SOFTWARE DESCRIPTION

SHOCK RESPONSE SPECTRUM SOFTWARE

For Response Spectrum Analysis of Shock and Vibration Data

Description

An optional integrated compiled "C" software package for the CAT System that provides fast, flexible and powerful SRS analysis functions for shock and vibration applications. The user friendly software was designed to speedup and simplify SRS testing and analysis. The package also includes all time domain analysis and editing features of Level 1 CAT software for shock analysis. These include: peak amplitude; velocity integrals and displacement plots; time durations; triaxial accelerometer resultant vector magnitude and angle solutions; and waveform editing functions which may be used to edit and isolate portions of digitized records in the time domain for SRS processing.

Features include: User selectable damping ratios; plus, minus and max-i-max spectra; absolute or equivalent acceleration displacement models; user selectable amplitude and frequency scaling from one to seven decades; and 3rd, 6th or 512 line high resolution filter frequency increment selection. Processing time of 3 seconds per 20 SDOF's per 2 KB of data gives a figure of merit of 7.32 microsec per data byte when running on a 80386SX CPU with matched coprocessor. Additional features include fast decimated data checks for quick determination of data validity, and time domain velocity integrals of waveforms for detection of DC data offsets.

All waveforms may be saved to hard disk for archiving, later recall and processing. A set of typical printer drivers and multi-report spoolers are provided to generate professional test reports.

The GHI SRS software operates in the DOS environment in conjunction with GHI transient recorder hardware optimized to work with GHI software routines.

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update

Software Features

The operation of the SRS software is divided into two modes: 1) data capture, editing and preparation, and 2) SRS computation and plotting. The first mode includes all standard GHI CAT Level 1 data capture and time domain analysis and editing modes. These functions are described in BULLETIN 062290. The second mode provides processing of any signal recorded and displayed on the waveform screen with a minimum of keystrokes. Software operation is very flexible, resulting from our intuitive menu-driven commands. No computer skills are needed nor does the user have to resort to any high level DOS command chains in order to structure a desired routine. All software functions are written in a compiled "C" executive and operate in a fashion similar to other professional software such as Lotus 1-2-3.

The GHI SRS software supports three hardcopy output modes. The first includes waveform traces of any signal recorded giving values of g max, velocity change and time in addition to plots of velocity and displacement (1st and 2nd integrals of acceleration), all in engineering units scaled according to the calibration factor of each transducer. The second mode is the fully annotated SRS report. The third is a table of numerical values of SDOF frequencies and related peak amplitudes.

The software closely follows program guidelines for improved recursive digital filter with low mass compensations. [1]

SRS Software Specifications

Program Type	Ramp Invariant Recursive Digital SDOF Model
Calculation Figure of Merit	7.32 microsec per byte*
Model Types	Absolute Base Input Acceleration, or Equivalent Static Acceleration Units.
Analysis Resolution	3rd or 6th Octave intervals or 512 Lines Total.
Analysis Ranges, Frequency or Amplitude	User selectable, 1 to 7 Decades, Decimal Log Log with starting or ending values at any decimal number.
Damping Ratios for Analysis	0 to 0.99, user selectable.
Tolerance Bars	Seven Break Points, 4 Bars Total.
Software Format	Compiled executable "C" code, approximately 220 Kbytes.
Raw Data Array Capacity, Max, Min	131,072 and 512 Twelve Bit Bytes

Specifications subject to change without notice.

* Based on 20 Mhz 80386SX CPU with Matched Coprocessor. Other combinations may be faster.

Operation

All system operations including the digitizing hardware are controlled from simple, intuitive menus. When a command key is pressed, the software puts a prompt on the screen which directs an additional action on the part of the user, or lists choices to be made. The integrated SRS software provides all time domain as well as SRS analysis capabilities for both shock and vibration.

After signals are captured, the recorded time domain waveform(s) are displayed on the Signal Screen. At this point, the user has several editing options such as expansion by horizontal Zoom to isolate a portion of a long record for SRS processing, or the waveform can be saved to hard disk.

The GHI SRS Software provides many choices for scaling, damping, model type, display format and screen editing for unsurpassed flexibility in analysis and plotting. The ability to change damping ratios gives the user the tools to experiment for predictive product performance when environmental shocks are analyzed.

SRS Routine Selections

Display [B]ars	Plots user entered Tolerance Bars on screen and reports.
[C]ompute	Initiates the SRS calculation using the model which is selected and displayed at the bottom of the SRS Screen.
Change [D]amping	Selects Model Damping Ratio between 0 and 0.99.
[E]rase	Clears SRS screen.
[G]rid	Overlays log log amplitude versus frequency grid on SRS screen and test report.
Enter [L]imits	Displays entry screen for user selection of tolerance bar break points and allowable variance bands.
Change [M]odel	Selects Absolute Base Input Acceleration or Equivalent Acceleration Static Units (Displacement)
Change Channel [N]umber	Selects any of displayed waveforms to be processed.
Change [O]ctave	Selects 3rd, 6th of 512 line resolution plot analysis precision. Also selects option to plot vertical lines at SDOF frequencies.
[P]rintout	Initiates the test report editing and printout routines.
[R]escale	Clears CRT and prompts for new amplitude and frequency scale end values. Any integer value may be used as either a starting or ending point and the resulting scales will be decimal log log.
Change [S]amples	Selects source of data for processing, either from Screen (Time decimated) or from Memory (Undecimated).
[W]aveform	Plots time domain waveform on SRS screen for reference.
E[X]it	Returns operation back to Signal Waveform Screen.

[X] indicates the intuitive key that is pressed to command the function.

After a SRS plot has been completed, the user may elect to change the channel number and plot a second SRS overlaying the first. If the computed SRS exceeds the user selected amplitude plot scale upper range, the user needs only to press the [R] Key (Rescale function) to change the amplitude range. When this is done, pressing the [C] Key (Compute) will instantly display the already computed SRS data on the newly scaled screen. In this fashion, computation times need not be wasted when incorrect amplitude plot scales have at first been chosen. Another useful feature of the software is the ability to output a numerical file that tabulates the SDOF frequencies and peak amplitudes that result from the SRS calculation. This is beneficial to those using controlled shakers in order to program the shaker to reproduce the computed SRS curve.

Anti-Aliasing Filters

While the SRS software routine has been optimized for oversampling digitizing systems, because of the wide range of applications and A/D performance settings available to the user, it is strongly suggested that the user analyze his particular situation to determine if anti-alias filters will be needed.

The GHI SRS Software running on the CAT System can take advantage of sample rates that are at least 10 times the highest frequency for analysis. The resulting Nyquist folding frequencies from using such high oversampling ratios are also very high. In many high frequency tests, there are very few transducers or sensor devices that produce noise that would be folded back into the analysis bandwidth.

A major reason for oversampling based software is doing away with the need to filter data. Filters can cause phase errors and other problems with data resulting in incorrect analysis results. For this reason, many labs choose not to use filters when taking pyroshock data using high oversampling digitizing hardware.

Example 1.

When doing pyro or high energy/frequency metal to metal shock, the 1 MHz aggregate sampling rate of the CAT system can provide single channel sampling rates of 1 Mhz. The Nyquist folding frequency of this sampling rate is 500,000 Hz. In order to have aliased noise folded back into an analysis bandwidth of DC to 100,000 Hz, the transducer would have to produce noise in the frequency bands of 900,000 to 1,100,000 Hz. This is not a common phenomena. In this case, the use of anti-aliasing filters would not be necessary.

Example 2.

When doing a 30 second seismic triaxial random vibration test in accordance with Bell Labs Telephone Equipment Test Specifications, or IEEE-344-77 requiring an SRS analysis frequency range of DC to 200 Hz, the aggregate 1 Mhz sampling rate of the CAT system would result in sampling rates of 1250 Hz per channel. The Nyquist folding frequency would be 625 Hz and noise in the frequency band of 1050 to 1450 would be folded back into the analysis bandwidth. In this case, the user will need to consider the use of anti-alias filters with low pass cutoff frequencies near 500 Hz. Such an electronic filter is easy to implement as far as cut-off frequency and rejection slope are concerned. However, a major problem is phase distortion and insertion loss of the filtered data and much care must be used in selecting such filters to minimize this problem.

GHI Systems offers customers multichannel anti-alias filters with high performance specifications as optional front end devices for the CAT System. These filters have programmable cutoff frequencies which can be selected by the CAT SRS software when the user picks a desired sampling rate for his test. If your application requires this type of input filter, please contact GHI SYSTEMS for quotations and specifications.

Report Printout

Reports may be printed from disk using the Print Queue, or direct from the signal screen. The user can format and edit the test report to include all test parameters, product/test procedure identifications, and comments that are normally hand entered. If the file is saved after SRS calculation, report entries, setup parameters and tolerance bar are also saved to disk for later recall and reuse. This facilitates quick and easy setup and reporting for repetitive tests.

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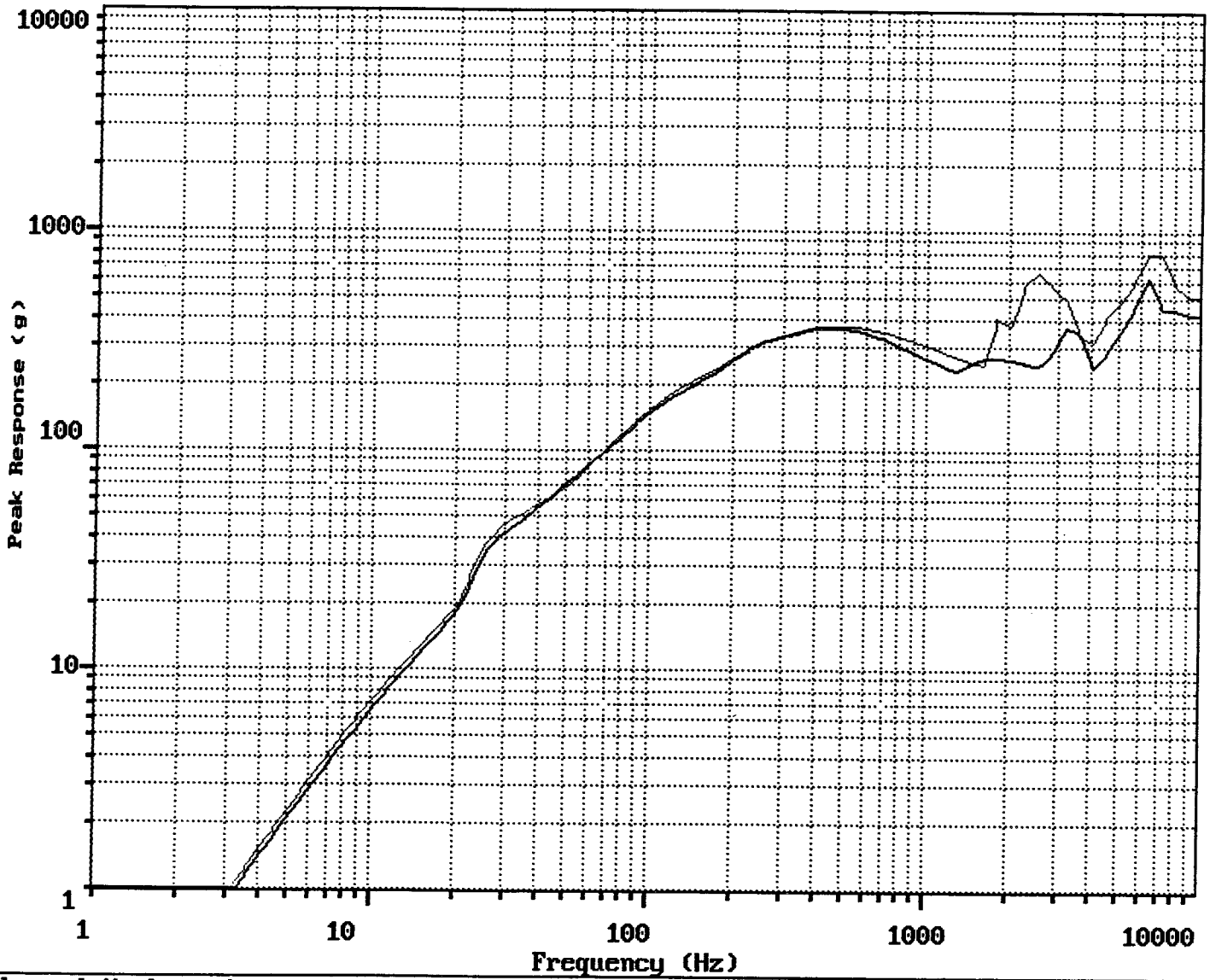
1. Smallwood, D.O., "An Improved Recursive Formula for Calculating Shock Response Spectra", **The Shock and Vibration Bulletin**, 51(2), pp 211-217, (Washington, DC, Shock and Vibration Information Center, Naval Research Laboratory, May 1981.

SRS Test Report

GHI SYSTEMS, INC. TRIAD CAT SYSTEM

Date	: Thu Aug 17 1989	Test Engineer	: A. B. Schwartz
Customer	: ABC Computers	Shock Machine	: See Below
Type of Test	: Table/Fixture SRS	Shock Pulse	: Half Sine



Channel Number= 1	Model = Acceleration
Damping = 0.05	Plot = 6th Oct.
Max Type = Maxi-Max	Samples from Memory

Remarks:

Channel #1 is bottom of table, PCB 303. Ch #2 is Endevco 2226C on fixture. Shock machine was a 36 inch with fixture made by ABC for testing hard disk drives. Purpose of the test was to identify fixture problems.

Illustrations on this page are from actual test reports produced by the GHI CAT running optional SRS Software. Note the flexibility of the CAT SRS software for scale ranges, tolerance limits, and to fit differing applications.

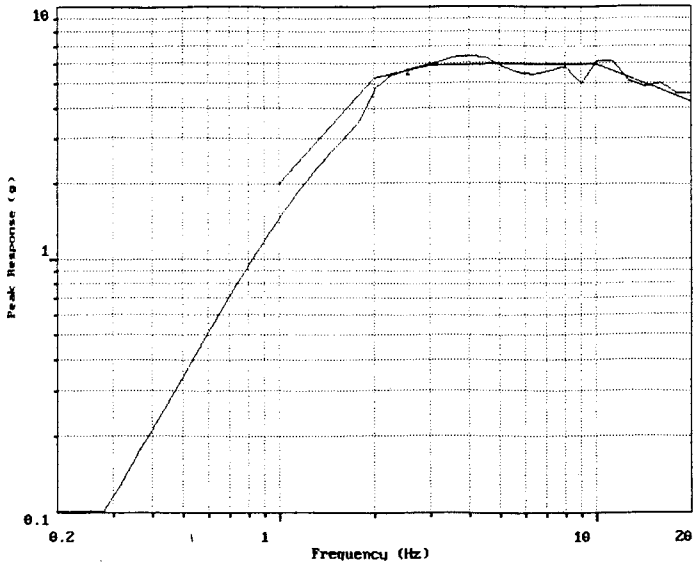


Figure 2. SRS of 3 g, 100 Msec trapezoid shock test response of nuclear weapon container transportation test. The tolerance bars (sections of straight lines) represents the SRS of the required 3 g, 100 Msec trapezoid shock pulse. In this way, an accurate check is made to determine if the shock meets the test peak amplitude and waveshape requirements. Note that the response curve corresponds to the required pulse amplitude spectrum over the specified frequency range. Also note the software's ability to scale plots to meet diverse applications.

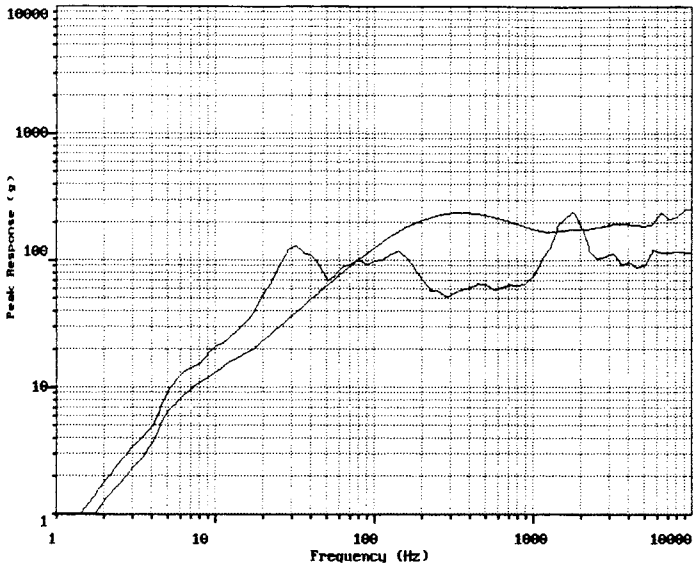


Figure 4. Dual plot SRS's of half sine shock machine excitation applied to a product and the response of the product. The purpose is to find product resonances quickly without resorting to time consuming swept sine vibration testing. Modal testing has shown that product resonances can be excited by a shock impulse. The smooth upper plot is that of the shock machine excitation and shows a classic half sine impulse with a bit of shock table resonance above 3 Khz. The lower trace is from the product response and shows significant resonances at 32 and 1800 Hz.

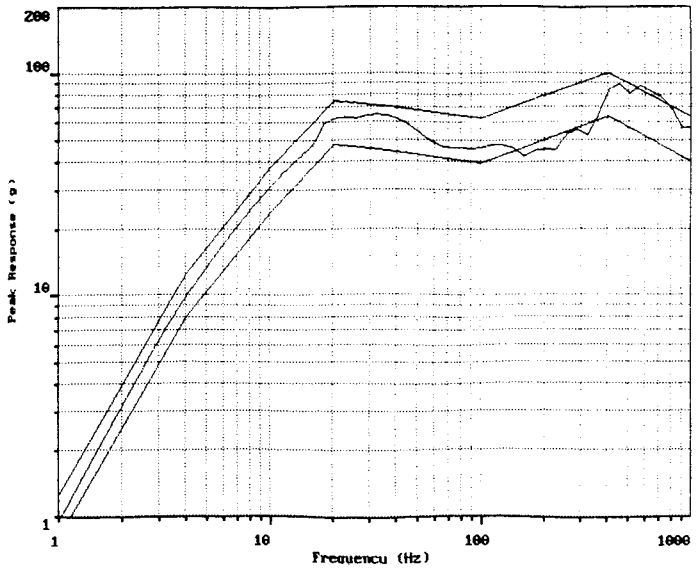


Figure 1. SRS plot and PASS/FAIL tolerance bars of packaged laptop computer drop test. The tolerance bars can be derived from product design specifications or from fragility test data.

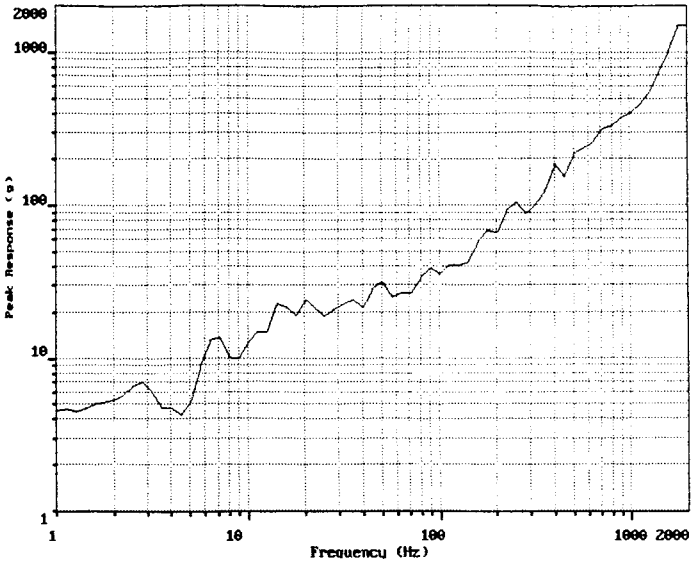


Figure 3. SRS applied to random vibration test. Data was recorded from an impact type stress screening shaker. The SRS analysis is used to show peak acceleration spectrum and randomness.

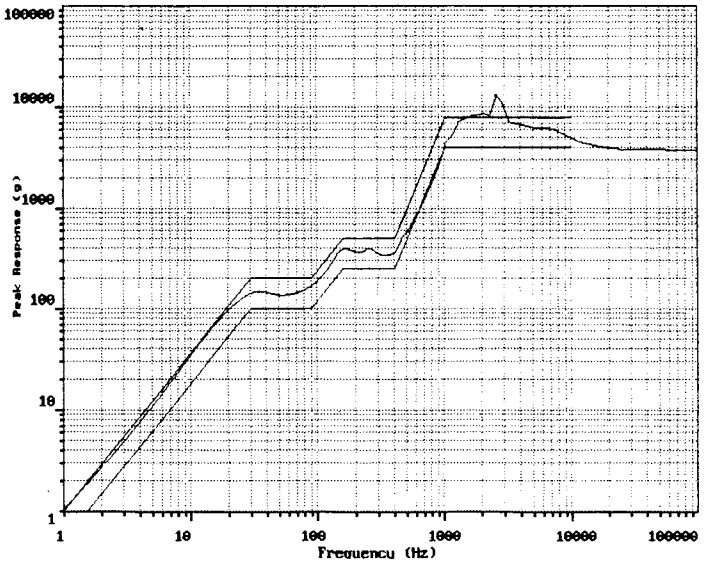


Figure 5. SRS with tolerance bars of PYROSHOCK test. Note the user selection of high amplitude and frequency 5 decade log-log scales.