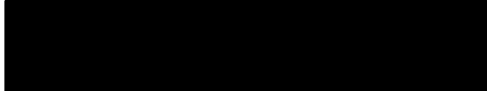
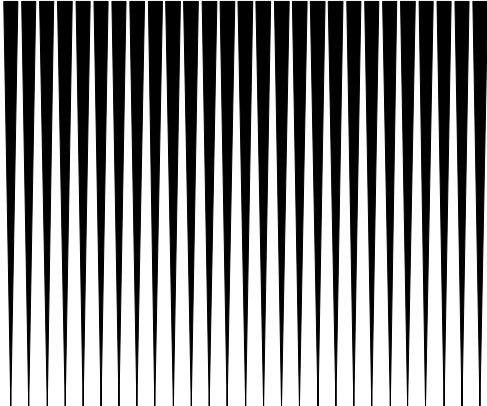




S P E C T R A L  
D Y N A M I C S



# **PUMA BASIC**



**Random  
Operating Manual**

**2400-0123A**

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**Puma Basic**  
**Random Operating Manual**

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# Puma Basic

## Random Operating Manual

# Chapter 1 - Introduction

---

## 1.1 Introduction

This manual describes the theory and operation of the PUMA Vibration Control System (VCS) when running the Random Application. Note that the Receiving Checkout Tests (RCT's) are used as examples and should be referred to often.

This manual is presented in nine chapters relating information about the applicable menus required to set up the operating parameters for the Puma VCS.

## 1.2 Getting Started

Before you begin, read the *PUMA System Description Manual*. This will help familiarize the user with the system, and give required information for unpacking, assembly and operation.

## 1.3 Software and Manuals

Software and manuals (along with vendor manuals, calibration devices and service training) are sold in various combinations.

### 1.3.1 Software

The Random closed-loop vibration control program and options are supplied on CD ROM. This CD ROM contains executable code for Random, test parameters, schedule parameters and the micro code for peripheral devices. The **software** is **licensed** and **requires a key** to activate it. The key and drivers are supplied on diskette.

### 1.3.2 Manuals

The PUMA VCS is supplied with a set of two system manuals and an application manual.

- PUMA System Description

Part Number 2400-0100

Other manuals may be included as purchase options.

## 1.4 Random Features

The PUMA VCS and the Random program provide digital real-time closed loop shaker control for production testing, design qualification and reliability testing applications. The system allows the definition, simulation, and closed loop control of random vibration excitation of a vibration shaker system.

The principal features of the Random software are:     Reference Spectrum – Up to 500 amplitude/frequency breakpoints/slopes

- ❑ Frequency Ranges – 5 to 5000 Hz
- ❑ Resolution – 100, 200 and 400
- ❑ Degrees of Freedom (DOF) – User defined (8 to 1,000)
- ❑ Control Accuracy -  $\pm 1$  dB for flat reference with 120 DOF with 90% statistical coincidence
- ❑ Output Type – True Gaussian random noise
- ❑ Sigma Clipping – Off, 2.5 to 6 sigma
- ❑ Control Strategy – Single point, multi-point average or extremal
- ❑ Automatic Operation – Selectable equalization start level, initial test level, level increment, time to full test level, startup rate and shutdown rate.
- ❑ Level Scheduling – User defined level, time at level, transition time to each level
- ❑ Test Schedule – User defined sequence of independent tests can be scheduled to run automatically
- ❑ On Line Controls – Step Level Up, Step Level Down, Full Level, Pause, Resume, Drive Update On/Off
- ❑ Analysis Function – Power Spectral Density (PSD) for control, auxiliary channels, drive, error functions, transmissibility and time traces.

#### **1.4.1 Safety Features**

Random provides the following safety features to protect the operator, the test equipment and the manufacturing operations:

- ❑ Shaker Limits
- ❑ Password login to prevent unauthorized system operation (optional)
- ❑ Alarm / Abort messages to indicate abnormal test conditions
- ❑ Alarm / Abort tolerance limits set by the operator for each spectral line
- ❑ Total overall acceleration RMS Alarm / Abort level operator settings for the acceleration spectrum
- ❑ User specified active frequency range for Alarm / Abort conditions
- ❑ A loop check continuity test automatically precedes each test
- ❑ Sigma clipping to prevent drive level from exceeding a threshold value
- ❑ Controlled test startup / shutdown rates
- ❑ Aborted testing for any control signal loss or excessive fluctuation
- ❑ Manual test Abort

## **1.4.2 Options**

The following options may be purchased for use with the system.

### ***1.4.2.1 Security***

The Security Option package enables the system administrator to place limits on the system including who has access and what level of access is available to individual users.

### ***1.4.2.2 Automation***

The Automation Option package includes RCI, RCP, Mission Simulation and Networking.

## **1.4.3 Compatible Equipment**

The PUMA VCS connects to any commercially available electro-dynamic or electro-hydraulic shaker and amplifier.

## **1.4.4 Reliability**

The PUMA Vibration Controller is designed and manufactured with state-of-the-art components and processes that improve the reliability of the system.

## **1.4.5 User Interface**

The PUMA Basic VCS, runs under a Microsoft Windows 98 SE, Windows ME and Windows 2000 operating systems. All user interaction is by keyboard and mouse. Test setup, control and data are displayed on a high-resolution color monitor. User help information is available for all program functions.

The color monitor provides real-time displays of:

- ❑ Program control menus
- ❑ Test definition parameters
- ❑ Spectra showing test conditions, with Abort / Alarm information

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**Puma Basic**  
**Random Operating Manual**

## **Chapter 2 - Test Concepts and Definitions**

---

### **2.1 Introduction**

This section discusses closed loop random vibration testing, and introduces the terminology used to describe the control capabilities provided in the Random program.

### **2.2 Closed-Loop Vibration Testing**

During manufacturing, shipment, and use, all products encounter stress. Product vibration testing is conducted by subjecting the product to mechanical vibration (stress). A random stress environment can accurately simulate many real-world shipping and operating conditions. Random stress environments are characteristically non-repetitive in time because mechanical energy is present at all frequencies over a frequency range.

Closed loop vibration tests are performed on both prototype and production line products to ensure that the product will survive actual production, shipping, and in-use conditions. These tests can identify design weakness, and allow early correction of design problems.

The Puma Vibration Controller can generate a wide range of random stress environments to satisfy any commercial, industrial, or military test requirements.

### **2.3 Channel and Spectrum Definitions**

During a vibration test:

The shaker attached to the product causes mechanical vibrations throughout the product.

At all locations on the structure where these vibrations are to be measured, accelerometers produce signals that are time-varying voltages  $x(t)$ , with amplitudes proportional to the measured acceleration and with units of volts. Other transducers can also be used.

Each vibration signal is sampled and digitized by an analog-to-digital converter (ADC) on one input channel of the vibration controller. This process changes the signal to a time-series of discrete values  $x(t_i)$ , where each value represents the amplitude of the original signal at some particular time  $x(t_i)$ . The digitizing is performed at a constant sampling rate  $S$ , measured in samples/second.

Within the Random software program, the digitized time-series values are collected into groups of  $N$  consecutive points, called frames. Each frame consists of  $N$  real values with units of volts. The values are equally spaced in time (due to the constant sampling rate), with a sampling interval of:

$$\Delta\tau = 1/\Sigma \sigma\epsilon\chi$$

The total time-interval covered by the data points in the frame, (frame acquisition time) equals:

$$N * \Delta\tau = N/\Sigma$$

Random converts each frame of time-series data into a Fourier Series Frame, using a Fast Fourier Transform (FFT). The Fourier Frame consists of N/2 complex values

$$\Xi(\phi_l),$$

Where each value represents the original signal's amplitude at a particular frequency ( $f_l$ ) - (where the units are still volts). The frequency range covered by the values in the frame is 0 Hz (dc) to S/2 Hz.

The values are equally spaced in frequency, with an interval of:

$$\Delta\phi = \frac{\Sigma/2}{N/2} = \frac{\Sigma}{N} \text{ Hz}$$

A spectrum of the type used in the vibration control process is a Power Spectral Density (PSD) function. A PSD is formed from the complex Fourier Series Frame by multiplying the frame by its complex conjugate to form a real product, called the Auto Spectrum.

This is divided by the frequency interval  $\Delta f$  to normalize the values with frequency. The resulting PSD consists of N/2 real points, equally spaced in frequency and covering the same frequency range (0 to S/2 Hz) as the Fourier Series Frame. Each value is proportional to the square of the amplitude of the original time signal at a particular frequency, and has units of  $V^2/\text{Hz}$ .

A small portion of the highest frequencies in the PSD are not used in the Random control functions, because they act as a guard band for aliasing protection. The sample rate (S) is chosen such that the highest frequency of interest or the test control bandwidth (BW) is suitably higher than the highest FFT frequency (S/2). This is usually referred to as over-sampling.

In Random the test bandwidth and number of spectral lines of resolution (R) are related to the sample rate and frame size as follows:

$$\Sigma = 2.56 * B\Omega$$

$$P = (N/2) / 1.28 = N / 2.56$$

Different spectra identified in the following paragraphs are computed and used by the vibration controller for closed-loop control and/or display during a random vibration test.

### 2.3.1 Control Spectrum

A separate control spectrum is calculated once each control loop. This calculation is the composite of all input channels specified as a control channel in the active setup parameters menu. During each loop, all spectra are combined to form an averaged control spectrum. It is then selectable as the "control" spectrum on the spectrum display.

---

**NOTE** Each channel defined as a control channel is also a measurement channel.

---

A separate measurement spectrum is calculated from each control channel and may be independently displayed.

The control signals are those input signals selected to control the external load and therefore affect the drive signal level. The Analog to Digital (A/D) channels that carry the selected control signals are designated the control channels. Any or all of the available input signals can be designated control channels.

### 2.3.2 Limit Channel Response Spectrum (Option)

A Limit Channel Response Spectrum is computed for each input channel defined as a limit channel in the active setup parameters. Each of the limit channel spectra can be selected as "Limit" in the spectrum display.

---

**NOTE:** Each channel defined as a limit channel is also a measurement channel.

---

A separate measurement spectrum is calculated from each limit channel and may be independently displayed.

The limit signals are those input signals selected to limit the external load and therefore affect the drive signal level. Any or all channels may be chosen, but one of the input signals has to be on a limit channel (there must be at least one control channel). The A/D channels that carry the selected limit signals are designated the limit channels. A limit channel cannot be defined as a control channel.

#### 2.3.3 Limit Channel Profile Spectrum(s)

The Limit Channel Profile Spectrum(s) are user-defined, or defined from a previously measured PSD, and specifies a limit to the amount of vibration to which the product under test will be subjected.

As part of each control loop, each limit channel profile spectrum is compared to the averaged spectrum from each Limit channel to keep the product under test from being subjected to an excessive amount of vibration.

### 2.3.4 Reference Spectrum

The Reference spectrum is user-defined or defined from a previously measured PSD, and specifies the amount of vibration to which the product under test will be subjected. As part of each control loop, the Reference spectrum is compared with the averaged control spectrum to re-estimate the accuracy of the control process.

### 2.3.5 Error Spectrum

The Error Spectrum is made up of the control error spectrum and if limit channels are defined, the composite limit channel error spectrum.

The control error spectrum is based on the ratio:

$$\frac{\text{reference spectrum}}{\text{averaged control spectrum}}$$

When there are no limit channels defined, the error spectrum is an exact copy of the control error spectrum.

When limit channels are defined, the error spectrum is set by the non-zero composite limit channel error spectrum lines.

The control error spectrum is used for lines where the composite limit channel error spectrum is zero.

The operation takes place once per loop, and then the error spectrum is used to correct the drive spectrum to maintain accurate control of the product under test. Because the error spectrum is based on a ratio, it has no units, and when the control is accurate, it has a value very close to 1.0.

### **2.3.6 Drive Spectrum**

The Drive spectrum (output spectrum) generates a continuous, time-varying voltage signal that is sent to the shaker's power-amplifier equipment. The Drive Spectrum is initially a scaled copy of the Reference Spectrum. Due to the non-flat frequency response of the shaker equipment, the actual signal applied to the product under test is quite different from the Reference spectrum. Once per loop, the drive signal will be re-computed by the control system. The Error spectrum, described above, is used to correct the Drive Spectrum.

The control loop process produces a Drive Spectrum that consists of the frequency content of the drive signal. This drive signal is sent to the shaker amplifier causing the average Control Spectrum from the test accelerometers to closely resemble the Reference spectrum.

The Random software maintains the Drive Spectrum as a Power Spectral Density (PSD) function with units of  $\text{mV}^2/\text{Hz}$ . Random converts the PSD to a continuous time signal by the reverse of the process that transforms the accelerometer input signals to control spectra, that is:

The PSD is multiplied by the frequency interval  $\Delta f$ .

A randomly computed phase function is added to the PSD, making it a complex quantity that resembles a Fourier series.

An Inverse Fast Fourier Transformation (IFT) is then applied to the complex quantity to convert it to a time-series frame.

This frame is repetitively output to the shaker amplifier via the system DAC, which produces a continuous voltage signal. To produce a truly random output signal, a different frame start point is computed for each output operation and the values at the boundaries of successive frames are smoothed.

### **2.3.7 Monitor Spectrum**

The Monitor spectrum (like the measurement spectra and transfer functions) is used for display. The Monitor spectrum, (and the averaged control spectrum) is computed from the control channel signals. The Monitor spectrum is independent of the Control spectrum and has separate averaging parameters that can be changed during a test.



### 2.3.8 Measurement Spectrum

Measurement Spectrum displays allows observance of the response signal from a single point on the product under test without interfering with the control process. The Measurement Spectrum is for display only. They are computed from each input channel's acceleration signal. All control, limit and measurement channels are available for display.

---

**NOTE** A channel defined as a measurement channel in the active setup parameters is *not* considered a control or limit channel.

---

All measurement channels have the same averaging parameters as the Monitor spectrum. These parameters can be changed during a test without affecting the control spectra.

### 2.3.9 Transfer Function

If the Random software has N available input channels, then a maximum N-1 separate transfer functions can be selected and displayed, where each transfer function is calculated from any two active (control or auxiliary) channels.

A transfer function,  $H(f)$ , is a complex quantity, defined as the cross spectrum of the two channels, divided by the product of the auto spectra of the channels. A transfer function indicates how the response signal at one point on the product under test is related to the excitation experienced by the product at a second point. All transfer functions are averaged, using the monitor/measurement averaging parameters.

A transfer function is calculated from any two active (control or measurement) channels. For a transfer function to be calculated the reference channel must be defined in the test setup for the measurement (response) channel. If a reference channel is not defined, only the transmissibility (no phase) between two channels may be displayed.

## 2.4 Equalization and Closed-Loop Control

We define equalization as the process of computing, correcting, and sending to the shaker a drive signal with a prescribed drive spectrum of such a shape and amplitude that the averaged control spectrum is the same as the reference spectrum. The principal equalization performance criteria are accuracy, speed, and smoothness.

### 2.4.1 Control Accuracy

Control accuracy depends on how closely the control spectrum can be made to conform to the reference spectrum. Accuracy depends on the number of Degrees

Of Freedom (DOF), the number of frequency lines, and the frequency resolution of the control spectrum. However, DOF is the main controlling parameter of control accuracy. If a high DOF is chosen, a slow correction takes place with lower variability in control accuracy. If a lower DOF is chosen there is faster correction to a change but higher variability in control accuracy.

The value of DOF affects the accuracy of the PSD-measurement process at the expense of greater measurement time. Table 2-1 shows how the DOF affects control spectrum accuracy, and Figure 2-1 is a plot of the expected, 99%-confidence control error as a function of DOF. For a detailed discussion of the derivation of this table and figure, refer to Advanced Discussion of Degrees of Freedom in Appendix C.

**Table 2-1. Control Error in dB Values as a Function of DOF**

<b>DOF</b>	<b>dB values</b>		<b>DOF</b>	<b>dB Values</b>
0			104	1.30
1	10.45		112	1.26
2	7.40		120	1.22
3	6.20		128	1.18
4	5.49		136	1.15
5	4.99		144	1.12
6	4.62		152	1.09
7	4.33		160	1.07
8	4.09		168	1.04
16	3.04		176	1.02
24	2.54		184	1.00
32	2.24		192	0.98
40	2.02		200	0.96
48	1.86		208	0.94
56	1.74		216	0.92
64	1.63		224	0.91
72	1.55		232	0.89
80	1.47		240	0.88
88	1.41		248	0.87

96	1.35		256	0.85
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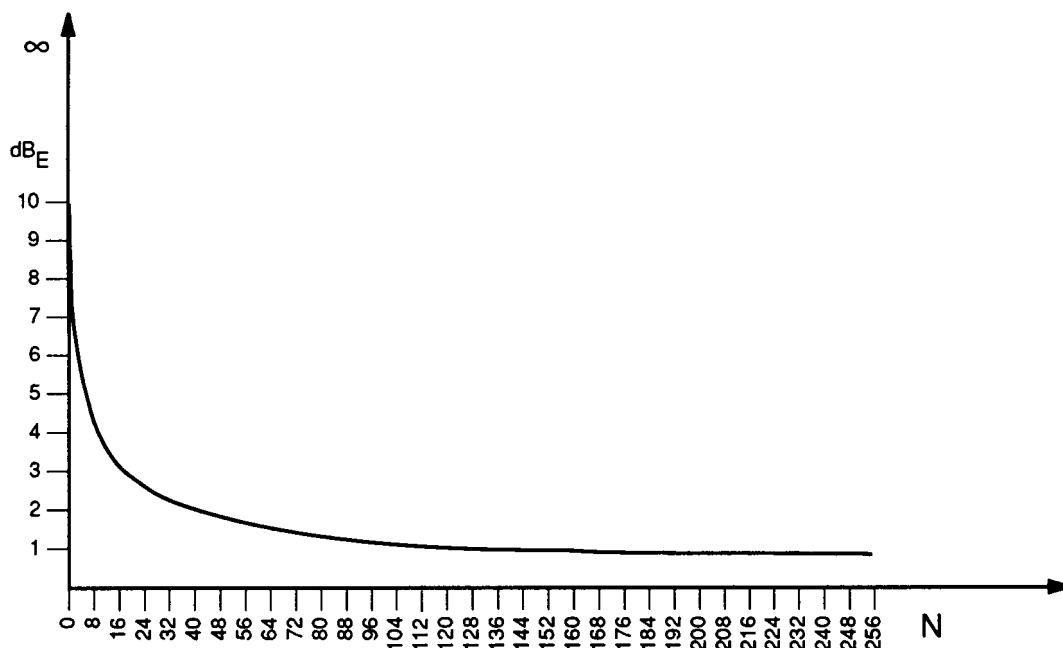


Figure 2-1. Plot of Sample Variance Table

### 2.4.2 Equalization Speed

Equalization speed is a measure of the time required to achieve equalization, and is a function of both the loop time and the number of loops required for equalization to occur. Equalization cannot be fast, smooth, and accurate simultaneously. Some trade-off is required.

Smoothness is the rate at which equalization occurs. It is dependent on the amount that the drive spectrum can change from one loop to the next. Ideally, equalization should be computed quickly, with smooth transition of corrected drive spectra, to a close match with the reference spectrum. The following paragraphs define some basic terms and relate how to determine equalization speed.

#### 2.4.2.1 Control Strategy

The Random program uses an exponentially averaged control spectrum, and the control error is discounted, so that stable operation is assured with no more than a 1.2 dB control overshoot in all cases. Stability is achieved by the feedback of a portion of the logarithmic error controlled by the function  $K_{DOF}$ .

As the DOF for particular tests increase, feedback consists of progressively smaller percentages of the control error, because the exponentially averaged control spectrum changes more slowly as the DOF increases.

The drive-spectrum-updating equation is:  $\log (D_{N+1}) = \log (D_N) + K_{DOF} * E_N$

Where:

$$E_N = \log \left( \frac{R}{C_N} \right)$$

$R$  is the desired spectrum,

$C_N$  is the control spectrum at the  $N^{\text{th}}$  loop,

$D_{N+1}$  is the new drive spectrum, and

$D_N$  is the current drive spectrum at the  $N^{\text{th}}$  equalization loop.

---

**NOTE** The drive-spectrum updating equation corrects the control errors once per loop.

The discount factor  $K_{DOF}$  insures a stable operation when using an exponentially averaged control spectrum  $C_N$  to prevent overshoots of no more than 1.2 dB.

---

#### 2.4.2.2 Equalization Speed

The exponentially averaged control spectrum can be defined as:

$$C_N = \frac{K_N}{P} + \left( 1 - \frac{1}{P} \right) C_{N-1}$$

Where:

$C_N$  is the exponentially averaged control spectrum; and  $K_N$  is the control spectrum at the  $N^{\text{th}}$  equalization loop, obtained by averaging four frames linearly.

and

(Degrees Of Freedom)  $DOF = 2 * 4 (2P-1)$ ,

therefore:

$$\frac{DOF + 2 * 4}{2 * 4} = 2P$$

so that:

$$P = \text{Func} (DOF) = \frac{DOF + 8}{16}$$

It may be useful to have the expression for equalization speed for an instantaneous spectrum change of 10 dB, corrected to within a 3 dB error-band. In this case, we use the number of loops to correct the instantaneous 10 dB spectral change to within 3 dB, or:

$$N = \text{Integer} [\text{DOF}/15] + 1$$

(Note that  $[\text{DOF}/15]$  must be rounded to an integer.)

### 2.4.3 Setup Parameters

The user-selected setup parameters described below determine equalization performance of: Control Bandwidth, Frequency Resolution, and the DOF.

#### 2.4.3.1 Control Bandwidth

This is the highest frequency value for the drive, control, and reference spectra. Control bandwidth is also the highest frequency for which the product under test is controlled. This frequency can be selected from 50 - 20,000 Hz. Increasing the control bandwidth shortens the loop time, giving faster equalization speed, but doing so increases the frequency resolution thus reducing the equalization accuracy.

#### 2.4.3.2 Frequency Lines

The number of frequency lines in the spectra is selectable in ranges of 100, 200, 400, or 800 (optionally 1,600 and 3,200). Increasing the number increases equalization accuracy but also increases the loop time, which decreases equalization speed.

#### 2.4.3.3 Control Spectrum Strategy and Averaging

Three kinds of control spectrum averaging occur in the control loop:

1. Four data frames are acquired from each control channel. These frames are averaged together to form an averaged single-channel PSD function for each control signal.
2. The multi-channel type of averaging occurs only if more than one control channel is selected. The PSD's for the individual control channels are combined to form an all-channel PSD, according to the Control Strategy setup parameter selected. The strategy choices are Average Lines, Minimum Lines, and Maximum Lines:

##### 2.4.3.3.1 Average Lines Strategy

Each line of the combined PSD is formed as the arithmetic average of the corresponding lines from each of the single-channel PSD's.

##### 2.4.3.3.2 Minimum Lines Strategy

Each line of the combined PSD is the smallest of the lines from the single-channel PSD's.

#### 2.4.3.3.3 Maximum Lines Strategy

Each line of the combined PSD is the largest of the lines from the single-channel PSD's.

1. The all-channel PSD updates the control spectrum from the previous loop ( $C_{old}$ ) to form the new control spectrum ( $C_{new}$ ). (If there is only one control channel, this statement applies to the four-frame averaged PSD for that channel.) The new control spectrum and the reference spectrum are used to compute the error spectrum.

The following uses the selected DOF value, and is used to compute the new control spectrum:

$$C_{new} = \left[ \frac{16}{(DOF+8)} \right] (PSD) + \left[ \frac{(DOF-8)}{(DOF+8)} \right] (C_{old})$$

This is called discount-averaging.

$$\text{If: } X = \frac{16}{(DOF+8)} \quad \text{Then: } \frac{(DOF-8)}{(DOF+8)} = 1 - X$$

Therefore:

$$C_{new} = X * PSD + (1 - X) * C_{old}$$

### 2.4.4 Degrees of Freedom (DOF)

The DOF value determines what proportion of the new control spectrum comes from the new PSD and from the old control spectrum. DOF values may be selected from 8 to 10,000 in increments of 8. For the smallest DOF value of 8:

$$C_{new} = PSD$$

This ensures that none of the old control spectrum will be used to compute the new control spectrum. For larger DOF values, an increasing amount of the old control spectrum is included in the new spectrum, and correspondingly less of the new PSD is used.

Table 2-2 shows the proportions of new PSD and  $C_{old}$  used in  $C_{new}$  for various non-sequential DOF values.

**Table 2-2.  $C_{old}$  and PSD for Various DOF Values**

DOF Value	Fraction of PSD	Fraction of $C_{old}$
8	1.0	0.0
16	0.667	0.333
24	0.5	0.5
32	0.4	0.6
40	0.333	0.667
56	0.25	0.75

72	0.2	0.8
120	0.125	0.875
152	0.1	0.9
1592	0.01	0.99

The choice of a DOF value determines the speed and smoothness of equalization. Any drive-spectrum change necessary to maintain equalization in the control loop is contained in the new PSD.

When:  $C_{\text{new}} = \text{PSD}$

and DOF equals 8, all of the change updates the drive. This results in an equalization process that is as rapid as possible. However, this rapid change also results in the largest possible discontinuity in drive-spectrum content from one loop to the next – that is, the least smooth equalization. As less and less of the new PSD is used in  $C_{\text{new}}$  (increasing values of DOF), the equalization becomes slower but more smooth.

#### 2.4.5 Pre-Stored Drive Parameters

The pre-stored drive parameter capability allows equalization speed to be greatly increased at the start of a test. However, this capability does not affect equalization accuracy or smoothness.

Pre-stored drive parameters can be used in a test where the same or an identical test specimen has been tested previously on the same shaker equipment, and where the drive spectrum that achieved accurate equalization in the earlier test is available for the current test, as follows:

**Pre-stored drive selected:** The initial drive spectrum is based on the drive spectrum from the previous test just run. Using this drive spectrum results in almost immediate equalization. It also reduces overall vibration stress of the product under test and the time required for the test.

**Pre-stored drive not selected:** The initial drive spectrum is a scaled copy of the reference spectrum.

## 2.5 Test Level Control

The drive signal sent to the shaker always contains the correct mixture of frequencies to control the external load. By contrast, the amplitude (level) of the drive signal varies with time in a controlled way as the test progresses, and the input signal levels change correspondingly.

### 2.5.1 Test Level Changes During Random Test

Figure 2-2 shows the varying levels that the input signal(s) pass through with time. At both the start and end of a test the drive signal is off. During the test the drive signal level rises in a controlled way to a maximum level. The input signal level(s) change as the drive level changes. Rises in the drive signal are at the start-up rate.

Lowering of the drive signal is at the shutdown rate. The following paragraphs describe the different stages that the input signal(s) pass through.

### 2.5.1.1 Loop Check

The Loop Check starts by checking the noise level of the system with the drive signal off. If the noise level of the system does not exceed the Loop Check - Max Noise (mV RMS) in the Limit Settings - Safety Limits Window, the program will begin to output the Drive signal (the randomized reference spectrum) and increase the signal to the Threshold Test Level. The input signal threshold level is 3 dB above the system noise level.

If the Drive signal reaches 3 dB above the noise level without exceeding the Loop Check - Maximum Drive (mV RMS): in the Limit Settings - Safety Limits Window, the Drive signal will increase.

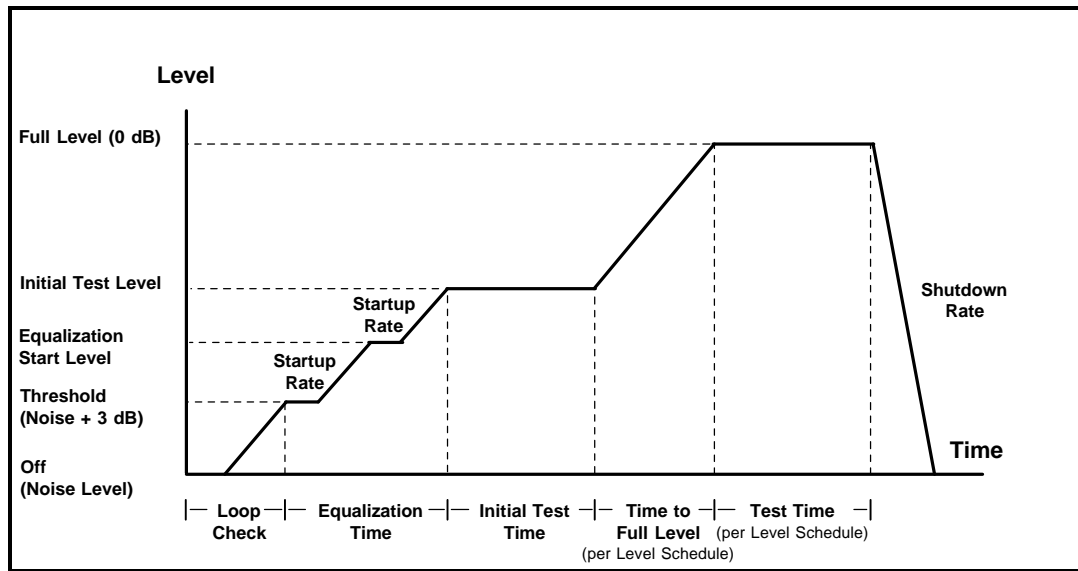


Figure 2-2. Level Changes Versus Time

### 2.5.1.2 Equalization Time

During Equalization, the drive signal increases to the Equalization Start Level. When this level is reached, the drive signal is corrected for the first time and then is continually corrected until the test stops (or when the drive update is off). If any alarms are encountered, the Drive signal will stay at this level until no further alarms are encountered.

The second increase is to the Initial Test Level: (selected in the Schedule Setup Window) at the Startup Rate selected in the Schedule Setup Window.

### 2.5.1.3 Initial Test Time

The Initial Test Time depends on the selection Time at Initial Test Level (Loops): in the Schedule Setup Window, and the mode (Automatic or Manual) being run.



The actual time will depend on the loop time, which is a function of acquisition bandwidth and number of lines of resolution.

#### ***2.5.1.4 Time to Full Test Level***

The Time to Full Test Level depends on the selections in the Schedule Setup/ - Startup Rate and Initial Test Level (dB below Full Level).

#### ***2.5.1.5 Test Time***

The Test Time begins when the Drive signal reaches Full Level (0 dB), and continues (unless aborted) until all of the levels selected in the Schedule Setup – Level Schedule Window have elapsed.

#### ***2.5.1.6 Shutdown***

At the end of the test, the Drive signal is reduced at the Shutdown Rate selected in the Schedule Setup Window.

### **2.5.2 Manual and Automatic Operation Modes**

The Operation Mode of a test, either Automatic or Manual, may be selected from the **TEST** Menu Option or Test Control. The Random program's real time test modification capabilities are only allowed in manual mode.

### **2.5.3 Safety Features**

Protecting both the unit under test and the shaker equipment is of great importance when conducting a vibration test.

The Random program contains several safeguards for this purpose. These safeguards insure that no abrupt change or out-of-tolerance value of the drive signal occurs that might damage the test specimen or actuator equipment. All features except the manual abort are automatic.

Random monitors most safety features at least once per control loop. A short loop time is useful because it increases equalization speed and allows more frequent safety checks.

The safety features minimize any chance of damage to the unit under test. The user retains final responsibility for:

- ☐ Using the safety features
- ☐ Maintaining the test equipment and all signal connections properly
- ☐ Properly preparing products for testing
- ☐ Choosing appropriate test parameters
- ☐ Selecting all maximum signal levels for a test carefully

The Random safety features include:

- ☐ Loop check

- ❑ Control signal loss, control spectrum alarm and abort limits, control spectrum acceleration rms alarm, and abort levels.
- ❑ Test startup and shutdown rates
- ❑ Power failure detection
- ❑ Drive-signal clipping
- ❑ Operator's ability to abort operations

If any safety condition is violated during a test, the test immediately aborts and a controlled test shutdown executes.

#### ***2.5.3.1 Drive Clipping***

Drive clipping is a Random safety feature that protects the shaker and test specimen from excessive drive levels and excessive loop-to-loop fluctuations in the drive level. The clipping process produces distortion in the drive signal, which results in a reduction of available dynamic range. This feature is selected in Limit Settings – Safety Limits. Sigma Clipping places a limit on the Peak to RMS level of the drive signal.

## **2.6 Test Scheduling (Option)**

Random automatically performs several tests in a specified sequence without having to start each test manually. Define the desired sequence of tests, save it as a test schedule file, and then run the test sequence by executing the file.

## **2.7 Data Storage and Data Review**

A myriad of information used in Random can be stored on and retrieved from disk, using various program functions and menus. Stored information includes, but is not limited to test setup parameters, the test schedule, spectra computed during a test, and the test summary listing. In the following, we summarize the storage and retrieval of this information.

### **2.7.1 Test Setup**

The test Setup file is a complete set of the parameters required to define a Random test for storage and retrieval. A test setup file also contains settings for spectrum display parameters. Create and save as many setup files as needed. Each file defines a single test and is identified by a user selected Test Name.

### **2.7.2 Test Schedule**

The Test Schedule file is a set of Test Names defining a schedule of tests to be run automatically that can be stored and retrieved in sequence. The user may define as many schedule files as needed.

### **2.7.3 Spectral Data**

At selected times during a test, the spectra the Random program calculates and uses can be stored on disk, as the spectral data file (.sdd). These spectra represent the test

conditions when they were stored. Using Puma's extensive Post Test Display capabilities, the file can be displayed after the test.

#### **2.7.4 Test Synopsis**

The test synopsis file contains items of information summarizing the completed test. If a spectrum data file has been created during the test, then the test synopsis information is automatically stored in a file with the same name as the data file and the suffix ".syn". The synopsis is a text file that can be reviewed, printed, or pasted into word processing applications (such as WordPad, Notepad or MS Word).



# Puma Basic

## Random Operating Manual

# Chapter 3 - Getting Started

---

## 3.1 Introduction

The Spectral Dynamics Computer Aided Test Suite (CATS) Vibration Controller (VC) program is called Puma Basic. It can be started by either a desktop shortcut icon or through the Start button. The path is:

<Start> ⇒ **P**ROGRAMS ⇒ SPECTRAL TEST SUITE ⇒ PUMA BASIC.

### 3.1.1 Log In

If the Security option (see paragraph 5.2.7) is in place the **User Log In** Dialog Box (Figure 3-1) appears. If there is no Security option the screen will appear as shown in Figure 3-2. To access the features of the PUMA Basic Vibration Controller program you must have a valid users name and password. See the system administrator for proper users name and passwords.

Enter a User Name and Password and click <LOG IN>. The Puma Basic Program Splash Screen shown in Figure 3-2 will appear. It will disappear in several seconds (or can be dismissed by clicking on it) leaving the **New** Dialog Box (Figure 3-3) from which the desired application can be launched. Click on RANDOM, and then click <OK>.



Figure 3-1. User Log In Dialog Box

A screen similar to the Spectral Dynamics Viewer Window (Graph Tool) shown in Figure 3-4 appears. Exact screen layout is dependent on the parameters previously set with the menu options under Puma Basic. Underneath Graph Tool is the Puma Basic Window that has the menu options required to set up the test(s). See Figure 3-5.



Figure 3-2. Puma Program Splash Screen

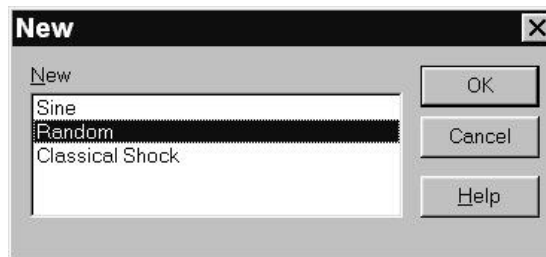


Figure 3-3. NEW Dialog Box

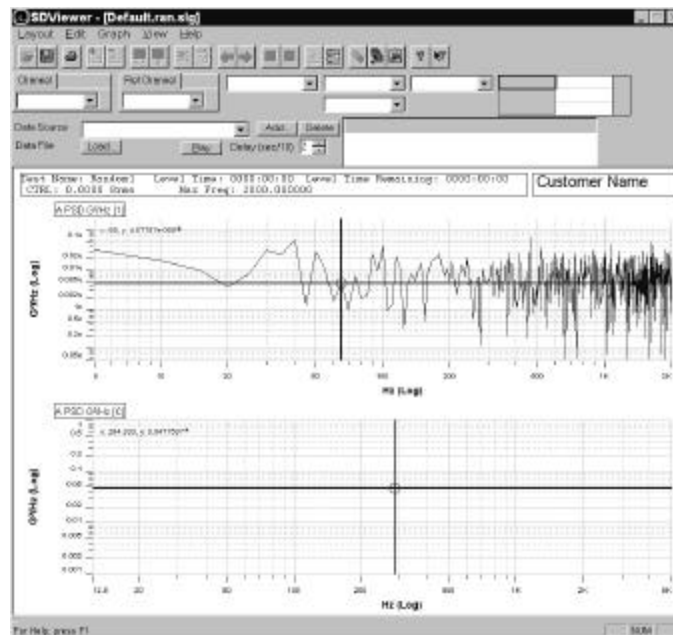


Figure 3-4. Typical PUMA Basic Viewer Window

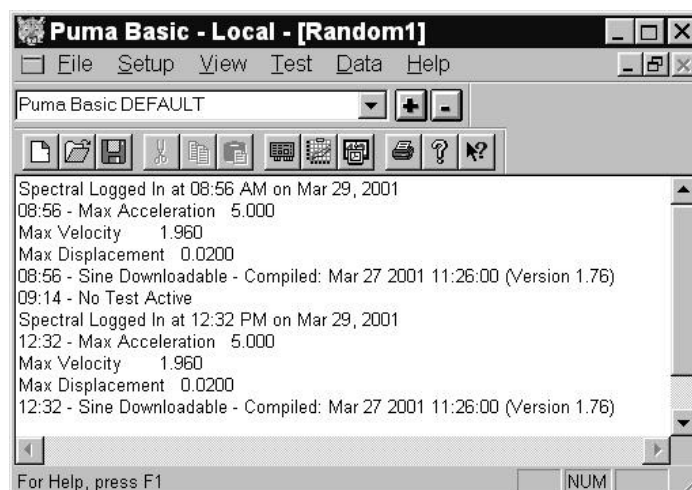


Figure 3-5. Puma Basic Window

### 3.1.2 Puma Window

The **Puma Basic** Window's **Title Bar** displays three segments of information (**Puma Basic —Local — Random 1**). **Local** indicates the user is running on the Local Puma system and not across the network. **Random 1** is the name of the currently loaded test. If the **Puma Basic** window is inaccessible minimize or drag the **Graph Tool** out of the way. Click on the **Puma Basic** Window to make it the active window to start the process of setting test parameters.

### 3.1.3 Random Menus

The **Puma** Window's **Menu Bar** contains six menu selections used by the PUMA CATS VC program. They are: **F**ILE, **S**ETUP, **V**IEW, **T**EST, **D**ATA, and **H**ELP. Each of these is discussed further within their own chapter.

Using hotkeys can activate many of the menu selections. An underlined letter indicates the character to use in conjunction with the <ALT> key. For instance, use <ALT> + <F> to activate the **F**ile menu.

Select **LOG OUT** from the **F**ILE menu when the system is unattended, and access to the program is to be restricted. The user must log in again to resume using the system. When logged in, the **LOG OUT** menu item is available (**LOG IN** is grayed out).

### 3.1.4 Setting Up Parameters

Initiating a test is done by either starting a new one from the very beginning or by running one that has already been predefined and saved to a file.

#### 3.1.4.1 New Test

The **S**ETUP Menu options are presented in Chapter 5.

Procedural Steps

2. Click **S**ETUP ⇒ **C**HANNELS. The Channel Definition Window appears. See Figure 3-6 and paragraph 5.2.1 for details.

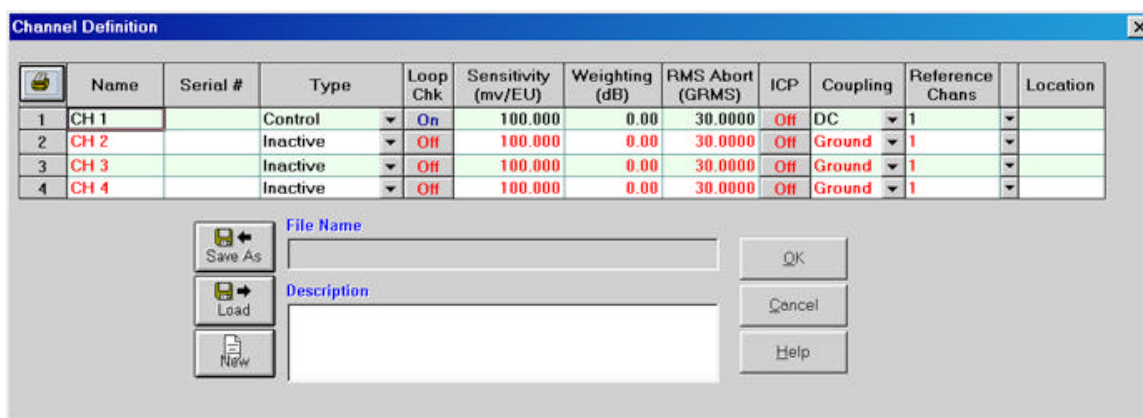


Figure 3-6. Channel Definition Window

- Input the required parameters and save them to a file.
- Click **SETUP** ⇒ **PROFILES**. The Profile Settings Window appears. See Figure 3-7. Refer to paragraph 5.2.3 for Profile Definition information.
- Input the required parameters and save them to a file.
- Click **SETUP** ⇒ **SCHEDULES**. The Schedule Setup Window appears. See Figure 3-8. Refer to paragraph 5.2.4 for Schedule Setup information.
- On the **Level Schedule** Index Tab, input the required parameters and save them to a file.

The test is now ready to run.

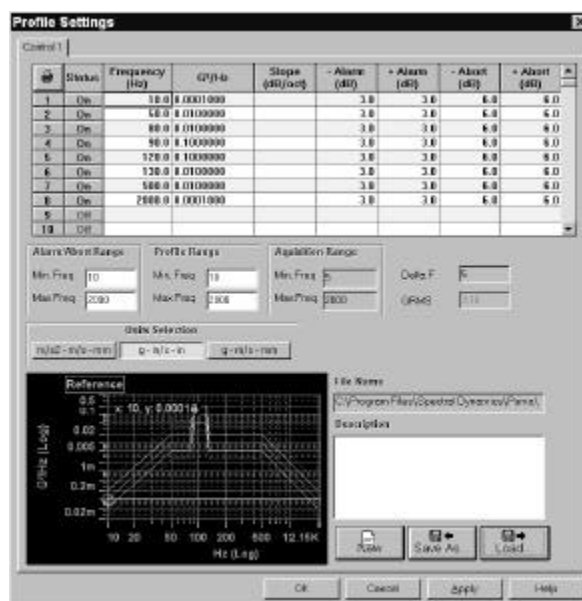


Figure 3-7. Profile Settings



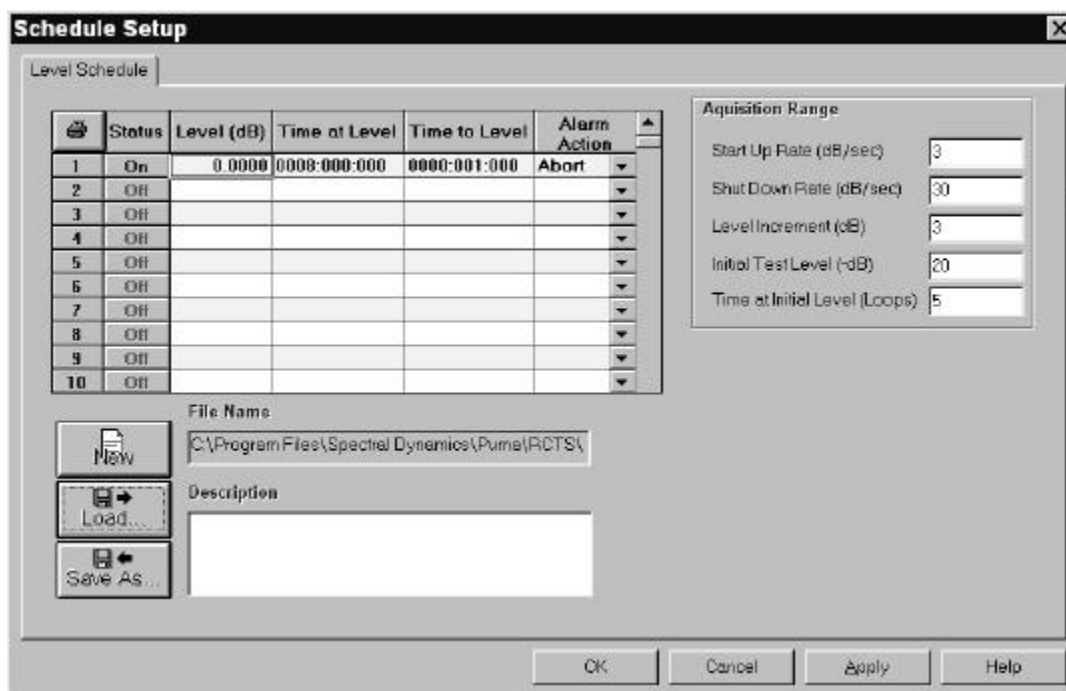


Figure 3-8. Schedule Setup

### 3.1.4.2 Existing Test

#### Procedural Steps

8. Click **FILE** ⇒ **NEW**. The **New** Dialog Box appears. See Figure 3-3.
9. Click **RANDOM** ⇒ <OK>. The screen defaults to the one used last. See Figure 3-9.
10. Click **FILE** ⇒ **OPEN**. See Figure 3-10.
11. Select appropriate **Files of Type** filter from the drop down list box.
12. Navigate the drive to the appropriate folder/file from the **Look In** drop down list box.
13. Select and open appropriate directory/folder in the list box.
14. Select and open test file.
15. Click <OPEN> on the standard Windows File **Open** Dialog Box.

The test is ready to run.

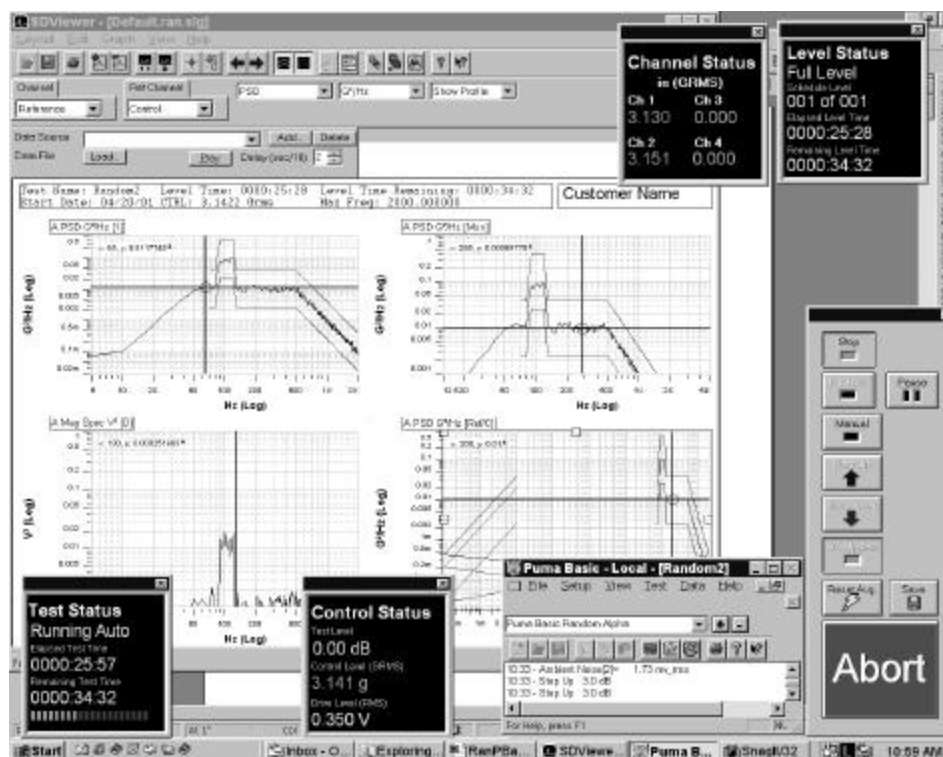
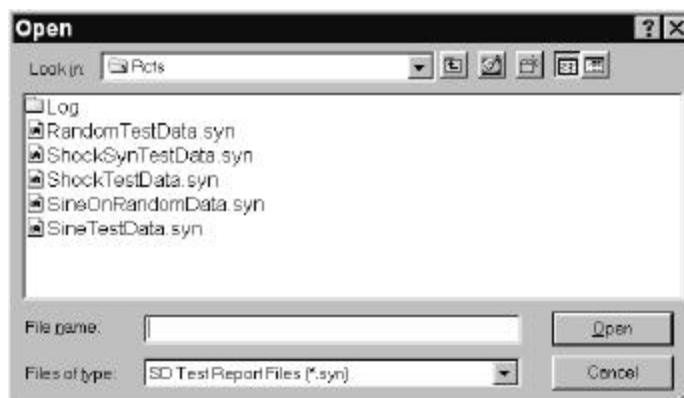
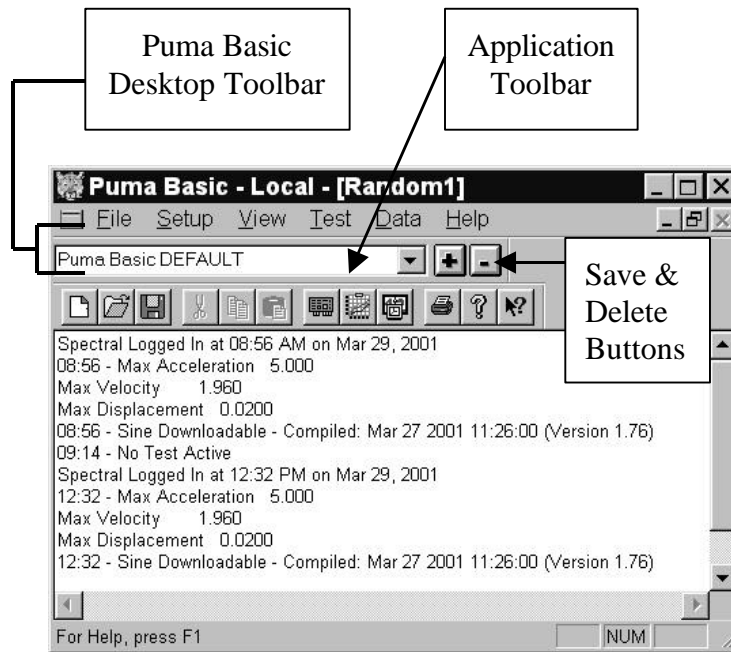


Figure 3-9. Results of Random ⇒ OK.

Figure 3-10. Results of File ⇒ Open

## 3.2 Arranging Screen Components

While running PUMA Basic there will always be at least two windows on the screen (**Puma Basic** Window and the **Spectral Dynamics Viewer** Window). There can also be the Test Control and various status panels. The location of these components is completely customizable. The Desktop Toolbar in the Puma Basic Window (Figure 3-11) allows multiple screen layouts to be saved and recalled.



**Figure 3-11. Desktop Toolbar**

In the example in Figure 3-9, “Puma Basic Random Alpha” is the screen layout name. To create a new layout, size the windows, arrange the plots, status panels and control as needed. Select the name in the Puma Basic Desktop Toolbar and enter a new name. Click the save (+) button. Saved layouts are available from the pull down menu button in the toolbar name box.

### 3.2.1 Common Areas of Host Dialogs

The layout of dialog boxes sometimes differs from one menu option to another. Even though the command buttons may be in a different position they will work the same from one menu option or window to another.

#### 3.2.1.1 File Selection Box

Throughout PUMA Basic there is a need to save the parameters of tests, load those same parameters for another test or just start on something brand new. The File Selection Box (FSB) (Figure 3-12) is shown in Figures 3-6 through 3-8. It is a common Windows tool and is used throughout the PUMA Basic platform though sometimes the format is somewhat different. The components of the FSB are outlined below for the primary setup areas of Channel Definition, Profile Settings and Schedule Setup.

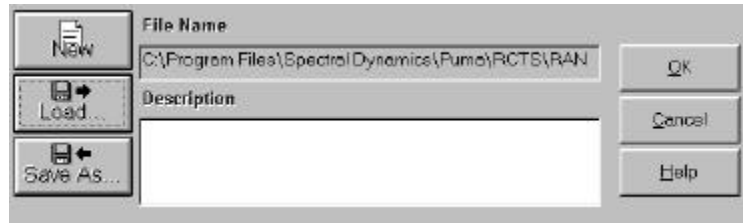


Figure 3-12. File Selection Box

#### 3.2.1.1.1 New Selection Command Button

- ☐ Channel Definition      The path / name of the currently open file is deleted from the File Name text box. It does not delete the numbers from any of the columns. It is **not** active during a test.
- ☐ Profile Settings      Clears all columns of data. It is **not** active during a test.
- ☐ Schedule Setup      Clears all columns of data. The path / name of the currently open file is deleted from the File Name text box. It is **not** active during a test.

#### 3.2.1.1.2 Load File Command Button

This button reacts the same way in all three parameter input categories. The **Open** Dialog Box is displayed for the user to choose a file to be loaded. All three categories are **active** during a test.

#### 3.2.1.1.3 Save As Command Button

This button also reacts the same way in all three parameter input categories. The **Save As** Dialog Box is displayed for the user to save a file. All three categories are **not** active during a test.

#### 3.3.1.1.4 OK Command Button

This button accepts any changes made, applies them and closes the **Open** Dialog Box.

#### 3.3.1.1.5 Cancel Command Button

This button closes the **Open** Dialog Box without applying any changes that may have been made.

#### 3.3.1.1.6 Apply Command Button

This button applies any changes that have been made and keeps the dialog box open.

#### 3.3.1.1.7 Help Command Button

This button launches the on-line help. If a dialog box is open it must first be closed to launch the help menus.

**Puma Basic**  
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## **Chapter 4 - File Menu**

---

### **4.1 Introduction**

The first of the six menu options in the PUMA Vibration Control System (Vibration Controller) is the **FILE** Menu option. Refer to the following chapters for other menu options.

### **4.2 The File Menu**

When the user selects **FILE** from the Random Menu Bar, the menu shown in Figure 4-1 will display. The **FILE** menu option has 16 sub-menus and a seven-file list (called a recent-file list) contained in a seven-section drop-down menu list. The recent-file list allows rapid access to files that have recently been used.

#### **4.2.1 File Sub-Menus**

The sub-menus of the PUMA Basic Random **FILE** Menu options available upon initially launching the program are shown in Figure 4-1. After the test is started, the menu options change. See Figure 4-4.

##### ***4.2.1.1 New Menu Option***

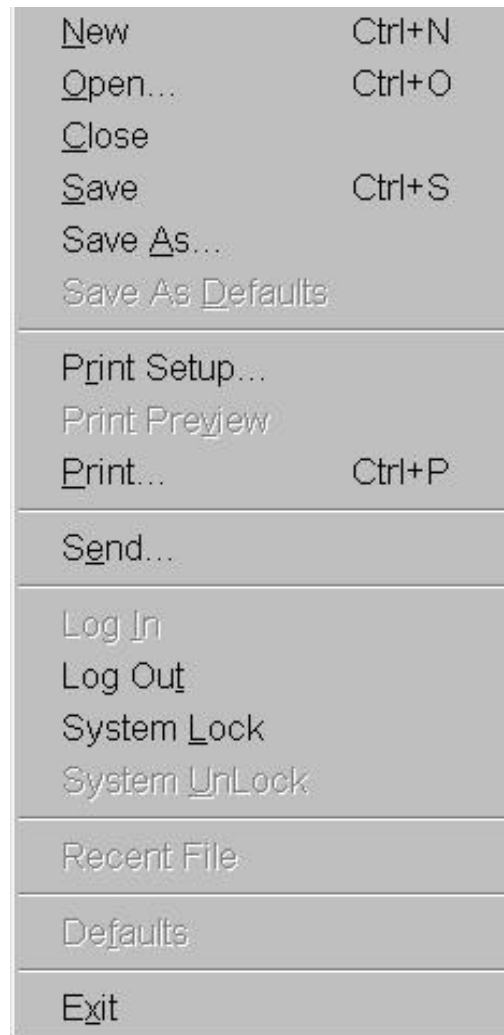
When **NEW** is selected, the **New** Option List Box will display. See Figure 4-2. This will initialize the test parameter settings for the test application chosen. Only test applications that are licensed for the system will appear in the list box. Available test applications are:

Random	Sine	Classical shock
--------	------	-----------------

Clicking on the **NEW** menu option and selecting another test while working on a test will initiate the display of a **SAVE** prompt unless there were no changes made to the test that was downloaded to work on.

##### ***4.2.1.2 Open Menu Option***

The **OPEN** menu option allows the user to select a previously stored test setup file. It displays a standard Windows **Open** (file) Dialog Box. The user can navigate to the desired file and open it. If the user wants to load a different test type (e.g. Sine) simply select the appropriate application file(s) and Puma will automatically launch it.



**Figure 4-1. File Menu Submenus Prior to Starting a Test.**



**Figure 4-2. New Option List Box**

#### **4.2.1.3 Close Menu Option**

The **C**LOSE menu option closes the currently loaded test setup. When **C**LOSE is clicked a **S**AVE prompt is displayed if the current test setup has had changes made to it. If no changes were made the currently displayed window will close.

#### **4.2.1.4 Save Menu Option**

When **S**AVE is clicked the first time a standard Windows **Save As** Dialog Box appears. It allows the user to save the currently loaded test setup. After the test has been named and saved as a file, clicking the button will not display any visual markers except the Save Progress Bar which briefly displays on the Status Bar during the time the file is being saved to disk.

#### **4.2.1.5 Save As Menu Option**

The **SAVE** **A**S Menu Option allows test setup parameters to be saved under a new file name. This option also launches the standard Windows **Save As** Dialog Box.

#### **4.2.1.6 Print Setup**

**P**RINT **S**ETUP is a standard Windows command that allows the user to select a printer, the size and source of paper and the orientation of the page. These selections will affect how things are printed when the **P**rint option is used.

#### **4.2.1.7 Print**

Click on **P**RINT to launch the standard Windows **Print** Dialog Box. From here the user may select a printer, what is to be printed and how many copies are required. The option to print to a file is also available.

#### **4.2.1.8 Send**

**S**END is a standard Windows command for sending files / tests via e-mail.

#### **4.2.1.9 Log In**

If the Security Option is installed, the **LOG** **I**N option is not available when the user is already using PUMA. It becomes available after logging out.

#### **4.2.1.10 Log Out**

If the Security Option is installed, the **LOG** **O**U**T** option is only available when the user is logged in to PUMA.

#### **4.2.1.11 System Lock/System Unlock**

These two features come with the security options. When **S**YSTEM **L**O**C**K is selected, the system is locked and that option becomes disabled. The **S**YSTEM **U**N**L**O**C**K option is then enabled. To regain access to the program, the user must select **S**YSTEM **U**N**L**O**C**K. The **User Log In** dialog box will display and allow you to login.

#### **4.2.1.12 Recent File List**

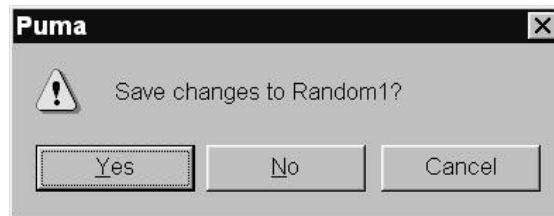
The recent file list is a standard Windows feature that has been adopted for Puma. It allows the user quick access to the most recently used setup files that have been

opened. These files are also available from the Windows Start menu. The path for usage is:

<START> ⇒ DOCUMENTS ⇒ FILE NAME

#### 4.2.1.13 *Exit*

**EXIT** is a standard Windows command. Exiting the program can be accomplished in two ways. The user can navigate **FILE** ⇒ **EXIT**, or by clicking on the close button (**X**) in the upper RH corner of the screen. Either of these will launch the prompt dialog seen in Figure 4-3. Clicking <YES> either saves the changes and terminates the application or launches the **Save As** dialog box. Clicking <NO> will terminate the application.



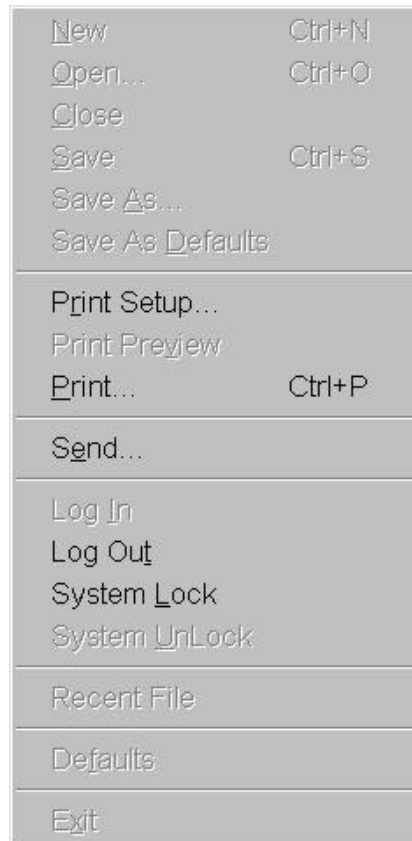
**Figure 4-3. Save Prompt Launched By Clicking An Exit Command**

## 4.2.2 Menus Available During The Test

While a test is running, not all of the **FILE** Menu options are available for use. See Figure 4-4. The available **FILE** Menu options during a test are:

- **P**RINT  
SETUP
- **P**RINT
- **S**END
- **L**OG  
OUT
- **S**YSTEM  
LOCK





**Figure 4-4. File Menu Submenus After Starting a Test.**

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## **Chapter 5 - Setup Menu**

---

### **5.1 Introduction**

The **S**ETUP Menu is where all of the test parameters are entered for a Random test setup. In most of the test setup submenus (e.g. channel definition) the individual test settings may be saved in a separate file that may be recalled by another test setup to speed creation of subsequent tests.

### **5.2 Submenus**

The following paragraphs give information about the seven **S**ETUP submenu options available. See Figure 5-1.



**Figure 5-1. Setup Sub-Menus**

#### **5.2.1 Channels**

The **C**HANNELS Menu option produces a Channel Definition Window (Figure 5-2) that allows the user to:

- Print a listing of the Channel Definition settings
- Change any or all of the 11 Channel Definition parameters
- Open a new file
- Load a previously saved test/file
- Use the **Save As** option to name/save a file
- Accept default / user selected file names and initiate selected action

Cancel selection / window

Get Help

### 5.2.1.1 Channel Definition

The Channel Definition window allows setup, recall, and storage of Puma Basic input channel settings. The **Channel Definition** Window columns are defined below.

**Name** - Up to 20 characters can be used to designate a unique name for the channel.

**Serial #** - Up to 20 characters can be used to designate a transducer serial number for the channel.

The screenshot shows the 'Channel Definition' window with a table of channel settings and input fields below it.

	Name	Serial #	Type	Loop Chk	Sensitivity (mv/EU)	Weighting (dB)	RMS Abort (GRMS)	ICP	Coupling	Reference Chans	Location
1	CH 1		Control	On	100.000	0.00	30.0000	Off	DC	1	
2	CH 2		Inactive	Off	100.000	0.00	30.0000	Off	Ground	1	
3	CH 3		Inactive	Off	100.000	0.00	30.0000	Off	Ground	1	
4	CH 4		Inactive	Off	100.000	0.00	30.0000	Off	Ground	1	

Below the table are input fields for 'File Name', 'Description', and 'New'. There are also buttons for 'Save As', 'Load', 'OK', 'Cancel', and 'Help'.

Figure 5-2. Channel Definition Window

**Type** - Select from five channel types:

- ☐ Control – Channel is designated as control channel and the Loop Check defaults to **On**.
- ☐ Measure – An active input channel not used in control averaging.
- ☐ Inactive – Channel is off and contains no parameters

By default, **Control** will always be listed first.

**Loop Check** - The **Loop Chk** option can be either **On** or **Off**. If it is on, an open channel “Safety” check is performed before the test is run.

**Sensitivity mv/g** - Transducer sensitivity is entered in milli-volts per g.

Weighting (dB) - Weighting is used in multi-channel average control (more than one control channel) to weight one channel vs. another. (6 dB attenuates the signal on the channel by  $\frac{1}{2}$ ).

RMS Abort (GRMS) - This safety parameter provides an abort of the test if the level on that channel exceeds the RMS Abort level.

ICP - The ICP function can either be **On** or **Off**. It provides a constant DC current source to power ICP type accelerometers.

Coupling - Input channel coupling:

- ☐ AC Coupling – It is used to block the DC component of the signal.
- ☐ DC Coupling – It is used to pass the DC component of the signal.
- ☐ Ground Coupling – It grounds the input channel. This is used when the channel is inactive.

Reference Chans- This is the level that is used in displaying data from this channel on a dB scale,  $\text{dB} = 20 \log (\text{level}/\text{level}_{\text{ref}})$ . Reference Chans

Reference Chans The user may select which channels may be used as reference channels when this channel is used as the response channel in a frequency response function (complex). If NONE is selected, only transmissibility (real) is displayed when this channel is used as the response.

## 5.2.2 Controls

The **CONTROLS** Menu option displays the **Test Settings** Window. This window has four tabs. They are:

- ☐ Acquisition
- ☐ Control Setup
- ☐ Data Storage
- ☐ Test File Setup

At the bottom of each tab are the four standard Windows Command Buttons.

- ☐ OK
- ☐ Cancel
- ☐ Apply
- ☐ Help

After the test starts only the *Cancel* and *Help* buttons are available. Test parameters cannot be changed. Please refer to the Windows documentation for information about these buttons.

### 5.2.2.1 Test Settings

The four **Test Settings** Window Tabs are described below.

### 5.2.2.1.1 Acquisition

The **Acquisition** Tab (Figure 5-3) sets the sampling and averaging parameters for data acquisition.

**Max Frequency (Hz)** - Select the data acquisition maximum frequency: 500, 1K, 2K and 5K. This value must be greater than or equal to the control maximum frequency.

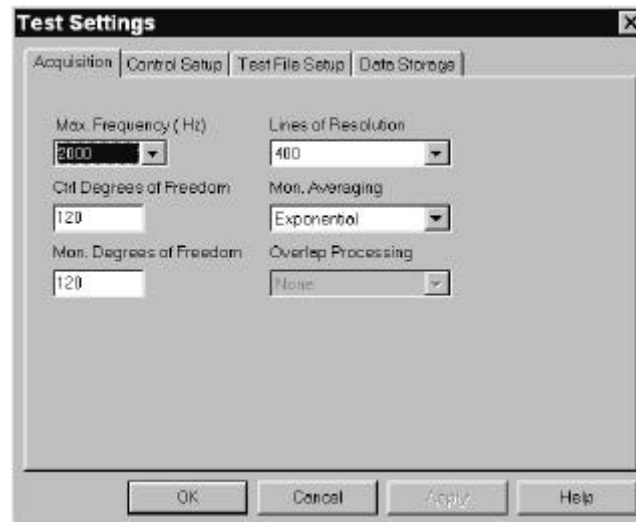


Figure 5-3. Acquisition Tab of Test Settings Window

**Lines of Resolution** - Select the number of spectral lines within the Max Frequency: 100, 200 and 400. The frequency "distance" between each line is known as the Delta F ( $\Delta F = \frac{\text{Max Freq.}}{\text{LOR}}$ ). A high number of lines of resolution in a test yield greater accuracy, however speed is compromised.

**Control Degrees of Freedom** - This is the statistical averaging parameter for the control PSD calculation. See Chapter for more information on DOF.

**Mon Averaging** - Select the type of averaging for monitor and measurement channels. *Exponential* sets a continuous exponential averaging as is done for the control channel. *Linear* specifies linear averaging for a fixed number of frames before averaging is halted.

**Monitor Degrees of Freedom** - This sets the discount exponent for exponential averaging or the number of frames for linear averaging ( $\text{number of frames} = \text{DOF}/2$ ).

### 5.2.2.1.2 Control Setup

The **Control Setup** Tab (Figure 5-4) has three toggle button boxes. The boxes and their buttons are described below.

Strategy – Allows user to assign the control strategy that can be applied to multi-channel control averaging:

- ❑ *Average* – The arithmetic average of the control channels at each spectral line
- ❑ *Minimum* – The minimum value of the control channels at each spectral line.
- ❑ *Maximum* – The maximum value of the control channels at each spectral line

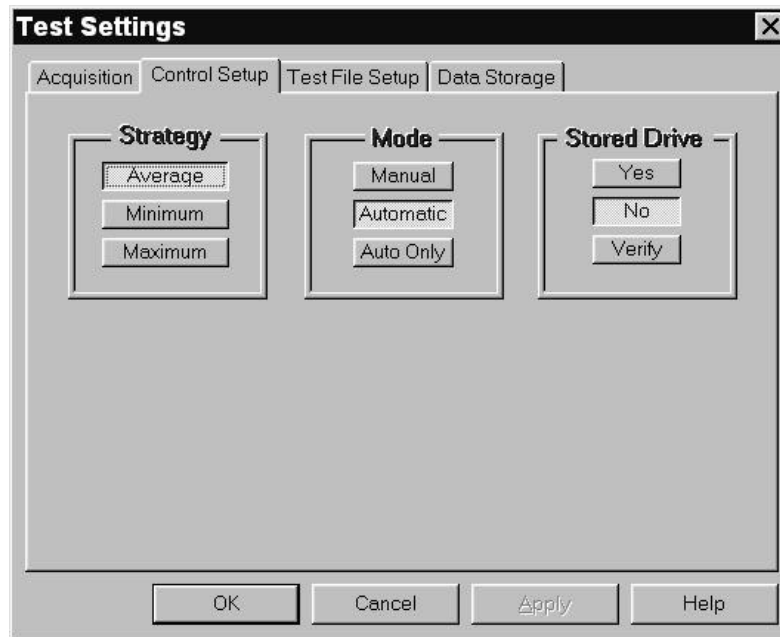


Figure 5-4. Control Setup Tab of Test Settings Window

**Mode** - Mode for operation of the test

**Manual** – The user may make modifications to the test while it is running.

**Automatic** – The user may only make modifications to the test while it is running if Manual is first selected.

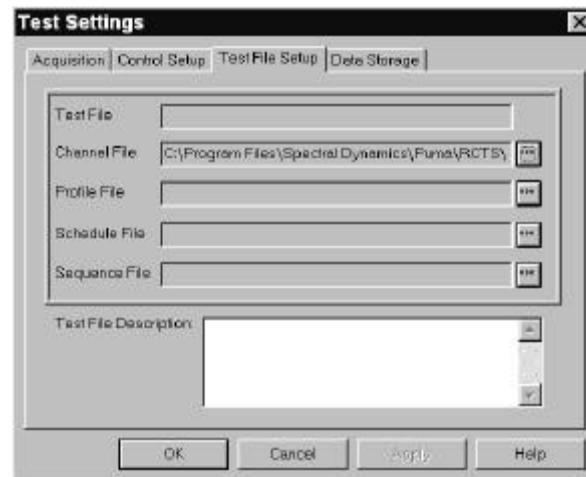
**Auto Only** – No modifications may be made to the test while running.

**Stored Drive** - This allows the user to speed up equalization for repetitive tests by loading a compensated drive signal from a previous test. This box can be set to *Yes*, *No* or *Verify*. Selecting *Yes* would use a pre-stored drive signal at the start of the test. Selecting *No* means the test will start normally with a scaled drive signal with the frequency content of the reference profile. Selecting *Verify* will result in the user being prompted whether to abort the test, use the pre-stored drive, or start the test normally.

### 5.2.2.1.3 Test File Setup

The **Test File Setup** Tab (Figure 5-5) shows the currently loaded setup parameters files. The boxes from top to bottom are:

- |                                       |  |
|---------------------------------------|--|
| <input type="checkbox"/> Test File    | <input type="checkbox"/> Schedule File         |
| <input type="checkbox"/> Channel File | <input type="checkbox"/> Sequence File         |
| <input type="checkbox"/> Profile File | <input type="checkbox"/> Test File Description |



**Figure 5-5. Test File Tab of Test Settings Window**

The user may either define each file through the corresponding file's dialog box or load the file directly from the **Test Settings** Dialog Box by using the browse buttons.

### 5.2.2.1.4 Data Storage

The **Data Storage** Tab (Figure 5-6) is used to select data storage options.

File Name Toggle Button Box – Defines the file where data will be stored.

The toggle buttons are:

- ☐ *Auto Generate* - Creates a unique file name based on the setup file name, day, date and time that the test started.
- ☐ *Query* - Prompts user for a file name after starting test.
- ☐ *Default* – All test data is saved in a default file named *RandomTestData.sdd*. The default file is overwritten each time the test starts.

Check Boxes



- ❑ Save On Level Change – Saves a frame of data each time the test schedule changes level
- ❑ Save Every X Second(s) – Saves a frame of data at each predetermined interval. Enter the number of seconds between data saves. If not used carefully file sizes can become quite large.
- ❑ Save On Alarm – Saves a frame of data each time the system alarms. Used to keep track of when the data trace exceeds the alarm lines on a profile.

---

**NOTE** – Any combination of these options may be used. PUMA BASIC Random will always save the last frame of data on <ABORT>, <STOP> or upon normal Test Completion.

---

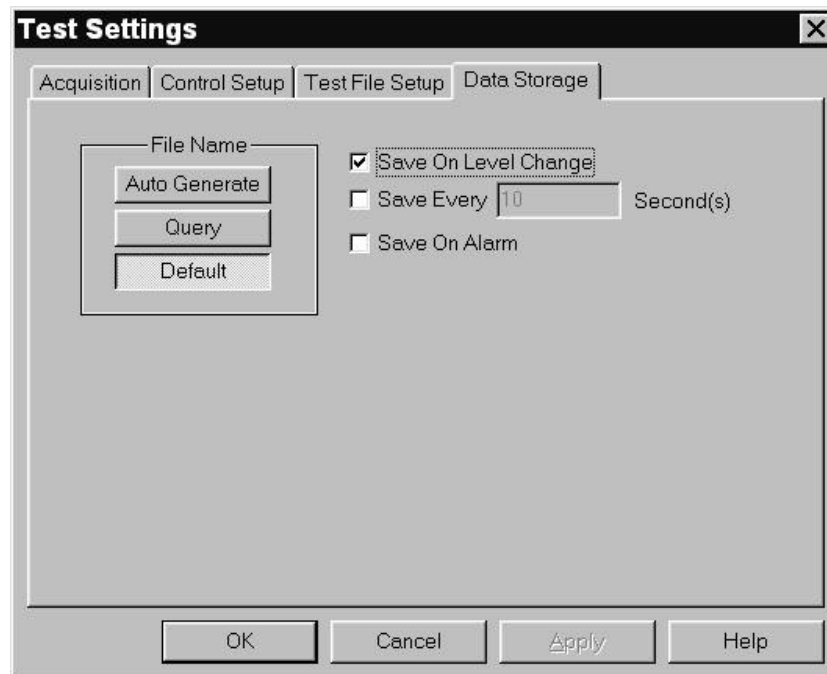


Figure 5-6. Data Storage Tab of Test Settings Window

### 5.2.3 Profiles

The **PROFILES** Menu Option displays the **Profile Settings** Window. See Figure 5-7. There will always be a **Control** tab. Next to the word Control in the tab is the channel number or numbers assigned as control channels in the channel table. This tab sets up the reference profile for the control channels.

#### 5.2.3.1 Profile Settings

Control profiles are defined in terms of slopes and frequency/amplitude breakpoints. A combination of up to 500 slopes and frequency/amplitude

breakpoints may be used to define a profile. By default the **Control** Tab will always display. Definitions of each parameter is provided below:

**Status** - Toggle on/off breakpoint or slope in the profile table. Hint: to insert or delete a line in the table, highlight the line by clicking on the line number to the left and use the keyboard insert/delete keys.

**Frequency** - Enter the breakpoint frequency in Hz between 0.0001 and 20000.

**G<sup>2</sup>/Hz** - Enter the amplitude for the breakpoint in G<sup>2</sup>/Hz.

**Slope (dB/oct)** - Enter the slope for a segment in dB/octave.

**-Alarm (dB)** - (Control Channel only) Enter negative alarm tolerance for this breakpoint in dB (negative sign is not necessary)

**+Alarm (dB)** - (Control Channel only) Enter positive alarm tolerance for this breakpoint in dB

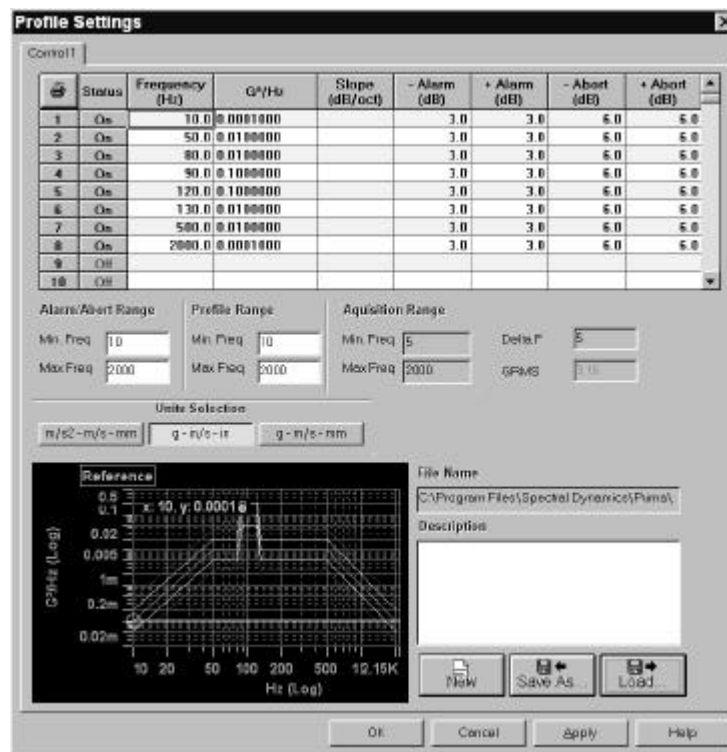


Figure 5-7. Profile Settings Window

**-Abort (dB)** - (Control tab only) Enter negative abort tolerance for this breakpoint in dB (negative sign is not necessary)

**+Abort (dB)** - (Control tab only) Enter positive abort tolerance for this breakpoint in dB

**Alarm/Abort Range** - Enter the minimum and maximum frequency range over which tolerances will be checked during the test. Range must be within Acquisition Range minimum and maximum frequency.

**Profile Range** - Enter the minimum and maximum range for the profile.

**Acquisition Range** - Display of Acquisition minimum and maximum frequency defined in the Control Settings.

**Delta F** - Display of the frequency spacing of data ( $\Delta F = \text{bandwidth} / \# \text{ lines of resolution}$ ).

**GRMS** - Displays total GRMS of the entered profile. Hint: To rescale the entire reference and maintain profile shape place mouse pointer in the GRMS box and right-click the mouse. A prompt will appear for a "New GRMS." Enter the new GRMS and click "OK." The breakpoints will be scaled to achieve the desired level.

#### 5.2.4 Schedules

The **SCHEDULES** Menu Option displays the **Schedule Setup** Window. It has a tab labeled **Level Schedule**. During setup if no schedule is defined the default will be applied automatically. It is approximately 45 minutes.

##### 5.2.4.1 Level Schedule

The **Level Schedule** Tab (Figure 5-8) is used to set the duration of the random test. The Level Schedule table parameters are:

**Status** - Toggle on/off level segment in the Level Schedule table.

Hint: To insert or delete a line in the table, highlight the line by clicking on the line number to the left and use the keyboard insert/delete keys.

**Level (dB)** - Enter the test level in dB relative to full test level (from -80 to 0 dB).

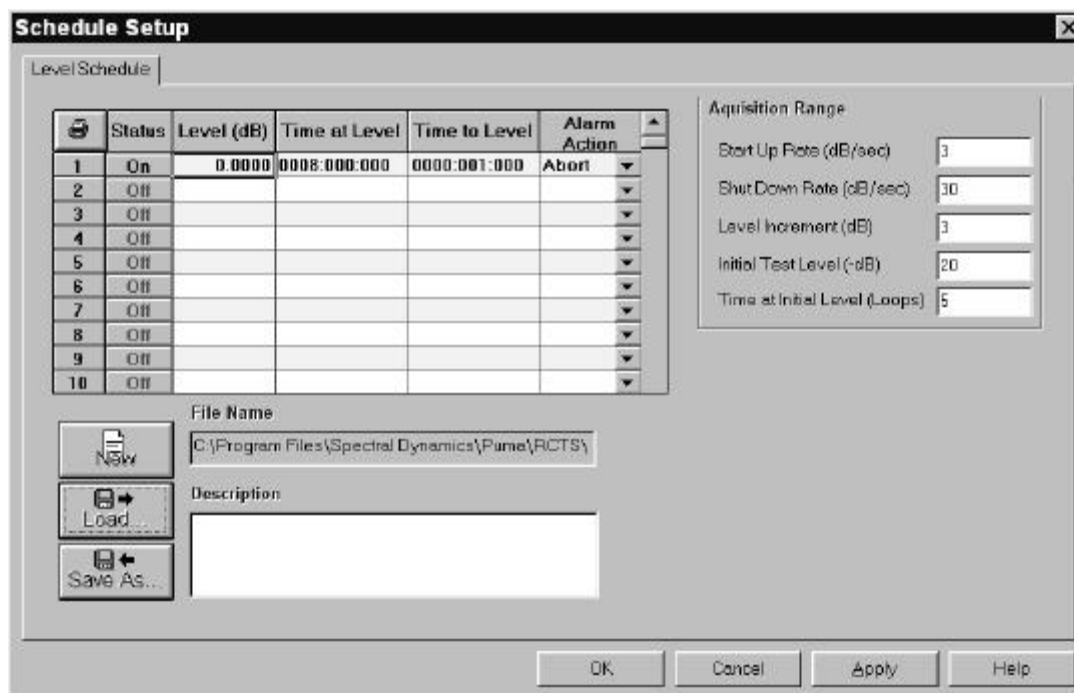


Figure 5-8. Level Schedule Tab of Schedule Setup Window

**Time at Level** - Enter the time to remain at this level before continuing to the next.

**Time to Level** - Enter the time to reach the next level once this level has completed.

**Alarm Action** - Select *Abort* or *Ignore*. This is the action to take if control persistently exceeds the Alarm level.

**Startup Rate (dB/sec)** - Enter the rate in dB/sec to proceed from the initial test level to full level

**Shutdown Rate (dB/sec)** - Enter the rate, in dB/sec, at which to shutdown after an abort or completion of the test.

**Level Increment (dB)** - Test level step increment.

**Initial Test Level (-dB)** - Enter the initial level relative to full test level at which to equalize and begin checking alarm and abort tolerances.

**Time at Initial Level (Loops)** - Enter the number of control loops to complete before continuing to full level in the Automatic mode. The actual time will depend on test bandwidth and resolution.

### 5.2.5 Limits

The **LIMITS** Menu Option displays the **Limit Settings** Window. It has two tabs labeled *Safety Limits* and *Shaker Limits*. Both are discussed below.

#### 5.2.5.1 Safety Limits Tab

The *Safety Limits* Tab (Figure 5-9) is used to set the parameters for safety checks. The checks are divided into 6 areas:

##### **Alarm Lines**

Specify the portion of the spectral lines that must exceed the alarm tolerances to trigger an alarm. This can be specified in either an absolute number of spectral lines or in a percent of the total spectral lines.

##### **Abort Lines**

Specify the portion of the spectral lines that must exceed the abort tolerances to trigger an abort. This can be specified in either an absolute number of spectral lines or in a percent of the total spectral lines.

##### **Sigma Clipping**

Enter the Sigma Clipping level. Sigma Clipping limits the ratio of peak to RMS allowed in the drive signal. Low values of Sigma Clipping can significantly clip the drive signal and result in a loss of control dynamic range.

##### **GRMS**

Specify the GRMS levels for the control signal at which an alarm or an abort will be triggered. This may be specified in either dB above the Reference Profile or in Absolute GRMS.

##### **Loop Check**

Specify the parameters to be used in the pre-test loop check.

##### **Max Noise (mV RMS)**

Enter the maximum acceptable noise level measured on control channels prior to output of a drive signal.

**Figure 5-9. Safety Limits Tab of Limit Settings Window**

### **Max Drive (mV RMS)**

Enter the maximum drive output level during loop check. If the control signal is not detected 3 dB above the measured ambient noise at this drive level the system is considered to be open loop and the test will not start.

#### **5.2.5.2 Shaker Limits Tab**

The **Shaker Limits** Tab (Figure 5-10) of the Limit Settings Window allows safety limits to be entered for shaker tables. Tables may be saved and recalled for laboratories with multiple shaker systems. If a test setup will exceed the limits in this table the system will provide a warning and prevent the test from being run.

Shaker limit parameters are:

#### **Acceleration**

Enter the maximum acceleration (+g, -g) for the shaker system.

#### **Velocity**

Enter the maximum velocity (+in/s, -in/s) for the shaker system.

#### **Displacement**

Enter the maximum displacement (+in, -in) for the shaker system.

#### **Voltage**

Enter the maximum input voltage (+V, -V) of the shaker amplifier.

### Symmetric Limits

Check this box to enter peak value limits only once (in positive value boxes) when symmetrical. The opposite limit is assumed to be the negative of the entered value. This makes table entries easier. In either symmetric or non-symmetric limit tests, the limit value is still assumed to be zero to peak.

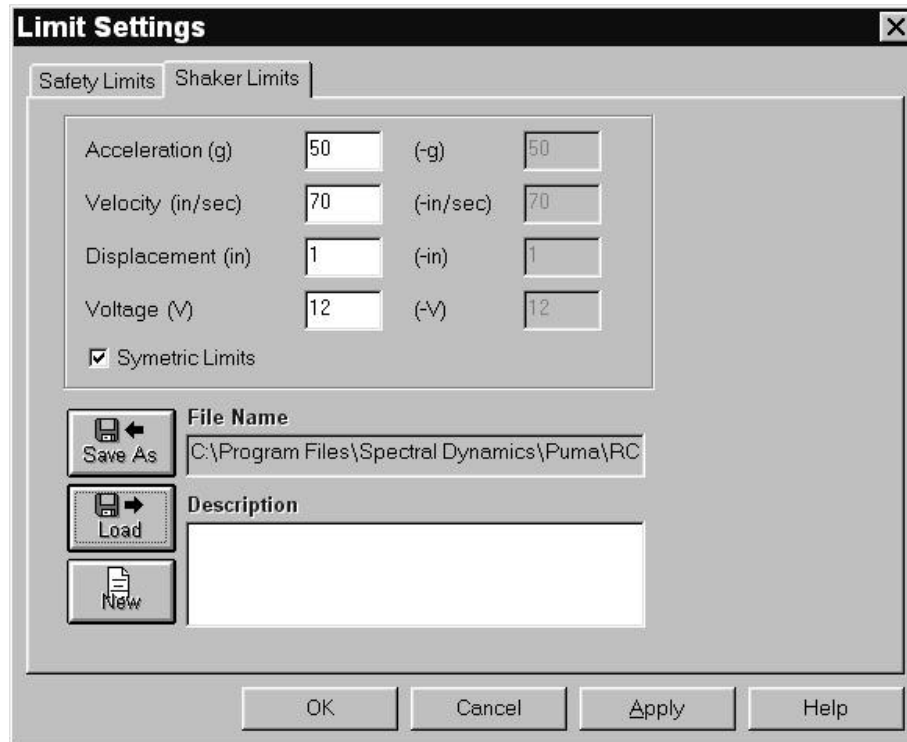


Figure 5-10. Shaker Limits Tab of Limit Settings Window

### 5.2.6 Remote Control Interface

The **REMOTE CONTROL INTERFACE** Menu Option displays the **Remote Control Interface** Window. See Figure 5-11. This window allows the user to specify actions to occur when TTL status lines on the Remote Communications Interface go high or low. The action options are:

Start – Start the currently loaded test	Abort – abort the running test	Load Test – Load a stored test setup
Full Level – Bring running test to full level	Resume – Resume the stopped or aborted test	Load Profile – Load a stored test profile
Stop – Stop the running test	Off – Test has not been started	Load Schedule – Load a stored test schedule

	High Action	Lo Action	Segment Name		Message
1	Full Level	Stop	C:\Program Files\Spectr	***	
2	Abort	Stop	C:\Program Files\Spectr	***	
3	Start	Resume	C:\Program Files\Spectr	***	
4	Off	Off		***	
5	Off	Off		***	
6	Off	Off		***	
7	Off	Off		***	
8	Off	Off		***	
9	Off	Off		***	
10	Off	Off		***	
11	Off	Off		***	
12	Off	Off		***	
13	Off	Off		***	
14	Off	Off		***	
15	Off	Off		***	
16	Off	Off		***	

File Name:

Description:

Buttons: New, Load..., Save As..., OK, Cancel, Help

Figure 5-11. Remote Control Interface Window

#### 5.2.6.1 Remote Control Interface setup parameters:

**Input Line Number** - Input status line channels 1 thru 16

**High Action** - Each channel has a default entry (Off) and a pull-down menu with eight action menu choices.

**Lo Action** - Same as the High Action.

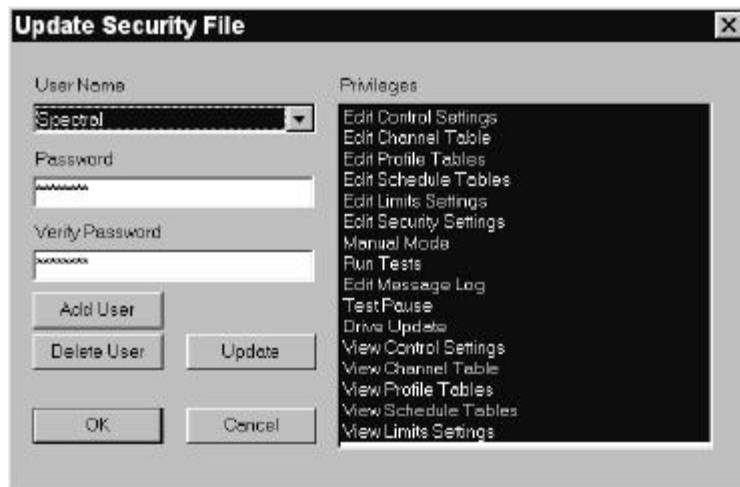
**Segment Name** - Each row has a Browser Button that displays the **Open** (File) Dialog Box to allow user to find the desired file.

**Message Column** - Enter text identifying Remote Communications Interface Line.

### 5.2.7 Security

The **SECURITY** Menu Option displays the **Update Security File** Window. See Figure 5-12. **This is a purchase option.** This window is used to update the security file by either adding or deleting employees names, their privileges or both. User privileges are added by highlighting the privilege in the **Privileges Table**.





**Figure 5-12. Update Security File Window**



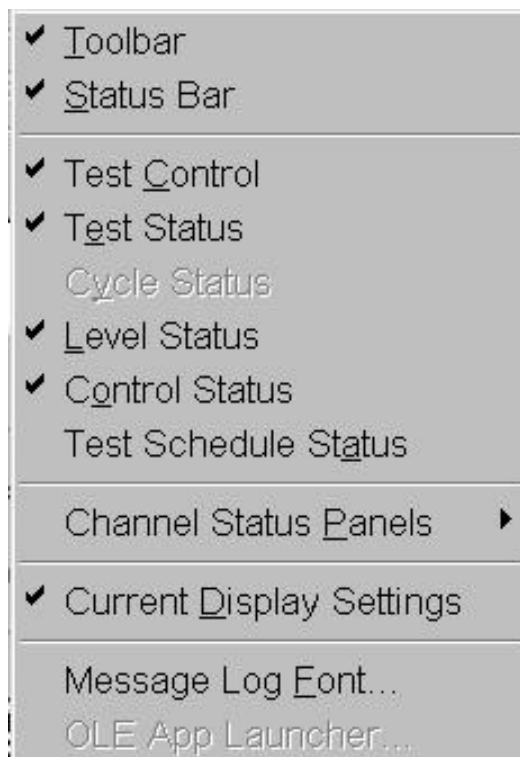
**Puma Basic**  
**Random Operating Manual**

## Chapter 6 - View Menu

---

### 6.1 Introduction

When **VIEW** is selected from the Menu Bar, the image shown in Figure 6-1 will display. Note that selections have been made. The checkmarks indicate items that will be seen either in a window or on the desktop during the test.



**Figure 6-1. View Menu**

The number of channels available are 4. The **MESSAGE LOG FONT** option displays a standard Windows dialog box that allows editing of font styles. See the Windows documentation for more information about this option.

### 6.2 View Submenus

Each of the remaining **VIEW** submenu items are described next.

## 6.2.1 Toolbar And Status Bar

When the **T**OOLBAR and/or **S**TATUS BAR options are selected, the Toolbar buttons and Status Bar information will display. See Figure 6-2.

### 6.2.1.1 PUMA Basic Desktop Toolbar

Tucked between the menu bar and the application tool bar is the **PUMA Basic Desktop Toolbar**. It is activated with the **C**URRENT **D**ISPLAY **S**ETTINGS Menu Option. When selected, each item in the list will arrange the desktop in a predetermined layout. Each template listed has its particular components specified by the user that is laid out in a specific arrangement. The user can modify each template and arrange the screen components to suit their needs. Clicking the <+> button saves a layout and the <-> deletes a layout.

### 6.2.1.2 Toolbar

The **T**OOLBAR buttons are shortcuts for various menu items. The first six, and the last three, are standard Windows Toolbar buttons. These are described in your Windows documentation. Information for the other three buttons, **C**HANNEL **S**ETUP, **P**ROFILE **S**ETTINGS, and **S**ETUP **S**CHEDULE, can be found later in this chapter.

### 6.2.1.3 Status Bar

The Status bar gives information about various activities currently running on the system. A message displays whenever the cursor touches a shortcut icon. It also has three toggle boxes that act as text boxes to indicate certain functions are available.

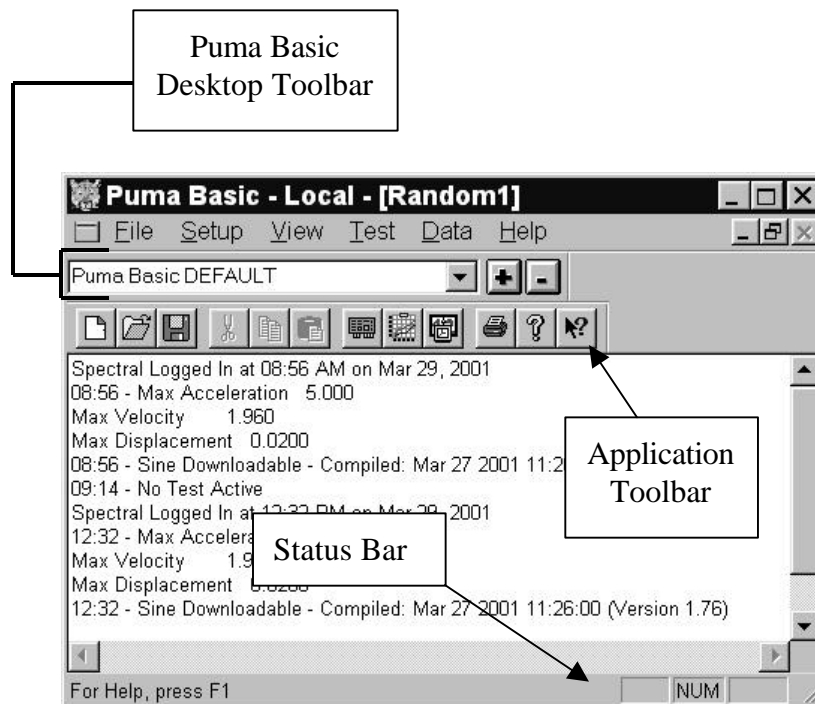


Figure 6-2. Toolbars and Status Bar

### 6.2.2 Test Control

When **TEST CONTROL** is selected from the **VIEW** menu prior to any test parameter input, the Test Control shown in Figure 6-3 will display. The **TEST CONTROL** shown in Figure 6-4 relates the appearance of a test in Auto Mode. The ten buttons used to control the test are described next.

#### 6.2.2.1 Start / Stop

Click the <**START**> button to begin the currently loaded test. After the test starts the button label changes to <**STOP**>.

#### 6.2.2.2 Pre-Test

Click the <**PRETEST**> button to make sure that the test will run correctly.

#### 6.2.2.3 Pause Continue

Click the <**PAUSE**> button during auto mode to pause the currently loaded test. The button label will change to <**CONTINUE**>.

#### 6.2.2.4 Manual

Click the <**MANUAL**> button to run the test in the manual mode. The **TEST CONTROL** displays the Level Scale feature shown in Figure 6-5 to view the test level in decibels (dB).

#### **NOTE:**

Manual Mode must be enabled to work any of the following buttons except <**RESET AVG.**>

#### 6.2.2.5 Step Up

Click the <**STEP UP**> button to increase the test one schedule level (as defined in Test Schedule Dialog).

#### 6.2.2.6 Step Down

Click the <**STEP DOWN**> button to decrease the test one schedule level (as defined in Test Schedule Dialog).

---

**NOTE:** A schedule must be loaded to have the <Step Up> and <Step Down> buttons respond.

---

#### 6.2.2.7 Drive Update

Click the <**DRV UPDATE**> button to toggle (on/off) the updating of the drive signal. Turning it off effectively replays the same drive signal continuously. **Use with caution.**

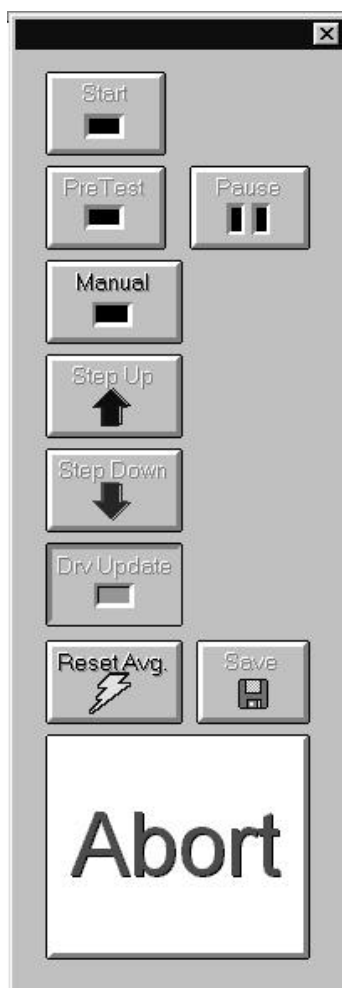


Figure 6-3. Test Control  
Prior To Test Start

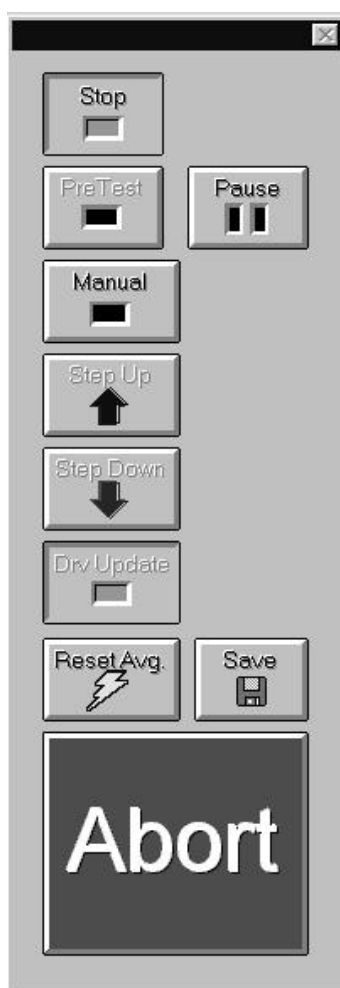


Figure 6-4. Test Control  
In Auto Mode

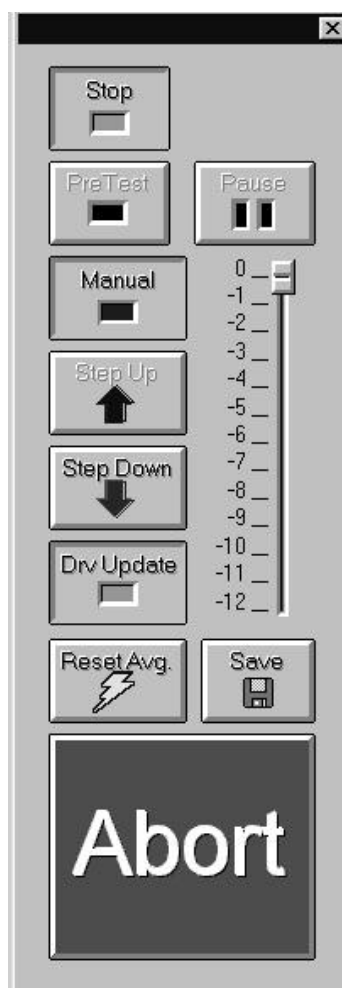


Figure 6-5. Test Control  
In Manual Mode

#### 6.2.2.8 *Reset Avg.*

Click the <RESET AVG.> button to reset the control averager.

#### 6.2.2.9 *Save*

Click the <SAVE> button to manually save the current frame of data to a file.

#### 6.2.2.10 *Abort*

Click the <ABORT> button to manually abort the currently running test. The user may also hit the orange Abort Test <F12> key on the keyboard. An optional External Abort Actuator Button is available from Spectral Dynamics.

### 6.2.3 Status Panel Options

When any of the **TEST STATUS**, **LEVEL STATUS**, **CONTROL STATUS**, **TEST SCHEDULE STATUS** or any **CHANNEL STATUS** options are selected, the Status Panels shown in Figures 6-6 through 6-10 will display.

### 6.2.3.1 Test Status

When **TEST STATUS** is selected from the **VIEW** menu, the Test Status panel shown in Figure 6-6 will display. The Test Status Panel gives information about the currently loaded test.

### 6.2.3.2 Level Status

When **LLEVEL STATUS** is selected from the **VIEW** menu, the status panel shown in Figure 6-7 will display. This panel gives information about the level of the currently loaded test.

### 6.2.3.3 Control Status

When the **CONTROL STATUS** option from the **VIEW** menu is selected, the status panel shown in Figure 6-8 will display. This panel gives information about the level of the currently loaded test.



Figure 6-6. Test Status Panel

Figure 6-7. Test Level Status Panel

Figure 6-8, Test Control Status Panel

### 6.2.3.4 Test Schedule Status

After the test is running, clicking on the **TEST SCHEDULE STATUS** Menu Option of the **VIEW** menu will cause the **Test Scheduling** Window (Figure 6-9) to appear. These schedules are loaded and run through the following pathway:

**SETUP** ⇒ **SCHEDULES** ⇒ **SCHEDULE SETUP** Window ⇒ **TEST SCHEDULE** Tab

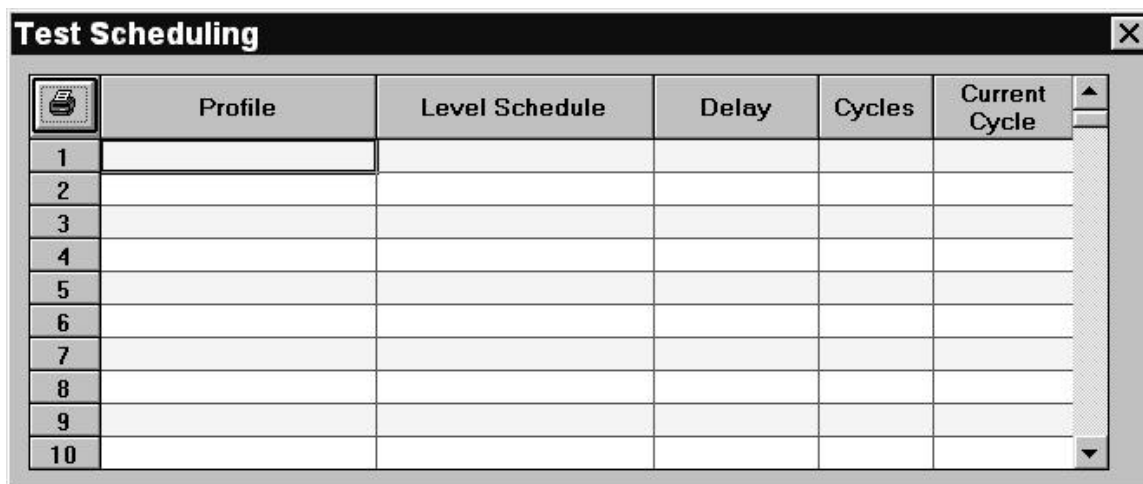


Figure 6-9. Test Scheduling Window

Load the desired profiles and schedules using the browse buttons then click the **< RUN SCHEDULE >** button.

#### 6.2.3.5 Channels Status

When a Channel Status option (**CHANNELS 1 TO 4**) is selected, a window similar to the one shown in Figure 6-10 will display. The Channel Status windows give GRMS information about the channels. The measurement is to the nearest one thousandth.

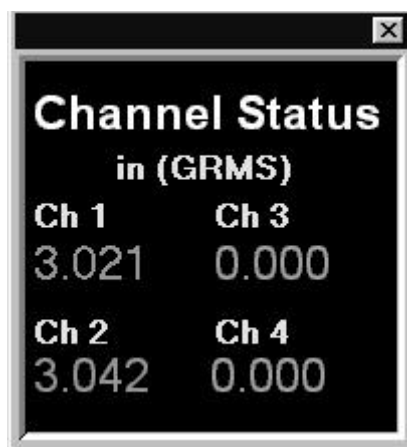


Figure 6-10. Typical Channel Status Panel

#### 6.2.4 Message Log Font

When **MESSAGE LOG FONT** is selected from the **VIEW** menu, a standard Windows font dialog box appears. Refer to the Windows documentation for further information.

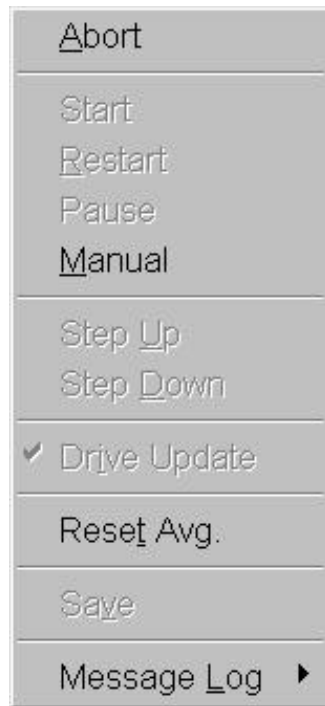


## Chapter 7 - Test Menu

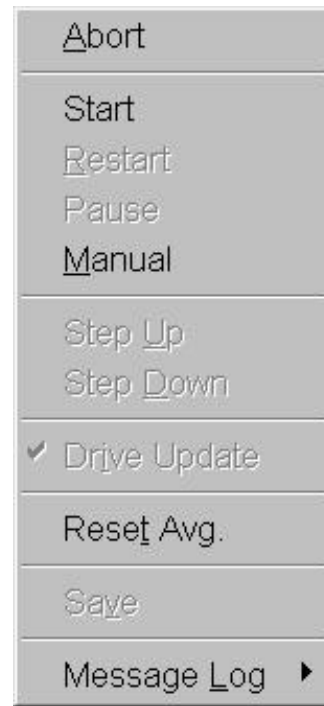
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### 7.1 Introduction

When the **T**EST Menu option is selected the image shown in Figure 7-1 displays. After the test begins, the options change as shown in Figure 7-2. Many different sub-menu listing combinations can be seen as shown by the following figures. Most of the commands can also be issued from the Test Control. See Chapter 6.



**Figure 7-1. The Test Menu Options Prior To Test Parameter Input (On Initial Launch)**



**Figure 7-2. The Test Menu Options Prior To A Test Start (After Test Parameter Input)**

### 7.2 Test Submenus

Each of the **T**EST Menu sub-menus is described in the following paragraphs.

#### 7.2.1 Abort

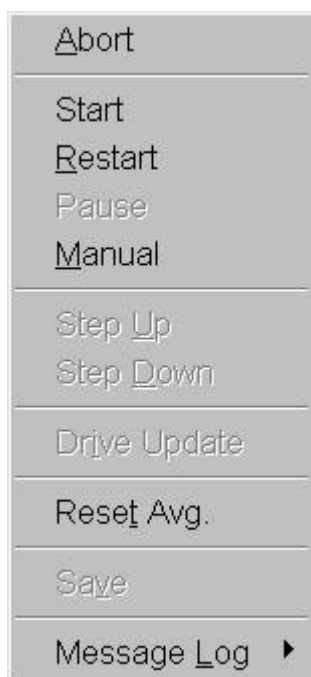
The **A**BORT Menu option allows the user to abort the currently running test. See Figures 7-3 and 7-4. The **A**BORT Menu option is always available as shown by all figures.

### 7.2.2 Start

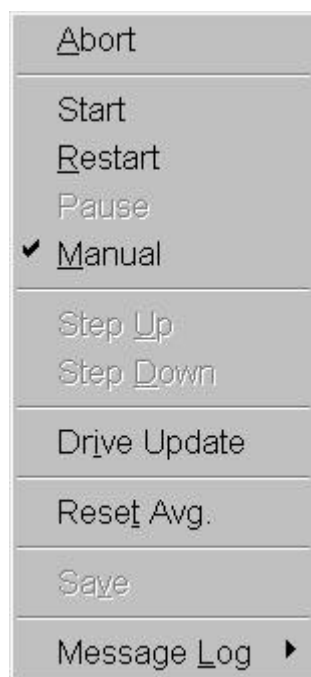
The **START** Menu option starts the test if either of two criteria has been met:

- ❑ A previous test file has been loaded
- ❑ Test parameters have manually been input for all phases of the test.

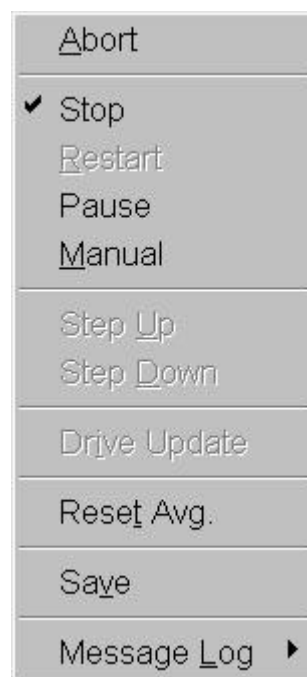
The resulting menu options available after clicking **START** are shown in Figure 7-5.



**Figure 7-3. Result of clicking ABORT while in AUTO Mode.**



**Figure 7-4. Result of Clicking ABORT while in MANUAL Mode.**



**Figure 7-5. Result of Clicking START while stopped in AUTO Mode**

### 7.2.3 Restart

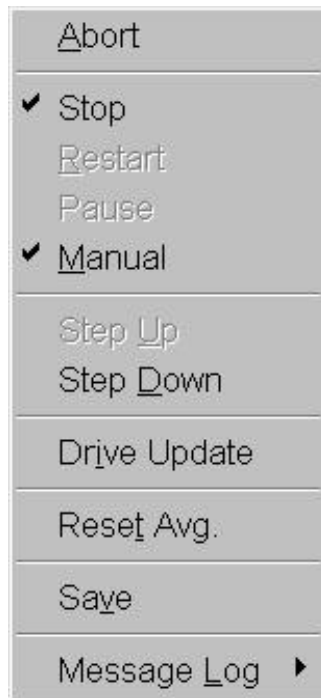
The **RESTART** Menu option restarts the test from the same point that the test was stopped with a **PAUSE** action in Auto Mode. The sub-menus are the same as default options during manual operation. See Figure 7-6.

### 7.2.4 Pause

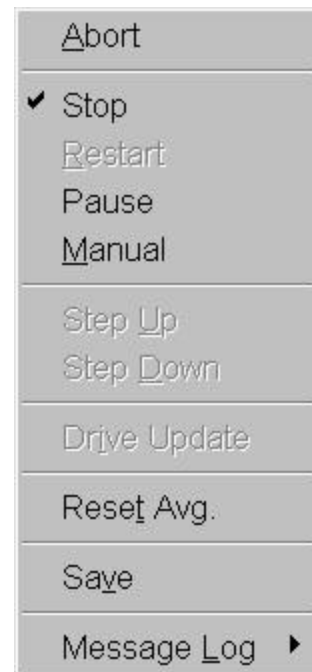
The **PAUSE** Menu option suspends the test and waits for a command to continue or stop. See Figure 7-7.

### 7.2.5 Manual

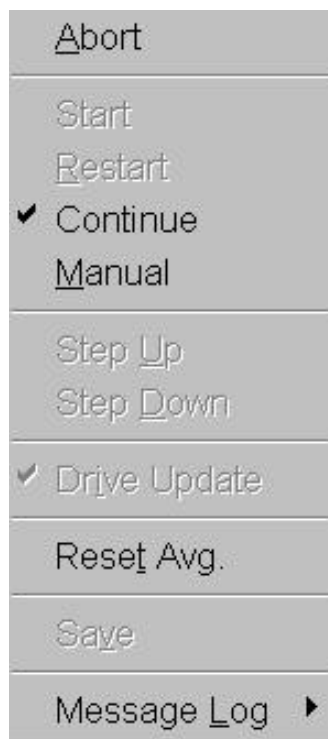
The **MANUAL** Menu option allows the user to take manual control of the test so that parameters other than the ones originally started with can be used. See Figure 7-6 for default menu options available. See Figure 7-8 for menu options available after clicking **MANUAL** to change back to AUTO mode.



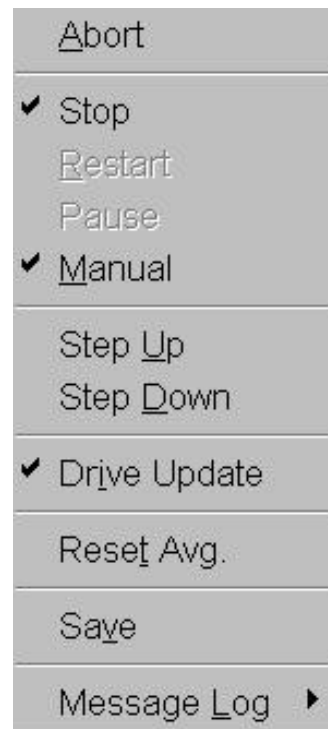
**Figure 7-6. The Default Test Menu Options During Manual Mode Operation**



**Figure 7-8. Result of Clicking MANUAL while in MANUAL Mode to reset AUTO MODE.**



**Figure 7-7. The Test Menu Options In Auto Mode After Clicking PAUSE**



**Figure 7-9. Test Menu Options In MANUAL Mode After Clicking STEP DOWN**

### 7.2.6 Step Up

The **STEP UP** Menu option allows the user to manually increase the test one schedule level while in the manual mode. The sub-menus are the same as default options during manual operation. See Figure 7-6.

### 7.2.7 Step Down

The **STEP DOWN** Menu option allows the user to manually decrease the test one schedule level while in the manual mode. See Figure 7-9.

### 7.2.8 Reset Average

In the Linear Averaging Mode, selecting **RESET AVG** will begin Monitor and Auxiliary Linear Averaging. In the Exponential Mode, selecting **RESET AVG** will begin Monitor and Auxiliary Exponential Averaging.

### 7.2.9 Save

The **SAVE** Menu option allows the user to save the current frame of data to a file.

### 7.2.10 Message Log

The Message Log is the file of information being generated and is displayed as the test is running. The **MESSAGE LOG** submenu has submenus of its own. See Figure 7-3. There is a Pre-Test and Post-Test Dump and a Message Priority selection with three submenus of its own. The submenus are discussed below.

#### *7.2.10.1 Pre-Test Dump*

When the test is started PUMA performs a PRETEST DUMP. It lists the specifications of the test and normally includes:

- Test Name (path)
- Channel Table (path)
- Control Profile (path)
- Additional Channel Profile Paths
- Schedule (path)
- Control DOF Value
- Auxiliary DOF Value
- Resolution Value
- Min. Frequency Value
- Max. Frequency Value

#### *7.2.10.2 Post-Test Dump*

The POST TEST DUMP lists any errors and the levels encountered during the test cycle. One example would be a Max Error Signal report.

#### *7.2.10.3 Message Priority*

The three levels of Message Priority are **High**, **Medium** and **All**. While it is highly recommended that the default (All) be used, the other choices are offered for those users that continually run the same test or repeat a number of cycles of the same tests and do not need to see all the log file messages.

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## Chapter 8 - Data Menu

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### 8.1 Introduction

When you select the **D**ATA Menu from the menu bar the options shown in Figure 8-1 will display.



Figure 8-1. The Data Menu Prior to Any Test Being Run

### 8.2 Data Submenus

All of the **D**ATA Menu items are described next.

#### 8.2.1 Display

The **DISPLAY** option is not available until after the testing begins. After the required parameters are input and the test has been started, the menu option reads: *Display Random Test Data.syn*. See Figures 8-2 and 8-3. This is a synopsis file that summarizes the most recent test that has been run.

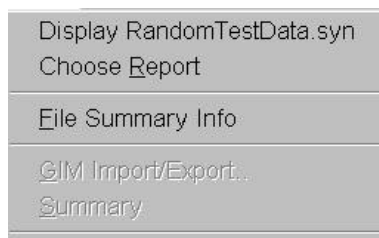
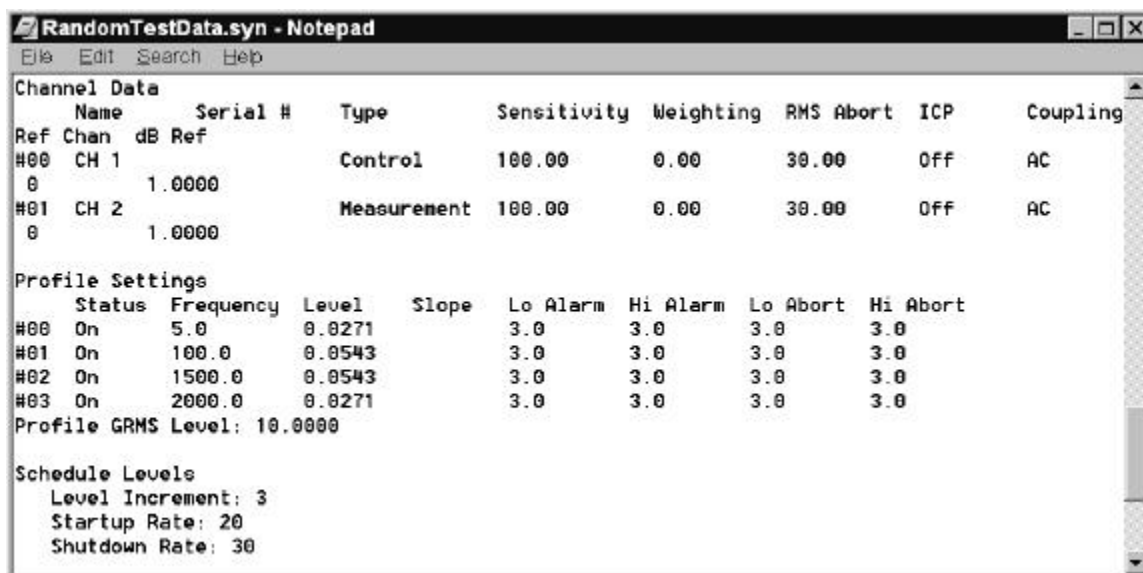


Figure 8-2. The Data Menu After Starting A Test



RandomTestData.syn - Notepad

File Edit Search Help

Channel Data

Ref	Chan	dB Ref	Type	Sensitivity	Weighting	RMS Abort	ICP	Coupling
#00	CH 1		Control	100.00	0.00	30.00	Off	AC
0		1.0000						
#01	CH 2		Measurement	100.00	0.00	30.00	Off	AC
0		1.0000						

Profile Settings

	Status	Frequency	Level	Slope	Lo Alarm	Hi Alarm	Lo Abort	Hi Abort
#00	On	5.0	0.0271		3.0	3.0	3.0	3.0
#01	On	100.0	0.0543		3.0	3.0	3.0	3.0
#02	On	1500.0	0.0543		3.0	3.0	3.0	3.0
#03	On	2000.0	0.0271		3.0	3.0	3.0	3.0

Profile GRMS Level: 10.0000

Schedule Levels

Level Increment: 3

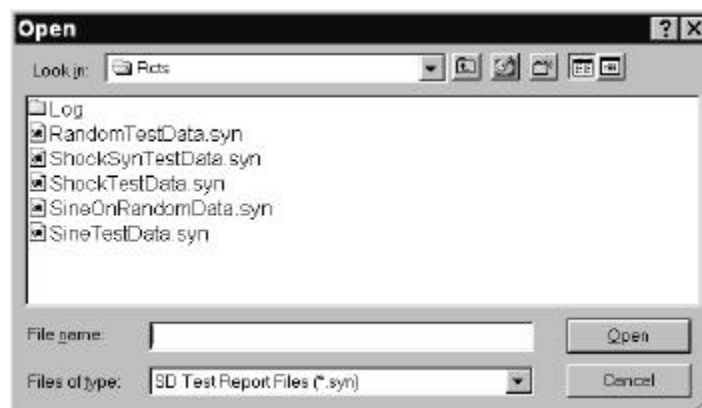
Startup Rate: 20

Shutdown Rate: 30

Figure 8-3. A Portion of the Test Data Synopsis File

## 8.2.2 Choose Report

The **CHOOSE REPORT** Menu option activates an **OPEN** Dialog Box similar to the **SAVE AS** Dialog Box, which allows the user to search for and select the file that contains the required report. See Figure 8-4.

Figure 8-4. Results of Selecting **Data** ⇒ **Choose Report**

## 8.2.3 File Summary Info

When the **FILE SUMMARY INFO** Menu option is selected, the **Document Properties** Dialog Box shown in Figures 8-5 and 8-6 will display. It has two index tabs, labeled: **Summary**, and **Statistics**, which are described next. At the bottom are the standard Windows buttons <OK>, <Cancel>, <Apply>, and <Help>. For information about these buttons see your Windows documentation.

### 8.2.3.1 Summary Tab

The **Summary** Index Tab contains seven fields. The first field Application, names the software program that is currently loaded. The other six fields Author, Keywords, Comments, Title, Subject and Template allow the user to add summary information.

### 8.2.3.2 Statistics Tab

Figure 8-6 displays the **Statistics** Index Tab information. It lists ten lines of basic information about when the file was created, how large it is, and so forth.

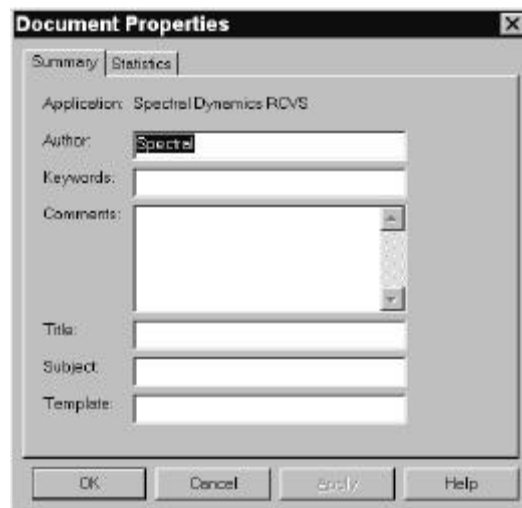


Figure 8-5. Summary Tab of Document Properties Dialog Box

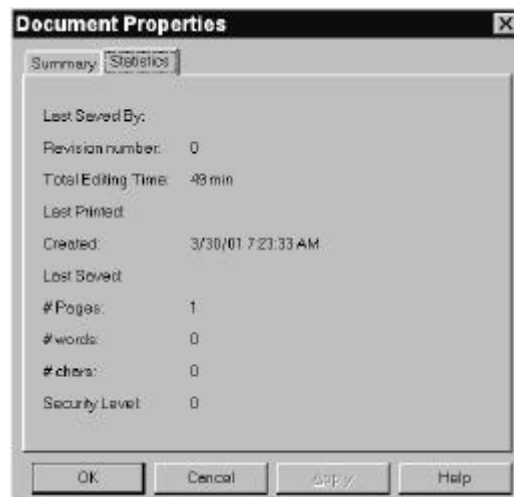


Figure 8-6. Statistics Tab of Document Properties Dialog Box

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# Chapter 9 - Help Menu

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## 9.1 Introduction

When the **H**ELP Menu option is selected, the menu shown in Figure 9-1 will display. This menu consists of **H**INTS, **S**UPPORT, **S**TARTUP **W**IZARD, and **A**BOUT **P**UMA **B**ASIC. After the test begins the menu changes. See Figure 9-2.



Figure 9-1. The Help Menu Prior to Starting Test

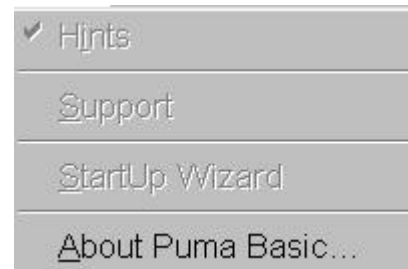


Figure 9-2. The Help Menu After Starting Test

## 9.2 About PUMA

The About PUMA Window (Figure 9-3) features a rolling, bouncing cube with pictures of a Puma and the CATS PUMA logo. The right side of the window displays version and build information along with copyright information.

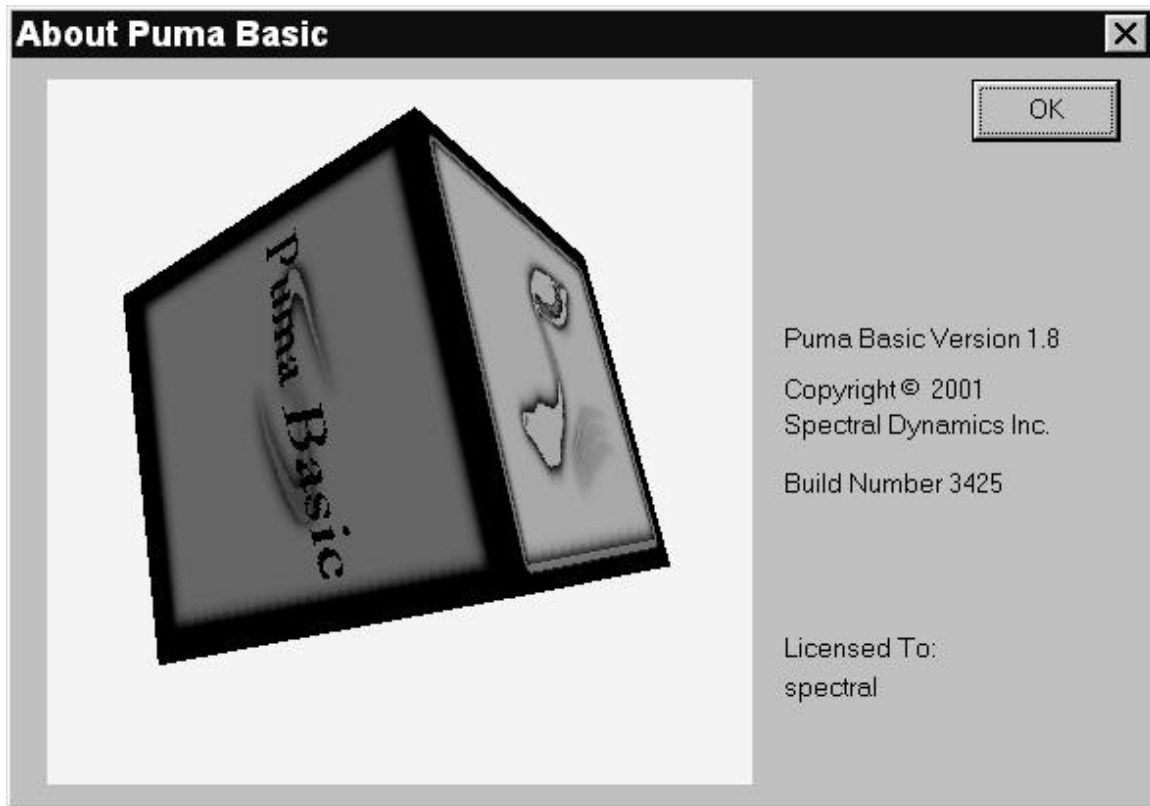


Figure 9-3. The About Puma Screen

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**2400-0123A**

**May 15, 2001**