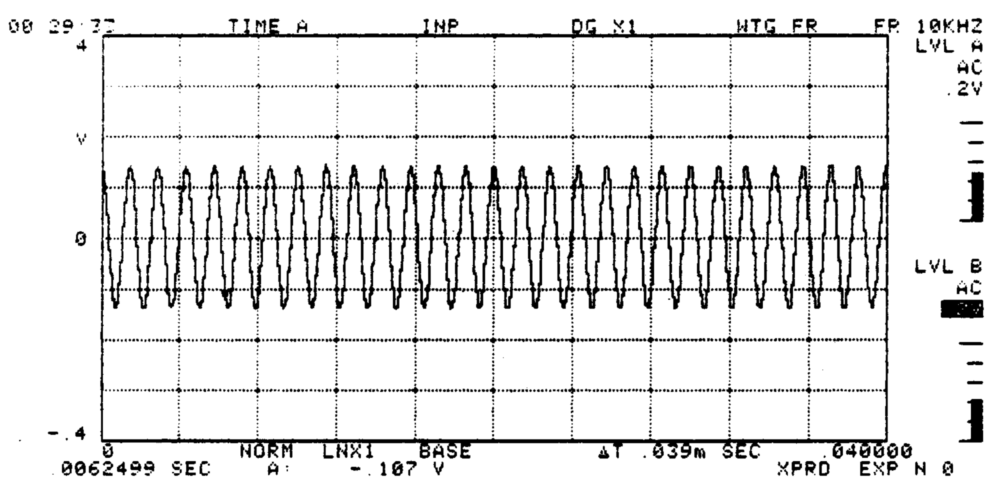


Figure 3-INP/PROC-24. Example of Signal Before Exponential Weighting is Applied

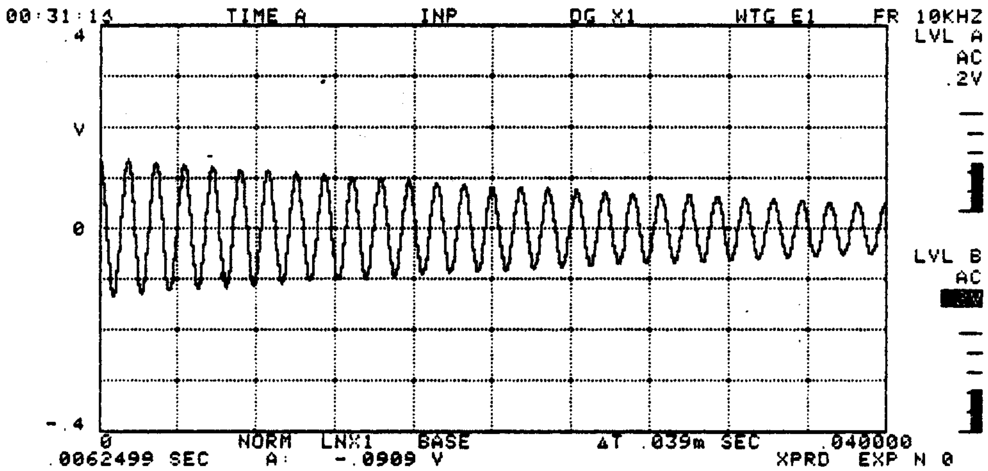


Figure 3-INP/PROC-25. FRCE/EXP 1, Last Cell is Attenuated 1/e

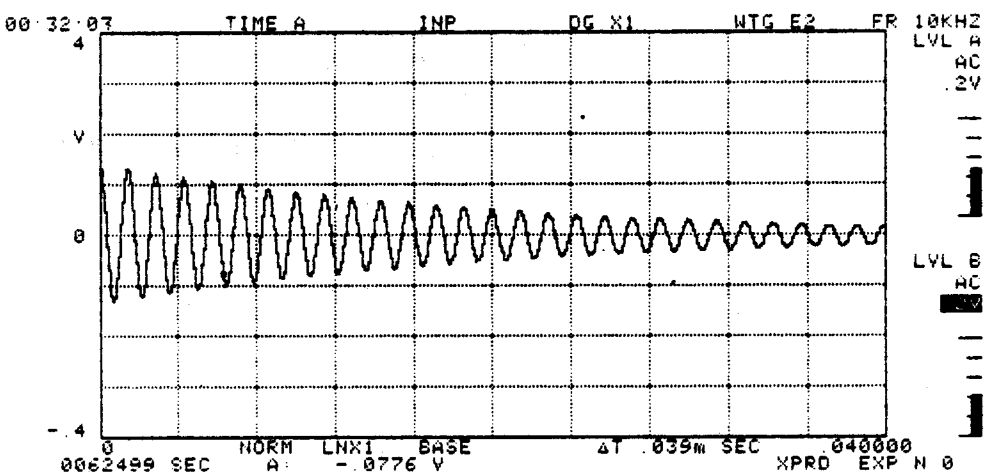


Figure 3-INP/PROC-26. FRCE/EXP 2, Last Cell is Attenuated 1/e^2

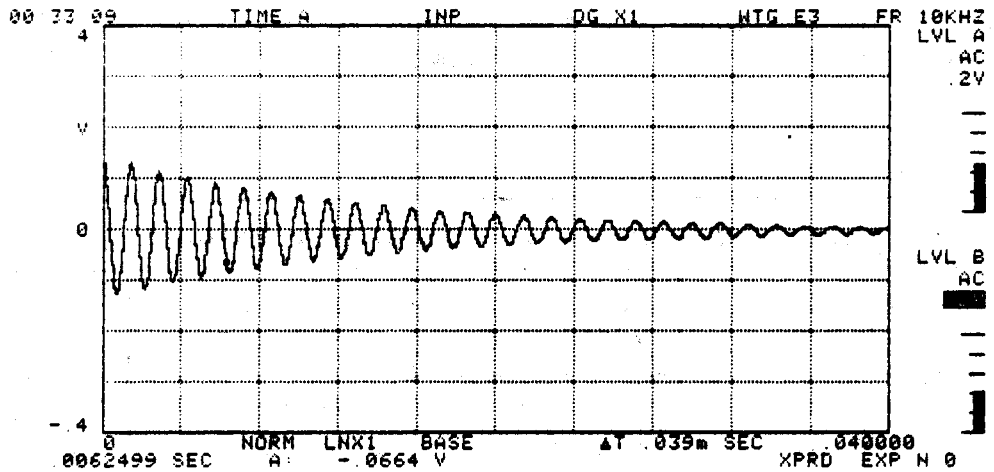


Figure 3-INP/PROC-27. FRCE/EXP 3, Last Cell is attenuated $1/e^3$

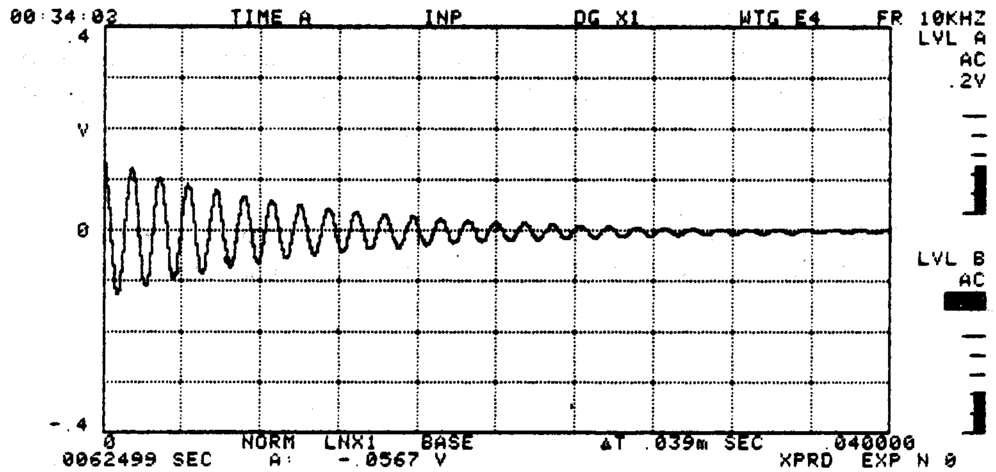


Figure 3-INP/PROC-28. FRCE/EXP 4, Last Cell is Attenuated $1/e^4$

More on Force Weighting

The primary application for this type of weighting is narrow-width impulse type data. This type of signal data may have a poor signal-to-noise characteristic. Noise information that is 60 dB down may be significant when compared to an impulse which may have a total area on the order of one or two cells. Even though the noise information has an amplitude at any one cell of about 1/1000 of the amplitude of the impulse, the noise occupies all 1024 cells. Hence the noise rms is on the same order as the impulse rms.

Using trigger delays (Setup Page 1) to position the impulse close to the beginning of the Memory Period, FORCE/RECT Weighting can be used to zero out most of the noise and vastly improve the signal-to-noise characteristic of the measurement.

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