Installation and Operation Manual
ProSeries Model SPS390
Dynamic Signal Analyzer
Part Four

Legacy Manual

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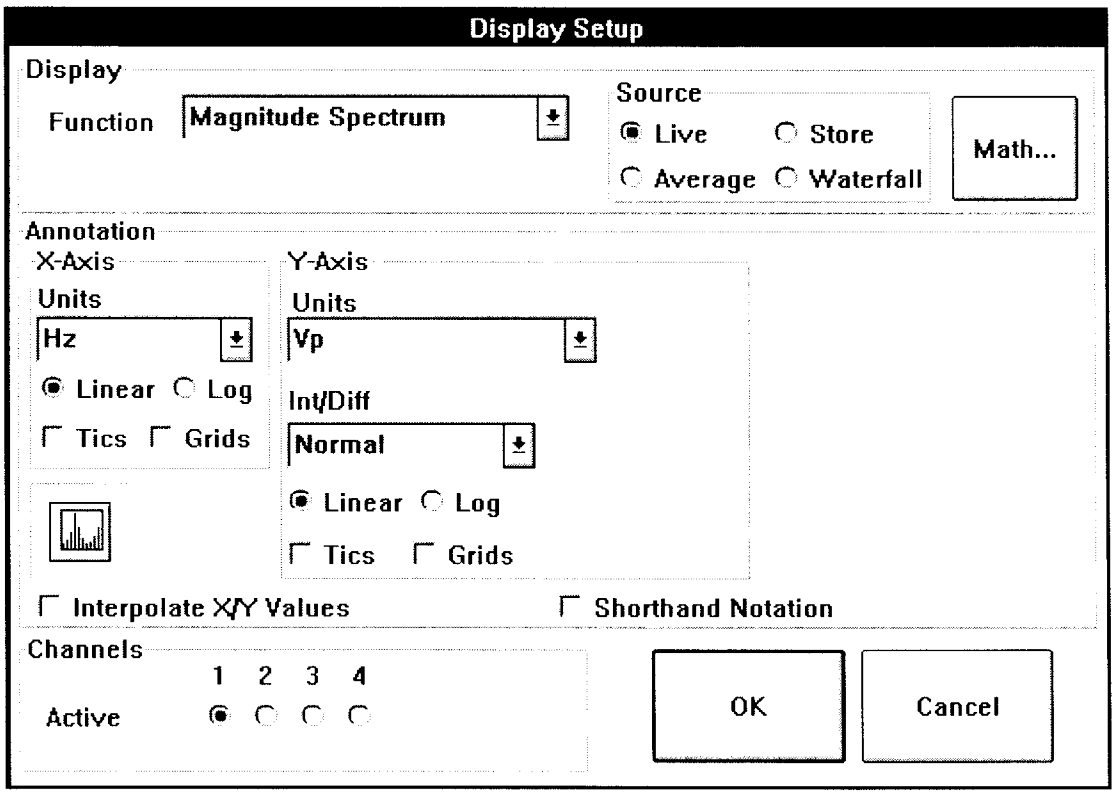
3–11 DIALOGS

3–11.1 Display Setup

The **Display Setup** dialog box is used to initialize a new display or modify the existing display parameters for an SPS390 display window. These parameters include:

- **Display Function**
- **Display Source**
- **Annotation X**- and **Y-axis Units**
- **X**- and **Y-Axis** scaling
- **Channel**(s) to be displayed
- **Math** functions



Display parameters, as opposed to acquisition and analysis parameters, are local to the display window. Creating a display or changing the parameters of a display has no effect on other displays or on the global SPS390 parameters.

The SPS390 allows up to nine display windows. After nine displays have been created, you cannot create more without first disposing of some of the existing display windows, as described in the display area section of this manual.

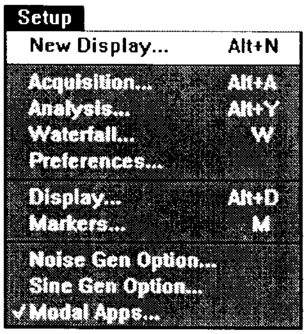
3–11.1.1 How to Invoke Display Setup

The **Display Setup** dialog is used both for creating new displays and for modifying existing displays.

New Display

To invoke the **Display Setup** dialog to create a new display:

- Use the trackball to:
  - Select the **Setup** menu
  - Select **New Display**



- Or use the keyboard:

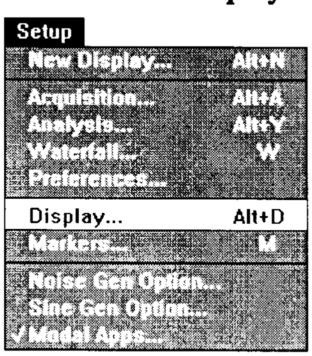
  Hold down the **ALT** key and press the **N** key.

  A new display window is not created until the **OK** button at the bottom right corner of the dialog is pressed. Selecting **Cancel** causes the dialog to disappear without creating a new display window.

Existing Display

To invoke the **Display Setup** dialog to modify an existing display, first make the display you wish to modify the active display (if it is not already) by clicking on it anywhere. Then:

- Use the trackball to:
  - Select the **Setup** menu
  - Select **Display**

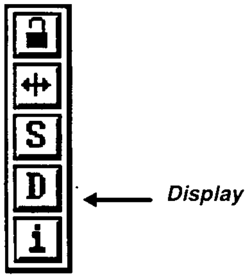


➤ Or use the keyboard:

Hold down the **ALT** key and press the **D** key.

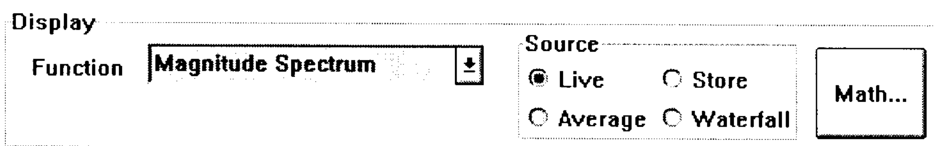
or

Select **D** in the Active Trace Window.



The display parameters for the active display are not changed until the **OK** button at the bottom right corner of the Display Setup Dialog has been pressed. Selecting **Cancel** causes the dialog to disappear without affecting the display parameters for the active display.

3–11.1.2 Display Group

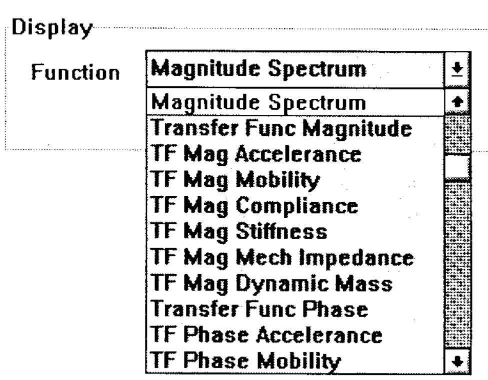


The **Display** group is used to set up the function and data source for SPS390 displays.

There can be up to nine displays simultaneously, with each display showing its own type of trace (for example, time, spectrum, or transfer function). Data for the trace may be either live, from the averager, from store memory, or from a disk file.

Function

The **Function** combo box allows you to select which type of trace is to be displayed from data currently in the SPS390 memory. Only valid display functions are listed, and these vary depending on the following factors:



- Averager Domain

  As specified in the Average group of the Analysis Setup Dialog.

- Store Contents

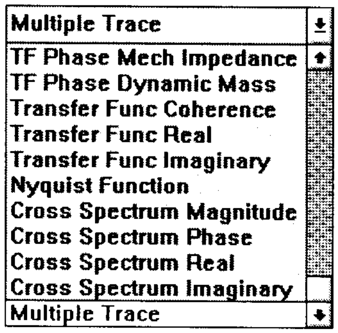
  As determined by the current status of store memory (empty or not).

- Mode Configuration

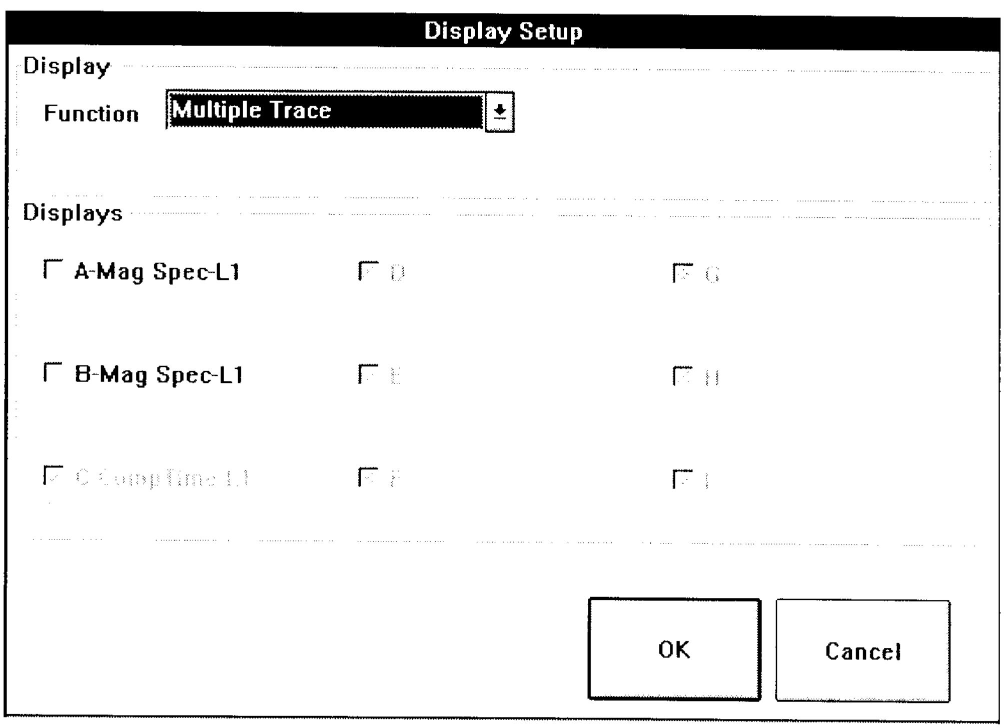
  As determined by the current status of the Mode Configuration dialog.

Multiple Trace

Although up to nine separate displays can be shown on the screen simultaneously, each is contained in its own individual window. If you want to overlay two or more traces in the same window, use **Multiple Trace**, the last item in the combo box.

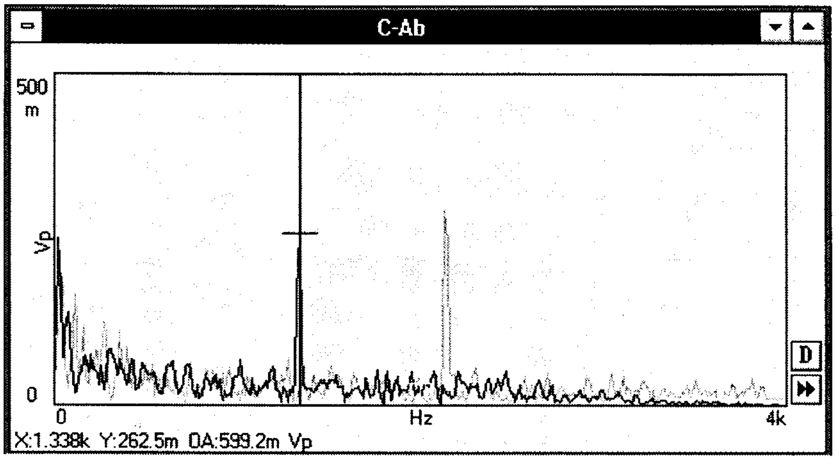


With this feature, up to eight displays, having a common X-Axis, can be overlapped in a single window. When **Multiple Trace** is selected, the **Display Setup** Dialog will change to a multiple trace selection dialog.

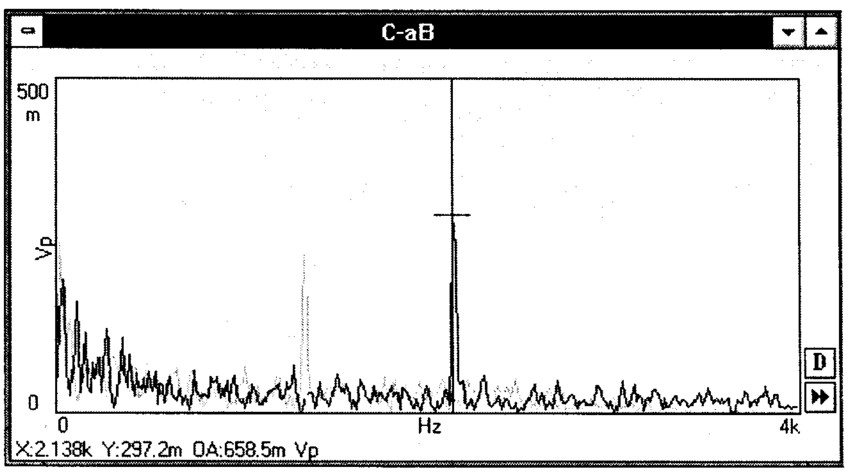


The traces must be available as individual displays before they can be overlaid into one composite screen.

Click on the boxes next to the displays you wish to overlay. One trace is always the dominant, or "hot" trace. In the display shown below, trace A is the hot trace. It appears darker, and is also identified by a capital letter in the name at the top of the display (**C-<u>A</u>b**).

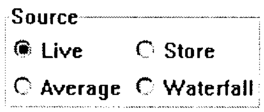


The double arrow icon in the lower right-hand corner permits the user to toggle through the overlaid displays and select the desired "hot" trace. If the double arrow is clicked once, trace B becomes the "hot" trace, as shown in the following display. It is now darker, and the name at the top of the display shows a capitalized B (**C-a<u>B</u>**).



When displaying multiple traces, the input memory must be in the Hold condition.

Source



The **Source** radio button group is used to determine whether the trace data is live, will come from the averager or waterfall, or will come from the storage memory. If a particular source is invalid for the selected display function, the corresponding radio button is grayed out.

If the trace is from a recalled disk file, the source will only show the source from which the data originated. It cannot be changed.

Table 1 shows the relationship between the **Display Function, Display Source**, and **Analysis** mode. For any given display function, the allowable display sources (L for Live, A for Average, and S for Store) are shown according to the analysis mode set in the **Mode** Menu. An empty entry (one that has neither an L, A, or S in it) indicates that the display function is not available for the given average domain.

For Orbit traces, the X- axis is the "reference" channel and the Y- axis is the "active" channel.

For Nyquist traces, the X- axis is the real component and the Y- axis is the imaginary component.

Octave Traces also display the overall level as an additional bar to the right of the main trace.

SPS390 HINT*: Only valid display functions are shown as dialog choices. However, when changing analysis modes, the currently selected displays may not be valid with the new mode for live and averager displays, but STORE may still contain valid data from the previous mode. Be sure to check that the function and source of the display agree with the new mode. If not, change the source first.*

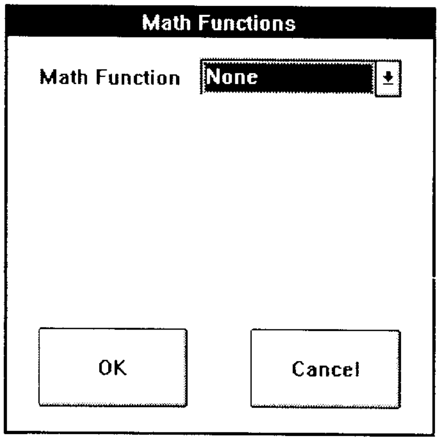
Table 1. Display Function, Display Source and Analysis Mode

Display Function	Analysis Mode				
	Sync Spectrum	Spectrum	Cross Properties	Correlation	Octave (Option)
Time Trace	L A S	L	L		
Compressed Time	L	L	L	L	
Orbit	L A S	L	L		
Magnitude Spectrum	L A S	L A S	L A S		
Transfer Function Magnitude	A S (Optional)		A S		
TF Magnitude Accelerance			A S		
TF Magnitude Mobility			A S		
TF Magnitude Compliance			A S		
TF Magnitude Stiffness			A S		
TF Magnitude Mech Impedance			A S		
TF Magnitude Dynamic Mass			A S		
Transfer Function Phase	A S (Optional)		A S		
TF Phase Accelerance			A S		
TF Phase Mobility			A S		
TF Phase Compliance			A S		
TF Phase Stiffness			A S		
TF Phase Mech Impedance			A S		
TF Phase Dynamic Mass			A S		
Transfer Function Coherence			A S		
Transfer Function Real	A S (Optional)		A S		
Transfer Function Imaginary	A S (Optional)		A S		
Nyquist Function	A S (Optional)		A S		
Cross Spectrum Magnitude			A S		
Cross Spectrum Phase			A S		
Cross Spectrum Real			A S		
Cross Spectrum Imaginary			A S		
Multiple Trace	L A S	L A S	L A S	L A S	L A S
Octave Spectrum					L A S
Cross Correlation				A S	
Auto Correlation				A S	

Math Functions

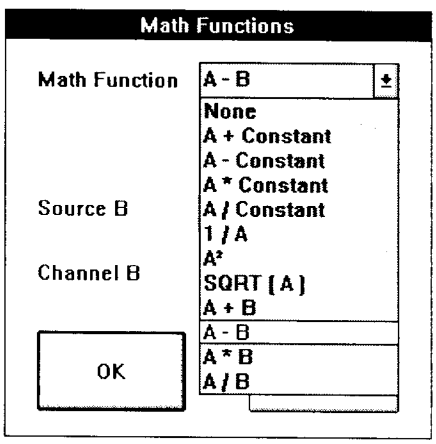
The **Math** Function feature allows the user to easily perform and display various mathematical computations on signal traces. The computations supported are addition, subtraction, multiplication, division, squaring, finding the square root, and working with constants.

To create a new display showing one of these functions, invoke the **Math Function** dialog by pressing the **Math** Functions button in the upper right-hand corner of the **Display Setup** Dialog.



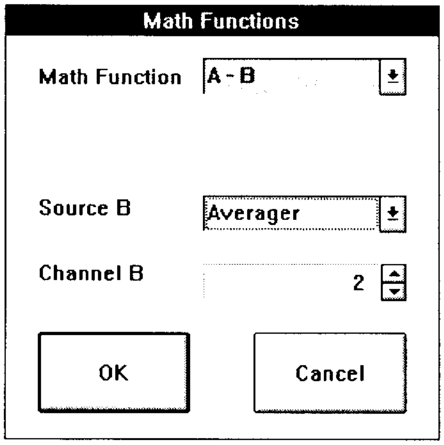
The "A" trace is considered to be the active trace, as defined in the **Display Setup**. The "B" trace is considered to be the reference which will be added, subtracted, etc., to/from the "A" trace. Both traces may be either live, averaged, or stored data.

The **Math Function** pull-down menu contains the following choices:

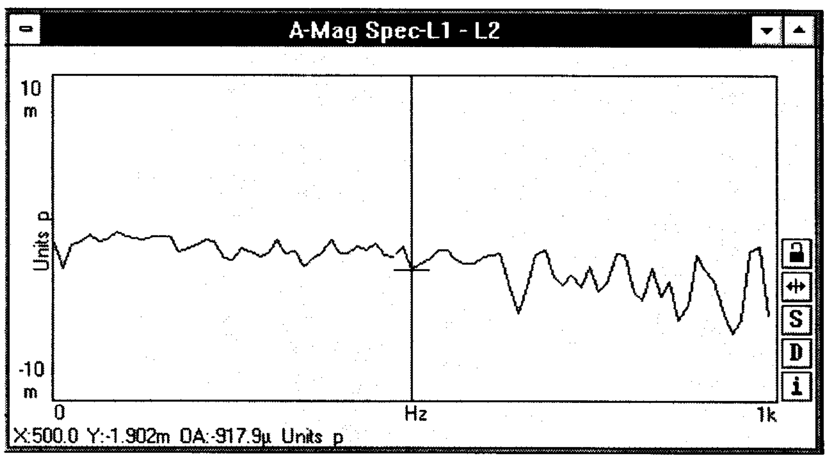


In this instance, **A–B** is selected, and the user is prompted to select the source and the channel for trace B. The source selections available depend upon the data that has been collected and placed in active memory. The choices can include live, averager, or stored data. The channel can be any of the active channels; use the arrows to scroll through the active channels until the desired channel number is displayed.

A typical selection is shown below.

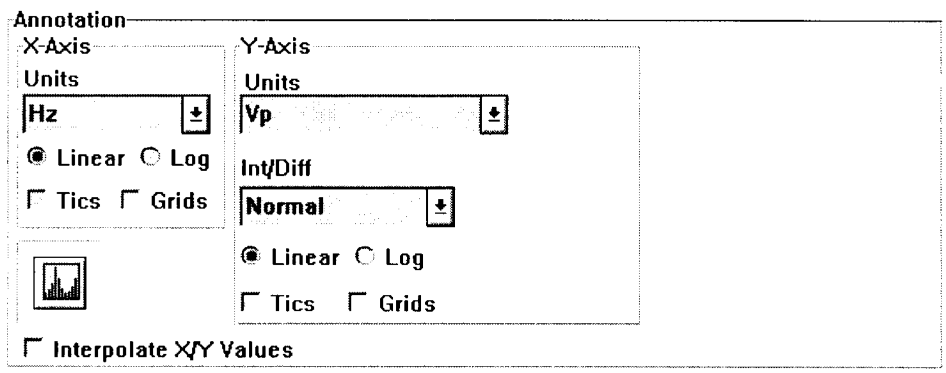


The following figure shows a sample **A–B** display. Note that the window title bar identifies the display as a subtraction function of two live traces.



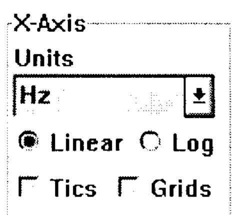
3–11.1.3 Annotation Group

The **Annotation** dialog is used for **X-** and **Y-Axis annotation, X-** and **Y-Axis** scaling, enabling/disabling grid and tic marks and, for Magnitude Spectrum integration and differentiation.



X-Axis Controls

The **X-Axis** controls are used to control the annotation and scaling of the display X-Axis.



Units (X-Axis)

The **Units** combo box allows you to select which units will be used on the X-Axis of the display. These units depend upon the display function and the axis scaling. Table 2 shows which units are available for the **X-Axis**, based on display function for axis scaling (blank entries denote invalid combinations of display function and scaling):

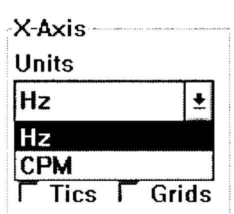


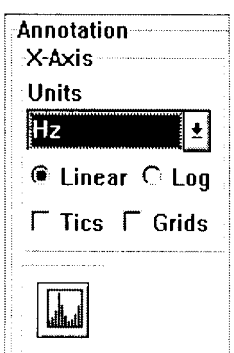
Table 2. X-Axis Units vs. Display Function

Display Function	Linear	Log
Compressed Time	Seconds	
Time Trace	Seconds	
Orbit	V, EU	
Magnitude Spectrum	Hz, CPM*	Hz, CPM*
Transfer Function Magnitude	Hz, CPM	Hz, CPM
TF Magnitude Accelerance	Hz, CPM	Hz, CPM
TF Magnitude Mobility	Hz, CPM	Hz, CPM
TF Magnitude Compliance	Hz, CPM	Hz, CPM
TF Magnitude Stiffness	Hz, CPM	Hz, CPM
TF Magnitude Mech Impedance	Hz, CPM	Hz, CPM
TF Magnitude Dynamic Mass	Hz, CPM	Hz, CPM
Transfer Function Phase	Hz, CPM	Hz, CPM
TF Phase Accelerance	Hz, CPM	Hz, CPM
TF Phase Mobility	Hz, CPM	Hz, CPM
TF Phase Compliance	Hz, CPM	Hz, CPM
TF Phase Stiffness	Hz, CPM	Hz, CPM
TF Phase Mech Impedance	Hz, CPM	Hz, CPM
TF Phase Dynamic Mass	Hz, CPM	Hz, CPM
Transfer Function Coherence	Hz, CPM	Hz, CPM
Transfer Function Real	Hz, CPM	Hz, CPM
Transfer Function Imaginary	Hz, CPM	Hz, CPM
Nyquist Function	V/V, EU/EU	
Cross Spectrum Magnitude	Hz, CPM	Hz, CPM
Cross Spectrum Phase	Hz, CPM	Hz, CPM
Cross Spectrum Real	Hz, CPM	Hz, CPM
Cross Spectrum Imaginary	Hz, CPM	Hz, CPM
Octave Spectrum (Option)	Hz (logarithmically distributed by band)	

*Orders if SRA option is installed

Scaling (X-Axis)

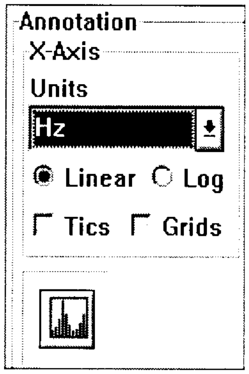
The **Scaling** radio buttons determine whether the scale for the axis is linear or logarithmic (base 10). If one of the scaling functions is invalid for the selected display type, the scaling defaults to the valid scaling function and the control corresponding to the invalid scaling function is grayed.



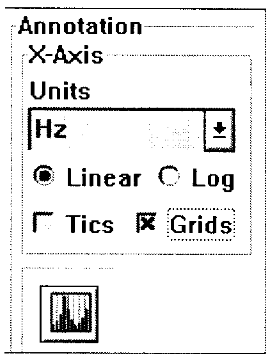
Grids and Tic Marks (X-Axis)

Grids and Tic Marks for this axis can be independently selected by choosing the desired options as follows:

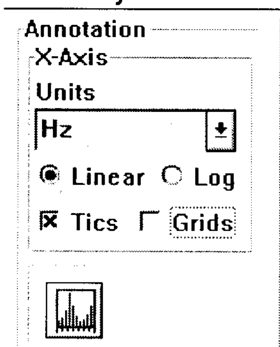
Open—no grids or tic marks; deselect both **Grids** and **Tics** options.



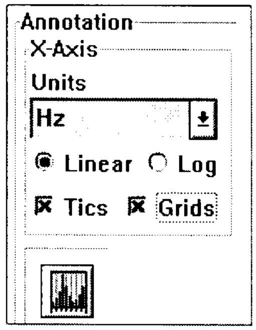
Grids Only—select the grid option



Tics Only—select the tics option

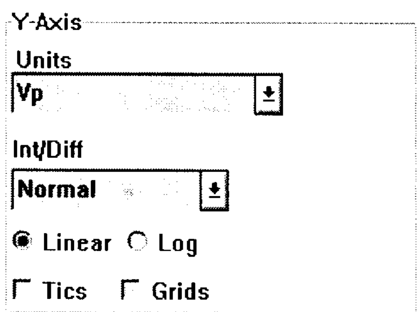


Grids and Tics—select both the grid and tic options



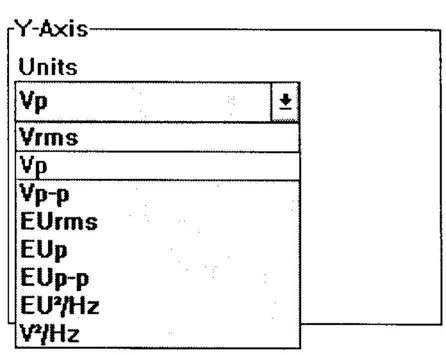
Y-Axis Controls

The Y-**Axis Controls** are used to control the annotation and scaling of the display Y-Axis.

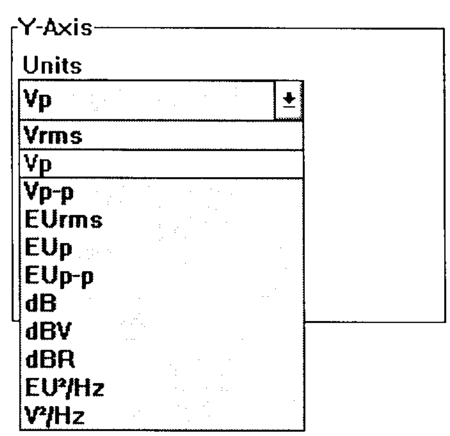


Units (Y-Axis)

The **Units** combo box allows you to select which units will be used on the Y-Axis of the display. These units depend upon the display function and the axis scaling. Tables 3 and 4 how which units are available for the Y-Axis based on display function and axis scaling (blank entries denote invalid combinations of display function and scaling):



Y LIN



Y LOG

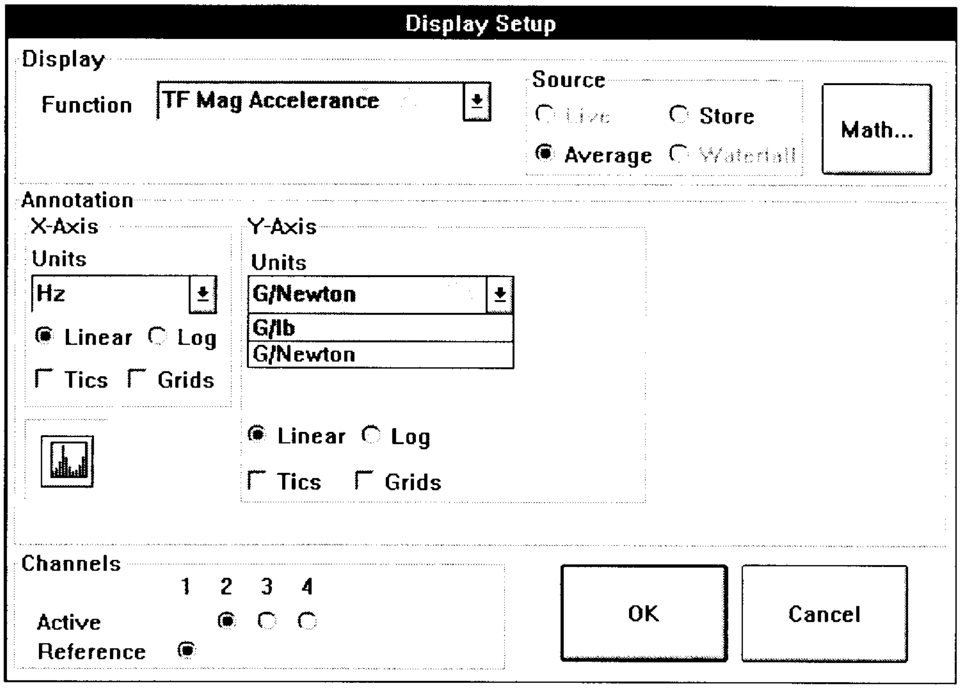
Table 3. Y-Axis Units vs. Display Function (Linear)

Display Function	Linear
Time Trace	V, EU
Compressed Time	V, EU
Orbit	V, EU
Magnitude Spectrum	Vrms, Vp, Vp-p, EUrms, EUp, EUp-p, V^2/Hz, EU^2/Hz
Transfer Function Magnitude	V/V, EU/EU
TF Magnitude Accelerance	G/lb, G/Newton
TF Mag Mobility	IPS/lb, m/Newton*sec
TF Mag Compliance	inches/lb, m/Newton
TF Mag Stiffness	lb/inch, Newton/m
TF Mag Mech Impedance	lb/IPS, Newton*sec/m
TF Mag Dynamic Mass	lb/G, Newton/G
Transfer Function Phase	-180 to 180, 0 to 360 degrees
TF Phase Accelerance	0 to 360 degrees, -180, +180
TF Phase Mobility	0 to 360 degrees, -180, +180
TF Phase Compliance	0 to 360 degrees, -180, +180
TF Phase Stiffness	0 to 360 degrees, -180, +180
TF Phase Mech Impedance	0 to 360 degrees, -180, +180
TF Phase Dynamic Mass	0 to 360 degrees, -180, +180
Transfer Function Coherence	0 - 1
Transfer Function Real	V/V, EU/EU
Transfer Function Imaginary	V/V, EU/EU
Nyquist Function	V/V, EU/EU
Cross Spectrum Magnitude	V^2rms, V^2p, V^2p-p, EU^2rms, EU^2p, EU^2p-p
Cross Spectrum Phase	-180 to 180, 0 to 360 degrees
Cross Spectrum Real	V^2rms, V^2p, V^2p-p, EU^2rms, EU^2p, EU^2p-p
Cross Spectrum Imaginary	V^2rms, V^2p, V^2p-p, EU^2rms, EU^2p, EU^2p-p
Octave Spectrum (Option)	Vrms, EUrms

Figure 4 Y-Axis Units vs. Display Function (Logarithmic)

Display Function	Logarithmic
Time Trace	
Compressed Time	
Orbit	
Magnitude Spectrum	Vrms, Vp, Vp-p, EUrms, EUp, EUp-p, V^2/Hz, EU^2/Hz, dB, dBV, dBR
Transfer Function Magnitude	V/V, EU/EU, dB, dBV, dBR
TF Mag Accelerance	G/lb, G/Newton
TF Mag Mobility	IPS/lb, m/Newton*sec
TF Mag Compliance	inches/lb, m/Newton
TF Mag Stiffness	lb/inch, Newton/m
TF Mag Mech Impedance	lb/IPS, Newton*sec/m
TF Mag Dynamic Mass	lb/G, Newton/G
Transfer Function Phase	
TF Phase Accelerance	
TF Phase Mobility	
TF Phase Compliance	
TF Phase Stiffness	
TF Phase Mech Impedance	
TF Phase Dynamic Mass	
Transfer Function Coherence	
Transfer Function Real	
Transfer Function Imaginary	
Nyquist Function	
Cross Spectrum Magnitude	V^2rms, V^2p, V^2p-p, EU^2rms, EU^2p, EU^2p-p, dB, dBV, dBR
Cross Spectrum Phase	
Cross Spectrum Real	
Cross Spectrum Imaginary	
Octave Spectrum (Option)	Vrms, EUrms, dB, dBV, dBR

Note that the six calculated mechanical Frequency Response Functions can be automatically scaled in metric as well as English units. When selecting Accelerance, for example, magnitude can be shown as G/lb or G/Newton. The correct scale factor for mV/Newton must be entered on the Acquisition dialog for metric conversion.



3–11.1.4 Integrate/Differentiate (Magnitude Spectrum Only)

For Magnitude Spectrum Traces, the data can be displayed normally, or integrated or differentiated. When **Magnitude Spectrum** is selected as the display function, an **Int/Diff** combo box is displayed. From this you can select:

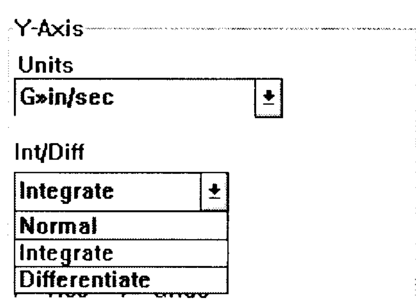
Normal

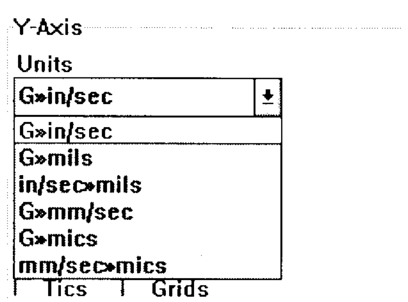
Integrate

Differentiate

When **Normal** is selected, the Units as listed in **Units (Y-Axis)** appear in the Units combo box for selection.

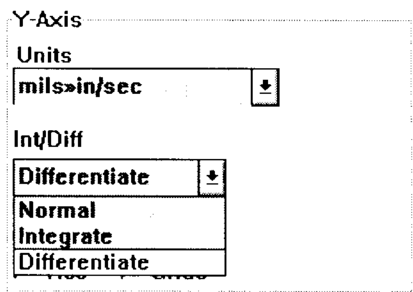
When **Integrate** is selected, the following illustration and table show the choices of units that appear in the **Units** combo box, and their meaning:

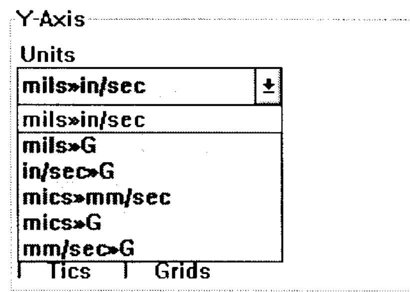




Units	English/Metric	Operation
g's >>n/sec	English	Integration
g's >>mils	English	Double Integration
in/sec >>mils	English	Integration
g's >>mm/sec	Metric	Integration
g's >>mics	Metric	Double Integration
mm/sec >>ic	Metric	Integration

When **Differentiate** is selected, the following illustration and table show the choices of units that appear in the **Units** combo box, and their meaning:

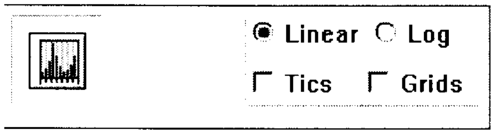




Units	English/Metric	Operation
mils >>in/sec	English	Differentiation
mils >>'s	English	Double Differentiation
in/sec >>'s	English	Differentiation
mics >>m/sec	Metric	Differentiation
mics >>'s	Metric	Double Differentiation
mm/sec >>'s	Metric	Differentiation

Integration and differentiation are accomplished by dividing or multiplying the data by $2\pi f$ or $(2\pi f)^2$ and by applying the appropriate units scaling and conversion factors.

Scaling (Y-Axis)

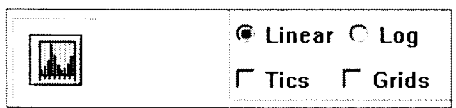


The **Scaling** radio button group determines the scale for the axis — linear or logarithmic (base 10). If one of the scaling types is invalid for the selected display function, the scaling defaults to the valid scaling type and the control corresponding to the invalid scaling type is grayed.

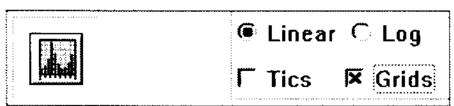
Grids and Tic Marks (Y-Axis)

Grids and **Tics** Marks for this axis can be independently selected by choosing the desired options:

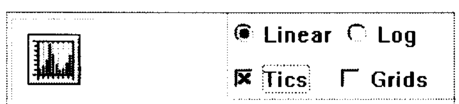
- Open — no grids or tic marks; deselect both Grids and Tics options.



- **Grids** Only — select the Grids option.



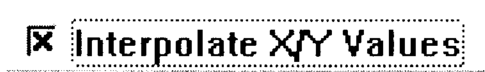
- **Tics** Only — select the Tics option.



- **Grids** and **Tics** — select both the grids and tics options.

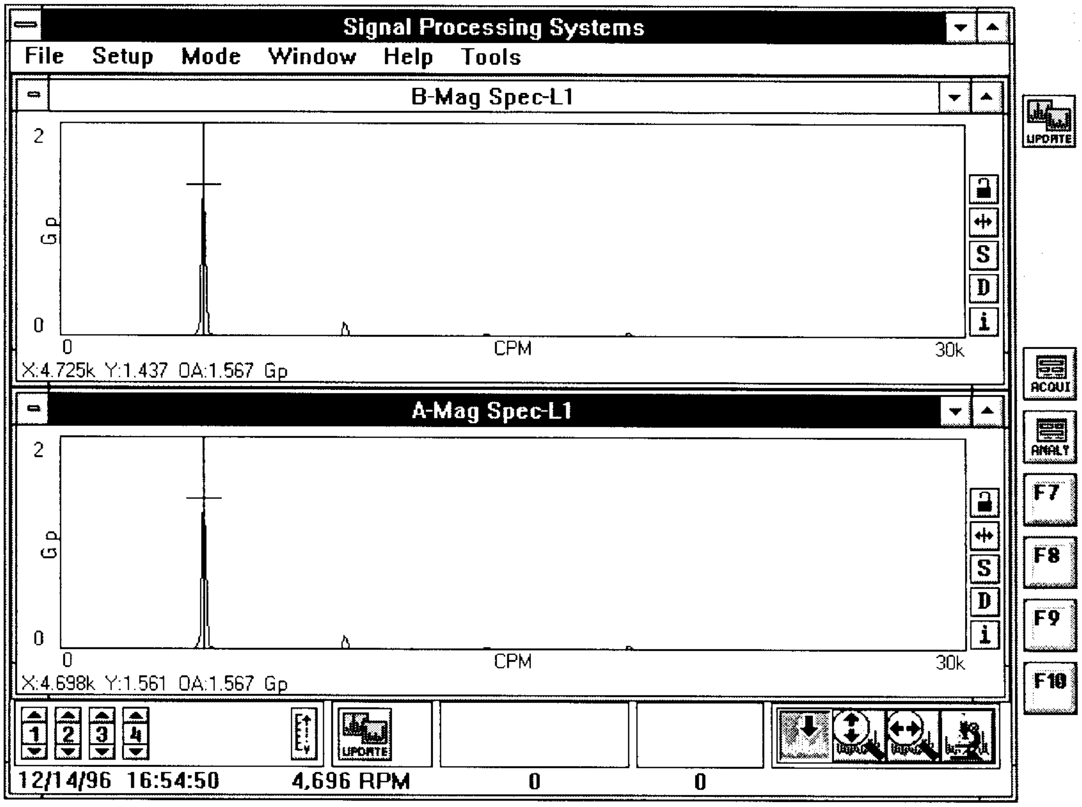
3–11.1.5 Interpolate X/Y Values (Magnitude Spectrum Only)

For Magnitude Spectrum traces, the X/Y values can be interpolated, by clicking on the **Interpolate X/Y Values** check box beneath the scaling graphic. This option is extremely useful when time is of the essence in pinpointing the exact frequency of a signal that was processed using a Hanning window.



The following figure shows a standard spectrum display (top trace) and an interpolated display (bottom trace). In both cases, a 200-line spectrum to 30,000

CPM is displayed, giving 150 CPM bin resolution. The actual machine speed, measured with a 1/rev tachometer, is also shown (4696 RPM).



60655-08L

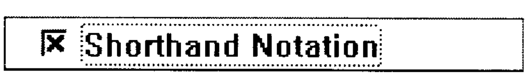
In the top trace, the nearest bin is at 4725 CPM. The bottom trace interpolates the actual frequency of the peak to 4698 CPM and also interpolates the peak amplitude. Note that this is about 0.1 g higher than the uninterpolated value. Both spectra were measured with a Hanning window.

The interpolation feature can mean an improvement in frequency resolution of orders of magnitude, without the typical loss of time associated with longer block lengths or zoom (methods sometimes used to accomplish the same objective). With the improved frequency resolution there is no attendant loss of amplitude accuracy, since the correct peak is also interpolated based on the characteristics of the Hanning window.

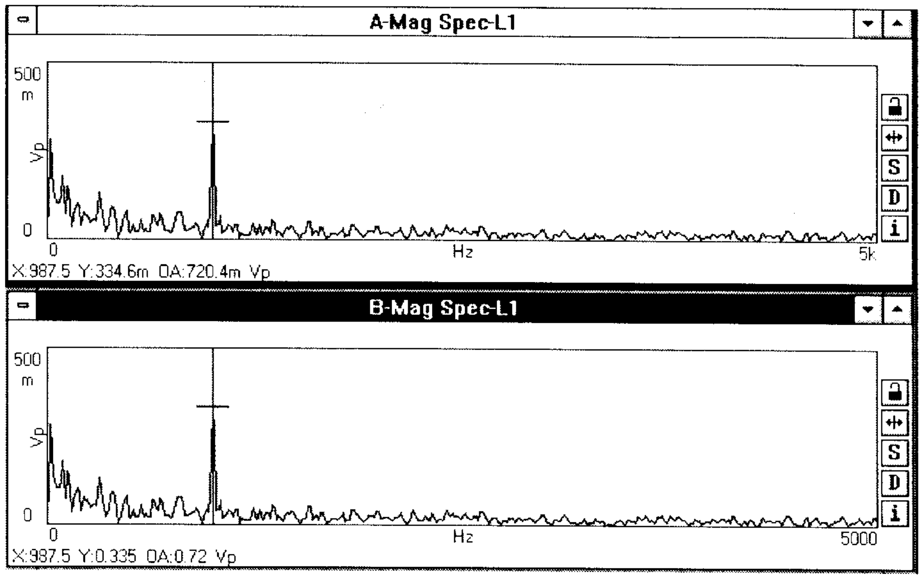
3–11.1.6 Shorthand Notation

Cursor readouts on spectrum displays are used to show magnitude and frequency values at selected points. In standard notation, the X-Axis cursor readout is typically limited to four digits plus a multiplier (k for kilo-, m for milli-, M for mega-, etc.). Magnitude values are also shown with a multiplier that permits four digits to cover the entire dynamic range of the analyzer.

However, when **Shorthand Notation** is selected, by clicking on the **Shorthand Notation** check box just above the **OK** button, real numbers up to nine digits are used for both X- and Y-Axis cursor readouts.



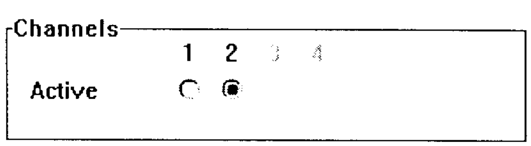
Note the differences in cursor readout in the two displays on the next page. The Shorthand readout is always given with a real number, less any decade or x1000 multipliers. This approach actually increases X-Axis resolution up to as many as five digits in Hz or seven digits in CPM. Likewise, amplitude values can be read out with as many as nine digits for large values and down to 0.001 for small levels.



Shorthand notation can be selected or deselected as desired after the display is presented.

3–11.1.7 Channels Group

The channels group is used to select which channel(s) will be used as the source for the trace data.

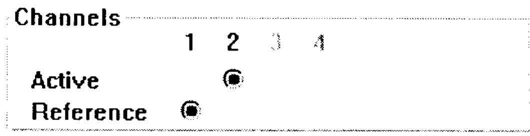


Active Channels

The **Active** channels radio button group allows you to select one active channel to be used as the source of the trace. The enabled channels are determined by the active channels selected in the Analysis Setup Dialog input group.

☞ *There must always be a single active channel for each display.*

Reference Channels



The **Reference** channels radio button group allows you to select one active channel to be used as a reference channel when displaying transfer function or cross spectrum traces.

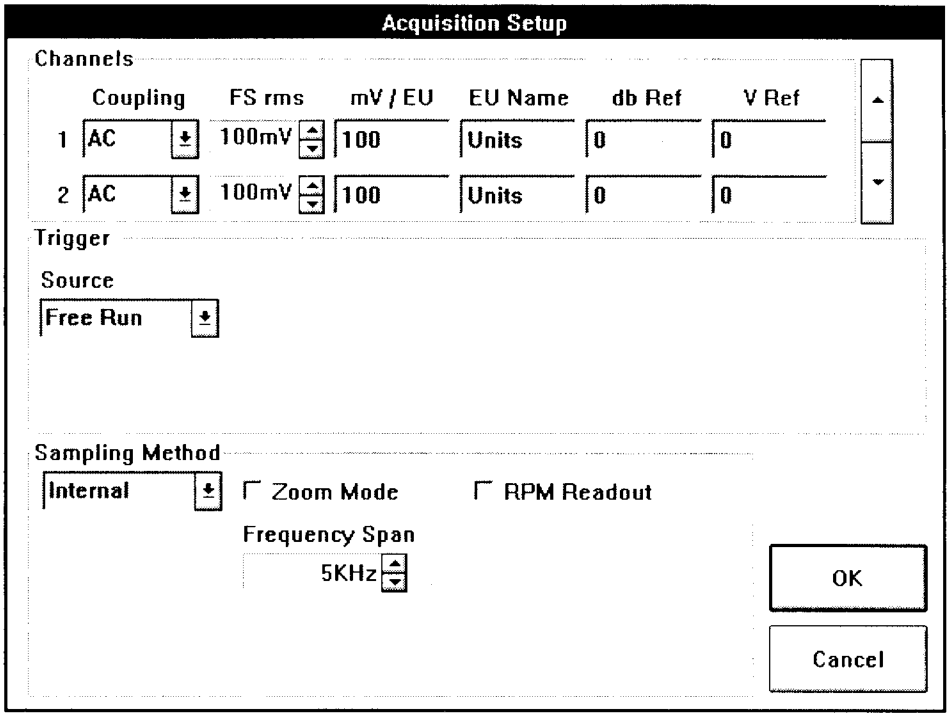
For ORBIT Traces, the reference channel is the X-Axis Channel.

3–11.2 Acquisition Setup

The **Acquisition Setup** Dialog is used to set up the channel, trigger, a sampling parameters. These include:

- **Channels Coupling**
- **Channels FS rms** (Full Scale)
- **Channels mV/EU** (mV to EU conversion factor)
- **Channels EU Name** (1 to 6 characters)
- **Channels dB Ref** and **V Ref** (dB and voltage reference factors)
- **Trigger Source**
- **Trigger Source Channel Delay**
- **Trigger Slope**
- **Trigger Threshold**
- **Frequency Span**
- **Zoom Center Frequency**
- **RPM Readout**

All acquisition parameters are global to the SPS390. Changing them may cause incompatibility between live data being collected and data currently in the averager. If such incompatibility is detected, the averager will cease averaging and you will not be able to resume averaging. The averager must be explicitly restarted (thus clearing the current averager contents) to perform averaging with the new acquisition parameters.



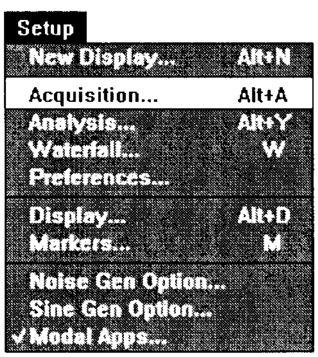
3–11.2.1 How To Invoke Acquisition Setup

To invoke the Acquisition Setup dialog:

- Use the trackball to:

  Select the Setup menu

  Select **Acquisition**



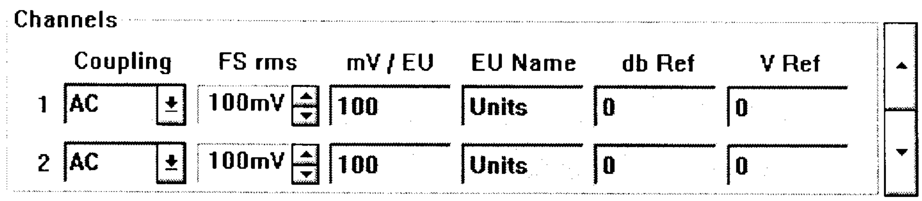
- Or use the keyboard:
- Hold down the **ALT** key and press the **A** key

Acquisition parameters are not set until the **OK** button at the bottom right corner of the dialog is pressed. Selecting **Cancel** causes the dialog to disappear without affecting the acquisition parameters.

➲ ***SPS390 HINT**: When beginning a data acquisition/analysis task, the acquisition parameter should be set up first and remain in effect until the task has been completed.*

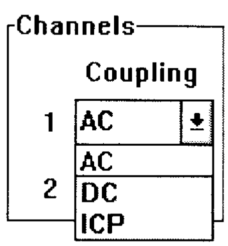
3–11.2.2 Channels Group

The channels group is used to set up the SPS390 channel parameters. Channels are configured here, but are activated on the **Analysis Setup** dialog. The SPS390 can have up to eight channels installed, two channels per card, and it will "recognize" how many cards are installed.



Each channel has its own parameters. Two channels at a time appear in the channels scroll box, and the next group of two channels can be selected by pressing the up/down arrow buttons on the right.

Channels Coupling

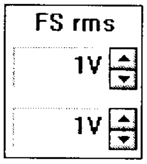


Coupling is selected on a channel-by-channel basis using the **Coupling** combo box. There are three choices for channel coupling:

- **AC** Alternating current signal source. The dc component is rejected.
- **DC** Direct current signal source. Both the ac and dc components are accepted.
- **ICP** Integrated Circuit Piezoelectric power source (transducer) 4 mA at 24 Vdc.

Note: I.C.P. .™ is a registered trademark of PCB Peizotronics, Inc.

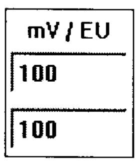
FS rms (Full Scale Voltage)



Channel full scale is set on a channel-by-channel basis using the **FS rms** scroll box. Full scale range is from 1 mV to 20 V selected in a 1, 2, 5 sequence, giving a total of 14 full scale ranges. Clicking on the up/down arrow increases/decreases the full scale voltage for the specified channel to the next higher/lower level, respectively. **AutoRanging** for a particular channel may be set by clicking one level above 20 V. When AutoRanging is activated, the most suitable gain based on the signal for the indicated channel will be selected. AutoRanging will be performed when the Dialog is ended, and when data acquisition resumes. The value that was selected during AutoRange will appear in the **FS rms** field the next time the Acquisition Dialog is entered.

mV/EU (Calibration Factor)

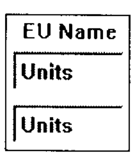
The **mV/EU** box is used to convert channel voltage (in mV) to a more convenient unit of your choice (called an Engineering Unit, or EU for short). All displays in the SPS390 are capable of using EUs for the units, in addition to the predefined units available. The calibration factor is then used to convert from voltage units to EUs.



The calibration factor is set by clicking inside the text box once to make it the active control, and then double clicking inside it to bring up the Virtual Calculator, which can be used to input or calculate the appropriate numerical value (accurate to three decimal places). The calibration factor is always entered in mV (i.e., the number of millivolts equivalent to 1 EU).

EU Name (Engineering Units)

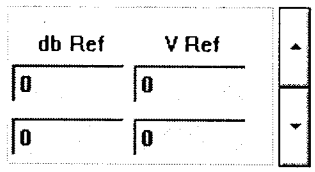
EUs can be set using the virtual keyboard in the same manner as mV/EU, or can be typed from a keyboard if available. An EU name can be any string of characters from 1 to 6 characters in length.



Reminder: For transfer function or cross property displays it is recommended that the default "Units" be changed to something more meaningful to the measurement. The selected reference channel will be the divisor in transfer function and cross property displays. If the operator enters in the word "Input" as the **EU Name** for the reference channel and "Output" as the data channel, the displays will be correctly annotated as "Output/Input" rather than the default "Units/Units".

dB Ref (dB Reference) and V Ref (Reference Voltage)

For acoustic measurements, a reference voltage (V Ref) can be equated to a dB Reference value by entering these two quantities in their appropriate text boxes. These values are used to calculate the dB amplitude in relationship to the entered quantities when the DBR Y UNITS Selector is chosen for a display.

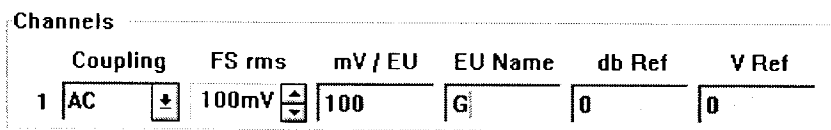


☞ *A dB reference can be entered independently from, or in addition to, the calibration factor. The default dB reference is 0 dB at 1.0 volts.*

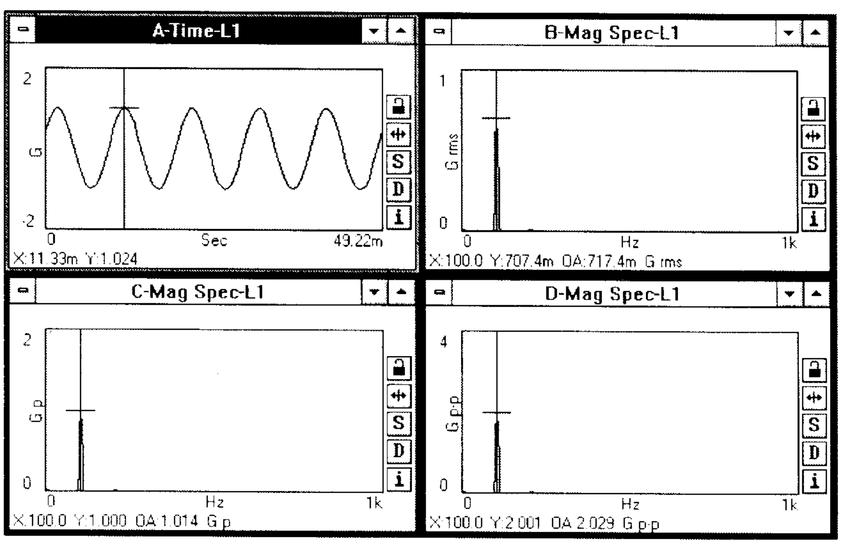
☞ *All entered channels' calibration data is saved when a **.cfg** file is saved.*

Calibration Examples

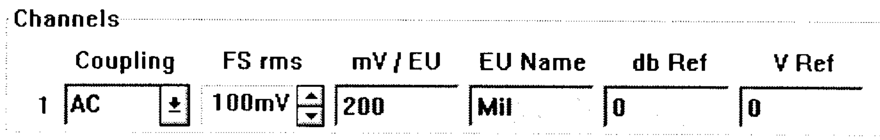
Assume an accelerometer transducer sensitivity is 100 mV/g. The **mV/EU** and **EU Name** are entered as shown in the following example:



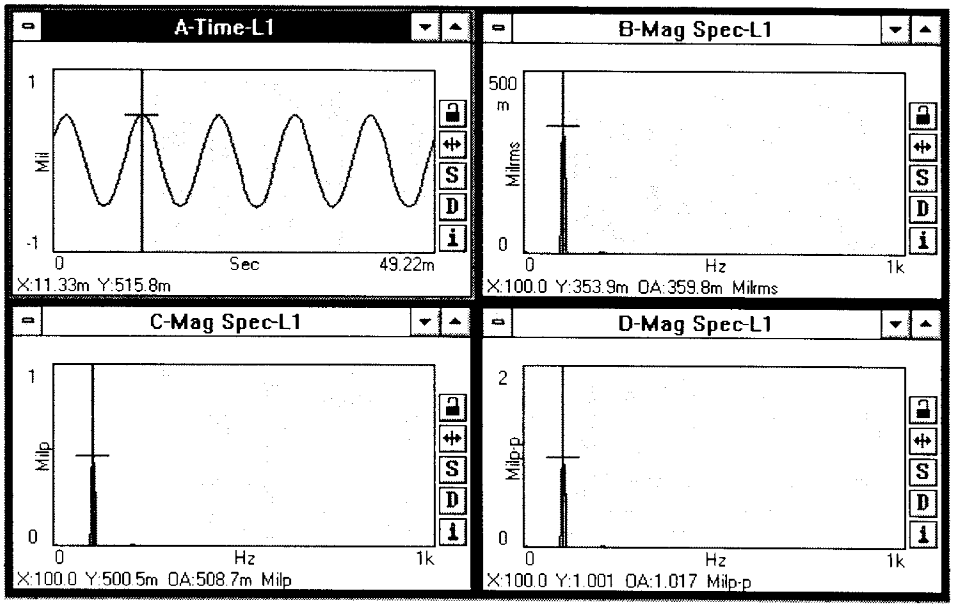
If a nominal 100 mV 0-p sine wave is generated by the accelerometer, the SPS390 acceleration readouts will be as shown in the following display examples:



Assume a displacement transducer sensitivity of 200 mV/Mil. The **mV/EU** and **EU Name** are entered as shown in the following example:

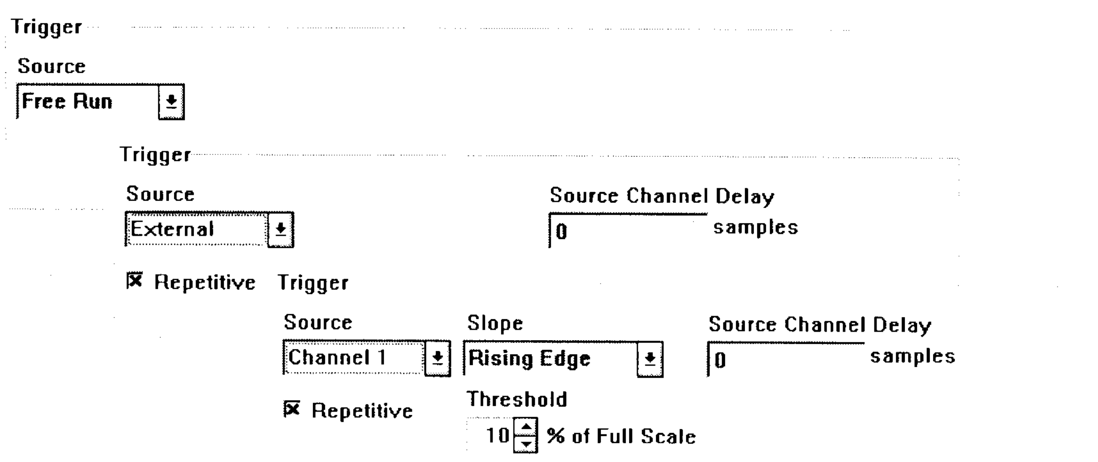


If a nominal 100 mV 0-p sine wave is generated by the displacement probe, the SPS390 displacement readouts will be as shown in the following display examples:



3-11.2.3 Trigger Group

The trigger group is used to set the parameters that control triggered acquisition in the SPS390. Triggering is not available when Zoom is enabled.

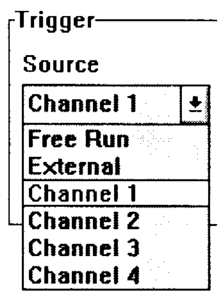


In triggered data acquisition, the SPS390 does not begin processing data until some event, or trigger, occurs. The amount of data collected is equal to a single block of data set in the input group of the **Analysis Setup** dialog, plus the negative delay number of samples, *or*, the positive delay number of samples. Negative delay samples are included as *part* of the data block. Positive delay samples are *outside* the data block.

You can set parameters to perform sampling only upon the first trigger or to repeatedly collect data upon every trigger. You can also specify the characteristics of the trigger, whether it is a TTL signal coming from an external trigger (tachometer) input or an analog signal coming from one of the channels. You can also control how soon data will be collected after (or before) the trigger occurs.

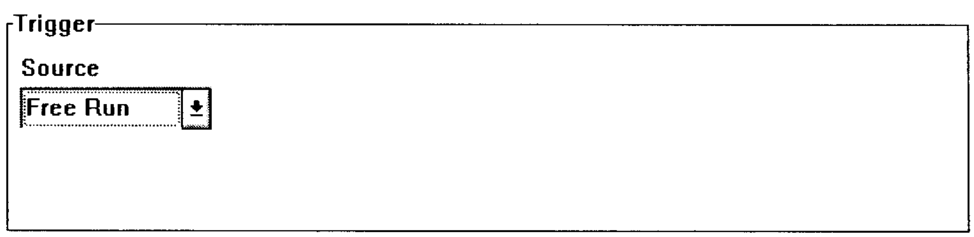
Source

The **Trigger Source** is selected using the Source combo box. There are three choices for trigger source:



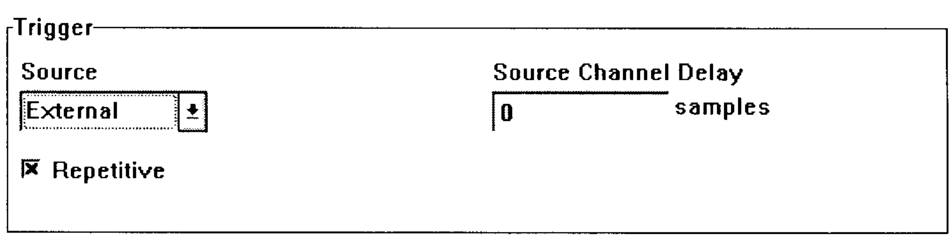
Free Run Source

In **Free Run** mode, data is acquired constantly, at the selected sample rate for processing given the current number of tasks being processed.



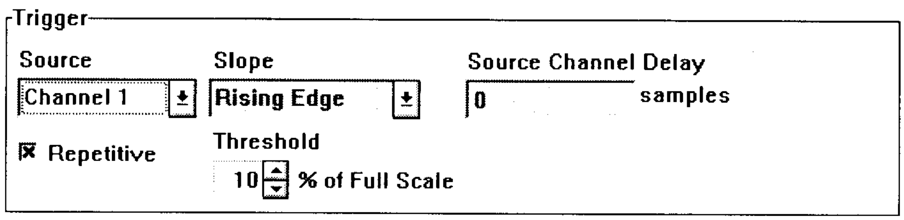
External Source

In external triggering, data is acquired time-relative to a TTL input signal on the dedicated EXT TRIG input.



Channel 1 → 8 Source

In channel (internal) triggering, data is acquired relative to the input signal on the specified channel.



When operating at 100 kHz, the first active channel must be the trigger channel.

Depending on the trigger source, other trigger options are either enabled or disabled.

Repetitive Source

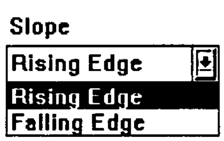
The **Repetitive** checkbox determines whether data will be collected only upon the first trigger, or upon each successive trigger.

☒ **Repetitive**

*Enabled for **External** and **Channel** trigger sources only.*

Slope Source

The **Slope** combo box selects the type of edge (rising or falling) to be used for the trigger. Used in conjunction with the trigger threshold, the slope eliminates ambiguity in the trigger specification for analog signal triggering.



Rising Edge

The **Rising Edge** (increasing voltage) of the signal at the specified threshold level will serve as the trigger.

Falling Edge Source

The **Falling Edge** (decreasing voltage) of the signal at the specified threshold level will serve as the trigger.

Enabled for Channel trigger source only.

Threshold Source

The **Threshold** scroll box is used to set the threshold (in terms of a percentage of the channel full scale voltage) for analog signal triggering. Any signal (with the appropriate slope—see preceding description) exceeding the threshold voltage will be used as the trigger. The threshold is an integer percentage in the range from -99% to 99% selectable in increments of 1%.

Threshold

10 % of Full Scale

Enabled for Channel trigger source only.

Source Channel Delay

The **Source Channel Delay** textbox is used to set the delay, in sample count, between the trigger and the start of data collection. This delay is for all channels and is an integer in the range not to exceed the **Extended Recorder Memory** size per channel.

Source Channel Delay

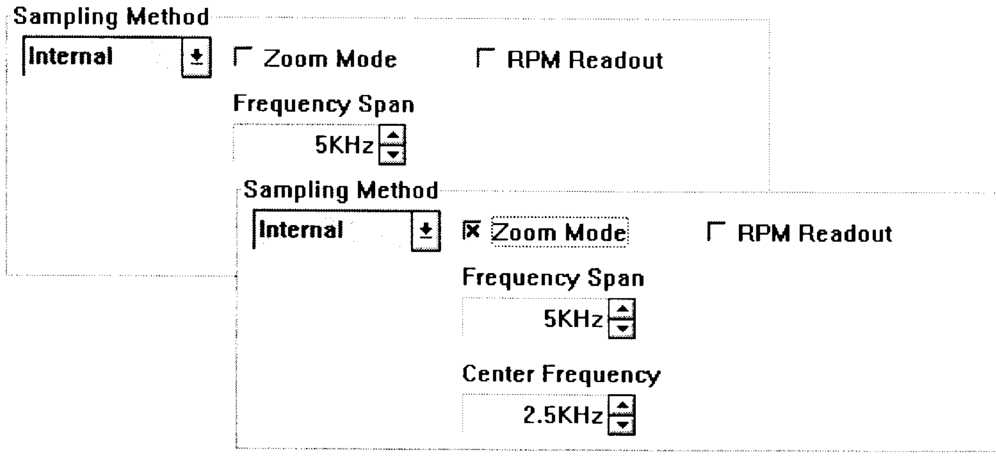
0 smpls

A positive delay causes post-triggering. The data block is collected *after* the trigger. A negative delay results in pre-triggering. Data is retained *before* the trigger event.

Enabled for ***External*** *and* ***Channel*** *trigger sources only.*

3–11.2.4 Sampling Method Group

The **Sampling Method** Group is used to control the sampling rate parameters for the SPS390. These controls are global to the SPS390, so changing them may cause incompatibility between live data being collected and data already in the averager.

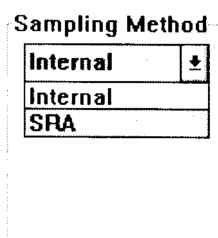


Sampling Method

The **Sampling Method** menu controls how the sampling will be performed. The choices are:

Internal (Clock)

SRA (Option)*



The internal clock generates a sampling frequency proportional to the requested analysis range for the requested analysis mode. (The actual digital acquisition rate is a combination of the clock sampling rate and digital decimation). For spectral processing in baseband mode (including time-based analysis), this rate is 2.56 times the **Frequency Span**. For zoom processing, the rate is calculated to provide the required zoom span for the requested center frequency.

***SRA** is only available if the **SRA** option is installed. Otherwise, **Internal** Clock sampling generation is the only available selection.

Zoom Mode

The **Zoom Mode** checkbox is used to toggle between the baseband and zoom modes when spectral processing modes are enabled. If the box is not checked, baseband mode is in effect. If it is checked, the SPS390 is in zoom mode. The baseband/zoom modes affect the operation of the frequency span and center frequency scroll boxes on this dialog and the frequency control indicator in the display windows.

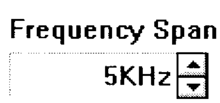
Real-time zoom (i.e., no data gaps) can be performed up to a range of 10 kHz, providing that (center frequency + 1/2 Frequency Span) does not exceed 10 kHz. Above this range, pseudo-real-time processing is in effect. This means that enough data to perform the zoom transform is first acquired to XRec Memory, the data is processed (and optionally averaged and/or displayed), and then more data is acquired. Therefore, there are data gaps proportional to the time it takes to perform the zoom transform on each channel. At very deep levels of zoom, this time can approach 5–10 seconds. The displays and averager will not update until a complete zoom transform is performed.

The level, or frequency span, of zoom above 10 kHz is directly proportional to the amount of available XRec memory selected on the analysis dialog. The default setting of 32768 samples is sufficient for a zoom of 20:1 at 20 kHz with a resolution of 400 lines. For deeper zoom factors, you must increase the amount of available XRec memory. The minimum zoom span is enforced by the SPS390, but is configurable by changing the amount of available XRec memory.

➲ ***SPS390 HINT:*** *If you need to select zoom above 10 kHz, set XRec memory to the maximum available to obtain the deepest zoom factor possible. Other methods include decreasing the number of channels and selecting a different analysis mode.*

Frequency Span

The **Frequency Span** scroll box allows you to select the frequency span for spectrum (FFT-based) and octave (digital filter-based) analysis.



For spectrum analysis, the **Frequency Span** can be set to any frequency range from 1 Hz to 100 kHz (for two-channel operation), or 1 Hz to 40 kHz (for 3–8 channel operation) in a 1, 2, 4, 5 sequence. Clicking on the up arrow increases the frequency to the next higher range, while clicking on the down arrow decreases the frequency to the next lower range.

In real time **Zoom Mode**, the frequency span can be set to any frequency range from 5 Hz to 10 kHz (as long as the new frequency span is in the range [5 Hz, min(center frequency, 10 kHz – center frequency). In pseudo-real time zoom, the minimum frequency span is limited by the amount of available XRec memory.

*The **Frequency Span** may also be changed by using the frequency control while a display is available, described in the section on Frequency Control. A 50 kHz Frequency Span is not available.*

Center Frequency

The **Center Frequency** scroll box is used to set the center frequency for Zoom Mode operation.

Center Frequency
2.5KHz

The center frequency can be set to any value in the range [frequency span/2, 100 kHz – frequency span/2] (for two-channel operation) or [frequency span/2, 40 kHz – frequency span/2] (for 3–8 channel operation) in increments of 1 Hz. Clicking on the up arrow increases the center frequency by 1 Hz, while clicking on the down arrow decreases the center frequency by 1 Hz.

*In baseband mode or octave analysis mode, the **Center Frequency** scroll box is not displayed.*

The frequency span may also be changed by using the frequency control while a display is available. This is described in the section on frequency control.

SPS390 HINT: *Due to the interrelationship between **Frequency Span** and **Center Frequency** for the FFT sampling method in zoom mode, it may be difficult to achieve the desired combination of **Frequency Span** and **Center Frequency** depending on the order in which the two values are set. The best way to set these values is to set the **Frequency Span** first and then select the **Center Frequency**.*

RPM Readout

RPM Readout

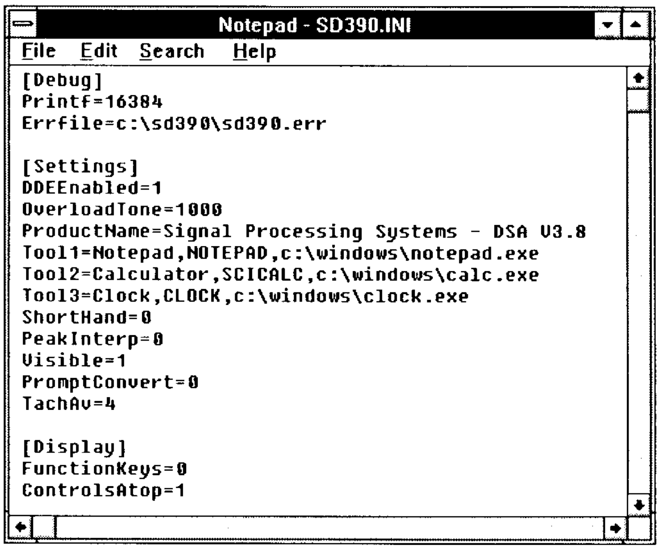
The **RPM Readout** checkbox determines whether or not an automatic readout of the RPM value appears on the display, when a frequency span of 10 kHz or less is selected. When this box is clicked, a **Pulses Per Rev** textbox appears in the lower left corner of the **Acquisitions Setup** Dialog. This textbox is used to set the number of pulses per revolution.

Pulses Per Rev
1.000

When **RPM Readout** is selected, RPM is shown on the display adjacent to the date and time.

The SPS390 uses the number of pulses per rev of the tachometer signal over a period of time to calculate the RPM and therefore present a live tach RPM readout, allow RPM triggering, and waterfall loading. Normally the tachometer is very responsive to the pulses and the distance, in time, between pulses. However, noisy tachometer signals can result in erratic RPM calculations and RPM readouts.

The SPS390 has a tachometer averaging technique to will smooth out irregularities in the tachometer readout. The default setting of this feature is 4. If your tachometer reading is unstable and it is desired to average the tachometer, you must change the initialization **SD390.ini** file to reflect the desired average. In the .ini file there is an entry TachAv=4. You may change this number to any desired number to smooth tachometer operation. An entry of 10 (TachAv=10) would mean that ten tachometer readings would be averaged together to present an averaged RPM reading for that period. This averaged RPM will be used in all subsequent operations. The following Windows Notepad shows the SD390.ini file.


Notepad - SD390.INI
File Edit Search Help

```
[Debug]
Printf=16384
Errfile=c:\sd390\sd390.err

[Settings]
DDEEnabled=1
OverloadTone=1000
ProductName=Signal Processing Systems - DSA V3.8
Tool1=Notepad,NOTEPAD,c:\windows\notepad.exe
Tool2=Calculator,SCICALC,c:\windows\calc.exe
Tool3=Clock,CLOCK,c:\windows\clock.exe
ShortHand=0
PeakInterp=0
Visible=1
PromptConvert=0
TachAv=4

[Display]
FunctionKeys=0
ControlsAtop=1
```

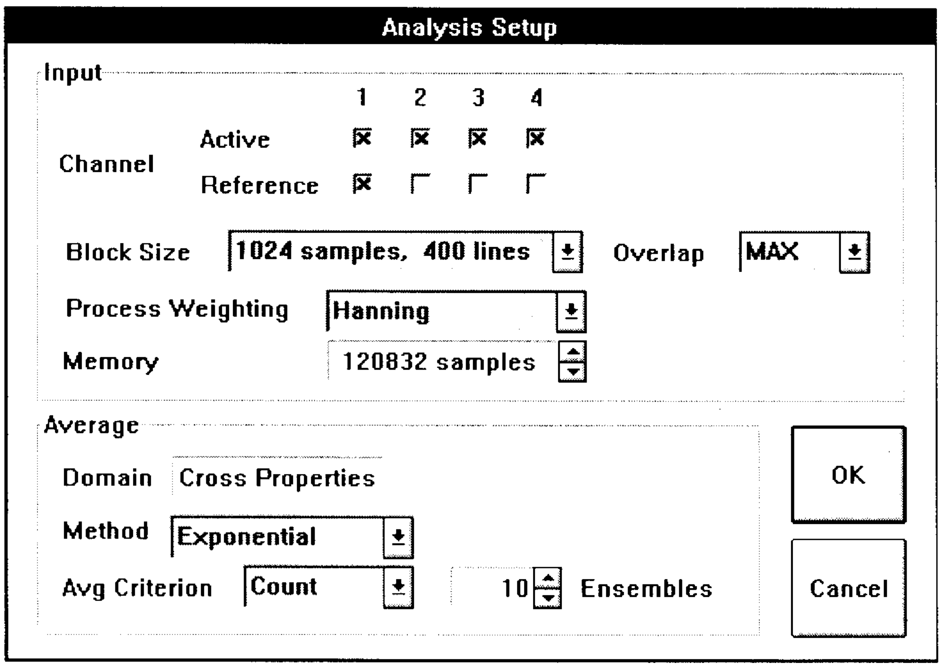
It is important to note that the larger the TachAV= number is in the .ini file, the longer the time constant for responding to an RPM change and become less responsive to rapid speed changes. If Delta RPM loading is taking place with a small RPM increment between records with a large TachAV number, then the possibility exists for missed records in the waterfall. Conversely, if the number is 1, then no averaging takes place and the readout is more susceptible to erratic readings.

When RPM readout is activated and tach data is available, it is stored along with the channel data in the extended recorder files (.XRC) files. When the extended recorder files are recalled, so is the analyzer setup configuration that was used to acquire that data. Because the TachAV= number is resident in the sd390.ini file, it is independent of any analyzer setup configuration. Thus it is possible to replay the extended recorder data with a different TachAv= number and re-analyze the data with a smoother RPM readout. This smoothing effect will only be observed if the raw tach signal was slightly noisy or erratic.

3–11.3 Analysis Setup

The **Analysis Setup** dialog box is used to set the SPS390 spectrum-based data analysis parameters. These parameters are based on the current analysis mode of the analyzer. For spectrum-based analysis, these parameters include:

- Active Channels
- Reference Channels
- Data Block Size
- Process Weighting (windowing)
- Overlap Factor
- Extended Recorder Memory Size per Channel
- Average Domain (for information only)
- Average Method
- Average (Stop) Criterion
- Average Running Count Or Time



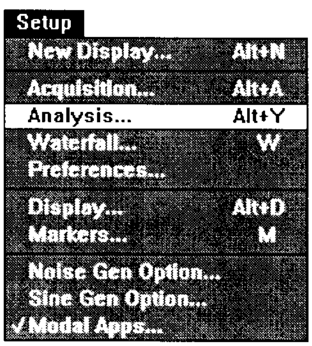
All analysis parameters are global to the SPS390. Changing them may cause incompatibility between live data being collected and data currently in the averager. If such incompatibility is detected, the averager will cease averaging and the instrument will not be able to resume averaging. The averager must be explicitly restarted (thus clearing the current averager contents) to perform averaging with the new acquisition parameters. Changing the Active Channel List will invalidate all data in the Extended Recorder Memory, thus invalidating all live displays.

3–11.3.1 How To Invoke Analysis Setup

To invoke the **Analysis Setup** Dialog box:

- Use the trackball to:

  Select the **Setup** menu
- Select Analysis



- Or use the keyboard:

  Hold down the **ALT** key and press the **Y** key,

  or

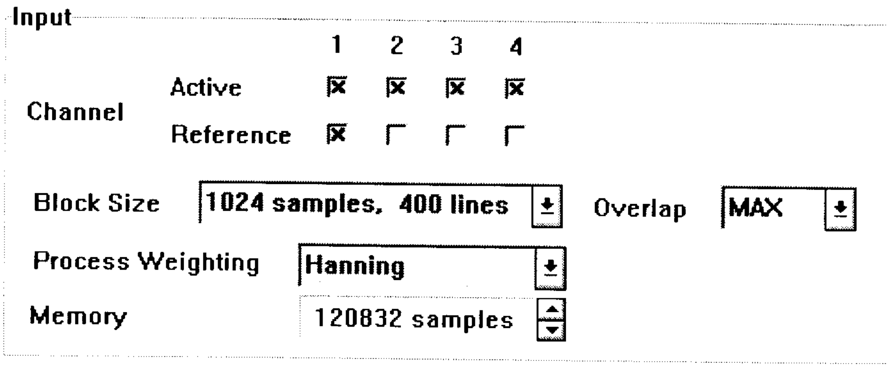
  Press the **ANALY** function button

Analysis parameters are not set until the **OK** button at the bottom right corner of the dialog is pressed. Selecting **Cancel** causes the dialog to disappear without affecting the analysis parameters.

- The parameters discussed in the following sections are valid when the SPS390 has one of these three analysis modes enabled:
- Sync Spectrum
- Spectrum
- Cross Properties

3-11.3.2 Input Group

The Input group is used to set the SPS390 data collection and analysis parameters.



Active Channels

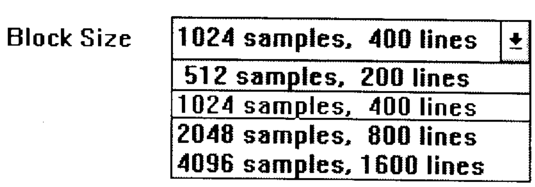
The **Active** channel checkboxes are used to select which channels are to be used for data collection. Those channels not designated as active will be ignored, thus freeing certain limited resources (such as memory) for use by channels of interest. There must be at least one active channel at any given time, but the number of active channels is limited only by the SPS390 hardware configuration.

The maximum frequency range will be reset to 40 kHz if the current frequency range is 100 kHz and more than two channels are enabled.

Reference Channels

The **Reference Channel** checkboxes are used to select which of the *active* channels are to be used as the reference channel for multi-channel analyses (such as transfer functions and cross products). Only a channel already designated as active can be used as a reference channel. This selector only appears when **Cross Properties** is selected as the analysis mode.

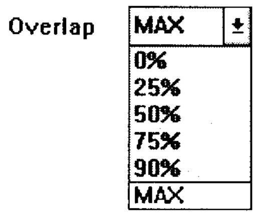
Block Size



Block size is selected using the **Block Size** combo box. The SPS390 divides the continuous stream of data it collects into blocks to facilitate processing. The sizes for processing are specified both in terms of spectral lines (for FFT analyses such as magnitude spectrum) and number of samples. The available block sizes are 512, 1024, 2048 or 4096 samples.

Overlap

The **Overlap** combo box is used to determine how much of the initial portion of a new data block is copied from the final portion of the previously collected data block. The percentage of overlap can be any of the following:



0%

No overlap. The data trace update rate is the same as the block processing rate.

25%

The first 25% of the new block is a copy of the last 25% of the old block; the last 75% of the new block consists of new data.

50%

New block: Last 50% old block, 50% new data.

75%

New block: Last 75% old block, 25% new data.

90%

New block: Last 90% old block, 10% new data.

MAX

For live analyses, the maximum overlap available is dependent upon the selected frequency span (see Acquisition Setup).

For data played back from the recorder memory, the maximum overlap is 90%. This technique is used primarily to improve the statistical average at low sampling frequencies.

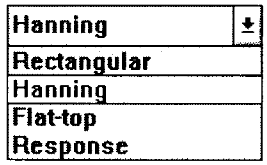
Overlap is ignored (set to 0%) for triggered data.

Since traces are displayed on a block-by-block basis, the display update rate can be limited by the rate at which blocks are produced. By using overlap, a new block is partially filled in with values from the previous block, thus speeding up trace display. Trace update and display refresh may not occur at the same rate.

Process Weighting

The **Process Weighting** combo box controls the type of weighting function (also known as a window) that will be applied in performing the Fast Fourier Transform (FFT) on blocks of time data. Weighting can reduce several sources of analytical error.

Process Weighting



☞ *See also* ***FFT Weighting***

First of all, the length of the signal represented by the block of time data may not be an integral multiple of the signal's period (the Fourier transform is meaningful only on periodic signals). This means that the FFT of the time data block will produce a spectrum that is not faithful to the true spectrum of the signal due to "flaring" at each component frequency. Weighting can be used to modify the time data block to artificially produce periodicity so that the resultant spectrum is much closer (but still not identical) to the actual spectrum than without weighting.

Secondly, it is often desirable to preserve certain features of the signal spectrum produced by the FFT while still reducing flaring. For example, some weightings preserve spectrum amplitude while others preserve spectrum frequency. Other weightings are used as filters to enhance or modify spectra to suit various requirements.

The SPS390 supports the following types of weighting:

- **Rectangular**

  Uniform weighting (flat weighting over entire block).

- **Hanning**

  A type of weighting that preserves the frequency resolution of signal spectra while sacrificing amplitude resolution.

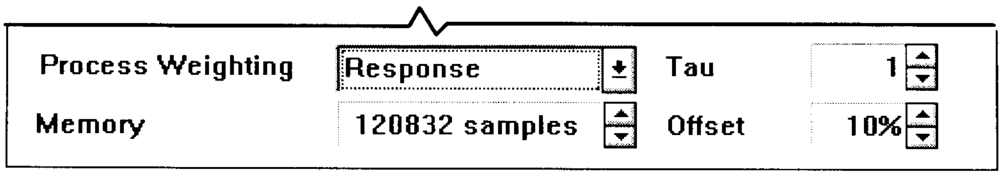
- **Flat-Top**

  A type of weighting that preserves the amplitude resolution of signal spectra while sacrificing frequency resolution.

- **Response**

  This is a special type of weighting used in impact/response testing to damp signals from lowly damped system responses.

Tau



The **Tau** scroll box controls the rate of exponential decay for response weighting. Tau is an integer in the range (1 → 15), and can be set in increments of 1. Higher values result in more pronounced signal damping (thus reducing the effects of object ringing in the force/response test).

The decay is given in the equation:

$\mathbf{DECAY = 1 - e^{-Tau}}$ (for amplitude attenuation within a data block)

☞ *Enabled for Response process weighting only.*

Tau	Decay
1	63.21205588%
2	86.46647168%
3	95.02129316%
4	98.16843611%
5	99.3262053%
6	99.75212478%
7	99.9088118%
8	99.96645374%
9	99.98765902%
10	99.99546001%
11	99.99832983%
12	99.99938558%
13	99.99977397%
14	99.99991685%
15	99.99996941%

Offset

The **Offset** scroll box controls the delay offset between the trigger and the beginning of signal damping to suppress ringing for response weighting. Offset is an integer percentage in the range (10% → 80%) and can be set in increments of 1%. Higher percentages result in greater delays between the trigger and the beginning of signal damping.

☞ *Enabled for Response process weighting only.*

Memory

The amount of desired extended recorder memory can be selected from a minimum of 8192 samples per channel to a maximum proportion on the **Mode** Menu. The maximum number of samples is also calculated by the analysis mode, number of active channels and Block Size.

Memory   120832 samples

Use the scroll arrows to increase or decrease the amount of memory which will be allocated to the extended recorder. As the maximum available memory may change as other parameters change, you may be able to gain additional memory by pressing the up arrow. Conversely, parameter changes may decrease the amount of available memory, so verify the number in this field when changes are made to other parameters.

A large amount of extended recorder memory may be required for deep zoom levels above 10 kHz, or if long transients at high frequencies are to be captured. A small recorder memory may be useful when short transients are to be captured and reanalyzed.

☞ *For more information on the extended recorder memory see Section 4, More on Extended Memory.*

3–11.3.3 Average Group

The average group is used to set the SPS390 ensemble averaging parameters.

Average
Domain   Cross Properties
Method   Exponential
Avg Criterion   Count   10   Ensembles

Domain

Domain   Cross Properties

The domain information box identifies which Averager is active. The domain is set from the **Mode Configuration** menu.

The Averager partially determines the types of analyses and displays that can be produced. See data sources in the **Display Dialogs** for more information.

The availability of certain trace displays is affected by the current average domain. The factory default Domain is set for Cross Properties. See the table in the description of the Display Setup Dialog's display type control.

Method

Method Linear

Linear
Exponential
Peak hold

Ensemble averaging is analogous to averaging numbers and involves the summation of a sequence of ensembles to produce a trace which is an "average" of the sequence. One ensemble represents one spectrum computation in the frequency domain or one time block in time domain averaging.

Averaging can be used to "even out" variations in the signal spectrum in order to determine mean or average signal behavior. In a similar manner, Time Domain averaging can also help eliminate the effects of random signal noise. During Time Domain averaging, the meaningful component of the signal will tend to reinforce itself while the noise component will tend to cancel itself out, using a **Triggered Acquisition** mode.

There are several different types of averaging, differing in the manner in which each ensemble contributes to the average of the ensembles as a whole. For example, all ensembles could contribute evenly to the average. Alternatively, new ensembles might contribute more to the average than ensembles acquired in the past. Each type of averaging has its own set of applications.

The SPS390 supports three different methods of averaging. Use the scroll arrows to select the desired method from the **Analysis Setup** dialog box.

➢ Linear

In linear averaging, each ensemble contributes equally to the average. The value at any point in the linear average is given by the equation:

AVG = (SUM OF ENSEMBLES)/(# OF ENSEMBLES)

The advantage of this averaging method is that it is fast to compute. However, this method is suitable only for analyzing shorter signal records or stationary signals, since the average tends to stabilize due to the finite resolution of the analyzer. The contribution of new ensembles eventually will cease to change the value of the average no matter how great or small the magnitude of the ensemble components.

Exponential

In exponential averaging, ensembles do not contribute equally to the average. New ensembles are weighted more heavily than old ones. The value at any point in the exponential average is given by the equation:

$$AVG = [OLD\ AVERAGE \times (1-1/S)] + [NEW\ ENSEMBLE \times (1/S)]$$

The advantage of this averaging method is that it can be used indefinitely. That is, the average does not converge to some value and stay there, as is the case with linear averaging. The average will dynamically respond to the influence of new ensembles and gradually ignore the effects of older ensembles. The constant S (Averaging Criterion) controls how heavily the average will be biased in terms of new ensembles. When S = 0, the average is simply the current trace (live). If S is very large, the average gradually changes. Other values of S cause a gradual, nonlinear "smoothing" of the average from live (dynamic, noisy) when S is small, to constant (gradual, less noisy) when S is large (>1,000).

The Averaging Criterion, S, is set in terms of the number, or count, of averages.

The effect of the averaging criterion is not linear. An averaging criterion of 100 averages does not result in a trace that is 10 times as smooth as a trace produced with an averaging criterion of 10 averages.

Peak Hold

This method, technically speaking, does not involve averaging in the strict sense of the word. Instead, the "average" produced by the peak hold method produces a record that at any point represents the maximum envelope among all the component ensembles. The value at any point in the peak hold "average" is given by the equation:

$$AVG = MAX(ALL\ ENSEMBLES)$$

Peak hold is useful for maintaining a record of the highest values attained at each point throughout the sequence of ensembles.

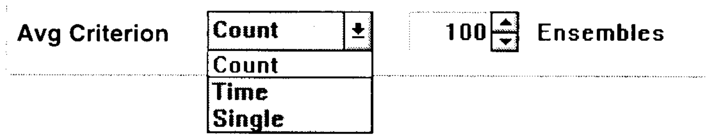
For cross property averaging, a slight variation on the standard peak hold algorithm is used, which makes peak averaging for this domain very useful in such applications as swept sine excitation testing. A new peak spectrum is added to all channels in the averager only when the peak spectrum exceeds the previous averaged spectrum for the reference channel. The effect of this is that the averager contains data only at the instant of maximum response on the reference channel. The noise at all other instances is not added to the averager.

To use this mode effectively, the reference channel must be the drive channel, and it is assumed that the response from the active channels (for a sine sweep) is greater at the drive frequency than the noise. The transfer function, magnitude and phase is indeed meaningful even though the average is based on samples at each bin over different periods of time. The actual result is the response at each bin to a nearly bin-centered sinusoid.

Averaging Criterion

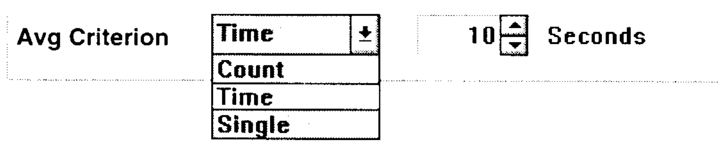
The **Avg Criterion** combo box is used to select whether the averager will stop on the basis of elapsed time or number of ensembles collected, or if single (manual) averaging will be performed.

➢ **Count**



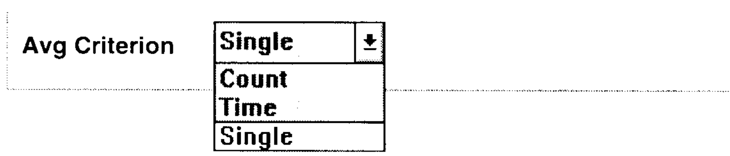
Averaging will stop after a specified number of ensembles have been collected. This is the preferred method when the time data is continuous or when the measurement size is defined.

➢ **Time**



Averaging will stop after a specified number of seconds have elapsed. This is the preferred criterion where the interval over which to collect the data is known (e.g., taped data).

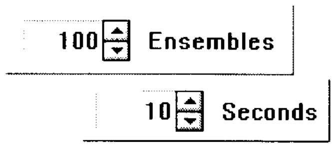
➢ **Single**



Averaging is performed manually, on a trace-by-trace basis, via the averager **Single** control, located in the averager group of the screen control area. This is the preferred method for interactively selecting the ensembles based on more complex criteria.

Single averaging must be used with repetitive trigger or free run acquisition.

Ensembles/Seconds



The **Ensembles/Seconds** scroll box is used to set the number of ensembles if the **Avg Criterion** is **Count**, or seconds if the stop criterion is **Time**.

The range for ensembles is (1 → 10,000). You can also select **MAX** ensembles by scrolling down once from 1 ensemble. In **MAX** mode, the averager will continue until it is manually stopped using the averager stop control, located in the averager group of the screen control area.

The range for seconds is (1 → 86,400 where 86,400 seconds = 24 hours). You can also select **MAX** seconds (24 hours) by scrolling down once from 1 second.

☞ *Enabled for Count and Time stop criteria only.*