GenRad

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2515-0100

Computer-Aided Test System Operating Manual

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SAFETY PRECAUTIONS

WARNING

Beware of possible internal lethal voltages present even though AC power has been disconnected. Death or serious bodily injury can occur. Only qualified personnel should perform any service or repair of the system components.

CAUTIONS

1. Before attempting any service, repair, or power switch setting changes, turn power OFF and disconnect unit from power source.

2. Before turning power ON remove the cardboard card from the floppy disk drive slot. Save this card. Reinsert it before transporting the unit to another location.

3. Do NOT operate the system with top cover removed. Serious damage to internal components may result due to overheating.

4. Before disconnecting the power cable, main unit, or any peripheral, turn power OFF. Do NOT perform any disconnection while system is operating.

SECTION I

DESCRIPTION AND GENERAL INFORMATION

This section provides an introductory description of the 2515 Computer-Aided Test System, its functions and features, its controls and connectors, and general information.

1.1 SCOPE AND RELATED DOCUMENTS

This manual is the basic user/operator guide for the 2515. It provides instructions for initial installation, a familiarization and basic operating procedure for new users, and comprehensive general operation and application descriptions for the basic data acquisition and signal analysis operating software. Also included are instructions for the use of the RT-11* software operating system in data file management operations.

Related manuals listed below are supplied with the system and include manuals provided for additional software.

2515 Computer-Aided Test System Service Manual	2515-0101
2515 Computer-Aided Test System Diagrams and Parts Lists	2515-0102
SDRC Modal Analysis User Manual	2515-0170
TSL2 Time Series Language for 2515 Systems	2515-0110

The service manual, Publication 2515-0101, contains hardware theory of operation, diagnostic and repair procedures, and the diagrams and parts lists manual, Publication 2515-0102, supports it. While the service and diagrams and parts lists manuals may be of interest to users, they are intended only for GenRad-qualified service personnel and are supplied so as to be on-site in case of service calls. Normal service philosophy is return to GenRad Service. All necessary installation and preventive maintenance procedures are contained in this user's manual.

*RT-11 is the Digital Equipment Corporation (DEC) single-user operating system for the microcomputer that controls the 2515. RT-11 is invisible to the user for general operation, but it is used directly for subsequent management of data files created during signal analysis operations.

1.2 PURPOSE AND FUNCTIONS

The 2515 is a portable multi-channel (4 channels standard, up to 16 channels optional), digital signal processing system for general purpose data acquisition and analysis. It provides numerous functions for spectrum and time series analysis, and includes several features for use in conjunction with SDRC MODAL software for structural mode shape analysis. MODAL software runs on the 2515 and can be called up directly from the basic panel operating program. The processing and versatile display functions, and miscellaneous functions, are summarized in table 1-1 along with hardware specifications and characteristics.

Although it is designed to be operated as an instrument from the front panel, and is fully self-contained for field portability, the 2515 is nonetheless a complete computer controlled and software driven system. It maintains the simplicity and directness of pushbutton operation, yet allows the flexibility of software control.

1.3 PHYSICAL DESCRIPTION

The 2515 consists of two separable units: a keyboard and the main chassis with control panel on the front and connector panel on the rear.

The keyboard is connected by cable to a rear panel connector. Functions available in the standard signal analysis software package (RTA) are all controlled from the pushbutton front panel. However, for users who may prefer keyboard operation, any front panel pushbutton function may be duplicated by entry of a two-character mnemonic code from the keyboard; or the keyboard and panel may be used together, for example by generally controlling operation from the panel but using the keyboard instead of the ENTRY section pushbuttons on the panel to make alphanumeric entries such as display labels and file names. The keyboard is required for operation of additional software packages such as MODAL analysis or TSL programming.

The main cabinet mounts the front pushbutton control panel, rear connector panel, 7" display CRT, and permanently installed 20-Megabyte Winchester disk drive. Inside are the system power supply and card cage for the system electronics. Further descriptions of the internal components are given in the functional block diagram discussion which follows.

Table 1-1. List of Specifications

DIMENSIONS AND WEIGHT

Main Chassis:	
Height	10.5 inches (27 cm)
Width	17.0 inches (43 cm)
Depth	24.0 inches (61 cm)
Weight	70.0 pounds (32 kg)
Keyboard Chassis:	
Height	1.8 inches (5 cm)
Width	19.3 inches (49 cm)
Depth	8.5 inches (22 cm)
Weight	5.6 pounds (2.52 kg)
Printer Chassis (Opt):	
Height	4.7 inches (11.8 cm)
Width	20.75 inches (52.7 cm)
Depth	8.4 inches (21.4 cm)
Weight	8.3 pounds (3.9 kg)

POWER REQUIREMENTS

Voltage	120, or 220-240 nominal
Frequency	50/60 Hertz
Power	800 Watts maximum

ENVIRONMENT

Temperature	10°C to 45°C, operating
Humidity	20% to 80% RH @ 40°C non-condensing
Safety Standard	UL 1244 specifications
Test Standard	GenRad Class 2

Table 1-1. List of Specifications (continued)

INPUT

Number of Baseband Mode Channels:	Four analog channels standard (optionally expandable to 16).
Number of Zoom Mode Channels:	Two channels standard (optionally expandable to 8).
Frequency Range:	DC to 25.6 kHz with alias protection on all channels.
Anti-Alias Filters:	14 selectable digital filter ranges below 25.6 kHz. One analog filter at 25.6 kHz.
Dynamic Range:	>70 dB with 12 bit A/D conversion, up to 20 kHz.
Amplitude Flatness:	±0.25 dB over the entire frequency range.
Input Sampling:	Simultaneous sample and hold (all channels).
Max Channel-to-Channel Difference:	Amplitude Phase 0.4 dB 2.0 degrees phase to 10 kHz 0.5 dB 4.0 degrees phase to 20 kHz 0.8 dB 8.0 degrees phase to 25 kHz
Input Impedance:	100K ohm shunted by <150 pf.
Input Coupling:	AC (-3 dB at 0.8 Hz), DC, ICP type transducer bias source.
Sensitivity:	Eight ranges (62.5 mV, 0.125 V, 0.25 V, 0.5 V, 1.0 V, 2.0 V, 4.0 V, 8.0 V peak input).
Maximum Operating Level:	10 volts (full-scale sensitivity typically tolerates a 20% overrange).
Maximum Voltage:	Protected to 25 V.

BASEBAND ACQUISITION

Bandwidths:	15 selectable ranges from 1.25 Hz to 20.48 kHz, plus 25.6 kHz.
Frame Size:	6 selectable ranges from 256 to 8,192 points/channel.
Frequency Lines:	320 alias-free lines for every 1,024 input points in the frame (except 400 lines on 25.6 kHz range).

Table 1-1. List of Specifications (continued)

ZOOM ACQUISITION

Operation:	User-specified window in the range d.c. to 25.6 kHz.
Control:	Center frequency selectable to 1.0 Hz resolution anywhere in d.c. to 25.6 kHz range.
Bandwidth:	Selectable in factors of 2 from 2.5 Hz to 20.48 kHz.

TRIGGERING

Acquisition Modes:	Free run or triggered.
Trigger Level:	Adjustable percentage of full scale.
Trigger Slope:	+ or -
Trigger Delay:	Pre-trigger and post-trigger delays
Pre-trigger:	$t \leq T$ (T is the time of one frame) (t is sample interval)
Post-trigger:	$\leq 32{,}000$ t (t is sample interval)
External Trigger:	TTL level.

STORAGE

Capacity:	20 Mbytes on Winchester drive and 0.5 Mbytes on mini-floppy drive.

Table 1-1. List of Specifications (continued)

OUTPUT SIGNALS	
Sine Wave:	1 Hz to 25.6 kHz in 1 Hz increments. 4.5 Vrms maximum level.
Random Noise:	25.6 kHz fixed bandwidth. 1.0 Vrms maximum level.
Band Translated Random Noise:	Noise bandwidth concentrated in analysis band (including zoom bands). 1.0 Vrms maximum level.
Amplitude Adjustment (all signals):	Adjustable attenuation of output level.
DISPLAY	
Size:	7-inch (diagonal measure).
Resolution:	640 lines horizontal. 480 lines vertical.

Table 1-1. List of Specifications (continued)

RTA DATA ACQUISITION

Input

Number of Channels:	Four (to optional 16) in baseband mode. Two (to optional 8) in zoom mode.
Sensitivity:	Eight ranges plus autoranging.

Baseband Resolution

Maximum Resolution (lines):

Maximum Number of Frequency Lines (Cross-Channel Acquisition Mode)	Number of Channels	
	Standard Memory	Optional Memory
320	16	16
512	12	16
640	8	16
1280	4	16
2560	2	12

Processing

Measurements Performed:

Time domain:	Input time, averaged time, auto correlation, cross correlation, impulse response.
Frequency domain:	Input spectrum, frequency response function, coherence, auto power spectrum, linear spectrum, power spectral density, cross power spectrum, transmissibility, coherent output power.
Amplitude domain:	Probability density function, cumulative distribution function.

Block Arithmetic Operations:	+, −, x, ÷, integration, differentiation.

Table 1-1. List of Specifications (continued)

Averaging	
Types:	Additive, subtractive, exponential, peak hold.
Control:	Run, stop, resume, automatic reject, manual reject.
Weighting Windows:	Uniform, Hanning, flat top, special (Blackman-Harris), force (impact), response (impact), correlation (zero padding).
Triggering	
Acquisition Modes:	Free run, auto arm trigger, manual arm trigger.
Free Run:	New measurement initiated at completion of previous measurement. Overlapped processing allows data frames to be 0%, 50% or MAX overlapped.
Automatic or Manual:	New measurement initiated when signal into armed trigger channel meets specified threshold. Any channel may be used for trigger.
Storage	
Spectrum Recall:	Data can be stored and retrieved with calibration and annotation information.
Setup/Recall:	Multiple setup states can be stored and recalled.
Display	
Graphics:	Real-time displays of measurement data with interactive format and unit selections.
Formats:	Full screen, split screen (top/bottom), superimposed displays of measured functions.
Cursors:	
Single:	Main cursor and reference cursor for relative readouts.
Sideband:	Up to 7 on both sides of main cursor.
Harmonic:	Up to 15 at harmonics of main cursor.

1.4 FUNCTIONAL DESCRIPTION

Some knowledge of the internal components and the data acquisiton hardware may aid in understanding and taking full advantage of the functions described in the section on operation. Figure 1-1 is a simplified block diagram of the major functional sections. The following paragraphs provide a brief overview of their functions and relationships.

1.4.1 General Structure

The DEC LSI-11/23 Processor and GenRad 2501 Microprocessor (a bit- slice processor) provide a two processor architecture allowing parallel operations for high speed performance. Refer to figure 1-1.

Compatible interfacing of the major components is performed by two buses. These are the LSI-11 Q-Bus and the Microprocessor bus.

The standard LSI-11/23 Processor allows the integration of a Q-bus interface to the Memory Controller, a Winchester/Floppy interface which is connected to the Floppy Disk Drive and storage chassis, and a four port serial interface. The serial interface ports integrate the control panel and remote or auxiliary peripherals to the system.

The 2501 Microprocessor uses the microprocessor bus to control the data acquisition system, signal output system, graphics display, and arithmetic booster hardware. The devices are controlled as Q-bus interface devices and are implemented through device emulation by the 2501 Microprocessor.

Subordinate to the microprocessor bus and the Q-bus are the analog input FIFO, pseudo-Unibus, and channel control buses.

The analog input FIFO bus from the channel control board sends data and FIFO status to the memory controller.

The channel control board communicates with and controls the channel boards using a common channel control bus.

The pseudo-Unibus is used to interface the Unibus memory with rest of the system via the memory controller. The LSI-11/23 processor controls the pseudo-Unibus by controlling the status of two control lines.

An independent display monitor is also integrated into the system and is provided raster scan graphics with 480(x) by 640(Y) resolution by the microprocessor system.

1.4.1.1 LSI-11/23 Processor Board. The LSI-11/23 Processor is manufactured by Digital Equipment Corporation, supported by the RT-11 operating system, and features a 18-bit addressing range. The 2515 system is based on the DEC LSI-11/23 processor thus allowing a wide range of diagnostic software and peripherals to be compatibly integrated.

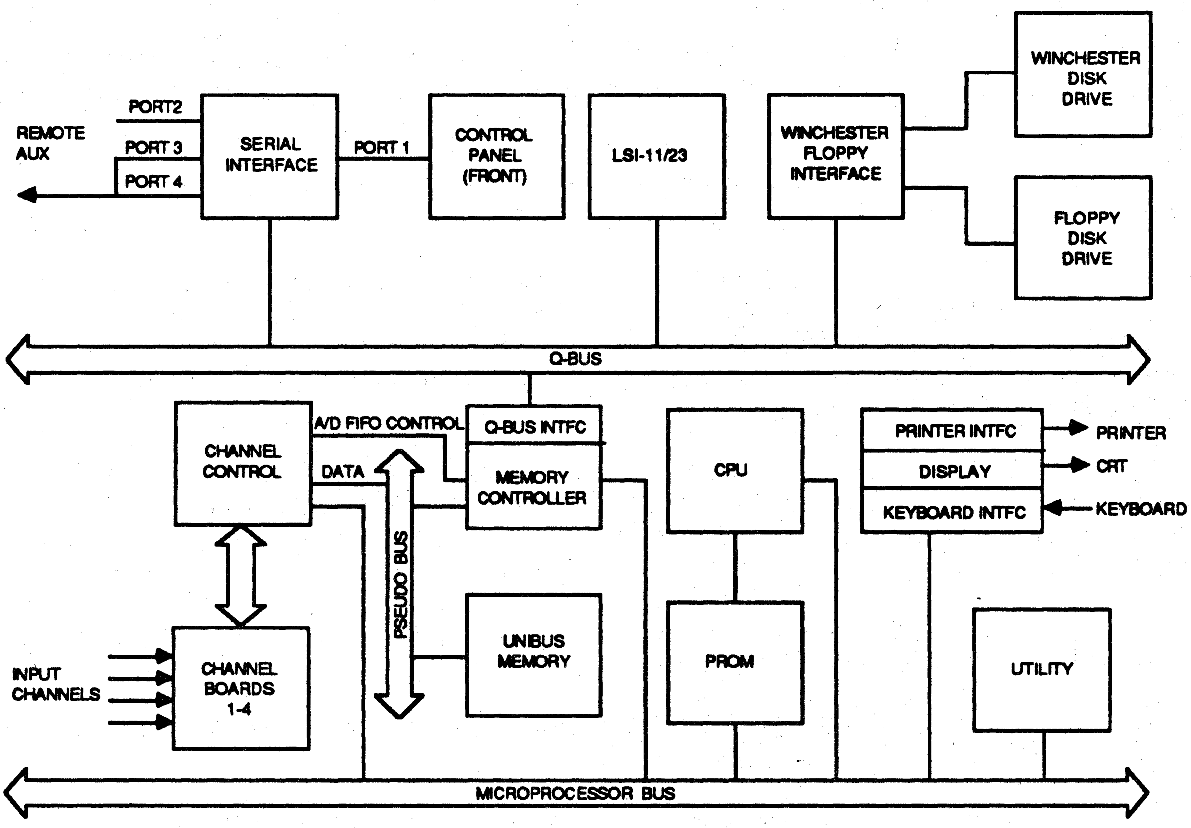


Figure 1-1. Simple Block Diagram, 2515 Computer Aided Test System

The LSI-11/23 processor controls the 2515 by interfacing with the 2501 microprocessor and the main memory via the Q-bus interface on the Memory Controller board. The DEC KEF-11AA floating point and memory management unit (MMU) is also installed in the standard 2515 system.

1.4.1.2 Winchester/Floppy Interface Board (WINC05). The WINC05 is a Q-bus compatible board. It provides DEC RX02 emulation for the 5¼-inch floppy drive at a 0.5 megabyte capacity and emulation of two RL01 devices for the Winchester at 10.0 megabyte capacity each.

The LSI-11/23 sees the WINC05 as two fully transparent controllers, Winchester and floppy.

1.4.1.3 Winchester Disk Drive. This disk drive is supported by the WINC05 RL01 emulation and provides 20.0 megabyte formatted capacity.

1.4.1.4 Floppy Disk Drive. This 5¼" flexible (floppy) disk drive is integrated into the system by an input/output cable connection at the rear panel and is controlled by the LSI-11/23 processor through the WINC05 controller. The 5¼" disk is two-sided, removable, and provides standard 96 tracks per inch in double density recording, amounting to 0.5 megabyte total storage capacity.

1.4.1.5 Serial Line Interface Board. The PM-DLV11J is a 4-channel (four ports) asynchronous serial line interface between the LSI-11 Q-Bus and other devices. Port 1 is used to interface with the front control panel. Port 2 connects the LSI-11/23 with a remote serial interface. Port 3 and 4 are for use with auxiliary serial interfaces and are spares for customer selected expansion. The interface receives parallel data from the Q-bus, converts it to a serial word and transmits to the peripheral device. It will also receive serial data and convert it to parallel data to be sent to the central processor, LSI-11/23.

1.4.1.6 Control Panel Boards 1 and 2. Operator control and selected inputs can be accomplished with the pushbutton switches located on the control panel. There are 79 dedicated switch locations and an additional 22 available for future expansion (total 101). Fourteen LED indicators provide mode and entry verification and cursor status. A tone generator and speaker provide 15 different tones alerting the user to the status of the inputs. When a selection is entered (a pushbutton is pressed) the data is immediately transmitted serially via the serial interface board to the LSI-11/23 processor.

1.4.1.7 2501 CPU Board. The 2501 microprocessor is a special purpose, high speed computer constructed from approximately 140 integrated circuits (some of which are located on the PROM board). The microprocessor has 32-bit wide instruction paths and 16-bit wide data paths. The instructions are stored in PROM and typically take approximately 300 nanoseconds to execute.

The basic arithmetic capability of the microprocessor is contained within a 4-chip LSI arithmetic unit, Am2901. The CPU contains a scratchpad and stack memory consisting of 256-words by 16-bits addressable in several modes. The 256-word memory is used to provide a fast storage supplement to that included in the Am2901 unit.

The CPU also has a dedicated hardware stack (16 levels deep) that is used to supplement subroutine calls, returns, and interrupts.

Additional devices are interfaced to the microprocessor by the use of a general purpose, high speed microprocessor bus.

1.4.1.8 PROM Board. The PROM board contains the microinstructions that are read out and executed by the 2501 microprocessor. The PROM board also contains the scratchpad memory, real time clock, and fractional multiplier.

The scratchpad memory is 256 words x 16 bits and is actually part of the microprocessor but is located on the PROM board for ease of layout. See paragraph 1.4.1.7.

1.4.1.9 Memory Controller Board. The memory controller contains the logic necessary to sequence memory accesses among three ports. These ports are provided for the LSI-11/23 processor, 2501 microprocessor, and the analog input FIFO port.

The memory controller arbitrates the priority given to the three ports. FIFO status affects the priority structure in that if the FIFO is 1/2 full it will be given service priority.

The memory controller board also contains a Q-bus slave and interrupt vector interface. This allows the microprocessor to interrupt the LSI-11/23 and act as a slave for three sets of Q-bus hardware I/O page addresses. This is used to emulate Q-bus devices.

1.4.1.10 Unibus Memory Board. The main memory is a 256 kilobyte add-in MOS memory. Optional memory expansion is provided by replacing this board with a 1.0 megabyte MOS memory board.

Access to the Unibus memory is governed by the memory controller (which provides 21-bits of address) and it alone communicates directly with the memory using the pseudo-unibus lines. This allows use of higher data rate Unibus memory on a Q-bus based system.

1.4.1.11 Utility Board. This board contains an arithmetic booster, and test signal generator and interfaces with the 2501 microprocessor.

The booster processor enhances the speed of multiply/accumulate operations in windowing, filtering, and FFT calculations and performs the necessary arithmetic calculations in conjunction with the microprocessor.

The test signal generator is designed to generate sine wave and random signals. The generated test signal output is available at the front panel BNC connector.

1.4.1.12 25 kHz Channel Board. The standard 2515 system contains four 25 kilohertz channels (on one 6-wide board) and is expandable up to 16-channels (four 6-wide boards, each containing four channels).

The channel board acquires analog signals and processes them with a combination of analog and digital filtering under the direction of the channel control board.

The basic sampling rate for the 25 kHz system is 65.536 kHz which is a 15.25 microsecond interval. Each board is capable of processing four baseband channels or two Zoom channels during one 15.25 microsecond interval. On each channel board, three distinct processes happen concurrently under direction of the channel control board.

1) Simultaneous sampling of all channels and sequential analog to digital conversion of four channels per board;

2) Multiplication of analog/digital results by a cissoid (Zoom) or constant (Baseband);

3) Digital filtering of the multiplier output with a cascade of decimate-by-two filters.

1.4.1.13 Channel Control Board. The control board provides the necessary timing and data buffering for up to four 25 kilohertz channel boards.

The control board is interfaced with the CPU board via the microprocessor bus and to an access port on the memory controller board. Communication with each channel board is accomplished by a common channel bus.

Channel board filtering computations are sequenced and in step under direction of the control board. Results of the calculations are transmitted to the control board which stores them into memory. Selected data goes to the FIFO to be output to memory along with trigger status information. Overload conditions are also sent to the control board for access by the 2501 microprocessor.

1.4.1.14 Medium Resolution Display Board. The display board provides the interface between the 2501 microprocessor, the keyboard, the line printer, the vector generator and the associated display. The board includes a bidirectional serial TTL keyboard interface which can be optionally converted to parallel by the addition of one integrated circuit. It also includes a compatible printer interface.

The display format is 640 horizontal by 480 vertical pixels. Individual pixels may be read or written by the 2501 microprocessor. On command, hardware scrolling provides the capability of moving the display up or down two or more scan lines.

The display memory comprises two frame buffers, separately accessed and displayed, to improve animated displays. An additional mode, SUPERMODE, allows superimposing both frame buffers on the CRT.

Video output is standard TV (RS-170) capable of driving a 75 ohm line. Additional TTL level horizontal and vertical sync outputs are provided. The vertical rate, 50 or 60 Hz, is selectable.

The keyboard interface performs all the receiving and transmitting functions (serial and parallel) between the 2501 microprocessor and the keyboard.

The printer interface allows the 2501 microprocessor to transmit 8 bits of parallel data and a strobe to the printer and also receive status back from the printer.

1.4.1.15 **Power Supply.** The power supply provides four outputs of +5V, +12V, +15V, and -15V. Input voltage is 115/230 VAC, 50-60 Hz, and is switch selectable. Additional AC line filtering is provided by a 10 amp line filter.

1.4.1.16 **Display Monitor (CRT).** A 7" display monitor is integrated into the standard 2515 system.

1.4.1.17 **Expansion Slots.** There are three 2-wide expansion slots which can be used for Q-bus options. There are also three 6-wide slots which will allow the expansion to 16 channels. The slots are configured for three additional 25 kilohertz boards.

1.5 SOFTWARE SUPPLIED

All panel program operating software is pre-installed and ready to run on the internal Winchester disk drive. The following software is supplied on floppies:

1 ea.	2515-0605	RT-11 Runtime System
1 ea.	2515-0650	RTA Real Time Analyzer
2 ea.	2515-0690	XXDP Diagnostics
1 ea.	2515-0691	RT-11 Diagnostics

1.6 OPTIONS AND ACCESSORIES

Several hardware options and accessories are available for system expansion and general use.

2515-9400	Rack Mount Kit
2515-9401	Channels 5-8 (with 16 ch. BNC box)
2515-9402	Additional Four (4) Input Channels
2515-9503	Large Screen Monitor
2515-9404	Extended Memory, 1 Mbyte total
2515-9405	Dual 8" Floppy Disk Drive
2515-9407, -9408	Shipping Cases
2515-9415	Digital Tracking Synthesizer (SPIN)
2515-9427	Accoustic Probe Kit (INTEN)
2515-9431	Printer/Plotter
2515-95XX	Scanner

Although printer paper, floppy diskettes, and ink cartridges are available from GenRad; HP92261A paper or equivalent, CDC 429 diskettes or equivalent and 51630A ink cartridges or equivalent can be used. For specific installation instructions for optional equipment, refer to Section II, paragraph 2.12.

Software and communication options are also available:

2515-9426	INTEN II
2515-9430	Ethernet Link
2515-9444, -9452	DataLink
2515-9450	TSL2
2515-9451	FORTRAN Toolkit
2515-9453	MODAL Plus
2515-9460	SPIN
2515-9469	IEEE Link

A GenRad representitive can provide detailed information and assistance in selecting these and additional system options.

1.7 CONTROLS, INDICATORS, AND CONNECTORS

Figures 1-2 and 1-3 and tables 1-2 and 1-3 summarize the functions of visible controls and connectors. Additional details on menu operations and connector wiring and functions are given in Sections II and III. The pushbuttons are only active when a program (such as RTA) that supports the use of the panel is being executed. Figure 1-4 illustrates the keyboard. Operation from the keyboard is discussed in Section III, paragraph 3.3.

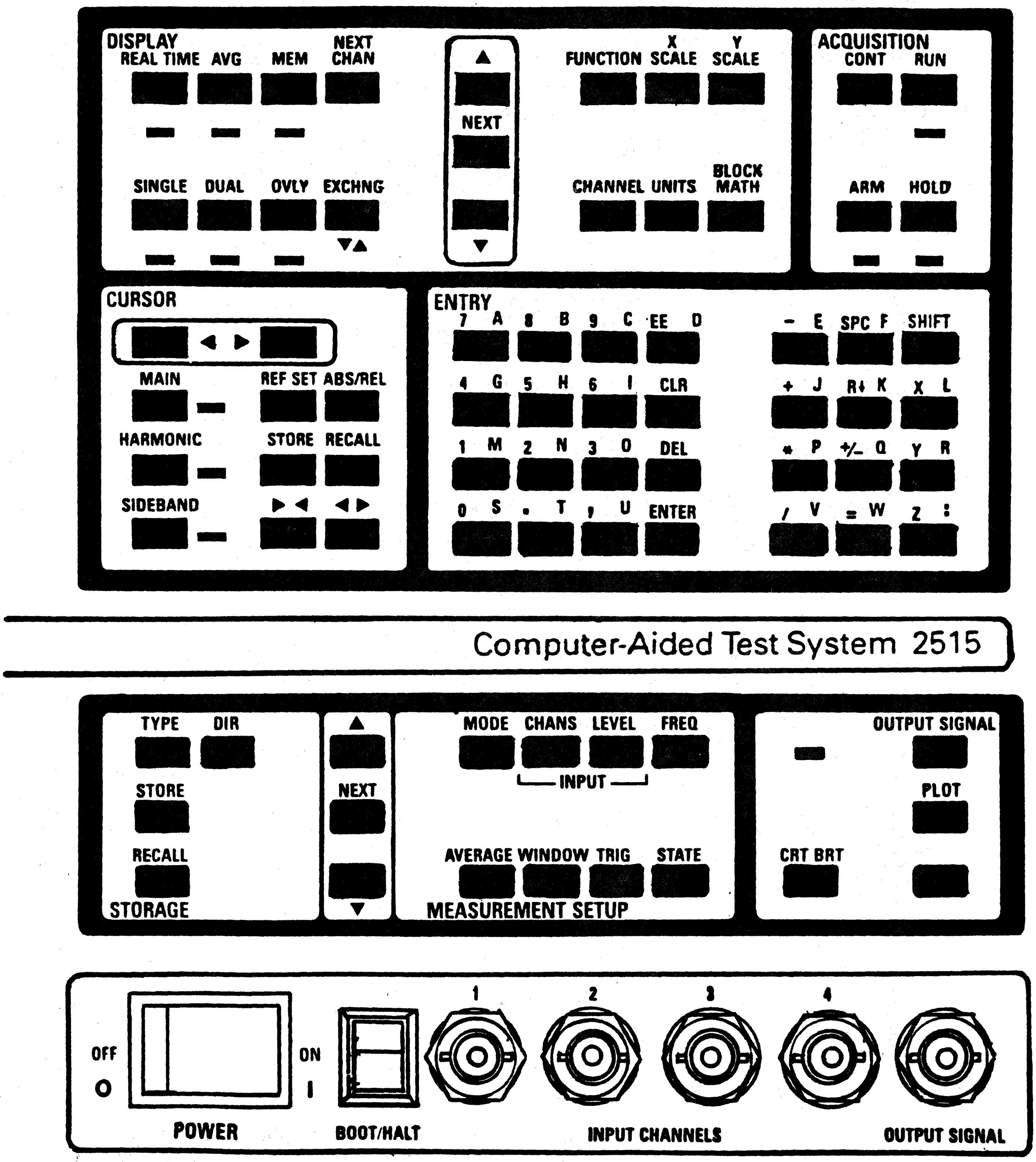


Figure 1-2. Front Panel Controls, Indicators, and Connectors

Table 1-2. Front Panel Controls, Indicators, and Connectors

Types: Immediate — causes an action
Menu — presents a menu of one or more pages for selection of functions
Entry -- requests or allows an alphanumeric entry

Name	Type	Function
DISPLAY Group		
REAL TIME	Immed	Displays instantaneous function of current input frame. FUNCTION menu provides choice of time domain, spectrum, all-channel levels, or orbit diagram of two channels.
AVG	Immed	Displays averaged auto or cross spectra, or functions computed from them as specified under FUNCTION.
MEM	Immed	Displays data retrieved from storage by the most recent RECALL.
NEXT CHAN	Immed	Sequences displays through the list of currently active channels or channel pairs for cross-channel functions.
SINGLE	Immed	Gives full screen to one display; allows presentation of setup summary on top two lines.
DUAL	Immed	Presents dual display (upper and lower) of two functions. Suppresses setup summary to allow room for both.
OVLY	Immed	Presents dual display of "lower" function overlaid on full grid and "upper" function, provided that the two displays are compatible.
EXCHNG	Immed	Exchanges upper and lower displays. Only the upper display is accessible for modification by other DISPLAY group functions.
NEXT	Immed	Turns "pages" to proceed through menus. NEXT also causes ENTER if there is a menu selection or an alphanumeric entry pending.
Δ (UP) ∇ (DOWN)	Immed	Move pointer to make menu selections or adjusts input channel level setting or Y axis scaling when no menu is present on the display.
FUNCTION	Menu	Presents menus for choices of function to be displayed and for complex fun tions the plotting format. Menus and available functions vary depending on current selections of auto or cross-channel mode, real time or averaged display, and mode of averaging in time or frequency domain.

Table 1-2. Front Panel Controls, Indicators, and Connectors (Continued)

Name	Type	Function
X SCALE	Menu	Presents menus for choices of X axis scale: linear or logarithmic, automatic or specified expansion, frequency scale in Hertz or cycles per minute or orders for rotating machinery.
Y SCALE	Menu	Presents menus for choices of Y axis scales: linear or logarithmic, automatic or expanded over specified ranges of values or decibel, and allows blanking of frequency response data (transfer function only) with coherence less than a specified level.
CHANNEL	Entry	Presents a prompt for entry of the number of the channel to be displayed, or a pair of channel numbers for cross-channel functions.
UNITS	Menu/ Entry	Presents menus for selection of units and normalization of units for Y axis of display. Provides choice of volts or user-specified engineering units, or dB units relative to either. Allows normalization of units to present readout in linear amplitude (units), power (units squared), power spectral density (units squared/Hz), or energy density (units squared seconds/Hz).
BLOCK MATH	Menu/ Entry	Provides access to arithmetic operations that may be performed on a spectrum or between two spectra. Includes add, subtract, multiply, divide, integrate, and differentiate. (This function is not presently implemented.)
ACQUISITION Group		
RUN	Immed	Starts and stops averaging accumulations. Press to start, press to stop and hold. Clears current average on start.
CONT	Immed	Continue an averaging run after stop. Does not clear average. In manual acceptance mode, indicates current frame is to be included.
ARM	Immed	Arms the trigger in manual mode. Indicator lights when trigger is armed, goes out when trigger event occurs.
HOLD	Indic	Lights when a new input frame is available. In manual acceptance mode, pressing the HOLD button rejects this frame. (Press CONT to accept the frame.)

Table 1-2. Front Panel Controls, Indicators, and Connectors (Continued)

Name	Type	Function
CURSOR Group		
< (left) > (right)	Immed	Moves main cursor. Cursor may also be initially positioned by pressing SINGLE and immediately ENTERing a numerical value for desired position entry.
MAIN	Immed	Turns off HARMONIC or SIDEBAND and prompts user for main cursor position.
HARMONIC	Immed	Displays additional cursor lines at harmonics of the main cursor frequency.
SIDEBAND	Immed	Displays additional cursor lines above and below the main cursor frequency to locate sidebands. Sideband cursors are spread or closed by the associated arrow buttons.
REF SET	Immed	Fixes a reference cursor at current location of main cursor. The ABS/REL function may be used to obtain cursor readout as ratios or differences between the main and reference cursors.
ABS/REL	Immed	When reference cursor is set, this function switches cursor readout between absolute values for main cursor or relative values between main and reference.
STORE	Entry	Stores current location of cursor for later recall. Up to 10 cursors may be stored, identified by reference numbers ENTER'ed after the STORE button is pressed.
RECALL	Entry	Restores a stored cursor, identified by number, to the display.
> < (dec) < > (inc)	Immed	Used to decrease and increase the sideband delta frequency during sideband cursor mode.
ENTRY Group		These buttons are used for alphanumeric entries and for arithmetic operations.
STORAGE Group		
TYPE	Menu/ Entry	Begins sequence of menus to create or open disk files, specify plotter setups, and select certain modes of operation. Also provides function deletion capability.
DIR	Menu/ Entry	Prints listings of records contained in the open file or in temporary storage memory buffers.

Table 1-2. Front Panel Controls, Indicators, and Connectors (Continued)

Name	Type	Function
STORE	Menu	Requests storage record identification and executes storage of AVG data.
RECALL	Entry	Requests entry of desired record identification and executes recall to MEM.
MEASUREMENT SETUP Group		
MODE	Menu	Selects basic operating mode of the system as follows: Auto-channel for individual channel operation; Cross-channel for reference-response pairs; Probability analysis; Exits program to Modal analysis (load MODAL software); Exits program to RT-11 operating system for file management.
CHANS	Menu	Presents tabular menu to select channels or cross-channel pairs to be active.
LEVEL	Menu	Presents menu for selection or entry of channel setup specifications such as: Full scale level for input; Channel coordinate (for use with MODAL program); Calibration factor for engineering units; AC/DC coupling; Channel label for displays.
FREQ	Menu	Presents menus for specification of frequency range (baseband or passband range), and resolution in terms of number of frequency lines.
AVERAGE	Menu	Presents menus to select averaging domain (time or frequency), mode (summation, subtraction, exponential discount, or peak hold), and number of frames to be processed. Includes specification of the frame acceptance mode for averaging: accept every frame, manual acceptance from HOLD, auto-reject of frames that do not meet certain conditions. Also controls pre-average auto ranging.
WINDOW	Menu	Presents menus for selection and specification of weighting windows to be applied to input frames, such as Hanning and impact response weighting.
TRIG	Menu	Presents menus for selection of triggering mode, source, level, slope, and delay.

Table 1-2. Front Panel Controls, Indicators, and Connectors (Continued)

Name	Type	Function
STATE	Print	Presents four-page printout of current status, including measurement setup, storage setup, upper and lower display setup. The state display begins with the most recently modified page and can be advanced to the other pages with the NEXT key.
MISCELLANEOUS		
CRT BRT		Increases CRT brightness in steps. The brightness can also be adjusted by using the keyboard SETUP key and keyboard UP-DOWN arrow keys.
OUTPUT SIGNAL		Presents sequence of menus to select sine wave or noise outputs and specify frequency and levels.
PLOT		Initiates output to thermal printer/plotter or optional digital plotters depending on STORAGE type plotter setup. (Not labeled on panel. First button below the OUTPUT SIGNAL button at lower right.)
BOOT/HALT		Manual boot if screen remains blank or system halts; automatically boots to RT-11 on power up. Push switch up to BOOT, down to HALT.
ON-OFF		Power switch, allows source voltage to be applied to or removed from system. Used to reinitialize system in event BOOT/HALT does not correct blank screen or system halt.
INPUT CHANNELS A, B, C, D	BNC Recept	Input channels 1 through 4, ±8 V peak maximum for calibrated analysis.
OUTPUT SIGNAL	BNC Recept	Sine wave or noise generator output.

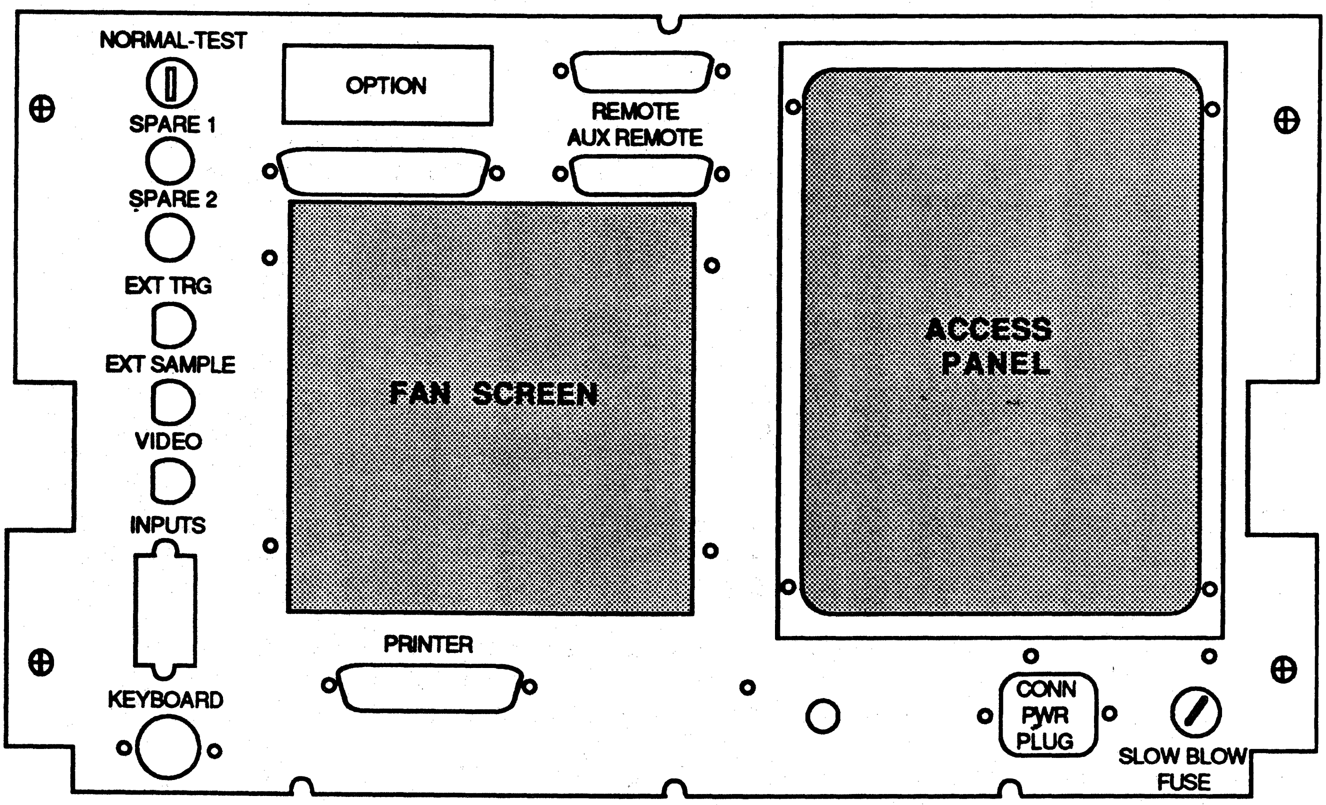


Figure 1-3. Rear Panel

Table 1-3. Rear Panel Connectors

Name	Type	Function
INPUTS	Coax	Channels 1 through 16 inputs, ±8 V peak maximum for calibrated analysis.
KEYBOARD	5-pin Recept	Mates with keyboard jack.
VIDEO	BNC Recept	Composite video output for external large-screen display monitor.
EXT SAMP	BNC Recept	Input for externally supplied sampling rate clock. TTL level, 0 to + 5 V maximum, 65,536 Hz maximum.
EXT TRIG	BNC Recept	Input for externally supplied digital trigger. TTL level, 0 to +5 V maximum.
FLOPPY DISK	50-pin	Mates with floppy disk drive cable.
REMOTE	25-pin	RS-232 port to LSI-11 bus (one channel, normally used for DATALINK remote file transfer).
AUX REMOTE	25-pin	RS-232 port to LSI-11 (two channels, one normally used for optional digital plotter, one spare).
PRINTER	36-pin	Mates with cable from thermal printer used for screen copy function.
OPTION	Blank	Reserved for additional option cabling.
120 V 220-240 V	3-cond	Power cord receptacle.

On the 2515 there are three RS-232 ports available: Ports 2, 3, and 4 that are labeled REMOTE for port 2 and AUX REMOTE for ports 3 and 4. Ports 3 and 4 are combined in the AUX REMOTE port. Port 1 is used for the front panel and is not accessible. The base address is 175640, and the vector is 340 for the interface. Refer to the table below.

PORT #	**ADDRESS**	**VECTOR**	**BAUD**	**RECOMMENDED USE**
PORT 1	175640	340	300	FRONT PANEL (ONLY)
PORT 2	175650	350	9600	DATALINK
PORT 3	175660	360	1200	DIGITAL PLOTTER
PORT 4	175670	370	300	UNRESERVED

REMOTE PORT PIN ASSIGNMENT

(PORT 2)

```
-< 4  <-- REQUEST TO SEND
-< 6  <-- DATA SET READY
-< 20 <-- DATA TERMINAL READY
-< 3  <-- RECEIVED DATA
-< 2  <-- TRANSMITTED DATA
-< 7  <-- SIGNAL GROUND
-< 1  <-- PROTECTIVE GROUND
```

AUX REMOTE PORT PIN ASSIGNMENTS

(PORT 3)

```
-< 4  <-- REQUEST TO SEND
-< 6  <-- DATA SET READY
-< 20 <-- DATA TERMINAL READY
-< 3  <-- RECEIVED DATA
-< 2  <-- TRANSMITTED DATA
-< 7  <-- SIGNAL GROUND
-< 1  <-- PROTECTIVE GROUND
```

(PORT 4)

```
-< 19 <-- REQUEST TO SEND
-< 25 <-- DATA SET READY
-< 18 <-- DATA TERMINAL READY
-< 16 <-- RECEIVED DATA
-< 14 <-- TRANSMITTED DATA
-< 7  <-- SIGNAL GROUND
-< 1  <-- PROTECTIVE GROUND
```

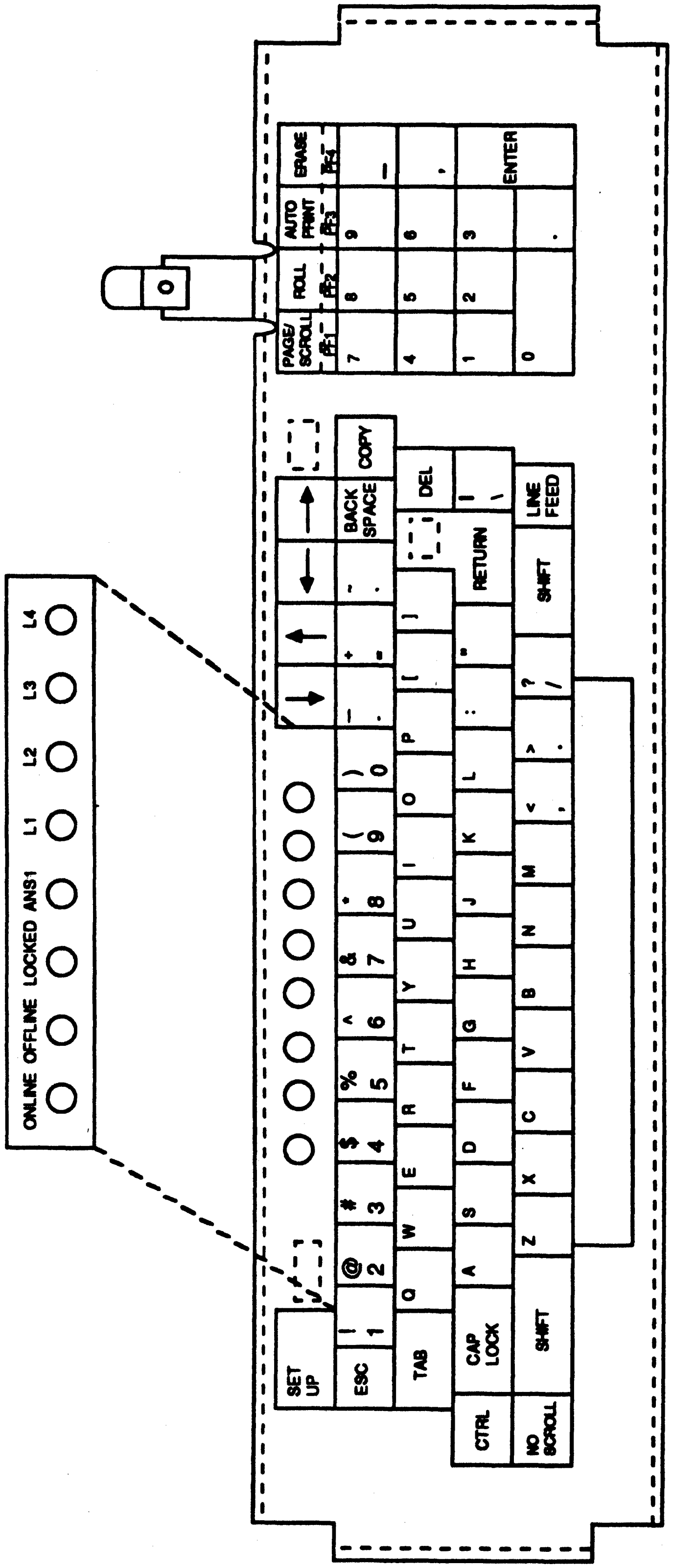


Figure 1-4. Keyboard

Table 1-4. Keyboard Special Function Keys

Name	Function
SETUP	Rolls screen up for two lines of special setup functions described in Section III. Also rolls screen back down.
COPY	Initiates output to thermal plotter-printer for screen copy. Not for optional digital plotters.
PAGE/ SCROLL (PF1)	Toggles display into PAGE mode where output is stopped when screen is full, or into SCROLL mode where old output is scrolled off the top of the screen as new output is added at the bottom. In PAGE mode, use ROLL or ERASE to continue. Intended for operating system use, not for RTA program.
ROLL (PF2)	Scrolls display up by six alphanumeric lines to allow continued output. For operating system use, not RTA analyzer program.
AUTO PRINT (PF3)	Toggles on/off. When on, the thermal plotter-printer copies alphanumeric information as it appears on the screen. For operating system use, not 2515 analyzer program.
ERASE (PF4)	Erases entire display.

1.8 PREVENTIVE MAINTENANCE

The air filters are the only components within the system requiring periodic preventive maintenance. These are located on the underside of the system. To clean the filters, remove the cover plate and pull the filters out. The filters may be vacuumed or washed with mild detergent to remove accumulated dust. Be certain to replace the filters with the arrow on the outside edge pointing in the proper direction: small filter air flow toward center; and large filter air flow toward rear of system. The filters should be checked at six month intervals.

SECTION II

INSTALLATION AND CHECKOUT TEST

This section provides instructions for installation, and a checkout test procedure to verify proper operation. The checkout test also serves as an introduction to acquaint new users with basic operation and to demonstrate some of the functions and features of the system.

2.1 WARRANTY CONSIDERATIONS

Installation and acceptance of the 2515 system are performed by the customer unless otherwise arranged in the terms of the sale. If GenRad Sales and Service is not notified to the contrary, acceptance, for the purpose of beginning the warranty period, will be assumed to occur 14 days after shipment (30 days after for international shipments). It is the customers' responsibility to perform the installation and checkout procedures in this section to verify proper operation as soon as possible after receipt of the equipment.

2.2 INITIAL INSPECTION

If there is any evident damage to shipping containers, request the carrier's agent to be present during unpacking. Inspect the cushioning materials for any signs of shipping damage. Unpack the equipment carefully and inspect the exterior for mechanical damage. If there is any damage or if the equipment fails to meet the operational test in this section or electrical specifications, notify the nearest GenRad Sales and Service field office immediately, and notify the carrier if applicable.

NOTE

> Save the shipping containers and packing material for future use if it should become necessary to return the equipment to a GenRad service depot for repair.

2.3 LOCATION

The 2515 is intended to be mounted on a sturdy bench or table. (An optional rack mounting kit is available.) Two to three inches of space must be allowed at the rear for cable access and free air circulation. The peripheral units may be located anywhere within cable reach of the main cabinet. The main cabinet unit weighs approximately 70 pounds (35.1 kg). For overall dimensions of the principal units refer to Table 1-1.

2.4 RACK MOUNTING

Instructions for rack mounting are supplied with the optional rack mounting kit.

2.5 ENVIRONMENT

For environmental requirements refer to Table 1-1.

2.6 LINE POWER REQUIREMENTS

The 2515 requires either of the following power sources:

110V nominal:	95V min to 132V max
220 or 240V nominal:	190V min to 260V max

Frequency: 47 to 63 Hz

Power: 650 watts, standard system
800 watts, fully loaded system

All units are grounded through their three-conductor power cords. No external grounding connections are required.

WARNING

The power source must be adequately grounded in accordance with international safety standards and equipped with a three-conductor grounding receptacle.

2.7 SETTING THE POWER SUPPLY FOR LINE VOLTAGE

The system is designed to operate at 120 VAC nominal or 220 and 240 VAC nominal. Power setting will normally be performed prior to shipment according to destination. If after installation, should on site power requirements change the following steps are to be followed:

2.7.1 2515 Main Chassis Unit

Step 1. Switch power ON/OFF switch to OFF.

Step 2. Disconnect power cable from ac power source.

Step 3. Remove 6 socket-head screws from sides of top cover and carefully lift cover off unit.

Step 4. Looking from the rear, on right side of power supply enclosure, locate small rectangular opening. Visually inspect interior switch.

Step 5. Using a ¼" flat screwdriver, push switch up for 220-240V; push switch down for 120V.

Step 6. On rear panel, install fuse of appropriate rating: 120V, 8A slo blow, or 220V, 4A slo-blow.

Step 7. On rear panel locate the 120V versus 220-240V label and remove the two retaining screws.

Step 8. With new voltage setting facing outward, re-attach label.

Step 9. Replace cover and 6 screws.

Step 10. Before unit is connected to ac power source, be certain power cable plug is changed to accommodate the voltage setting.

2.7.2 Switch Settings For Optional Printer/Plotter

Printer/Plotter option is shipped with a separate power module for either 110 or 220 volt operation and cannot be changed.

2.8 FLOPPY PREPARATION

(1) The floppy disk drive is shipped with a cardboard card inserted in the disk slot to prevent motion of the heads and internal parts. Remove this card before powering up the unit.

CAUTION

Save this card and reinsert it before shipping the unit or transporting it to other locations.

NOTE: Brand new floppy diskettes must be hardware-formatted and then initialized for the RT-11 operating system before they can be used. Refer to the RT-11 instructions in Section IV for these procedures.

(2) To load paper in the optional thermal printer refer to the instruction manual supplied with the equipment or the instructions printed on the packaged paper.

2.9 UNIT INTERCONNECTIONS

All connections for auxiliary units are made at the rear panel. All connections are clearly marked for their associated units and none of the connectors are identical except for REMOTE and AUX REMOTE which carry the RS-232 serial line interface ports. (Note that the REMOTE connector is wired for only one port (number 2), whereas AUX REMOTE provides two ports (numbers 3 and 4). Port number 1 on the internal four-port interface board is used by the front panel.) Figure 2-1 shows the connections to be made for the standard external units and common options.

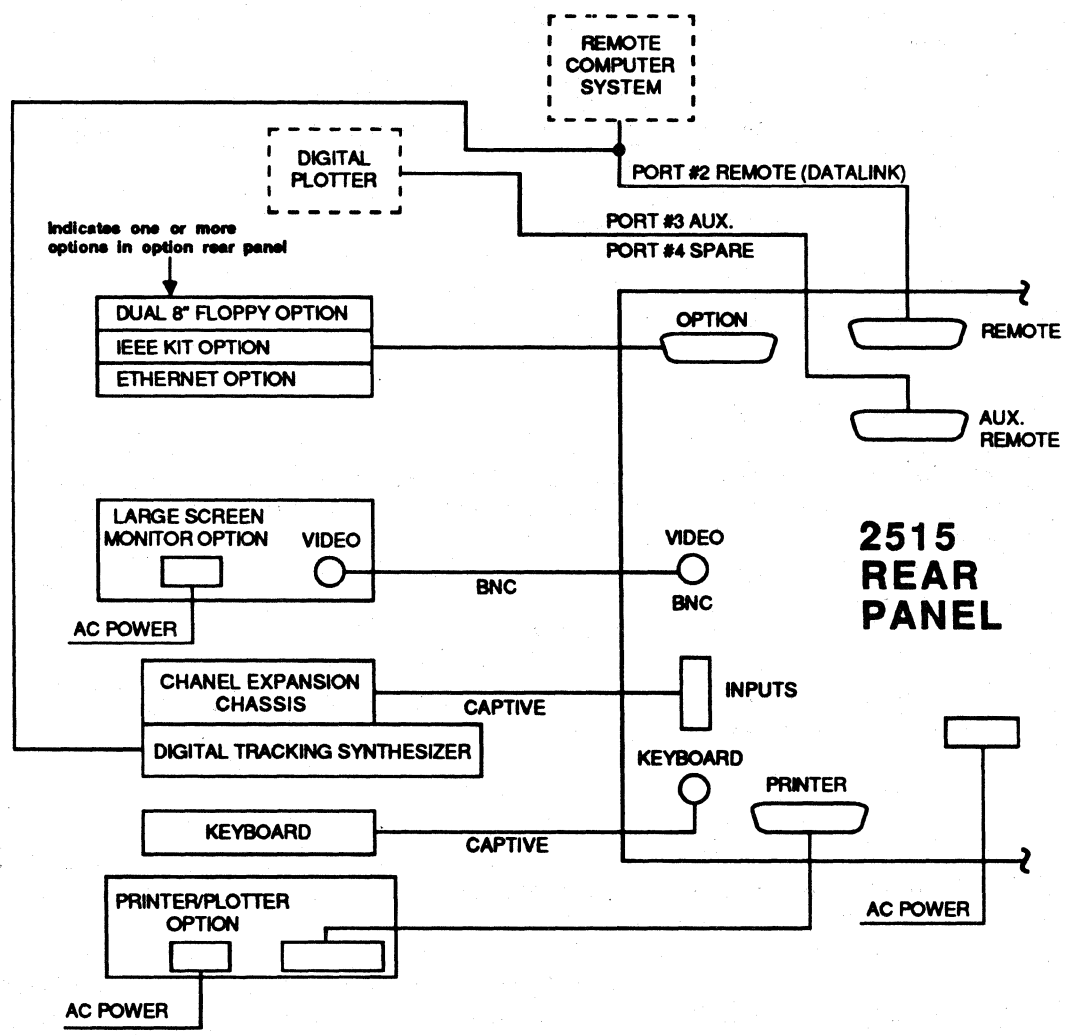


Figure 2-1. Unit Interconnections

2.10 SIGNAL CONNECTIONS

Input signals for the first four (standard) input channels are made through the front panel BNC connectors.

For more than four channels, the channels 5-8 option includes an external BNC connector panel chassis, with captive cable and connector for connection to the rear panel INPUTS connector as shown in figure 2-1.

Output from the internal sine wave and noise generator is supplied at a front panel BNC (OUTPUT SIGNAL).

Input connections for an external trigger pulse or an external sampling rate clock are made at the rear panel BNC's. Both of these inputs are applied to TTL circuitry and levels should be limited between 0 and +5 volts.

2.11 TEST AND FAMILIARIZATION PROCEDURE

The checkout test is performed in seven stages. Except for recall of the stored transfer function (which is tested later), stages 1-5 exercise most of the system hardware and, if successfully passed, give a good indication that the system software and hardware are operating properly. The remainder of this procedure is primarily exercises for new users to demonstrate typical procedures and some of the additional functions. These stages are as follows:

Stage 1. Power up and start up procedures to run the data acquisition (i.e., the panel) program are performed.

Stage 2. Recall a stored panel setup that is provided on the disk specifically for this test procedure. (Reference paragraph 2.11.4) This demonstrates the setup storage and recall feature and the STATE function summary of the setup. This quickly provides a known starting point for the first test.

Stage 3. Set up an output signal to be used as the input to both the reference and response channels. This demonstrates the output signal function and provides a known test signal without requiring the support or calibration of external equipment. (Reference paragraph 2.11.5.)

Stage 4. Execute a cross-channel analysis operation and average, and examine the transfer function result to verify proper operation of the arithmetic hardware and demonstrate some display function. (Reference paragraphs 2.11.6, .7, and .8.)

Stage 5. Store the transfer function result in a disk file. This demonstrates the basic procedure to open a file and tests that the system can write to the floppy disk hardware. (Reference paragraph 2.11.9.)

Stage 6. Change the setup. This demonstrates the typical measurement setup procedure, from beginning to end, to setup for measurement of a transfer function. It also exercises the other two input channels in the standard system. (Reference paragraph 2.11.10.)

Stage 7. Recall the stored transfer function. This demonstrates that the system can read from the disk, and illustrates the operation of the MEMory display functions. (Reference paragraph 2.11.11.)

The following paragraphs provide step-by-step procedures to check the system for proper operation, accompanied by descriptions for new users to demonstrate the basic operating rules and to exercise several of the system functions and features.

For use as a test procedure, all actions required by the user, such as buttons to be pressed or menu selections to be made, are printed in bold-face type for quick reference. To perform the test, just execute the required actions and check the resulting displays against the accompanying pictures or the described indications.

For new users, the procedural steps include a brief description of the operation being performed, indicating what is intended and what is happening. This procedure demonstrates basic operations as an introduction to the complete detailed descriptions in the later sections.

2.11.1 Test Equipment Required

These procedures use the built-in sine wave and noise generator output signals for test and calibration. The only equipment required is two BNC-to-BNC patch cables and a BNC tee connector.

2.11.2 Test Connections

Use the two BNC-to-BNC patch cables and tee connector to connect the front panel OUTPUT SIGNAL to front panel INPUT CHANNELS 1, the reference channel, and 2, the response channel.

2.11.3 Power-up and Program Start (Stage 1)

Step 1. **Set the POWER switch ON.** The system will take about 10 seconds to start the disk, execute a brief basic self-test diagnostic, and call the hardware bootstrap loader program. As the display CRT warms up, you will see a display similar to the following:

```
                        000021

                        000000

                        177760

                        177760

                        000001

                        000000



DEV>
```

The 6-digit numbers are the result of the microcode start-up diagnostic. The last number is the number of tests failed and should be 000000. "DEV> " is a prompt from the hardware bootstrap loader to enter the code for the device on which the system software is resident.

Step 2. **Press the RETURN key on the keyboard.** This is a default response to the DEV> prompt, telling the system to boot from the default device which is device DL0: (Note: You can boot from other devices as described in Section III.) If you do not respond (with a carriage return (CR)) to the DEV prompt, the system will automatically boot DL0 in about 1-½ minutes.

The hardware loader will load and start the RT-11 operating system monitor, which in turn will execute a brief startup program that sets default devices or default program names for the system (e.g., .SET TT SCOPE) and then stops with a request for entry of the date and time such as follows:

```
 DEV>
RT-11SJ(GR0)V05.00
█

2515 System
Prom Revision - 1-Nov-83
Channels - 1-4
Memory Size:  128k Words
18-Jan-84  Change Date? --->
```

Step 3. Change Date? **Enter today's date** from the keyboard. The format for changing the date is as follows:

(CR):	Accept the current date as printed.
23(CR):	To change the day only.
19-Jan(CR):	To change the day and month only.
3-Jan-83(CR):	To change the complete date.

Step 4. Enter the time: **Press RETURN key** to omit the time. The format for entering the time (from the keyboard) is as follows:

HH:MM:SS

After date and time, the RT-11 monitor will return a prompting dot (.) indicating that it is ready for commands.

Step 5. Enter the command: **.R RTA (carriage RETURN).** R is a RUN command to the monitor. RTA is the file name of the 2515 panel program. It stands for Real Time Analyzer. The program will present a banner such as shown below for several seconds while it creates some "scratch" files that it uses for its own purposes.

GenRad

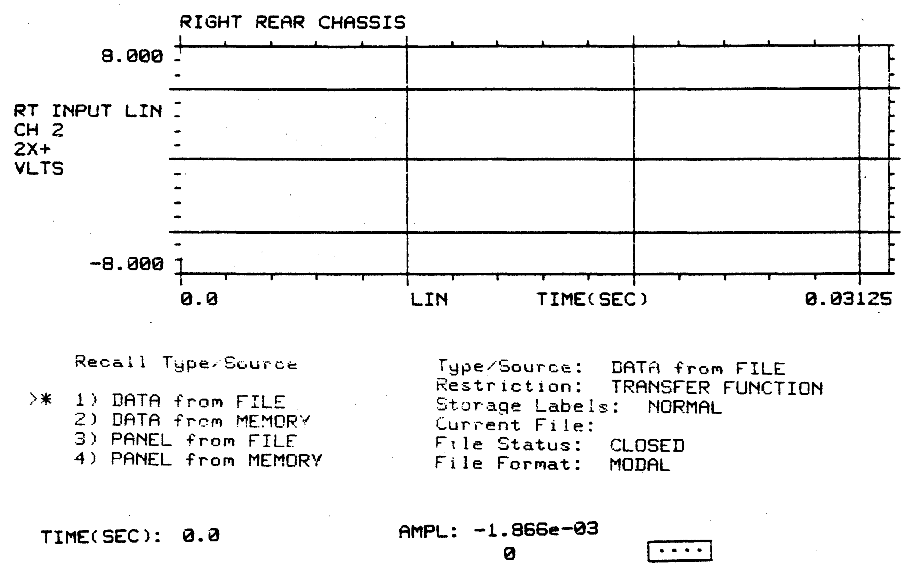
RTA Data Acquisition

Version X.X

The initial display is determined by the last panel setup. It is not significant for this procedure.

2.11.4 Load Stored Checkout Test Parameters (Stage 2)

Step 6. **Press the STORAGE RECALL button** at the lower left of the panel. The initial display will shrink to the upper half of the screen and the recall menu will appear as shown below:



The asterisk (*) at the left of the menu indicates the current selection. The pointer (>) is moved by the UP-DOWN arrow buttons to make a new selection. Note also the box containing four dots on the lower right. Each dot represents one channel and each box indicates one channel board (4 channels each) in the system.

Step 7. **Position the pointer at Panel from Memory,** using the UP-DOWN arrow buttons.

Step 8. **Press the ENTER button** (in the ENTRY group). The asterisk will move to indicate that the selection is now "PANEL from MEMORY", and this selection will be reflected in the summary list at the right of the screen.

NOTE: ENTER makes a selection without turning the menu page. The NEXT button also makes a selection the same as ENTER, but it also turns the menu page so you do not see the asterisk move. However, a NEXT selection will be reflected in the summary at the right.

Step 9. **Press the NEXT button** to turn the page for the following menu:

ENTER Memory Buffer #
* 0
> ___

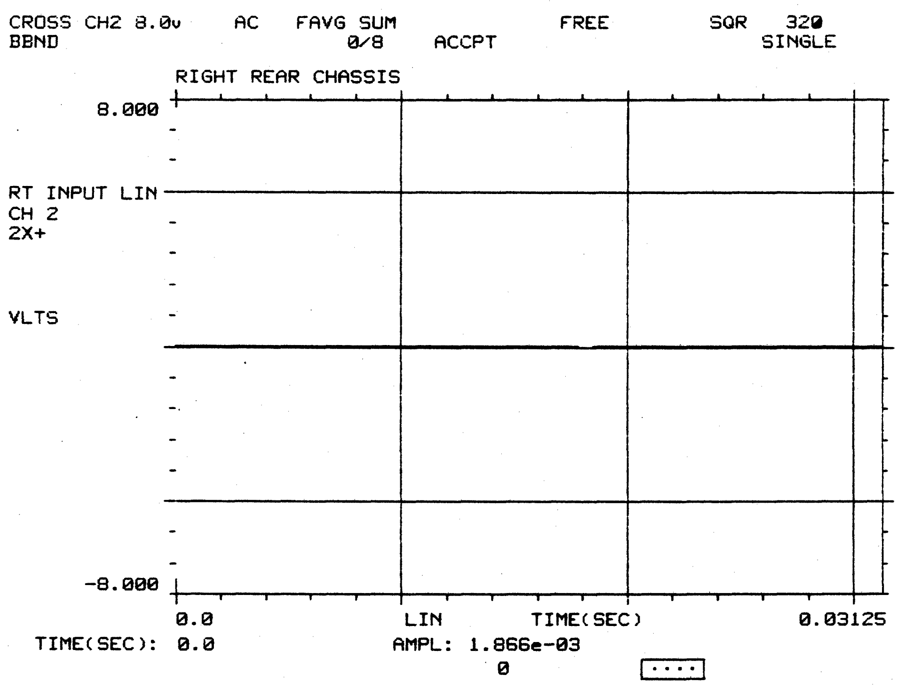
This is an entry-type menu. The asterisk indicates the current value, and the pointer is prompting for a new entry.

Step 10. In the ENTRY group, press:

0 ENTER

Panel Memory Buffer #0 contains the panel setup parameters for this checkout test, which take effect upon ENTER.

Step 11. **Press SINGLE.** This turns the final RECALL menu page and restores the full display, which should now appear as follows:



NOTE: The "missing" left edge line of the grid indicates that the cursor is there at time 0.0 seconds as indicated by the cursor readout line at the bottom of the screen.

2.11.5 Set Up Test Output Signal (Stage 3)

Step 12. Check that the front panel OUTPUT SIGNAL connector is connected to input CHANNEL 1 and 2.

Step 13. **Press the OUTPUT SIGNAL button.** The output signal menu will appear at lower left:

```
>*  1) OFF
    2) SINE WAVE
    3) RANDOM
```

Step 14. **Select RANDOM,** using UP-DOWN arrows, press ENTER.

Step 15. **Press NEXT** to make the selection and turn the page for the following menu:

ENTER the RMS Level of	Signal Level: 0.0
Output Signal	Output Signal: RANDOM
(0-1.0V) Random	Random Bandwidth: ACQUISITION
(0-4.5V) Sine	Random Type: NON-REPEATING
*0.0	Pattern #: 1
> ___	Burst Window: OFF

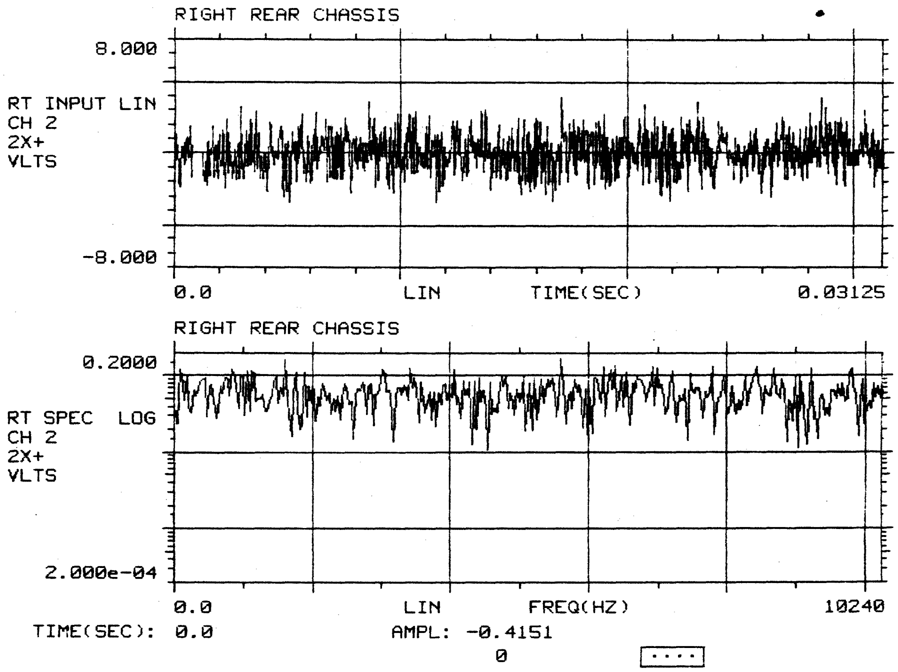
NOTE: Whenever the system is started, or a panel setup is recalled, the output signal level is not saved and is reset to 0.0 to avoid unexpected outputs that could damage connected external equipment.

Step 16. From the ENTRY group, enter the maximum value:

1.0 ENTER

The noise signal should appear in the upper display of Channel 2 input signal.

Step 17. **Press the DUAL button** in the DISPLAY group. The menu area will now be replaced by the "lower" display, which by startup default is the real-time, single-frame spectrum of the Channel 2 input. The display should now appear as follows:



NOTE: The spectrum display may occasionally be rescaled automatically to accommodate spikes in the changing spectrum. Scaling is described in subparagraphs 5.10.5 and 5.10.6.

2.11.6 Change Input Level and Test Overload (Stage 4)

When the upper display is a Real Time INPUT signal and there is no menu on the screen waiting for an input, the UP-DOWN arrow buttons may be used to change the maximum input level of the displayed channel directly, without going through the MEASUREMENT SETUP LEVEL button menus. Proceed as follows:

Step 18. **Press the DOWN-arrow button once.** Note that the upper (input) display range (and the maximum input level of the front end) change from ±8 V to ±4 V.

Step 19. **Press DOWN-arrow again.** Check that the range changes to ±2V and that there is an OVLD indication at lower right with a reverse video box in the channel 2 position. Note that channel 1, with the same input signal, does not overload, because its maximum input level has not been changed from the original ±8 V.

Step 20. **Press UP-arrow twice** to restore ±8 V range on channel 2.

2.11.7 Switch Displays and Compare Channels

Step 21. **Press NEXT CHAN** in the DISPLAY group. Both upper and lower displays will switch to channel 1, which should appear the same as channel 2 except for the channel number and MODAL coordinate (1X+) in the annotation at the left. (Channel 2 was first in this sequence because it is the first response channel.)

Step 22. **Press EXCHNG** in the DISPLAY group. The upper input and lower spectrum will swap positions.

Only the current upper display is accessible for modification by the panel controls.

Step 23. **Press CHANNEL** in the DISPLAY group. At the lower left in reverse video will appear the prompt:

Channel =

Step 24. In the ENTRY group, press:

2 ENTER

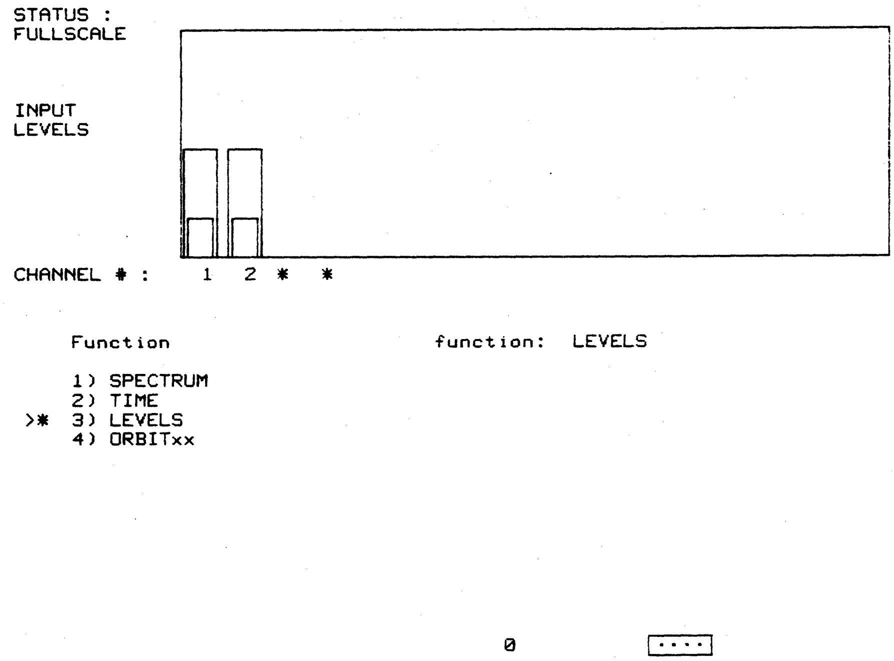
The CHANNEL button affects only the upper display, which should now be channel 2 spectrum.

Step 25. **Press the FUNCTION button.** The lower display will be replaced by the display function menu for REAL TIME displays:

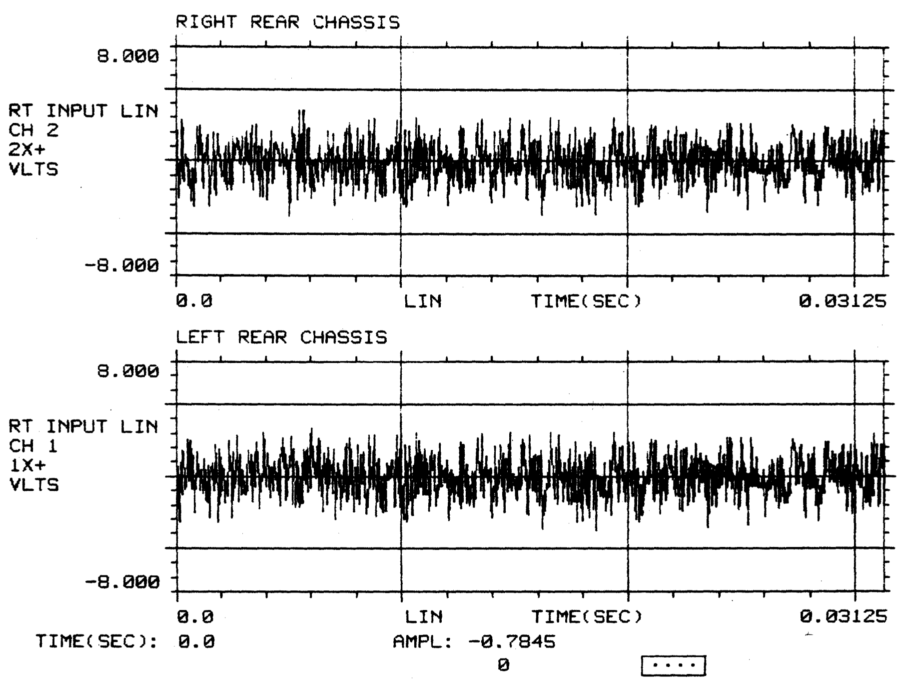
```
>*  1)  SPECTRUM
    2)  TIME
    3)  LEVELS
    4)  ORBIT
```

Step 26. **Select TIME and press ENTER.** Upper display is now channel 2 time domain input. FUNCTION menu remains in place of lower display.

Step 27. **Select LEVELS and press ENTER.** The levels display presents a bar chart of peak and rms levels for all active channels as shown below. Installed but inactive channels are indicated by asterisks.



Step 28. **Select TIME again and press NEXT.** This turns the last FUNCTION menu page and restores the DUAL display, which should be the identical noise input signal on channels 2 and 1:



2.11.8 Set Up Display and Run an Average for Transfer Function Measurement

Step 29. **Press AVG in the DISPLAY group.** Because no average has yet been run, the upper display will present the message:

AVERAGED FUNCTION IS NOT AVAILABLE

requested RESPONSE channel is 2

requested function: SPECTRUM

Step 30. **Press Y SCALE** in the DISPLAY group. The menu is:

1) LIN AUTO SCALE
2) LIN EXPAND
>* 3) LOG AUTO SCALE
4) LOG EXPAND

Step 31. **Select 3) LOG AUTO SCALE and press SINGLE** to make the entry and restore full screen display. The default AVG function display is the auto spectrum of the response channel. In the following step, observe the averaging count at the top and bottom of screen, and watch the "noise" spectrum flatten as more frames are averaged.

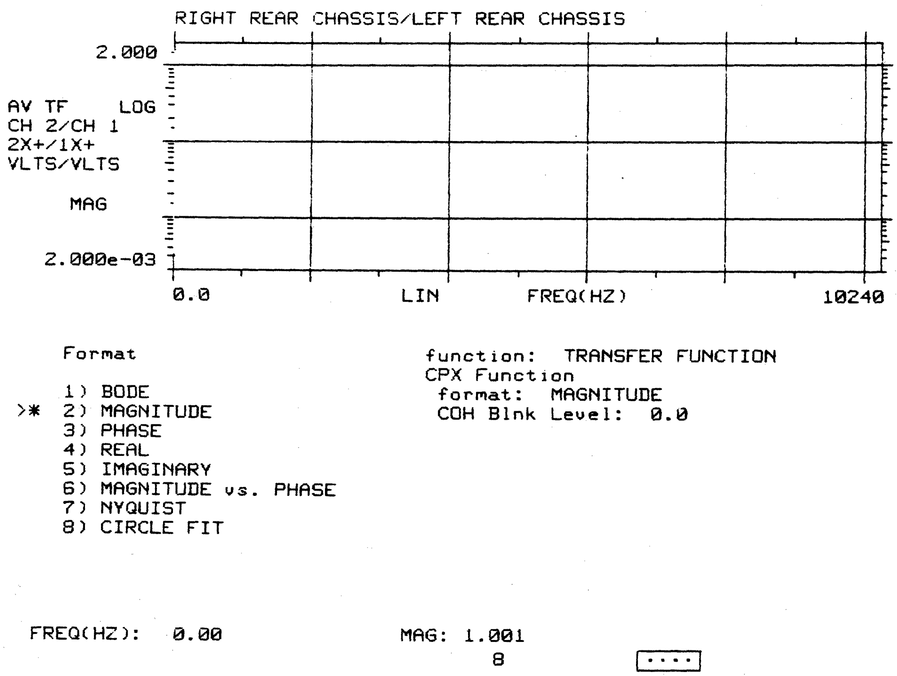
Step 32. **Press RUN** in the ACQUISITION group to start the average. (Repeat if desired.)

Step 33. **Press the FUNCTION button** for the menu of averaged function choices:

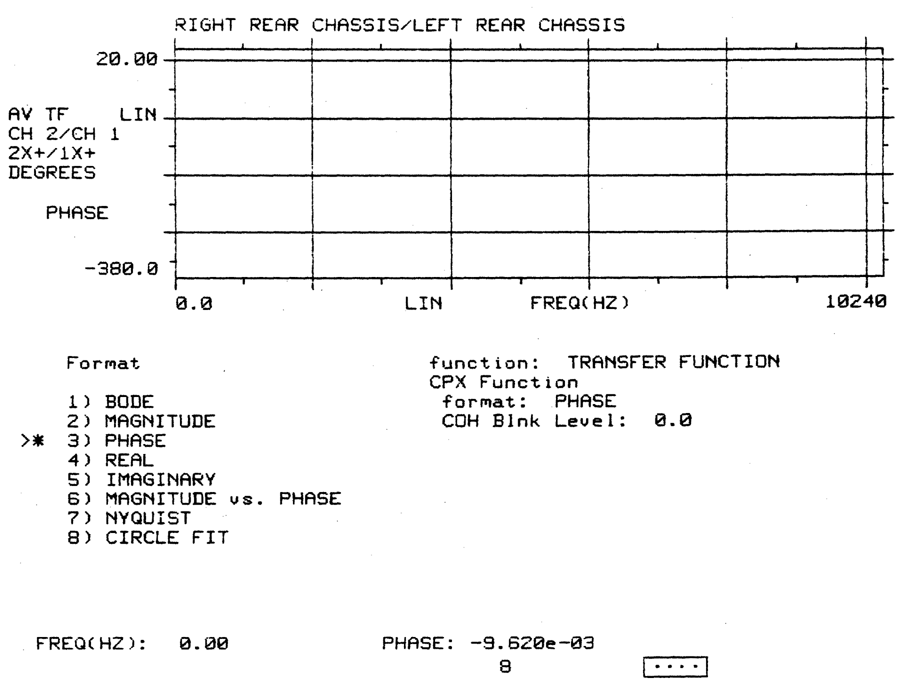
>* 1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORY

Step 34. **Select 3) TRANSFER FUNCTION and press NEXT.** This will advance the FUNCTION menu to the Format page, and switch display to Transfer Function. Check that the transfer function value is a straight line at magnitude 1.000 as shown below:

NOTE: If transfer function did not exceed a value of 1.000, the top line of the auto-sealed grid may be 1.00 instead of 2.000 as shown.

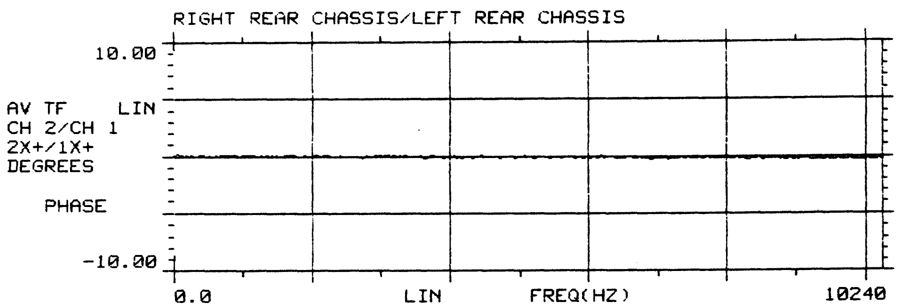


Step 35. **Select 3) PHASE in the menu and press ENTER.** Check that the phase is a straight line at value 0 degrees as shown below.



NOTE: The auto-scale for phase extends from 20 degrees down to -380 degrees. The grid lines are at 0, -100, -200, and -300. If desired to better observe the phase display, proceed as follows:

a. Press Y SCALE
b. Select LIN EXPAND, press NEXT
c. For min, max values, in the ENTRY group press:
 -10,10ENTER
d. The display should be expanded as below



ENTER MIN,MAX values
for LIN Y EXPANSION
* -10.00,10.00

>

Y Scale: LIN EXPAND
EXPAND Min Y: -10.00
EXPAND Max Y: 10.00

FREQ(HZ): 0.00

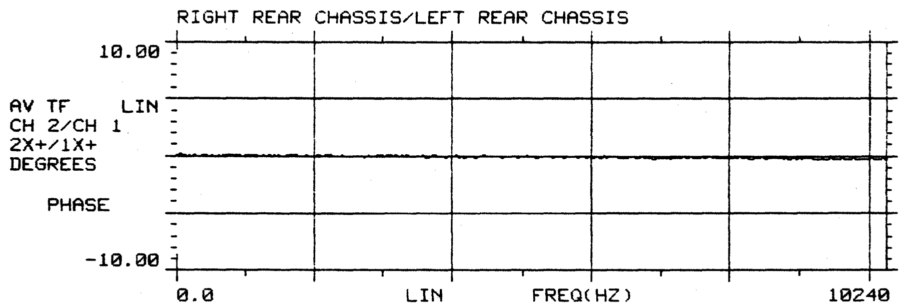
PHASE: -9.620e-03
8

This procedure has exercised most of the system hardware and several of the software functions. If successfully completed, it provides a good indication that the software and hardware are operating properly and the system is ready for use. The following paragraphs provide further demonstrations of functions for operator introduction.

2.11.9 Storage Exercise (Stage 5)

2.11.9.1 STORE.

Step 36. **Press the STORAGE/STORE button** at the lower left of the panel. The STORE menu will appear as follows:




```
    Storage Type/Destination          Type/Dest:  DATA to FILE
                                      Storage Grouping:  SINGLE
>*  1) DATA to FILE                   Restriction:  TRANSFER FUNCTION
    2) DATA to MEMORY                 Storage Labels:  NORMAL
    3) PANEL to FILE                  Current File:
    4) PANEL to MEMORY                File Status:  CLOSED
                                      File Format:  MODAL


 FREQ(HZ):   0.00              PHASE: -9.620e-0
                                          8
```

Step 37. **Move pointer to DATA to MEMORY,** using the UP-DOWN arrow buttons.

Step 38. **Press NEXT.** The following menu will appear:

ENTER RES COORD, REF COORD,
and SEQ#
*2x+, 1x+, 0
>

The pointer prompts for a new entry. An entry here would modify the coordinate labels before storing the function. The default values come from the function in the AVG display.

Step 39. **Press NEXT.** The following menu will appear:

ENTER Memory Buffer #
* 0
>

The pointer prompts for an entry. Enter 2 and press ENTER. The AVG data will be stored in MEMORY BUFFER #2 and verified by the "action succeeded" message.

2.11.9.3 DIR.

Step 40. If **STORAGE/DIR button is pressed** the following menu appears:

Directory

>* 1) User Disk File
2) Memory
3) Memory Panel

Step 41. Select 2) Memory, **press NEXT** and the directory of memory buffers appears. Note that buffer 2 is filled.

2.11.9.4 RECALL. To recall the data to the display and to make sure it was properly stored, press EXCHNG. This moves the AVG display to the lower display buffer.

Step 42. **Press RECALL** and the following menu appears:

Recall Source/Type

>* 1) DATA from FILE
2) DATA from MEMORY
3) PANEL from FILE
4) PANEL from MEMORY

Step 43. **Select 2) Data from memory** and **press NEXT.** The following menu appears:

Enter Memory Buffer #
* 2
>

Enter 2 and **press NEXT.** The display source changes to memory. Note that the screen now shows the stored data as it did before except that ME (memory) has replaced AV in the function type label.

For comparison of data, do the following:

Press EXCHNG, FUNCTION, NEXT, select 3, and press ENTER.
Press NEXT twice and press EXCHNG again.

Step 44. **Press DUAL.** The AVG data will appear in the lower display for comparison.

Step 45. **Press FUNCTION** and note that the Format menu appears since the function may not be modified for a recalled function.

Step 46. **Select BODE** and **press ENTER.**

Step 47. **Press EXCHNG, then NEXT** (to format menu).

Step 48. **Select Bode format. Press ENTER** again, **then DUAL.** Now the Bode displays may be compared, storing the displayed function, not format data. Note that storing and recalling functions into named user files is nearly identical to memory buffer storage except that the user must first open or create a file under the TYPE button before pressing STORE.

2.11.10 Measurement Setup Exercise (Stage 6)

Step 49. **Press CHANS.** The list on the right shows the current channel pair selections with asterisks (*) indicating the active channel pairs.

Step 50. Use the up and down arrows to move "@" sign. Move the @ symbol to pair 2, 1 and then **press 3, 4 ENTER.**

Step 51. **Press SINGLE.** The AVG display now says that "AVERAGED FUNCTION IS NOT AVAILABLE" since the setup information has been modified in such a way as to invalidate the current AVG data. There are other setup changes which will also cause this to occur.

Step 52. Move the BNC connections from input channels 1 to 4 and 2 to 3.

Step 53. **Press REAL TIME** data source.

Step 54. **Press FREQ, select Baseband, then press NEXT.** The following menu requests:

ENTER Maximum Frequency

Step 55. **Respond** by entering 5000 ENTER.

Note that the range actually appearing as the current value is 5120. User entries are converted to the next larger available hardware range.

Step 56. **Press TRIG** and, from the menu, **select 3) AUTO ARM EVERY FRAME** for auto-armed trigger mode. **Press ENTER.** Note that the ARM and HOLD lights alternately flash.

Step 57. **Press AVG, then RUN,** and observe the AVG again.

Step 58. **Press EXCHNG.**

Step 59. Recall memory buffer 2 to the upper display by **pressing RECALL, then NEXT,** then enter 2, and **press ENTER.**

Step 60. **Press DUAL.** Compare the differences in labelling.

2.11.11 Return to RT-11

Press MODE (measurement group).

Select 5), then press ENTER.

SECTION III

GENERAL OPERATION

There are general operations that are common to the operation of any program being used in the 2515 system. This section will describe general program relationships, keyboard operation, and optional printer/plotter operations. Only those printer/plotter operations specifically affecting 2515 system operation are described.

3.1 GENERAL PROGRAM RELATIONSHIPS

Application software packages for the 2515 system are designed to run under the Digital Equipment Corporation RT-11 single-user operating system for the LSI-11 processor. A subset of RT-11, called Run-Time RT-11, is supplied with the system and is included on application disks so that each one is a self-contained, ready-to-run package. Run-Time RT-11 provides a monitor which performs various services for the application programs, a device handler routing for the disk drive, and numerous utility functions that you will use for managing files on disks.

The 2515 analysis system, RTA Real Time Analyzer, software runs under the Run-Time RT-11 operating system software. When the system is shipped, all of the necessary RT-11 programs, a bootstrap routine, and the RTA operating program file are resident on the internal Winchester disk drive.

Detailed descriptions of program operations for the Run-Time RT-11 and RTA Real Time Analyzer programs are provided in Sections IV and V, respectively.

3.2 SYSTEM POWER ON

When power is turned on (Power On/Off switch is pressed to ON) the system executes a self-test diagnostic. This is indicated by the appearance of six 6-digit numbers in the center of the screen. The last number being equal to zero indicates that no errors were detected during the diagnostic (see paragraph 2.11.3, Step 1). A flashing cursor at the lower left corner of the screen is displayed when the diagnostic has finished and the system is waiting for the Winchester disk to get up to operating speed. When up to speed, a prompt from the hardware bootstrap program is displayed at the lower left corner:

DEV>

Strike the carriage RETURN key on the keyboard to bootstrap the RT-11 monitor program from the Winchester disk, DL0:, which is the default system device.

NOTE: To boot to the floppy disk (if appropriate software is mounted) enter device code DY in response to the prompt. If no entry is made, the system will automatically boot from the Winchester after approximately a 90 second delay.

NOTE: If the system is turned off, then on rapidly, the Winchester will continue to spin down, and then spin up again. This will cause a long delay the DEV> prompt appears.

The monitor runs a startup program that will print a list of some of the system characteristics and then stop with a request for entry of date and time. To accept the date as displayed, strike RETURN key. To change the date, enter all or part of the new date in the form dd-mmm-yy (see paragraph 2.11.3, Step 3). To skip the time, strike RETURN. If desired, enter a time in the form hh:mm:ss.

3.3 KEYBOARD OPERATION

If desired, the system may be controlled entirely from the keyboard without using the panel (or by a combination of both). The keyboard is illustrated in figure 1-4. Special function keys are listed in table 1-4 and described in the following subparagraphs.

All panel pushbuttons are represented by two-letter codes and are listed in Section V, paragraph 5.14.

When the system is in a menu state that is **expecting** a "text" entry, that is, alpha characters or mixed alphanumerics, alphanumerics will be echoed just as if they were entered by the ENTRY group buttons until the entry is terminated by:

ENTER = (backslash) on keyboard
NEXT = RETURN on keyboard

or ; on keyboard which is the terminator to return to command mode and ignore previous "text" entry, the same as pressing another button before ENTER or NEXT.

When the system is expecting a pure numeric entry, numerals will be echoed, but any alpha characters will be taken as command codes.

At all other times alpha characters from the keyboard will be taken to be two-letter command codes for the pushbuttons. These alpha entries are not echoed. They take effect as soon as recognized. No execution terminator is required. For example, if the system is <u>not</u> in a "text"-entry menu state, typing the characters:

DAMF

will cause it to select the AVG display (code DA), and put up the MEASUREMENT SETUP FREQ menu (code MF).

3.3.1 SETUP

There are several system options and auxiliary functions that are controlled via the keyboard SETUP key.

Pressing the keyboard SETUP key toggles the setup function on and off. When the key is first pressed (at any time during operation), the entire display scrolls up slightly to allow presentation of two lines of system option functions at the bottom of the screen as shown below. When done with these operations, press the keyboard SETUP key again to erase these lines, scroll the display back down, and restore the program to normal o~eration.

1 line on	3 color normal	5 click off	7 scroll fast	
2 mode GR	4 cursor block	6 rate 60 Hz	8 maintenance	0 reset

Pressing the corresponding numeral key on the keyboard will toggle these conditions on or off, or enter the indicated state, as described below:

1	Line ON/OFF	Toggles the terminal (i.e., the keyboard and display and the terminal emulator functions of the GenRad microprocessor) on-line and off-line and back. In off-line the terminal operates independently and does not communicate with the system.
2	Mode GR/ANSI	Toggles the terminal mode between GenRad standard and ANSI modes. GR mode is required for 2515 program operation.
3	Color Normal/Reverse	Toggles the display presentation between normal video and reverse video with light background and dark lines.
4	Cursor block/under	Toggles the alphanumeric cursor between a background block at the next character position versus an underscore line at the next character positon. The cursor appears only during RT-11 operations. It is not used by the signal analysis program.
5	Click off/on	Toggles the keyboard key-click simulator off and on.

6	Rate 60 Hz/50 Hz	Toggles the display and clock rates between 60 and 50 Hz to correspond to the local power line frequency. The power-up default rate, 60 or 50 Hz, for this item is set by an internal jumper wire as appropriate for the original destination of the system. This item should not be changed unless the system is operated from a different power line frequency.
7	Scroll fast/slow	Toggles the screen scrolling rate between normal fast and a slower rate intended to allow reading of text copy as it is scrolled by. Used with RT-11 operations.
8	Maintenance	Sets the system into startup diagnostic mode for maintenance procedures. Six 6-digit numbers appear on the screen. **NOTE:** Do not select maintenance if there is anything in memory you wish to preserve. If you enter maintenance mode, press the "X" character (for exit) twice to return to RT-11; or press the BOOT switch to reboot the system.
9	Not Used.	
0	Reset	Sets conditions 1-5 and 7 to first state listed. Set 50/60 Hz to power-up default. Resets terminal to alpha, scroll, and fill modes.

The keyboard setup function also allows adjustment of CRT brightness.

Press keyboard SETUP key.
Use (up-arrow) and (down-arrow) for brighter and dimmer.

3.3.2 COPY

Pressing the COPY key initiates output to the Printer/Plotter (option). There is a delay of about 4 seconds while the display is moved to the invisible display memory. For superimposed displays (such as those used in the RTA program) the dual plane/dual intensity image is OR'd onto the invisible plane. Subsequent displays are restricted to the single visible plane which temporarily disables the dual plane and intensity mode. Once the image is copied the printer receives the raster image. The time required to make a screen copy will vary depending on the content of the screen. The time should not exceed 90 seconds.

Pressing the CTRL and COPY keys simultaneously aborts the screen copy operation but is recognized only after the internal image move operation is completed.

Pressing the SHIFT and COPY keys places the terminal into AUTOPRINT mode as described in subparagraph 3.3.3.

If SHIFT, CTRL, and COPY are pressed, the AUTOPRINT mode is terminated.

3.3.3 PAGE/SCRL (PF1)

Pressing this key toggles terminal operation between PAGE and SCROLL modes.

SCROLL mode is the power up default. In this mode old text is scrolled off the top of the screen when the page fills and new text is output to the bottom line on the screen. The NO SCROLL key will transmit CTRL-S or CTRL-Q to stop or start transmission of characters and, therefore, will stop or start scrolling in programs which support CTRL-S/Q. The NO SCROLL condition is indicated on the keyboard LEDs by LOCKED being illuminated.

When the PAGE mode is selected keyboard LED labelled L1 will be illuminated. In PAGE mode, output to the screen stops when the bottom of the screen is reached. This condition is indicated by LOCKED being lit. The PAGE FULL condition is cleared by pressing either the ROLL or ERASE keys.

3.3.4 ROLL (PF2)

This key scrolls the screen up by six lines to allow continued output and is active in either PAGE or SCROLL modes.

3.3.5 AUTOPRINT (PF3)

Pressing this key toggles the AUTOPRINT mode on or off. When this mode is on, the printer/plotter (option) will echo subsequent character output to the terminal. AUTOPRINT MODE ON is indicated on the keyboard LEDs by L3 being illuminated.

3.3.6 ERASE (PF4)

Using this key erases the entire screen display. It will also clear the PAGE FULL conditon on PAGE mode but will not affect the NO SCROLL condition in SCROLL mode.

SECTION IV

RT-11 OPERATING SYSTEM

This section gives a general description of the Run-Time RT-11 operating system and of each of the functions available through RT-11 monitor commands.

4.1 GENERAL DESCRIPTION OF RUN-TIME RT-11

The Run-Time RT-11 package consists of a bootstrap loader, a monitor and device handler system programs, and some file management utility programs. These programs are supplied in the files which are listed and briefly described below. Some of these may or may not be present or may be replaced by similar files depending on the particular software package:

Bootstrap Loader	(Not visible in directory)
SWAP.SYS	Reserved file area for monitor swap routines
RT11SJ.SYS	Single job monitor
TT.SYS	Terminal device handler
DY.SYS	Double density floppy disk drive handler
DL.SYS	RL02 disk handler
LP.SYS	Line printer handler
VM.SYS	Virtual memory pseudo-device
RESORC.SAV	System resource utility program
FORMGR.SAV	Disk formatter program
DUP.SAV	Device utility program
PIP.SAV	Peripheral interchange program
BUP.SAV	Backup utility program
DIR.SAV	Directory reader program
SIPP.SAV	Save image patch program
SYSINT.SAV	GenRad date, time and hardware initializer routine
STARTS.COM	GenRad indirect command file for startup
TTCON.SAV	GenRad utility for console terminal
TTAUX.SAV	GenRad utility for auxiliary terminal
KED.SAV	Keyboard editor for auxiliary VT100 type terminal
EDIT.SAV	Keyboard editor for auxiliary VT100 type terminal

4.1.1 The Bootstrap Loader

The bootstrap loader actually consists of three parts:

- A hardware bootstrap in ROM is activated by the main power or BOOT/HALT switches on the 2515 unit.

- The hardware boot is capable only of loading the first block from the disk into memory. That first block contains a simple loader that reads the rest of the bootstrap from other fixed locations on the device.

- The boot then loads the disk handler and the monitor programs. The boot also performs various initializing functions before turning over control to the monitor. The system distribution disks will have a bootstrap written on them. However, the bootstrap does not exist as a file. It is actually contained within the monitor file. When new system disks are created, the COPY/BOOT function must be used to extract the boot from the monitor file and write it into its assigned location at the beginning of the new disk.

4.1.2 Monitor

The monitor program file has several parts: a copy of the appropriate bootstrap for itself, the resident monitor (RMON), the keyboard monitor (KMON), and user service routines (USR). The resident monitor is loaded by the bootstrap and is always present in memory when the system is running. RMON provides various services for executing application programs and general management and arbitration for the various other components. RMON occupies about 2K of memory and resides at the highest usable locations of the first 32K of memory. For the system, that means from address 28K downward, since the area from 28K to 32K is reserved for peripheral device addresses.

It is the KMON keyboard monitor that actually communicates with the operator via the prompting dot and the monitor command set. KMON allows the operator to request such functions as assigning logical names and calling programs to run (including the system utilities that are called by monitor commands). The user service routines (USR) provide various service for application programs, such as performing file operations. The KMON and USR segments are not necessarily resident. They will remain in memory if a loaded application program does not require their space. However, if the program does (and most GenRad application programs do), KMON and USR are swapped in only when needed. The area of the user program that they overlay is temporarily swapped out and saved on the RT-11 disk. This is why the reserved area represented by the file SWAP.SYS is required on the disk.

4.1.3 Device Handlers

The several device handler files are small routines that provide the hardware-mode communication with peripheral devices. They are normally called in by the monitor only when required. The only ones applicable to 2515 system are the TT.SYS terminal handler, the DY.SYS handler for the double density floppy drive and the DL.SYS handler for the Winchester. All of these must be present on your system disks. The VM.SYS handler, which allows use of extended memory as a fast pseudo-disk, is also available. This is described in paragraph 4.8.

4.1.4 Device and File Management Programs

The device and file management programs provide the support services necessary for maintaining and manipulating files on your disks. With the exception of SIPP, these programs and all of their functions are accessible through the keyboard monitor commands that are described in the rest of this section. The monitor translates these keyboard entries into a command string format that is acceptable to the utility programs. The monitor then loads and starts the appropriate program and passes the command to it for execution. Their general functions are as follows:

- **RESORC.SAV** surveys and prints various system resource and configuration information for the monitor SHOW command.

- **FORMGR.SAV** performs the disk media formatting operation.

- **DUP.SAV** performs device-related operations for the monitor commands COPY/DEVICE, INITIALIZE, COPY/BOOT, BOOT, SQUEEZE, and CREATE.

- **PIP.SAV** performs file-related operations for the monitor commands COPY, TYPE, PRINT, RENAME, and DELETE.

- **DIR.SAV** performs the several directory read and print operations under the monitor command DIRECTORY.

- **BUP.SAV** performs file and device backup and restore operations using the monitor command BACKUP.

- **SIPP.SAV** installs patches in binary program files. SIPP is not applicable to normal operation but might be used to install any future distributed patches, for which additional instructions would be supplied.

4.1.5 GenRad Utility Programs

GenRad utility programs provide miscellaneous functions unique to the 2515 system, as follows:

- **STARTS.COM** is an indirect command file for startup. An indirect command file serves as an automatic operator. This command supplies alphanumeric command inputs just as they might be typed from the keyboard. Whenever the single job monitor is bootstrapped, the monitor searches the system disk for a file by this name and executes its commands. The STARTS.COM file that is supplied contains commands to set a monitor condition for video-type terminals and to RUN the SYSINT, utility. Usually, this file also contains the command to RUN the application program if there is only one on the disk.

CAUTION

> If the monitor does not find a STARTS.COM file, it prints the error message "KMON-F-Command file not found". This message can be ignored unless a STARTS.COM file was expected. This may occur if STARTS.COM is omitted from some of the working copy volumes. If it is not present, SYSINT should always be manually run to prevent problems from indeterminate analog start up and input conditions.

- **SYSINT** is run by STARTS.COM to specifically request entry of a date and time after booting the system, and to set up some initial conditions in all analog input channels. If this is not done, channels that are not used by subsequent application programs would be left in an indeterminate state. This state allows them to drift up to high voltage levels that can interfere with input multiplexer operation. If STARTS.COM is not present to do this automatically, SYSINT should be manually run before running application programs.

4.2 DEVICE AND FILE IDENTIFICATION

4.2.1 Standard Physical Device Names

All devices supported by RT-11 have permanent physical device codes. These codes are recognized by the monitor and most of the application programs. The codes are listed below. Note that devices can also be referred to by logical names which can be assigned with a monitor command. If a unit number n is not given for multiple unit devices, unit 0 is assumed by default. Note that the colon (:) is part of the name and must always be included.

TT: The terminal (keyboard in, display out).

DYn: Double-density floppy disk drive, DSD 440 or equivalent.

SY: The system unit from which the monitor was booted. This is actually a logical name. However, this name is always associated with the bootstrap device and cannot be assigned elsewhere. If it is a multiple unit device, SY: refers to whichever unit was specified in the boot and SYn: may be used to refer to other units.

DK: The system default device and unit to which the system will refer if no dev: is indicated in a file reference. This also is a logical name. It is initially assigned to SY: when the system is booted, but can then be assigned elsewhere. DKn: refers to other units of the same device.

VM: Virtual memory device. See description in paragraph 4.8.

4.2.2 File Specifiers

Complete specification of a particular file consists of a file name, a file type, the device where it is or is to be located, and optionally for output files, space allocation in terms of device blocks (see next paragraph):

dev:filnam.typ [size]

File names may consist of 1 to 6 characters. File types consist of 0 to 3 characters. Both are alphanumeric only, that is they contain the letters A-Z and the digits 0-9. They do not contain symbols or embedded spaces. Names and types may be assigned as desired. However, the system uses certain type conventions and defaults, listed below, which should be observed. Note that the [size] argument is optional. If the argument is included, the square bracket characters are required. Also note this form of the [size] argument is restricted to command lines entered directly to file utility and application programs. When a size is to be given in a command to the monitor (.), it must be specified with the /ALLOCATE:size option. This is noted in the command descriptions hereafter.

4.2.3 Defaults

If parts of the filespec are omitted, the system will assume or supply defaults as follows. Also note that some special file type restrictions listed.

dev: The current system default device DK:. Initially, it is the same device as SY:, but it can be assigned.

filnam: The file name is normally not defaulted. It can be replaced by wildcards as described in the next paragraph. Some of the commands will assume one of those wildcards if no file name is given.

.typ The following file types are significant (as noted below) to Run-Time RT-11 and should be observed. Note that GenRad application programs, TSL in particular, assign and seek certain defaults of their own which are noted in the separate application software manuals.

.SYS is reserved for RT-11 system files. SYS files will not be included in most file operations unless they are specifically requested with a /SYSTEM option on the command.

.BAD file type is used to cover bad (unreadable) areas on disks. Files with this type are made permanently resident in their specific locations. This is done so that the bad blocks will not be reused. These files are not included in wildcard operations. The INITIALIZE function can be instructed to scan for bad blocks and to create files named FILE.BAD to cover them. An exception to the general rule about no duplicate file names is that more than one FILE.BAD can exist on the same device.

.SAV indicates a memory image (saved) program file that can be loaded and run. For example, DUP, PIP, and DIR, and GenRad application programs are all .SAV files. The monitor RUN command searches for .SAV files if a type is not specified.

.COM indicates an indirect command file for the monitor. Indirect files can supply commands to the monitor just like a keyboard operator. Whenever the single-job (SJ) monitor is bootstrapped, it automatically searches for a command file named STARTS.COM. Such a file is usually provided on GenRad application disks. The purpose of this file is to request input of a system date, to initialize the A to D subsystem, and to automatically start the application program if there is only one on the disk. If a STARTS.COM file is not found on the booted disk, the monitor prints an error message ("Command file not found"). This message can be ignored. Command files are usually created via the RT-11 text editor. The text editor is not provided in Run Time RT-11. It is possible to create a simple COM file with TSL or with an RT-11 COPY function with TT: as the source "file".

.DIR is the default type that is assigned by the DIRECTORY function if its output is directed to a file instead of a printing device.

.DAT is a data file. This is not directly applicable to RT-11 operations. However, it is used as the default for several MODAL and application program outputs. Therefore, it may appear on some distribution disks that supply test data.

(size) Number of blocks to be allocated for a new file. See the paragraph on general file operations for default allocations and special symbols.

4.2.4 Wildcards

Several of the file manipulation commands will accept the wildcard symbols asterisk (*) or percent (%) to replace all or part of a file name or type. This allows the representation of several files in a single filespec expression. The asterisk (*) can replace a file name, a file type, both, or any number of characters when embedded in file name or type.

Example:

DY1:*.SAV — means all files on device DY1 that have the type .SAV.

MYPROG.* — means all files on the default device (DK:) that have the name MYPROG.

DY1:*.* — means all files on device.

M*G.* — means all files of any type on DK: whose file names begin with M and end with G. This would include MYPROG above. It would also include MG.*, MAG.*, MXXG.* and so on.

The percent symbol (%) is an embedded wildcard for one character only.

Example:

DY1:M%G.DAT — means all files on DY1: of type .DAT whose file names are three characters long and begin with M and end with G. This would include MAG.DAT, M2G.DAT, and so on. It would not include MYPROG or MG as above.

The commands that will accept wildcards are listed below along with the defaults they assume if no wildcard symbols are supplied:

Command	Input Default	Output Default
DIRECTORY	DK:*.*	TT:
COPY, RENAME	DK:*.*	DK:*.*
TYPE, PRINT	DK:*.LST(N/A for Run-Time)	always TT: or LP:
DELETE	DK:filnam.*	not applicable

Examples:

COPY DK: DK1: or COPY *. DK1:	all files from default dev: to default dev: unit #1
COPY *. TSL DY1:*.* or COPY *.TSL DY1:	all .TSL files from DK: to DY1: retaining their original names
DIR	list all files on DK:
DIR DY1:*.TSL	list only .TSL files from DY1:
COPY MYSUB DY1:	all files named MYSUB, regardless of type, from DK: to DY1:, retaining their names and types. Equivalent to: COPY DK:MYSUB.* DY:*.*

Some combinations, which will usually be obvious, are illegal and will be refused. However, it is possible in some cases to delete files by mistake. Therefore, always check the use of wildcards carefully. The DELETE command normally requests confirmation for each file of a wildcard operation. COPY and RENAME do not request confirmation unless told to do so. While the latter two do not affect the original file, they might delete another file if duplicate names occur on the output device. See the general operation rules and the /NOREPLACE option.

4.3 DEVICE, DIRECTORY, AND FILE ORGANIZATION

4.3.1 Blocks

All information on an RT-11 random access device (i.e., disk) is organized and accessed by the operating system in software blocks of 256 16-bit words, regardless of the device type. This does not necessarily correspond to the physical organization of the device. Floppy disks, for example, have sectors of a track (hardware blocks) that contain only 128 or 256 bytes of data. Nonetheless, data is written and read on these disks by software that deals in 256-word blocks. File sizes and relative locations in directories are in terms of 256-word blocks. Therefore, all further reference herein is in terms of 256-word software blocks. Note that all sizes in blocks and starting block numbers (file addresses) are stated in decimal. This is the way sizes are listed in directories unless the /OCTAL option is specifically invoked in commands.

4.3.2 Bootstrap

Blocks 0 and 2-5 of a device are reserved for the bootstrap loader for a particular monitor on that device. Except for the bootable initial distribution disks, the COPY/BOOT function must be used to read the appropriate bootstrap out of a monitor file and write it into this area. This must be done before the disk can be started by hardware boot. A bootstrap can also be written on a new device by the COPY/DEV function. Both of these have been demonstrated in the previous section and are described further in the paragraph on device manipulations with DUP.

4.3.3 Volume Identification

Block 1 of the device is reserved for a volume ID and owner's name (12 characters each). These may be assigned or changed with the INITIALIZE function. Block 1 also contains a code indicating that the device is in RT-11 format plus some additional code information for the operating system.

4.3.4 Directory

The directory begins in block 6. For the operating system, directories are organized in "segments". Each segment occupies two blocks. A segment contains a few words of directory information for the system and space for 72 file entries. DY floppies normally have four segments, blocks 6 through 13, providing space for up to 288 file entries. This theoretical limit can be reached by packing disks. However, because of the way the directory segments are handled by the system, the practical limit is usually about half of the maximum (approximately 150 entries). The default directory size can be changed when the disk is first INITialized. For example, the directory size can be made larger if hundreds of small files are expected. Conversely, the size can be made smaller if only a few large files are expected and maximum space for data is desired.

4.3.5 Directory Entries

A directory entry consists of seven words which contain the following information for a file:

- File Status can be permanent (closed), tentative, or empty (never used or deleted).
- File Name and Type
- File Date
- File Size in blocks used
- File Address (starting block number), which is actually determined indirectly from a starting point and the file sizes.

Tentative and empty areas also have directory entries indicating their sizes and locations. These areas are listed as UNUSED in /FULL directories.

4.4 GENERAL NOTES ON FILE OPERATIONS

RT-11 uses a contiguous file structure. That is, a file must always occupy consecutive blocks on the device from its beginning to its end. There is no linking of a file from one area to another.

When a device is initialized, the directory area is created and cleared. This makes the entire device (UNUSED) and available for new files. The INIT function just changes statuses to (UNUSED). It does not actually erase any data from the disk. Therefore, if a copy of the previous directory exists, it is possible to recover files from an accidentally INITed disk by recreating directory entries. However, this is a difficult process and is not fully described herein. There is also an INIT/RESTORE option that can recreate the previous directory as long as no new files have been written.

As files are written to the disk, they are assigned consecutive areas and consecutive entries are made in the directory. When files have been deleted, empty areas will be created.

When a new output file is to be created, it will initially be allocated a space equal to one-half the largest available area on the device or all of the second largest area, whichever is larger. A size can be specified in blocks with the [size] argument or /ALLOCATE option. In this case, the file will be located in the first area large enough for the file. The special code -1 for size will allocate all of the largest area.

A tentative directory entry is made for a new file in the appropriate location with the file name, type, and date. The current system date is used if it is a new file and if the system is dated. The date of the source file is used for a COPY operation unless the /SETDATE option is specified. In this case, it will assign the current system date for the output file.

Note that a tentative entry may have the same name and type as a permanent file on the same device unless the /NOREPLACE option is invoked to protect against this. If this is done, the new entry will be refused with a warning message. If this is not done, the old file will be deleted when the new one is closed.

The file is thus opened and the write-to-file operation can proceed until the program is through with it or until the allocated space is filled. In the latter case, a warning message will be supplied and the operation will not be completed. That is, the file will not be closed unless the operator does so with a monitor .CLOSE command. When the operation is successfully completed, the file is closed automatically by the RT-11 utilities and most GenRad application programs.

Closing a file reduces its size from the space allocated to the space actually used, changes the directory status from tentative to permanent, and deletes any previous file with the same name and type.

Deleting a file does not erase any data nor the directory entry. It merely changes the status from permanent to empty. This makes it appear as (UNUSED) in directories and makes its space available for use by new files. The deleted file continues to exist and its directory information can still be obtained with the special /DELETED option of the DIRECTORY command. Thus, an accidentally deleted file or any remaining portion of it can be recovered as long as it has not been written over by new file data.

NOTE

A tentative entry in the directory must always be followed by an (UNUSED) entry. This is done to account for any remaining space when part of the allocated area is not re-used. Therefore, the system does a lot of pushing down of directory entries to allow for these (UNUSED) entries as deleted areas are reused. This is part of the reason why only about half of the theoretical maximum number of directory entries is available in normal usage.

4.5 PROMPTING AND COMMAND CHARACTERS

The following characters are output as prompters for input:

. Keyboard monitor is ready for a command entry.

* Utility or application program is ready for an entry.

The monitor recognizes the following single (or combination) keystroke characters as commands. CTRL/x means hold CTRL key and strike x key.

RETURN	Terminator and execution command for all operator entries.
CTRL/C	Terminates program execution and returns control to the keyboard monitor for command input. Two CTRL/Cs will be required if the system is not already looking to the keyboard for input. Echoes ^C and (.).
CTRL/U	Deletes current input line and echoes CR-LF to allow re-entry on next line. This function is also provided by the ERASE LINE key if it is present on the keyboard.
DELETE or **RUBOUT**	These functions are provided by the BACKSPACE key. Deletes the last character of the current line for each BACKSPACE. See the notes on Error Erase state in the terminal description.
CTRL/S	Stops operations that are outputting to the terminal. Essentially the same as a terminal busy or page full condition.
CTRL/Q	Resumes terminal output from the point where it was stopped. No output is lost. Essentially the same as a ROLL or HOME key command after a page full.
CTRL/O	Suppresses terminal output but allows program to continue. Toggles on/off. Output between CTRL/Os is lost. Cancelled by CTRL/C.

4.6 MONITOR COMMAND SYNTAX

4.6.1 Command Line Format

The monitor will accept commands in either long or short form. The long form is where only the command (and /options) is entered and the monitor prompts for the rest of the information. The short form is where all command information is entered on a single line. Where (CR) indicates RETURN and (SP) indicates one SPACE, these two general forms are as follows:

Long Form, with prompts:

```
COMMAND[/option/option/etc](CR)
PROMPT1?input(from)filespec[/option](CR)
PROMPT2?output(to)filespec[/option](CR)
```

Short Form, one line:

```
COMMAND[/option](SP)in-file[/option](SP)out-file[/option](CR)
```

Options that apply to a particular file, such as /ALLOC:size or /BEGIN (with file), must be associated with the filespec. Options that apply to the whole command can usually appear anywhere in the command line. In a few cases noted in the descriptions which follow, these options must be associated with the command word. If the long form is used, the command options must be on the first line. For example:

```
.DIRECTORY DY1:/FULL/BLOCKS
```

is correct, but in long form it must be:

```
.DIRECTORY/FULL/BLOCKS
File?DY1:
```

4.6.2 Abbreviations

The monitor commands and options are all English language words and may be spelled out fully in a command line. They may also be abbreviated to as few characters as will distinguish the command to the monitor. For example, ASSIGN may be abbreviated to AS, since that is enough to distinguish it from any other command that begins with A. DEASSIGN requires three characters (DEA), since DE could also be DELETE. The monitor will issue a warning message if a command entry is ambiguous. As a general rule, four characters is sufficient. The options that begin with NO may require six characters such as NOREPL for NOREPLACE.

4.6.3 Factoring

More than one input filespec, separated by commas, can be specified for several of the commands. Such commands can be shortened by factoring. That is, using parenthetical expressions to associate one part of the filespec with several specifications of another part. For example, the command line:

```
COPY DY1:FILEA.DAT,DY1:FILEB. DAT,DY1:FILEC. DAT DY0:
```

can be factored to

```
COPY DY1:(FILEA.DAT,FILEB.DAT,FILEC.DAT DY0:
```

or even

```
COPY DY1:FILE(A,B,C).DAT DY0:
```

In the second line, device DY1: applies to all the expressions in parentheses. Complex factoring of the form (DY0,DY1):FILE.(TSL,DAT) is not allowed and certain other combinations will be rejected with error messages.

4.7 MONITOR COMMAND DESCRIPTIONS AND FUNCTIONS

The following paragraphs describe the commands and options for functions available from the monitor. The command set is subdivided by paragraph for the utility programs that perform each function. This is done because there are several of the options that are common to various commands within a particular utility. A summary list of all the monitor commands in alphabetic order is given in Appendix A.

4.7.1 Direct Monitor Functions

Except as noted for SHOW, the commands described in this paragraph are performed within the monitor itself. They will allow .REENTER to a resident program when they are done. The commands listed on the second line are available from the run-time RT-11.

DATE, TIME, ASSIGN, DEASSIGN, SHOW, R, RUN, CLOSE, REENTER

LOAD, UNLOAD, INSTALL, REMOVE, RESET, GET, START, B, E, D, SAVE

DATE dd-mmm-yy e.g., DAT 6-JUN-84

GenRad application package disks usually include a startup command file that requires entry of date. This monitor command may be used if the date during file management operations is to be changed. Typing DAT without arguments will print back the current system date (if any).

TIME hh:mm:ss e.g., 10:25:17

The time entry that is requested by the SYSINIT startup routine is for the GenRad 2501 microprocessor. That time is used by some GenRad application programs, and can be set or read by the RT-11 TIME command. Typing TIME without arguments with print back the current system time, if any.

ASSIGN dev: nam: e.g., AS DY1: FIL:
AS DY1: DK:

DEASSIGN nam: e.g., DEA TSL:
DEA DK:

These commands allow a logical name of up to three characters to be given to either of the disk drives. After the first assignment above, floppy drive #1 can be referred to as device FIL: in file specs. After the second assignment, DY1 becomes the system default device as well. Any subsequent filespecs that do not include a device will refer to DY1:. The first deassignment simply removes the FIL name from DY1:. The second removes default code DK from DY1:. The second also restores DK to the system device SY where it is initially assigned when the system is booted. A DEASSIGN with no arguments removes all logical names from all physical devices (except DK for SY). Note that more than one logical name can be assigned to the same device. A logical name can only be assigned to one device at a time. Therefore, assigning a name to one deassigns it from any others. The system device logical name SY cannot be assigned to any other, nor are the names BA, FG, or EL allowed. These names have special meanings for other capabilities of full RT-11.

SHOW (no arguments)

This command will list all of the peripheral devices known to the running monitor with the status of their handlers (i.e., "resident" or "loaded"). It will also show any logical names that may have been assigned to them.

NOTE

> The utility program RESORC.SAV must be present on the system volume. A previously resident program cannot be RE-ENTERed after SHOW. RESORC provides several other options for SHOW, none of which are applicable to the analyzer configuration.

R filespec
RUN dev:filespec

These commands load and start memory image program files. The default file type is .SAV. The R command can be used only for programs on the SY system device. RUN must be used for any other device.

CLOSE (no arguments)

This command closes (makes permanent) any open tentative files. It is not used in normal operation. It may be useful to save partial files that were not completed because of unexpected program termination.

REENTER (no arguments)

This command restarts a resident program (for those that allow it), without clearing or resetting any memory areas. REEN restarts the basic program but does not continue operations that were in progress. REEN will not be allowed after exits caused by errors that may have corrupted necessary conditions. An illegal command message will be returned.

NOTE

> None of the following direct monitor functions has any normal use in the system. They are listed and very briefly described here only because they are available from the monitor. Some of them may be used to install patches in existing programs. If so, additional instructions would be supplied.

LOAD dev: (,dev:,dev:)
UNLOAD dev: (,dev:,dev:)

The first command makes the device handlers for the indicated devices permanently resident below the resident monitor. Conversely, the second command removes them.

INSTALL dev:
REMOVE dev:

These two commands modify the internal device table of the monitor (the one listed by SHOW) to make it aware that additional or special devices and handlers exist in the system. Not used in normal systems.

RESET (no arguments)

This command does a general cleanup of the user program area. It purges input/output (I/O) channels, unloads device handlers, and reinitializes conditions for the user program area. It can be used if the monitor or a device needs initialization (not same as INITIALIZE command) before execution. It can also be used to cancel the effect of a preceding GET. Not used in normal GenRad operations.

GET filespec

This loads a memory image program file (default type .SAV) without starting it. It can be used with B (Base), E (Examine), D (Deposit), START, and SAVE for modifying and testing programs. The RUN command above is a combination of GET and START.

START address(octal,even)

Starts a resident program at the address specified or at the normal transfer address of the program if none is given.

B address(octal,even)

Base. Sets a relocation base address for the following Examine and Deposit commands. Address default is 0.

E address(octal,even) -address

Examine. Prints the content of the specified address (relative to the relocation Base if one was entered) or of all addresses inclusive if a first-last combination is given.

D address(octal,even)=value ,value,value,etc.

Deposit. Writes the value into the address given (relative to the relocation Base if one has been entered). Multiple values are written into successive addresses.

SAVE filespec address(-address2) (,address3) (-address4))— Writes a memory image file (default type .SAV) of the memory area(s) specified by the addresses given. Used to save copies of programs that have been modified by means of Deposit commands while they were in memory. Not used for normal GenRad system operations.

4.7.2 Hardware Formatting Function (FORMGR.SAV Program)

Floppy disks must be formatted to be used in double density on DY drives. The basic format function has been described in detail in the initial operating procedures of Section III. However, the FORMGR command has additional options which are described under the general command form below. Note that reformatting and/or verifying can frequently restore bad blocks on a disk.

CAUTION

FORMGR irretrievably destroys any previous data on the disk.

```
RU FORMGR *
   * dev( /Options)
         /Y
         /V:(ONL)
         /P:value
         /W
         /S
```

/Y—The FORMGR function normally prints the warning query "dev:/FORMGR-Are you sure?" before proceeding with the operation. The /Y option suppresses this message.

/V (:ONL)—Verification is a process of writing and reading a specified bit pattern to and from every word on the disk. It is normally used mainly for investigation of hardware problems but sometimes will restore bad blocks. If the :ONL option is not specified, the disk will also be reformatted before verification. ONL suppresses formatting. Note that verification also is a data destructive process. Neither should be used on a disk that contains anything wanted. If the /P option below is not given, verify will use pattern #8.

/P:value—Value is an octal integer in the range 0-377 indicating which of the patterns listed below is to be used. The default, if /P is not given, is #8. P:0 runs #1. P:25(octal) runs #1, 3, and 5. P:377(octal) runs all eight.

Bits Position Set	Pattern	#16-bit Pattern (octal)
0	1	000000
1	2	111111
2	3	163126
3	4	125252
4	5	052525
5	6	007417
6	7	021042
7	8	102410

/W—This option, which is also available on several other commands, is provided mainly for the benefit of systems with only one disk drive. However, it may prove useful on occasion. The /W option causes the monitor to fetch the utility program and initiate the function. It will then pause before execution to allow a different volume to be substituted on the device specified in the command line. At the pause and upon completion, it prints messages and a query for the operator to respond Yes when he is ready; e.g., "Mount volume you wish to format. Continue?" (Yes).

/S—This option formats a diskette in single density mode. Default is double density.

4.7.3 Device Manipulation Functions (DUP.SAV Utility Program)

The following listed monitor commands are performed by the Device Utility Program (DUP). These commands have to do with special operations on devices as opposed to file operations:

INITIALIZE   COPY/BOOT   COPY/DEV   BOOT   SQUEEZE   CREATE

INITIALIZE [/options]dev:
- / [NO]QUERY
- /VOLUMEID [:ONLY]
- /SEGMENTS:n
- /BADBLOCKS [:RETAIN]
- /WAIT
- /RESTORE

The INITIALIZE function is required for all new disks before they can be used by RT-11. It may be used to "clear" a used disk for reuse. On a new disk, INIT creates a directory setup so the disk can be used. On a used disk, it changes the status of all existing files. This change is such that the entire disk appears to be (UNUSED) and is available for writing new files.

CAUTION

> With the single exception of the /VOL:ONLY option, INIT effectively destroys any files already on the disk. It does not actually erase any data or directory entries. However the change of file status makes it difficult to recover files (at least after any new ones have been written). If the analyzer is accidentally INITed, the /RESTORE option can be used to cancel the mistake as long as no new files have been written.

/NOQUERY—INIT normally requests confirmation with the query "dev:/Init are you sure?". This requires entry of a Yes response to continue. The NOQUERY option suppresses that confirmation message.

/VOLUMEID [:ONLY]—This option allows entry of a volume identification and owner's name of up to 12 characters each, for which it will prompt on following lines. The :ONLY option can be used to change volume ID on a used disk without re-initializing it. The ID can be read with a DIRECTORY command option.

/BADBLOCKS[:RETAIN]— This option causes INIT to scan the device for bad blocks. If any are found it will write files named FILE.BAD over them. This prevents their use in subsequent normal file operations. If bad blocks are found in the bootstrap or directory areas, the device is unusable and a fatal error message is printed. If you wish only to scan for bad blocks on a used disk without initializing, use the DIRECTORY/BAD function. If the RET option is appended to the /BADBLOCKS option, the INITIALIZE function will not perform the bad block scan. However, it will retain any FILE.BAD files from a previous INIT. This saves the time required for bad block scan without losing previously found bad blocks when a disk is re-INITed.

/SEGMENTS:n—INIT uses a default value to establish the number of directory segments on a disk; i.e., the size of the directory. This option can be used to increase or decrease the space allocated. See the paragraph on device and file structure. Note that n is segments, each of which is two blocks. Each has a maximum capacity of 72 entries per segment.

/WAIT—This option is mainly for systems with only a single disk. When it is used, the system will enter the INIT operation. It will then pause and print an instruction to mount the volume that is to be INITed. Upon a <u>Y</u>es response, it then proceeds. When done, it prints another instruction to remount the system volume.

/RESTORE—This option "uninitializes" a volume, restoring the directory to its condition prior to the last INIT. This allows recovery of a volume that was accidentally INITed. However, RESTORE can only be used if no files have been written on the volume since it was last INITed. Also note that /RESTORE does not restore the bootstrap blocks. If this function was performed on a system disk, the bootstrap blocks must be rewritten with the COPY/BOOT command. RESTORE is only to recover from an accidental INIT. It does not restore files that were previously DELETED.

COPY/DEVICE[/options] dev:[/options] dev:[/options]

/FILE	filespec	filespec
/NOQUERY	/START:n /END:n	/START:n

COPY/DEVICE is an absolute block-oriented function, as opposed to the file-oriented COPY function under the PIP program described in the next paragraph. In its basic form with no options, it simply copies the input device block-by-block to the output device. It will produce an exact duplicate of as much as will fit on the output.

<u>Example:</u>

.COPY/DEV DY0: DY1:

This mode copies all data from the input device such as the bootstrap and volume ID blocks, the directory, the files, and even the unused areas. This is useful for making duplicate disks, provided that there are no bad blocks on the output device and that the devices have the same number of physical blocks. If bad blocks are encountered in the input, an error message is printed. However, the operation is retried. If only one error message is printed, it may be assumed that the copy was successfully completed. If the devices have different numbers of blocks, the operation proceeds until the smaller one is exhausted or filled. However, although this function will operate between different size devices, it is not recommended. Invalid directories may result.

The COPY/DEV function has additional options for more flexibility. These options are to copy specified areas or to copy between a device and a file (or vice versa) as follows:

/NOQUERY—Since COPY/DEV is destructive of existing data on the output device, it normally prints the confirming query "dev:/COPY; Are you sure?" This query must be answered with a Yes response. This option suppresses that query.

/START:n, /END:n—These options must be associated with the device specifiers rather than the basic command. They make it possible to copy a specified portion of the input device to a specified area of the output device. The decimal block number on the device is n.

/FILE, with a filespec—This option allows copying of the image of a device or portion thereof to be stored in a named file on another device, and the reverse.

COPY/BOOT dev:monfil.SYS dev:

Before a volume can be hardware booted as a system device, the bootstrap routines must be written into their fixed locations in device blocks 0 and 2 through 5. The distribution disks have bootstraps appropriate for the system device. For all subsequent copies of system volumes this function must be used to make them bootable from the front panel. This command extracts the bootstrap information from the monitor and device handler file for the target device. This information must already be present on the target volume. The information is written into its assigned blocks.

Example:

COPY/BOOT DY1:RT11SJ.SYS DY1:

A subsequent boot of this device will load the monitor whose name was given in this command. All monitors supplied by GenRad have the name RT11SJ. However, it is legal to change the monitor name if desired. In that case, a device bootstrap would boot whichever name was given in this command when the boot was copied onto the device. The BOOT command described below can be used for a "software boot" of a specific monitor file regardless of the boot written on the volume. Since the boot is taken from the device handler for the device specified as the target, it will always correspond to that device. That is, if writing a boot on a DY device, the volume can only be booted from a DY device.

BOOT[/options] dev:[monfil.SYS]
/WAIT

This command, given from a running monitor, reboots the system with a new monitor. If only a dev: is specified, it performs a "hardware" boot. It bootstraps the monitor whose boot has been written in blocks 0 and 2 through 5 of the volume by the preceding COPY/BOOT command. If a monitor file name is given, it performs a direct boot of that file and does not use the hardware boot blocks. This latter mode was intended mainly for full RT-11 where different versions of the monitor might reside on the same volume. Note that this also makes it possible to boot from a volume that has not had a boot written on it. Assigned logical device names may be used in place of physical device names. The date and time are preserved across this command boot, whereas they are not for a front panel boot. The options are:

/WAIT—This option is intended mainly for systems with only a single disk. It loads and initiates the operation. It pauses with a query to remove the system volume, replace it with a different one, and responds Yes to continue the boot.

SQUEEZE[/options] dev:
/NOQUERY
/WAIT
/OUTPUT:dev:

As the system is used and files are created and deleted, disks will become fragmented with many small <UNUSED> areas. The SQUEEZE operation compresses all files to the beginning of the disk. It consolidates all unused blocks in one area. It may also happen that a directory becomes full when there is still room on the device. The directory has not reached its maximum capacity as described in the paragraph on general file operations. A squeeze operation also compresses the directory and makes room for more entries. SQUEEZE does not move files with type .BAD. If any exist, the space before each one is used only as long as the next complete file will fit into it. When the next file will not fit, an unused area will be left and the next file will be located after the .BAD file. SQUEEZE renames all .BAD files to FILE.BAD.

CAUTION

It is essential that files not be moved into areas with bad blocks. If this were done, it could result in an unusable copy. Always use DIR/BAD to scan for bad blocks before a SQUEEZE. If any are found in unused areas, use CREATE to write .BAD files over them. Preferably, the disk should be backed up before a SQUEEZE. The /OUTPUT:dev: option shown below then may be used. If bad blocks are found in existing files, the monitor will report an error. The monitor will abort if the error persists through a retry.

SQUEEZE does not affect the bootstrap blocks. If the current system volume is squeezed, the monitor will be automatically rebooted at the end of the operation. This is done to prevent possible crashes if .SYS files were moved from their previously known locations. The options are:

/NOQUERY—SQUEEZE normally prints an "Are you sure?" query and requires a Yes confirmation. NOQUERY suppresses this message. NOQUERY is also the normal mode for the /OUTPUT option.

/WAIT--This option is mainly for single disk systems. It allows squeezing disks other than the system disk. It initiates the operation, but then pauses with instructions for the operator to mount the volume to be squeezed, and then remount the system volume. This cycle may have to be repeated several times.

/OUTPUT:dev—This option leaves the input volume unchanged. It copies all the files to the output volume in squeezed format. This is essentially the same as the wildcard copy of all files used in Section III to duplicate disks. The only exception is that for SQUEEZE the output volume must be newly INITALIZEd (i.e., empty). It is not necessary to use the /SYS option to include .SYS type files. SQUEEZE does not copy .BAD files and it does not copy the bootstrap blocks.

CREATE filnam.typ[/START:n[/ALLOCATE:n]][/EXTENSION:n]

This function creates a file by either making a directory entry for it or extending the size of an existing file. It does not store or alter data in the new area it covers. It is frequently used in conjunction with the /DELETED option of DIRECTORY to recover files that have been accidentally deleted. If options are not specified, it will start the file in the next available space and allocate one block or extend by one block. CREATE is not allowed if the new or extended file would overlap any existing files. Note that all the options must be associated with the filespec rather than the command word.

/START:n—This option specifies the starting block number (in decimal) for absolute location of new files. Starting blocks of existing files and empty areas can be obtained with the /BLOCKS and /FULL options of DIRECTORY.

/ALLOCATE:n—This option specifies the size of the file in blocks (decimal). If n is not given, 1 is assumed.

/EXTENSION:n—This option specifies the size of the extension for existing files in blocks (decimal). If n is not given, 1 is assumed.

4.7.4 File Manipulation Functions (PIP)

This paragraph describes the commands that operate on files as opposed to the preceding device operations. All of these functions call on the PIP utility program. They are:

COPY TYPE RENAME DELETE

4.7.4.1 Common Options. Several of the available options in this group are common to all or more than one of these functions. The common options are described below and then just listed in the command descriptions afterward. Options that are unique to one command are described under that command. Note that all of these commands will accept wildcard designations to operate on a category or set of files.

/SYSTEM—System files (type .SYS) will not be included in Copy, Rename, or Delete operations unless this option is specified.

/SETDATE—The existing date on an input file is normally carried through a Copy or Rename operation. If this option is specified, the date for the output file will be changed to the current date unless the system is currently not dated.

/NEWFILES--If this option is invoked the operation will be performed only on the files specified and only on those that bear the current system date. That is, it will be performed on the files created "today".

/ (NO)REPLACE—The system will normally open a new file with the same name as an existing one. It will then delete the old one when the operation is successfully completed. The NOREPL option will prevent the operation if a duplicate name is specified.

/ (NO)QUERY—The delete command normally prints a list of files to be deleted. It requests confirmation (?) by Yes entry for each of the files to be deleted. This confirmation request can be suppressed by /NOQUERY. Conversely, the COPY and RENAME operations do not normally request confirmation for each file. However, they can be instructed to do so by /QUERY. This allows the operator to selectively copy or rename only certain files from a wildcard group.

NOTE

> /QUERY above and /LOG below are normally mutually exclusive. For DELETE, the normal query list supplies a log. For COPY, the normal log appears unless /QUERY is specified. If both query and log are wanted, it must be so indicated in the command with /QUERY/LOG (or just /LOG for DELETE which will always query unless instructed otherwise).

/(NO)LOG--The COPY and RENAME commands normally print a log of the files involved if there is a wildcard in the filespec and if /QUERY is not specified. It can be suppressed with /NOLOG. DELETE normally prints only a query list. However, a log can also be requested with /LOG.

/EXCLUDE—For COPY and DELETE. This option instructs the system to operate on all files on a device <u>except</u> the ones specified in the input filespec.

<u>Example:</u>

COPY/EXCLUDE *.SAV,*.DAT DY1:*.*

will copy all files from the current default device to floppy DY1 except for image (program) files .SAV and data files .DAT. .SYS and .BAD files are also never included unless specifically requested.

/WAIT—This option is intended mainly for systems with only a single disk drive. When a command is invoked with the /WAIT option, the system will load the appropriate utility and initiate the function. The system then stops and prompts with a message to replace the system volume with the input and/or output volumes to be operated on. When ready, respond Yes to a "Continue?" query. If operating on a single device, the input/output swap may have to be repeated several times. When the operation is complete, another message instructs the system volume to be remounted. The only time the /WAIT option is absolutely required in a dual disk system is when it is desired to copy files between disks, neither of which has the system programs.

4.7.4.2 Commands, Options, and Defaults. Listed below are the commands of this group. This is followed by a list of their options with descriptions of the ones not covered in paragraph 4.7.4.1. Options listed on the same line are mutually exclusive. Options separated from others by a blank line must be used alone. Others may be combined in the command as desired. The default options that will be assumed if others are not specified are underscored. No operation will be performed that would result in deletion of a protected file. For example, even if /REPLACE is specified in a COPY command, the operation would not be performed if a protected file of the same name exists on the target device. Protection is assigned or removed only by the RENAME command.

COPY[/options] input-filespecs output-filespec[/ALLOCATE:size]

/SYSTEM	(Include .SYS files)
/SETDATE	(Assign current system date)
/NEWFILES	(Include only current system date)
/[NO]QUERY	(Confirmation request)
/[NO]LOG	(List copied files for wildcards)
/EXCLUDE	(All except input filespecs)
/[NO]REPLACE	(Delete old file if duplicate)
/WAIT	(Initiate, then pause for volume swap)
/CONCATENATE	
/PREDELETE	
/SLOWLY	
/IGNORE	
/DEV	See preceding paragraph on device operations (DUP)
/BOOT	See preceding paragraph on device operations (DUP)
/[NO]PROTECTION	(Give the output file protected status.)

The COPY function reads the input file(s) and writes it (them) into new output files. Up to six input file specs may be listed, separated by commas, and/or wildcards may be used. Only one output filespec is allowed. It may contain name or type wildcards but no embedded wildcards. If wildcards are used in input, the corresponding name or type in output must be a wildcard. The only exception is the /CONCATENATE option in which the output filspec must represent a single file. Therefore, no wildcards are allowed. Type .SYS files will not be copied unless /SYS is specified. Type .BAD files will not be copied unless they are specifically identified by filnam.BAD. The function will preserve the date of the input file for the output, delete any old files with the same name as the new output after the operation, and print a log listing if wildcards are involved.

Example:

.COPY A%B.DAT DY1:*.BAK

This copies from the default device all files of type .DAT whose names have three characters beginning with A and ending with B to floppy drive DY1. The copies will have the same names. However, their types will be changed to .BAK (backup).

CAUTION

> This use of output wildcards could delete any files on DY1 named A%B.BAK unless /NOREPL is used to guard against it.

The unique copy options are:

/CONCATENATE—Normally each input file is copied to a separate output file. If /CONC is specified, all input files will be concatenated into a single output file. This concatenation will be in the order in which they are listed and/or found on the device. The filespec of the single output file cannot contain any wildcards. Concatenation can also be specified without /CONC by using plus signs instead of commas to connect the input files, e.g.:

COPY A.DAT+B.DAT+C. DAT DY:XYZ. DAT

/PREDELETE—If this option is specified, an existing file with the same name as a new output file will be deleted before the copy is performed. This option can be used on crowded devices to recover space for new files provided they will fit where the old one was.

CAUTION

> If errors occur in the operation, you may be left with no usable copy.

/[NO]PROTECTION—These options assign or remove protected status from the output file. A protected file cannot be deleted by a DELETE command or by creating a new file with the same name. Protected status is indicated by a P following the file size in directory listings. It can be removed by the specific UNPROTECT or RENAME/NOPROTECT commands. If no protection option is specified, the output file will have the protection status of the input file.

/SLOWLY—This option performs the copy operation one block at a time. It can sometimes perform an operation that previously failed because of read errors.

/IGNORE—This option forces the block by block copy of SLOWLY. It also instructs the system to ignore any input errors. It can sometimes recover files that are otherwise unreadable and allows the operation to proceed even if errors still occur.

/ALLOCATE:size—This option specifies the number of blocks to be initially allocated for each output file. The special size code -1 will allocate all of the largest contiguous area. Note that in this monitor command form the size must be specified with /ALLOC. It cannot be given as a [size] suffix on the filespec.

TYPE [/options] input-filespecs

/[NO]LOG	(list copied files)
/QUERY	(confirmation request for wildcards)
/NEWFILES	(current system date only)
/WAIT	(start, then pause for volume SWAP)
/COPIES:n	
/DELETE	

The TYPE function is merely a special case of COPY which is intended only for ASCII files and direct output to the TT: terminal. If a .typ is not given in the filespec, the default is type .LST (for "listing"). Type .LST files do not normally occur in application software. The unique options are:

/COPIES:n—Specifies n = 2 to 32 (default 1) repetitions for multiple copies.

/DELETE—Deletes the file after it is printed. **CAUTION:** No confirmation queries.

RENAME[/options] input-filespecs output-filespecs

/NEWFILES	(current system date only)
/[NO]REPLACE	(delete old duplicates)
/QUERY	(confirmation request)
/[NO]LOG	(list renamed files)
/SETDATE	(change date to current system date)
/SYSTEM	(required for .SYS files)
/WAIT	(start, then pause for volume swap)
/[NO]PROTECT	(see below)

This function assigns a new name and/or type to an existing file. It operates only on the directory entries and does not tamper with the file data. Otherwise, it follows the same general rules as the preceding COPY operation and its options. Up to six input filespecs can be listed but only one output. For wildcard operations, RENAME normally prints a log listing of the files. This listing may be suppressed with the /NOLOG option or replaced with /QUERY for selective renaming. The dev: for input and output must be the same. Renaming from one device to another cannot be done. The /SYS option must be given to operate on .SYS type files. Files that are .BAD will not be included in an operation unless identified explicitly by name and type. If a file already exists with the same name as the new (output) name, the old file will be deleted unless /NOREPL is specified or it has protected status as follows:

/[NO]PROTECT—These options assign or remove protected status for a file. A protected file cannot be deleted by a DELETE command or by creating a new file with the same name. Protected status is indicated by a P following the file size in directory listings. Protected status is carried through COPY and/or RENAME operations. It can only be removed by the specific RENAME/NOPROTECT option, or by the UNPROTECT command.

DELETE[/options] filespecs

/[NO]QUERY	(confirmation request)
/LOG	(list deleted files)
/NEWFILES	(current system date only)
/EXCLUDE	(all except those specified)
/SYSTEM	(required for .SYS files)
/WAIT	(start, then pause for volume swap)

This function deletes files (up to six filespecs, and wildcards) by changing their directory status from permanent to empty (UNUSED). Thus, it makes their space available for new files. Accidentally deleted files can be recovered until the space is re-used. DELETE follows the same general rule and options as COPY and RENAME.

The only exception is that its default condition is to request /QUERY confirmation instead of printing a log unless /NOQUERY is specified. If /LOG is specified, confirmation will not be requested unless /QUERY is also specified. Files .BAD will not be deleted unless they are identified explicitly by name and type. .SYS files will not be deleted unless the /SYS option is included.

4.7.5 Directory Operation (DIR.SAV Program)

All of the functions of the DIR.SAV program are called through the single basic command DIRECTORY with several options described below. These functions merely read and output information about existing (or deleted) files. None of these functions alters anything on the device. If filespecs are specified in the command, the system will list directory information only for those files (or groups of files if a wildcard is used). This is true except for the /EXCLUDE option which lists all files except those specified. Up to six filespecs may be specified. If only a device is specified, the directory will include all files on that device. If not even a device is indicated, the directory will list all files on the DK: default device. If no options are requested, the default output is printed on the terminal in two columns, reading across, in the order in which files are physically located on the disk. Each listing will show file name and type, size in 256-word blocks, protected status (if applicable), and date, if any. The size, and block number address when requested, are normally printed in decimal. However, they can be requested in octal. The basic command form and options are as described below. Some of the options are mutually exclusive in certain combinations that will be obvious when attempted:

DIRECTORY[/options] filespecs[/BEGIN]

/TERMINAL/PRINTER/OUTPUT:filespec[/ALLOCATE:size]

/VOLUMEID[:ONLY]	(print ID and owner, if any)
/EXCLUDE	(list all files except "filespecs")
/NEWFILES	(files with current system date only)
/BEFORE:dd:mmm:yy	(files prior to date only)
/DATE:dd:mmm:yy	(files of date only)
/SINCE:dd:mmm:yy	(files after date only)

/ORDER:category (:NAME, :TYPE, :DATE, :SIZE, :POS)[/REVERSE]

/SORT:category[/REVERSE] (same as ORDER)

/ALPHABETIZE[/REVERSE] (same as ORDER:NAME)

/COLUMNS:n	(print in n = 1-9 columns, default 2)
/BRIEF	(print only filnam.typ, 5 columns)
/FAST	(same as BRIEF)
/BLOCKS	(include start block numbers)
/OCTAL	(print size and block in octal)
/FULL	(include < UNUSED> areas)
/FREE	(list < UNUSED> areas only)
/DELETED	(list only deleted and tentative files)
/WAIT	(start, then pause for volume swap)

/BADBLOCKS[/FILES] [/START:n] [/END:n] [/VERIFY]

/BEGIN—This option must always be associated with the filespec. If given, the directory will include only the specified file and all that are physically after it on the device, in position order. Other ORDERs cannot be specified with this option.

/TERMINAL/PRINTER/OUTPUT:filespec [/ALLOC:size]—The directory is normally printed on the terminal. It can be directed to a line printer if available or to an output file itself. In this case, the size allocation in blocks can be specified. The default type if not given is .DIR.

/EXCLUDE—List all files on the device except those indicated by the specified filespecs.

/NEWFILES/BEFORE/DATE/SINCE—These four options are mutually exclusive. /NEWFILES lists only those with the current system date. Note that the dates for these options are entered with colons(:) rather than hypens (-) as they are for the monitor .DATE command. The ranges are dd = 1-31, yy = 73-99, and first three characters for the month. Any part of the date may be defaulted. If no date is given, the current system date is assumed. If only a day is given, it is assumed that day of the current date month and year. If only a month is given, it assumes the first day of that month in the current year. If only a year is given, it assumes 1 JAN of that year. If the system is undated, it is considered date 0. This is the same as an undated file entry in the directory. /NEWFILES is the same as /DATE[defaulted].

/ORDER:category— The directory listings will be printed in the order specified by one of the following categories. (Numbers come after letters in alpha listings.):

:NAME	alphabetical by filnam, then alphabetical by type for same names
:TYPE	alpha by type, alpha by filnam for same types
:DATE	oldest file first, alpha for same dates
:SIZE	smallest file first, alpha for same size
:POS	(default) physical position on device but see note below.

/REVERSE may be applied to any of the above. /SORT is an alternate name for /ORDER, and /ALPHA is a shorter entry for /ORDER:NAME.

NOTE

For all of the ORDER options (including defaulted :POS), multiple columns read top to bottom rather than across as for the default case.

/COLUMNS:n—This option will normally be used to change the default 2 columns to n.

/BRIEF/FAST—These options are the same. They print only the filname and .typ, always in five columns, omitting size and date.

/BLOCKS—This option includes the absolute starting block number for each file. This is done to indicate the physical location of the file on the device. It is useful in recovery operations for accidentally deleted files. Block numbers are in decimal unless the /OCTAL option is invoked.

/OCTAL—Prints the file sizes and block numbers in octal instead of decimal. This is helpful where a function requires an octal address.

/FULL—Includes listings of the (UNUSED) areas between files.

/FREE—This option gives a list of (UNUSED) areas only. With this option, sizes of the ones remaining can be quickly seen.

/DELETED—This option prints the directory information for files that have been deleted but have not had their directory entries destroyed by re-use of their areas. Tentative (unclosed) files are also included. The block numbers are in decimal unless the /OCTAL option is invoked. This can be useful in re-creating accidentally deleted files with the DUP CREATE function.

NOTE

> If several contiguous files have been deleted, the /DELETE option may list only the first file name with a size. This size includes the entire area of all the contiguous files.

/BADBLOCKS [/FILES] [/START:n] [/END:n] [/VERIFY]—This option scans a volume for bad blocks. Unlike the INIT/BAD function, it does not INITIALIZE the volume nor write FILE.BAD over bad blocks. It can be performed on a volume that has been in use to detect bad blocks that may have developed from age or misuse. If any blocks return hardware errors when they are read, DIR/BAD prints a list of their absolute block numbers in decimal unless the /OCTAL option is invoked.

If the **/FILES** option is included, the list will also include the names of files in which the bad blocks are located.

The **/START:n** and **/END:n** options allow you to limit the range of the scan by giving starting and ending block numbers, n, in decimal. The defaults are block 0 (the first block on the device) and the last block on the device.

The **/VERIFY** option carries the scan one step further. Instead of just reading the block for a checksum, the scan will read the block, write the same data back to it, and read it again. The block may sometimes recover. If it does, it will report a "soft" error. However, this still does not guarantee the integrity of the data in the block. Therefore, /VERIFY should be used only after a failure and should be regarded with caution.

4.7.6 Backup Operation

The functions supplied by the BUP.SAV program (backup operation) are provided through the single monitor command BACKUP. The BACKUP command copies the contents of large files or an entire volume to a set of smaller volumes (such as floppies). Since the stored file information is not directly accessible in this "backup" format, this operation should be used for archival storage only. The reverse operation of restoring the fragmented file or volume to its original form is required to regain access to "backup" format information.

The format of the BACKUP command is:

BACKUP[/options] input-filespace output-filespace

/DEVICE	(save or restore entire volume)
/RESTORE	(restore file or volume from backup operation)

In the command syntax, the input-filespec represents the data to be copied. Wildcards are not allowed. The device and filename must be specified. When storing a file, the default output-filename is the same as the input-filename. The BACKUP options are described below:

/DEVICE — If an entire volume is to be stored, this option is used. The input-filespec contains only the volume name and the output-filespec specifies the output device. The default output filename is the input volume name with the default extension .BUP unless otherwise specified in output-filespec.

For example, saving the contents of DL0: to a set of floppies is accomplished by the command:

```
BACKUP/DEVICE DL0: DY0:
```

which generates a backup file on DY0: called DL.BUP. Since multiple floppy disks are required for this operation, BACKUP will prompt you to mount another volume in the same drive when the current volume is full.

/RESTORE — To restore the file or volume, this option must be specified in addition to entering the proper input and output devices. The restore operation gets the data from the backup volume to restore the desired file or volume. If multiple input volumes are required, you are prompted to mount them in the proper order.

To restore the DL0: device in the example above, enter the following command:

```
BACKUP/DEVICE/RESTORE DY0: DL0:
```

Note that output volumes must be specially initialized as backup volumes. Mounting a device that is not initialized for BACKUP results in an error message. Initialization is performed with the following command:

INITIALIZE/BACKUP device

Multiple backup operations cannot be performed to the same backup medium.

BACKUP can only be performed to volumes that are smaller than the input file or volume unless the output device is magtape. Initialization is not required for magtape devices (such as TK-50) since these volumes are automatically initialized during backup. Magtape devices are not provided as standard options for the GenRad 2515 by GenRad.

4.8 VIRTUAL MEMORY HANDLER: VM

The Virtual Memory handler (VM) allows extended memory to be accessed as though it were a disk. In general, you can use VM just as you would use DL or DY. The INIT command is used to initialize the extended memory area reserved for VM before writing files to it. The DIRECTORY command can be used to obtain a list of the files stored on VM, as with any other device. The RT-11 monitor, utilities, and bootstrap can be copied to VM, and the system run from VM. It can be advantagous to use VM, as file accesses to VM may be much faster than to a physical disk such as DL. (There are some situations where the VM device may actually be slower than a disk. This will occur when running the RTA program with high bandwidth and/or a large number of channels.)

The VM handler must share memory with other programs which uses extended memory for data storage. Any memory space which is used by the VM handler is not available for use by the RTA program. Therefore, it may not be appropriate to use the VM handler with the RTA program unless a minimum 512k words of memory is available. When the RTA program runs, it determines whether the VM handler is both available and resident. If both conditions are met, the program determines how much memory the VM handler has allocated (as indicated by the VM base), and allocates all memory up to the base thereof. If the memory available is insufficient to support minimum functionality, the RTA program aborts with an error message.

Several steps must be taken before use can be made of the VM device. The size of the device must be established, the device must be initialized, and any files desired must be copied to it. If VM is to be used by any other program, the VM handler must be loaded.

4.8.1 Setting the Size of VM

The VM handler determines the amount of physical memory on the system and use all of the space from its base address to the top of memory. Therefore, you alter the size of the device by varying the base address using a SET command:

.SET VM BASE = n

In this, n is the desired base address in octal, divided by 100(octal). For example, use the value 10000 to set the base address at the 128k-word boundary. The base address must fall on a 4k-word boundary. The following list shows the amount of "disk" space which can be obtained with various selections of the base address. The K-Word column represents the base address for VM as specified by the entry in column 2. The last 2 columns indicate how many blocks will exist on the VM pseudo device for two memory configurations.

		Blocks Available On Device	
K-Words	n	(128k System)	(512k System)
28*	1600	344.	1936.
32*	2000	328.	1920.
64*	4000	256.	1792.
68*	4200	240.	1776.
96	6000	128.	1664.
128	10000	0	1536.
256k	20000	0	1024.

Use the SET command whenever the base address is to be changed (and before the first use of VM). It need not be issued every time the system is booted or turned on. When this SET command is entered, the message "VM-W-Remove and reinstall" is printed. The commands:

.REM VM:
.INST VM:

should be issued following the SET command. (If the handler was loaded, ".UNLOAD VM:" should be issued before the .REM command is issued.)

4.8.2 Initialization and Use of VM

Unlike the commands noted in paragraph 4.8.1, which are needed only when a change in the size of VM is required, other commands must be issued each time the system is powered up before VM can be used. It is important to note that VM resides entirely in memory, and is therefore volatile. When the system is turned OFF, the directory, and all files on VM, are lost. Data written to VM should be copied to DL or DY before the system is powered down. The contents of VM can also be destroyed if another program is run while the VM handler is not loaded.

After powering up, issue the following:

```
.INIT(NOQ(VERY)) VM:
```

to establish the directory. Any files desired on VM should then be copied with:

```
.COPY
 from: file1. sav, file2. scr...
 to: VM:
```

For example, if you wished to run the RTA program from VM, enter the following:

```
.COPY
 from: RTA.SAV
 to: VM:
```

If the VM device is to be used by TSL2 or the RTA program, it must be loaded prior to running the programs:

```
.LOAD VM:
```

Note that if the VM handler is not loaded prior to running either the RTA or TSL2 programs, the contents of VM can be corrupted, even if no attempt to access VM is made by the program. After this occurs, you must either reboot or reinstall the handler, and initialize the VM directory.

To run the program on VM, enter the following:

```
.RUN VM:RTA
```

Files can be written to the VM device from the RTA or TSL2 programs simply by including "VM:" as the device code in the file specification.

4.9 USING VT100 AS AN AUXILIARY TERMINAL ON THE 2515

The 2515 system can be equipped with an auxiliary terminal such as a VT100. The connector for the terminal is normally the REMOTE connector on the rear panel of the 2515 (see Figure 1-3).

The TTAUX.SAV and TTCON.SAV programs, supplied in the run-time RT-11 package, provide a means for dynamically switching system control between the basic CONsole terminal and an AUXiliary terminal. The RT-11 system maintains hardware addresses and interrupt vector pointers for service of the console terminal. When the TTAUX.SAV and TTCON.SAV programs are executed, they enter the system to change those addresses and pointers, thus substituting the auxiliary terminal for the normal console or vice versa.

When an auxiliary terminal is installed, you can transfer control to it anytime the keyboard monitor is listening by entering the following command:

```
.R TTAUX
```

Thereafter all input/output is performed on the auxiliary terminal until you switch back or reboot the system. These changes are performed only in the running system and do not affect any monitor or device handler files.

KED.SAV is the keyboard editor that can be invoked when an auxiliary terminal such as a DEC VT-100 (TTAUX.SAV) is used. For a description of the KED editor, refer to the Digital Equipment Corporation, Keypad Editor User's Guide, order number AA-H853A-TC or equivalent.

To return to the basic console, enter the following command anytime the keyboard monitor is listening:

.R TTCON

This restores the monitor's normal console addresses, which are 177560(8) through 177566(8) and interrupt vector 60(8).

The only interface supported by TTAUX is the DLV11 asynchronous serial line interface. The REMOTE RS-232 port on the rear panel of the 2515 is factory set for the following addresses and interrupt vector (all octal):

175650	receive command and status register (RCSR)
175652	receive data buffer (RBUF)
175654	transmitter command and status register (XCSR)
175656	transmitter data register (XBUF)
000350	interrupt vector

The REMOTE RS-232 port is normally set up for the following parameters, which must also be selected on the terminal to be used:

Baud rate:	9600 (received and transmit)
Parity:	8 data bits, no parity
Start/Stop bits:	1 stop bit

The TTAUX program as supplied assumes that the addresses and the vector listed above and when executed, modifies the running monitor accordingly. If the terminal interface is installed with different addresses or vector, the addresses and vector in the TTAUX program must be changed to match. These hardware reference addresses reside at fixed locations in the TTAUX program and can be changed with the Save Image Patch Program (SIPP) as follows:

```
.R SIPP
*dev: TTAUX.SAV
Base?    0

Offset?  1000
Base     Offset   Old      New?
000000   001000   175650   (new RCSR)<CR>
000000   001002   000350   (new vector)<CR>
000000   001004   000000   <CR>
000000   001006   175652   (new RBUF)<CR>
000000   001010   175654   (new XCSR)<CR>
000000   001012   175656   (new XBUF)<CR>
000000   001014   xxxxxx   (CTRL/Y)<CR>
*(CTRL/C)
```

Parenthetically, the AUX REMOTE RS-232 PORT can also be used for auxiliary terminals. In this case it is either used as channel 3 or channel 4. The corresponding addresses and interrupt vectors along with other information is tabulated below:

	chan 3	chan 4
RCSR	175660	175670
RBUF	175662	175672
XCSR	175664	175674
XBUF	175666	175676
vector	000360	000370
Baud	9600	300
Parity	none	none
Start/Stop bit	1	1

Channel 3 is wired in the AUX REMOTE RS-232 connector the same as the REMOTE, which is a standard connection. The pin connection is:

Pin 2	(transmit data)
Pin 7	(ground)
Pin 3	(receive data)

Channel 4 is wired as the "secondary" port in the AUX REMOTE connector with the following connection:

Pin 14	(transmit data)
Pin 7	(ground)
Pin 16	(receive data)

The connection to the terminal is through a "null-modem" cable, which has transmit and receive lines reversed.

SECTION V

RTA PROGRAM OPERATION

This section contains detailed descriptions of the 2515 system operations using the RTA (Run-Time RT-11) program. Descriptions provided include measurement setups and operations, data storage operations, and display and cursor operations.

Before proceeding, new users should first perform the test and familiarization procedures presented in Section II.

5.1 STARTING THE RTA PROGRAM

To begin operation of the RTA program (also referred to as the 2515 program) first perform the power on instructions described in Section III.

Once power on is accomplished, a prompt (.) appears on the display. If the RTA Version 1.0 panel setup is to be used, an installation command must be performed at this time. To do this type:

```
COP    PANMEM.SCR    PAN2.SCR
COP    DATMEM.SCR    DAT2.SCR
```

The start up program may contain a command to automatically start the RTA program. If it does, a full display grid appears on the screen and the system is ready for panel operation.

If not, start the RTA program from the monitor. Type the command:

```
.R RTA
```

The R is a RUN command to the monitor. RTA (Real Time Analyzer) is the 2515 program file name.

5.2 RETURNING TO RT-11

At times during normal operation, you may want to stop the RTA program and return to the operating system. This is required mainly for manipulation of files that have been created on one or the other disk. RT-11 is not required to create files. That is done from the front panel by means of the STORAGE function. However, RT-11 does provide the means to obtain directories of the files that exist, to copy files from one device to the other, to rename files, to delete files, and to perform various other management operations. Descriptions and instructions for these operations are given in Section IV.

There are two methods to return to RT-11; one quick and one preferred.

Preferred Method:

1) Press the MEASUREMENT SETUP MODE button to obtain the mode menu.

2) Move the pointer to select EXIT TO RT-11.

3) Press the ENTER or NEXT button.

This method enters a shutdown routine that closes any open files, preserves the current panel setup information in memory buffer 16 (see Storage Functions), and erases the screen for a clean start with RT-11. Upon return to the 2515 program, the panel setup is restored from the memory buffer automatically.

Quick Method: Enter CTRL/C twice. (Hold the CTRL key and strike the C key.) This method aborts the 2515 program and immediately return control to the RT-11 monitor, which identifies itself by printing a prompting dot (.) at the left of the screen. This method is fast and convenient, but does not preserve any current setup information or any open data files.

5.3 RESTARTING THE RTA PROGRAM

In response to the RT-11 prompt (.), type the command:

.R RTA

The panel setup that was in effect upon the last "EXIT TO RT-11" from the 2515 program is automatically restored.

5.4 DISK DRIVE IDENTIFYING DEVICE NAME CODES

The RT-11 system uses fixed two-letter (or two-letters plus a number) codes followed by a colon (:) to identify peripheral devices such as the disk drives. In creating data or setup files from the front panel, you need these codes if you wish to specifically assign a file to one disk or the other. The applicable codes are:

SY: The system device; that is, the device from which the system programs have been loaded by the initial bootstrap operation. For the 2515, this is usually equivalent to device DL0:

DK: The system default device; that is the device that is assumed if no device code is included in a file reference. DK: is initially the same as SY:, but you may specifically assign it to another device if desired.

DL:
DL0:
DL1: The Winchester disk. The Winchester is organized and addressed as two separate devices, which may be specifically referred to as DL0: and DL1:. Plain DL: without a numeral refers to DL0:, which is ordinarily the system device (SY:) and the default device (DK:), unless you have booted from a different device or assigned the default to a different device as described in the next paragraph.

DY: The floppy disk. This is a default for DY0:. If additional floppy disks should be added to the system, they would be DY1:, DY2:, and DY3:. Note that this is not yet supported by the storage function. If files are to be created by RTA on DY:, load DY: before running RTA. If this is not done, no room (in lower memory) can be allocated for the DY: handler.

5.5 ASSIGNING THE DEFAULT DEVICE

When the system is started, the default code DK: is assigned to the SY: system device which is normally Winchester DL0:. This means that any time you refer to a file by its name without specifically including one of the other device codes (DL1: or DY0:) the file is placed on or searched for on DL0:. However, if you wish, you can assign the DK: default to one of the other devices by going to RT-11 and using its ASSIGN command. For example, if you want your data files to go to the floppy disk (DY:) without having to give a device code when you give the file name, the RT-11 command would be:

```
.ASSIGN  DY:  DK:
```

For convenience, you can assign logical device names to any of the disks. If you want to refer to them as A, B, and C, the commands would be:

```
.ASSIGN DL0:  A:
.ASSIGN DL1:  B:
.ASSIGN DY:   C:
```

Further descriptions of file and device names are given in a following paragraph on Storage Functions and in the RT-11 descriptions of Section IV.

5.6 DISPLAY FORMATS AND ANNOTATION

The display function is capable of maintaining two complete and independent data displays: an upper display and a lower display.

The upper display takes full screen when you select SINGLE display, and is the only one that is active or accessible for modification by the panel controls. To change the lower display function, you must use the EXCHNG button to swap the upper and lower displays. The upper display also governs in case of certain conflicts for combined displays, and the upper display is the one whose source is indicated by the REAL TIME, AVG, and MEM indicators. Also, for combined displays, the cursor readout applies only to the upper display.

The lower display is simply held in a separate memory area and is available for display in the DUAL or OVLY modes. All of its setup parameters are carried with it and it is independent of the upper display except for certain restrictions described in the following when in DUAL or OVLY modes:

NEXT CHAN	Increments both upper and lower displays.
X SCALE	Rescales both displays if they are of the same X-axis window type.

Y SCALE Rescales both displays if they are of the same Y-axis window type.

UNITS Changes X or Y axis units if they are the same on both upper and lower functions.

WINDOW The window types are discussed in paragraph 5.8.7.1.

You may have both time and frequency domain displays on the screen at the same time, or real-time and averaging or memory displays at the same time.

The display format is basically selected by the DISPLAY group pushbuttons labeled:

SINGLE Full screen display of one function.

DUAL Dual upper and lower display of two functions.

OVLY Dual superimposed (overlaid) display of two functions.

EXCHNG Swaps upper and lower displays.

Figure 5-1 shows typical displays and annotation of each of these formats and of a display with a menu from one of the panel pushbuttons. The annotation that is not self-explanatory is described in the following paragraphs.

5.6.1 SINGLE Display, Full Annotation with Setup Summary

The following paragraphs list the functions, sources, and abbreviations of the display annotation shown in figure 5-1.

5.6.1.1 Measurement Setup Summary. The SINGLE display format allows space at the top of the screen for two lines that summarize the setup parameters described in the paragraphs on Measurement Setup functions, as follows:

a.	MODE Setup	AUTO	Auto-channel
		CROSS	Cross-channel
		PROB	Probability functions
b.	FREQ Setup, Basic Range (range in Hz on x-axis)	BBND	Baseband
		ZOOM	Passband

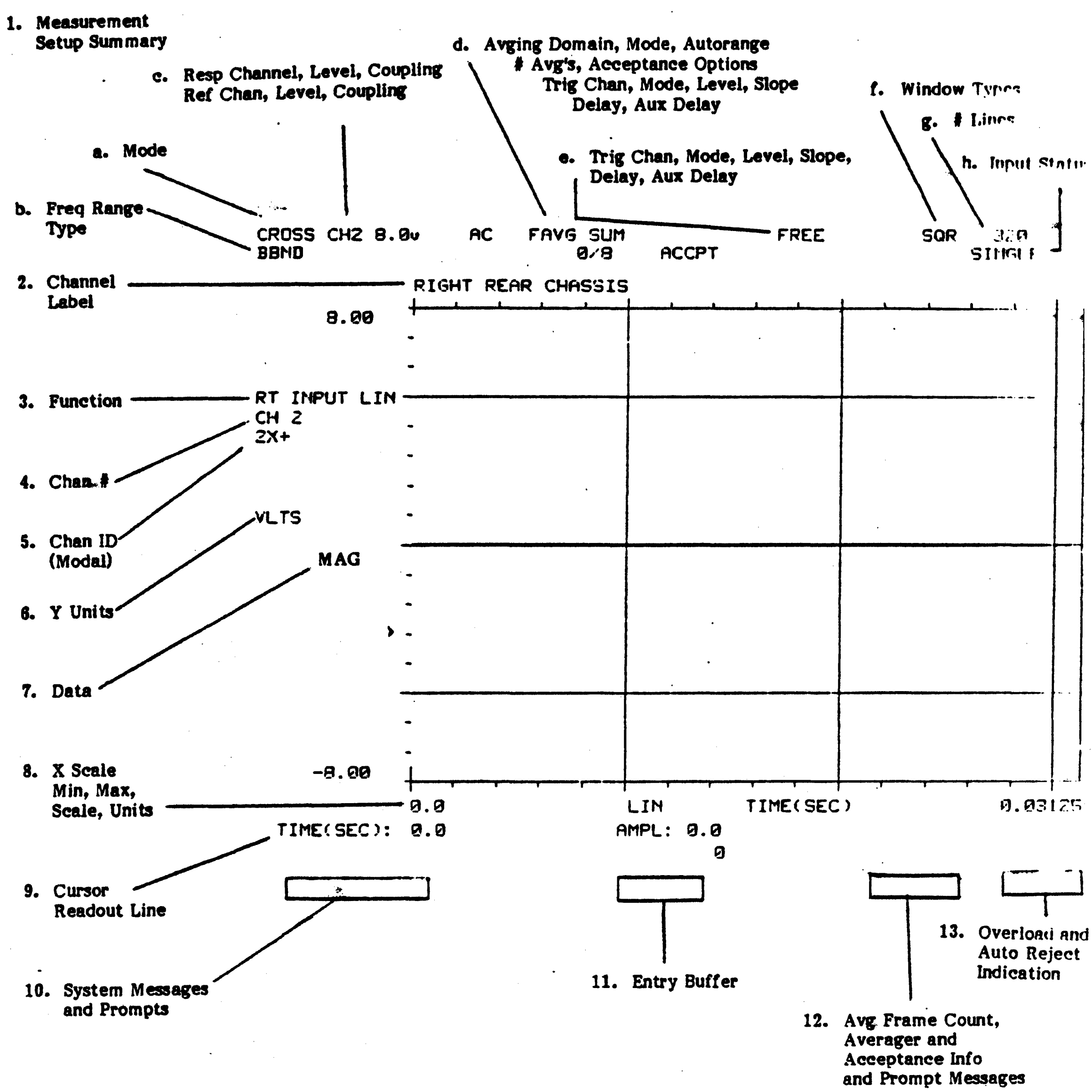
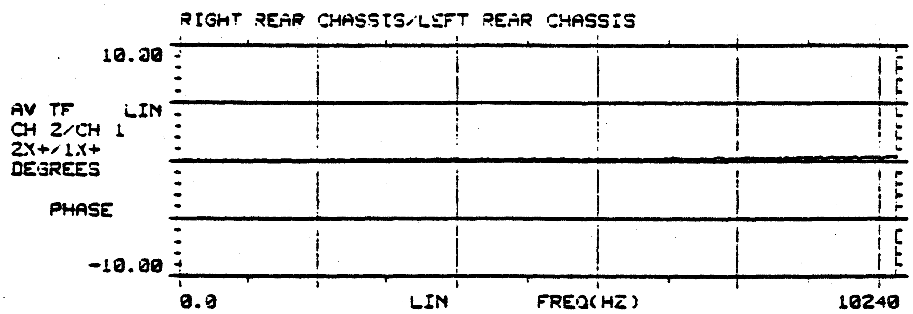


Figure 5-1. Display Formats and Annotation (Sheet 1 of 2)

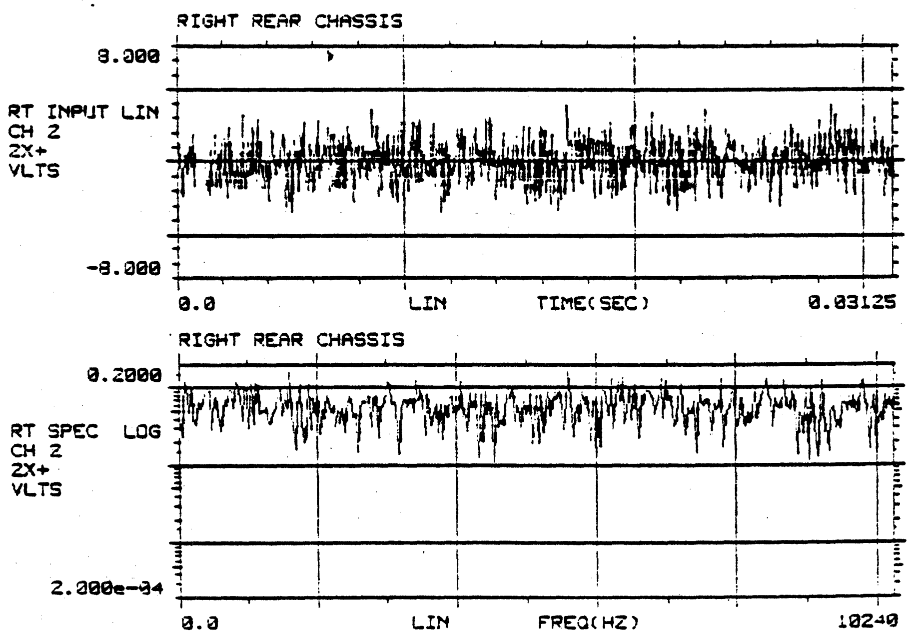


Storage Type/Destination

>* 1) DATA to FILE
2) DATA to MEMORY
3) PANEL to FILExx
4) PANEL to MEMORY

Type/Dest: Data to File
Storage Grouping: Single
Restriction: ANY FUNCTION
Acquisition Type: SHAKER TEST
Current File:
File Status: CLOSED
File Format: MODAL
Previous Action: recall
SUCCEEDED

FREQ(HZ): 0.00 PHASE: -359.9
8



TIME(SEC): 0.0 AMPL: -0.4151
0

Figure 5-1. Display Formats and Annotation
(Sheet 2 of 2)

c.	CHANS/LEVEL Setup	Number, level, coupling, e.g.:	
	Resp Chan (top line)	CHx	Channel Number
	Ref Chan (2nd line, if Cross-channel display)	4.0V	Voltage range 0.0625 to 8.0
		AC	AC coupling
		DC	DC coupling
		ZERO	Zero input
		BIAS	2mA current for PCB
		DCR	Software DC removal
d.	AVERAGE Setup		
	Domain	FAVG	Frequency domain average
		TAVG	Time domain average
	Mode	SUM	Summation average
		DIF	Subtractive average
		EXP	Exponential average
		PEAK	Peak hold average
	Number of frames, processed/requested	e.g. 273/500	
	Auto range, if ON	AR/x	(x = minimum percent full scale peak)
	Acceptance options	ACCPT	Accept every frame
		MAN	Manual (CONT to accept)
		REJOV	Reject overload, underrange
		REJDH	Reject double hits
e.	TRIG Setup		
	Source Chan	CHx	Channel number
	Mode	FREE	Free run
		A1st	Auto arm 1st frame only
		AEVR	Auto arm, every frame
		MAN	Manual arm
	Level and Slope, e.g.:	20 P	+20%, Positive slope
		-40 N	-40%, Negative slope
	Delay, trig chan/aux	DLY ±a/b	Percent of frame length
f.	WINDOW Types	SQR	Square (none)
		HANN	Hanning
		FTOP	Flat top
		SPEC	Special
		CORR	Correlation
		IM	Impact
g.	FREQ Setup, number of lines of resolution, e.g.:	80, 160, 320, 512, 640, 1280, 2560	
h.	Overlap Process, Input Status	x%	If overlap (100, 50, MAX), or
		SINGLE	Single buffered
		DISC	Discontinuous

5.6.1.2 **Channel Label.** A channel label of up to 18 characters is optionally entered by you in the MEASUREMENT SETUP LEVEL menus. If one has been supplied it is printed directly over the top of the data display. Furthermore, if the display is a cross-channel function, the labels from the two channels are combined with a separator character indicating the type of operation. For example, a transfer function might be labeled:

RIGHT MOTOR MOUNT/LEFT CHASSIS (response/reference)

The cross-spectrum would be:

RIGHT MOTOR MOUNT * LEFT CHASSIS (response * reference)

5.6.1.3 **Function.** The function label indicates the type of function being displayed as shown in the following abbreviation list:

RT	Real Time
AV	Average
ME	Memory
INPUT	Time domain function
SPEC	Auto spectrum
CSPEC	Cross spectrum
TF	Transfer function
COH	Coherence function
TFCOH	Transfer function with coherence blanking
IMPUL	Impulse reponse
TRMIS	Transmissibility
COP	Coherent output power
ACOR	Auto correlation
XCOR	Cross correlation
TIME	Time history (time domain average)

5.6.1.4 **Channel Number.** The channel or channels being displayed are always indicated here. For cross-channel functions, the two channels are separated by an operator character. A transfer function for example might indicate:

AV TF
CH1/CH4 (i.e., response/reference)

5.6.1.5 **Channel ID.** The channel ID is provided for use in conjunction with MODAL analysis. Like the channel label, the channel ID is entered optionally in the LEVEL parameter menus of MEASUREMENT SETUP, and is used to identify MODAL channel reference and response locations and coordinates according to a scheme specified in the MODAL program. If used, the channel ID is printed where indicated, and if the display is cross-channel, both channel ID's are printed, separated by an operator character.

5.6.1.6 Y Units. The Y units annotation indicates the units of the scale as selected by the display UNITS function, such as volts (VLTS), volts-squared per Hertz (VOLTS/^{2}Hz), or decibels (dB), or corresponding engineering units if selected.

5.6.1.7 Y Data. Y data indicates the type of data being displayed when there is a choice for the function such as MAGnitude, PHASE, REAL, or IMAGinary.

5.6.1.8 X Min, Max, Scale, and Units. The X axis readout indicates the range of the scale, whether the scale is LIN or LOG, and the units, either TIME or as selected by the DISPLAY UNITS menu, which allows a frequency domain choice of Hertz or cycles per minute or orders for rotating machinery. Note that the minimum and maximum values refer to the ends of the scale, not to any nearby tick marks.

5.6.1.9 Cursor Readout Line. The cursor readout indicates the X position of the cursor in X axis units, and the Y amplitude in Y axis units. The cursor readout always refers only to the upper display.

5.6.1.10 System Messages and Prompts. This area is used to present system and error messages and prompts for the operator for panel buttons that require an entry but do not have menus, such as the display CHAN select. Error messages may be missed when they initially occur. Therefore, once they have occurred and have been printed, the system leaves them on the screen until they are acknowledged. If you are moving fast, the error message may refer to some step or operation prior to your most recent actions.

To erase an error message, press the CLR button (in the ENTRY group).

5.6.1.11 Entry Buffer. Alphanumeric entries from the ENTRY group buttons or the keyboard that do not appear directly in the menu area are echoed in this area until the ENTER button is pressed.

5.6.1.12 Average Frame Count, Averager and Acceptance Info and Prompt Messages. In addition to the setup summary lines at the top, the current count of frames averaged is also shown at lower right so it is visible in split or menu displays. This area is also used for the following prompting and information messages in conjunction with averaging operations:

ARNG	Auto-ranging is in progress.
ARM?	Waiting for ARM command in manual arm trigger mode.
REJ?	Waiting for CONT(inue) or HOLD decision in manual acceptance mode. Waiting for ARM if in manual arm trigger mode.

5.6.1.13 Overload and Auto Reject Indication. These acquisition status indications are presented at the lower right of the screen in a row of from one to four rectangles, depending on the number of channels installed in the system. Each rectangle represents the four channels on one input circuit board, and normally contains four dots to indicate this. If an overload occurs in the input, or if the signal level is below the minimum percentage of full scale specified for auto-reject in averaging runs, the dot is replaced by a box of reverse video in the appropriate channel position, containing an up-arrow for overload or a down-arrow for underrange. A message area just left of the channel status boxes presents acquisiton status information as follows:

AREJ	The last frame was auto-rejected based on overload or under-range criteria.
DHIT	The last frame was auto-rejected based on double hit criteria.
OVLD	One of the channels has overloaded. This message is replaced by AREJ or DHIT during auto-reject averaging.
ORUN	The input FIFO has been overrun. Invalid data results.

In the ORUN conditon all the channel squares are shown in reverse video with no arrows. In RTA, V1.0, the ORUN conditions are seen if more than 12 channels are activated on the 20.48 kHz or 25.6 kHz bandwidths.

NOTE: Overload detection is performed by observing the peak input signal level, without regard to the setup bandwidth that the system is operating on. It is quite possible to have an overload of the input amplifier, and get a corresponding overload indication without any visible evidence of it in a display of the input waveform. An offending high-frequency component would be filtered out by the bandwidth anti-aliasing filters before the data reaches the display.

It is also possible to observe an apparent overload or clipping in an input waveform display without an overload indication. This can happen because the hardware design allows an "overload" range of approximately 20% beyond the selected levels of the input range. For example, if the system is set for the ±4 V peak input range, it can accept and correctly process a sine wave input up to approximately ±5 V peak (no offset) without clipping or distortion.

5.6.2 DUAL Display Format

The DUAL display shrinks the full display to the upper half of the screen and adds the second display in the lower half. Annotation for each display remains the same as for SINGLE with these exceptions:

- The setup summary lines at the top of the screen are not displayed.
- The cursor readout at the bottom of the screen refers only to the upper display.

5.6.3 OVLY Display Format

The OVLY display superimposes the lower display data on the upper full screen display. The format and annotation are the same as for SINGLE display with these notes and restrictions:

- The two displays must be the same type of x-axis window or the overlay is not allowed.
- The parts of the setup summary lines at the top of the screen that are not applicable to all functions and all channels refer only to the upper display.
- The cursor readout at the bottom refers only to the upper display.
- The channel number(s) and MODAL channel ID, if available, for the lower display are added to the left side annotation below the Y axis units and scale information.
- If the axis scales of the two displays are not the same ranges, the upper scales are used.

5.7 MENU OPERATIONS, SELECTIONS, AND ENTRIES

5.7.1 Selection by Pointer

Whenever a multiple choice menu appears on the screen, there are two symbols associated with it in the left margin. An asterisk (*) indicates the selection that is presently in force. A pointer (▷), which you control with the UP-DOWN arrow buttons, indicates the next selection (the one that takes effect when you press ENTER or NEXT).

When the menu first appears, the pointer and the asterisk are in the same location, and the display in the upper half of the screen updates as usual. As soon as you begin to make a selection, that is, when you move the pointer away from the asterisk, the display stops and the message "PAUSE" appears at the lower left. This allows the program to devote full attention to your menu operations and reduces response time to selections. Note that this pause is only for the display function and does not affect data acquisition or processing.

To complete the selection, press ENTER or NEXT. The current selection asterisk moves to the new pointer location, the selection takes effect, and the display starts again. Using the ENTER button leaves the current menu on the screen for further changes if desired. Using the NEXT button makes the entry and also turns the menu to the next page (or restores the full screen display from the last page of the menu).

5.7.2 Selection by Item Number

All items in multiple choice menus are numbered. Rather than using the UP-DOWN arrows and the pointer, you can also make selections by entering the item number (with the ENTRY group buttons) and then pressing ENTER or NEXT. This method is a little faster and is preferred by some operators when they are familiar with the menus. Numerical entries are echoed at the bottom center of the screen as they are made. Beginning an item number entry makes the display pause, the same as for pointer selections.

5.7.3 Alphanumeric Entries

Many of the menus request entry of a specific parameter value by the operator, rather than a multiple choice selection. These entry menus all begin with the word ENTER and, like the multiple choices, they use the asterisk and pointer symbols. The current value (if any) is printed next to the asterisk and the pointer in the left margin indicates that the system is ready for a new entry. For example:

```
ENTER Maximum Frequency
  * 5120

> ________________
```

When you begin an alphanumeric entry, the characters you enter appear next to the pointer and the display pauses until you complete the entry. To complete the entry, press ENTER or NEXT. Upon ENTER, the new value is transferred from the pointer to the asterisk to take effect, and the current menu remains in place. Upon NEXT, the entry takes effect and the menu proceeds to the next page.

5.7.4 Multiple and Null Parameter Entries

Several of the entry-requesting menus want two or more values; for example:

```
ENTER MIN, MAX Values
for Lin X Expansion
  *0.0,10240.0
> _______________
```

Each value entered must be separated from the following one by a comma character (,), without a space.

If you wish to leave one or more values unchanged or unspecified, you may simply enter the comma(s) to account for them, without entering any value. For example, to change only the maximum frequency for the expansion window above you could enter:

```
>,100
```

Entering only the first parameter leaves the second unchanged.

5.7.5 Keyboard Entries

You can make alphanumeric entries from the keyboard as well as from the ENTRY group buttons. The equivalent keys are:

Panel	Keyboard
ENTER	/ (backslash)
NEXT	RETURN
DEL	DEL
CLR	! (exclamation mark) For numerical entries only. For alpha entries, you must first press the semicolon (;) to identify a following character as a command, then press the exclamation mark.

If a menu with a prompt that requires a text string appears and you want to key in a comand (instead of replying to the prompt), enter a semicolon (;) first. If not, the command entered from the keyboard is taken as the text string for the prompt and results in an error.

5.8 MEASUREMENT SETUP FUNCTIONS

The following paragraphs describe the functions, features, and the setup menus controlled by the MEASUREMENT SETUP group of buttons. The list below also includes (in parentheses) two designations which represent the equivalent keyboard command.

The measurement setup determines the operations that are performed on the input data as it is being acquired, conditioned, processed, and averaged. Conditions controlled by the setup functions cannot be changed after an averaging run; that is, none of the setup functions are post-processing operations like the display functions that allow changes in the presentation of the data after it is acquired. Measurement setup includes the following controls:

MODE (MM)	Sets the basic system processing mode for auto-channel, cross-channel, or probability computations. Also controls exits to the optional MODAL analysis package or the RT-11 operating system.
CHANS (MC)	Selects the channels to be processed and specifies the reference and response channel relationships for cross-channel operations and allows MODAL coordinate input.
LEVEL (ML)	Sets the full scale voltage level range and selects input coupling for each channel. Also allows operator assignment of location and coordinate codes for MODAL analysis, specification of an engineering units-per-volt conversion factor, and assignment of a channel label to be printed on displays.
FREQ (MF)	Selects baseband or zoom processing, sets frequency range, and resolution in terms of number of frequency lines.
AVERAGE (MA)	Selects type of averaging, number of frames to be processed (or exponential discount factor), and modes of acceptance or rejection for individual frames. Also to invoke input level autoranging.
WINDOW (MW)	Selects weighting or shaping functions to be applied to input data, and overlapped processing for low frequency ranges.
TRIG (MT)	Sets trigger mode, source channel, level, and slope, and allows specification of delays for advanced or retarded trigger recognition.
STATE (MS)	Prints a summary report of the entire system setup status.

5.8.1 Notes on Processing Modes

There are two front panel setup functions that have significant effects on what functions can be obtained after processing. These are the choice of auto-channel vs. cross-channel mode, and time domain vs. frequency domain averaging. Both of these determine what functions of the input signals are accumulated during the data acquisition and averaging processes, and also affect the initial allocation of buffer areas in memory for the processing operations. This in turn affects the total memory space required, and at some point begins to restrict the number of lines of frequency resolution that can be obtained for a certain number of channels or channel pairs.

In AUTO-CHANNEL mode, the system operates as multiple single-channel spectrum analyzers. With frequency domain averaging in effect, the process is as follows: An input frame of time-domain signal data is acquired on all active "response" channels. A direct Fourier transform is performed on that frame to produce a linear complex spectrum (the DFT) consisting of voltage amplitude and phase data in a format of real (in-phase) part and imaginary (quadrature) part. The complex spectra cannot be averaged because phases vary randomly from frame to frame and the average tends to zero. Therefore the next step is to multiply each complex spectrum frame by its own self-conjugate. This produces a raw auto power spectrum consisting of sum-of-the-squares magnitude-squared information. The power spectrum no longer contains phase information, but it is non-complex and can be accumulated in multiple frame averages. Thus at the end of the process, the only data that remains is the real auto power spectrum for each channel. This data can be scaled in various ways for display, but the complex phase information and the time domain information can no longer be recovered. Therefore, the only choice of FUNCTION for AVG display is SPECTRUM.

In time domain averaging for auto-channel mode, this is not the case. Time domain averaging is performed by accumulating a summation average of the several individual time-domain input frames. Time domain averaging is only appropriate for somewhat repeatable signals such as transients or signals with known periodic components, and the input frames must be synchronized by triggering or the average would tend to zero to some dc level.

At the end of the averaging run, the retained data is a conglomerate time record for each channel. This time record still contains phase information, and the display routines can still compute the linear complex spectrum as well as the auto-spectrum. Therefore, the display FUNCTION selector provides a choice of TIME HISTORY or SPECTRUM, and the SPECTRUM choice has a NEXT Menu that allows choice of the various complex formats such as Bode, magnitude or phase, real or imaginary, and Nyquist (imaginary versus real). The magnitude display is equivalent to the auto-spectrum display of frequency domain averaging. If time history is chosen, NEXT will lead to a menu for selection of NORMAL time history or ORBIT display (see page 5-53).

In CROSS-CHANNEL mode (frequency domain averaging), the system must preserve relative phase information between the reference and response channels of each channel pair. To do this, it computes a cross power spectrum for each channel pair as well as the auto power spectrum for each active channel. To allocate memory buffer areas and locations for the cross spectra, the channel pairs must be known before processing starts.

For example, if you designate channel 1 as a reference channel and channels 2, 3, and 4 as response channels, the system computes and retains the spectra necessary to produce transfer functions for channel pairs 1-2, 1-3, and 1-4. But you cannot later obtain a transfer function between, for example, channels 2 and 3.

In processing, the system takes one frame of input signal data from all channels, performs the direct Fourier transforms to produce linear complex spectra, then computes and accumulates the auto power spectra as it does for auto-channel mode. It then computes and accumulates the complex cross power spectra for each designated channel pair.

The cross spectrum is the complex conjugate product of the two linear complex spectra. It represents the common power and the phase difference between the two channels and, although complex, it can be averaged in the frequency domain. Thus at the end of an averaging run, the system retains an averaged auto spectrum for each active channel, and an averaged cross spectrum for each designated channel pair.

The display routines compute the transfer function by dividing the complex cross spectrum by the real auto spectrum. All of the other functions that are available from display are similarly derived from the cross and auto spectra by mathematical operations, including the inverse Fourier transform, to produce the time domain functions such as the impulse response and the correlation functions.

5.8.1.1 Probability Mode. The PROBABILITY mode is used to compute the probability density and the cumulative distribution of each active channel. If this mode is selected, reference channels are disabled.

To obtain the probability density function (PDF) of a signal level, a fixed sample size of signal levels must be collected first.

The process of PDF averaging is similar to ASPEC averaging in that it allows summation and exponential modes, autoranging, and user specified number of averages.

The value of each element (data{i}) in the average buffer is obtained by:

(data{i} current) = (data{i} old) * (discount -1)/discount
+ PDF value * (1/discount).

When the cumulative density function (CDF) is desired, each data value is simply the summation of all the previous data values (after conversion to probability, instead of probability density) up to that data point. The last CDF data value should be unity. Use the following menu sequence:

a. Press MODE. The basic processing modes appear:

```
   1)  AUTO CHANNEL
   2)  CROSS CHANNEL
>*3)  PROBABILITY
   4)  EXIT TO MODAL
   5)  EXIT TO RT-11
```

b. Press AVERAGE. (This menu is omitted when PROBABILITY is selected.)

1) FREQUENCY
>*2) TIME

When you select PROBABILITY mode, windows are not allowed. In this case, selection is always coerced to the TIME DOMAIN.

The AUTO ACCEPT menu appears. Disregard this menu and continue.

c. Press AVG.

d. Press FUNCTION.

>*1) PROBABILITY DENSITY
2) CUMULATIVE DISTRIBUTION

Probability density or distribution functions may be stored in either MODAL or standard files. While coordinates may not be important for identifying data blocks, they are stored for MODAL recall.

To store a probability density function (PDF) or a cumulative distribution function (CDF) the file has to be opened with the capability of storing any function.

5.8.1.2 Memory Allocation. The RTA program allows a variety of acquisition processing and display modes. The memory requirements for each combination of these modes are different. The ability to modify the number of spectral lines and the number of channels especially require that buffer space be dynamically allocated during the setup process. You are generally aware of this process except for two reminders:

1) If there is not enough space to perform the desired operations a "not enough memory" message appears at the lower left. Data acquisiton stops when this occurs and does not resume again until the current (or some other) parameter is modified so that the memory size can accommodate the need.

2) Modification of parameters that cause memory to be re-allocated invalidate the data in the AVG buffers and a "...not available" message appears in a blank display function.

The parameters which cause memory allocation to occur when they are modified are listed below.

Processing mode	Frequency type
Trigger mode	Frequency range
Active channels	Number of lines
Averaging domain (time/freq)	

5.8.2 Mode Setup

The MODE button presents the following menu for choice of the basic processing mode:

>* 1) AUTO CHANNEL
2) CROSS CHANNEL
3) PROBABILITY
4) EXIT TO MODAL ANALYSIS
5) EXIT TO RT-11

AUTO CHANNEL operation computes only the auto-spectrum (or time domain average) for all active channels. In auto-channel mode, all active channels are designated response channels in the INPUT CHANS function described in paragraphs 5.8.3 and 5.8.4.

CROSS CHANNEL operation computes the auto-spectrum (or time domain average) for all active channels, including reference channels, and additionally computes the cross spectrum between each reference-and-response channel pair that is designated in the INPUT CHANS setup (paragraph 5.8.3).

PROBABILITY mode computes an amplitude histogram and cumulative distribution for each active channel. See paragraph 5.8.1.1 for more description.

EXIT TO MODAL ANALYSIS mode exits from the 2515 data collection program directly to the optional MODAL or MODAL PLUS analysis program (if present). Certain file information is preserved and passed between these two programs as described in paragraph 5.8.2.1.

EXIT TO RT-11 makes a graceful exit from the 2515 panel program to the RT-11 operating system for file management operations.

When exiting to either MODAL ANALYSIS or RT-11, the current panel setup information is saved. This setup is restored when RTA is run again.

5.8.2.1 Exiting the 2515 Panel Program and Running the MODAL Analysis Program. One of the principal applications of the 2515 is for modal analysis investigations. In this application, the 2515 panel program performs the data collection functions, to create and fill a file of frequency reponse functions for the MODAL program; that is, the MODAL program's (H) Function file. If the 2515 data collection function is performed first, you can assign a name to this file that is appropriate for MODAL, and MODAL can subsequently find it when it is attached to the MODAL Project file.

On the other hand, if MODAL has been running previously and exits to the 2515 panel program, a project file will have been created. That project file in turn contains a reference to a Function (H) file. When MODAL exits to the 2515 panel, the Function (H) file specification automatically becomes the active file for the 2515 panel STORAGE function*, and the project file information is preserved in the 2515 program. Then, when 2515 exits back to MODAL, the project file information is passed back and the MODAL program, although restarted, comes back ready to run in essentially the same state it was before.

*You can change the active storage file if it is not desired to store into the MODAL Function file.

5.8.3 Input Channel Select Setup - CHANS

All of the following descriptions are for cross-channel mode. For auto-channel mode and probability mode, all of the individual channels are regarded as "response" channels, and there are no reference channels. The reference channel column in the table is blank, and reference channel entries are ignored if they are made.

5.8.3.1 Active Channels Setup. Pressing the (INPUT) CHANS button presents a tabular listing of all channel pair setups on the right side of the screen, and instructions for its use at the upper left of the screen as shown below. Unlike other menus, which leave the "upper" data display on the screen, this menu occupies the full screen. This allows listing of as many as 16 channel pairs (the maximum number of channels available) on the screen at one time, and it is assumed that if new channel setups are being made the current display data is of no interest.

```
Response, Reference channel         res chan      ref chan
pair assignments                       @*2           *1
                                         3            1
* designates active channel              4            1
                                         1            1

To modify, use arrows to
move @ and ENTER new response,
reference channels

ENTER 0 to deactivate pairs

ENTER RESPONSE, REFERENCE
CHANNEL(S)
*2, 1
>____
```

The channel pair list contains as many lines and allows as many channel pair setups as there are channels physically installed, in the system. The example above assumes four channels. The pairs, and active channels are shown as they would appear when the checkout test parameters have been recalled from panel setup memory buffer #0. Otherwise, this channels list reflects the setup that was in force before the last "EXIT TO RT-11" operation. Note that it is not necessary that all installed channels are included in the list, and no particular order of channel numbers is required. You have complete freedom to assign channel pairs in any arrangement, the only restrictions being that the number of pairs is limited to the number of channels installed. Also note that the list always has as many lines as there are channels in the system, but not all channels listed must be active. In fact, you must specifically activate (or deactivate) channels by making entries in the list.

To activate a pair already entered in the list, use the UP-DOWN arrow buttons to move the @ symbol to the desired line in the list, then press ENTER or NEXT. Asterisks (*) appear next to the channel numbers in the list to indicate that they are now active.

The @ symbol at the left of the list marks the current line. The response and reference channels on that line are also shown below the entry menu at lower left, next to the asterisk that indicates the current value of parameters, i.e.:

ENTER RESPONSE, REFERENCE

CHANNEL(S)
* a, b (resp, ref channels on current @ line)
>x, y (enter new resp, ref if desired)

To change a line of the table and activate the new pair, move the @ symbol to the desired line. Then press the ENTRY group numeral buttons for the desired resonse channel, followed by a comma (,) followed by the reference channel (e.g., 3, 2). These entries are echoed at the new-value pointer below the entry menu. Then press ENTER. The new values are transferred to the current value in the menu, and to the current line in the table, with asterisks to indicate that they are active.

To deactivate a pair, move @ to the desired line, then enter 0 for the new value. The channel numbers remain in the table, but their associated asterisks are erased to indicate that they are no longer active as a pair. The physical channels remain active if they are part of some other active pair.

It is not possible to deactivate the last channel or channel pair. Also, deactivating the trigger channel when in a triggered mode of operation is not allowed.

5.8.3.2 **ZOOM Effects.** There are normally four input channels on each physical channel card that is installed in the system. However, when ZOOM processing is selected under the FREQ setup function, only two channels per card may be used. This usually requires some adjustments in the active channels table when the mode is switched from baseband to ZOOM.

To make the adjustment, the system searches the active channels table, line by line. It allows only the first two channels that it finds on each card to remain active, and adjusts any subsequent entries accordingly. For example, consider the following baseband table:

res chan	ref chan#
*1	*4
*2	*4
*3	*4
*4	*4
*5	*4
*6	*3
*8	*8

After switching to ZOOM, channels 1 and 4, the first pair, would remain active on channel card #1. Channels 2 and 3 would be disallowed. On the second card, channel 5 would remain active because its reference channel, 4, remains active on the first card. However, channel 6 would not be allowed because its reference channel, 3, is not available. Nor would channels 7 or 8 be allowed, because the combination would require three channels on the second card.

If you attempt to activate more channels or to change the channel setup while in ZOOM mode, the channel number entries are accepted into the table, but the channels are not activated except as adjustments are made to conform to the two-channels-per-card limitation as stated above. If you see "too many channels" or "MUST reduce # of chans", you must de-allocate the extra channels. The original baseband channel setup is preserved in a separate table and is returned to use whenever the system is returned from ZOOM mode to baseband mode.

5.8.3.3 Channel MODAL Coordinate Assignments. After the active channel setup above, press the NEXT button to turn to page 2 of the CHANS setup menus. This page presents a listing of only the active channels, together with the MODAL analysis coordinate codes that are currently assigned to them, as follows:

```
Active channels and their            CH #      COORD
Modal coordinate labels
                                      1         1X+
To modify, use arrows to              2         2X+
move @ to CH #, and ENTER             3         3X+
new label                             4         4X+


Move @ to Channel and
ENTER the New Coord
* 1X+
>
```

The order of channels may not always be the same since the reference channel(s) is always listed first.

This listing allows MODAL users to change one or all channel coordinate assignments at one place, when making MODAL setup changes. To make a change, use the UP-DOWN arrow buttons to select a channel with the @ symbol, then enter the new coordinate.

Note that these same coordinate assignments can also be made one channel at a time in the channel LEVEL setup described in the next paragraph, or during a storage operation just before storing processed functions. All three of these coordinate assignment menus are interconnected; for example, changing a coordinate assignment during the storage operation carries back to be reflected in the CHANS listing above, and in the individual channel setups of the LEVEL function described below.

Note: MODAL/MODAL PLUS does not recognize coordinates in numerical part > 8000; RTA does not store function data for such cases (> = 8000), except for panel data which is designated by 8100Y+.

5.8.4 Input Channel LEVEL Setup

The LEVEL setup sets the input parameters for each channel. It also provides for the assignment of engineering unit conversion factors and channel labels for displays, and the assignment of a MODAL analysis location coordinate, which is required when the collected data is used for subsequent MODAL analysis. The LEVEL setup may be made for any installed channel, regardless of whether or not it is active under the preceding CHANS select setup.

Pressing the LEVEL button (and the NEXT button) presents a summary of the setup for the currently selected channel and the sequence of menus shown schematically below. Parentheses and underscoring indicate operator entries or variables. Details of these menus and their functions are described in the following paragraphs.

Setup Channel: (channel #)
Volts Full Scale: (e.g., 8.0)
MODAL Coordinate: (e.g., 42Y-)
Cal factor: (numerical value)
Cal units: (units text)
per 1.0 volt
Coupling: (e.g., AC)
Chan ID: (18 character label)

ENTER Channel #
to be Set Up
* (current channel number)
> ____ (enter new chan #)

(NEXT)

Volts Full Scale
1) 8.0v
2) 4.0v
3) 2.0v
4) 1.0v
5) 0.5v
6) 0.25v
7) 0.125v
8) 0.0625v

(NEXT)

ENTER Modal Coordinate
in Form nnX+
* (current coordinate)
> ____

(NEXT)

Cal Factor=(FACTOR) "UNITS"
Per 1.0 Volt
ENTER (FACTOR)
* (current numerical factor)
> ____

(NEXT)

CAL Factor=(FACTOR) "UNITS"
PER 1.0 VOLT
ENTER "UNITS"
* (current units text)
> ____

(NEXT)

Coupling
1) AC
2) DC
3) ZERO
4) BIAS SOURCE
5) DCR: S/W DC REMOVAL

(NEXT)

ENTER Channel I.D. Label
* (current label, if any)
> ____

(NEXT)

Returns to full display

5.8.4.1 Channel Number to be Set Up. Enter the number of any channel that is physically installed in the system. The summary information immediately reflects this channel, and all subsequent entries take effect on this channel.

5.8.4.2 Volts Full Scale. Select the smallest full scale input range that accommodates the signal without overloading.

NOTE: If desired, you may select automatic input level ranging under the AVERAGE setup function. Autoranging then performs when you press the RUN button to begin an averaging run. When autoranging is to be used, you may select any arbitrary range here, and it adjusts automatically when you press RUN. The autoranging criteria are described in the paragraph on Average Setups.

However, autoranging is not performed on the trigger channel. For triggered mode acquisition, you must still specifically set the input range for the trigger channel.

NOTE: The input level range can also be changed "on-line" as follows: Whenever the active (upper) display is an input time domain function and no menu is present, you can increase or decrease the input level range for the channel being displayed by pressing the UP-ARROW (↑) or DOWN-ARROW (↓) buttons.

5.8.4.3 MODAL Coordinate. This information is not required and may be skipped if the system is being used for general signal analysis. (A default value is supplied by the program.) However, it is required if data is being collected and stored in an "H" function file for subsequent use in MODAL analysis. The 2515 uses these coordinates for identifying frequency response functions within the file, and the MODAL program needs them for sorting and indexing the functions. The assignment of these coordinates is normally performed as part of the MODAL geometry setup and is familiar to users of the MODAL program. The entry is of the form:

nnnnX+

where nnnn is the numerical value between 1 and 8000 that identifies a location in the MODAL geometry definition.

X is one of the characters X, Y, or Z, specifying the axis of the transducer in the modal geometry.

\+ is one of the characters + or -, identifying the direction of the response relative to the reference.

Note that a MODAL coordinate entered here for a channel is also reflected in the all-channel coordinate listing of page 2 of the CHANS select menu described in the preceeding section. Conversely, a change of coordinate in that listing, or subsequently in a storage operation, automatically makes a corresponding change in each of these individual channel setups.

The MODAL coordinate is printed in display annotation along with the channel number. For cross-channel displays, the two MODAL coordinates are displayed together, with an appropriate separating operation character; for example, a transfer function display with channel 1 response and channel 4 reference might indicate:

CH1/CH4
17Y+/20Y-

5.8.4.4 Calibration Factor and Units. The Calibration Factor and Units entries allow specification of a factor for conversion from the basic input calibration in volts to the engineering units of the application, such as g's, inches, or pounds. Whether or not these units are applied to displays is determined by a selection in the DISPLAY UNITS control function. If engineering units are turned on, the displays are scaled with the engineering units and conversion factor specified here.

The factor and units are entered separately in two entry-menus as shown in the menu summary at the beginning of this paragraph. Example: If you are using an accelerometer that produces 10 millivolts per g, and you want your results in g's, your calibration factor would be 1g/.010 volt = 100 g PER 1.0 VOLT, which you would enter as (FACTOR) = 100, "UNITS" = g. The "UNITS" text is restricted to 8 characters. Note that the RTA program expects the calibration factor to be a positive number.

5.8.4.5 Coupling. The input coupling menu provides the following choices:

AC	Capacitive input coupling which acts as a high pass filter to block dc and slowly varying offsets that might cause overranging (3 db at 0.8 Hz).
DC	Direct coupling to the input preamps.
ZERO	Grounds the input to the preamplifier in front of the analog filter for test or calibration purposes.
BIAS SOURCE	Provides a 2 mA current source at the input connectors for use of accelerometers such as the ICP-type that have built-in FET buffer amplifiers. These accelerometers can be connected directly without the need for external amplifiers. Coupling is forced to AC to block the dc offset that results from the current source.
DC: S/W DC REMOVAL	This selects dc coupling but uses a software algorithm to remove the dc component after each input frame is acquired. This operation occurs after the A/D converter and therefore does not help in overrange situations caused by dc bias. The algorithm determines the mean value of all the samples in the frame and then subtracts that mean value from each sample.

5.8.4.6 Channel ID Label. This final item in the INPUT LEVEL menus allows assignment of any desired label, up to 18 characters for each channel. The channel ID labels are printed just above the top line of the grid in the displays. For cross channel functions they are combined with the label of the other channel in the same way as the CHx identification and the MODAL coordinates as described above. The labels are also carried along with the data when functions are stored in memory or disk files. However, note that the storage function format can preserve and return only 14 of the 18 characters allowed.

5.8.5 Frequency Range and Resolution Setup

The FREQ button presents the summary setup listing and the series of menus and entry requests as shown below. Although these parameters appear simple and straightforward, there are several special cases and internal adjustments in frequency setups that are discussed in further detail in the following descriptions:

Frequency Type

1) BASEBAND
2) ZOOM

(NEXT)

(if BASEBAND):
ENTER Maximum Frequency in Hz
* (current value)
> ____

(if ZOOM):
ENTER Zoom Minimum, Maximum
* (current min, max)
> ____

(NEXT)

# of lines

1) 80
2) 160
3) 320
4) 512 *MODAL
5) 640
6) 1280
7) 2560

(NEXT)

External Sample
1) OFF
2) ON

(NEXT) restores full display

Frequency Type: (e.g. BASEBAND)
BASEBAND max freq: (e.g., 10240)
ZOOM min freq: (e.g., 160)
ZOOM max freq: (e.g., 340)
# of Lines: (e.g., 320)
External Sample: OFF
frame size: (e.g., 1024)
resolution: (e.g., 32.00)
sampling interval: (e.g., 3.052e-05)

5.8.5.1 Summary List Information. The summary listing on the screen shows the exact values that are currently in force, after any necessary internal adjustments have been made to your entries. Note the following: (1) Both of the current BASEBAND and ZOOM frequency ranges are indicated in the list for reference. Which of these is currently in force is indicated by the first line, "Frequency Type". (2) The last three lines in the summary (frame size, resolution, and sampling interval) are provided for reference. They are not made by operator entries, but are derived directly from your choice of frequency range and number of lines resolution. The frame size is determined from the selected number of lines.

The system operates on power-of-2 frame sizes from 256 points up to 8192 points. For an input frame size of N, the Fourier transform computes N/2 complex frequency line coefficients. However, the upper 3/8 of this range may be contaminated by aliased higher frequency components because of the roll-off of the anti-aliasing filters. That portion of the range is simply discarded after the Fourier computation. Taking the "standard" frame size of 1024 input points as an example, 512 frequency lines are computed, of which 5/8, or 320, are valid and are retained. Or, looking at it from the operator's point of view, selecting number of lines = 320 results in an input frame size of 1024.

The same ratio applies for all other resolution selections except the special case of "512 MODAL" which is described below. There is another special case, also described below, for the maximum frequency range of 25.6 kHz, in which additional frequency lines may be retained to provide additional bandwidth without decreased resolution. The indicated resolution in the summary listing is the indicated bandwidth divided by the number of lines. The derivation of the sampling interval is somewhat more complicated, but in all cases it is a power-of-2 multiple of the fastest sampling interval, which is (1/65536) second.

5.8.5.2 Frequency Type: Baseband or ZOOM. Baseband frequency range always begins at dc (0 frequency) and extends to the maximum frequency entered in the next menu. For baseband processing, all four channels on each installed channel card are available. ZOOM processing allows you to specify a passband frequency range with a minimum and maximum frequency to be processed, and thus to obtain better frequency resolution over narrower bands of interest. Note that when you select ZOOM processing, you are restricted to a maximum of two channels on each installed channel card. When you select ZOOM, the active channels table is modified accordingly, as described previously under "Input Channel Select Setup."

When ZOOM processing is in force, time domain displays of the input signal are no longer valid for the shape of the input waveform. Instead, they show the complex time domain function that is created after the input signal has been passed through the frequency-shifting multiplier and the decimating filters. This condition is indicated in the display by displaying two functions (the real part and the imaginary part[1]) using disconnected dots, rather than the continuous line trace that is used for real input waveforms. These displays are still valid for amplitude information.

---

[1]The sine wave shows up in the display even if the input signal is grounded. This is due to the dc offset in the analog circuit, which is normally removed by software. When ZOOM mode is chosen, the dc value is multiplied by sine and cosine of the center frequency required by the ZOOM process to shift the spectrum. This non-zero offset results in the sine wave displayed. This effect is only seen when the ZOOM band comes near or includes the dc line.

5.8.5.3 Frequency Ranges, Baseband. If you select baseband processing, the NEXT menu requests

ENTER Maximum Frequency

You may enter any number (in Hz) for the desired maximum frequency. If your entry is greater than the system maximum (25,600 Hz), it is adjusted downward. If it is within the system range, it is adjusted upward to the next higher range available from the hardware that includes the requested maximum. These adjustments are reflected in the entry menu and the summary listing. The available ranges are:

25600*
20480
10240
5120
2560
1280
640
320
160
80
40
20
10
5
2.5
1.25

NOTE: A different set of frequency ranges are used if you select 512-line resolution for use with the MODAL analysis program. They are listed in paragraph 5.8.5.5 which describes 512-line resolution under the number of lines menu which follows frequency range selection.

*The 25,600 Hz bandwidth is a special case that does not follow the factor-of-2 sequence of the other available ranges. It provides the same frequency resolution as the 20,480 Hz range. However, on these uppermost ranges, the system uses only the basic 25.6 kHz analog anti-alias filter and does not require any of the decimating digital filters used for lower ranges. The analog filter has somewhat sharper rolloff characteristics than the digital filters. This allows 400 alias-free frequency lines out of 512 computed, instead of the 320 out of 512 lines for lower ranges. If you select the 20,480 range, the system saves only 320 lines per 512 computed, in conformance with other ranges. But, if you select the 25,600 range, the system retains and displays all of the good 400 lines, thus providing the additional bandwidth. The additional lines at this bandwidth are reflected in the summary setup listing on the display. For example, if you select 640 lines in the following "# of lines" menu, the summary indicates that you are actually getting 800 lines.

In addition to numerical entry, you may also use the display cursor position to select a maximum frequency, as follows:

1) On a frequency function display, position the main cursor at the desired maximum frequency for the baseband analysis range.

2) Press the FREQ button, select BASEBAND, and press NEXT.

3) When the menu requests "ENTER MAXIMUM FREQUENCY", press the "equals" (=) button in the ENTRY group, to refer to the display cursor.

4) Press ENTER. The system selects the standard frequency range listed above that is next above the cursor position. That selection is reflected in the menu and the summary listing just as if it had been entered numerically.

5.8.5.4 Frequency Ranges, ZOOM. If you selected ZOOM processing in the first FREQ menu, the NEXT menu requests entry of both a minimum and a maximum frequency for the range:

ENTER Zoom Minimum, Maximum

____, ____

You may enter any two values (in Hz), separated by a comma, for this range, provided only that the difference between them must not be greater than the maximum ZOOM passband, which is 20,480 Hz. If you request a band greater than that, the entry is ignored and an error message appears at the lower left of the screen. The system adjusts your entries to the ranges available from the hardware as follows: First, it selects an available ZOOM passband large enough to cover the requested range. The available ZOOM passband ranges are the same as those listed for baseband ranges above, excluding the largest, 25600 Hz, and the smallest, 1.25 Hz. The selected passband is then centered on a frequency halfway between the requested minimum and maximum. Exception: If the requested band is too near the low or high end of the total system range, the ZOOM band is shifted up or down as necessary to keep it from extending below 0 or above 25600. Entering only the maximum or minimum value in this menu takes the other value from the current hardware setting, not the previous user entry.

Note that selecting 0 for the minimum frequency does not cancel the zoom processing mode. If you want baseband processing (four channels per card), you must return to the first page of the FREQ menu and specifically select it.

In addition to numerical entries, you may also use the display cursors to define and select a zoom range, as follows:

1) On a frequency function display, position the main cursor at the desired zoom minimum frequency.

2) Press (CURSOR) REF SET to mark the minimum.

3) Reposition the main cursor at the desired zoom maximum frequency.

4) Press the FREQ button, select ZOOM, and press NEXT.

5) When the menu requests "ENTER Zoom Minimum, Maximum", press the "equals" (=) button in the ENTRY group, to refer to the display cursors.

6) Press ENTER. The system selects the next broader standard zoom band and centers it on the range defined by the cursors. This selection takes effect immediately and is reflected in the menu and summary listing just as if it had been made by numerical entries.

5.8.5.5 Number of Lines of Resolution. After bandwidth, the FREQ setup function presents a NEXT menu for selection of frequency resolution within the band. The selection is made in terms of the number of frequency lines or filters across the band. Actually, it is setting the frame size and indicating how many valid non-aliased lines are available after the spectral computation. Note that additional lines are available for the maximum 25,600 Hz bandwidth, which uses only the initial analog anti-alias filter. The number of lines for 25,600 BW is not indicated in the selection menu, but is reflected in the summary listing if the 25,600 BW is in force. For example, if you select 320 lines, the summary list shows # of lines = 400. The choices and related values are:

# of Lines Menu	# of Lines If 25.6 kHz BW	Frame Size, # of Samples	# of Lines Computed by Fourier Transform
80	100	256	128
160	200	512	256
320	400	1024	512
512 MODAL	Not appl	2048	1024
640	800	2048	1024
1280	1600	4096	2048
2560	3200	8192	4096

Note: Any data set with greater than 5120 words cannot be stored in memory. But such data can be stored into Standard file. A recall of such data from Standard file has only a partial copy (5120 words) filled in the upper or lower MEM buffers. (See page 5-48.)

5.8.5.6 512 Lines for MODAL, A Special Case. The choice of 512 lines of resolution is provided to allow more efficient use of file storage space when collecting frequency response functions for use with the MODAL analysis program. The MODAL file storage format always uses and operates on blocks of 512 or less complex frequency points for its frequency response functions. Note that you are not required to use the 512 selection for MODAL.

You can just as well operate at lesser resolutions (e.g., 320 lines), which simply do not fill the MODAL file storage blocks, or at greater resolutions (e.g., 640 or 1280), which partially fill additional 512 element storage blocks and require the use of MODAL "sequence numbers" for file identification. However, the selection of 512-line resolution fully uses the 512-element storage blocks, and thus allows increased bandwidth over that which can be obtained using 320 line resolution.

To produce 512 lines, the system must set up and operate the same as it would for 640 lines, and it is constrained to the same set of sampling frequencies (and thus bandwidths) that are used in normal processing. The 512-line function is then obtained simply by truncating and discarding the highest 128 lines of the 640 line function. This truncation of valid lines that otherwise would be included in the normally available bandwidths results in an entirely different set of bandwidths for 512-line resolution. They are:

2 Hz	64 Hz	2048 Hz
4	128	4096
8	256	8192
16	512	16,384 Hz maximum
32	1024	

When you select 512-line resolution, the system takes the normal bandwidth that is currently in force and adjusts it to the next higher 512 line bandwidth as listed above; or, if 512 line resolution is already in force, operator-requested bandwidths are adjusted upward to the next frequency in the list above, rather than to one of the normal bandwidths listed previously under "Frequency Ranges." Data Acquisition then processes as if it were set up for 640 lines.

There is an exception. If the bandwidth selected is greater than the maximum bandwidth of 16,384 Hz that is allowed for 512 lines, then the bandwidth is reduced to the 16,384 maximum and the frequency resolution is improved by a factor of 2.

NOTE: A similar process of bandwidth adjustment occurs when you switch from 512 lines back to a normal resolution. That is, whenever it is necessary for the system to adjust the bandwidth for any reason, it always attempts to go higher to include the previous bandwidth. If, for example, you switch back and forth between 320 and 512 lines, the bandwidth continues to expand until it reaches maximums. In most cases, it is best to set the desired number of lines first, and then go back to enter the desired maximum frequency or frequency range for ZOOM.

5.8.5.7 External Sample OFF/ON. The final page in the FREQ setup menus provides for enabling an external sampling clock connected to the rear panel EXT SAMPLE input connector for special applications. (TTL level signal 0-5V.)

External sampling is switched OFF at start up of the RTA program to protect the system. If external sampling is to be used, it can be switched ON by using the FREQ setup menu sequences. An external signal has to be connected to the rear panel EXT SAMPLE connector or the system keeps waiting for the external sampling clock.

CAUTION

The maximum input frequency is 65,536 Hz. Any higher causes FIFO overflow. Note also calculations, for resolution and sampling intervals, assume the internal sample frequency of 65,536 Hz.

5.8.6 Averaging Setup

Pressing the AVERAGE button presents the following setup summary and starts the series of menus shown below and described in following paragraphs:

Averaging Domain: (e.g., FREQUENCY)
Averaging Mode: (e.g., SUMMATION)
# of Averages: (e.g., 256)
Autorange: (e.g., OFF)
Accept: (e.g., MANUAL)
Accept Min Peak %: (e.g., 35)

Averaging Domain

1) FREQUENCY
2) TIME

(NEXT)

Averaging Mode

1) SUMMATION
2) SUBTRACTION
3) EXPONENTIAL
4) PEAK HOLD

(NEXT)

ENTER # of Averages
* (current value)
> ____ (0 - 32767)

(NEXT)

Pre-average Autorange

1) OFF
2) ON

(NEXT)

Data Acceptance into Avg

1) ACCEPT EVERY FRAME
2) MANUAL ACCEPT (CONT)
3) AUTO REJECT
4) AUTO REJECT w/ DBL HITS

(NEXT)

ENTER Minimum % Full Scale
for an ACCEPTABLE SIGNAL LVL
* (current %)
> ____ (1 - 100%)

(NEXT) restores full display

NOTE: In PROBABILITY mode the Averaging Domain menu is skipped and only selections 1) and 3) of Averaging Mode are allowed.

5.8.6.1 **Averaging Domain.** FREQUENCY domain averaging accumulates the auto power spectra (and cross power spectra if in cross channel mode) that are produced after the direct Fourier transform processing has been applied to each successive input frame. TIME domain averaging accumulates a normalized summation of the time domain input frames before the Fourier processes are performed. Time domain averaging requires that the input must be triggered or somehow synchronized from frame to frame to preserve phase information and prevent the data from averaging away to zero or some dc level.

5.8.6.2 Averaging Mode. The system provides the following choices of averaging algorithms for frequency domain averaging. This menu does not appear for time domain.

a. SUMMATION. In the summation mode, all input frames are equally weighted. The averaging buffer is cleared when the RUN button is pressed to start a new average. The run stops when the number of frames processed equals the "# of Averages" parameter selected below. The average is normalized as it is accumulated, according to the following formula:

$$A_1 = A_0 (K-1)/K + SS^* (1/K)$$

A_1 is the new average.
A_0 is the previous average.
SS^* represents the current frame of input auto or cross spectrum.
K is the number of the last frame processed for SUMMATION.
K is fixed by the "# of Averages" parameter selection for EXPONENTIAL discount averaging.

b. DIFFERENCE. The difference mode is the opposite of summation in that new frames are subtracted from the existing average. The average buffer is not cleared at the start of a RUN. This mode is useful in situations such as acoustic analysis of a machine that cannot be removed from a noisy environment. You can take a SUMMATION spectrum of the machine and background noise, then turn off the machine and use DIFFERENCE averaging to subtract out the spectrum of the background. Note that the average data is not normalized in the same way it was in additive averaging:

$$A_1 = A_0 - SS^* (1/K)$$

The results are really valid only after the number of averages K has been completed. This value should be equal to the number of averages previously accumulated in additive average mode.

c. EXPONENTIAL. The exponential mode discounts the weight of older data in the average for analysis of signals that may be changing with time. The discount factor is set by the "# of Averages" parameter below. The averaging buffer is cleared at the start of a RUN, and the run continues indefinitely until you press the RUN button again to stop it. The discount algorithm is the same as shown for summation above except that the factor K is fixed by the # of Averages parameter. The smaller the # of Averages selection, the faster the decay of older data and the greater the weight of the current frame. An exception is made for the first frame of a run. The first frame is not discounted at all, so that the averaged spectrum immediately assumes the full value of the input. Otherwise, the system would have to process a number of frames equal to the # of Averages selection before the average would approach the full value.

d. PEAK HOLD. (Not applicable for cross-channel mode or time domain averaging. If either is in force, this selection is not allowed in the averaging mode menu.) This mode compares the amplitude of each frequency line from each input spectrum to the corresponding line in the averaging buffer and retains the greater of the two. Thus at the end of the "average", the result spectrum shows the maximum amplitude that occured at each frequency during the run. The buffer is cleared when you press RUN, and the run continues indefinitely until you press RUN again to stop it. The "# of Averages" parameter is not used.

5.8.6.3 Number of Averages. For SUMMATION and DIFFERENCE modes, this parameter sets the number of frames to be processed and averaged before the run is automatically stopped. For EXPONENTIAL mode, this parameter sets the factor for exponential discounting as described above under Averaging Modes. Exponential runs continue indefinitely until you press RUN again. PEAK HOLD mode does not use this parameter, and also runs indefinitely until you press RUN again.

5.8.6.4 Pre-Average Autorange, OFF/ON. The full scale range for input levels is initally set up through a LEVEL button menu, selecting from the available ranges, ±8, 4, 2, 1, 0.5, 0.25, 0.125, and ±0.0625 volts. This pre-average autorange function, if selected, allows the system to automatically adjust the input level ranges at the start of an averaging run, according to the signal levels that are actually present at the inputs. Autoranging is performed as follows: When the RUN button is pressed, the system begins testing acquired time domain input frames for the following conditions:

a. No input hardware overload.

b. No value in the acquired frame exceeds 100% of the current full scale setting. For auto-ranging this condition is considered an overload condition. (This condition can occur without overload because the input hardware allows 25% signal over-ranging without clipping or data distortion.)

c. The peak value in the frame must be greater than the "Minimum % Full Scale" parameter that is specified in the last average setup query below, until the 0.0625 volt range is reached, at which point only overload is looked at.

The system acquires one input frame on all active channels at whatever input level range setting is currently in force for each channel. Any channel that shows an overload or that contains a value greater than full scale has its level setting increased (gain decreased) by one step. All other channels are checked for a peak value at least as great as the specified minimum percentage of full scale. Channels that do not meet that level have the level range decreased (gain increased) by one step. This process is repeated as necessary, with the following exceptions to prevent oscillation between two ranges.

If a channel has had its range increased (gain decreased) because of overranging on the previous frame, the range is not decreased if the current frame is below the minimum. Conversely, if the range has been decreased (gain increased) because of previous low signal, but the channel now overranges, the range is increased back to its previous level. In other words, if the signal characteristics and the specified minimum peak are such that the level setting might oscillate, the algorithm favors overload protection over low signal protection. If a channel continues to overload at its greatest range (±8V), the system does not allow an averaging start.

When a frame has been acquired that meets all conditions on all channels, the input levels are fixed and that frame is processed and placed in the averaging buffer to begin the averaging run. Note that autoranging does not continue through the run. If input signal levels change after the input level settings have been made, overranges and underranges may occur. However, you can use the autoreject option to reject such frames and omit them from the average.

Exception for Triggered Mode Acquisition: If triggered input acquisition is in effect, autoranging is not performed on the trigger channel. You must set an appropriate input level specifically for the trigger channel, under the LEVEL setup function. This simplifies the operation and avoids problems that may arise from complications such as highly variable impact test inputs or failure to trigger at all if the trigger level is set too high. Once an appropriate trigger channel setting has been found, all other channels autorange exactly as described above. Also, note that the autoreject option described below does operate on the trigger channel, so that once an averaging run is started, defective trigger channel frames can be omitted.

5.8.6.5 **Data Acceptance into Average.** This menu provides an option for continued examination of time domain input frames during an averaging run, and allows manual or automatic rejection of frames that do not fall within certain limits. The choices are:

a. ACCEPT EVERY FRAME. No tests are performed on the input frames. All frames are processed and passed to the average.

b. MANUAL ACCEPT (PRESS CONT). In this mode, each new set of input frames is held for you to examine them as desired. The HOLD Indicator lights when the frame has been acquired, and remains lighted until you have manually disposed of the frame as follows:

   1. To accept the frame, press CONT. The frame is processed to the average and the system returns to acquisition state. Note that if you are in TRIG-MAN ARM mode, you must also press ARM to re-arm the trigger for acquisition.

   2. To reject the frame:

      (a) In FREE-RUN or AUTO ARM trigger mode, press HOLD to reject the frame and allow the system to return to acquisition.

(b) In TRIG-MAN ARM mode, just press ARM to re-arm the trigger for new acquisition. The old frame is rejected if you did not press CONT.

c. AUTO REJECT. In this mode, the system automatically examines each new input frame on all channels and rejects them all if any one does not meet the following criteria:

1. No input hardware overload.

2. The peak value must be at least equal to the "Minimum % Full Scale" parameter specified below.

Note that this acceptance criteria is the same as autoranging, except that the average accepts frames containing values greater than 100% of full scale if they did not cause hardware overload. This acceptance algorithm also applies to the frame on the trigger channel (unlike autoranging which does not apply to the trigger channel).

d. AUTO REJECT w/ DBL HITS. This mode tests all channels for the same conditions as AUTO REJECT above, and additionally applies the following test to the trigger channel for impact testing, to detect double hits (i.e., second bounce impacts):

The criteria for a double hit on the trigger channel is to find the peak absolute value in the entire data frame. Move 1/64 of the frame size ahead in the frame and, from there to the end of the frame, search for another peak whose amplitude is greater than 10% of the maximum peak already recorded. If no such peak exists the frame is accepted.

5.8.6.6 **Minimum % Full Scale**. The final menu in the AVERAGE setup requests:

ENTER Minimum % Full Scale
for an Acceptable Signal Lvl

This parameter sets the minimum acceptable peak signal level for autoranging and auto reject, specified as a percentage of the full scale LEVEL setting. For autoranging, the full scale range is decreased (gain increased) one step if the peak value in an acquired frame does not reach this minimum level (unless overloading occurs or previously occurred at the lower range). For auto reject, frames are rejected if the peak value does not reach this minimum level.

5.8.7 Windowing Setup

The discrete Fourier transform, performed on an input frame of finite length, tends to produce an effect known as spectral "leakage" or "smearing." In effect, the algorithm assumes the input frame to be one period of a continuous periodic signal. If all the frequency components of the input signal happen to be exactly periodic in the length of the input frame (that is, if they fall exactly on one of the discrete frequency lines of the computed spectrum), then the computed spectrum would be exactly correct for the continuous input. In the more likely case that the input signal contains components that do not coincide with the discrete frequency lines (i.e., that are not periodic in the length of the input frame), then the spectral computation also produces and includes frequency components necessary to account for the discontinuities represented by the abrupt beginning and end of the frame. The effect is a spreading or smearing of the spectrum and reduction of the apparent amplitude of frequency components that fall between the discrete lines of the computed spectrum.

Various windowing or weighting functions may be applied to the signal to reduce or eliminate these effects. The type of window to be used depends on the nature of the input signal. The 2515 provides a choice of four window types for continuous input signals, plus two weighting functions for transient signals such as the impact and response signals of impact testing.

Pressing the WINDOW setup button presents the following window setup summary and menus. The window choices are described in the following paragraphs.

Window Type

1) SQUARE
2) HANN
3) FLAT TOP
4) SPECIAL
5) CORRELATION
6) IMPACT

Window Type: (e.g., HANN)
Refr window start: (e.g., 200)
# of resp windows: (e.g., 10)
Frame Overlap: (e.g., NONE)

(NEXT)

ENTER % Full Frame Until
Reference Window Taper
* (current value)

> ____

(NEXT)

NOTE: The reference and response window summary lines above and the reference and response parameter queries at the left are only for the IMPACT window and appear only when IMPACT is the currently selected type.

ENTER # of Exponential
Resp Windows to Apply

* (current value)

> ____

(NEXT)

Frame Overlap

1) NONE
2) 50%
3) MAX

NOTE: The frame overlap menu does not appear if triggered data acquisition is in effect. Overlapping is not appropriate for triggered acquisition.

(NEXT) restores full display

5.8.7.1 Window Type. The system provides the following choice of window functions.

a. SQUARE. No weighting function is applied. In effect, the act of operating on a finite length input frame is a windowing operation where the continuous input signal is multiplied by a rectangular (time) function of unity value within the frame and zero value outside the length of the frame. This has sometimes been referred to as the "boxcar" window.

b. HANN. The HANN window is generally most appropriate for random-type signals. In the time domain, the Hann weighting function is a cosine-bell shape with period equal to the frame length. Multiplying the input frame by this function imposes a quasi-periodicity on the continuous input, in effect modulating it by a frequency equal to the lowest frequency line in the spectral result. In the frequency domain result, this has the effect of broadening the filter bandwidth of each spectral line by spreading the energy of a periodic component into three adjacent lines. This reduces the apparent amplitude of pure sinusoidal components, but also gives much greater roll-off of the "leakage" effect by eliminating the abrupt end-of-frame discontinuities.

   Application of the Hann function also reduces the total energy in the frame but this is corrected by a simple factor such that the total rms energy of the spectral result is the same as the total rms energy of the original input frame. Note, however, that this does not correct the amplitude of pure sinusoidal components, which is why the Hann window is appropriate for random signals but not for calibration or other absolute measurements using sinusoidal inputs. The windowing operation is actually performed by convolution in the frequency domain, so it is not visible in time domain displays of the input signal.

c. FLAT TOP. The flat top window is provided primarily for use with pure sinusoid inputs such as calibration signals. It is corrected such that a sine wave input at any frequency produces the same spectral amplitude that it would have if no window were applied and the sine frequency fell exactly on one of the computed discrete spectral lines. However, the main lobe of the flat top window equivalent filter shape is quite broad, spanning several spectral lines. This window is not suitable for resolving closely spaced components in the input signal. This window operation is performed by convolution in the frequency domain and is not visible in real-time displays of the time domain input signal.

d. SPECIAL. The special window contained within the program is a seven-term Blackman-Harris window, which is generally useful for both random and periodic or deterministic signals. The operation is performed by convolution in the frequency domain and is not visible in real-time displays of the time-domain input signal.

e. CORRELATION. The correlation window is required when the analysis is being performed to obtain correlation functions. Correlation functions are produced by performing an inverse Fourier transform of the auto or cross spectrums. Without this window, the implied periodicity of the input signal as represented by the computed spectrum causes an effect known as "wrap-around error." The windowing operation actually consists of filling only half of the input frame with samples of the input signal and zeroing the other half of the frame. This provides a half-frame separation between the implied periods of the input signal, and applies a known triangular weighting to the correlation function result rather than the unknown wrap-around effect. When the correlation window is applied, frequency domain results are somewhat corrupted. Conversely, if the correlation window is not applied, correlation functions may still be computed by the display, but they contain the wrap-around effect. The correlation window is performed on the time domain input, and can be seen in Real Time input displays because the display presents only the half frame of sampled data and does not include the half frame of zero values.

f. IMPACT. This impact selection provides two types of windows for use with transient inputs such as those obtained from impact testing with a force (impulse) hammer for the reference and accelerometers for response. The force window is applied only to the reference channel and is shaped to eliminate the measurement noise associated with small values toward the end of the impulse frame. The response window is applied to all response channels and is an exponential decay weighting to damp the response if it tends to ring longer than the time length of the frame. When IMPACT window is selected, the NEXT button presents the following two parameter requests to specify the windows as described below:

   ENTER % Full Frame Until
   Reference Window Taper

   This parameter specifies the percentage of the frame length to contain unweighted samples from the beginning of the frame to the point where tapering begins. (Entering 0 disables the force window altogether, allowing use of the following response window alone.) The reference (force) window is a half-cycle cosine shape of length equal to 1/16 the length of the frame, with unity amplitude at the beginning, tapering down to a value of zero.

   If the response window below is used, it is also applied to the reference channel. This is done to maintain a strictly correct transfer function measurement between reference and response.

   ENTER # of Exponential
   Resp Windows to Apply

This parameter specifies the factor k in the window expression below; that is, the time constant of the decaying exponential, or the number of times a "standard" window is applied. The standard window is the one defined by SDRC for MODAL analysis data collection. This parameter is carried along with data stored for subsequent MODAL analysis. The MODAL program can correct for the window's contribution to damping. (Entering 0 disables this window altogether.) The window expression is:

x'(n) = x(n)*W(n)
W(n) = (1-.0002*k*(1024/M))**n

where n is the index from the start of the frame,
x(n) is the time domain function,
W(n) is the window function,
k is the number of windows parameter entered above.
M is the number of samples in the frame.

The exponential window always begins on the first point in the frame, so you should be careful about using trigger advance in capturing transients. If the initial response signal is delayed in the frame, its amplitude could be considerably reduced.

5.8.7.2 Frame Overlap Processing. Overlapped frame processing allows more frequent spectral updates when operating on low frequency ranges where the input frame acquisition time is significantly longer than the processing time. Without overlap, the system does not present a new display of the input, nor compute a new input spectrum until a complete new independent input frame is acquired. At the lowest frequency range, this can be as long as 256 seconds. With overlap, the system is allowed to operate on "interim" frames, consisting partially of the latest acquired input samples and partially of as many samples of the previous frame as are required to fill out the current frame size. A minimum overlap of 50% (one-half frame) is required. When acquisition time is less than twice the processing time, overlapping is disabled. The frequency range at which this occurs varies, since processing time for a set of frames varies with several factors such as the function selected and particularly the number of active channels. The actual percentage overlap is reported at the upper right corner of the screen in the setup summary lines of the FULL display. The overlap menu provides the following choices:

a. NONE. Disables overlap so that all new frames processed are independent of each other.

b. 50%. Sets fixed half frame overlap such that each processed frame (except the first) consists of N/2 new points and N/2 points from the previous frame, where N is the frame size, as long as the relationship of process time to acquisition time allows it. Overlap is disabled when 50% overlap cannot be achieved.

c. MAX. System processes the latest N points as fast as possible as soon as the previous process completes. Overlap processing is disabled if 50% overlap cannot be achieved.

NOTE: Overlapped processing is not appropriate for triggered data acquisition, which is discontinuous by nature. This menu does not appear if a TRIG mode has been selected.

NOTE: In Frequency domain averaging you cannot apply a window to the data after the average has been completed. You must set the window to the desired type before starting the average.

In Time domain averaging, the data may be displayed with different windows after the average but this change is limited to SQUARE, HANN, FLATTOP, and SPECIAL. The IMPACT and CORRELATION windows must be changed before averaging for valid results.

Stored data (MEM displays) cannot have the window type changed in either Time or Frequency domain averaging.

5.8.8 Trigger Setup

Pressing the TRIG setup button presents the summary of the current trigger setup as shown at the right below, and begins the following sequence of menus for modification of trigger conditions. Parentheses and underscoring indicate variables or operator actions:

Trigger: (e.g., TRIG-MAN ARM)
Channel: (e.g., 4)
Trigger Level: (e.g., +20%)
Slope: (e.g., +)
Delay: (e.g., -20)
Aux Delay xx (e.g., 40)
Beep: (e.g., ON)

Trigger

1) FREE RUN
2) AUTO ARM 1st FRAME
3) AUTO ARM EVERY FRAME
4) MANUAL ARM

<u>(NEXT)</u>

ENTER Trigger Channel #
(0 selects EXTERNAL TRIGGER)
* (current trigger channel)
> ____

<u>(NEXT)</u>

ENTER Trigger Level
% of Full Scale
* (current level)
> ____

<u>(NEXT)</u>

Slope
1) +
2) -

<u>(NEXT)</u>

ENTER Trigger Delay
in % of FRAME
(- Delay for Pre-Trig)
* (current delay)
> ____

<u>(NEXT)</u>

ENTER Auxiliary Delay
IN % of FRAME
* (current value)
> ____

<u>(NEXT)</u> restores full display

5.8.8.1 **Trigger Mode.** The trigger mode menu provides these choices for triggered acquisition:

a. FREE RUN. No triggering is required for input acquisition. Acquisition of a new frame begins as soon as there is buffer space available for it. The input is double-buffered; that is, one buffer can be refilling while the previous buffer is being processed. This acquisition can be continuous until the system is set up for some combination of bandwidth and number of channels that causes total processing time to be greater than input buffer filling time. When you select FREE RUN, the remaining trigger setup menus appear but have no affect on acquisition until a triggered mode of operation (below) is selected.

b. AUTO ARM 1st FRAME. Input acquisition does not start until the specified trigger event occurs on the trigger channel. After the initial start, acquisition is continuous, the same as the free-run mode above.

NOTE: The trigger mode can thus be used as a remote start command for averaged data collection, where the start command is derived from the input data stream itself; that is, after pushing the RUN button, input acquisition, and the averaging RUN, does not start until the input signal again satisfies the trigger conditions.

Note also that this mode takes 50% more memory for the acquisition buffers than the other three modes. Selecting this mode might cause the "Not Enough Memory" message to appear in the bottom left of the screen. You must either not use this mode, use a smaller number of lines, or de-allocate some channels.

c. AUTO ARM EVERY FRAME. The specified trigger event is required to start acquisition of each new frame. However, as soon as each acquired frame is processed, the trigger circuitry is automatically re-armed to recognize a new trigger as soon as it occurs. The ARM indicator in the ANALYSIS controls light whenever the system is ready and is waiting for a trigger.

d. MANUAL ARM. The specified trigger event is required to start acquisition of each new frame. Furthermore, the trigger circuitry is not armed or re-armed until you press the ARM button in the ANALYSIS group. The ARM indicator remains lit until the trigger occurs.

5.8.8.2 **Trigger Channel.** The channel selected here for the trigger source must be an active channel under the current INPUT SELECT setup, or be a 0 for the rear panel EXT TRIG input. The external trigger event is a TTL high to low transition or a switch closure to ground. Although they are not applicable to external trigger, the following level and slope menus still appear, to get to the delay menus.

5.8.8.3 **Trigger Level.** The trigger level is specified as a percentage of the positive or negative full scale range that is specified for the trigger channel under the INPUT LEVEL setup. Example: If channel 1 is the trigger channel and channel 1 LEVEL is set for ±2.0 V, then entry of -40 for trigger level causes triggering when the signal passes through the -0.8 V level.

5.8.8.4 Trigger Slope. The + or - selection determines whether trigger occurs as the signal is rising or falling through the specified trigger level.

5.8.8.5 Trigger Channel Delay. The trigger channel delay parameter, specified as a percentage of the input frame length in time, refers to the time of the beginning of data frame acquisition on the trigger channel, relative to the time of the trigger event. The delay may be a positive number, meaning the data frame begins some time after the trigger event, or a negative number, meaning the start of data acquisition is advanced in time before the trigger event; that is, the trigger event itself is contained within the acquired frame. Negative delay (advance) is commonly used in impact testing to insure that the beginning of the reference excitation transient, from which acquisition is triggered, is captured in the acquired frame. The maximum negative delay (i.e., advance) is -100%, or one frame length.

The maximum positive delay is determined by a sample counter with a capacity of 32,767. The allowable positive delay therefore varies with frame size. As percentage of frame length it is approximately equal to (32,767/frame size) x 100.

5.8.8.6 Auxiliary Delay. The auxilliary delay parameter refers to the delay in percent of frame length for all other channels relative to the trigger channel. Only 0 or positive delays are allowed. Other channels cannot be advanced relative to the trigger channel. A delay of 0 here causes all channels to be collected at the same time. Positive delays are commonly used when triggering from an impact excitation channel on larger structures where there is a known or predictable propagation delay before the response appears at the response channels. The maximum delay is the same as shown above for the trigger channel.

5.8.8.7 Note on Effect of Hysteresis, Digital Filter, and Zoom on Triggered Impact Signal. You may encounter some problems when acquiring triggered data under certain conditions.

One problem involves the use of positive slope to trigger an impact signal. For negative slope triggering, it is easier to get the data, while it is somewhat more difficult to collect data using positive slope triggering without hitting the hammer very hard.

Another problem concerns bandwidth. In the case of low bandwidth, it is hard to obtain the signal. Conversely, high bandwidth eases the data collection.

Next, under ZOOM mode, the trigger is unreliable.

This note is intended to clarify these possible problems and to provide some suggestions to remove them.

Trigger Slope

RTA handles trigger with noise immunity in mind. In order to avoid triggering by noise, a 10% hysteresis is built in. As a result, for trigger to occur at a positive slope, the input signal has to increase from 10% (of the full scale) below the trigger level specified. For negative slope, the signal has to decrease from 10%

above the trigger level. This allows random noise on the signal of interest to be as large as 10% of full scale without allowing a false trigger on the wrong slope.

When an impact or any positive pulse signal which is normally at a 0 volt level occurs and trigger level is set to less than 10% of full scale and positive slope is chosen, the signal level cannot go below 0 volt level unless post-peak ringing occurs which brings the signal 10% below the trigger level and back up. Usually this does not occur on the hammer signal. For negative slope, however, the impact signal most likely has a chance to come from 10% above down to the trigger level, therefore fulfilling the requirement. Thus, it is easier to trigger the impact signal with a negative slope.

To reduce this difficulty, use a higher trigger level (greater than 10%) if permitted. Pre-trigger delay should be specified to recover data prior to the trigger point.

Note: The hysterisis circuit is disabled in systems shipped after December 1984 and the above restrictions will not apply.

Bandwidth

In an impact test, usually many response channels are attached to the mechanical structure, while the reference (or force) channel is from the roving hammer. The bandwidth of interest is usually determined by the measured bandwidth of the response channels. This bandwidth is often low. The force channel often spans a much higher bandwidth. A low bandwidth filter used on the trigger channel greatly attenuates this signal, hence the difficulty in triggering.

To avoid this situation, the first reaction is usually to increase the gain. Since the force channel has such a broad bandwidth and most of its amplitude is reduced by the filter, increasing the gain overloads the A/D converter in front of the digital filter.

One can approach this problem by sufficiently band-limiting the hammer signal either electrically or mechanically (using soft tip). This reduces the impact signal amplitude by reducing its bandwidth to a range comparable to that of the response signal. Since this reduction occurs prior to the amplifier stage, turning up gain without overload is now possible. Additionally, the attenuation of the impact signal due to digital filters is minimized because its energy is distributed well within the filter bandwidth.

Trigger Under ZOOM

Trigger under ZOOM is a bit limited. Briefly, the ZOOM action is accomplished by multiplying the signal by a complex exponential which shifts the center frequency of interest down to be centered around DC. This complex exponential is expressed in terms of sine (imaginary part) and cosine (real part). These two signals are then put through bandpass filters (ZOOM band), resampled, and complex Fast-Fourier transformed to yield the zoomed spectrum.

The trigger signal is derived from only the real part of the complex signal. This sinusoidally modulated signal certainly has a shape different from the original. The end result can be unpredictable triggering.

5.9 ACQUISITION FUNCTIONS (AVERAGER OPERATION)

The ACQUISITION group of pushbuttons controls spectrum averaging operations, in conjunction with the conditions specified by the measurement setup AVERAGE and TRIGGER functions. This group includes the following buttons, whose functions are below with their respective two-letter equivalent keyboard commands.

RUN
CONT
ARM
HOLD

RUN (AR)

The RUN button starts and stops the accumulation of averaged spectra. Pressing the button the first time clears the average buffers (except for DIFFERENCE mode averaging), clears the average count to 0, and turns on the RUN indicator. The actual start of new acquisition depends on the trigger mode setup. Note that if autoranging has been selected, the system may have to acquire and test several new frames before it begins processing and passing them to the average. The information message "ARNG" appears at lower right while auto-ranging is in progress. For SUMMATION or DIFFERENCE averaging modes, the run is stopped automatically when the specified frame count is reached. For other modes, the run continues indefinitely until it is manually stopped by pressing the RUN button again.

Pressing the RUN button while an averaging run is on stops the averager. The frame currently being processed is included in the average, but the frame curently being acquired is not.

CONT (AC)

The CONT button performs two different actions, dependent on the mode, as follows:

(1) Auto-accept mode: If averaging has been stopped, CONT restarts it. CONT has the same effect as RUN, except that it does not clear the average or reset the count. It does not include the frames that were being processed or acquired when it was pressed.

(2) Manual Acceptance Mode: The CONT button is used to accept input frames into the average. Each new input frame is held for examination. The HOLD indicator lights and the prompting message "REJ?" appears at lower right. Press CONT to accept the frame. Press HOLD to reject it.

NOTE: If an averaging run has been stopped in manual acceptance mode, pressing CONT the first time merely restarts acquisition for a new frame to be held. It does not accept the last real-time input frame that was acquired while averaging was stopped.

HOLD indicator	The HOLD indicator lights each time a new frame has been completely acquired. In real-time or auto-accept averaging it only flashes momentarily as the frame is passed to the process. In manual acceptance averaging, the HOLD indicator remains lighted until the frame is accepted by pressing CONT or rejected by pressing HOLD. (In manual ARM trigger mode it is not necessary to press HOLD to reject a frame. If you do not press CONT to accept the frame, pressing ARM to re-arm the trigger automatically rejects the previous frame.)
HOLD button (AH)	The HOLD button is used only to reject frames in manual acceptance averaging.
ARM indicator	When triggered acquisition is in effect, the ARM indictor lights when the trigger is armed and remains lighted until the trigger conditions are met to start acquisiton. If the ARM indicator is lighted, the system is idle, waiting for a trigger.
ARM button (AA)	The ARM button is used only for MANUAL TRIGGER mode or to re-send a pseudo-random output signal, if this feature is selected. It must be pressed to arm the trigger and allow the system to recognize a trigger event for acquisition. When manual arm is in effect, the prompting message "ARM?" appears at the lower right to remind you that you must press the button to start operations. (In manual ARM trigger mode it is not necessary to press HOLD to reject a frame. If you do not press CONT to accept the frame, pressing ARM to re-arm the trigger automatically rejects the previous frame.) During pseudo-random output and with triggering enabled, this re-sends the pseudo-random output. This is in case triggering misses the signal the first time due either to improper equipment connection or to incorrectly set trigger levels/slopes.

5.10 DISPLAY FUNCTIONS

The following paragraphs describe the functions, features, and parameters controlled by the DISPLAY group of pushbuttons.

Using the DISPLAY group, you may specify the source data to be displayed in the functions area of the display screen. Make the selections from the selections on the screen and immediate response buttons.

The DISPLAY group controls two parameter sets which are referred to as the Upper and Lower displays. The DISPLAY group buttons (and keyboard codes) are as follows:

REAL TIME (DR)	FUNCTION (DF)
AVG (DA)	X SCALE (DX)
MEM (DM)	Y SCALE (DY)
NEXT CHAN (DN)	CHANNEL (DC)
SINGLE (DS)	UNITS (DU)
DUAL (DD)	BLOCK MATH (DB)
OVLY (DO)	
EXCHNG (DE)	

5.10.1 Modifying the Displays

You can modify the displays in a variety of ways dependent upon the current screen format. You can also exchange the positions of the displays (i.e., the upper display becomes the lower display and vice-versa).

5.10.1.1 Reversing Upper and Lower Displays. Press EXCHNG button to exchange the positions of the displays.

5.10.1.2 Screen Format Selection. Use one of the following buttons in the display to select screen format:

SINGLE	Provides a full screen display of one channel, one function.
DUAL	Provides dual upper and lower display of two functions.
OVLY	Provides dual superimposed display of two functions.

5.10.1.3 Modifying Upper Display Only. Regardless of screen format selection (see above 3.7.1.2), the following buttons affect the upper display only.

FUNCTION	REAL TIME	MEM
CHANNEL	AVG	

If the screen format selected is SINGLE, then only the upper display is affected, meaning one channel/one function is modified. The following buttons may be additionally used to modify the display:

X SCALE	UNITS
Y SCALE	NEXT CHAN

5.10.1.4 Modifying Upper and Lower Displays/DUAL or OVLY Format. If the DUAL or OVLY formats are selected, both the upper and lower displays may be modified (and their associated menus) by using the following buttons:

X SCALE — Rescales both displays if they are of the same X-axis window type.

Y SCALE — Rescales both displays if they are of the same Y-axis window type.

UNITS — Changes X or Y axis units if they are the same on both upper and lower functions.

NEXT CHAN — Increments both upper and lower displays.

5.10.2 Selecting Data Source

The data source to be displayed is provided by one of three buttons: REAL TIME, AVG, OR MEM. Only one source is active at a given time. Accompanying LED indicators verify which mode is currently active on the display. If the display is in the DUAL screen format, the LEDs indicate the source of the upper display only, and because the lower display does not necessarily have the same source.

If any of the source buttons is pressed, any menu present on the screen is removed. This serves to remind you that a different set of parameters may be modified.

5.10.2.1 REAL TIME Source. The REAL TIME source button selects display of the REAL TIME input data; i.e., the unaveraged data that is used in the averaging computation. This data is available for display at all times and serves as the scope function for the instrument program. When data is "...not available" for displays, a blank function contains this message. This occurs at slow frame rates (low bandwidths) and when the trigger event has not yet occurred.

5.10.2.2 AVG Source. If AVG is pressed, the data source is the average buffers containing the averaging results. If the averager has never been run, there is no data in the average buffers. A blank function appears with a "...not available" message. Modifying certain setup parameters also invalidates the data in the average buffers. Refer to paragraph 5.8.1.1. This message also appears, once the RUN button has been pressed, until the first frame of data has been processed.

5.10.2.3 MEM Source. The MEM button selects the display data from recalled memory buffers or disk file data. Selection of this source indicates that the data is "...not available" if no function has been recalled. The menu interactions for display modification are somewhat different when MEM is the data source. STORE functions are of specific function types and cannot be changed to another function type after recall. You can change the format of complex functions much the same as for AVG data. You cannot change between VOLTS and EU units for MEM source displays since the channel EU factors are not saved. Modification of the processing window is ignored in MEM displays. Channel specification via CHANNEL or NEXT CHAN is also ignored.

There are two special MEM data buffers: "upper" and "lower". Each is filled separately when RACALL data goes into the upper display, a copy is made to the "upper" MEM data buffer. When RECALL data goes into the lower display (through EXCHANGE), the "lower" MEM data buffer is filled. Subsequent pushing of MEMory button transfers data from the MEM data buffer back to its corresponding display buffer.

5.10.3 Selecting Channels For Display

Two buttons are provided for specifying an active channel to be displayed:

CHANNEL and NEXT CHAN.

5.10.3.1 CHANNEL. When this button is pressed a query prompt is displayed:

Channel Pair	=	(for displayed CROSS CHANNEL data)
Channel	=	(for displayed AUTO-CHAN data)

The sequence of steps is as follows:

a. Press CHANNEL. "Channel Pair =" appears.

b. Enter the number of an active channel or channel pair (ENTRY area).

c. Press ENTER or NEXT to activate entry. The display channel changes to the selected channel. Note that if the channel number is entered not an active channel, the entry is ignored.

During AUTO channel mode, the response channel list is checked.

During CROSS channel mode, when an AUTO channel function is displayed, both reference and response channel entries are checked in the active channel list. The above step b. is modified as follows:

b. Enter response channel number, followed by reference channel number.

Example: 4, 1

If the reference channel is not entered, it remains the same and only a new response channel is changed, and vice-versa.

Example: 4

If a response channel is entered and the reference channel does not match with any of the active channel pairs, the channel pair displayed will be the first channel pair with the correct response channel in the active channel pair list. If only a response or a reference channel is entered and does not appear in the appropriate column of the channel pair list, the entry is ignored. The CHANNEL button entries always modify only the upper display.

5.10.3.2 NEXT CHAN. When the NEXT CHAN button is pressed, action taken is dependent upon screen format and channel function selections.

- PROBABILITY or AUTO Channel /SINGLE Format: A sequence is made through the list of active response channels.
- DUAL or OVLY Format: NEXT CHAN changes both the upper and lower displays.
- CROSS Channel /SINGLE Format: A sequence is made first through the list of active response channels, then through any active reference channels if an AUTO channel function is shown in the upper display. If a CROSS channel function is being displayed then the channel pair list is sequenced through.
- Mixed AUTO and CROSS Channel Functions/DUAL or OVLY Format: The channel pair list is sequenced through. The AUTO channel is then restricted to the response channel of the current channel pair.

5.10.4 Selecting FUNCTION Type

The FUNCTION button allows you to select the function type to be displayed. It also allows selection of certain format parameters. When you press FUNCTION, the following setup summary appears:

Function:
CPX Function:
Format:
COH Blnk Level:

The menu that appears depends on which data source is currently selected: REAL TIME, AVG, or MEM. ORBIT appears if it is an orbit display.

5.10.4.1 REAL TIME Function Menu. The following menu appears if you press the REAL TIME button:

```
     Function

> * SPECTRUM
    TIME
    LEVELS
    ORBIT
```

SPECTRUM — Selects the frequency domain representation of the input samples.

TIME — Selects the time domain sampled data.

LEVELS — Selects a special format display which shows the PEAK and RMS levels of all the active channels relative to full scale all on a single display.

ORBIT — Provides a time domain display which shows two channels relative to each other on the X and Y axis.

5.10.4.2 AVG Function Menus. If the current mode is AUTO CHANNEL and the data source selected is the AVG button, the following menu appears on the display:

> * SPECTRUM
  TIME HISTORY

SPECTRUM — This selection shows the averaged AUTO SPECTRUM data or the LINEAR SPECTRUM of the time averaged signal when time domain averaged data has been collected.

TIME HISTORY — This selection is available only if time domain averaging is being used. It shows the averaged time domain input data.

If the current mode is CROSS CHANNEL, and AVG is the data source, the following menu appears:

Function

> * AUTO SPECTRUM
  CROSS SPECTRUM
  TRANSFER FUNCTION
  COHERENCE
  IMPULSE RESPONSE
  COHERENT OUTPUT POWER
  AUTO CORRELATION
  CROSS CORRELATION
  TIME HISTORY

If cross spectrum or transfer function is selected, the following menu appears. It is also displayed if time domain averaging is used and SPECTRUM is selected. The magnitude and phase information is usually lost in the averaged AUTO SPECTRUM calculation but is preserved in the TIME averaged data since it is processed in the time domain and the SPECTRUM selection performs the DFT (Direct Fourier Transform) to produce a complex result (LINEAR SPECTRUM). For block math results that have complex data format, this menu can also appear. No circle fit is done on block math result. If it is chosen, a Nyquist plot is presented.

CPX Function Format

```
> * 1) BODE
    2) MAGNITUDE
    3) PHASE
    4) 0REAL
    5) IMAGINARY
    6) MAGNITUDE vs. PHASE
    7) NYQUIST
    8) CIRCLE FIT
```

AUTO SPECTRUM

Provides the average of the squared spectrum magnitude, representing the mean power at each frequency.

$$G_{AA} = \overline{S_A \cdot S_A{}^*}$$

CROSS SPECTRUM

Provides the averaged complex product of spectrum A and spectrum B and indicates which frequencies match between A and B.

$$G_{AB} = \overline{S_B \cdot S_A{}^*} = \overline{|S_A' S_B| \, COS(\phi B - \phi A)} + j\,\overline{|S_A \div S_B| \, SIN\,(\phi B - \phi A)}$$

TRANSFER FUNCTION

Presents the ratio of the cross spectrum of A and B to the input power spectrum of input A. It represents the gain and phase lag given by a system with input A and response B.

$$H_{AB} = \frac{G_{AB}}{G_{AA}} = \frac{\overline{S_B \cdot S_A{}^*}}{S_A \cdot S_A{}^*}$$

---

*: Complex conjugate

COHERENCE

Indicates the linear cause and effect relationship between the input time function on A and the input time function on B.

$$\gamma^2{}_{AB} = \frac{G_{AB} \cdot G_{AB}^*}{G_{AA} \cdot G_{BB}}$$

$$= \frac{|G_{AB}|^2}{G_{AA} \cdot G_{BB}}$$

IMPULSE RESPONSE

Provides the time response of a system to an inpulse input and is the inverse transform of the transfer function.

$$IR = F^{-1}\{H_{AB}\}$$

COHERENT OUTPUT POWER

Represents the power spectrum in the output signal B that is coherent with the input signal A. The total power spectrum indicates the entire content of signal B while the coherent output power function indicates only that portion caused by signal A; i.e., only by A through a linear process.

$$COP = \frac{G_{AB} \cdot G_{AB}^*}{G_{AA}}$$

AUTO CORRELATION

Provides the time domain statistic by comparing similarities of the input time function of a channel (A or B) to replicates of itself, delayed by an artificially introduced time delay. As the time delay approaches zero, the statistic approaches the square of mean value. Oscillations in the time domain statistic indicate bandwidth and periodicity of the input time function signal of the channel.

$$R_{AA}(\tau) = F^{-1}\{G_{AA}\} = \frac{1}{P} \circ \int^{\rho} A(t) \cdot A(t+\tau)dt$$

CROSS CORRELATION

Compares the similarity of the input time function between two channels (A and B). The value of the artificially introduced time delay that maximizes the correlation indicates the time lag between signals A and B.

$$R_{AB}(\tau) = F^{-1}\{G_{AB}\}$$

$$= \frac{1}{P} \circ \int^{\rho} A(t)B(t+\tau)dt$$

*: Complex conjugate

CIRCLE FIT — Produces a least squares circle fit on displayed function data with a phase interpolation algorithm to obtain the modal frequency and damping factor.

TIME HISTORY — For time averaged data only; this selection shows the averaged time waveform for averaged time frames.

$$S_{\bar{A}} = F\{A(t)\}$$

The format selection menu is followed by a menu which allows the specification of a COHERENCE blanking level:

ENTER Coherence Blanking
Level (0.0 = OFF)

Displays of complex data types (for transfer function only) only show data for which the coherence is greater than the entered level. Data values below the coherence blanking level are not displayed.

If the current mode is PROBABILITY and AVG is selected as the data source, a choice of averaged functions is available on the following menu:

>* PROBABILITY DENSITY
CUMULATIVE DISTRIBUTION

5.10.4.3 ORBIT Display. If ORBIT is selected from the REAL TIME function menu (see paragraph 5.10.4.1) an "orbit plot" can be generated. The ORBIT display depicts the phase relationship between two signals which are, in certain vibration studies, collected with probes on a machine at two different angular positions (e.g., 0 and 90 degrees).

In the RTA program, these two signals can both be real-time input signals, or both averaged, or a real-time versus an averaged signal, as long as a certain set of conditions are met.

An ORBIT display is generated from two time domain data blocks, each having n elements. The source of each block can be RT, AVG, or MEM. The X, Y coordinates of the curve are taken, in time sequence order, from the beginning of the blocks. These two blocks must be placed in the upper and lower displays first and must meet the following requirements:

1. The current upper and lower displays must be time-domain functions.

2. The blocks must have an equal number of elements.

3. The blocks must have the same real-time duration.

If any of these conditions are violated, "INCONSISTENT DATA" appears at the system message area, but the display is not changed.

If ORBIT is selected and allowed there is no split screen. The display is coerced to SINGLE. This is because it takes both displays to specify one orbit, just as it takes both displays to specify the overlap displays.

Both displays' labels are present on the left hand side of the plot. If the menu is present, however, only the upper display label shows up. The upper labels correspond to the Y-axis and the lower labels correspond to the X-axis. Between the two sets of labels, ORBIT appears to denote the format.

Note that there is no storage or recall of an orbit function. However, when storage is requested, only the upper display time-domain data is stored. To reconstruct the orbit display, it is necessary to recall the correct constituent time-domain functions separately into the upper and lower displays.

Note also that there is no cursor and no way to perform block math, group storage, or log scale operations. The display defaults to linear in the event of an error.

The menu sequence is as follows:

For REAL-TIME orbit:

Step 1. Press REAL TIME.

Function

1) SPECTRUM
2) TIME
3) LEVELS
>*4) ORBIT

Select ORBIT. The data is processed based on the current upper and lower displays. The lower display may be any time-domain function of any source (e.g., RT, AVG, or MEM), so long as the previously mentioned conditions are met.

For AVG orbit:

Step 1. Press AVG.

Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENCE OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
>*10) TIME HISTORY

Select one of the four time-domain functions, numbers 5, 8, 9, or 10.

Step 2. Press NEXT.

Format

1) NORMAL
>*2) ORBIT

Press NEXT CHAN button to get the next pair. This changes both upper and lower, Y and X, simultaneously. There is no check for a valid channel pair.

For AUTO CORRELATION function in ORBIT, pressing NEXT CHAN increments through the active channel table.

For CROSS CORRELATION function in ORBIT, pressing NEXT CHAN increments through the active channel PAIR table.

When ORBIT is from mixed CROSS and AUTO functions, pressing NEXT CHAN does both of the above.

Whichever selection is made, NEXT CHAN in ORBIT mode writes the RES channel numbers of the constituent functions.

To change the upper channel: press CHANNEL, enter the channel number, and press ENTER.

To change the lower channel: press CHANNEL, enter a comma followed by the channel number, and press ENTER.

5.10.5 Y SCALE Function

The Y Scale button is used to select the type of scaling desired for the Y axis of the display. It has the following first menu and summary:

Y Scale	Y Scale: LOG AUTO SCALE
	EXPAND Min Y:
1) LIN AUTO SCALE	EXPAND Max Y:
2) LIN EXPAND	
3) LOG AUTO SCALE	dB Range: (if LOG AUTO SCALE)
>* 4) LOG EXPAND	

LIN AUTO SCALE — The full scale value is selected through an autoscale algorithm which looks for the maximum value in the data block to be displayed and sets the full scale value to be the next largest value in a 1, 2, 5 sequence. For unipolar displays, the minimum Y value is always 0.0. For bipolar displays, the maximum and minimum values are set to be equal to the maximum absolute value. For time domain input displays, the maximum, minimum is fixed at plus or minus the maximum value of the input level range.

LIN EXPAND	This selection allows you to specify in the next menu the maximum and minimum values to be used in generating the display.
LOG AUTO SCALE	The full scale value is selected in the same way as for LIN except that the minimum value cannot be zero and must default to a user specified range of decibels. This may be entered in the menu which follows.
LOG EXPAND	As in LIN EXPAND, you specify a maximum and minimum value for the display parameters. The maximum and minimum choice is found in the menu which follows. There are some functions for which LOG scaling is not meaningful. These displays default to LIN scaling but the choice between AUTO SCALE and EXPAND is still recognized.

The next menu in this tree depends upon the first selection made and is displayed as follows:

LIN AUTO SCALE is selected = No further menus appear.

LIN EXPAND is selected = The next menu is:

ENTER MIN,MAX values
for Lin Y Expansion

The desired upper and lower limits are entered in the currently displayed units.

LOG AUTO SCALE is selected = A decibel range is displayed for selection:

dB Range

120
100
80
>*60
40
20

LOG EXPAND is selected = The next menu prompts for the minimum and maximum expansion values in the current display units:

ENTER MIN,MAX values
for Log Y Expansion

5.10.5.1 Modifying Scaling in AUTO SCALE Displays. You may scale the display vertical scale in AUTO SCALED displays using the ↑ and ↓ arrow buttons when there is no other menu active. In LIN AUTO SCALE the vertical scale is multiplied by 2**n every time the ↑ or ↓ arrow button is pressed. ↑ increments the value of n by 1 each time and ↓ decrements the value of n. In LOG AUTO SCALE, the vertical scale is modified by a 10 dB offset each time these buttons are pressed. ↑ adds 10 dB of offset to the display and ↓ subtracts 10 dB from the display maximum Y value and minimum Y value. (In LOG AUTO SCALE the limits are still multiplied and divided by 2. The plus and minus 10 dB is only for LOG AUTO SCALE with dB turned on.)

Initialization of this type of display modification is performed when any of the following parameters is changed:

Y Scale type
Function type
Function format
Data source
Y axis units
CHANNEL
EXCHNG
NEXT CHAN

In LOG, the decibel offset is set to 0 and in LIN, the gain factor is set to 1.

5.10.6 X SCALE Function

The X SCALE button allows the scaling of the X axis to be selected from the following menu and summary:

```
     Y Scale                          Y Scale:  LIN AUTO SCALE
                                      EXPAND Min X:
>* 1)  LIN AUTO SCALE                 EXPAND Max X:
   2)  LIN EXPAND
   3)  LOG AUTO SCALE
   4)  LOG EXPAND
```

LIN AUTO SCALE	This uses the maximum and minimum limits of the data block to be displayed to set the maximum, minimum limits of the display.
LIN EXPAND	This allows you to input specific limits for use in display generation. These limits are entered in the next menu to be displayed.
LOG AUTO SCALE	The maximum becomes the first positive frequency value in the block, i.e., 32 Hz.

LOG EXPAND This selection provides a LOG X axis display with user specified minimum and maximum values from the next menu.

LOG X scaling is not meaningful to some functions such as TIME. These displays default to LIN scaling but recognize the choice between AUTO SCALE and EXPAND. For AUTO CORRELATION and CROSS CORRELATION displays the first 10% and last 10% of the data is not displayed if AUTO SCALE is selected. Truncation of the frequency time domain causes "edge effects" which are not meaningful and, therefore, are not displayed. This data can be seen in EXPAND mode. For a similar reason, the last 10% of the Impulse Response function is not shown in AUTO SCALE mode.

If LIN or LOG AUTO SCALE is selected no menu follows.

If LIN EXPAND is selected the following menu appears:

ENTER MIN,MAX Values
for Lin X Expansion

If LOG EXPAND is selected, the following menu appears:

ENTER MIN,MAX Values
for Log X Expansion

5.10.6.1 X and Y Expansion Windows. To avoid having to specify the window repeatedly when changing the function type, a number of different windows are maintained for the X and Y limits of the displays. The following windows are saved separately for the function types listed:

Y-AXIS EXPANSION WINDOWS

Power Amplitude Window
SPECTRUM (Real Time)
AUTO SPECTRUM
CROSS SPECTRUM*
TRANSFER FUNCTION*
TRANSMISSIBILITY
COHERENT OUTPUT POWER
AUTO CORRELATION
CROSS CORRELATION
LINEAR SPECTRUM*
(* in Bode, Magnitude, and Magnitude vs. Phase formats)

Real Amplitude Window (in Real format)
Imaginary Amplitude Window (in Imaginary, Nyquist and Circle Fit formats)
Phase Window (in Phase format)
CROSS SPECTRUM
TRANSFER FUNCTION
LINEAR SPECTRUM

Amplitude (vs. Time) Window
- TIME
- TIME HISTORY
- IMPULSE RESPONSE
- ORBIT

Coherence Window
- COHERENCE

Probability Density Window
- PROBABILITY DENSITY

Cumulative Distribution Window
- CUMULATIVE DISTRIBUTION

X-AXIS EXPANSION WINDOWS

Time Window
- TIME
- TIME HISTORY
- IMPULSE RESPONSE
- AUTO CORRELATION
- CROSS CORRELATION

Freq Window
- SPECTRUM
- AUTO SPECTRUM
- LINEAR SPECTRUM
- TRANSFER FUNCTION
- COHRENCE
- TRANSMISSIBILITY
- COHERENT OUTPUT POWER

Real Window (in Nyquist and Circle Fit formats)
Phase Window (in Magnitude vs. Phase format)
- CROSS SPECTRUM
- TRANSFER FUNCTION
- LINEAR SPECTRUM

Orbit X window
- ORBIT

Probability X window
- PROBABILITY DENSITY
- CUMULATIVE DISTRIBUTION

When you make changes between Y SCALE modes you need to modify the magnitude and power vs. frequency windows. The following parameters apply:

a. The maximum values of these windows are preserved when the Y SCALE is changed.

b. The minimum value of the amplitude windows is initialized to zero when changing from LOG to LIN Y scale.

c. When changing from LIN Y scale to LOG Y scale the minimum values in these windows are changed as follows:

Power Amplitude Window
    Min value = max value * 10**(-dBRange param/20)
Magnitude Window
    Min value = max value * 10**(-dBRange param/10)

The remaining windows do not need to be changed when the Y scale is changed.

5.10.6.2 Window Units. The units of the window are the units of the current display. If new units are selected, the display window units are not modified and must be respecified.

5.10.7 UNITS Function

When you press this button, a menu of unit selections displays. The selections allow you to specify the units which are to be used in the display annotation. This first menu is as follows:

```
      Amplitude Units              Ampl Units:
                                   Ampl Normalization:
>* 1)  V                           Freq Units:
   2)  EU                          ORDER Reference:
   3)  dBV
   4)  dBEU
```

V — This selection means "volts" which are the basic units of calibration of the input circuitry. The ORDER Reference line appears only if ORDER is chosen in later Frequency Units menu.

EU — These Engineering Units are the units specified by you for each of the input channels in the INPUT LEVEL menus. The text that is used is that which you entered. The relationship of the EUs to V is determined by a calibration factor which you also enter in the input range. If EU is selected, then the normal V calibration is modified by the scale factor (volts per engineering unit) and is displayed with the user entered text string. You may also specify an EU conversion factor which is selected in the menu that follows within this mode.

dBV These units are logarithm decibel units relative to a 1.0 volt reference. The amplitudes are read out in dBV units.

dBEU These units are logarithm decibel units relative to the user entered reference.

If a conversion is made to decibel units, the minimum/maximum limits for the appropriate window is automatically converted to decibel values (and vice-versa).

If memory is being displayed, the arrow only moves to valid selections. If storage is done with EU, only EU and dBEU can be selected. If storage is performed with V, only V and dBV can be selected.

5.10.7.1 Units Normalization Menu. The next menu in the units sequence is the specification of the units normalization of the selected units type. This normalization is only appropriate for power functions. This menu appears for all function types but only allows selection of units appropriate to the particular function, e.g., Transfer Function allows U or U2 only, ASPEC allows all possible normalizations.

Units Normalization

```
>* 1)  U
   2)  U2
   3)  U2/Hz
   4)  U2*SEC/Hz
```

Note that Normalization can also be selected for stored functions recalled to memory display since normalization is not applied to the data when it is stored.

U This selection uses the exact units as specified in the menu.

U2 These are squared units which is the natural format for displays of power spectra.

U2/Hz The per Hertz normalization calibrates the spectral values in units of power spectral density (PSD). This normalization is accomplished by dividing the U2 spectral value by the frequency resolution for the current frequency bandwidth and frame size. For broadband noise this selection would yield equivalent measured values independent of the current frequency resolution. For periodic signals, such as a sine wave, the results can be difficult to interpret since division by the resolution only rescales the measured sine wave, which itself has an infinitely narrow bandwidth.

U2*SEC/Hz Normalizes the readout for energy density measurements. Since the PSD measures energy per unit time, this selection multiplies by the measurement time to give energy density. Since this is equivalent to dividing by the frequency resolution for FFT based machines, this normalization is equivalent to dividing by the frequency resolution twice. As in U2/Hz, this selection may not be appropriate for measurement of periodic signals.

5.10.7.2 Frequency Units. The frequency units (along the X-axis) are specified in the third menu of the UNITS function. The menu is as follows:

Frequency Units

>* 1) HZ
2) CPM
3) ORDERS

HZ — The normal units readout for the abscissa. This selection scales the frequency plots as cycles per second and labels the X-axis as FREQ(HZ).

CPM — This is cycles per minute and corresponds to a multiplication by 60 of the Hertz values (cycles per second); i.e., CPM scales frequency plots as cycles per minute and labels the X-axis as FREQ(CPM).

ORDERS — This is a readout of abscissa units relative to some frequency reference. It is useful when dealing with rotating machinery where the first order would be the fundamental rotational speed which would be the first order (units = 1.0 ORDER). In this case the X-axis is labeled ORDERS(HZ/'#'), where "#" is the current user supplied order reference.

If ORDERS is selected then the order reference must be entered when the system prompts:

ENTER Order Reference
in Hz

When the frequency units menu is changed, the X-expand limits are automatically updated to reflect the change. For example, if the setting was HZ and the X-expand limits were 0 to 10240, a change to CPMs would automatically change the X-expand limits to 0 to 6.144 e+5 (10240*60 = 6.144 e+5).

If storage is required, frequency domain functions are always stored as the current setup dictates. When recalled, they look the same as just before they were stored, with one exception. The reference in ORDERS is not saved. Although a recalled X-axis scale looks the same for a saved ORDERS function, the units label reads "ORDERS", and does not include a reference number. HERTZ and CPMs look the same.

When a function is recalled, the panel forces the frequency units menu to the saved state. Once a function has been recalled, the frequency units menu cannot be changed.

Note that the user entered reference of ORDERS is restricted to .00001 <= reference <= 99,999.

5.10.8 Block Math Function

Block Math allows you to apply additional scaling factors and block vs. block operations to Average and Memory data blocks. A Block Math operation involves the upper display data and the lower display data or a user entered scale factor. The result of Block Math operations resides in the upper display data buffer. Block Math operations are categorized into single and double operand types.

5.10.8.1 Double Operand Operations. For double operand operations, the upper display data is always the first operand. The second operand can be either the lower display data or a specified complex number, depending on the operation desired. The double operand Block Math operations are performed by pushing the +, -, *, or /buttons, corresponding to addition, subtraction, multiplication and division operations respectively. When one of these buttons is pressed a prompt to enter the operand number (#) appears at the lower left corner of the screen. If a number is entered, the upper display data is operated on with this value. The number is entered in the format "a, b" where "a" and "b" are the real and imaginary parts of a complex number. If either number is not entered it is assumed to be zero. Only "a" (the real part of an imaginary number) is entered if a scalar value is entered to operate on a real data block.

If the ENTER button is pressed without a numeric entry, the upper display data is operated on with the lower display data as the second operand. This operation leaves the Block Math result in the upper display while the lower display data remains unchanged.

5.10.8.2 Block Math Operand Units. Data blocks used in Block Math operations are "internal" display data buffers which can not have the same numeric format as the data shown on the display. For example, a Transfer function can be displayed as a real "Magnitude" but the Block Math operation would be performed on the "internal" complex data block. Also, "internal" data blocks have units normalization appropriate to their function type. This can be changed on the display with the UNITS NORMALIZATION menu but the "internal" data is not modified. For example, an AUTOSPECTRUM is internally stored in squared units. The display can plot this data with VOLTS normalization which requires the square root to be calculated when generating the display. However, this operation leaves the "internal" buffer in squared units. Block Math performed on this display data is performed on the "internal" data. Thus, scaling the VOLTS display data by a user entered value would require entering a squared scaling value. The converse is true for functions that are internally represented in linear units and are being displayed with squared normalization.

The following functions are internally represented in squared units:

- AUTOSPECTRUM (frequency domain averaging mode)
- TRANSMISSIBILITY
- COHERENT OUTPUT POWER

All other functions are internally represented in linear units including AUTO-SPECTRUM when it is collected in time domain averaging mode (also known as a Linear Spectrum).

The /Hz UNITS NORMALIZATION selections are ignored when performing Block Math since this is also a display normalization. To include such normalization the frequency resolution factor must be applied to the data with a user entered scale factor.

Internal data blocks are not stored in dB units. Therefore, if dB display units are in effect you must compute a non-dB scale factor that corresponds to the desired dB value. For squared units functions:

dB value = 10 * log10(M)

and for a linear units block operant:

db value = 20 * log10(M)

where M is the scale factor that would be entered.

Note that the units normalization of the result of a Block Math data block is considered to be linear regardless of the original function type. This means that subsequent operations will always treat the data block as linear. For example, multiplication of the data block by one prior to any other scaling operation allows you to ignore the linear versus squared distinction. This can also be accomplished by taking the square root of the squared block before applying linear scaling factors. The square root is described in the section describing the single operand operations.

5.10.8.3 Block Math Results Display. The results of the Block Math operation are displayed somewhat differently than other data displays. The display menu selections are also somewhat restricted.

When Block Math is performed the Y axis is labelled BLOCK MATH. If the resultant data block is complex the label COMPLEX appears. Complex data is also identified as being normalized in MAG (magnitude) or MAG SQ (magnitude squared).

The Display FUNCTION type cannot be changed but a complex data result allows display in any of the complex data formats (such as BODE, NYQUIST, etc.).

The display UNITS menu allows selection of Units or Units Squared but only if Y axis is the magnitude of complex data. A units change can not be performed on real data. The /Hz units normalization can not be applied to the display results.

The BLOCK MATH result remains on the display until either AVG or MEM data is selected. At that time the Block Math calculations are cleared and the display returns to the original AVG or MEM data blocks.

5.10.8.4 **Block Math Restrictions.** Block Math operations can only be executed on Memory or Averaged display data.

There is no Block Math on probability functions. Note that CIRCLE FIT is not allowed on Block Math results. A CIRCLE FIT display is changed to a NYQUIST plot if Block Math is requested.

Block vs. block operations can only be performed on data blocks which have compatible X axis domain (time/freq) and the same data units range.

Since all Block Math have to allocate working buffers, no operation is performed if there is not enough space. For averaged data obtained in Auto Channel Mode, multiplication by a complex number necessitates the doubling of the display buffer; therefore, it is not allowed.

5.10.8.5 **Single Operand Operations.** Single operand operations includes integration; differentiation; taking reciprocal, square root, or square; taking the real part, the imaginary part, or the complex conjugate of the block. The operand is always the upper display data block. The operation performed is always driven by a menu selection. When the BLOCK MATH button is pressed, one of the following menus appears.

If a time domain function is in the upper screen:

>* 1) INTEGRATE
2) DIFFERENTIATE
3) RECIPROCAL
4) SQUARE ROOT
5) SQUARE

If a real frequency domain function:

>* 1) DIVIDE BY (jw) SQUARED
2) MULTIPLY BY (jw) SQUARED
3) RECIPROCAL
4) SQUARE ROOT
5) SQUARE
6) COMPLEX

Note that the COMPLEX selection actually involves the upper and lower display data as two operands.

If a complex frequency domain function:

>* 1) DIVIDE BY (jw)
2) MULTIPLY BY (jw)
3) RECIPROCAL
4) SQUARE ROOT
5) SQUARE
6) CMPLX CONJUGATE
7) REAL
8) IMAGINARY

5.11 CURSOR FUNCTIONS

The following text describes the cursor functions controllable at the front panel. Eleven pushbuttons, used separately or in combination, provide three cursor modes and related readouts.

5.11.1 Front Panel Control of Cursor

The front panel contains the following buttons for control of the cursors:

CURSOR	
( ) <	> ( )
Main ( ) ==	Ref Set Abs/Rel ( ) ( )
Harmonic ( ) ==	Store Recall ( ) ( )
Sideband ( ) ==	> < < > ( ) ( )

The cursor display and readouts apply only to the upper display data. LEDs on the panel indicate which of three modes the cursor is in.

Single mode:	Main cursor and a settable reference cursor.
Harmonic mode:	Main cursor and its harmonics.
Sideband mode:	Main cursor with multiples and sub-multiples of a selectable delta frequency.

The cursor modes apply both in the frequency and time domain even though harmonic cursors in a time domain display may not be meaningful. The main and reference cursors are buffered between time and frequency displays for convenience.

5.11.2 Single Cursor Mode

5.11.2.1 MAIN Button. Pressing the MAIN button causes the cursor to enter single cursor mode.

5.11.2.2 < and> Buttons. The< and> buttons control the motion of the main single cursor. The main cursor only appears on data points in the buffer and cannot be placed between the data values. For example, the cursor jumps across the screen at low frequencies in a log x axis plot so that it only appear on valid data points.

If the entire data block is displayed on the screen the cursor wraps around to the other end when it reaches the last data point. If the display is expanded the cursor continues to move through the undisplayed portion of the data block and then wrap around.

5.11.2.3 MAIN xxx <ENTER>. Once the mode is set to single cursor mode the main cursor may also be positioned at your entered location. To do this, press the MAIN button and enter an X-axis value at the ENTRY section of the panel. This is terminated by pressing the ENTER button. Pressing any other button after the MAIN button disables this form of cursor entry. If ENTER is pressed immediately after MAIN with no value entered, the REF cursor disappears and the main cursor is moved to the left side of the display.

If the operator enters a value which is outside of the range of the data block, the cursor wraps around to the other side of the block.

5.11.2.4 REF SET Button. Pressing the REF SET button causes a reference cursor to appear at the current position of the main cursor. The main cursor can then be moved away from this position and the reference cursor remains there. The REF cursor appears as a broken vertical line. Each time the REF SET button is pressed, the reference cursor resets to the value of the current main cursor. The reference cursor is cleared whenever the MAIN button is pressed followed by ENTER.

Note that the main and reference cursors are buffered for time domain and frequency domain display modes so that you can switch between a time domain and a frequency display and still have the cursors at the same locations.

5.11.2.5 ABS/REL Button. The ABS/REL button allows the cursor readout values to be either absolute or relative. Relative cursor readout is only valid if there is a reference cursor set. The cursor readout is then a relative measure between the main and reference cursors. Pressing this button repeatedly toggles the cursor readout between the relative and absolute modes. More details of the actual readouts are in the cursor readout, paragraph 5.11.3.

5.11.2.6 STORE x <ENTER>. The STORE button followed by a numeric entry in the range 0 to 9 causes the current main cursor location in current X-axis units to be stored for later recall. The cursor itself is not affected by this action.

5.11.2.7 RECALL x <ENTER>. The RECALL button is used in conjunction with the STORE button to allow you to quickly move to preselected locations in the data block. Enter a numeric value between 0 and 9 (followed by <ENTER>) and the location stored there is made the current location of the main cursor.

There is no differentiation between units of the locations that are stored so that the time and frequency domain cursors may be mixed in these storage buffers. It is up to you to make sure that time domain cursors are not used to set the frequency domain cursor. This does not cause a problem except that the cursor value is truncated to be within the display block and on a data value.

5.11.2.8 > < and < > Buttons. These buttons are inactive in single cursor mode.

5.11.2.9 HARMONIC and SIDEBAND Buttons. These buttons get you to the harmonic and sideband cursor modes from single mode.

5.11.3 Single Cursor Mode Readout

The main cursor appears on the screen as a solid vertical line. The reference cursor appears on the screen as a broken vertical line. Text readout gives the cursor location in EU (engineering units) and the amplitude value at that location. If the reference cursor is set then the readout is relative to the reference cursor and is normally the arithmetic difference of the main and reference cursor values for time frequency and phase. The amplitude readout indicates the ratio of the main and reference values. The text readouts associated with this cursor mode are listed below:

	Absolute Units	Relative Units
Single Cursor	Main freq Main ampl val	Main freq Main ampl val
Single w/ref	Main freq Main ampl val	Main freq - ref freq Main ampl ÷ ref ampl
Single Cursor (Bode display)	Main freq Main magn Main phase	Main freq Main magn Main phase
Single w/ref (Bode display)	Main freq Main magn Main phase	Main freq - ref freq Main magn ÷ ref magn Main phase - ref phase

Note that relative readouts of ratios (e.g. main ampl ÷ ref ampl.) is actually a difference (main ampl - ref ampl) if dBV or dBEU units are selected.

5.11.4 Harmonic Mode

5.11.4.1 **HARMONIC Button.** Pressing HARMONIC causes the cursor to enter the harmonic mode. When the harmonic mode is entered the current main cursor location determines the location of the fundamental frequency for which the harmonics are displayed. No immediate mode entries are allowed as they are after pushing the MAIN button.

5.11.4.2 **< and > Buttons.** The < and > buttons are used as a fine adjust on the cursor for the harmonic mode. This adjustment moves the cursor within ±0.5 a data point to make up for the discrete nature of the samples so that the main cursor peak frequency can be specified more accurately. This allows the harmonic cursors to be lined up better since they are multiples of the main cursor.

When the ±0.5 point is passed, the main cursor on the display increments to the next line. In other words, in the harmonic mode the motion of the cursor is made much slower (finer). The frequency readout indicates interpolated values of frequency.

To move more quickly to a desired location, return to the main cursor mode, move the cursor, and then return to harmonic mode again. Note that the adjustment of the main cursor is not preserved when switching to single and then back. It is rounded to the nearest real location.

5.11.4.3 **REF SET Button.** There is no reference cursor in the harmonic mode, and the REF SET button is ignored.

5.11.4.4 **ABS/REL Button.** The ABS/REL button allows the cursor readout to go between relative and absolute modes. The relative readout is not referenced to the reference cursor as it was in the single mode. The only difference is that in relative mode the amplitude value represents the value of the main cursor divided by the sum of the amplitude values at all the displayed harmonic locations. See the cursor readout in paragraph 5.11.5.

5.11.4.5 **STORE and RECALL Buttons.** The STORE and RECALL buttons behave in the same way as they do in the single mode except that the actual interpolated frequency value is stored. If it is recalled in the harmonic mode it has the same location. If it is recalled in the single mode the location is truncated to the nearest actual data point. The adjusted harmonic cursor may be preserved using STORE and RECALL.

5.11.4.6 **> < and < > Buttons.** The MAIN and SIDEBAND buttons are inactive in harmonic mode.

5.11.4.7 **MAIN and SIDEBAND Buttons.** The MAIN and SIDEBAND buttons get the cursor out of harmonic mode.

5.11.5 Harmonic Mode Cursor Readouts

Up to 16 harmonics of the main cursor are displayed. The text readouts associated with this mode are as follows:

	Absolute Units	Relative Units
Harmonic Cursor	Interp main freq Main ampl val	Interp main freq Main/Sum of harm vals
Harmonic Cursor (Bode display)	Interp main freq Main magn Main phase	Interp main freq Main/Sum of harm vals Main phase

5.11.6 Sideband Cursor Mode

In sideband cursor mode, integer multiples (and sub-multiples) of the specified delta frequency surrounding the main cursor are displayed.

5.11.6.1 **SIDEBAND Button.** The SIDEBAND button sets sideband mode and restores the sideband cursor delta frequency to whatever it was set to the last time you were in sideband mode.

5.11.6.2 SIDEBAND xxx <ENTER>. If a valid engineering unit (EU) value is entered immediately after the SIDEBAND button is pressed, this value is interpreted as a user entered delta frequency which is truncated as needed to make it a valid entry.

The delta frequency is the difference between the main and the first sideband. Note that the innermost sideband cursors are restricted to both being within the data block being displayed. Note that if the cursor is not already in sideband mode the DELTAFREQ= prompt does not appear until the button is pressed the second time.

5.11.6.3 < and > Buttons. The < and > buttons are used to fine adjust the position of the main cursor in the same way it was adjusted in the harmonic mode. The main cursor does not move to the next line when the halfway point is reached as it did in the harmonic mode. Instead, the adjusted cursor wraps around about the same main cursor line.

5.11.6.4 REF SET Button. No reference cursor is allowed in sideband mode, and the REF SET button is ignored.

5.11.6.5 ABS/REL Button. The relative and absolute cursor modes are toggled with the ABS/REL button. Relative mode allows readout of the delta frequency value and the sum of the amplitudes between the innermost sideband cursors. See readout information that follows in paragraph 5.11.7.

5.11.6.6 STORE and RECALL Buttons. The STORE and RECALL buttons work as they did in sideband mode with the same restrictions noted in the harmonic mode.

5.11.6.7 > < and < > Buttons. The > < and < > buttons decrease and increase the sideband delta frequency. The sidebands stop moving when they collapse on the main cursor location and when either of the innermost sidebands reaches the limits of the data block (not just the limits of the displayed data).

5.11.6.8 MAIN and HARMONIC Buttons. The MAIN and HARMONIC buttons get the cursor out of the sideband mode.

5.11.7 Sideband Cursor Mode Readout

The text readouts associated with the sideband cursor mode are as follows:

	Absolute Units	Relative Units
Sideband Cursor	Interp main freq Main ampl val	Interp delta freq Sum of ampls between two innermost sideband cursors
Sideband Cursor (Bode display)	Interp main cursor Main magn Main phase	Interp delta freq Sum of ampls between two innermost sideband cursors Main phase

5.12 STORAGE FUNCTIONS

The STORAGE group pushbuttons provide the controls for storage of data or panel setups into temporary memory buffers or permanent external disk files. Screen copy and plotter operations are also controlled from this group, together with the PLOT button at lower right. The buttons and their associated sub-menus perform the following principal functions (equivalent two-letter keyboard codes are in parenthesis):

TYPE (ST) — Provides the preparatory setup functions to:

- Create new disk files.
- Re-open existing disk files.
- Specify file format, storage restrictions, and labelling conventions.
- Specify whether outputs to file are to be one function record (the upper display) or all available channel pair records.
- Manage files by deletion of records or increases of size of the file.
- Select type of plotter and specify plotter conditions.

STORE (SS) — Executes a storage operation, after determining whether the source is a data function record or a panel setup, and whether the destination is to be a file set up by TYPE or temporary storage in a memory buffer.

Note: The temporary "memory buffers" are actually in a "scratch" file on disk. Data and setups stored in "memory" continue to exist even after the system is stopped and re-started.

PLOT (^P) — Executes output to the plotter selected under the TYPE setup.

RECALL (SR) — Executes the recall operation after determining whether it is to read back a panel setup or a function record and whether it is from the current open file set up by TYPE or from a memory buffer.

DIR (SD) — Presents a directory listing of the function records in the currently open file or in the memory buffers as requested.

5.12.1 Creating a New File Under the TYPE Function

Before executing file storage or recall operations, you must create the file or open an existing file with the STORAGE/TYPE function. Pressing the TYPE button presents the following initial menu and setup summary:

Storage Mode

>* 1) USER FILE
2) PLOTTER SETUP

Restriction: TRANSFER FUNCTION
Storage Labels: NORMAL
Current File:
File Status: CLOSED
File Format: MODAL

The Plotter Setup selection is discussed in paragraph 5.12.5. Selecting "1) User File" starts the following sequence of setup menus to specify the file.

Storage Grouping

>* 1) STORE ONLY UPPER DISPLAY
2) STORE ALL FUNCTIONS

This selection determines how many functions are stored upon an execution command from the STORE button. As indicated, the first choice writes into the file only the function currently being displayed in the upper display. The second choice causes the system to cycle through all active channels (pairs), writing one function for each channel (pair). Note that when the system cycles through all the active channels (pairs), storage leaves display pointing to the last active channel (pair). For RECALL, function records may only be read one at a time.

If you select STORE ONLY UPPER DISPLAY, the following menu provides the function selection. (This menu is omitted when in probability mode.)

Storage Restriction

>* 1) TRANSFER FUNCTION ONLY
2) ANY DISPLAYED FUNCTION

This menu is a convenience for you. Select option 1) to store transfer functions only. An error message appears if you attempt to store non-transfer function data. To store non-transfer functions, select option 2). For real functions, the number of elements doubles.

The menu following the storage restriction menu pertains to the MODAL coordinate labels that are applied to the functions when they are stored. (This menu is omitted when in probability mode.)

Storage Labels

>* 1) NORMAL
2) SWAP REF & RESP

Selection 2) causes the reference and response labels that are stored into the data file to be swapped at the time that storage occurs. This selection does not alter the labels on the AVERAGE functions as they appear in the RTA program itself. If the stored functions are later recalled to the RTA program, they appear with their labels in the swapped form, but they are also labeled as MEMORY data.

Selection 2) is provided primarily for MODAL analysis using an impact hammer in conjunction with one or more fixed accelerometers. This type of testing generally produces a large number of frequency response functions with many different reference coordinates and a small number of (perhaps only one) response coordinates. The structure of the MODAL program is such that it is much more convenient to analyze data containing many response coordinates and a small number of reference coordinates. For linear time-invariant systems, the law of reciprocity tells us that a frequency response function measured, for example, from 10X to 15Y has the same magnitude and phase as a frequency response function measured from 15Y to 10X. This allows us to swap the labels at the time the functions are stored and interpret the functions as if they were made from a small number of reference sites and a large number of response sites. Usually, for impact testing it is important that, within the acquisition program itself, the force channel be identified as the reference channel. This assures that the frequency response function is calculated properly and that the results are dimensionally correct. Also, it should be clear that the process of swapping the reference and response labels has nothing to do with taking the reciprocal of the frequency response function itself; the resultant function is still interpreted as an acceleration response to a force input.

After pressing NEXT, the file allocation menu appears:

File Allocation

>* 1) SELECT EXISTING FILE
2) CREATE NEW FILE
3) DELETIONS FROM FILE
4) INCREASE SIZE OF FILE

This menu selects the file management operation to be performed. The following descriptions are for selection of "CREATE NEW FILE." The other operations are described later. The NEXT query is:

ENTER File Name
(Press NEXT)
* (current file, if one is open)
> ddn:filnam.typ

Here you assign the new file name or refer to an existing file. The file name is stated in the standard RT-11 operating system format:

ddn:filnam.typ

where ddn is the two-letter device code and one-digit unit number (DL0 or DL1)

filnam is up to six alphanumeric characters of your choosing (A-Z, 0-9 only)

.typ is a three-character file type extension

If ddn: is not specified, the file is placed on the system default device, DK. DK is initially the same device from which the system is booted, normally DL0, but note that the default can be assigned to any device as described earlier in this section. Also, it is important to know that RT-11 handles file access requests by way of routines called device handlers. These are only copied into memory from the system storage device when they are needed. If an RTA user specifies a file storage device whose handler has not been loaded, there may not be enough room for the handler and the RTA program in memory. This results in the error message "No room for Handler." If .typ is not specified, the type .DAT (for data) is assigned by default. The filnam portion must be entered. Upon NEXT the system proceeds to:

ENTER File Label
        * (current label, if any)
> <u>enter up to 24 characters as desired</u>

This entry is optional and is provided for use with the MODAL analysis program which prints it in file directory listings. It is not used elsewhere within the 2515 signal analysis program. Upon NEXT, the system requests:

File Format

>* 1) MODAL
2) STANDARD

The MODAL format is provided for use with the MODAL program. It has the required format for a MODAL frequency response function ("H") file.

MODAL functions are stored in a block floating point format. Functions stored into a MODAL file are typically a complex data type such as a transfer function. If a real function such as an auto-spectrum is stored, the number of elements contained within each record doubles.

MODAL format stores functions in 512-element records. If higher resolution (more frequency lines) has been specified, this larger record is broken up into a series of overlapping 512-element records with successive directory sequence numbers.

A typical complex function storage in successive sequence numbers is shown below:

COMPLEX FUNCTION

ELEMENT 1 289 512 689 800 1089 1200 1600 . . .

SEQ # n

n + 1

n + 2

n + 3

The STANDARD format is different from the MODAL file format in three specific aspects.

1. The record size can be varied.
2. Large frame data is not separated into subframes.
3. Data number format is preserved as floating point or integer.

STANDARD format is used to store floating point data (numbers) to provide greater accuracy. The entire function is always stored within one record and is not broken into overlapping 512-element records as is done in MODAL format. (Refer to Appendix B for RTA File Format.)

The system next requests the amount of disk space to be reserved for the file with the following query:

ENTER # of Function Records

For MODAL files, enter the number of transfer function records to be stored. Four disk blocks per function record is always assumed for MODAL format files. If transfer functions larger than 512 lines of resolution are stored, each transfer function will require more than one function record per transfer function as described previously. In addition to the four blocks per record allocated in the file, there is also space reserved for a two-word directory and a 64-word function header for each function record.

If a STANDARD file format has been selected, the following query appears:

ENTER # of Blocks/Function

Where the MODAL format assumed four disk blocks per record, the STANDARD format allows space to be allocated for larger or smaller function records. The "# of Function Records" entry specifies the amount of directory and header space required. The "# of Blocks/Function" entry specifies the amount of data space to be allocated in the file. There are 256 words per disk block. Functions to be stored will have the following number of words per element.

Time History (INTEGER)	1 word per element
Spectrum (Floating Real)	2 words per element
Transfer Function (Floating Complex)	4 words per element

A 512 line (element) transfer function requires a total of 2048 words. This means that there are eight blocks per function. A 320 line spectrum requires 640 words which would use up more than two blocks per function. In this case, three blocks must be specified since only integer values are allowed. This parameter entry does not restrict the size of the functions that can be stored in a STANDARD format file. Different sizes can be stored in the same file but either the directory or the date space in the file might be exhausted before the other is filled. If this occurs, one of the following messages will appear:

"funct header space full"
"no space to store function"

At this point the system has all the information it needs to create a new file. Upon a NEXT command, it attempts to do so and briefly presents the message

Attempting to Open File

Normally after a few seconds, this is replaced with the message "Action SUCCEEDED" in the menu area, with a corresponding indication in the summary Previous Action item and the status item which indicates "File Status: OPEN."

If for some reason the file cannot be opened, you are presented with a "Previous Action FAILED" message. The reason for failure is shown in the system message area at lower left.

If the file name you have requested already exists on the disk, the operation has not yet failed. The following option menu appears:

File Name Already Used

>* 1) ATTACH TO EXISTING FILE
2) SELECT NEW NAME

"Attach" merely means re-open the existing file. This does not expand the file or chain between two separate files. If you select the new name option, the process described above is repeated, beginning at "ENTER File Name."

If the file format is flipped from one to the other, the current active file is closed with a message "File Format STD/MODAL Swapped." This prevents erroneous data storage or recall.

5.12.2 Opening an Existing File Under the TYPE Function

Function files are automatically closed by the RTA program whenever you exit from the RTA program or when he opens a new file. For the special case when you begin a project by running MODAL and selecting a project and function file and then exiting to the RTA program, the function file is automatically re-opened by the RTA program when it begins executing. Further, every time you exit to MODAL and back, the function file name is retained and the file is re-opened. Opening an existing file is performed under the TYPE function and the procedure is the same as described above for new files except that you will of course select item 2) SELECT EXISTING FILE, and the menu sequence ends with the request:

ENTER File Name
* (current file if one is open)
> ddn:filnam.typ

The default device DK: and default type .DAT are assumed if you do not enter them.

Upon NEXT, the system presents the message:

"Attempting to Open File"

This is followed in a few seconds by:

"Action SUCCEEDED" (or Previous Action FAILED)

When the file is opened, the summary at the right of the screen is updated to reflect the information about this new file. If the file cannot be opened, an error message appears at lower left. The most common is:

"filenam not found"

meaning that no file with the entered name exists on the device.

5.12.3 Deleting Records from a File Under the TYPE Function

After a file has been used to store function records, then individual function records, or a sequence of records, may be deleted from it. Deletions are performed only on the currently open file. If the file from which you wish to delete is not the currently open file, you must go through the TYPE function as described in the preceding paragraph to open the file that you want.

To delete records from the currently open file:

1. Press TYPE.
2. Select "1) USER FILE"
3. Answer the "Storage Grouping" query. The answer is irrelevant.
4. Select "3) DELETIONS FROM FILE"

The system then asks:

ENTER Range of Records
to Delete (n:m)
*
 >_____

This entry is allowed to have the forms accepted in the DIRECTORY operations. See paragraph 5.12.8.

CAUTION

Deletions occur as soon as you press NEXT or ENTER.

To delete a single record, enter its number only and press NEXT. To delete a sequence of records, you may enter the first and last record number (inclusive), separated by a colon (:). If a range of record numbers is specified with other qualifiers, all the qualified records within the range are deleted. Upon NEXT, the system indicates:

Attempting to Delete Records

followed by the "Action SUCCEEDED" (or FAILED) message. Failure error messages appear at the lower left.

Note that after records have been deleted they are reused in reverse order; that is, the last deleted record space is used first.

5.12.4 Increasing the Size of a File Under the TYPE Function

If a file becomes full, it can be expanded by the TYPE function. The file to be expanded must be the currently open file. If it is not open, you must go through the TYPE function as described in paragraph 5.12.2 using SELECT EXISTING FILE to open it and return through the TYPE function to select this operation.

To increase the size of an existing, currently open file, make selections from the following menu sequence:

1. Press TYPE. The system responds with

   Storage Mode

   ```
   >* 1) USER FILE
      2) PLOTTER SETUP
   ```

2. Select USER FILE and press NEXT. The system responds with

   Storage Grouping

   ```
   >* 1) STORE ONLY UPPER DISPLAY
      2) STORE ALL XFER FUNCTION
   ```

3. Select one of the options and press NEXT. The system responds with

   Storage Restriction

   ```
   >* 1) NORMAL
      2) SWAP REF & RESP
   ```

4. Select one of the options and press NEXT. The system responds with

   File Allocation

   ```
      1) SELECT EXISTING FILE
      2) CREATE NEW FILE
      3) DELETIONS FROM FILE
   >* 4) INCREASE SIZE OF FILE
   ```

5. Select INCREASE SIZE OF FILE and press NEXT. The system responds with

   ```
   Enter # of Functions to Add
   * 0
   >______
   ```

6. As in the file creation sequence, a MODAL format file assumes four blocks per function record. Additional function records are needed for large overlapped functions. For STANDARD format files, the number of blocks per function record is the same as the original file. Upon pressing NEXT, the system reports:

   Attempting to Open File

This is followed by the "Action SUCCEEDED" (or FAILED) message. Failure error messages appear at the lower left (system message area) to indicate "no space or directory full." If any other error occurs, an applicable message so indicates, such as "file renaming error" or "read or write pass error."

The size increase operation is actually performed by creating a new larger file and then copying the data from the existing file into it. The old file's type is renamed as .BAC for back up. At this moment, "file type changed to BAC" appears in the message area. If an error occurs here, the file is closed and the message says so. Otherwise, the program goes on to open a new file with the type name .DAT. At this point, if no space is available for the size-increased file, the back up file resumes the extension .DAT and remains open. If successful, "open new file" shows up. At the time of copying data from old (.BAC) file to new file (.DAT), "COPYING..." blinks until completion. The deletion of the back up file is left to the operator. The deleted records (functions), if any, are squeezed out. This avoids the RT-11 operating system restriction that a file cannot be expanded unless there is empty space immediately following it.

5.12.5 Plotter Setups under the TYPE Function

The system supports three types of plotters, and more than one may be connected at the same time. Plot execution is controlled by the PLOT button at the lower right of the panel (located below OUTPUT SIGNAL), but before executing a plot you must use the STORAGE TYPE function to select the plotter and specify a pen speed.

Execute the STORAGE TYPE function as follows:

1. Press the TYPE button in the STORAGE group. The system displays

   Storage Mode

   1) USER FILE
   >* 2) PLOTTER SETUP

2. Select "Plotter Setup" and press the NEXT button. The system displays

   Plotter Type

   >* 1) SCREEN COPY
   2) HPGL
   3) TEK 4662

   "Screen Copy" refers to the standard option Printer/Plotter, which is connected to the rear panel PRINTER connector and is interfaced thorugh the 2515 display circuitry to print a dot-by-dot reproduction of the display on the screen.

   "HPGL" calls on plotting software for driving the family of Hewlett-Packard digital plotters that are controlled by the HP Graphic Language (HP-GL).

   "TEK4662" calls on plotting software for the Tektronix Model 4662 digital plotter.

3. Select the plotter type and press NEXT. The system displays

```
ENTER % Pen Speed
   * (current setting)
> ________
```

This parameter is for plotters that allow a reduction of their normal pen speeds. This is sometimes required for certain types of pens and for plotting on transparency media.

4. Enter a number from 1 to 100. 100 represents the plotter's normal maximum speed. The Tek 4662 without the multi-pen option does not allow remote speed selection. Fast and slow speed selection on plotter rear panel switch A must be used.

This completes the plotter setup. Plot outputs are directed to the selected plotter whenever you press the PLOT button, until the setup is changed.

5. Press NEXT. The system returns to the full display.

To abort a screen copy or digital plot, the PLOT button can be pressed a second time. However, a screen copy cannot be aborted until after the print head actually begins to move. There is typically a delay of about four seconds from the time that a screen copy is requested until the print head begins printing. During this time, a memory copy is being made of the current display. After this delay, you can resume interaction with the RTA program while the plot is proceeding. During a screen copy, the displays have a slightly degraded appearance because only one view plane is available for viewing. As soon as the screen copy is completed, the displays return to their normal form.

In order to clarify what action is taking place, the PLOT button produces a normal panel button beep when a plot is initiated but creates a 'warbling' sound when a plot is aborted.

Unlike the screen copy plots, the digital plotter operations interrupt the execution of the RTA program. The displays are re-drawn very slowly (the same rate at which they are transmitted to the digital plotter) and all panel buttons except the PLOT button are ignored while the plot proceeds. During this time, the program can still be interrupted by typing^C at the keyboard. The RTA program does not produce digital plots of state banners or file directories.

For multi-pen plotters, three pens are used. These should be the first three pens. Single pen plotters are not affected. It is not necessary to select the first pen before beginning the plot.

5.12.6 Executing a Storage Operation with the STORE Function

The STORE button actually initiates storage of displayed data or panel setups into disk files or the temporary memory buffers (which, in fact, are actually in a pre-defined disk file). To store into your disk file, you must have previously defined the file under the TYPE function, and the file must be open when you attempt to STORE. Storage into the temporary memory buffers is controlled completely under this STORE function as described below and does not require any previous actions. "Storage" to a hard copy plotter does not involve this STORE function, and is controlled by the TYPE setup and the PLOT button.

1. To execute a storate operation, press the STORE button. The system responds with

Storage Type/Destination

>* 1) DATA to FILE
2) DATA to MEMORY
3) PANEL to FILE
4) PANEL to MEMORY

Descriptions of the selections are contained in sub-paragraphs 5.12.6.1 through 5.12.6.4.

Data Storage allows the current upper display data to be saved. Any data stored to disk or memory must be present in either the current Average or Memory display buffer. This display data buffer contains the desired FUNCTION type calibrated with the Engineering units factors (if EU was selected for UNITS).

The contents of the data buffer does not include calibration based on the following user display selections:

Display Format for complex functions such as

Magnitude
Phase
Nyquist
etc.

dBV or dBEU units

Units Normalization such as

U
U2
U2/Hz
U2*SEC/Hz

The display data buffer is also internally represented in either linear or squared units, depending on the Function type. The following functions are always internally represented in squared units:

- AUTOSPECTRUM
- COHERENT OUTPUT POWER
- TRANSMISSIBILITY

All other functions are internally stored in linear units (including the AUTOSPECTRUM selection in Time Domain Averaging mode, also called Linear Spectrum).

This means that a display of an AUTOSPECTRUM in VOLTS (linear units) requires that the square root be taken when the data is plotted on the display. The data buffer remains in squared units. The data is also stored in squared units.

This storage method saves data buffers calibrated only by Engineering units so that the other calibration factors can be applied when the data is recalled in the same way as they are applied prior to storage.

5.12.6.1 Data to File. The Data to File selection stores data into the currently open user disk file. If the resolution is greater than 512 lines, the function occupies more than one record space in the file and MODAL sequence numbers are assigned automatically. At the present time, the RTA program contains no provisions for reassembling these separated records, so they must be recalled and displayed separately. The storage of data frames longer than 512 lines is always handled in such a way as to provide at least one block (128 complex lines) of overlap coverage between adjacent records. This is essential for any parameter estimation or curve fitting procedures applied to the stored data. Upon selection of Data to File if STORE ONLY UPPER DISPLAY grouping was previously selected, the system requests:

ENTER RES COORD, REF COORD,
and SEQ #
* (current resp, ref from display, and seq # 0)
> ___________

This query allows modification of the location coordinates in MODAL analysis surveys. These parameters comprise the directory entry for the current upper display function to be stored. The sequence number allows storage of multiple functions having the same coordinates. To revise the coordinates before storage, enter the change now. If the query is not answered (i.e., just press ENTER or NEXT), the assigned coordinates are those from the display, which in turn were assigned to the input channels in the MEASUREMENT SETUP. The precise way these coordinates are used is governed by the STORAGE LABEL selection described in paragraph 5.12.1.

If 2) STORE ALL FUNCTIONS is selected in the storage grouping menu (see page 5-72), a different coordinate modification menu appears here (like the one shown on page 5-21). The next menu allows for the modification of sequence numbers. If the file is in MODAL format and all large frame functions are stored, each function begins with the same sequence number.

Under this multiple storage mode, for auto channel acquisition, the active channel is looked up and the data in those channels are stored. If CROSS channel is selected, and the displayed function is a dual-channel function (e.g., transfer function), then the active channel pair is looked up and data is stored accordingly; if the displayed function is a single-channel function (e.g., auto spectrum), then a table of active single channels is set up and data storage is according to this table, so that no data is repeatedly stored.

Immediately upon ENTER (or NEXT), the system attempts to write the data to file and presents the message:

Attempting to store

This is followed by "Action SUCCEEDED" (or FAILED). Failure messages are presented at the lower left. The most common reasons are:

file not found
AV TF function only
no space or directory full

If the STORE ALL TRANSFER FUNCTIONS grouping has been previously selected, the next menu to appear is the same one that appears to allow MODAL coordinate assignments under the CHANS button (see paragraph 5.8.3.2). Since multiple functions are stored, you are invited to modify any or all of the coordinate labels in case they have changed since the last set of functions was stored. Simply pressing NEXT leaves the coordinate labels (and the directory entries they produce) unchanged. The next menu to appear requests you specify a sequence number only. This allows storage of a distinguishable set of functions having the same coordinate identifiers.

In the event of resolution greater than 512 lines, the sequence number specified is the starting number for the series of ascending sequence numbers.

5.12.6.2 Data to Memory. The Data to Memory selection stores the data into the entered memory buffer. It also prompts for RES COORD, REF COORD, and SEQ # as described above.

ENTER Memory Buffer #
(Press NEXT)
* 1
> ______

There are 16 data buffers (numbered 1 through 16) into which you may store averaged data from the upper display. Storage into these buffers always occurs one function at a time and is unaffected by the 'Storage Restriction' menu. Storage obeys the reference-and-response-swapping selection. Data stored into a buffer which already contains data wipes out the previous data. No warning message is provided.

In order to use disk space in an optimal manner, each buffer is only 20 blocks long. For transfer functions, therefore, the maximum block size that can be stored in a memory buffer is 1280 lines. A larger block size results in an error, and an error message appears.

Data stored into the memory buffers is not automatically displayed when MEM is selected as the data source. Data is displayed only when the data is recalled, as it is done for functions stored in your file. Functions containing large numbers of lines are not broken up into a series of sequence numbers as they are when stored into a MODAL format user file. The floating point data is not converted to TSL format.

This data is actually stored in a data file called 'DAT2.SCR.' This file is retained when the power is switched off. If you delete or rename DAT2.SCR, the RTA program creates a new file named DAT2.SCR when it next begins executing.

5.12.6.3 **Panel to File.** The Panel to File selection stores the current panel setup into an open user file. This allows the setup information to be stored in the same file as the data for more complete documentation. Note that only one panel setup per file is allowed. 8100Y+ is used for reference and response coordinates to designate the panel in your disk file. When the directory of the file is listed, the panel record is labeled as "panel related."

5.12.6.4 **Panel to Memory.** This selection stores the current panel setup into one of the 15 available panel memory buffers. Storing panel setup information into memory allows setups to be recalled without the need to manually restore all the measurement setup parameters. The display selections are stored although the display is always forced to REAL TIME upon panel recall. The AVG and REAL TIME function scaling and format selections are stored. Most storage parameters are stored so that once your file is re-opened storage continues as it did when the setup was saved. However, your file is not automatically opened when the panel is recalled. AVG data is not preserved when panel recall is performed. You are asked for the buffer number by:

```
ENTER Memory Buffer #
* 0
> ______
```

Enter a buffer number from 1 to 15. Note that the default buffer 0 shown in the query is illegal. Buffer 0 is reserved for the fixed parameter set used in the checkout test. You can recall from it but not store into it. Also note that buffer 16 is used by the system to automatically store the current panel setup when you return to RT-11 or exit to MODAL or MODAL PLUS. It may be recalled only. This most recently stored panel setup buffer is recalled each time the RTA program begins to restore the state of the system when it was exited. This panel setup information is stored in a data file called PAN2.SCR which is recreated if deleted or renamed by you.

5.12.7 Recalling Stored Data with the RECALL Function

The RECALL function provides the reverse of the four STORE operations, to recall data records or panel setups from your files or the temporary memory buffer file. To recall from your file, the file must be currently opened by the TYPE function. Pressing the RECALL button presents the following menu to select one of these operations:

```
     RECALL

     Recall Source/Type

>*   1)  DATA from FILE
     2)  DATA from MEMORY
     3)  PANEL from FILE
     4)  PANEL from MEMORY
```

All recalled functions are displayed as MEM data source. The display of MEM data is very similar to the display of AVG data. In addition to the fact that the

MEM light is illuminated while recalled data is being displayed, the prefix, 'ME' appears in front of the function type label. Also, you will notice that certain of the display menu interactions are slightly different when the displayed data is MEM data rather than AVG data. For example, the FUNCTION menu is not provided for the obvious reason that it is not possible to alter the function type of recalled data. However, the FORMAT menu which normally follows the FUNCTION menu is provided for recalled data, and it is the first menu to appear when the FUNCTION button is pressed while displaying MEM data. There are two MEM data source buffers; one for the upper and one for the lower display. This allows comparison of two recalled functions.

Note that the units may be changed from VOLTS to dBV or EU to dBEU but changes from EU to V are not allowed. Changes in normalization are allowed for recalled functions.

5.12.7.1 Data from File. The Data from File selection recalls one function record from the currently open file. The data is placed in the MEM display buffer which is accessed by the MEM button. The display selection is forced to MEM to display the recalled data. The MEM button also replaces the AVG or REAL TIME data display with the most recently recalled data. Two additional buffers in DATMEM.SCR are used for this purpose: one corresponds to the upper display, the other to the lower display. The data in the buffer is simply a copy of data recalled through the RECALL sequence. If the recalled data is greater than 20 blocks, the excess part is not copied in this buffer type. But, for MODAL format, the recalled data is always 4 blocks at a time, so no problems occur. The excess part is not seen by pushing MEM, but is seen only through RECALL.

Upon NEXT, the system requests the specific data record with the query:

```
ENTER REC #, SEQ #, RES COORD,
and REF COORD
   *
> _________
```

You may enter any one or all or a combination of these parameters to specify the particular record you want. Commas must be used to account for null arguments that you do not use. Record number alone is sufficient and usually simplest. If you enter an ambiguous parameter (for example a reference coordinate only) for which several records may exist, the system returns the first record in the file that satisfies the parameter. If you enter a non-existent combination, the system indicates "Action FAILED" and returns the message "record ____ does not exist." Use the DIR function to check the file content.

There is a particularly advantageous interaction between the ENTER button and the RECALL function. For the RTA program, the general definition of the ENTER button response is 'execute the selected action but do not proceed to the next menu.' This allows a succession of entries to be applied without re-initiating the entire menu sequence that led to the current menu. In the case of function recall, it is possible to recall a series of functions and view them in the upper display while retaining the function recall menu in the lower display. This allows rapid review of a large number of stored functions with a minimum number of button entries. Whenever NEXT is used following a function request, the recalled function appears as a full screen display and the RECALL function menu is erased.

5.12.7.2 Data from Memory. Upon NEXT, the system requests:

ENTER Memory Buffer #
* 1
> ________

Recalling data from memory places the recalled function into the upper MEM display buffer and forces the MEM data source display. As noted in paragraph 5.12.7.1, there are some restrictions which apply to manipulations of this recalled data. The display changes specifically disallowed are:

a. V to EU units
b. Function type
c. Window type
d. Channel number

5.12.7.3 Panel from File. After selection of Panel from File, the stored panel setup is restored. If no setup has been stored in the file, the message "Pnl not in user file" appears in the lower left corner.

5.12.7.4 Panel from Memory. The Panel from Memory selection recalls panel setups from the temporary memory buffers. The system requests:

ENTER Memory Buffer #
* 0
> _____

Enter a number from 0 through 15. Buffer number 0 is reserved for the checkout test setup and may be recalled but not written into. Buffer number 16 is used for EXIT to RT-11 or chaining to MODAL. It is the default panel and is read in at the program start up time.

5.12.8 DIR Function, Directory Operations

The directory function provides listings of the function record content of the currently open user disk file or of the temporary memory buffers. Pressing the DIR button presents the following initial menu for these operations:

DIR

Directory

>* 1) User Disk File
2) Memory
3) Memory Panel

5.12.8.1 User Disk File. A file must have been opened under the TYPE function to obtain a directory. The directory prints a listing of the function records in the file in record number order. The directory includes the function frequency (x-axis) range, sequence number, response and reference coordinates, channel ID label, and date and time of creation. This selection is followed by the query:

```
ENTER
REC #, SEQ #, RES COORD,
and REF COORD
 *
 >____
```

If you do not answer (i.e., just press ENTER), the system prints a full directory of every record in the file. However, since a file frequently may contain hundreds of records, this query allows you to selectively obtain a directory of only certain sets of records of interest. You may enter any one or all or a combination of these parameters. Furthermore, for the REC # you may specify a range by entering first and last record numbers separated by a colon (:) character. The system lists all records that satisfy a parameter, but note that the parameters are logically ANDed; that is if you enter more than one, the directory includes only those records that satisfy all. For example, if you enter:

```
40:150,,,2X+
```

the system lists all records that have reference coordinate 2X+ and that also are in the range of record numbers 40 through 150. If the list is longer than a full page, the listing is suspended and PRESS NEXT appears in the system message area. Pressing NEXT resumes the listing. Pressing any other key aborts it.

5.12.8.2 Memory. The directory of data memory buffers lists all 16 buffers and includes the same information as disk file directories.

5.12.8.3 Memory Panel. A list of 15 buffers is displayed in the directory lines. NCHAN refers to the number of channels of the hardware setup at the time the panel was stored. If NCHAN is different from the actual hardware (i.e., memory board has been added or removed since the panel data being stored), a warning of incompatible panel is issued and some of the channel set up may not be preserved.

5.13 PANEL COMMAND SEQUENCE, STORAGE AND RECALL

The keyboard must be used to store a panel command sequence in RTA program. Up to ten files (command sequences) numbered 0 to 9 can be stored. The file is named

```
seqX.pnl
```

where X represents a number between 0 and 9.

To represent each command, the two-letter codes entered at the keyboard are the same codes listed in paragraph 5.14.

One exception to this is the use of a <CR>(carriagereturn). The<CR>is entered into the file as a ')'. Every 40 characters, a <CR><LF> is placed into the file and consequently is not recognized.

Additionally, spaces are not recognized as commands but are used if text is being entered into a menu.

To initiate storage of a command sequence:

1. At the keyboard, press $. The display prompts for the sequence number that names the file.

2. Press a number (between 0 and 9) and then press ENTER. This names and creates the file. If the file already exists, the following prompt appears.

   ARE YOU SURE?

3. To indicate a YES answer, press Y, then ENTER. Any other key means NO.

   At this time, ASCII representation of all used keys are placed in the file. If the number of characters exceeds one block (256 words), the file is extended one more block. There is no limit to the size of the command file provided there is sufficient disk space. If the sequence goes beyond one block, an EXTENDING FILE prompt appears.

4. To end the sequence and close the file, press $.

   This is acknowledged by the displayed message

   SEQUENCE ENDED

5.13.1 Editing the Command File

The command file can be edited by using an RT-11 editor. The commands can be entered using the same characters that are entered on the keyboard. For example:

DY means Y SCALE menu
MF means FREQuency menu
< represents a down arrow
> represents an up arrow
@ represents DELETE
) represents NEXT < CR>

Comments are enclosed in quotations. Note that text strings cannot contain $,), , or ;. These characters have specific command meanings.

5.13.2 Recalling the Command File

To recall a sequence, press the ROLL button or ↶ on the keyboard. This is followed by a prompt for a sequence number.

Press # (between 0 and 9) ENTER.

The corresponding file is opened and each character is put through the same code used in the keyboard entry.

NOTE: Pressing the RECALL panel sequence button while recall is processing results in an abort.

5.14 OUTPUT SIGNAL FUNCTION

The following output signals are available from the OUTPUT SIGNAL BNC on the front panel:

Sine Wave	Sine wave is available with a resolution of 1 Hz. In ZOOM, the frequency is restricted to be at the band center but in baseband the frequency of the sine wave is user selectable.
25 kHz Random	A pseudo-random sequence generator creates a signal which is output at the 64 kHz sample rate and repeats every 2**24 samples. The bandwidth of this signal is fixed at 25 kHz. Unlike the other random signal selections, 25 kHz random produces a signal whose amplitude and spectral distribution are completely independent of the acquisition selections.
Non-Repeating	The bandwidth of this random signal is selected to yield the maximum amplitude within the passband of the measurement. This means that if ZOOM is used, the random sequence is reduced in bandwidth to match the measurement bandwidth and is then translated by the ZOOM center frequency.
Repeating Pattern	This type of excitation provides repeating psuedo-random signals. Twenty-two sequences are available. These sequences have approximately the same spectral properties as the Non-Repeating Signal.

Both repeating and non-repeating patterns can be gated by a user specified burst duration. The output signal is controlled via menus accessed by pressing the OUTPUT SIGNAL button on the lower panel.

5.14.1 OUTPUT Signal Button

The OUTPUT SIGNAL button allows the selection of the signal type, sine wave frequency, and adjustment of the signal amplitude. Pressing the OUTPUT SIGNAL button causes the following menu selections to display:

```
Output signal

>* 1) OFF
   2) SINE WAVE
   3) RANDOM
```

When ZOOM is enabled the sine wave frequency is restricted to the ZOOM center frequency since this signal is actually generated by the ZOOM twister modulation circuitry. If you are in ZOOM acquisition mode, this parameter is automatically set to the ZOOM frequency. You are not allowed to move the frequency since this corrupts the data.

The first selection, 1) OFF, turns off all random signals. Choose either 2) or 3), press NEXT, and the following menu appears:

```
Output Signal

ENTER the RMS level of               Signal Level:  4.5
Output Noise (0-1.0V)  Random        Type:  RANDOM
             (0-4.5V)  Sine          Bandwidth:  ACQUISITION
*  .666                              Random Type:  REPEATED
                                     Pattern #:  5
                                     Burst Window:   OFF
>                                    Burst Duration:  20%
```

The maximum levels are different for the two signal types. They are restricted to be equal to or less than 4.5 volts for the sine wave and 1.0 volts for random signal types.

When RTA begins, the signal type and sine wave frequency parameters are set to values they had when the program was exited. The level parameters are initialized to 0.0 volts to avoid transients in externally connected equipment.

If 2) SINE WAVE has been selected, enter the level and, press NEXT to arrive at the next menu.

```
ENTER Sine Wave Frequency
with 1 Hz Resolution
* 5000

>
```

Enter the desired frequency and the sine wave signal appears.

If 3) RANDOM has been selected, enter the level and press NEXT.

```
Output Signal Bandwidth

>* 1) ACQUISITION BANDWIDTH
   2) 25 kHz
```

If 2) 25 kHz is selected, the next menu is the Burst Window menu. If 1) ACQUISITION BANDWIDTH is chosen, the signal repetition menu appears.

```
Random Signal Type

    1) NON-REPEATING
>*  2) REPEATED PATTERN
```

Selection 1) NON-REPEATING, specifies that the hardware random signal generator is used for the output signal. This signal is adjusted to have a power spectrum that is roughly constant throughout whatever data acquisition bandwidth the RTA program is currently set to. It does actually repeat, but the repetition period is so long (approximately 20 million samples) that it can usually be ignored.

Selection 2) REPEATED PATTERN, specifies that an output signal be calculated and stored in computer memory for repeated use. The output signal frame size is chosen to match the acquisition frame size currently in use. If the burst window (see below) is set to "Off", the output signal repeats with a repetition interval equal to the duration of the acquisition frame.

The advantage of this selection is that the spectrum of the test signal consists of a set of narrow lines that fall exactly on the analysis lines of the Fourier transform. As a result, Fourier leakage is minimized.

You should be aware that there are disadvantages to this selection, however. One of these is that the harmonic content of the repeated signal is significantly higher than that of the non-repeating signal. Another is that the RTA program may run out of memory because of the need to retain a copy of the output signal during acquisition. This limitation appears for large frame sizes or large numbers of channels. A third disadvantage is that, if the system being measured is non-linear, repeatedly averaging the response to the same signal fails to smooth the effects of the non-linearities. In order to alleviate this problem, the next menu is provided.

```
ENTER the random
Pattern # (1 to 22)
* 5
>
```

The patterns numbered 1 through 20 are statistically equivalent to each other. They are provided as a means of investigating the linearity of the system under test. If the system is linear, the measurement of its transfer function produces the same results for any of the twenty patterns. If discrepancies appear when different patterns are used, the system being tested is exhibiting non-linear behavior. A linearized estimate of the system transfer function can be obtained by averaging together measurements made using several different patterns.

Patterns 21 and 22 are "chirps" rather than random sequences. The ratio of the peak value to RMS value of a chirp is approximately 1:4. The peak-to-RMS ratio of the random signals produced by the RTA program is more than twice this amount. As a result, chirp signals may be used when measuring systems with limited dynamic range.

The next menu sequence allows a selection of burst window.

```
Burst Window

   1) OFF
>* 2) RECTANGLE
   3) HANNING
```

Selection 3) provides a random signal with Hanning filter applied. If 2) is selected the following menu appears:

```
ENTER the Burst Duration
* 20
>
```

REPEATED or NON-REPEATED random excitation provides a burst of excitation. The duration of the burst as a fraction of the acquisition frame is specified by the number (in %) entered.

5.14.2 Triggering With Output Signals

If the burst window is switched off, the output signal is continuous and independent of any trigger selections. With the burst window on and manual-arm triggering selected, an outout burst is produced every time the ARM button is pressed.

When the query, ARM? appears at the bottom of the screen, you may press the ARM button. This arms the triggering process and initiates the output burst. If a trigger signal is not detected, the trigger remains armed and you can produce additional output bursts by pressing the ARM button again.

When the burst window is switched on and acquisition pre-triggering has been selected, the sum of the pre-trigger interval and the output burst duration should not exceed the duration of the data frame. If this condition is not met, the trigger is not enabled before the burst begins and part of output signal occurs before the data frame.

5.14.3 Over-run Condition: Acquisition Rate Limitations Resulting From DMA Output

When you select either Repeated Pattern or Burst Window, the output signal process makes use of a memory buffer from which the 2501 microprocessor transfers the output data to the output port. Because the microprocessor also participates in the data acquisition processing, the maximum attainable acquisition rate is diminished when using these types of output signal. Failure to complete the requested acquisition and output processing in the required time results in the message "ORUN" being written onto the screen adjacent to the over-load indication box at the lower right corner. In order to correct this situation, you should either select a smaller number of channels or diminish the acquisition bandwidth. Other factors that affect the attainable maximum acquisition rate include triggger selections, frame size, and auxiliary delay.

Also note that performing a screen copy while the DMA output is turned on can result in the system hanging up due to the same microprocessor overhead.

5.15 PANEL TO KEYBOARD MAPPING

Most menu and immediate type buttons on the panel are mapped to two-letter commands which are used by the other control interfaces. For keyboard operation, some single-key commands to control the cursor and menu entry are provided.

	Panel Button	Keyboard Character Command
Display		
	REAL TIME	DR
	AVG	DA
	MEM	DM
	NEXT CHAN	DN
	SINGLE	DS
	DUAL	DD
	OVLY	DO
	EXCHNG	DE
	FUNCTION	DF
	X SCALE	DX
	Y SCALE	DY
	CHANNEL	DC
	UNITS	DU
	BLOCK MATH	DB
Acquisition		
	RUN	AR
	CONT	AC
	ARM	AA
	HOLD	AH
Cursor		
	<	<- Key
	>	-> Key
	MAIN	CM
	HARMONIC	CH
	SIDEBAND	CS
	REF SET	CR
	ABS/REL	CA
	STORE	SC
	RECALL	RC
	> <	< Key
	< >	> Key

	Panel Button	Keyboard Character Command
Entry	(Most of these buttons have a counterpart on the keyboard and so they are passed through as ASCII without need for mapping.)	
	0 thru 9	0 thru 9 keys
	A thru Z	A thru Z keys
	EE	E
	CLR	!
	DEL	Delete
	ENTER	(backslash)
	-	-
	+	+
	x	*
	÷	/
	SPC	Space bar
	ROL	∫
	+/-	'
	=	=
	SHIFT	(Not required since keyboard has Alpha)
	:	:
	,	,
Menu Control		
	↑ (Up arrow)	↑ (Up arrow)
	↓ (Down arrow)	↓ (Down arrow)
	NEXT	Carriage return
Storage		
	TYPE	ST
	DIR	SD
	STORE	SS
	RECALL	SR
Measurement		
	INPUT CHANS	MC
	INPUT LEVEL	ML
	TRIG	MT
	FREQ	MF
	AVERAGE	MA
	WINDOW	MW
	MODE	MM
	STATE	MS

Panel Button	Keyboard Character Command
CRT Control	
CRT BRT	Provided by keyboard SETUP arrows
Output Signal	
OUTPUT SIGNAL	OS
Plot	
PLOT start	^P (Where^ is CTRL, press^ and P
PLOT stop	simultaneously.)

Note that the following ASCII characters are not allowed in strings since they are used for immediate control:

←
→
↑ (Up arrow)
↓ (Down arrow)
CR (Carriage return)
LF (Linefeed)
>
<
ʃ
'

It is sometimes useful to supply additional annotation to the display before a plot is made to the screen copy device. This can be done with the terminal set to local mode via the SETUP key. However, since the RTA program turns off the terminal cursor it must be turned on again by typing ^A before entering the local terminal mode.

As is common with most RT-11 system programs, the program may be aborted by typing ^C twice. Note that none of the setup information is preserved if the program is stopped in this way.

SECTION VI

OPTIONAL EQUIPMENT

GENERAL INFORMATION

This section will provide general information for available optional equipment for the GR 2515 system and is presented as a courtesy to GenRad customers. Pertinent information currently available is included at the time of this printing. Information relative to optional equipment may be inserted in this section by the customer for easy access.

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6.1 EXTENDED MEMORY (PN 2515-9404) INSTALLATION

Average time required to install the extended memory is one-half hour.

a. Visually inspect the extended memory board. Verify that memory jumpers are intact.

b. Remove top cover of system by removing the six pan head screws on the sides. Carefully lift cover up and off.

c. Remove the 256 kilobyte memory board from slot 5.

d. Install extended memory board into slot 5. Verify it is properly seated.

e. Reinstall top cover and six screws.

f. Test with microcode diagnostic using M1-M5.

g. Check system operations using RTA program, PN 2515-0650.

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6.2 CHANNELS 5-8 (PN 2515-9401) AND ADDITIONAL CHANNELS (PN 2515-9402) INSTALLATION

Average time required to install channels 5-8, 9-12, and 13-16 is one-half hour.

a. Remove top cover of system by removing the six pan head screws on the sides. Carefully lift cover up and off.

b. Install channels 5-8 board in slot 12.

c. Install channels 9-12 board in slot 13.

d. Install channels 13-16 board in slot 14.

e. Verify that each circuit board is properly seated.

f. Reinstall top cover and six screws.

g. Connect BNC (expansion chassis) box to connectors J3 through J8 for channels 5-16. See paragraph 6.3 for instructions.

h. Test operation by using RT-11 diagnostics, PN 2515-0691, ANLTST test.

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6.3 CHANNEL EXPANSION CHASSIS (PN 2515-3005)

The channel expansion chassis, also referred to as the BNC distribution box, is provided with the addition of channels 5-8 and accommodates up to sixteen channels. Channels 1-4 are provided on the expansion chassis and are connected in parallel with the front panel input BNCs.

The chassis is connected to the rear panel at the multiple coax connector labelled INPUTS.

Care should be exercised when installing this connector. The pins may become bent when the knurled fasteners are tightened if the connector is not aligned squarely.

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6.4 LARGE SCREEN MONITOR (PN 2515-9403) INSTALLATION

Install the monitor by connecting the supplied BNC coax cable from the real panel BNC marked VIDEO to the monitor rear BNC connector.

Adjustments for brightness and contrast are provided on the rear of the monitor.

A separate AC power cord is supplied.

Before turning power on, assure that the rear panel switches are set for the proper line voltage. Line voltage information is contained in Section II, paragraph 2.7.2.

6.5 PRINTER/PLOTTER AND DIGITAL PEN PLOTTER

6.5.1 Printer/Plotter Installation

To install the Printer/Plotter, attach the supplied cable to the rear panel of the printer and to the 2515 rear panel connector marked PRINTER.

Consult the Printer/Plotter Manual for instructions for installing ink cartridges and paper.

A separate AC power module and cord is supplied for either 110 or 220 volt operation.

6.5.2 Digital Pen Plotter Installation

Programs written for the 2515 system will support one or both of the following digital plotters not supplied directly by GenRad:

Tektronix 4662 Plotter (with or without multi-pen option)

Hewlett Packard Plotters (Those supporting HP-GL and RS-232 I/F; HP 7470A, 7440A, and 7475A plotters are suggested for use with the 2515 system. The HP7550 plotter has enhanced features such as automatic paper feeder.)

Digital plotter commands are issued through the RS-232 serial port located on the 2515 rear panel labelled AUX REMOTE. Note that IEEE bus access to the plotters is not provided.

It is necessary to use a null modem cable to connect the 2515 to either of the two plotter types. This cable serves the purpose of interchanging the transmit and receive lines connecting the two devices. Without it, the 2515 transmit line will be connected to the plotter transmit line and no communication will occur.

Connect the HP 7470 plotters by plugging the null modem cable into the HP interconnect cable on the side labelled COMPUTER.

Connect the Tek 4662 by plugging the null modem cable into the rear panel connector labelled COMPUTER.

6.5.3 Operation

The Printer/Plotter supports the following types of hardware operations:

a. Screen Copy. The screen image is reproduced on the plotter as a pixel map of the screen. Details are provided in Section III, paragraph 3.3.2.

b. Autoprint. Terminal text is also echoed on the printer when the autoprint mode is enabled. See Section III, paragraph 3.3.5.

c. Line Printer. The Printer/Plotter also serves as a line printer for the system. Directories and listings which are directed to the LP: (line printer) device in RT-11 will appear on the printer. Consult the Printer Manual if special setup control sequences are desired.

The digital pen plotter only supports Screen Copy.

6.5.3.1 **HP 7470/7440/7475 Switch Setting**. The switch which controls the RS-232 interface characteristics is located next to the serial connector at the back of the plotter. This switch should be set to 00010111 as viewed from the front of the plotter. The setting selects a baud rate of 1200, disables parity checking, and sets the plotter to power up into the "programmed on" state. For the RTA program, the setting for the Y/D switch does not matter. Function plots for the MODAL Program, however, require that the switch be set to D.

The HP7550 is setup using local menus instead of switch settings. Consult the HP7550 manual to set this plotter for the serial (MODEM) port with the following conditions:

Data flow:	Remote mode, Standalong mode
Handshake:	XON/XOFF
Data compatibility:	Half duplex, Parity off, 8-bit, Baud rate 1200

6.5.3.2 **Tektronix 4662 Switch Setting**. Set the switch located on the Tek 4662 rear panel to 2-2-2-3. This setting selects copy-mode-scaling, no-parity-checking and 1200 baud.

6.5.3.3 **Plotter Speed Setting.** Programs supporting the digital plotter will usually allow selection of plotting speeds. Reduced plotting speed can be useful for improving the quality of the plots and for directly drawing transparencies. The HP and Tek 4662 plotters, with multi-pen options, will allow selection over a wide range of plotting speeds under program control. Without option 31 (Tek's multi-pen option), the plotter can only be switched from fast to slow by resetting switch A located on the plotter rear panel.

6.5.3.4 **Pen Selection.** Programs which attempt to use multiple pens will function properly on a single pen plotter. For multi-pen plotters, the pens must be loaded into the first pen positions. It is not necessary to manually select the first pen before beginning the plot.

6.6 RACK MOUNT KIT

The GR 2515 system is installed in the rack mount kit using the drawings supplied with this option.

APPENDIX A

This appendix contains the following RTA program menus and displays obtained by pressing pushbuttons on the front control panel.

DISPLAY GROUP 1

System Initialize

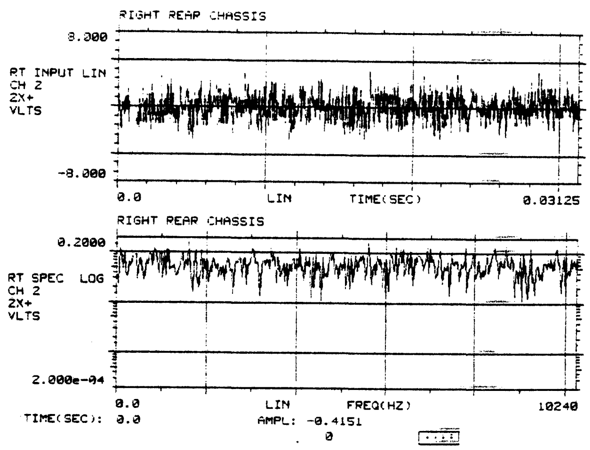
```
000021

000000

177760

177760

000001

000000
```

```
 DEV>
RT-11SJ(GR0)V05.00

2515 System
Prom Revision - 1-Nov-83
Channels - 1-4
Memory Size:  128k Words
19-Jan-84  Change Date? --->
Please Enter The Time:
00:00:00
```

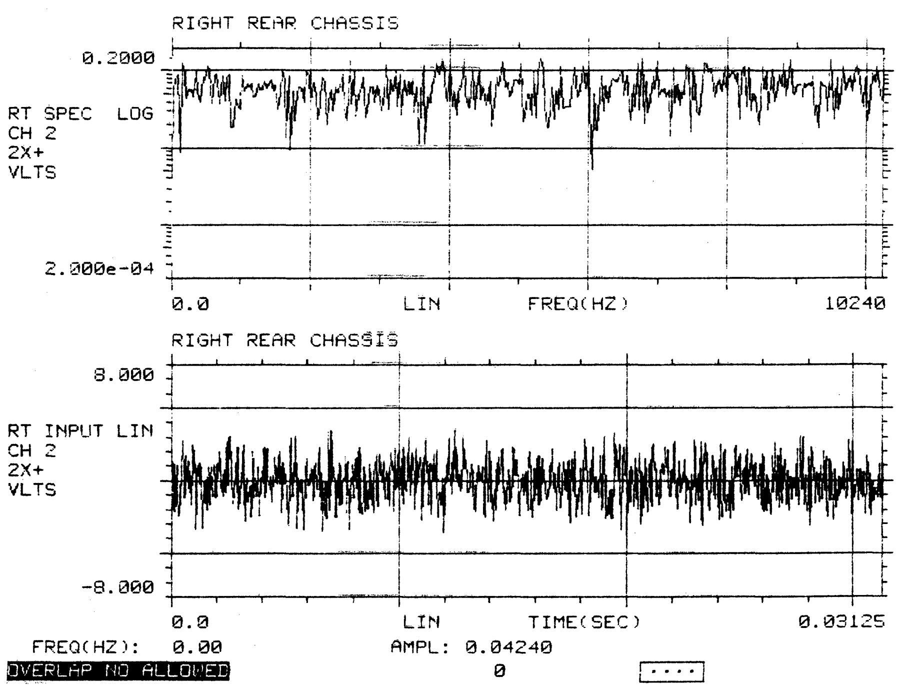
DISPLAY GROUP 2

DISPLAY Group Pushbuttons, Typical Displays and Menus

A. DUAL Pushbutton



B. EXCHNG Pushbutton



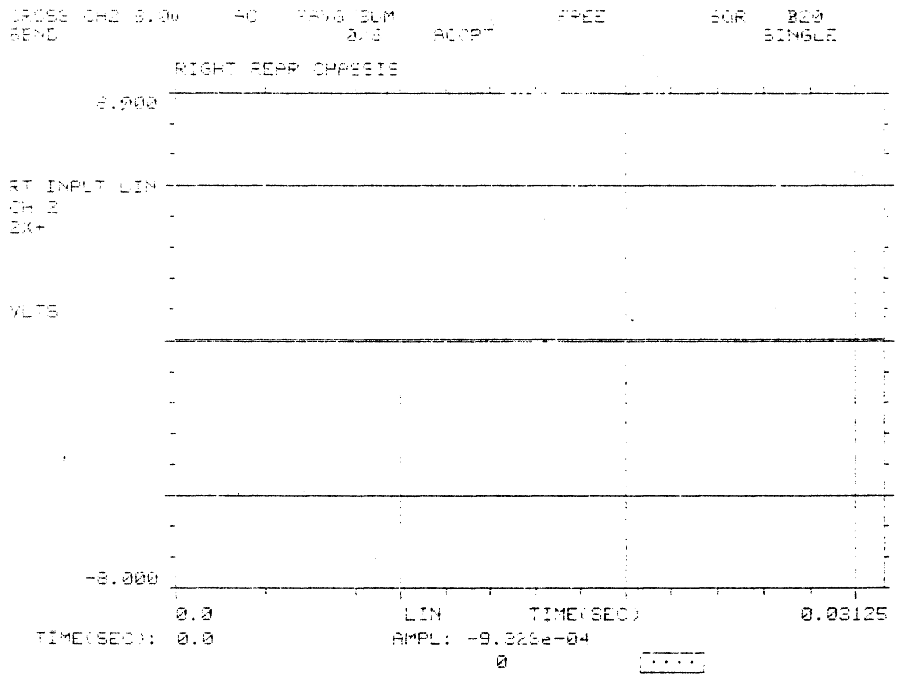
C. OVLY Pushbutton

Not available in this version.

D. NEXT CHAN Pushbutton

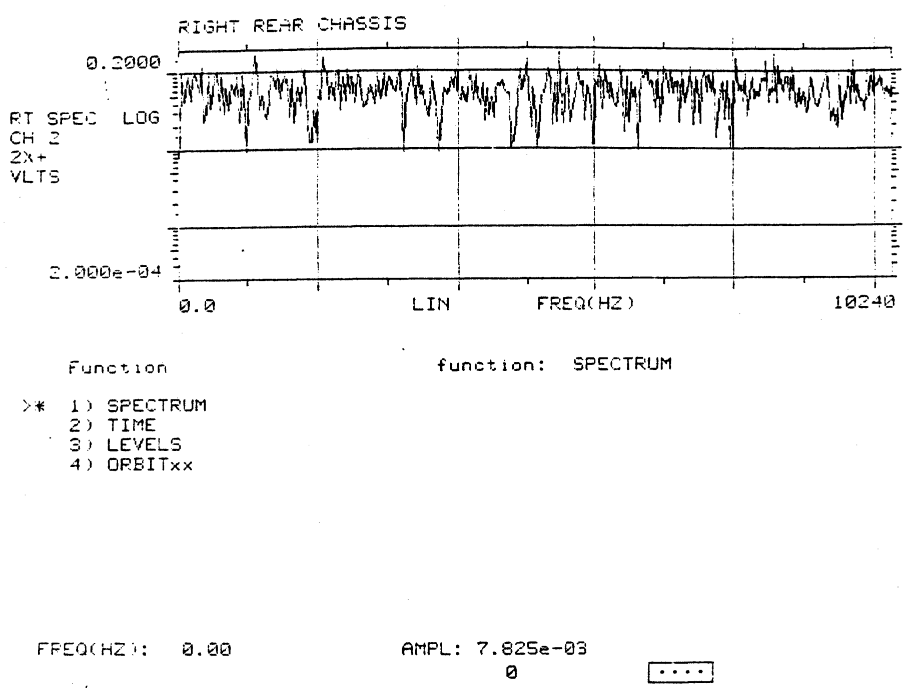
Not available in this version.

E. SINGLE Pushbutton

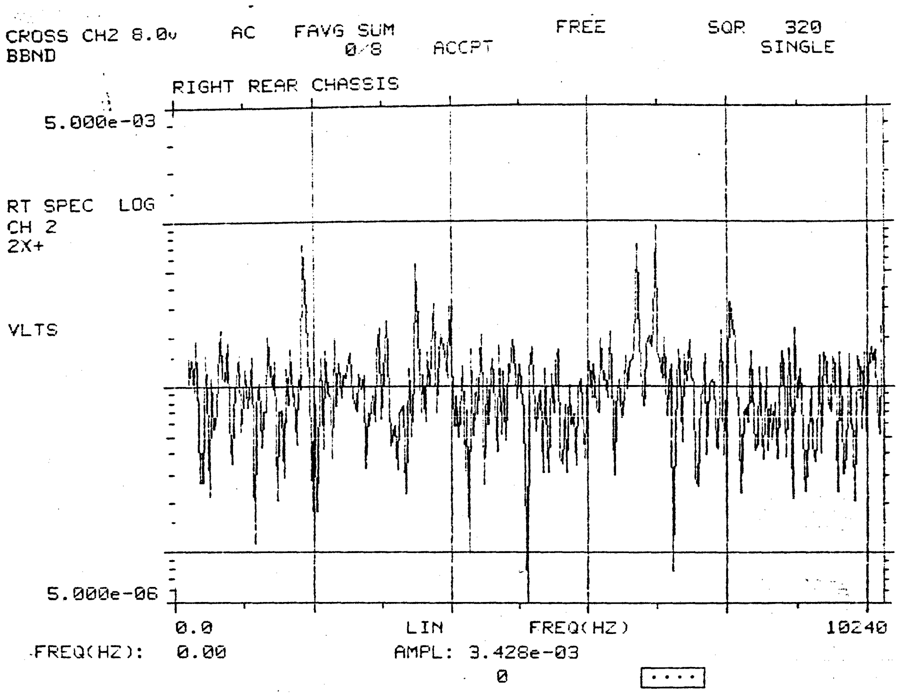


F. FUNCTION Pushbutton, Menus and Typical Displays (REAL TIME)

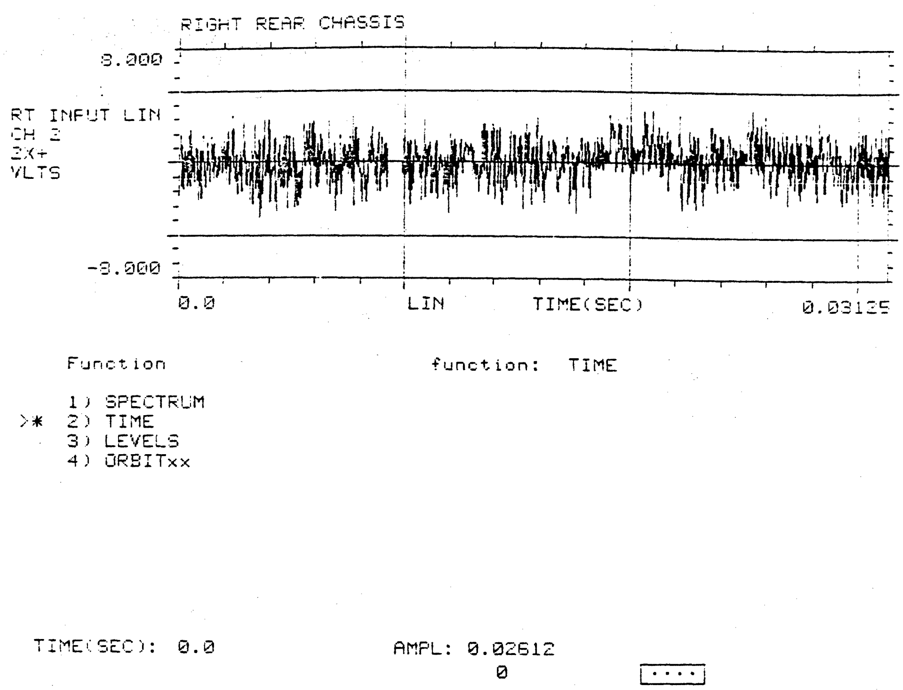
1)



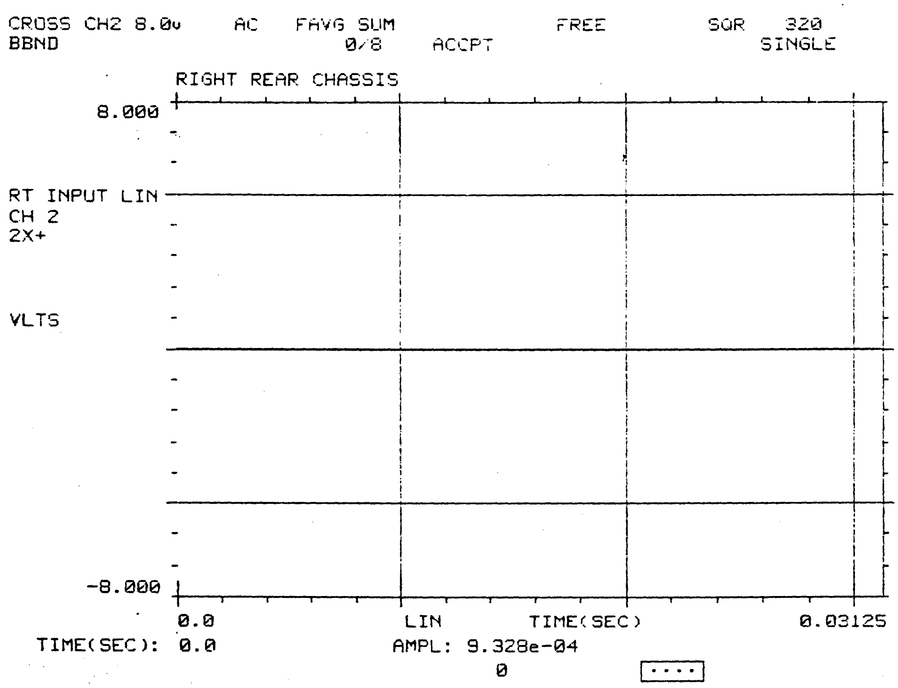
1a)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND 0/8 ACCPT SINGLE
RIGHT REAR CHASSIS
5.000e-03
RT SPEC LOG
CH 2
2X+
VLTS
5.000e-06
0.0
LIN
FREQ(HZ)
10240
FREQ(HZ): 0.00
AMPL: 3.428e-03
0

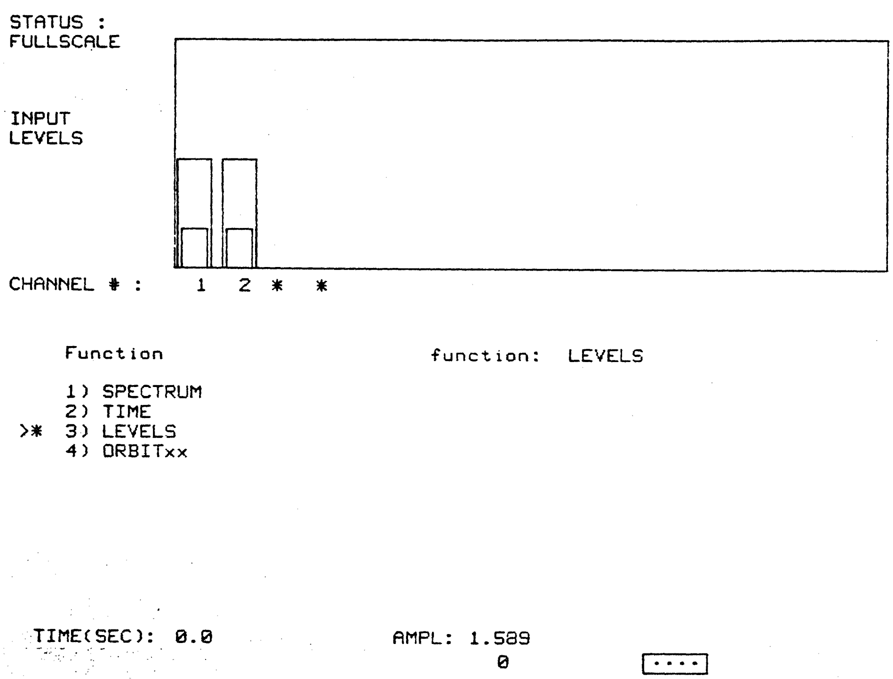
2)


RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
VLTS
-8.000
0.0
LIN
TIME(SEC)
0.03125
Function
function: TIME
1) SPECTRUM
>* 2) TIME
3) LEVELS
4) ORBITxx
TIME(SEC): 0.0
AMPL: 0.02612
0

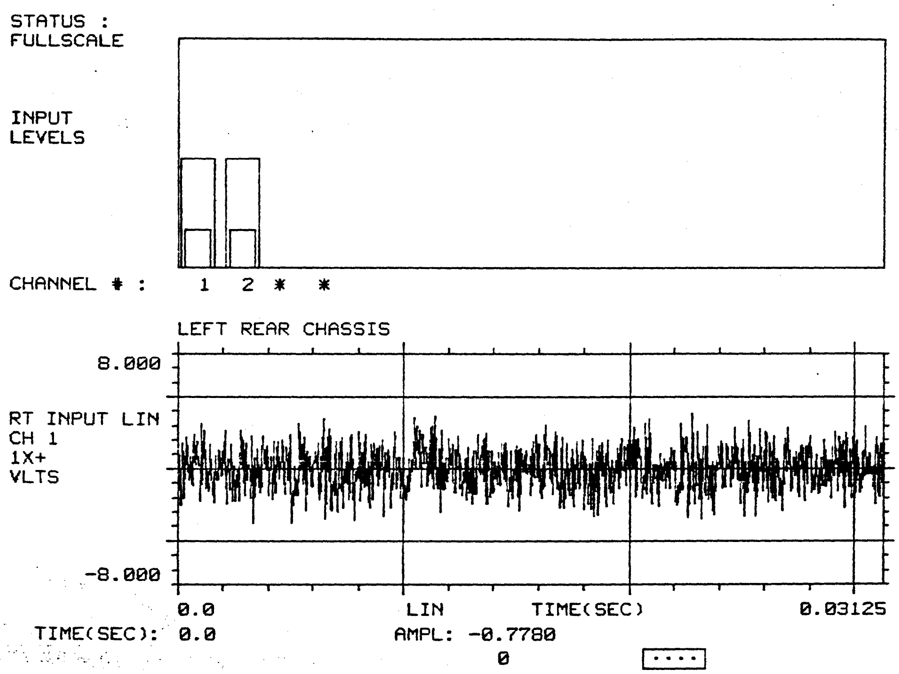
2a)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND 0/8 ACCPT SINGLE
RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
VLTS
-8.000
0.0
LIN
TIME(SEC)
0.03125
TIME(SEC): 0.0
AMPL: 9.328e-04
0

3)


STATUS :
FULLSCALE
INPUT
LEVELS
CHANNEL # : 1 2 * *
Function
function: LEVELS
1) SPECTRUM
2) TIME
>* 3) LEVELS
4) ORBITxx
TIME(SEC): 0.0
AMPL: 1.589
0

3a)



G. AVG Pushbutton

AVERAGED FUNCTION IS NOT AVAILABLE

requested RESPONSE channel is 2

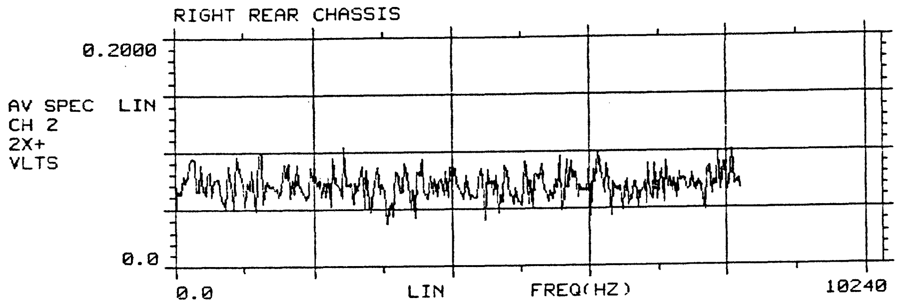
requested function: SPECTRUM

H. MEM Pushbutton

MEMORY data is not available

I. Y SCALE Pushbutton Menus

1)



Y scale

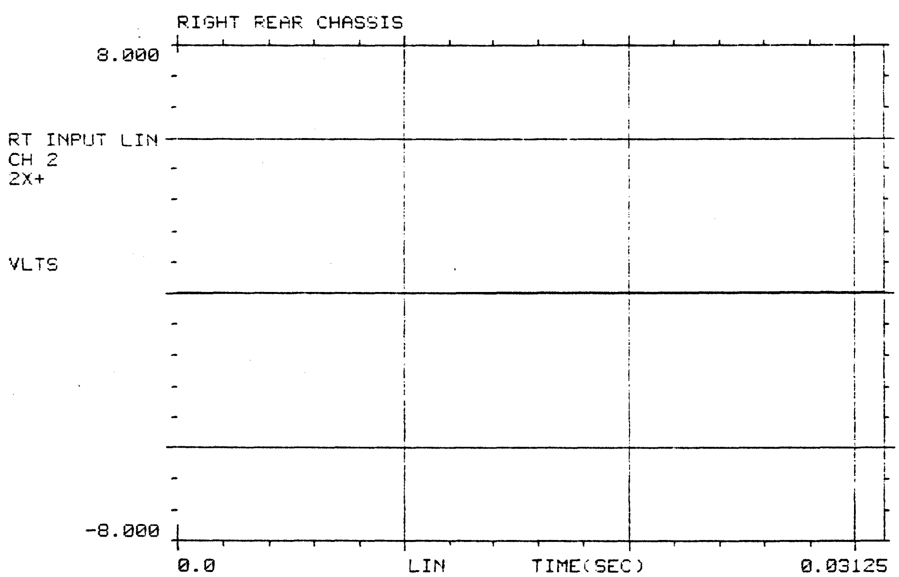
>* 1) LIN AUTO SCALE
2) LIN EXPAND
3) LOG AUTO SCALE
4) LOG EXPAND

Y Scale: LIN AUTO SCALE
EXPAND Min Y: -10.00
EXPAND Max Y: 10.00

FREQ(HZ): AMPL:
8

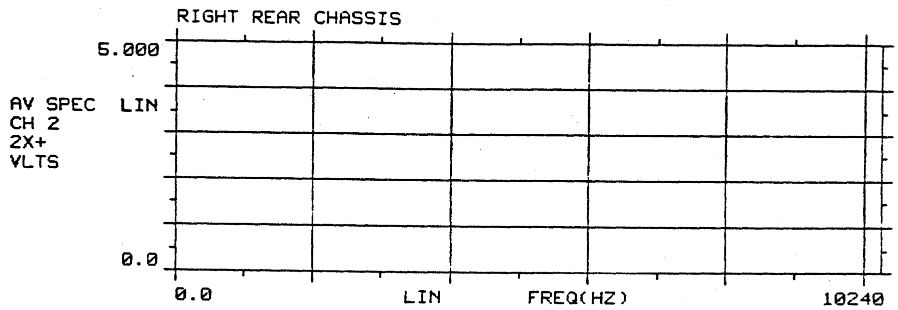
1a)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND 0/8 ACCPT SINGLE



TIME(SEC): 0.0 AMPL: 9.328e-04
0

2)



Y scale

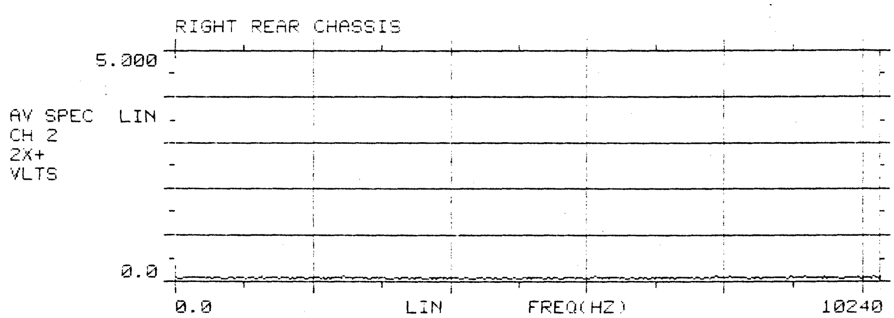
1) LIN AUTO SCALE
>* 2) LIN EXPAND
3) LOG AUTO SCALE
4) LOG EXPAND

Y Scale: LIN EXPAND
EXPAND Min Y: 0.0
EXPAND Max Y: 5.000

FREQ(HZ):

AMPL:
8

2a)



ENTER MIN,MAX values
for LIN Y EXPANSION
* 0.0,5.000

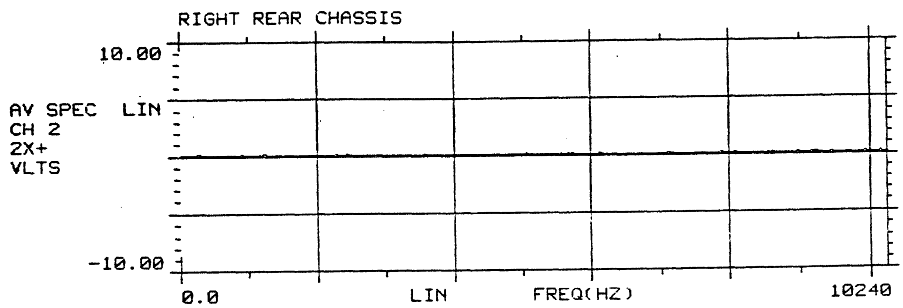
>

Y Scale: LIN EXPAND
EXPAND Min Y: 0.0
EXPAND Max Y: 5.000

FREQ(HZ): 0.00

AMPL: 0.02766
8

2b)



ENTER MIN,MAX values
for LIN Y EXPANSION
* -10.00,10.00

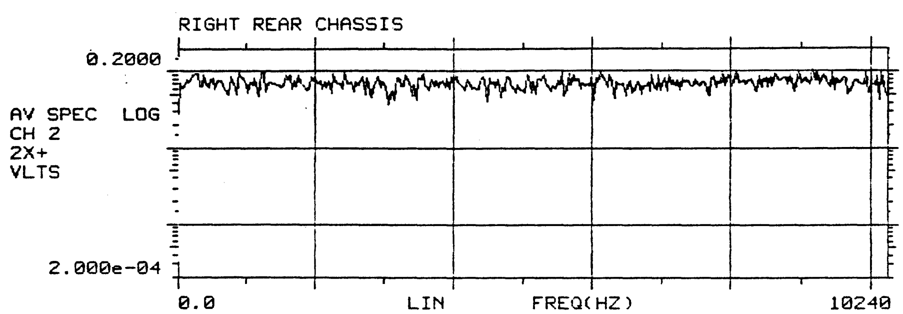
Y Scale: LIN EXPAND
EXPAND Min Y: -10.00
EXPAND Max Y: 10.00

>

FREQ(HZ): 0.00

AMPL: 0.02766
8

3)



Y scale

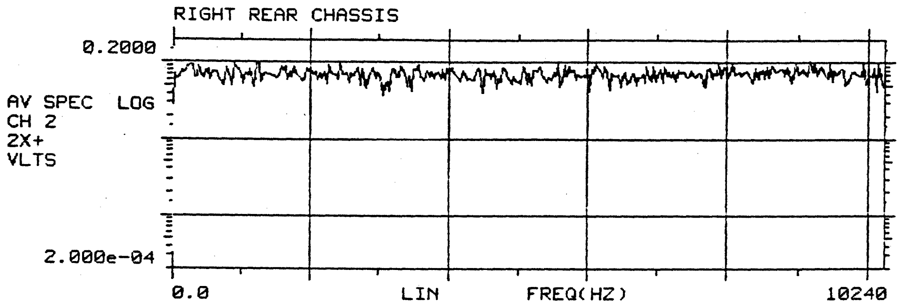
1) LIN AUTO SCALE
2) LIN EXPAND
>* 3) LOG AUTO SCALE
4) LOG EXPAND

Y Scale: LOG AUTO SCALE
EXPAND Min Y: 0.0
EXPAND Max Y: 5.000
dB Range: 60

FREQ(HZ): 0.00

AMPL: 0.02766
8

3a)



Db Range

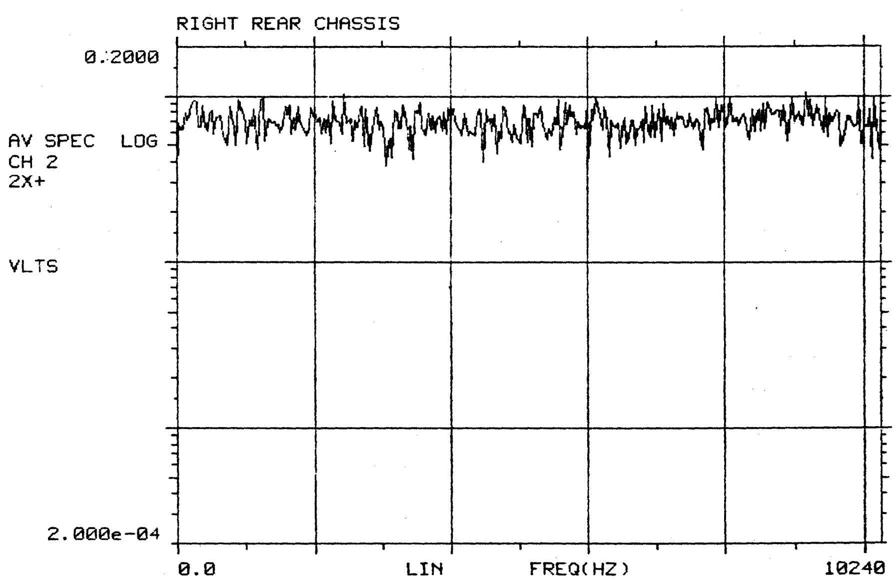
1) 120
2) 100
3) 80
>* 4) 60
5) 40
6) 20

Y Scale: LOG AUTO SCALE
EXPAND Min Y: 0.0
EXPAND Max Y: 5.000
dB Range: 60

FREQ(HZ): 0.00 AMPL: 0.02766
8

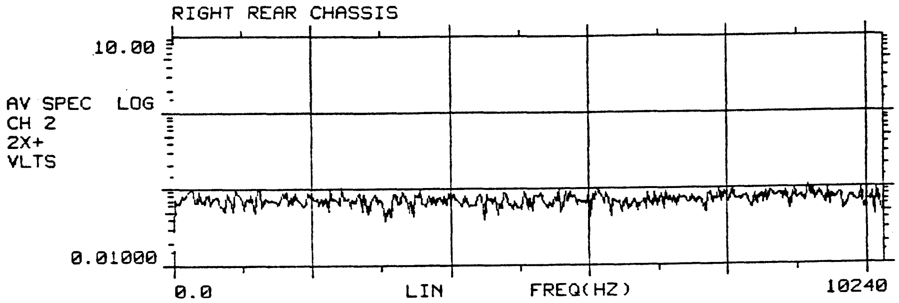
3b)

CROSS CH2 8.0v AC FAVG SUM FREE SQR ÷320
BBND 8/8 ACCPT SINGLE



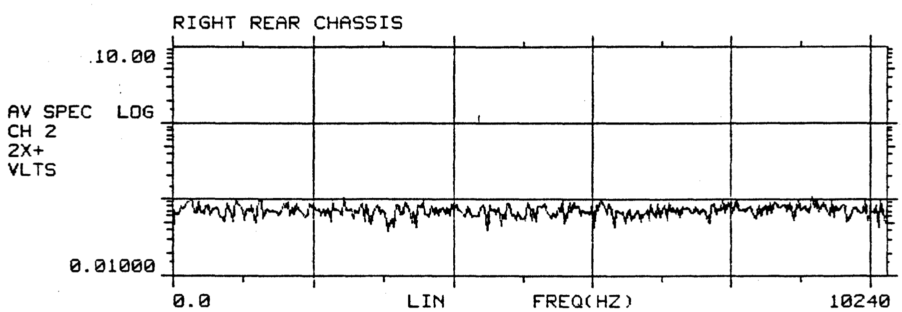
FREQ(HZ): 0.00 AMPL: 0.02766
8

4)




```
Y scale                      Y Scale:  LOG EXPAND
                             EXPAND Min Y:      -10.00
   1) LIN AUTO SCALE         EXPAND Max Y:       10.00
   2) LIN EXPAND             dB Range:  60
   3) LOG AUTO SCALE
>* 4) LOG EXPAND


FREQ(HZ):   0.00             AMPL: 0.02766
                                    8
```

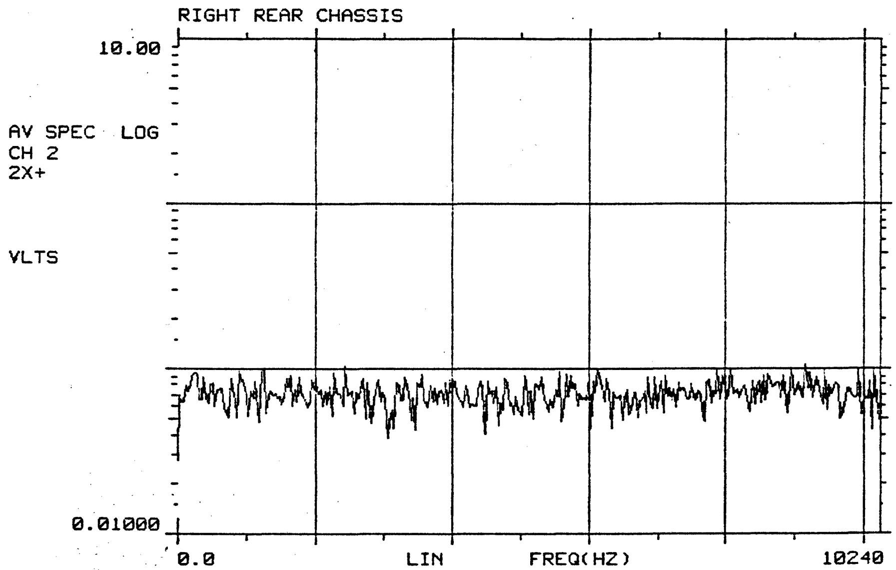
4a)




```
ENTER MIN,MAX values         Y Scale:  LOG EXPAND
for LOG Y EXPANSION          EXPAND Min Y:      -10.00
* -10.00,10.00               EXPAND Max Y:       10.00
                             dB Range:  60
>


FREQ(HZ):   0.00             AMPL: 0.02766
                                    8
```

4b)

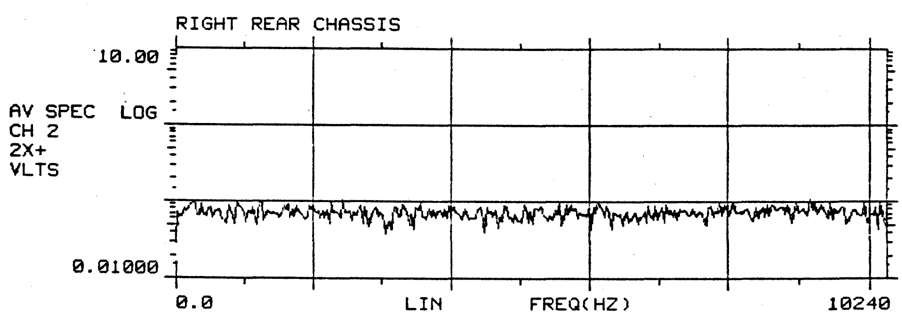
```
CROSS CH2 8.0v    AC   FAVG SUM              FREE         SQR   320
BBND                        8/8    ACCPT                      SINGLE
```




```
FREQ(HZ):  0.00                AMPL: 0.02766
                                   8          [....]
```

J. X SCALE Pushbutton Menus

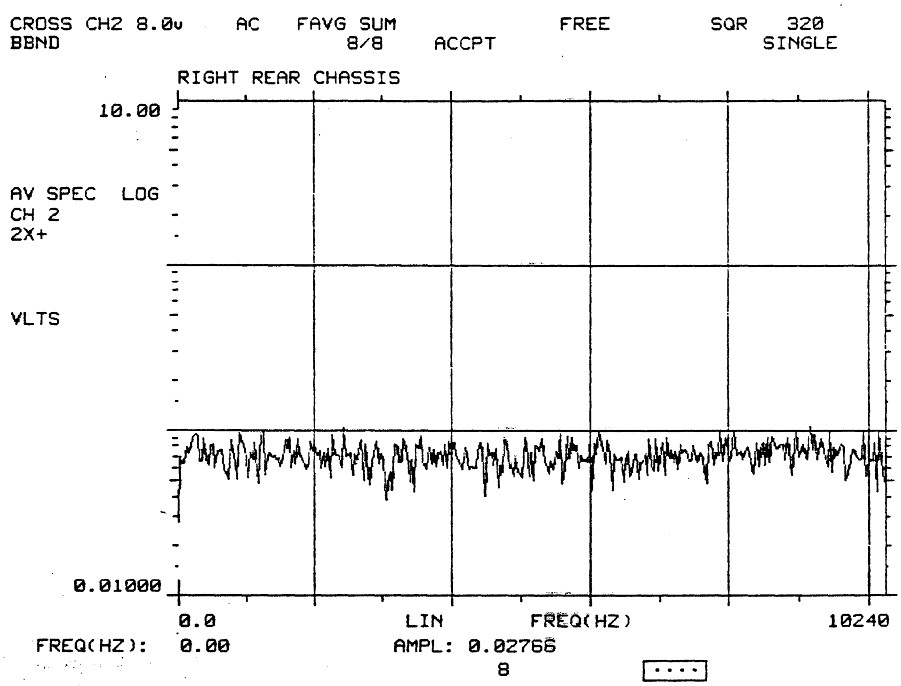
1)



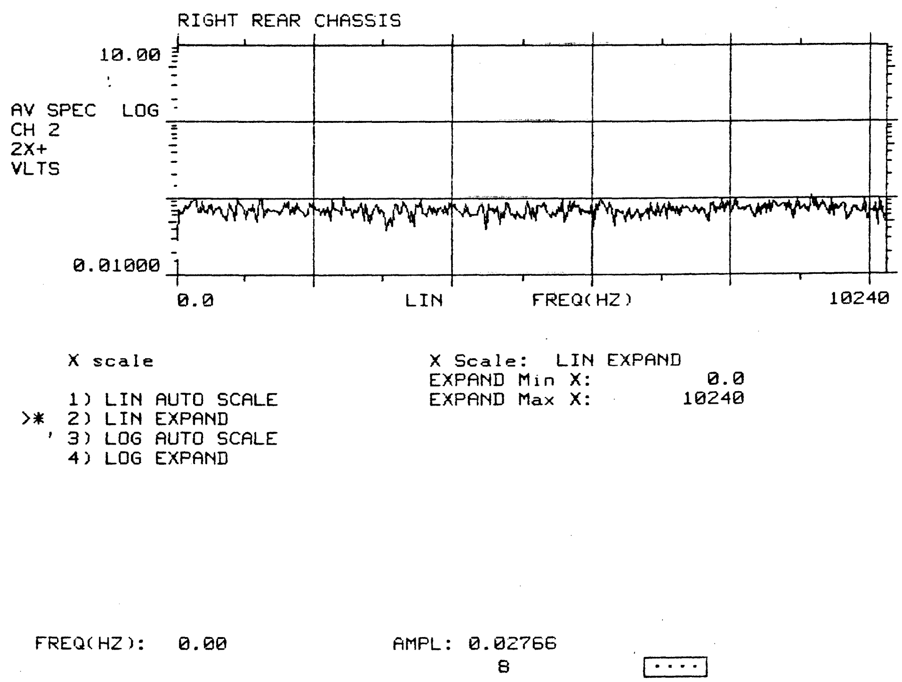

```
    X scale                          X Scale:  LIN AUTO SCALE
                                     EXPAND Min X:        0.0
>*  1) LIN AUTO SCALE                EXPAND Max X:      10240
    2) LIN EXPAND
    3) LOG AUTO SCALE
    4) LOG EXPAND
```

```
FREQ(HZ):  0.00                AMPL: 0.02766
                                   8          [....]
```

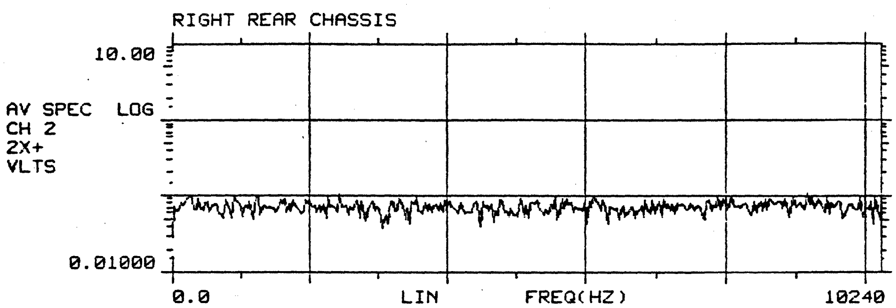
1a)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS
10.00
AV SPEC LOG
CH 2
2X+
VLTS
0.01000
0.0
LIN
FREQ(HZ)
10240
FREQ(HZ): 0.00
AMPL: 0.02766
8

2)


RIGHT REAR CHASSIS
10.00
AV SPEC LOG
CH 2
2X+
VLTS
0.01000
0.0
LIN
FREQ(HZ)
10240
X scale
1) LIN AUTO SCALE
>* 2) LIN EXPAND
3) LOG AUTO SCALE
4) LOG EXPAND
X Scale: LIN EXPAND
EXPAND Min X: 0.0
EXPAND Max X: 10240
FREQ(HZ): 0.00
AMPL: 0.02766
8

2a)



ENTER MIN,MAX values
for LIN X EXPANSION
* 0.0,10240

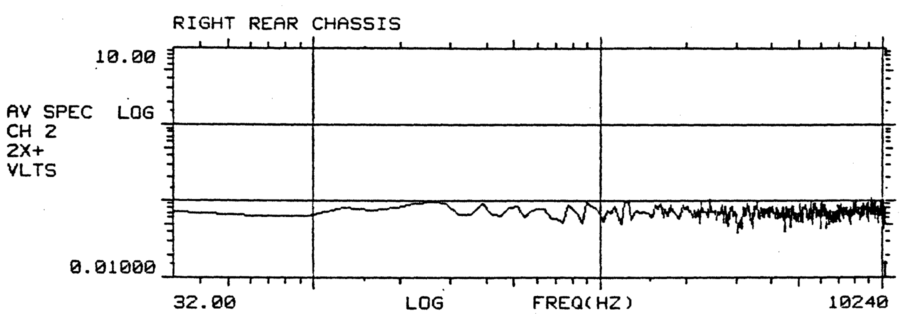
>

X Scale: LIN EXPAND
EXPAND Min X: 0.0
EXPAND Max X: 10240

FREQ(HZ): 0.00

AMPL: 0.02766
8

3)



X scale

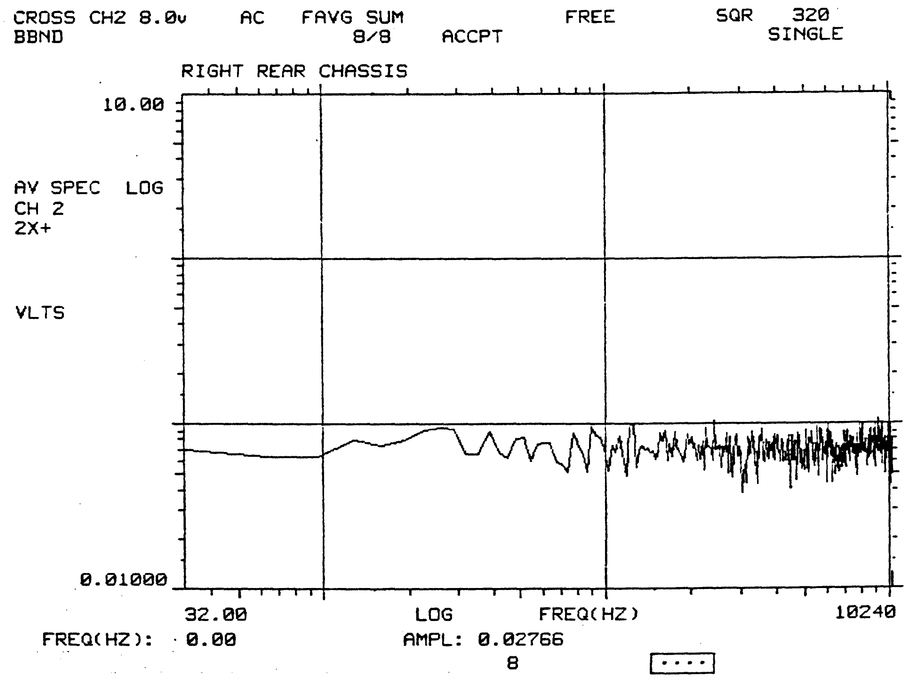
1) LIN AUTO SCALE
2) LIN EXPAND
>* 3) LOG AUTO SCALE
4) LOG EXPAND

X Scale: LOG AUTO SCALE
EXPAND Min X: 0.0
EXPAND Max X: 10240

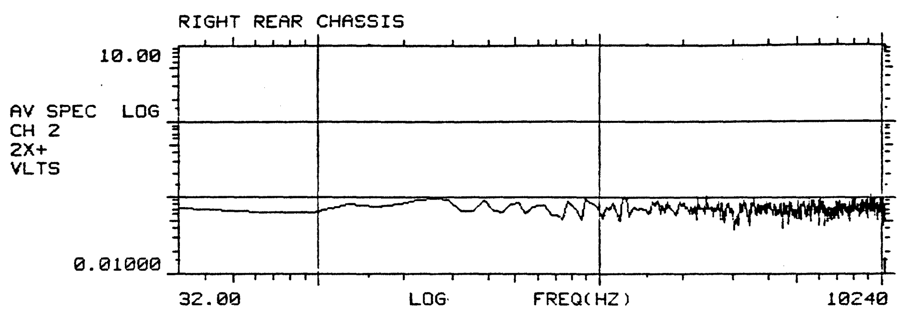
FREQ(HZ): 0.00

AMPL: 0.02766
8

3a)



4)



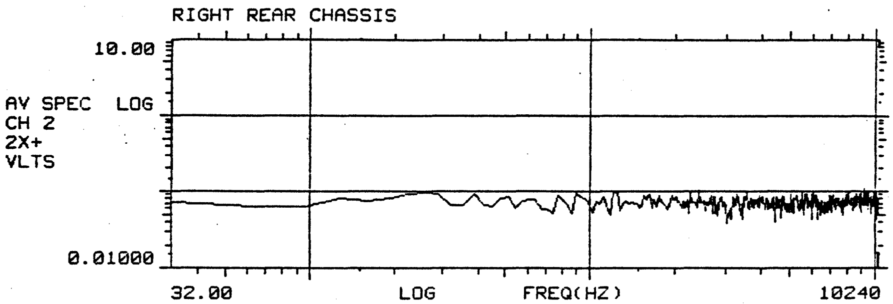
X scale

1) LIN AUTO SCALE
2) LIN EXPAND
3) LOG AUTO SCALE
>* 4) LOG EXPAND

X Scale: LOG EXPAND
EXPAND Min X: 0.0
EXPAND Max X: 10240

FREQ(HZ): 0.00 AMPL: 0.02766
8

4a)



ENTER MIN,MAX values
for LOG X EXPANSION
* 0.0,10240

>

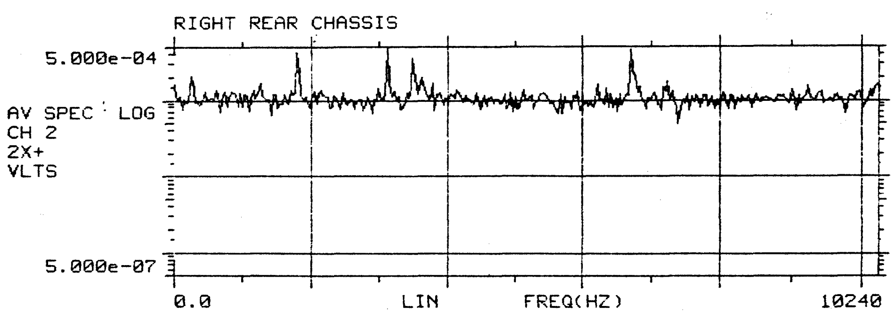
X Scale: LOG EXPAND
EXPAND Min X: 0.0
EXPAND Max X: 10240

FREQ(HZ): 0.00

AMPL: 0.02766
8

K. FUNCTION Pushbutton Menus and Typical Displays (AVERAGE)

1)



Function

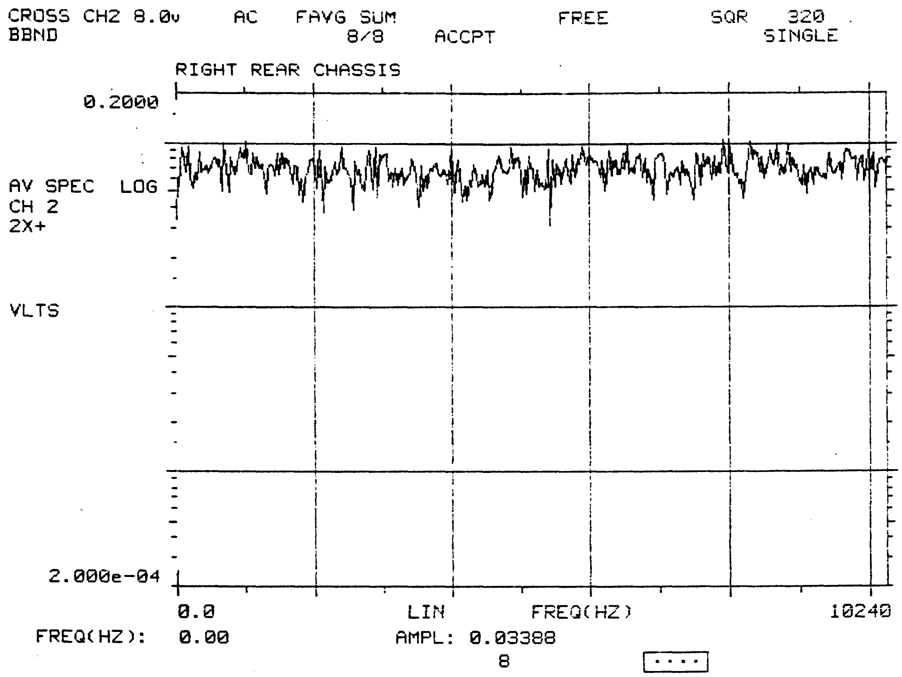
>* 1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

function: AUTO SPECTRUM
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

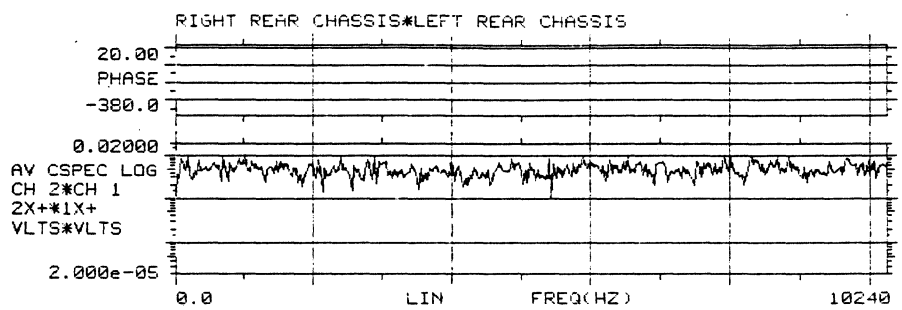
FREQ(HZ): 0.00

AMPL: 1.568e-04

1a)



2)



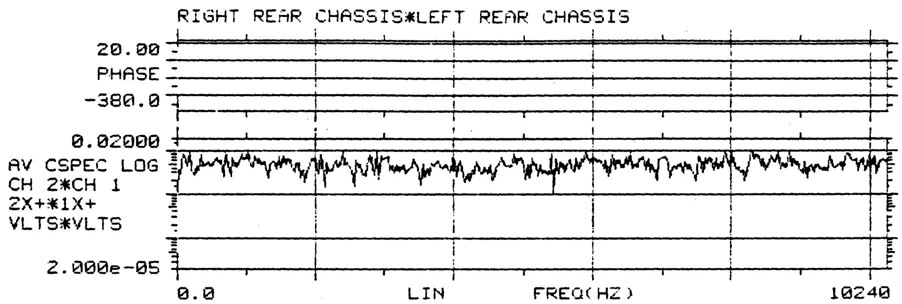
Function

1) AUTO SPECTRUM
>* 2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

function: CROSS SPECTRUM
CPX Function
format: BODE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 1.100e-03 PHASE: -360.0
8

2.1)



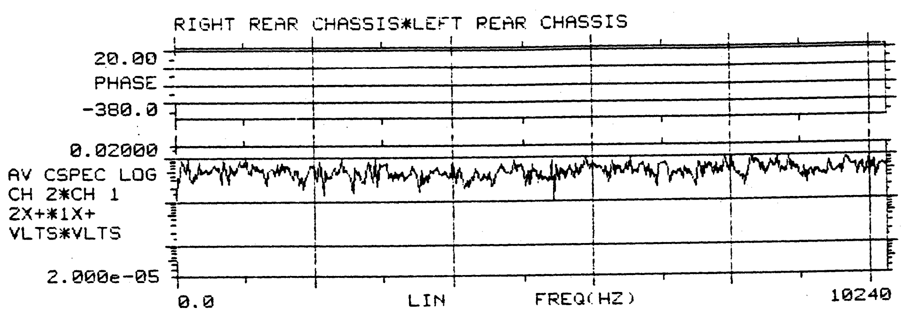
Format

>* 1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: CROSS SPECTRUM
CPX Function
format: BODE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 1.100e-03 PHASE: -360.0
8

2.1a)



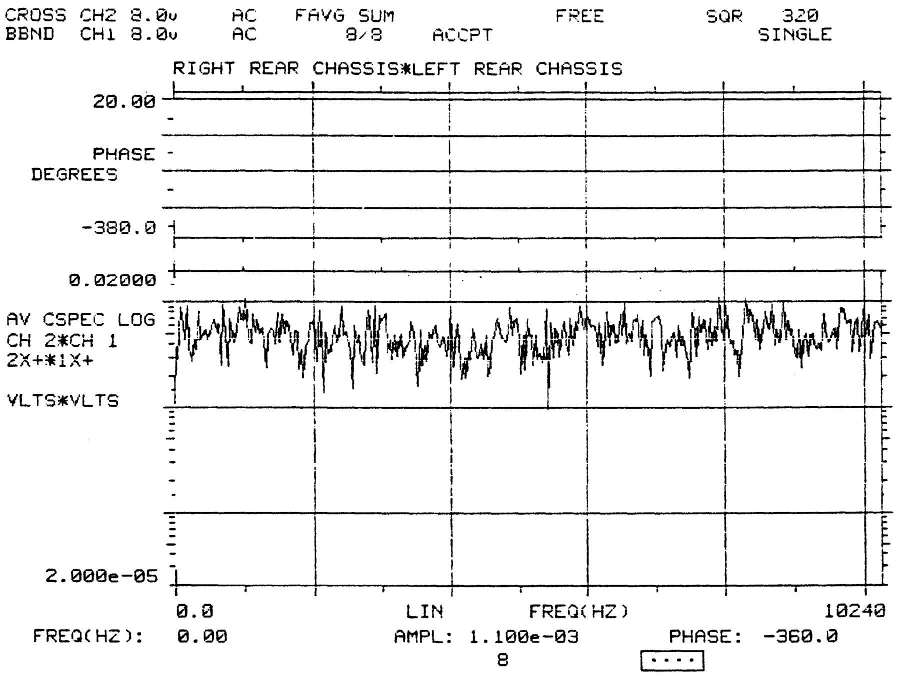
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

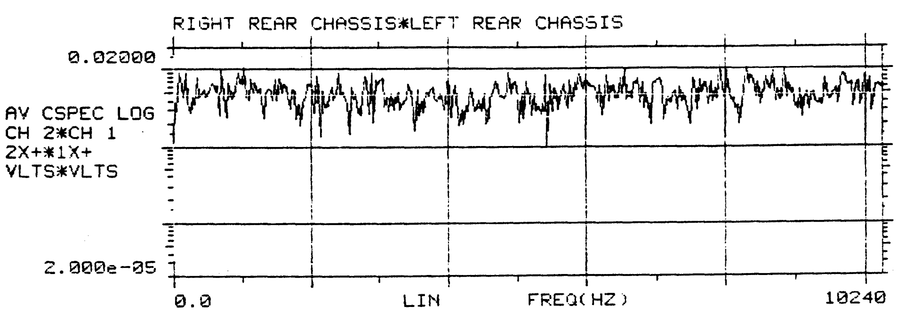
function: CROSS SPECTRUM
CPX Function
format: BODE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 1.100e-03 PHASE: -360.0
8

2.1b)



2.2)



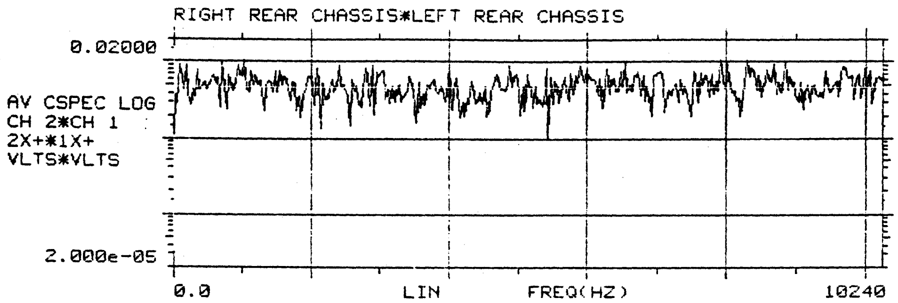
Format

1) BODE
>* 2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 1.100e-03
8

2.2a)



ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

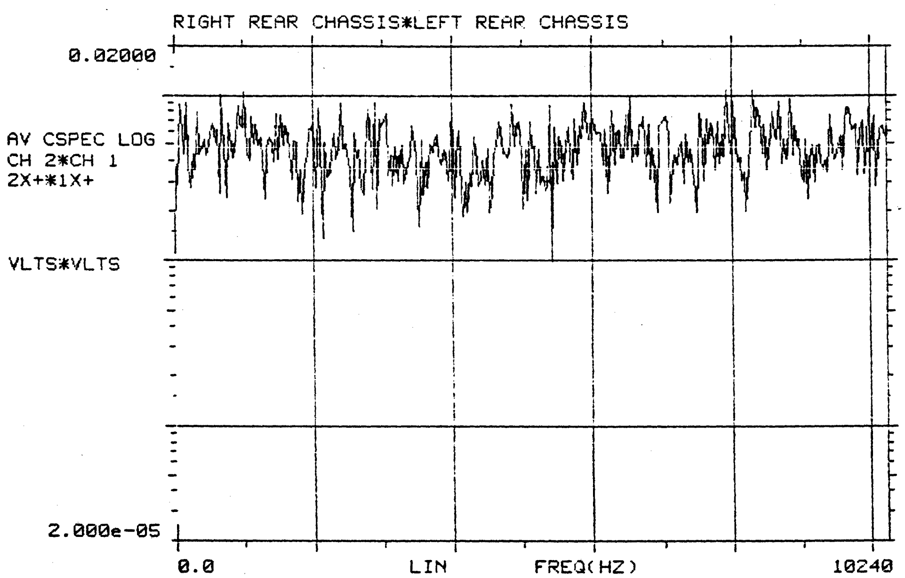
>

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 1.100e-03
8

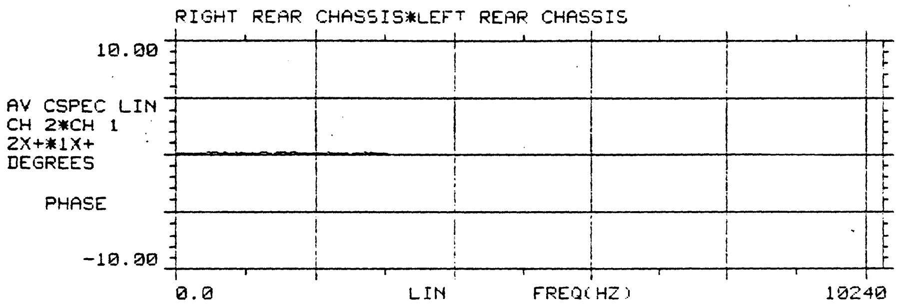
2.2b)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



FREQ(HZ): 0.00 AMPL: 1.10 e-03
8

2.3)



Format

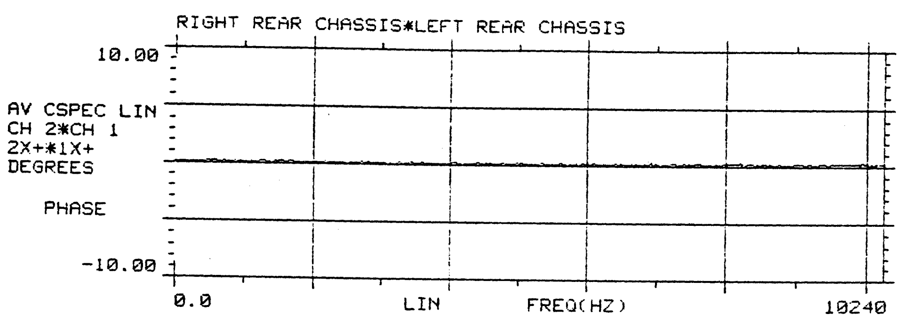
1) BODE
2) MAGNITUDE
>* 3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: CROSS SPECTRUM
CPX Function
format: PHASE
COH Blnk Level: 0.0

FREQ(HZ):

PHASE:
8

2.3a)



ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

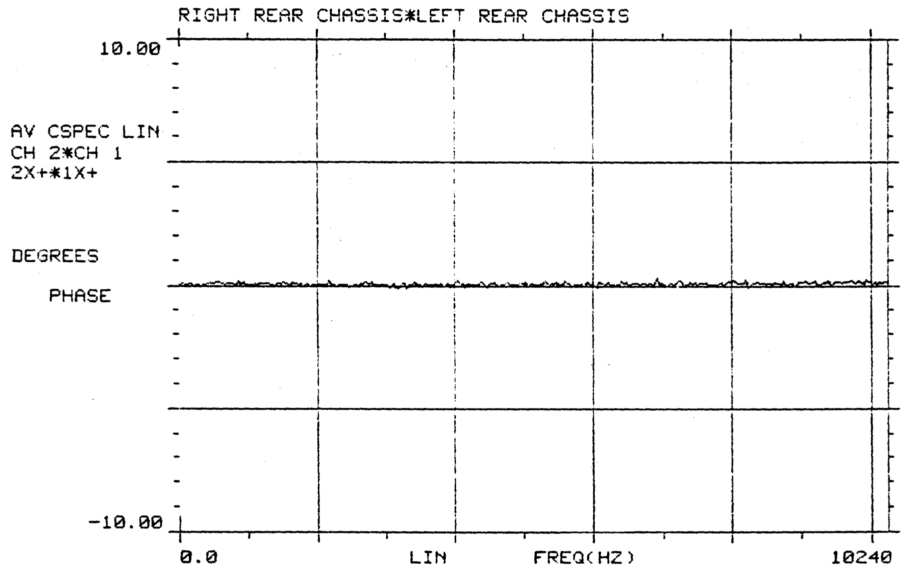
function: CROSS SPECTRUM
CPX Function
format: PHASE
COH Blnk Level: 0.0

FREQ(HZ): 0.00

PHASE: -360.0
8

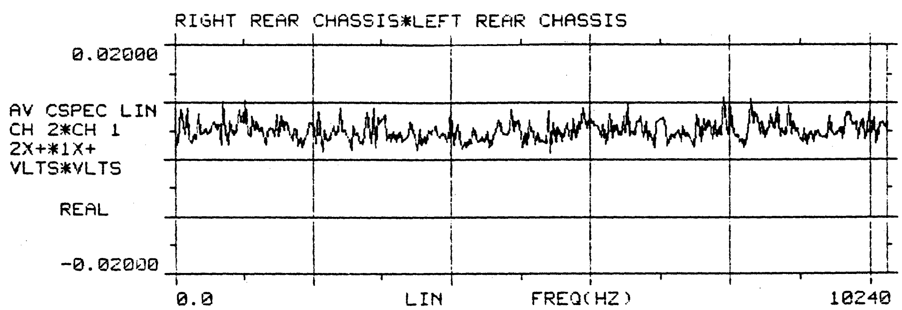
2.3b)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



FREQ(HZ): 0.00 PHASE: 360.0
8

2.4)



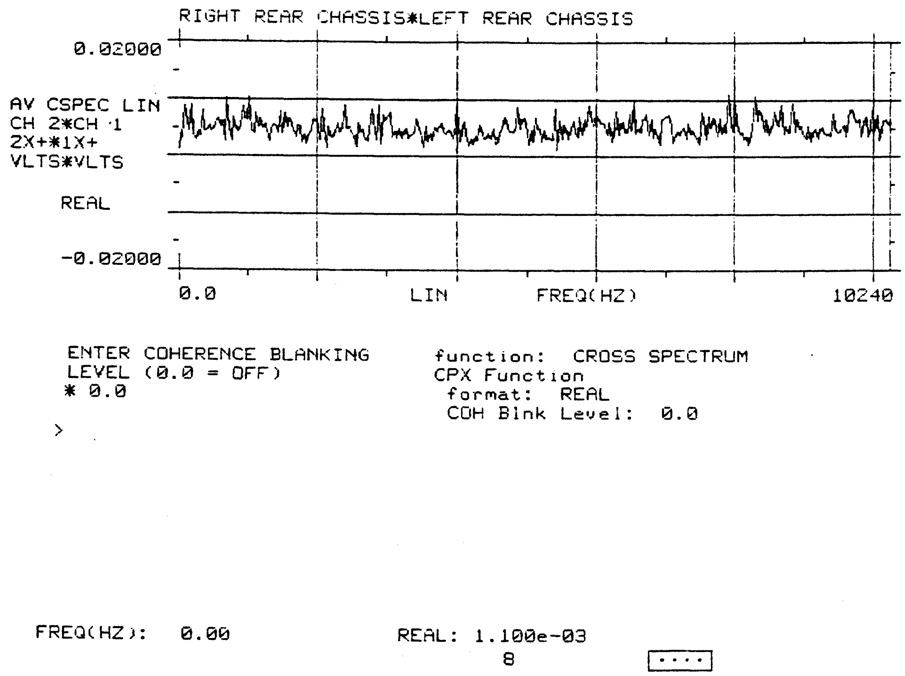
Format

1) BODE
2) MAGNITUDE
3) PHASE
>* 4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

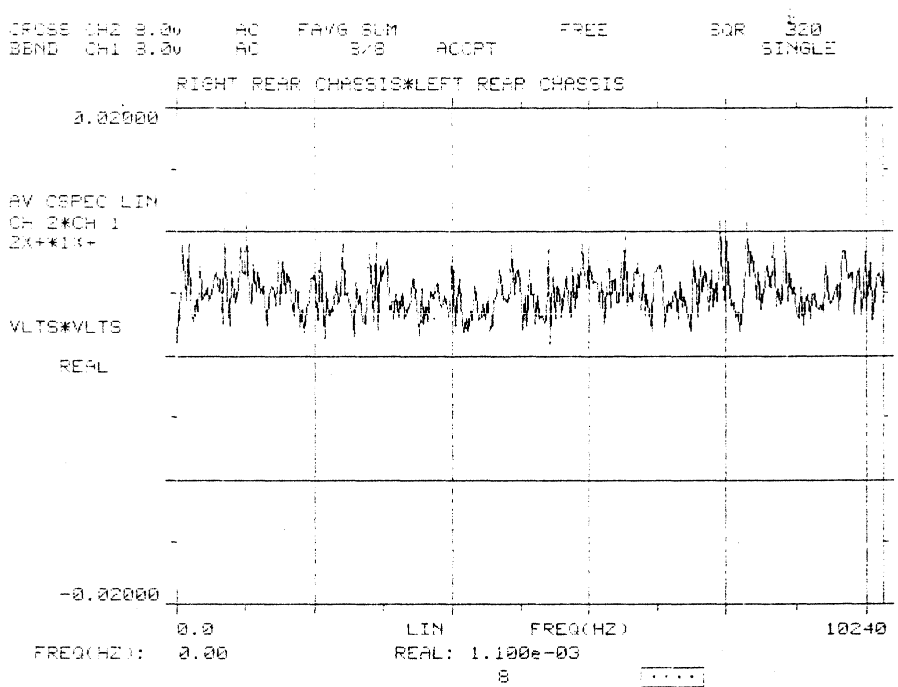
function: CROSS SPECTRUM
CPX Function
format: REAL
COH Blnk Level: 0.0

FREQ(HZ): REAL:
8

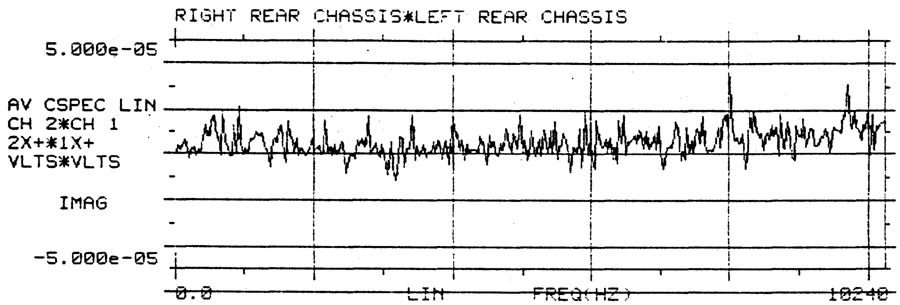
2.4a)


RIGHT REAR CHASSIS*LEFT REAR CHASSIS
0.02000
AV CSPEC LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
REAL
-0.02000
0.0
LIN
FREQ(HZ)
10240
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0
function: CROSS SPECTRUM
CPX Function
format: REAL
COH Blnk Level: 0.0
FREQ(HZ): 0.00
REAL: 1.100e-03
8

2.4b)


RIGHT REAR CHASSIS*LEFT REAR CHASSIS
0.02000
AV CSPEC LIN
CH 2*CH 1
VLTS*VLTS
REAL
-0.02000
0.0
LIN
FREQ(HZ)
10240
FREQ(HZ): 0.00
REAL: 1.100e-03
8

2.5)



Format

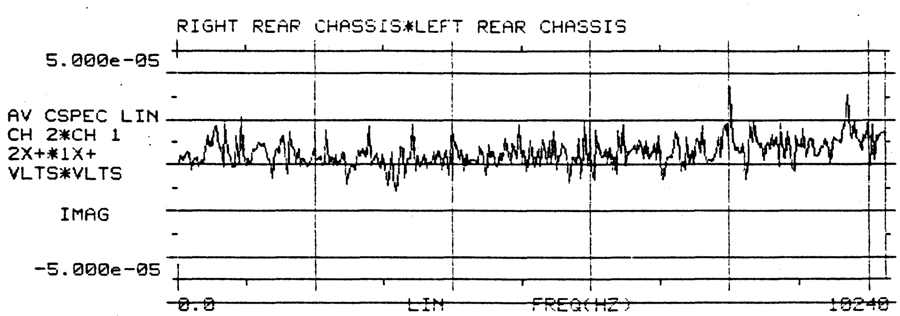
1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
>* 5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: CROSS SPECTRUM
CPX Function
format: IMAGINARY
COH Blnk Level: 0.0

FREQ(HZ): 0.00

IMAG: 4.172e-07
8

2.5a)



ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

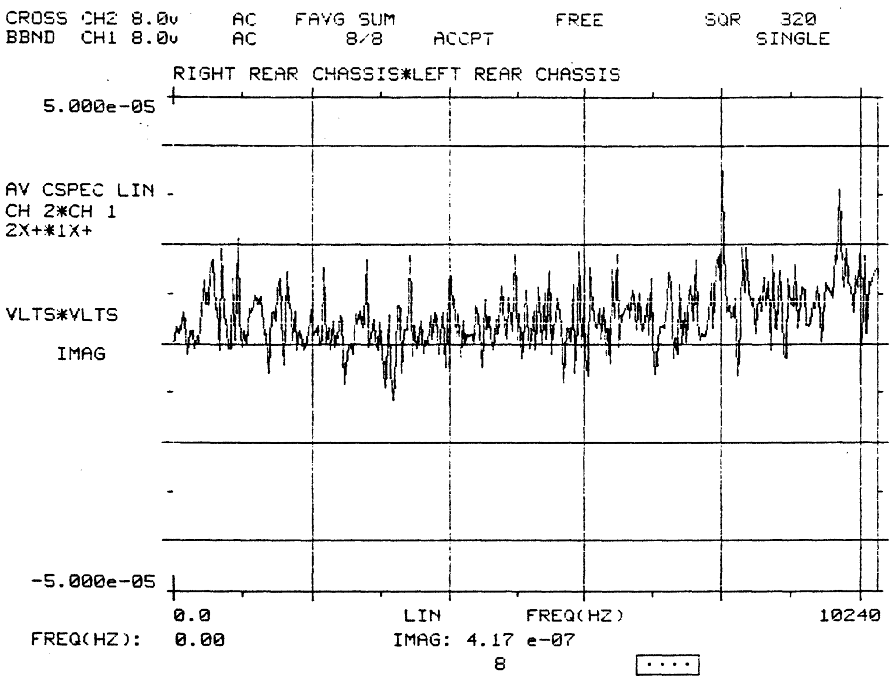
>

function: CROSS SPECTRUM
CPX Function
format: IMAGINARY
COH Blnk Level: 0.0

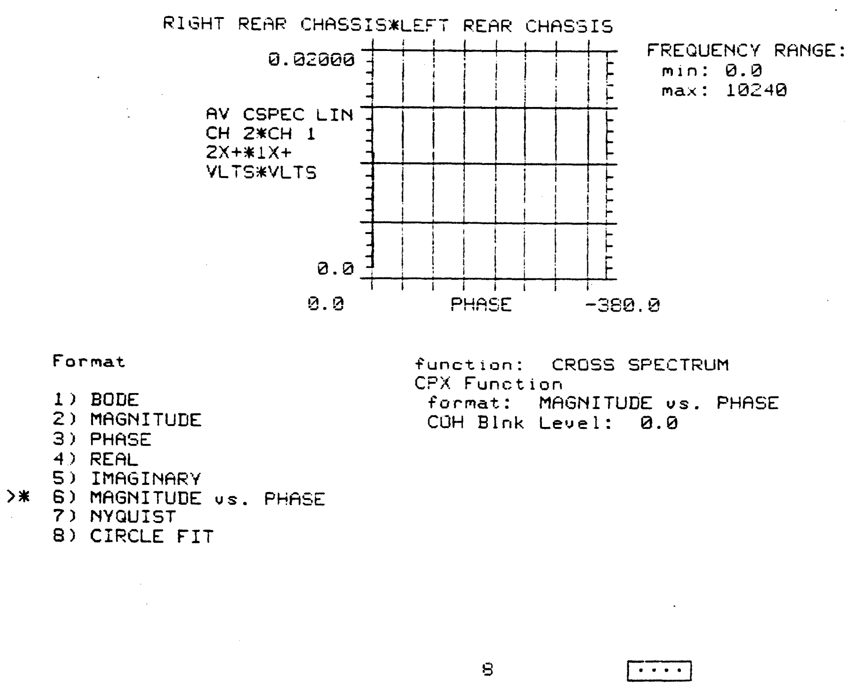
FREQ(HZ): 0.00

IMAG: 4.172e-07
8

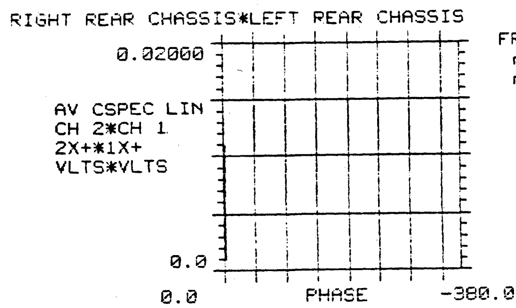
2.5b)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS*LEFT REAR CHASSIS
5.000e-05
AV CSPEC LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
IMAG
-5.000e-05
0.0
LIN
FREQ(HZ)
10240
FREQ(HZ): 0.00
IMAG: 4.17 e-07
8

2.6)


RIGHT REAR CHASSIS*LEFT REAR CHASSIS
0.02000
AV CSPEC LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
0.0
0.0
PHASE
-380.0
FREQUENCY RANGE:
min: 0.0
max: 10240
Format
1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
>* 6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT
function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0
8

2.6.1)



FREQUENCY RANGE:
min: 0.0
max: 10240

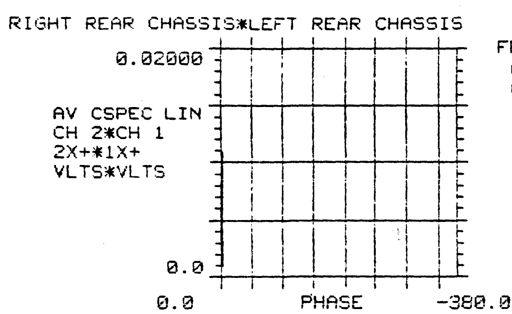
Frequency Scale

>* 1) AUTOSCALE
2) EXPAND

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8 [....]

2.6.1a)



FREQUENCY RANGE:
min: 0.0
max: 10240

ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

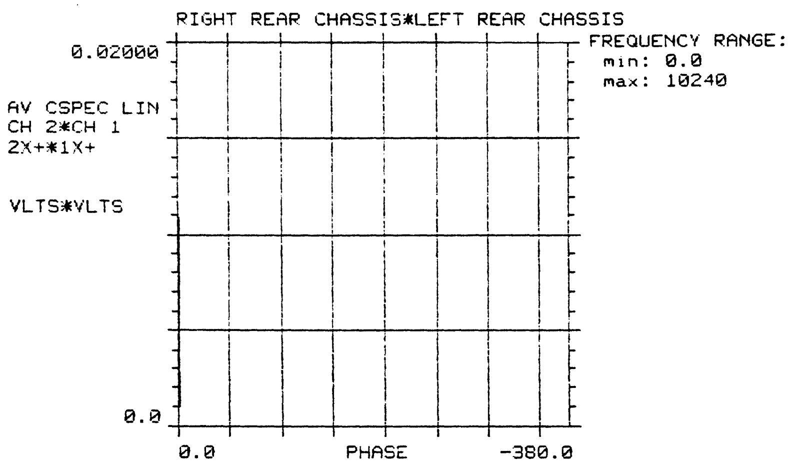
>

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8 [....]

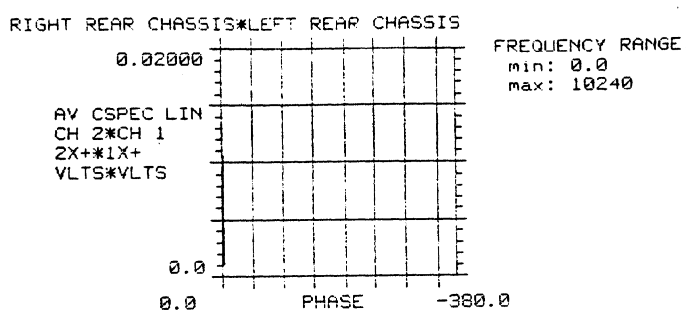
2.6.1b)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



8

2.6.2)



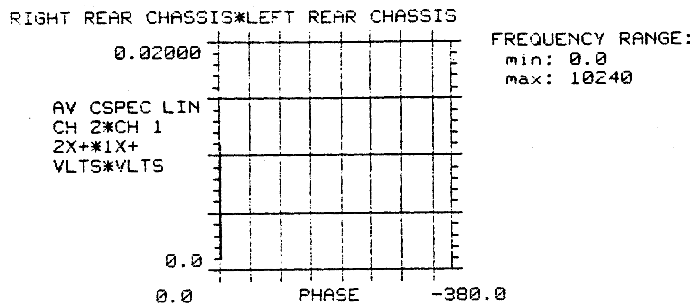
Frequency Scale

1) AUTOSCALE
>* 2) EXPAND

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

2.6.2a)



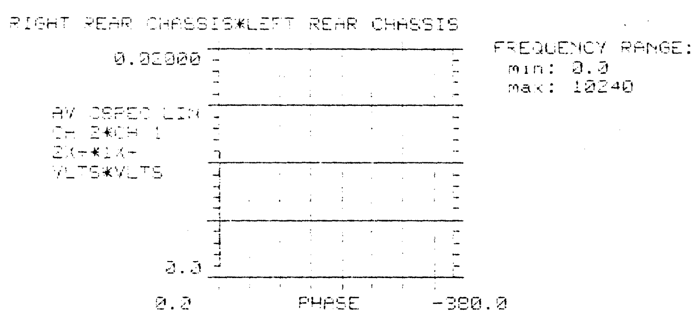
ENTER MIN,MAX for
for Frequency Expansion
* 0.0,10240

>

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

2.6.2b)



ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

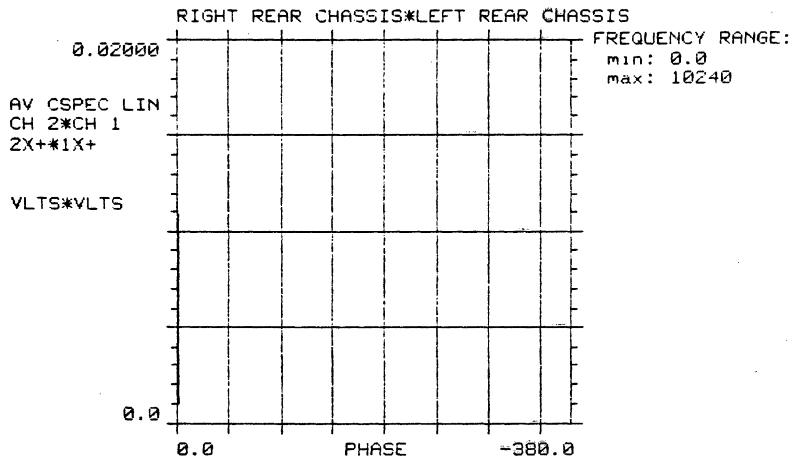
>

function: CROSS SPECTRUM
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

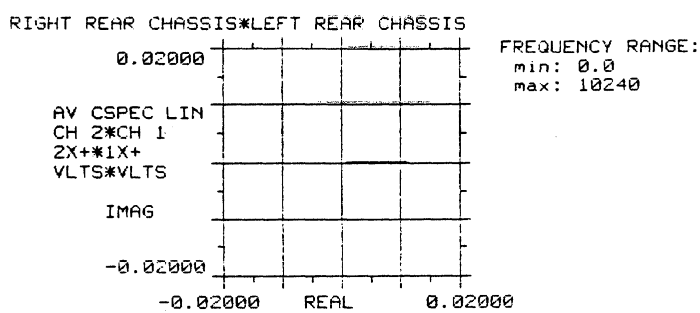
2.6.2c)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



8

2.7)



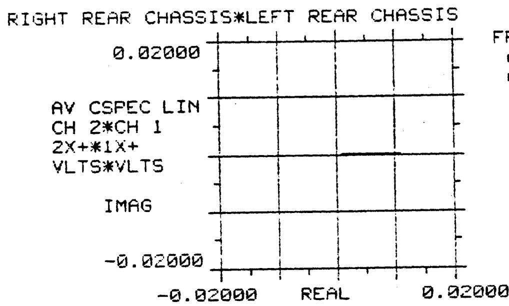
Format

1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
>* 7) NYQUIST
8) CIRCLE FIT

function: CROSS SPECTRUM
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

2.7.1)



FREQUENCY RANGE:
min: 0.0
max: 10240

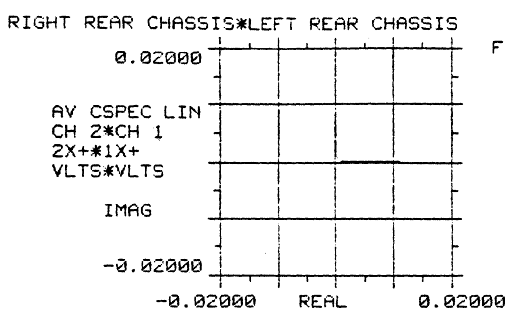
Frequency Scale

>* 1) AUTOSCALE
2) EXPAND

function: CROSS SPECTRUM
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8 [....]

2.7.1a)



FREQUENCY RANGE:
min: 0.0
max: 10240

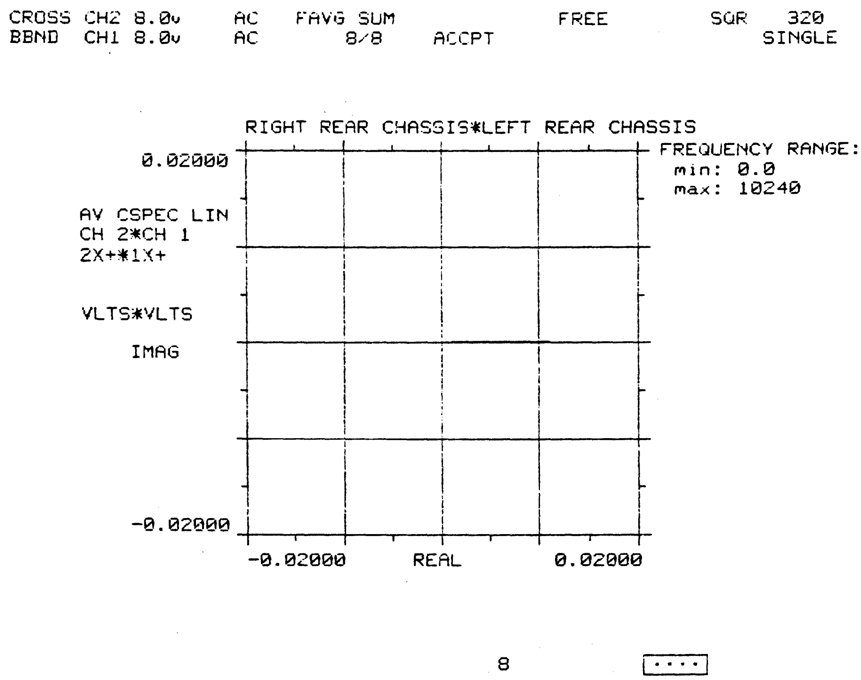
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

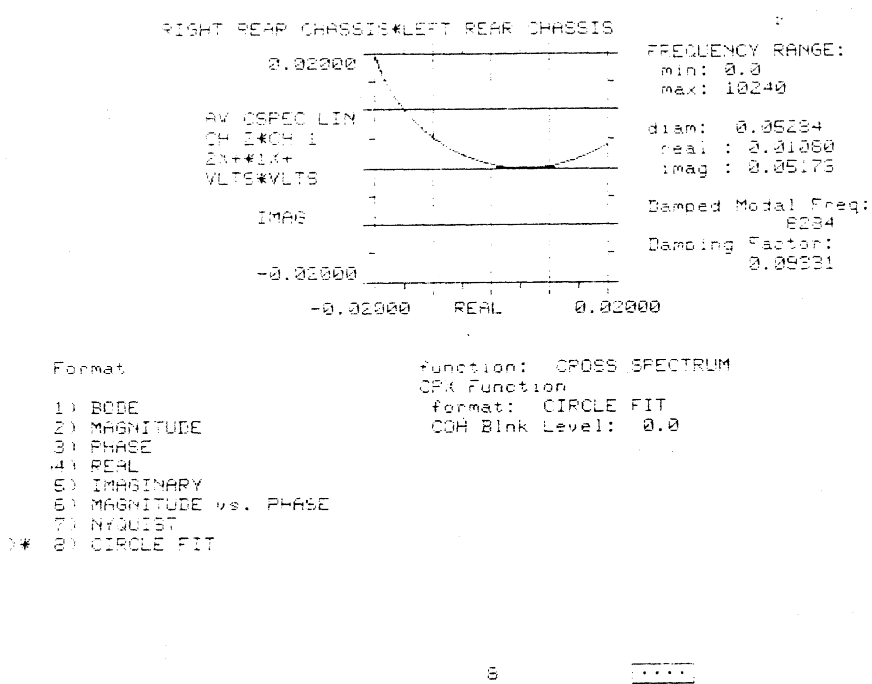
function: CROSS SPECTRUM
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8 [....]

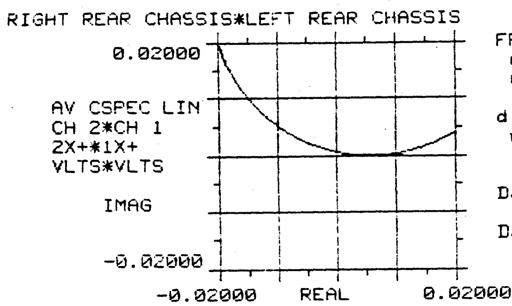
2.7.1b)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS*LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
0.02000
AV CSPEC LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
IMAG
-0.02000
-0.02000
REAL
0.02000
8

2.8)


RIGHT REAR CHASSIS*LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
0.02000
AV CSPEC LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
IMAG
-0.02000
diam: 0.05284
real : 0.01060
imag : 0.05175
Damped Modal Freq:
6284
Damping Factor:
0.09331
-0.02000
REAL
0.02000
Format
1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
>* 8) CIRCLE FIT
function: CROSS SPECTRUM
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0
8

2.8.1)



FREQUENCY RANGE:
min: 0.0
max: 10240

diam: 0.05284
real : 0.01080
imag : 0.05173

Damped Modal Freq:
6284
Damping Factor:
0.09331

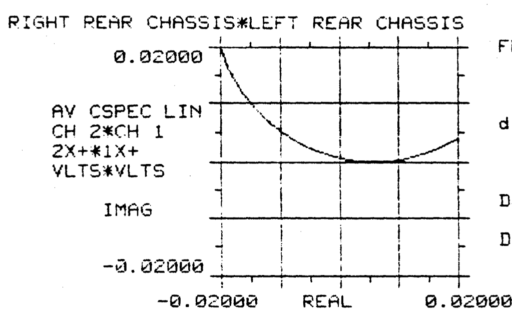
Frequency Scale

>* 1) AUTOSCALE
2) EXPAND

function: CROSS SPECTRUM
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

8 [....]

2.8.1a)



FREQUENCY RANGE:
min: 0.0
max: 10240

diam: 0.05284
real : 0.01080
imag : 0.05173

Damped Modal Freq:
6284
Damping Factor:
0.09331

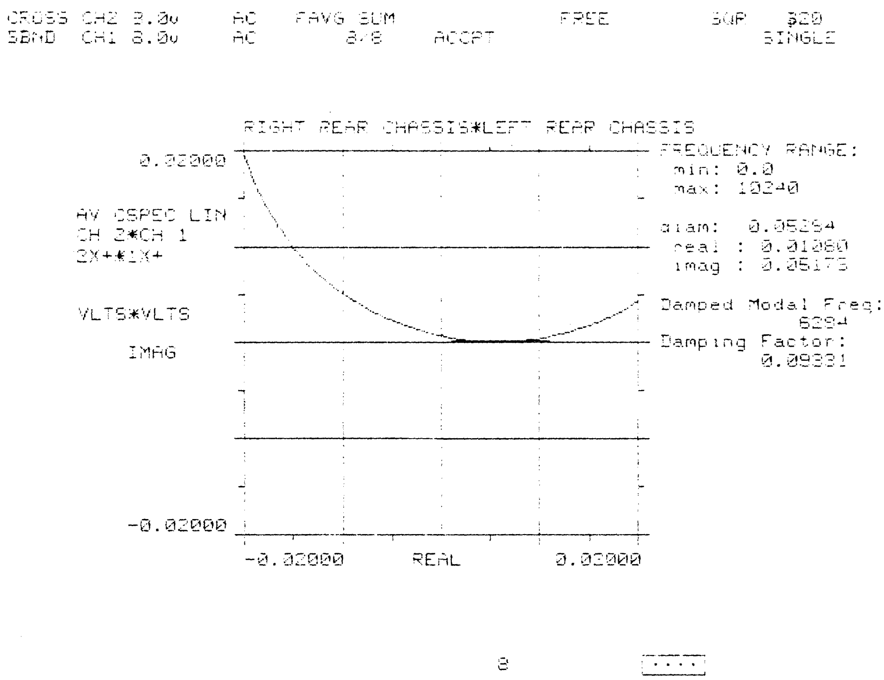
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

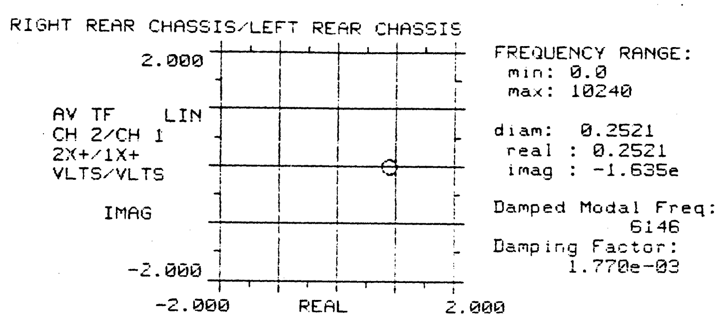
function: CROSS SPECTRUM
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

8 [....]

2.8.1b)



3)



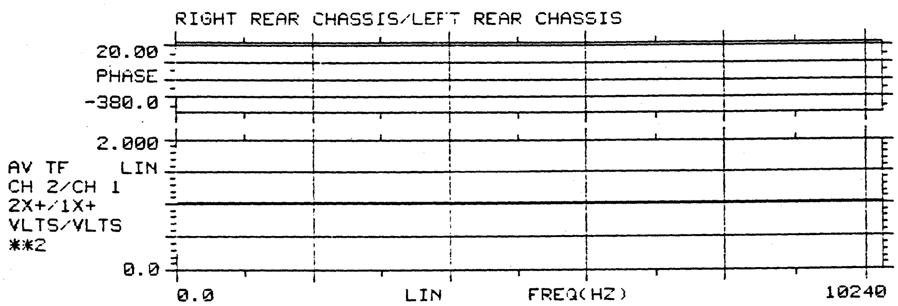
Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
>* 3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

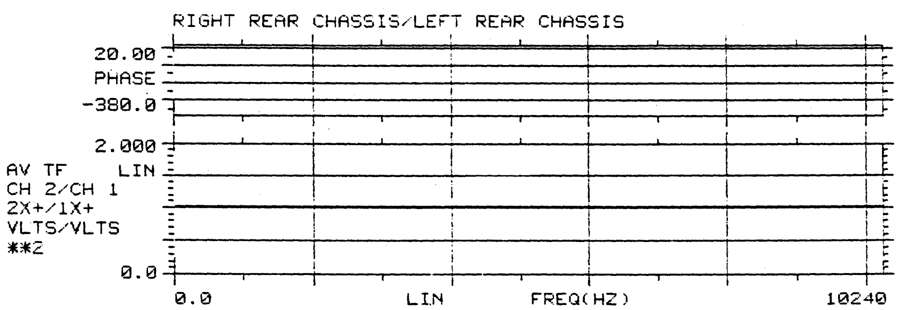
8 [....]

3.1)



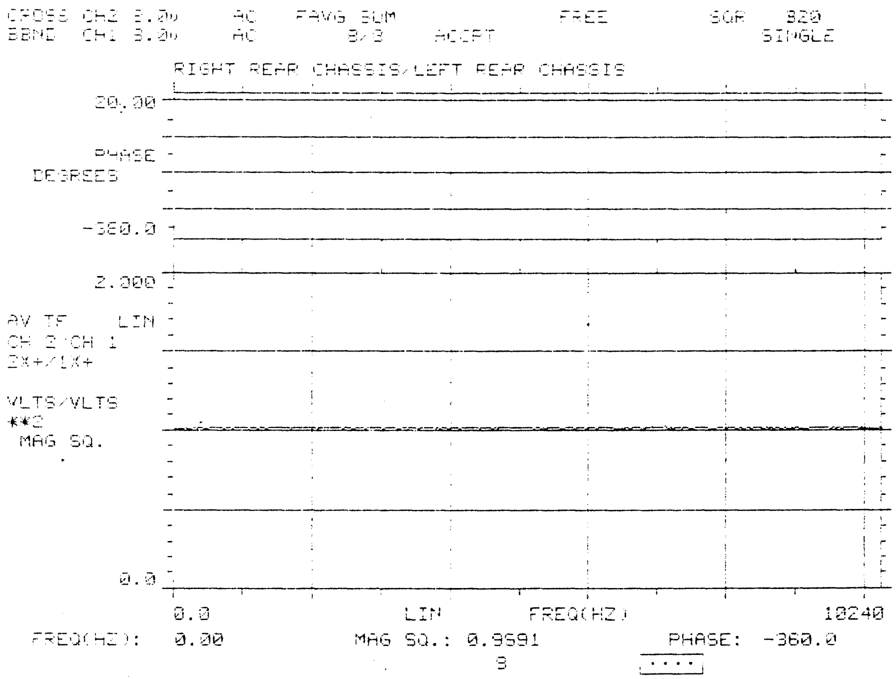

```
    Format                         function:  TRANSFER FUNCTION
                                   CPX Function
>*  1) BODE                         format:  BODE
    2) MAGNITUDE                    COH Blnk Level:  0.0
    3) PHASE
    4) REAL
    5) IMAGINARY
    6) MAGNITUDE vs. PHASE
    7) NYQUIST
    8) CIRCLE FIT


FREQ(HZ):   0.00          MAG SQ.: 0.9991          PHASE:  -360.0
                                   8
```

3.1a)

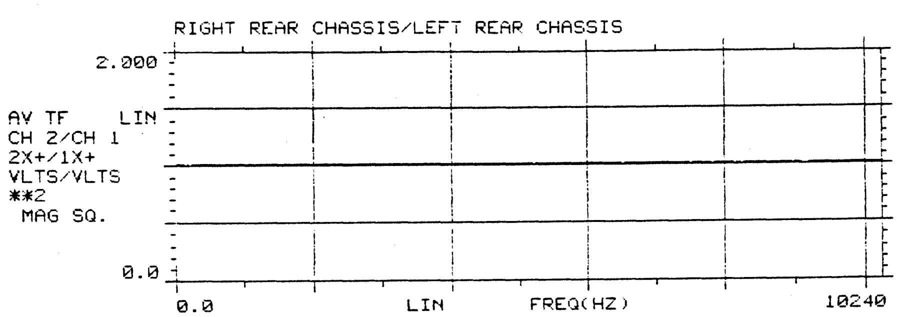



```
 ENTER COHERENCE BLANKING      function:  TRANSFER FUNCTION
 LEVEL (0.0 = OFF)             CPX Function
* 0.0                           format:  BODE
                                COH Blnk Level:  0.0
>


FREQ(HZ):   0.00          MAG SQ.: 0.9991          PHASE:  -360.0
                                   8
```

3.1b)



3.2)



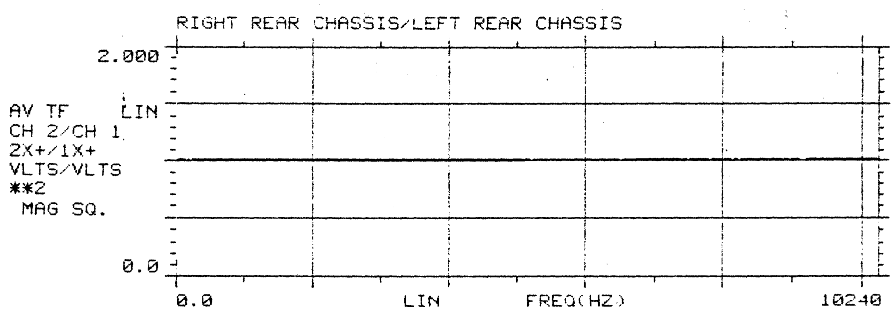
Format

1) BODE
>* 2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 MAG SQ.: 0.9991
8

3.2a)



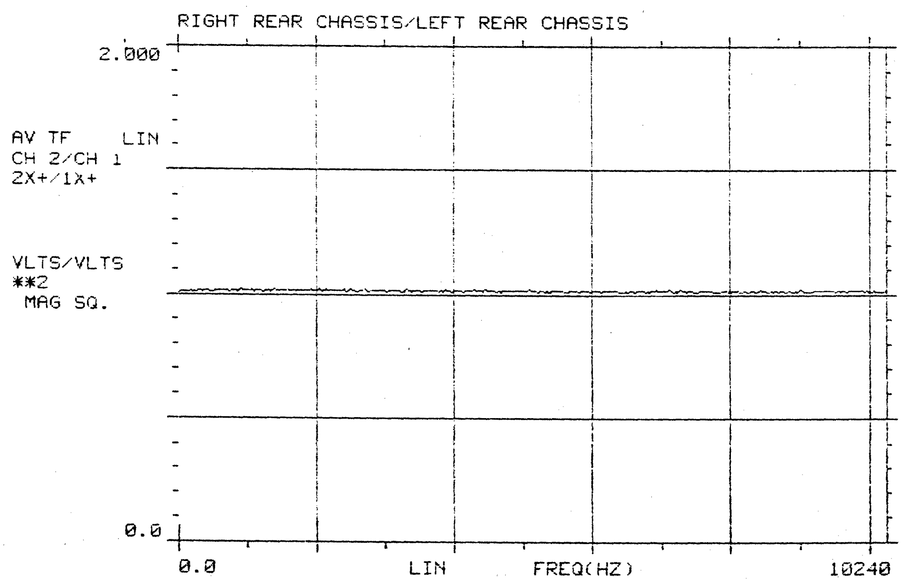
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 MAG SQ.: 0.9991
8

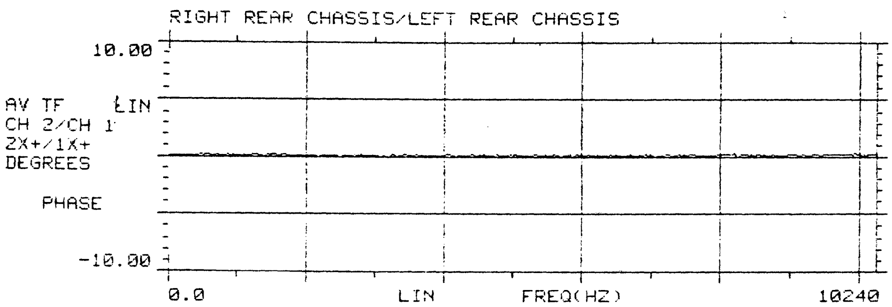
3.2b)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



FREQ(HZ): 0.00 MAG SQ.: 0.9991
8

3.3)



Format

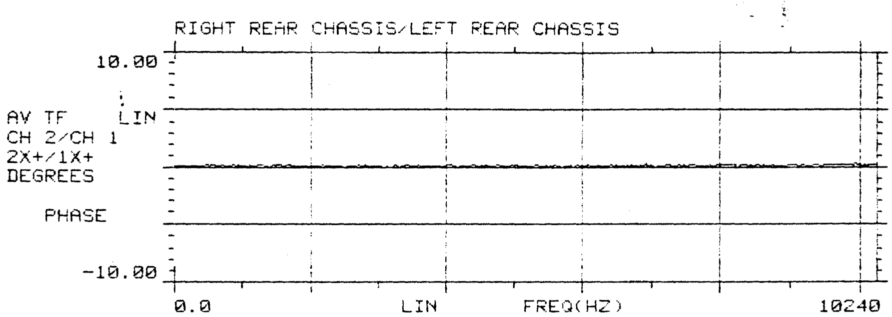
1) BODE
2) MAGNITUDE
>* 3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: TRANSFER FUNCTION
CPX Function
format: PHASE
COH Blnk Level: 0.0

FREQ(HZ): 0.00

PHASE: -360.0
8

3.3a)



ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

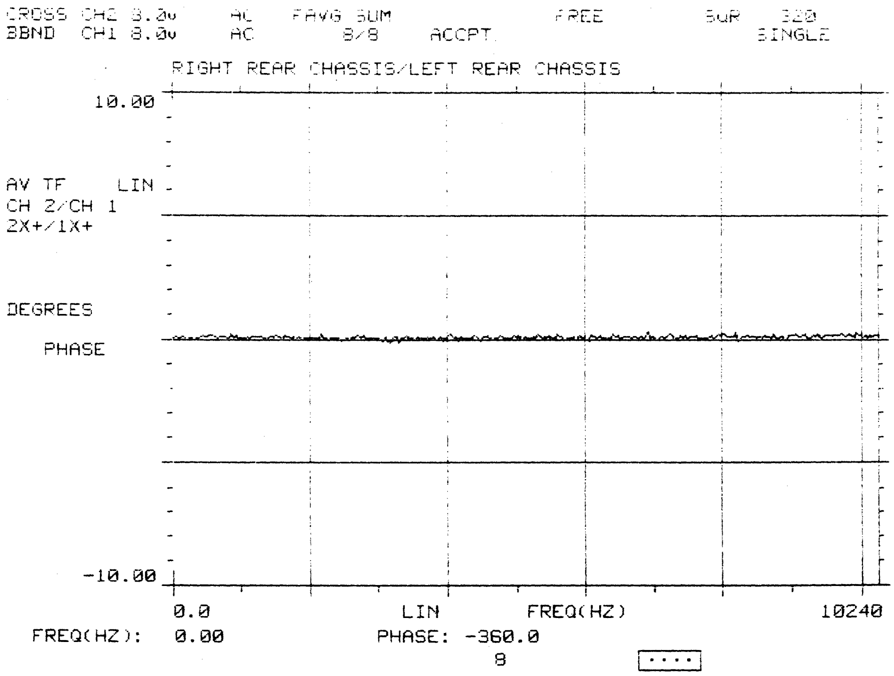
>,

function: TRANSFER FUNCTION
CPX Function
format: PHASE
COH Blnk Level: 0.0

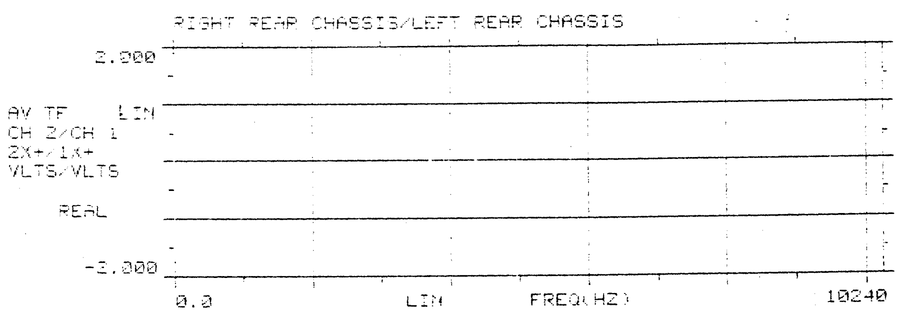
FREQ(HZ): 0.00

PHASE: -360.0
8

3.3b)



3.4)



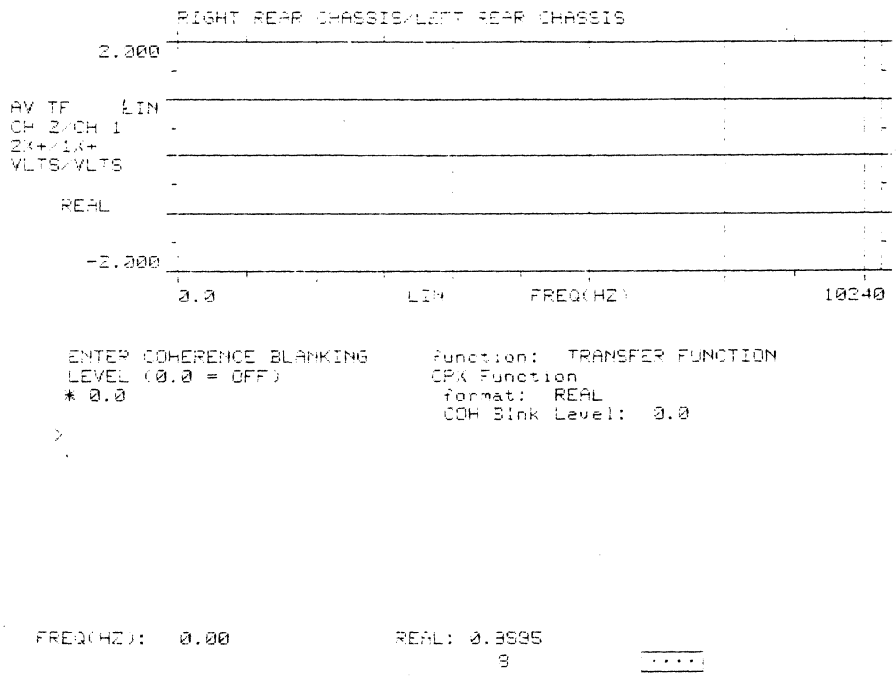
Format

1) BODE
2) MAGNITUDE
3) PHASE
>* 4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

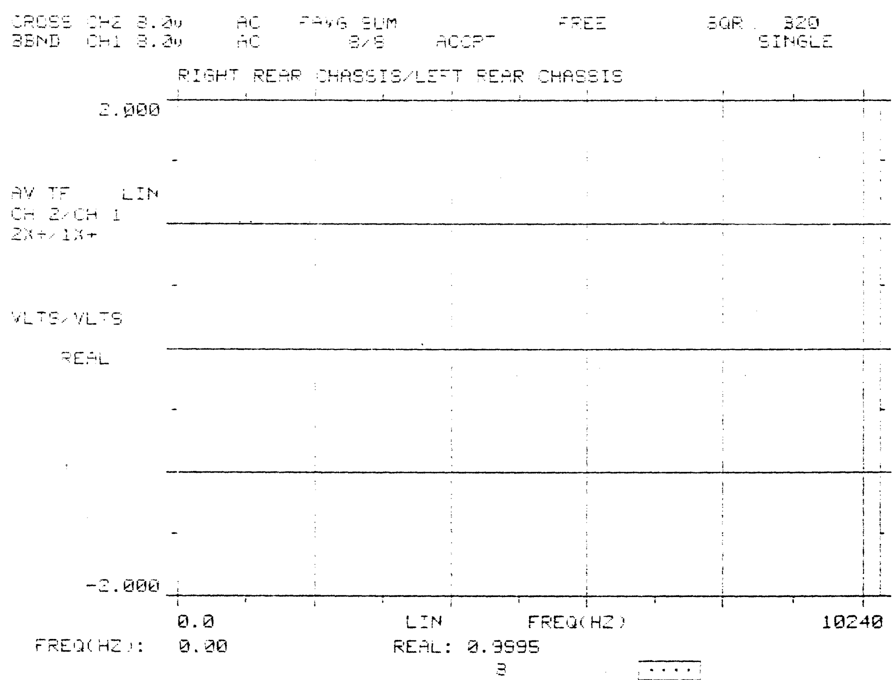
function: TRANSFER FUNCTION
CPX Function
format: REAL
COH Blnk Level: 0.0

FREQ(HZ): 0.00 REAL: 0.9995
8

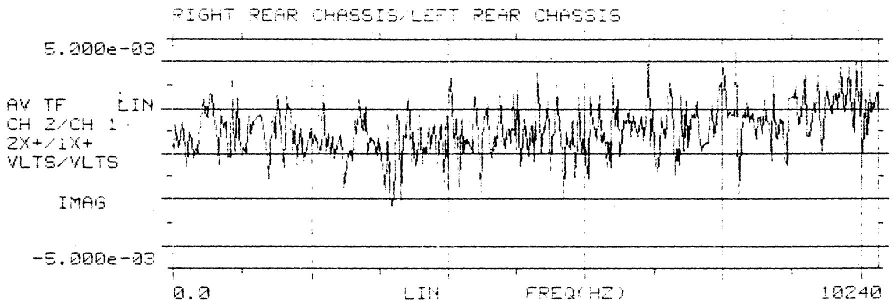
3.4a)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
REAL
-2.000
0.0
LIN
FREQ(HZ)
10240
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0
function: TRANSFER FUNCTION
CPX Function
format: REAL
COH Blnk Level: 0.0
FREQ(HZ): 0.00
REAL: 0.9995
9

3.4b)


CROSS CH2 8.0v AC FAVG SUM FREE SGR 320
BEND CH1 8.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
REAL
-2.000
0.0
LIN
FREQ(HZ)
10240
FREQ(HZ): 0.00
REAL: 0.9995
9

3.5)



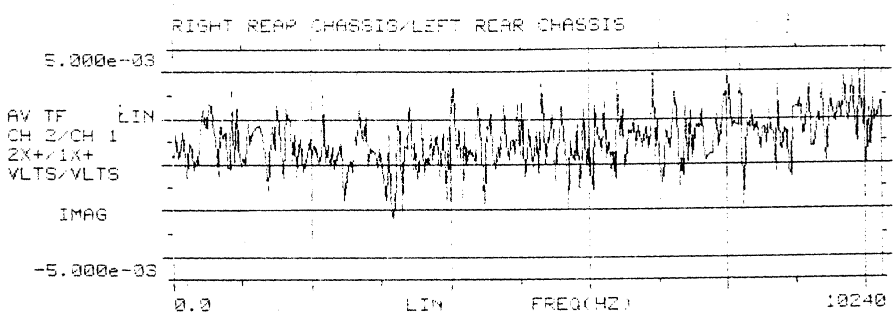
Format

1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
>* 5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: TRANSFER FUNCTION
CPX Function
format: IMAGINARY
COH Blnk Level: 0.0

FREQ(HZ): 0.00 IMAG: 3.791e-04
8

3.5a)



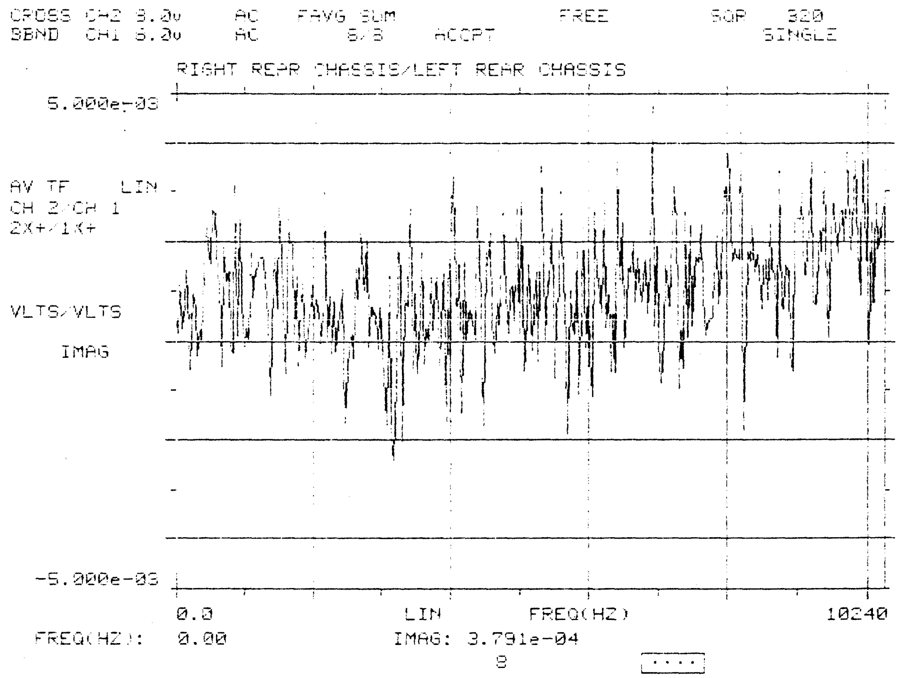
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

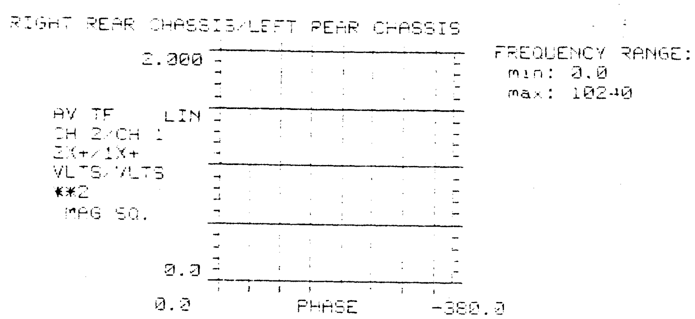
function: TRANSFER FUNCTION
CPX Function
format: IMAGINARY
COH Blnk Level: 0.0

FREQ(HZ): 0.00 IMAG: 3.791e-04
8

3.5b)



3.6)



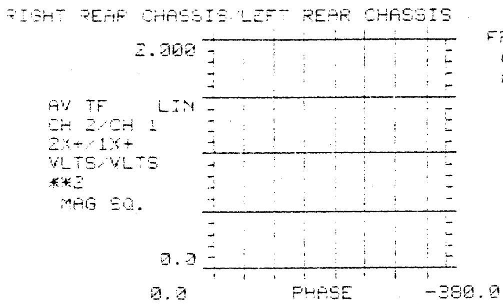
Format

1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
>* 6) MAGNITUDE vs. PHASE
7) NYQUIST
8) CIRCLE FIT

function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

3.6.1)



FREQUENCY RANGE:
min: 0.0
max: 10240

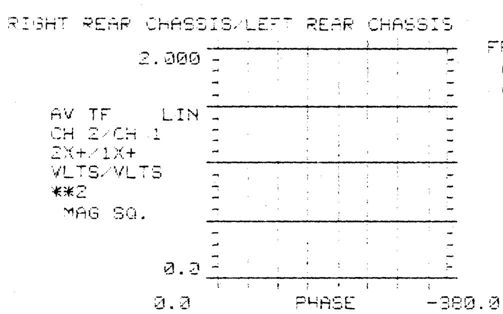
Frequency Scale

>* 1) AUTOSCALE
2) EXPAND

function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

3.6.1a)



FREQUENCY RANGE:
min: 0.0
max: 10240

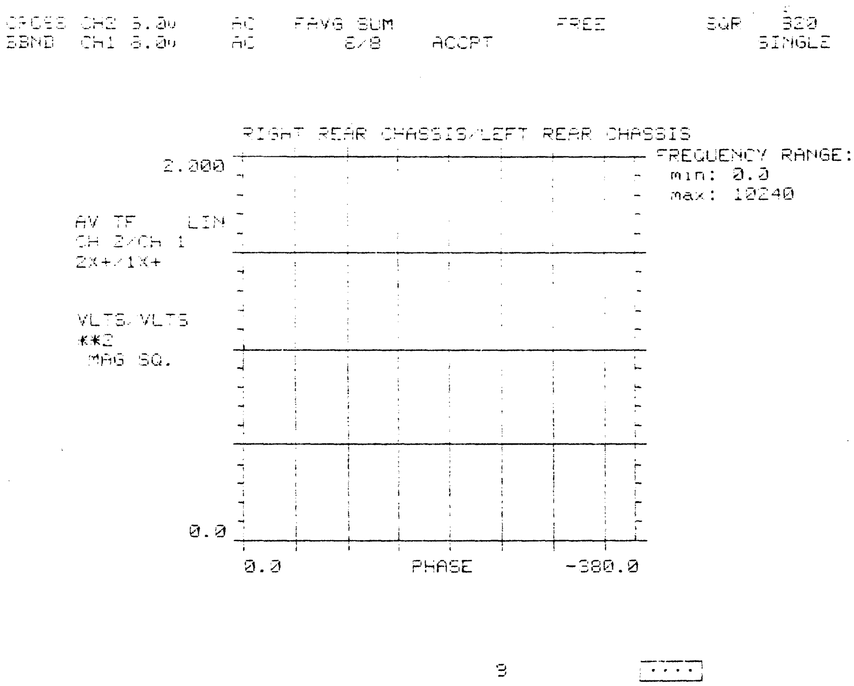
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

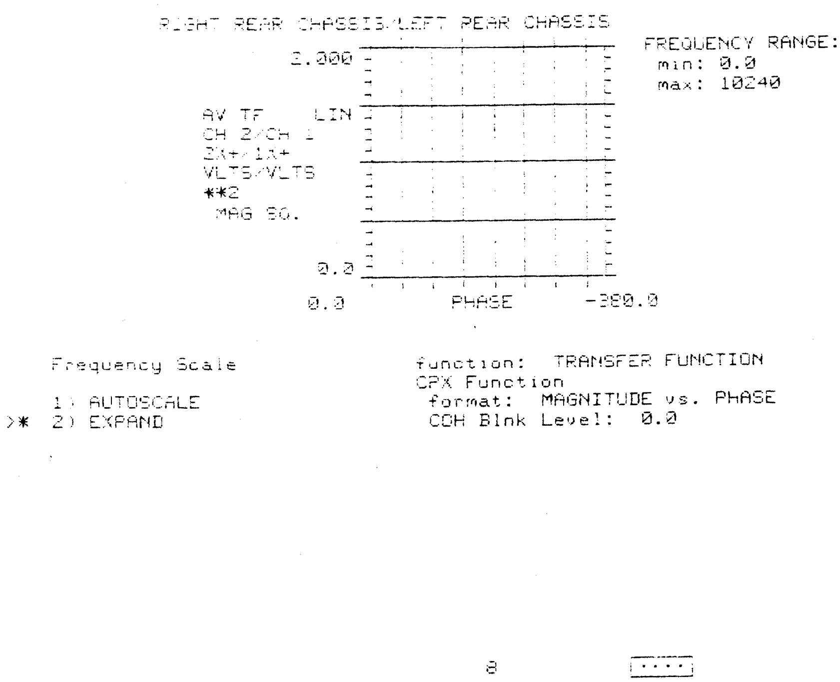
function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

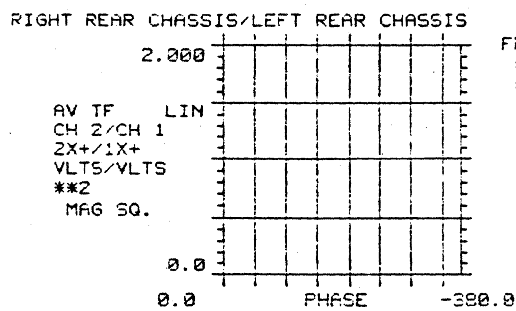
3.6.1b)


CROSS CH2 5.0v AC FAVG SUM FREE SQR 320
SBND CH1 8.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS/LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
**2
MAG SQ.
0.0
0.0
PHASE
-380.0
9

3.6.2)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
**2
MAG SQ.
0.0
0.0
PHASE
-380.0
Frequency Scale
1) AUTOSCALE
>* 2) EXPAND
function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0
8

3.6.2a)



FREQUENCY RANGE:
min: 0.0
max: 10240

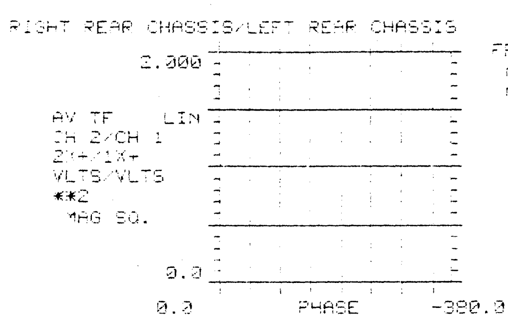
ENTER MIN,MAX for
for Frequency Expansion
* 0.0,10240

>

function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

3.6.2b)



FREQUENCY RANGE:
min: 0.0
max: 10240

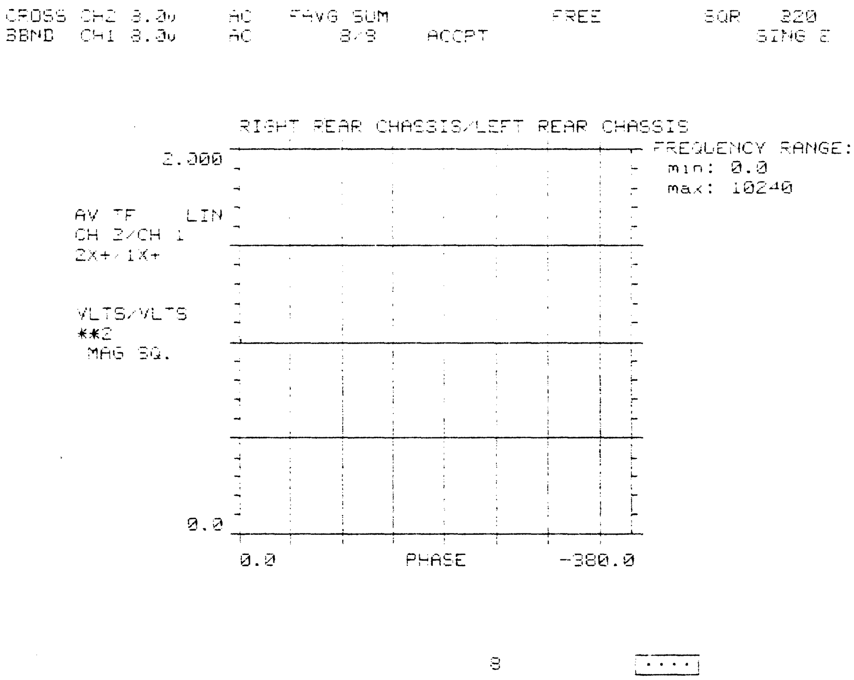
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

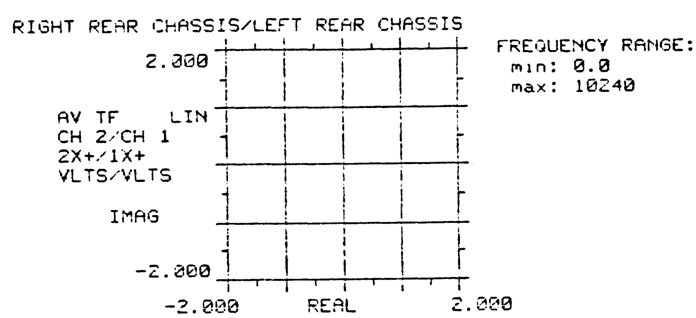
function: TRANSFER FUNCTION
CPX Function
format: MAGNITUDE vs. PHASE
COH Blnk Level: 0.0

8

3.6.2c)



3.7)



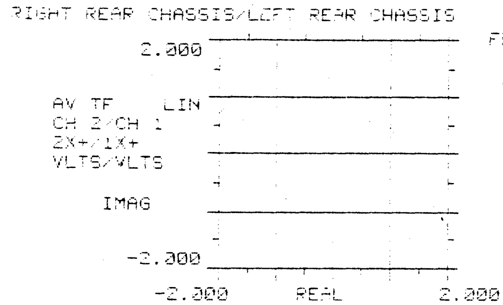
Format

1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
>* 7) NYQUIST
8) CIRCLE FIT

function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

3.7.1)



FREQUENCY RANGE:
min: 0.0
max: 10240

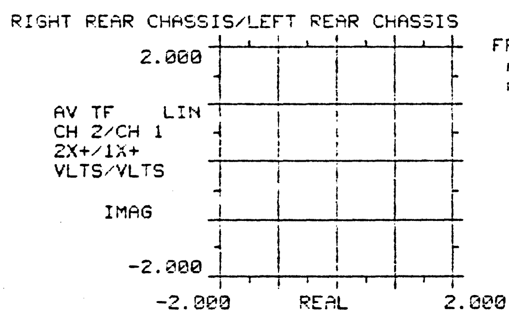
Frequency Scale

>* 1) AUTOSCALE
2) EXPAND

function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

3.7.1a)



FREQUENCY RANGE:
min: 0.0
max: 10240

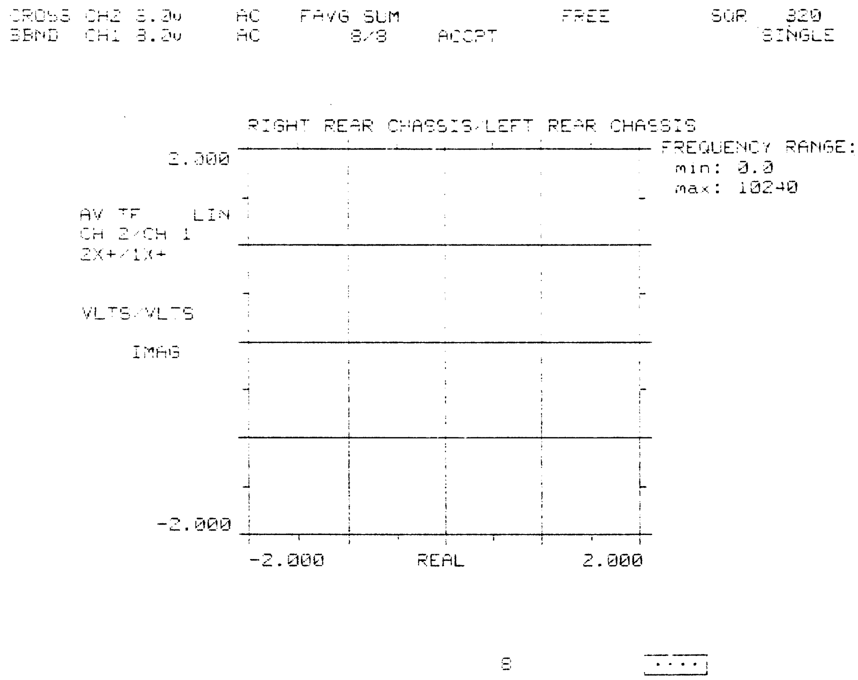
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

>

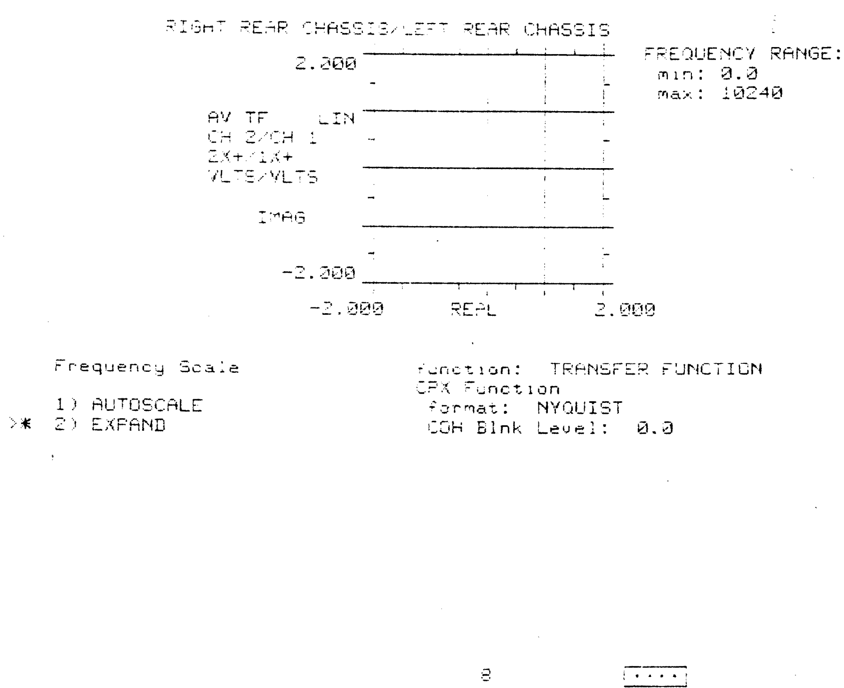
function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

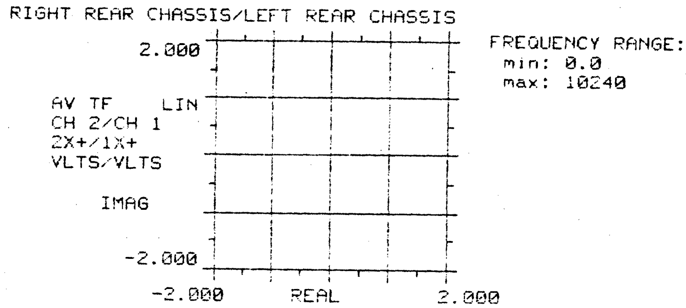
3.7.1b)


CROSS CH2 3.0v AC FAVG SUM FREE SGR 320
SBND CH1 3.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS/LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
8

3.7.2)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
FREQUENCY RANGE:
min: 0.0
max: 10240
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
Frequency Scale
1) AUTOSCALE
>* 2) EXPAND
Function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0
8

3.7.2a)



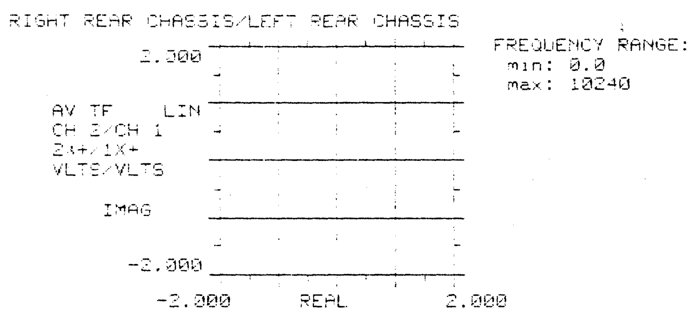
ENTER MIN, MAX for
for Frequency Expansion
* 0.0, 10240

>

function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

3.7.2b)

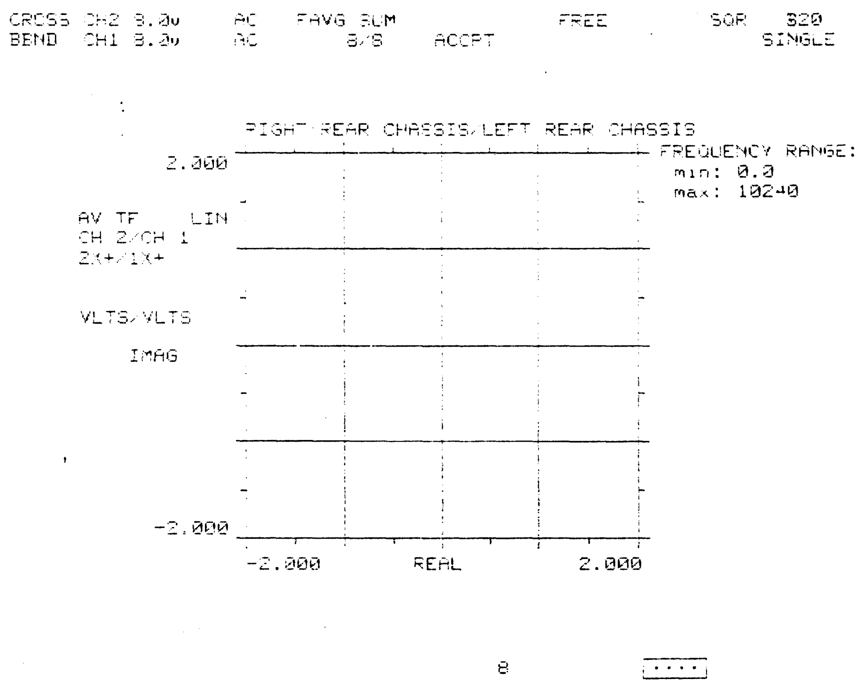


ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0

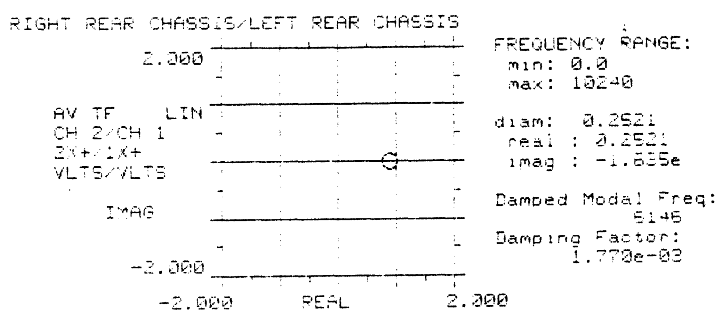
function: TRANSFER FUNCTION
CPX Function
format: NYQUIST
COH Blnk Level: 0.0

8

3.7.2c)



3.8)



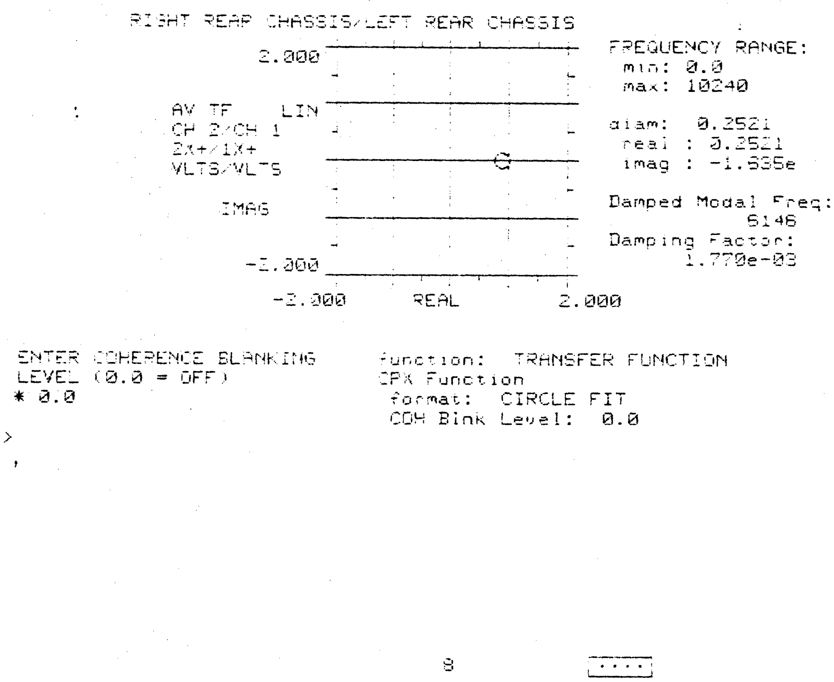
Format

1) BODE
2) MAGNITUDE
3) PHASE
4) REAL
5) IMAGINARY
6) MAGNITUDE vs. PHASE
7) NYQUIST
>* 8) CIRCLE FIT

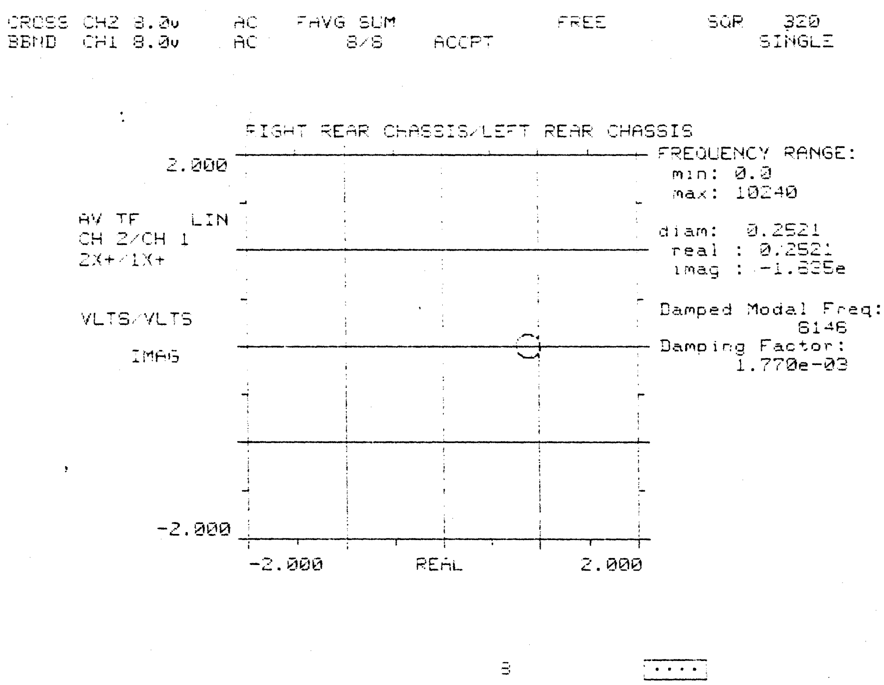
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

8

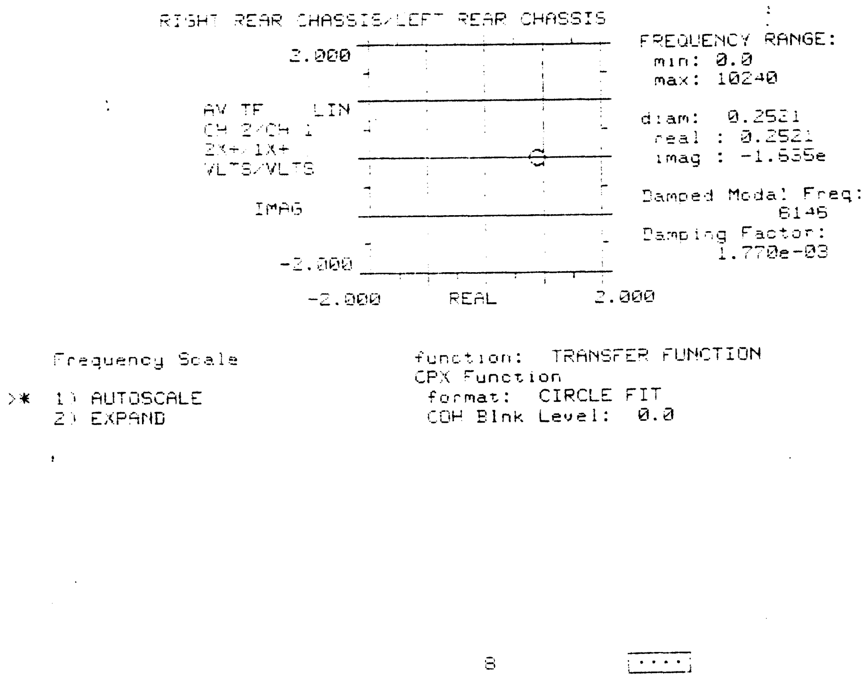
3.8a)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.635e
Damped Modal Freq:
6146
Damping Factor:
1.770e-03
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0
8

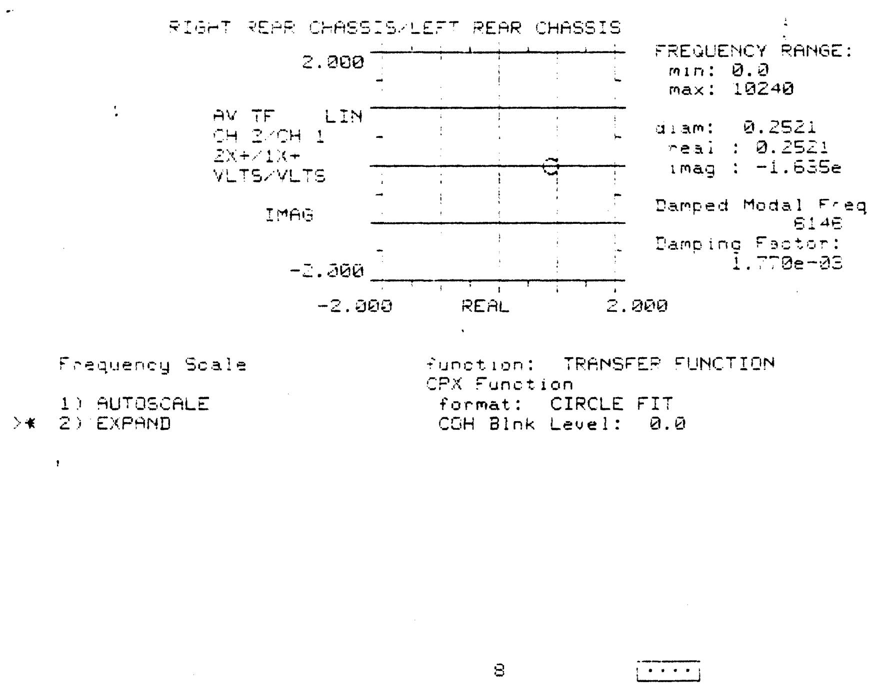
3.8b)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.635e
Damped Modal Freq:
6146
Damping Factor:
1.770e-03
8

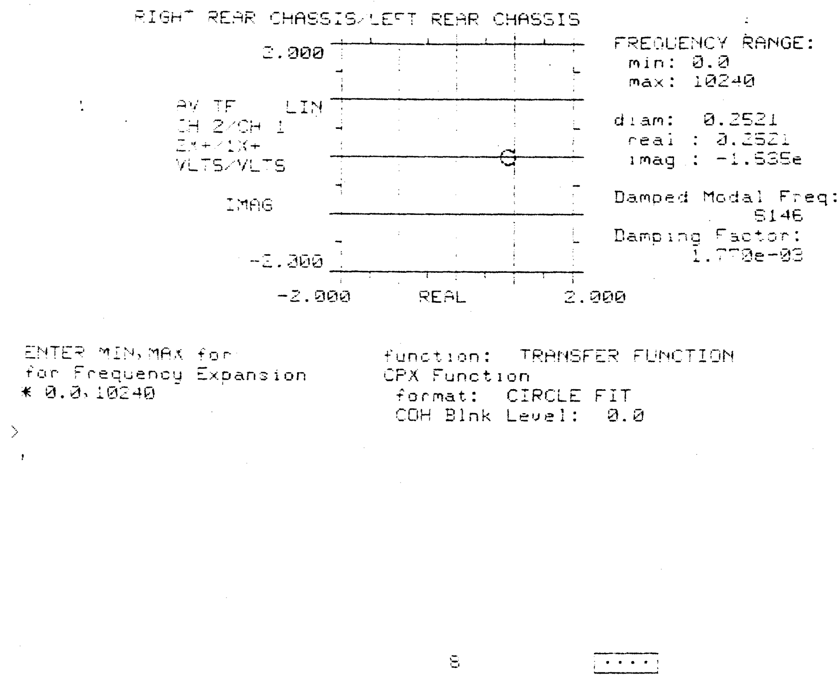
3.8.1)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.635e
Damped Modal Freq:
6146
Damping Factor:
1.770e-03
Frequency Scale
>* 1) AUTOSCALE
2) EXPAND
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0
8

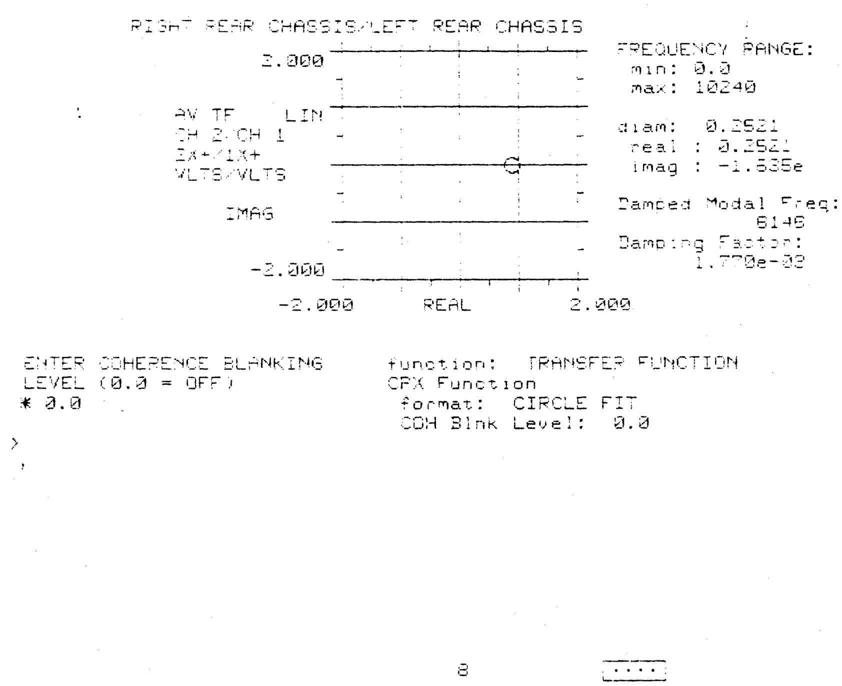
3.8.2)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
2X+/1X+
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.635e
Damped Modal Freq:
6146
Damping Factor:
1.770e-03
Frequency Scale
1) AUTOSCALE
>* 2) EXPAND
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0
8

3.8.2a)

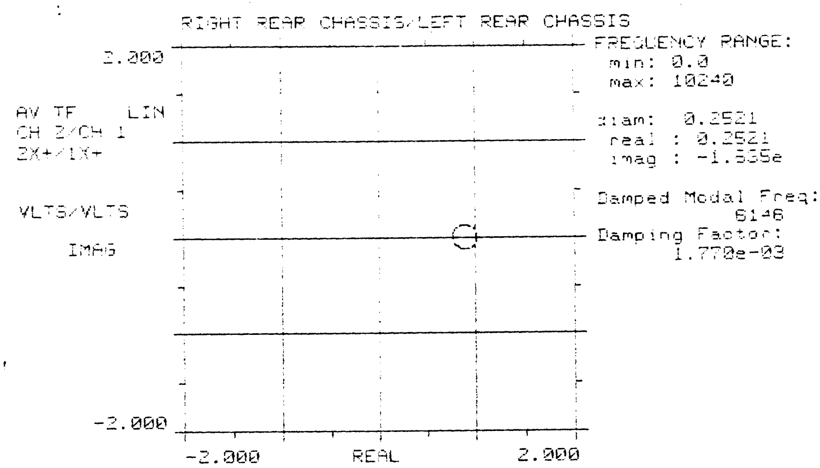

RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.535e
Damped Modal Freq:
5146
Damping Factor:
ENTER MIN,MAX for
for Frequency Expansion
* 0.0,10240
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

3.8.2b)


RIGHT REAR CHASSIS/LEFT REAR CHASSIS
2.000
AV TF LIN
CH 2/CH 1
VLTS/VLTS
IMAG
-2.000
-2.000
REAL
2.000
FREQUENCY RANGE:
min: 0.0
max: 10240
diam: 0.2521
real : 0.2521
imag : -1.535e
Damped Modal Freq:
5146
Damping Factor:
ENTER COHERENCE BLANKING
LEVEL (0.0 = OFF)
* 0.0
function: TRANSFER FUNCTION
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

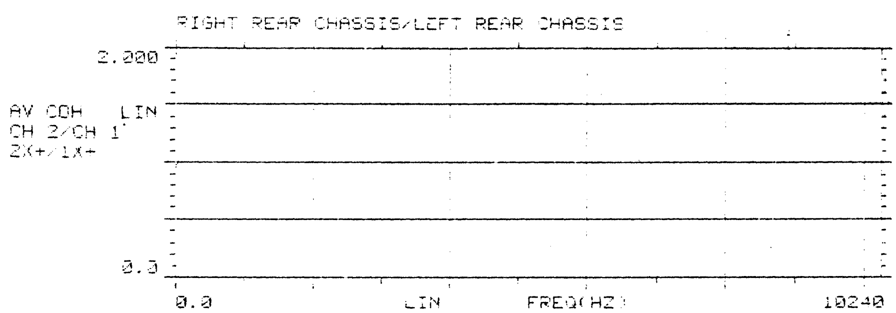
3.8.2c)

CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND CH1 8.0v AC 8/8 ACCPT SINGLE



8

4)



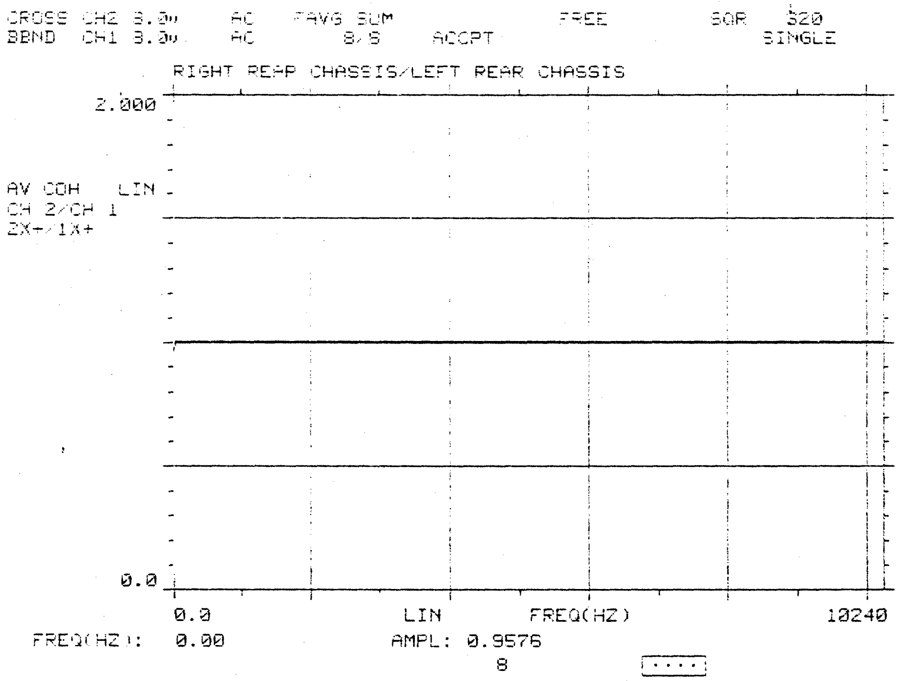
Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
>* 4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

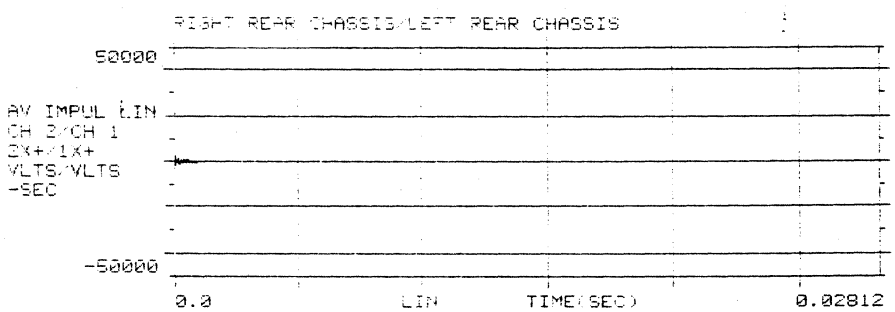
Function: COHERENCE
CPX Function
format: CIRCLE FIT
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 0.3576
8

4a)



5)



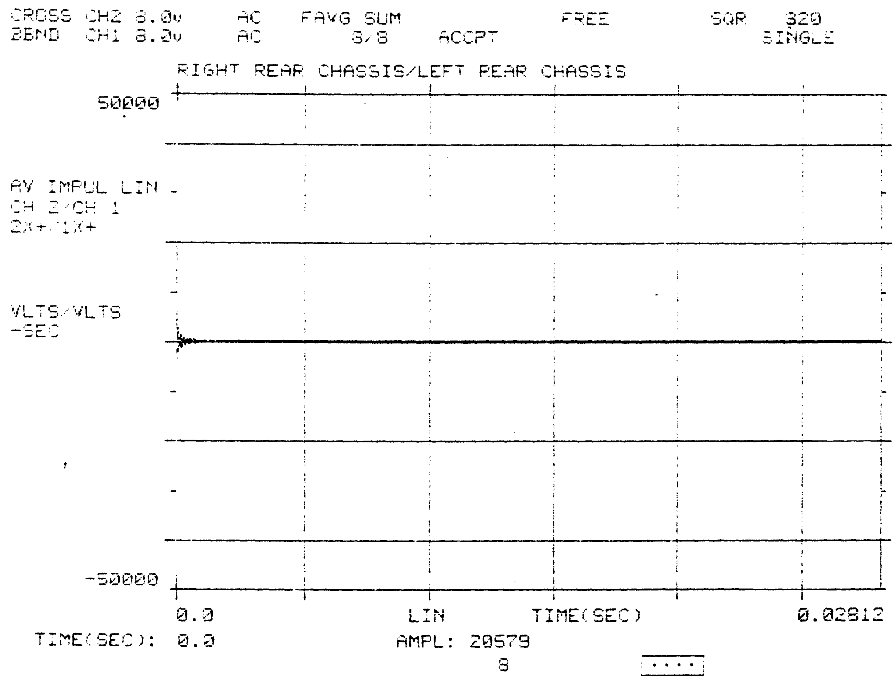
Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
>* 5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

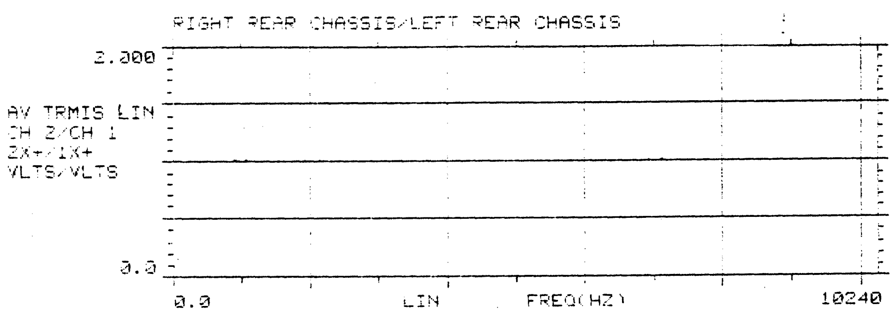
function: IMPULSE RESPONSE
CPX Function
format: REAL
COH Blnk Level: 0.0

TIME(SEC): 0.0 AMPL: 20579
8

5a)



6)



Function

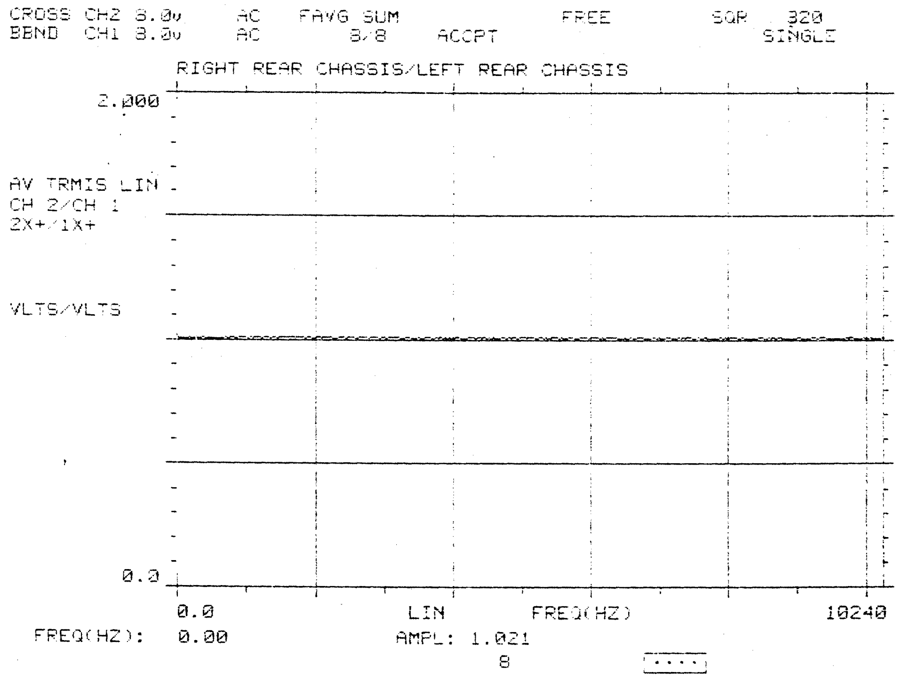
1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
>* 6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

function: TRANSMISSIBILITY
CPX Function
format: REAL
COH Blnk Level: 0.0

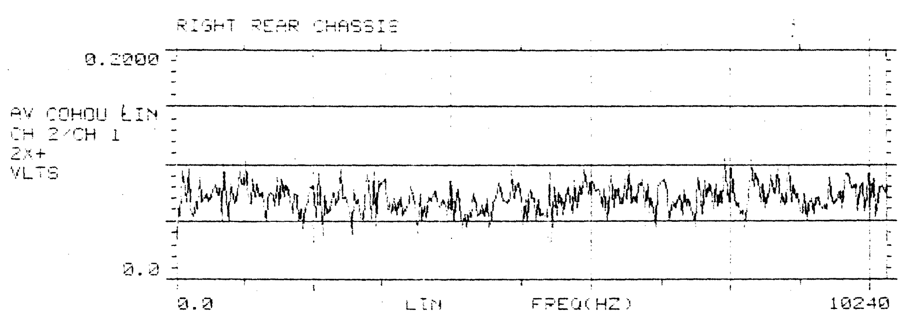
FREQ(HZ): 0.00

AMPL: 1.021
8

6a)



7)



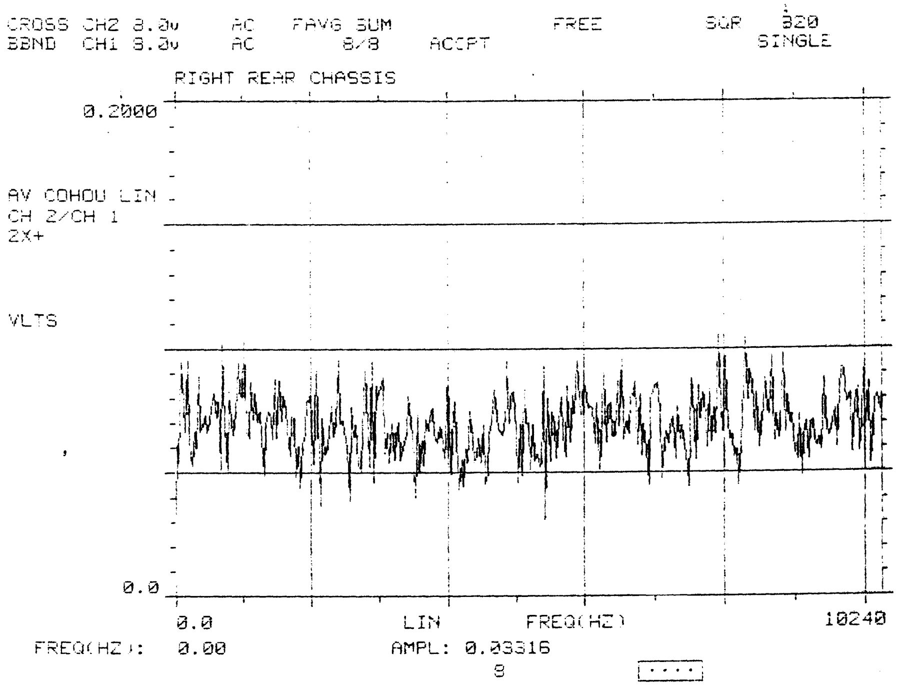
Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
>* 7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

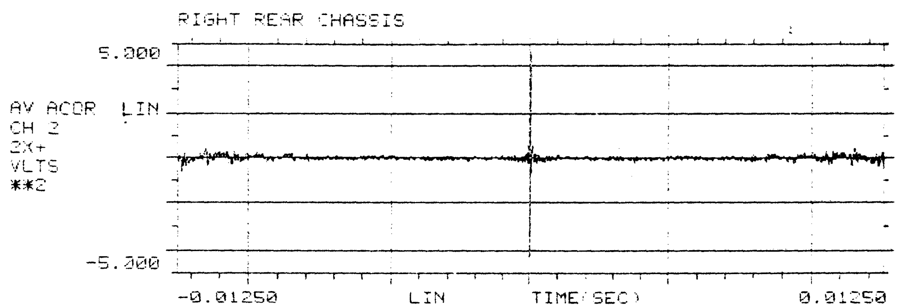
function: COHERENT OUTPUT POWER
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

FREQ(HZ): 0.00 AMPL: 0.03316
8

7a)



8)



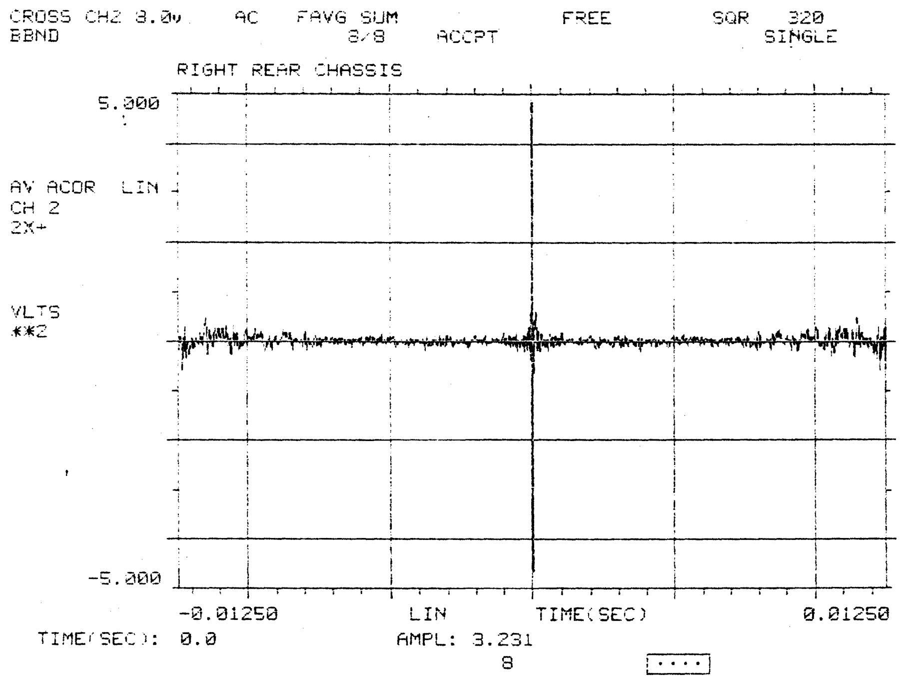
Function

1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
>* 8) AUTO CORRELATION
9) CROSS CORRELATION
10) TIME HISTORYxx

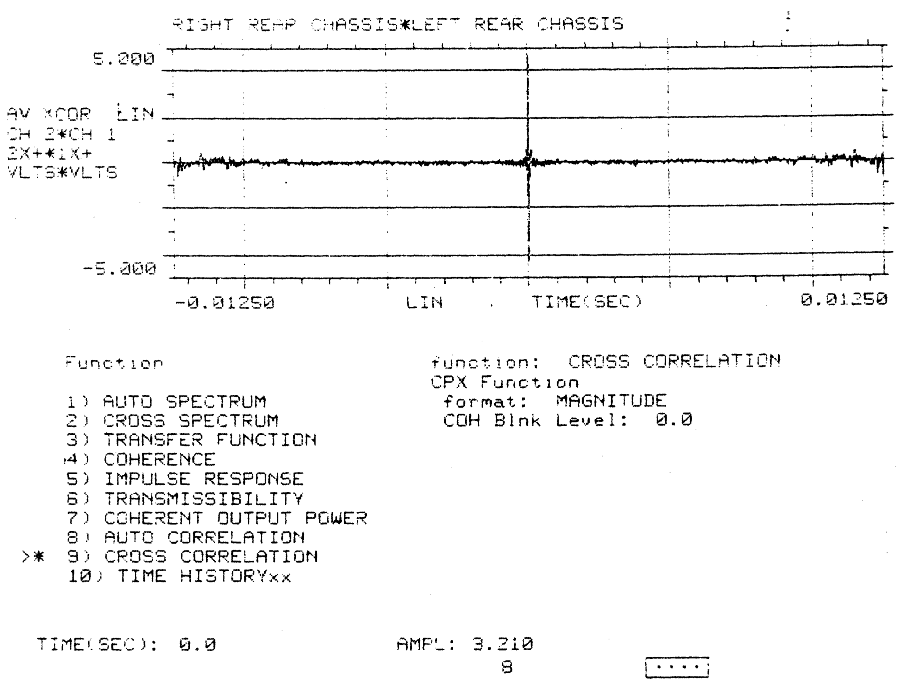
Function: AUTO CORRELATION
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0

TIME(SEC): 0.0 AMPL: 3.231
8

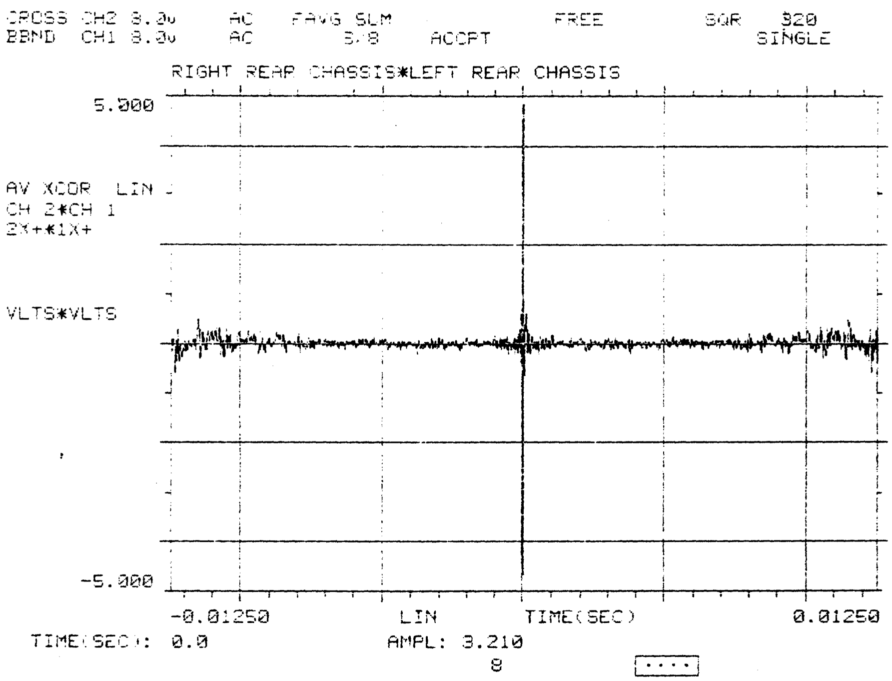
8a)


CROSS CH2 8.0v AC FAVG SUM FREE SQR 320
BBND 8/8 ACCPT SINGLE
RIGHT REAR CHASSIS
5.000
AV ACOR LIN
CH 2
2X+
VLTS
**2
-5.000
-0.01250
LIN
TIME(SEC)
0.01250
TIME(SEC): 0.0
AMPL: 3.231
8

9)


RIGHT REAR CHASSIS*LEFT REAR CHASSIS
5.000
AV XCOR LIN
CH 2*CH 1
2X+*1X+
VLTS*VLTS
-5.000
-0.01250
LIN
TIME(SEC)
0.01250
Function
1) AUTO SPECTRUM
2) CROSS SPECTRUM
3) TRANSFER FUNCTION
4) COHERENCE
5) IMPULSE RESPONSE
6) TRANSMISSIBILITY
7) COHERENT OUTPUT POWER
8) AUTO CORRELATION
>* 9) CROSS CORRELATION
10) TIME HISTORYxx
function: CROSS CORRELATION
CPX Function
format: MAGNITUDE
COH Blnk Level: 0.0
TIME(SEC): 0.0
AMPL: 3.210
8

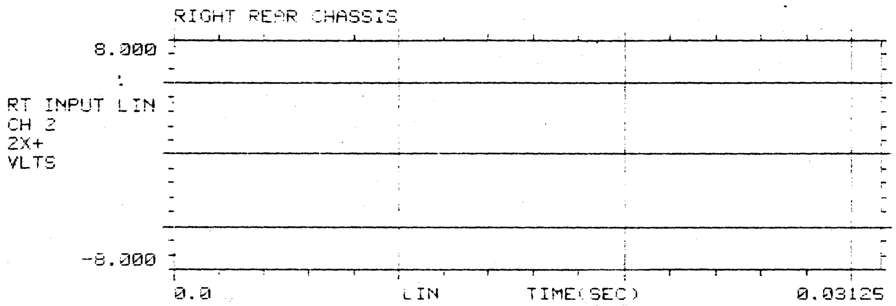
9a)



10) Not available in this version.

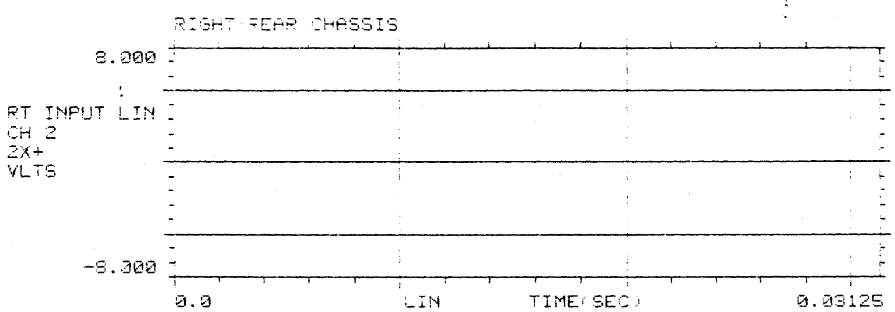
L. UNITS Pushbutton Menus and Typical Displays

1)



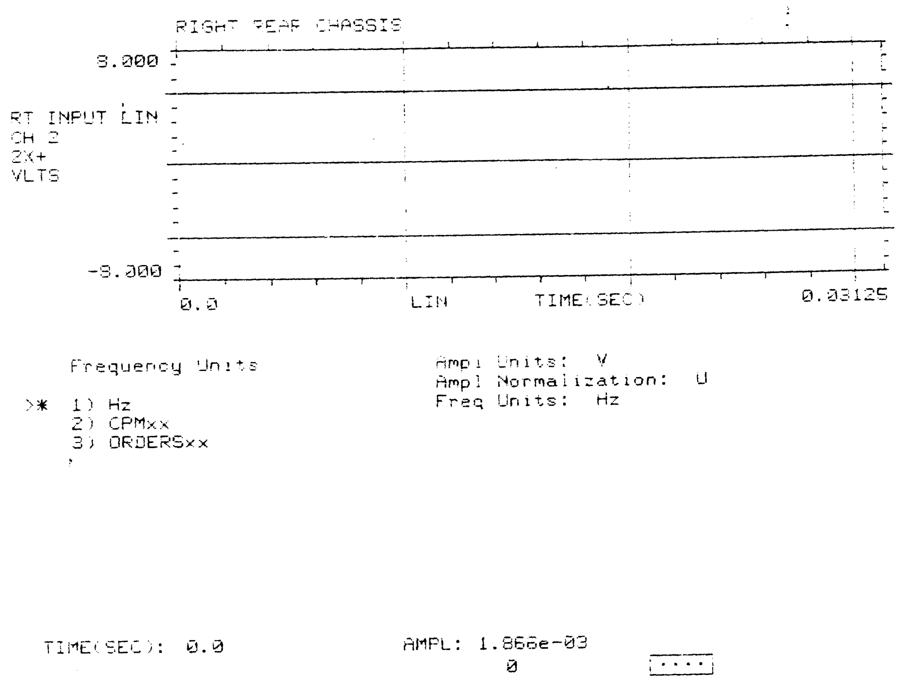

```
    Amplitude Units                    Ampl Units:  V
                                       Ampl Normalization:  U
>*  1) V                               Freq Units:  Hz
    2) EU
    3) dBV
    4) dBEU


 TIME(SEC):  0.0                 AMPL: 0.0
                                        0
```

1.1)

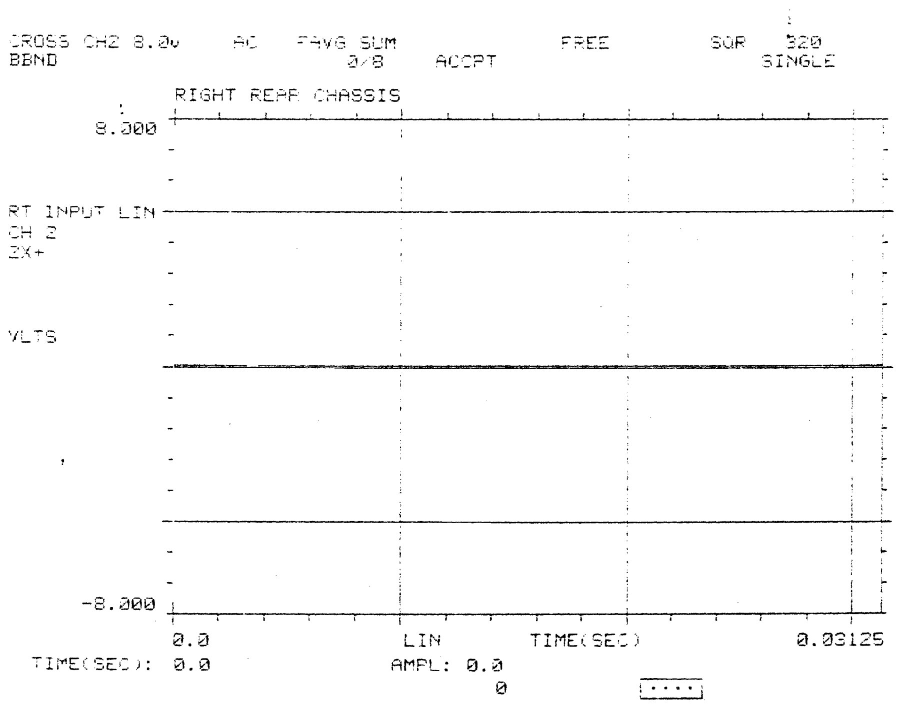



```
    Normalization                      Ampl Units:  V
                                       Ampl Normalization:  U
>*  1) U                               Freq Units:  Hz
    2) U2
    3) U2/Hz
    4) U2-SEC/ Hz


 TIME(SEC):  0.0                 AMPL: 1.866e-03
                                        0
```

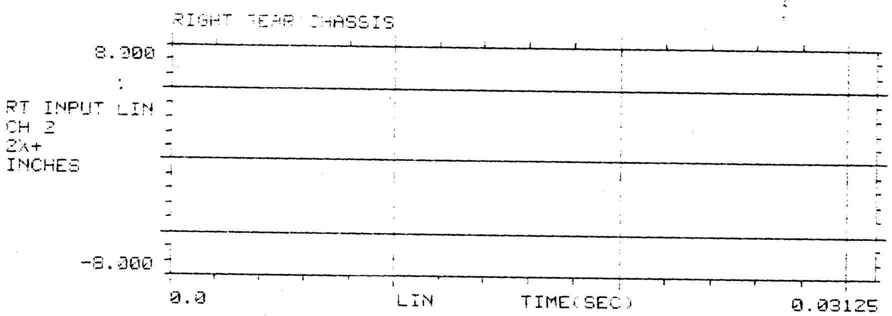
1.1.1)


RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
VLTS
-8.000
0.0
LIN
TIME(SEC)
0.03125
Frequency Units
>* 1) Hz
2) CPMxx
3) ORDERSxx
Ampl Units: V
Ampl Normalization: U
Freq Units: Hz
TIME(SEC): 0.0
AMPL: 1.866e-03
0

1.1.1a)


CROSS CH2 8.0v
BBND
AC
FAVG SUM
0/8
ACCPT
FREE
SQR
320
SINGLE
RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
VLTS
-8.000
0.0
LIN
TIME(SEC)
0.03125
TIME(SEC): 0.0
AMPL: 0.0
0

2)



Amplitude Units

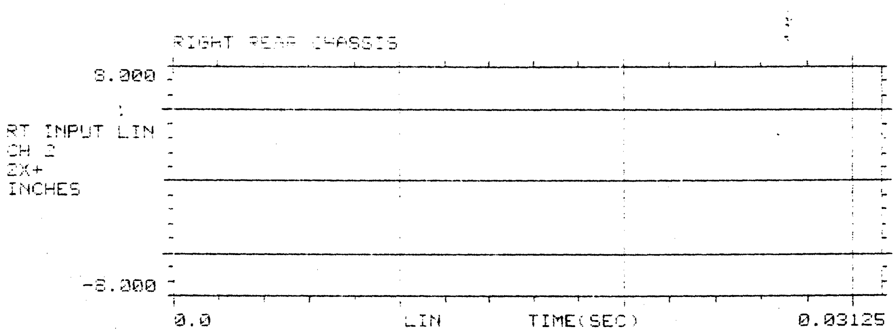
1) V
>* 2) EU
3) dBV
4) dBEU

Ampl Units: EU
Ampl Normalization: U
Freq Units: Hz

TIME(SEC):

AMPL:
0

2.1)



Normalization

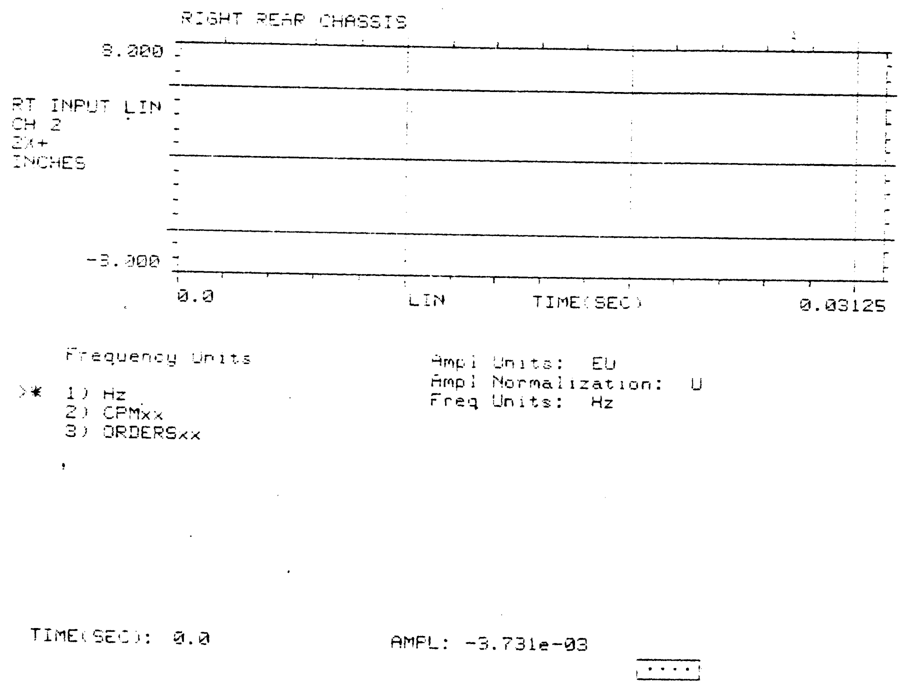
>* 1) U
2) U2
3) U2/Hz
4) U2-SEC/ Hz

Ampl Units: EU
Ampl Normalization: U
Freq Units: Hz

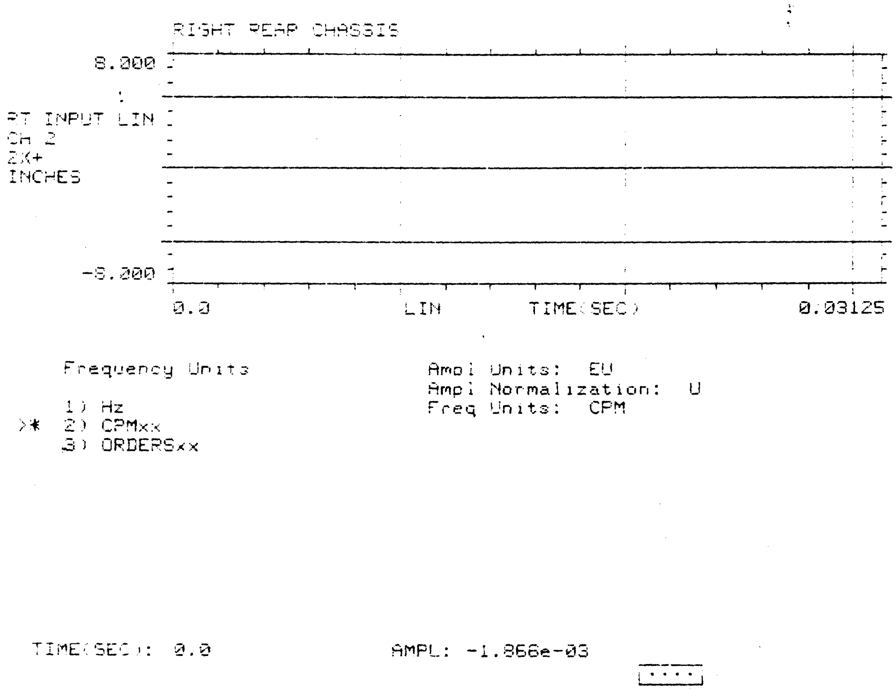
TIME(SEC): 0.0

AMPL: -1.866e-03

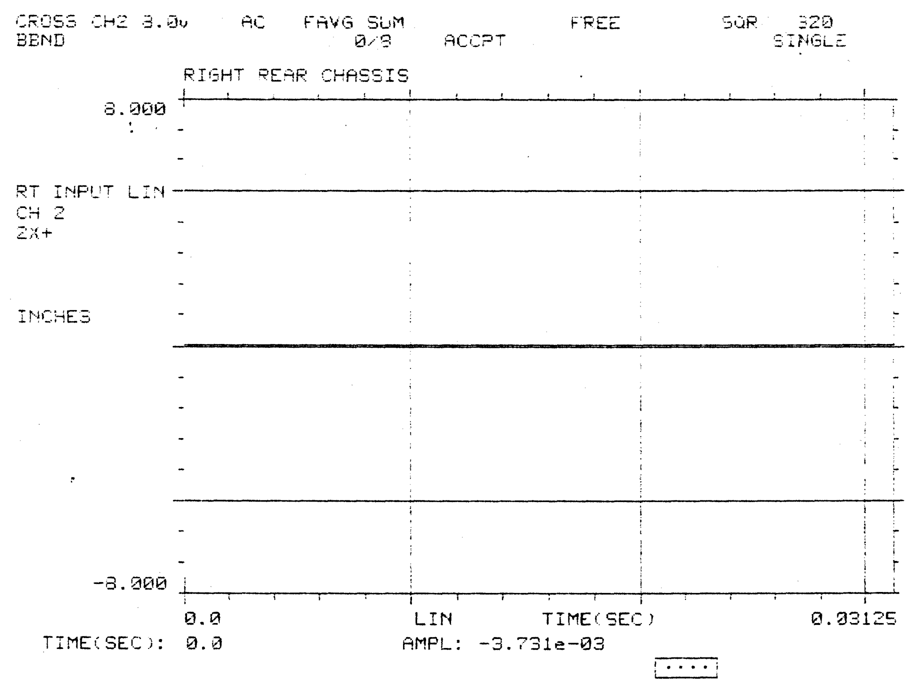
2.1.1)


RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
INCHES
-8.000
0.0
LIN
TIME(SEC)
0.03125
Frequency Units
>* 1) Hz
2) CPMxx
3) ORDERSxx
Ampl Units: EU
Ampl Normalization: U
Freq Units: Hz
TIME(SEC): 0.0
AMPL: -3.731e-03

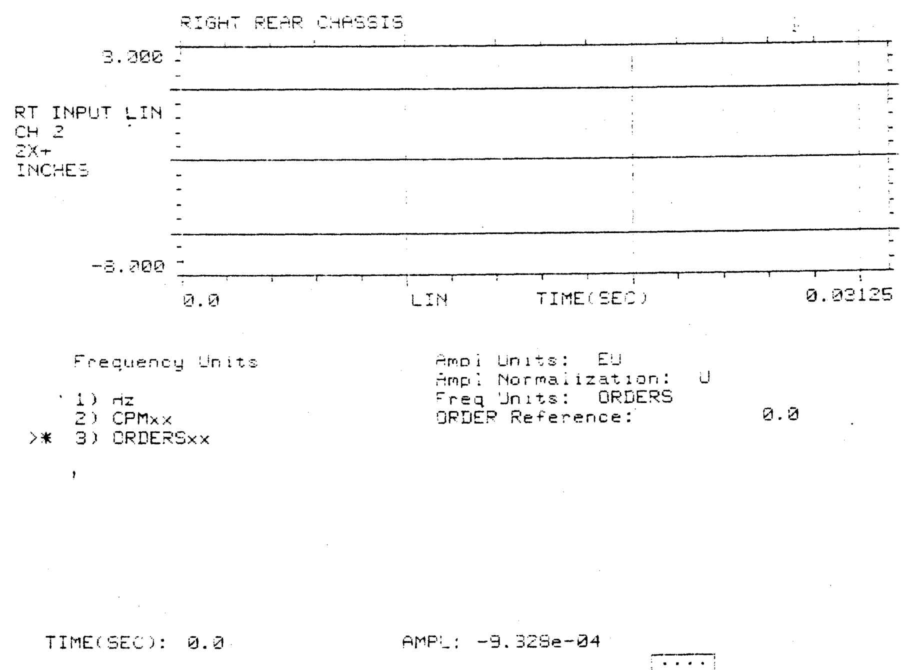
2.1.2)


RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
2X+
INCHES
-8.000
0.0
LIN
TIME(SEC)
0.03125
Frequency Units
1) Hz
>* 2) CPMxx
3) ORDERSxx
Ampl Units: EU
Ampl Normalization: U
Freq Units: CPM
TIME(SEC): 0.0
AMPL: -1.866e-03

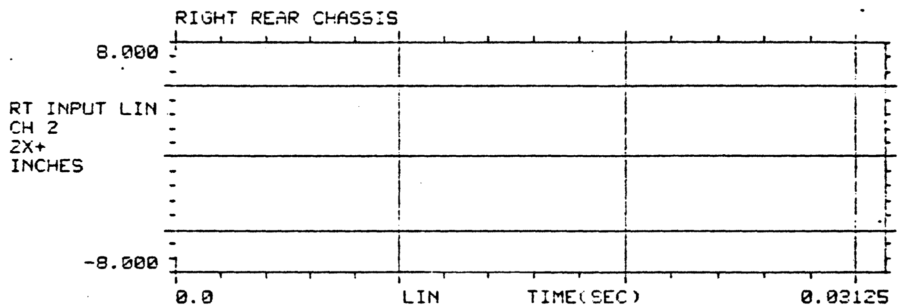
2.1.2a)


CROSS CH2 3.0v AC FAVG SUM FREE SQR 320
BEND 0/8 ACCPT SINGLE
RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
ZX+
INCHES
-8.000
0.0
LIN TIME(SEC)
0.03125
TIME(SEC): 0.0
AMPL: -3.731e-03

2.1.3)


RIGHT REAR CHASSIS
8.000
RT INPUT LIN
CH 2
ZX+
INCHES
-8.000
0.0
LIN TIME(SEC)
0.03125
Frequency Units
1) Hz
2) CPMxx
>* 3) ORDERSxx
Ampl Units: EU
Ampl Normalization: U
Freq Units: ORDERS
ORDER Reference: 0.0
TIME(SEC): 0.0
AMPL: -9.328e-04

2.1.3a)



ENTER ORDER REFERENCE
in Hz
* 0.0

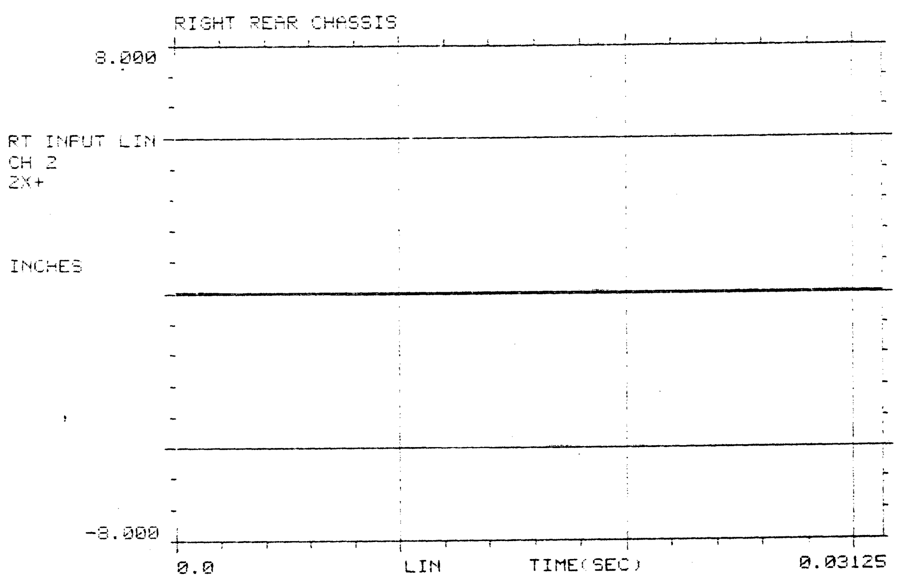
>

Ampl Units: EU
Ampl Normalization: U
Freq Units: ORDERS
ORDER Reference: 0.0

TIME(SEC): 0.0 AMPL: -2.799e-03

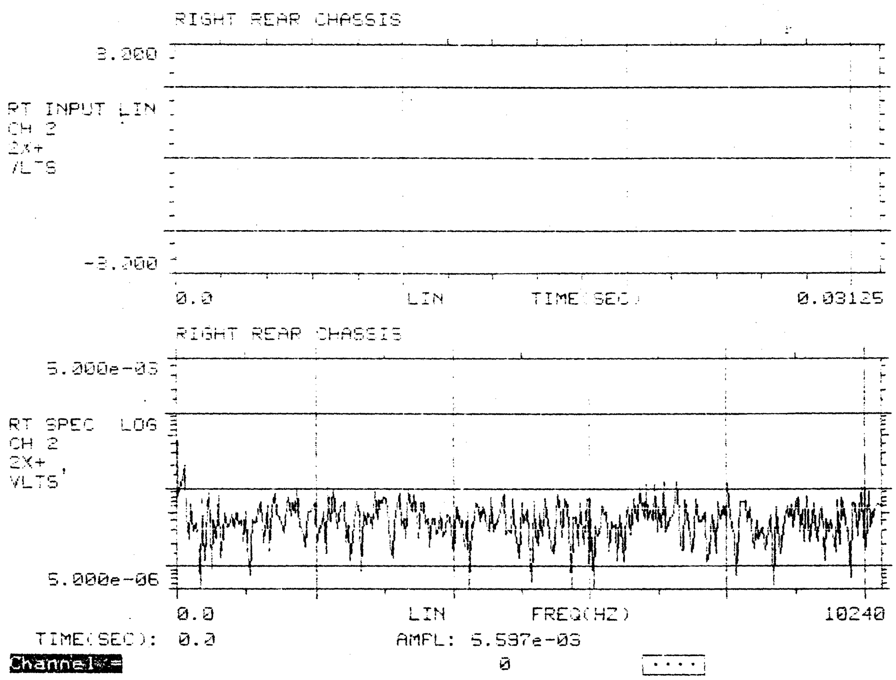
2.1.3b)

CROSS CH2 3.0 AC FAVG SUM FREE SQP 320
BBND 0/8 ACCPT SINGLE



TIME(SEC): 0.0 AMPL: 9.328e-04

M. CHANNEL Pushbutton



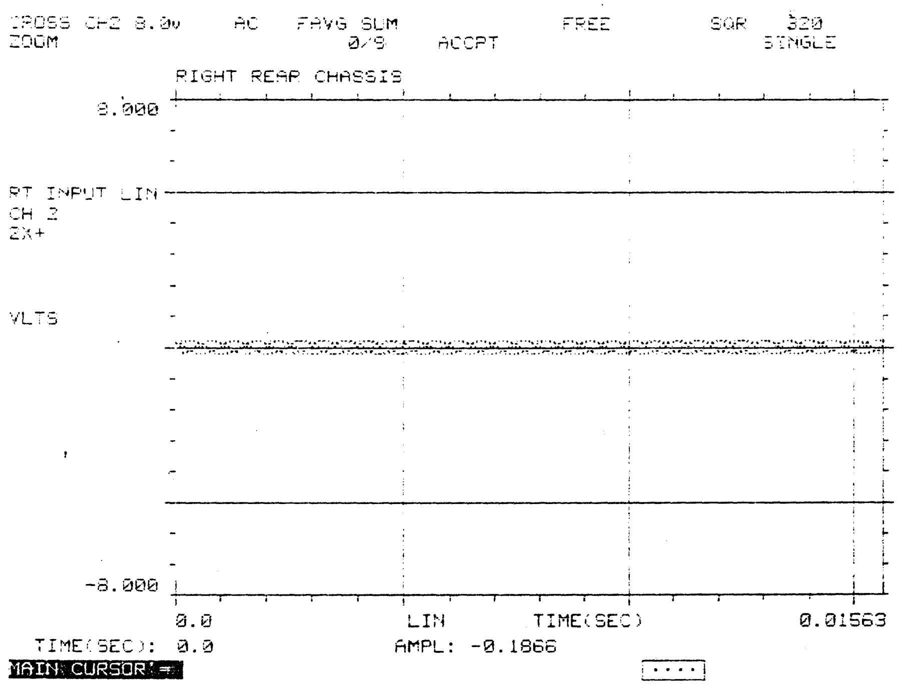
N. BLOCK MATH Pushbutton

Not available in this version.

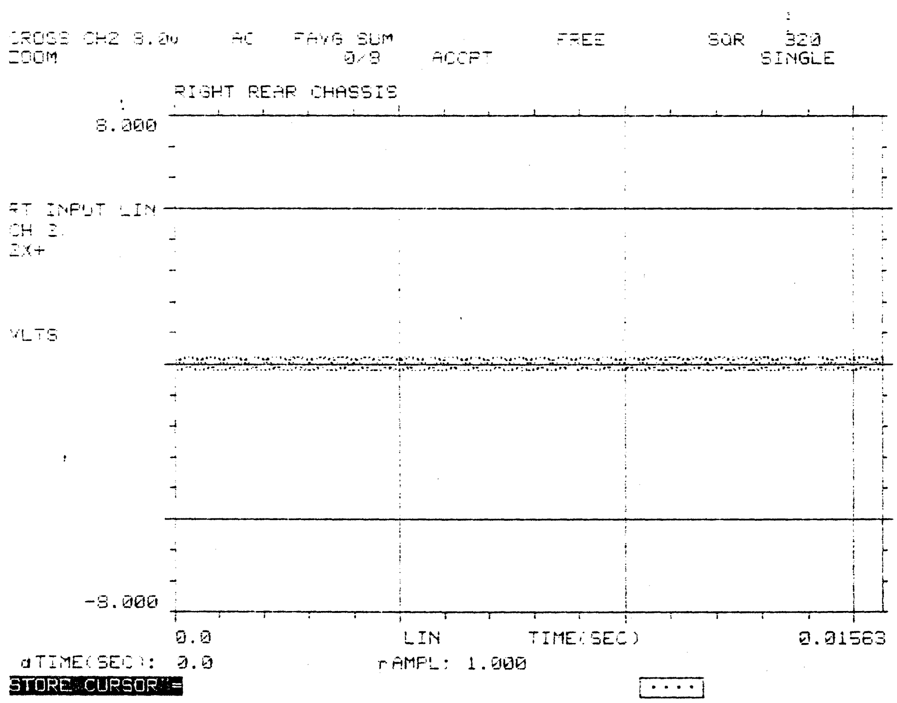
DISPLAY GROUP 3

CURSOR Group Pushbuttons, Typical Displays and Menus

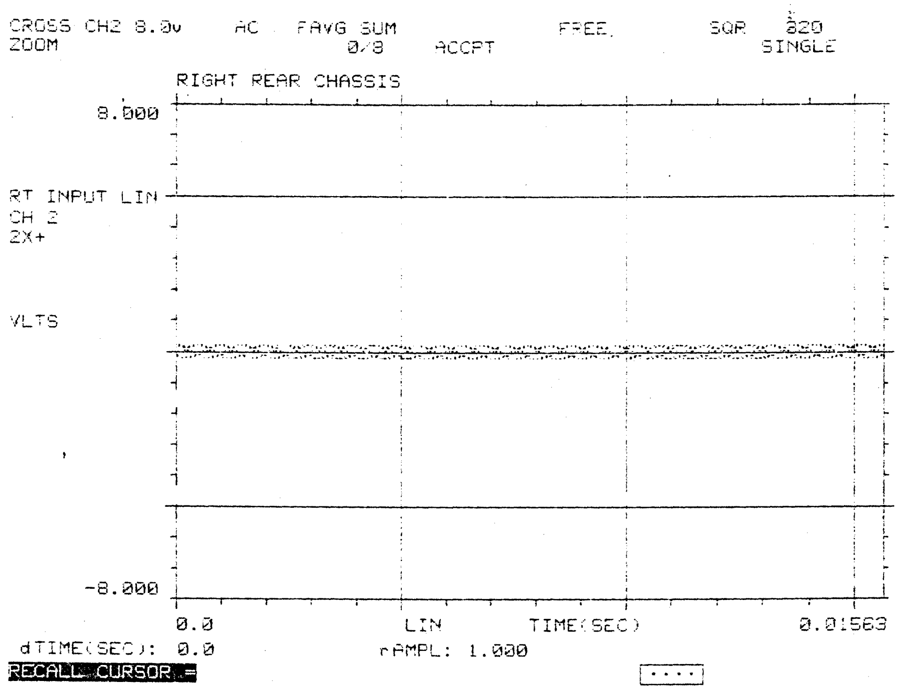
A. MAIN Pushbutton



B. STORE Pushbutton



C. RECALL Pushbutton



DISPLAY GROUP 4

STORAGE Group Pushbuttons, Typical Displays and Menus

A. TYPE Pushbutton

1)

```
    Storage Mode                        Restriction:  ANY FUNCTION
                                        Acquisition Type:  SHAKER TEST
>*  1) USER FILE                        Current File:
    2) PLOTTER SETUP                    File Status:  CLOSED
                                        File Format:  MODAL
                                        Previous Action:  create
                                        FAILED
```

1.1)

```
    Storage Grouping                    Restriction:  ANY FUNCTION
                                        Acquisition Type:  SHAKER TEST
>*  1) STORE ONLY UPPER DISPLAY         Current File:
    2) STORE ALL XFER FUNCTIONS         File Status:  CLOSED
                                        File Format:  MODAL
                                        Previous Action:  create
                                        FAILED
```

1.1.1)

```
    File Allocation                     Restriction:  ANY FUNCTION
                                        Acquisition Type:  SHAKER TEST
>*  1) SELECT EXISTING FILE             Current File:  JLL
    2) CREATE NEW FILE                  File Status:  OPEN
    3) DELETIONS FROM FILE              Label:  JLL2
    4) INCREASE SIZE OF FILExx          Size:  7 Blocks
                                        File Format:  MODAL
                                        Previous Action:  deletion
                                        FAILED
```

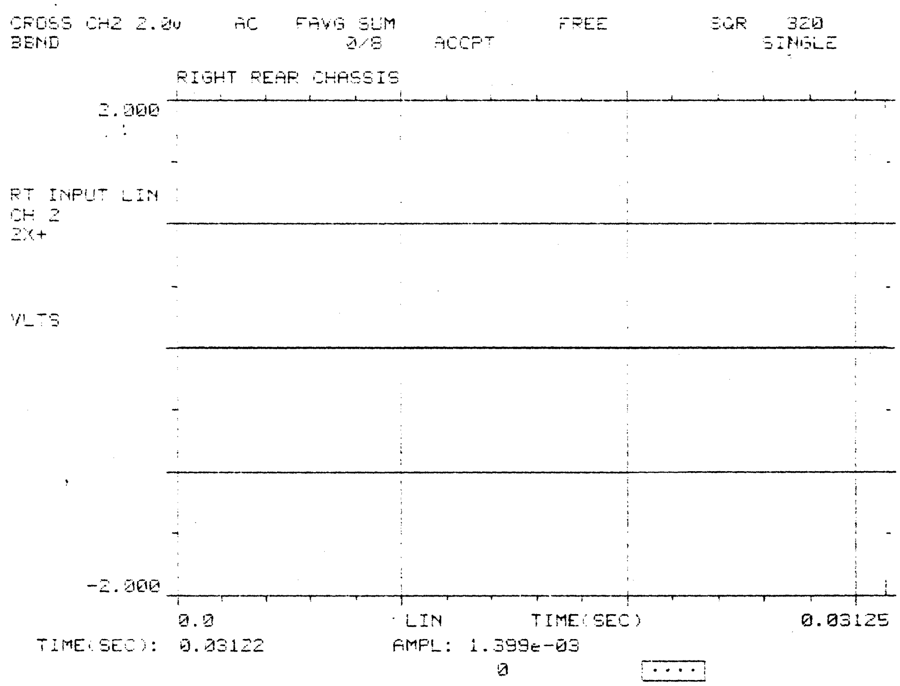
1.1.1a)

```
    ENTER FILE NAME                     Restriction:  TRANSFER FUNCTION
    Press Next                          Acquisition Type:  SHAKER TEST
    * JLL                               Current File:  JLL
                                        File Status:  OPEN
  >                                     Label:  JLL2
                                        Size:  7 Blocks
                                        File Format:  MODAL
                                        Previous Action:  open
                                        SUCCEEDED
```

1.1.1b)

```
Action SUCCEEDED            Restriction:  ANY FUNCTION
*                           Acquisition Type:  SHAKER TEST
                            Current File:  JLL
                            File Status:  OPEN
                            Label:  JLL2
                            Size:  7 Blocks
                            File Format:  MODAL
                            Previous Action:  open
                            SUCCEEDED
```

1.1.1c)



1.1.2)

```
File Allocation                  Restriction:  TRANSFER FUNCTION
                                 Acquisition Type:  SHAKER TEST
   1) SELECT EXISTING FILE       Current File:  JLL
>* 2) CREATE NEW FILE            File Status:  OPEN
   3) DELETIONS FROM FILE        Label:  JLL2
   4) INCREASE SIZE OF FILExx    Size:  7 Blocks
                                 File Format:  MODAL
                                 Previous Action:  open
                                 SUCCEEDED
```

1.1.2a)

```
ENTER FILE NAME              Restriction:  TRANSFER FUNCTION
Press Next                   Acquisition Type:  SHAKER TEST
* LEG                        Current File:  LEG
                             File Status:  CLOSED
>                            File Format:  MODAL
                             Previous Action:  open
                             SUCCEEDED
```

1.1.2b)

```
ENTER FILE LABEL             Restriction:  TRANSFER FUNCTION
*                            Acquisition Type:  SHAKER TEST
                             Current File:  LEG
>                            File Status:  CLOSED
                             File Format:  MODAL
                             Previous Action:  open
                             SUCCEEDED
```

1.1.2.1)

```
File Format                  Restriction:  TRANSFER FUNCTION
                             Acquisition Type:  SHAKER TEST
>* 1) MODAL                  Current File:  LEG
   2) STANDARDxx             File Status:  CLOSED
                             File Format:  MODAL
                             Previous Action:  open
                             SUCCEEDED
```

1.1.2.1a)

```
ENTER # of Function Records  Restriction:  TRANSFER FUNCTION
* 0                          Acquisition Type:  SHAKER TEST
                             Current File:  LEG
>                            File Status:  CLOSED
                             File Format:  MODAL
                             Previous Action:  open
                             SUCCEEDED
```

1.1.2.1b)

```
Attempting to Open File
*

,
```

```
Restriction:  TRANSFER FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEG
File Status:  CLOSED
File Format:  MODAL
Previous Action:  open
SUCCEEDED
```

1.1.2.1c)

```
Action SUCCEEDED
*

,
```

```
Restriction:  TRANSFER FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEG
File Status:  OPEN
Label:  SHILOH
Size:  7 Blocks
File Format:  MODAL
Previous Action:  create
SUCCEEDED
```

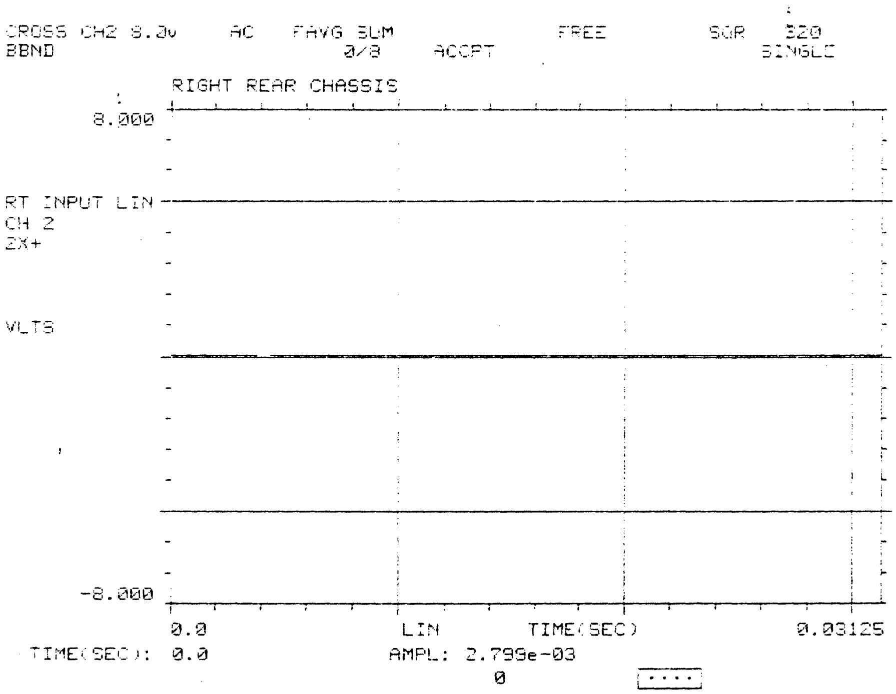
1.1.2.1d)

```
Previous Action FAILED
*

,
```

```
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  create
FAILED
```

```
 TIME(SEC):  0.03122          AMPL: 0.01283
no file name given                  0          [....]
```

1.1.2.1e)



1.2)

```
Storage Restriction

  1) TRANSFER FUNCTION ONLY
>* 2) ANY DISPLAYED FUNCTION
```

```
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  JLL
File Status:  OPEN
Label:  JLL2
Size:  7 Blocks
File Format:  MODAL
Previous Action:  create
SUCCEEDED
```

1.2.1)

```
Acquisition Type

>*  1) SHAKER TEST
    2) IMPACT TEST
```

```
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  JLL
File Status:  OPEN
Label:  JLL2
Size:  7 Blocks
File Format:  MODAL
Previous Action:  create
SUCCEEDED
```

1.2.2)

```
    File Allocation                   Restriction:  ANY FUNCTION
                                      Acquisition Type:  SHAKER TEST
    1) SELECT EXISTING FILE           Current File:  JLL
>*  2) CREATE NEW FILE                File Status:  OPEN
    3) DELETIONS FROM FILE            Label:  JLL2
    4) INCREASE SIZE OF FILExx        Size:  7 Blocks
                                      File Format:  MODAL
                                      Previous Action:  create
                                      SUCCEEDED
```

1.2.2a)

```
    ENTER FILE NAME                   Restriction:  ANY FUNCTION
    Press Next                        Acquisition Type:  SHAKER TEST
    * JLL                             Current File:  JLL
                                      File Status:  OPEN
    >                                 Label:  JLL2
                                      Size:  7 Blocks
                                      File Format:  MODAL
                                      Previous Action:  create
                                      SUCCEEDED
```

1.2.2b)

```
    ENTER FILE LABEL                  Restriction:  ANY FUNCTION
    * SHILOH                          Acquisition Type:  SHAKER TEST
                                      Current File:  JLL
    >                                 File Status:  OPEN
                                      Label:  SHILOH
                                      Size:  7 Blocks
                                      File Format:  MODAL
                                      Previous Action:  create
                                      SUCCEEDED
```

1.2.2.1)

```
    File Format                       Restriction:  ANY FUNCTION
                                      Acquisition Type:  SHAKER TEST
>*  1) MODAL                          Current File:  JLL
    2) STANDARDxx                     File Status:  OPEN
                                      Label:  SHILOH
                                      Size:  7 Blocks
                                      File Format:  MODAL
                                      Previous Action:  create
                                      SUCCEEDED
```

1.2.2.1a)

```
ENTER # of Function Records   Restriction:  ANY FUNCTION
* 1                           Acquisition Type:  SHAKER TEST
                              Current File:  JLL
>                             File Status:  OPEN
                              Label:  SHILOH
,                             Size:  7 Blocks
                              File Format:  MODAL
                              Previous Action:  create
                              SUCCEEDED
```

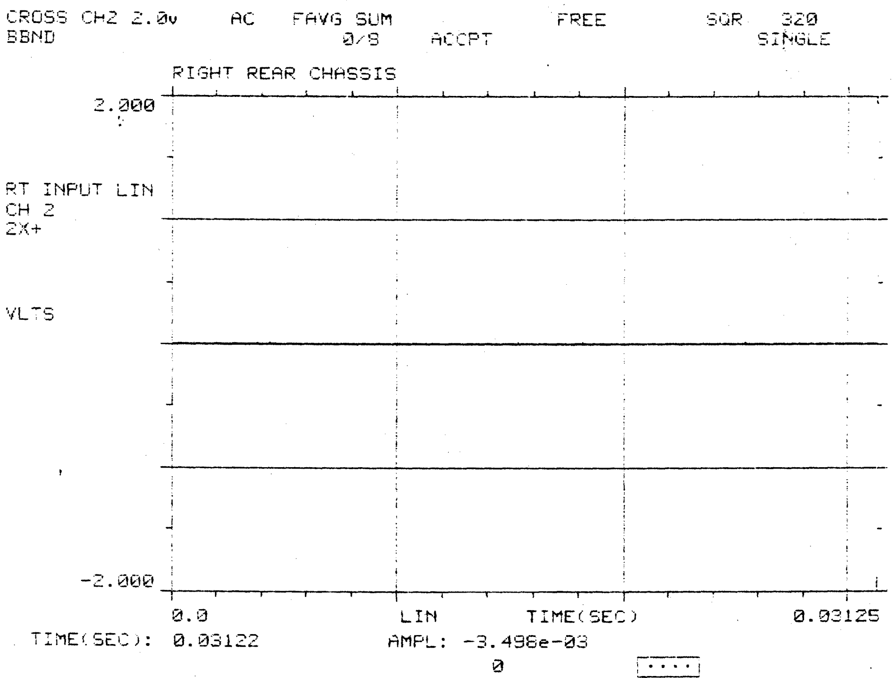
1.2.2.1b)

```
   File Name Already Used     Restriction:  ANY FUNCTION
                              Acquisition Type:  SHAKER TEST
>* 1) Attach to Existing File Current File:  JLL
   2) Select New Name         File Status:  CLOSED
                              File Format:  MODAL
   ,                          Previous Action:  create
                              FAILED
```

1.2.2.1c)

```
Action SUCCEEDED              Restriction:  ANY FUNCTION
*                             Acquisition Type:  SHAKER TEST
                              Current File:  JLL
                              File Status:  OPEN
                              Label:  JLL2
,                             Size:  7 Blocks
                              File Format:  MODAL
                              Previous Action:  open
                              SUCCEEDED
```

1.2.2.1d)



1.2.3)

```
File Allocation

   1) SELECT EXISTING FILE
   2) CREATE NEW FILE
>* 3) DELETIONS FROM FILE
   4) INCREASE SIZE OF FILExx
```

```
Restriction: TRANSFER FUNCTION
Acquisition Type: SHAKER TEST
Current File: LEG
File Status: OPEN
Label: SHILOH
Size: 7 Blocks
File Format: MODAL
Previous Action: create
SUCCEEDED
```

1.2.3a)

```
ENTER Range of Records
to Delete (n:m)
(Press Next)
*

>,
```

```
Restriction: TRANSFER FUNCTION
Acquisition Type: SHAKER TEST
Current File: LEG
File Status: OPEN
Label: SHILOH
Size: 7 Blocks
File Format: MODAL
Previous Action: create
SUCCEEDED
```

1.2.3b)

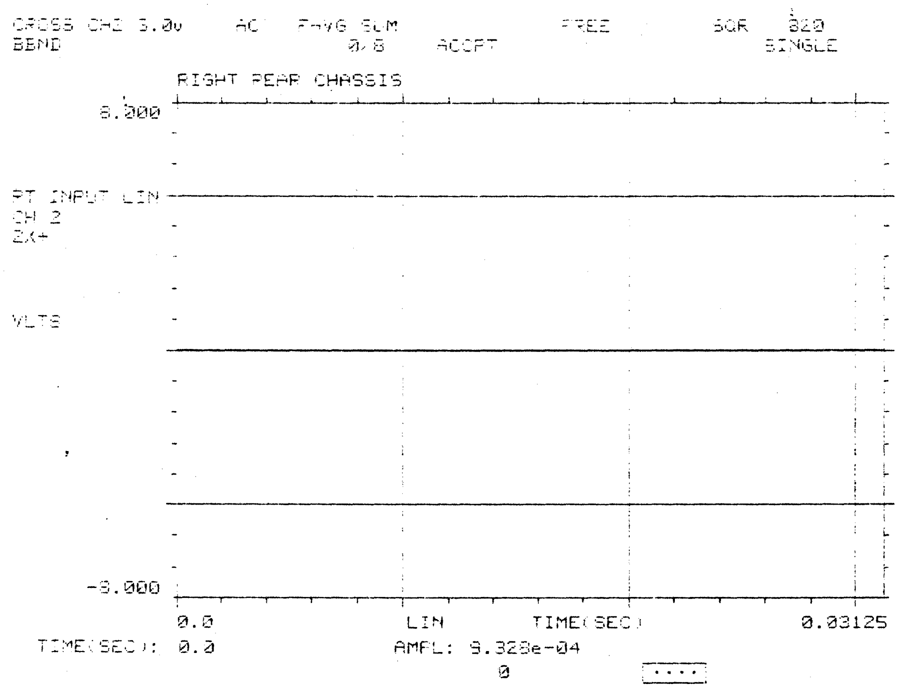
```
Attempting to Delete Records Restriction:  TRANSFER FUNCTION
*                            Acquisition Type:  SHAKER TEST
                             Current File:  LEG
                             File Status:  OPEN
                             Label:  SHILOH
                             Size:  7 Blocks
                             File Format:  MODAL
                             Previous Action:  create
                             SUCCEEDED
```

1.2.3c)

```
Action SUCCEEDED             Restriction:  TRANSFER FUNCTION
*                            Acquisition Type:  SHAKER TEST
                             Current File:  LEG
                             File Status:  OPEN
                             Label:  SHILOH
                             Size:  7 Blocks
                             File Format:  MODAL
                             Previous Action:  deletion
                             SUCCEEDED
```

1.2.4) Not available in this version

1.2.4a)



2)

Storage Mode

1) USER FILE
>* 2) PLOTTER SETUP

Plotter Type: SCREEN COPY

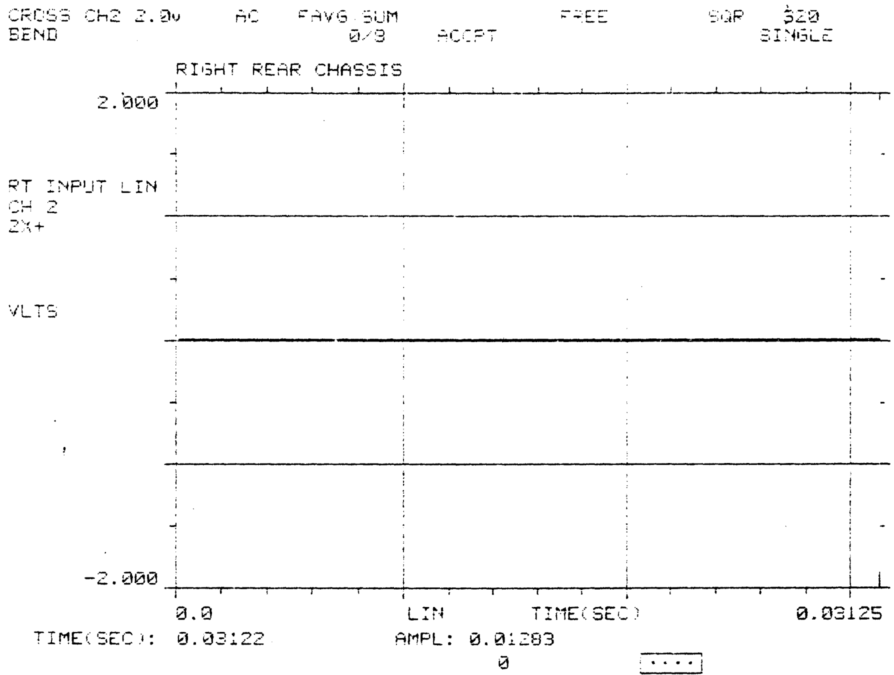
2.1)

Plotter Type

>* 1) SCREEN COPY
2) HPGL
3) TEK 4662

Plotter Type: SCREEN COPY

2.1.a)



2.2)

Plotter Type

1) SCREEN COPY
>* 2) HPGL
3) TEK 4662

Plotter Type: HPGL
Pen Speed: 100

2.2a)

ENTER % Pen Speed
* 100

>

Plotter Type: HPGL
Pen Speed: 100

2.3)

Plotter Type

1) SCREEN COPY
2) HPGL
>* 3) TEK 4662

Plotter Type: TEK 4662
Pen Speed: 100

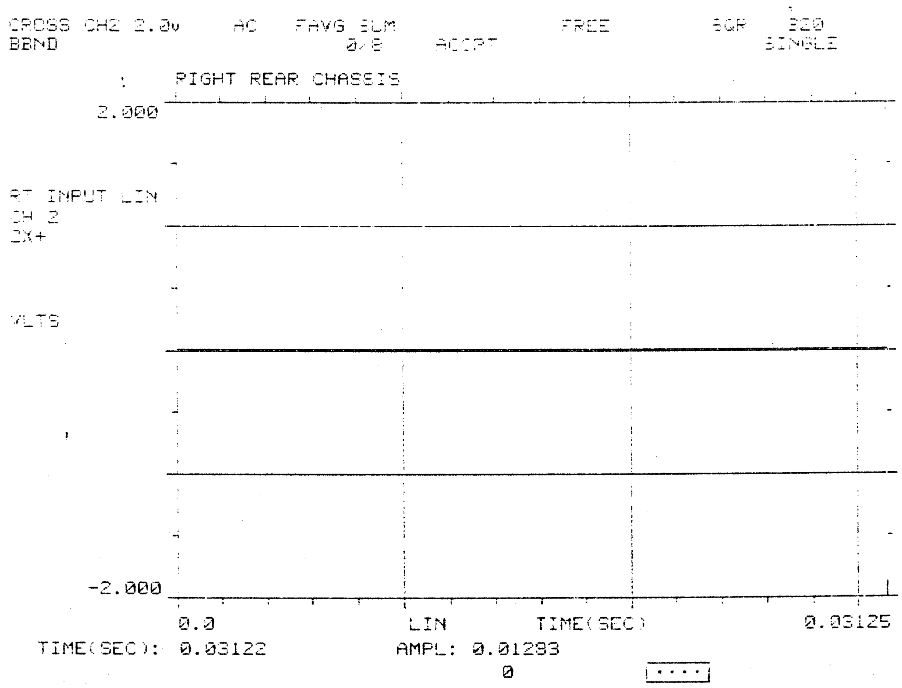
2.3a)

ENTER % Pen Speed
* 100

>

Plotter Type: TEK 4662
Pen Speed: 100

2.3b)



B. DIR Pushbutton

1)

```
   Directory

>*  1) User Disk File
    2) Memory
    3) Memory Panelxx
```

1a)

```
ENTER
REC #,SEQ #,RES COORD, and
REF COORD for Directory
*

>
```

1b)

```
ENTER
REC #,SEQ #,RES COORD, and
REF COORD for Directory
*

>
```

2)

```
   Directory

    1) User Disk File
>*  2) Memory
    3) Memory Panelxx
```

2a)

```
B# <-range          S#  resp    ref     labels          date       time

 1   -----empty buffer-----
 2   -----empty buffer-----
 3   -----empty buffer-----
 4   -----empty buffer-----
 5   -----empty buffer-----
 6   -----empty buffer-----
 7   -----empty buffer-----
 8   -----empty buffer-----
 9   -----empty buffer-----
10   -----empty buffer-----
11   -----empty buffer-----
12   -----empty buffer-----
13   -----empty buffer-----
14   -----empty buffer-----
15   -----empty buffer-----
16   -----empty buffer-----
```

3) Not available in this version.

C. STORE Pushbutton

1)

```
  Storage Type/Destination        Type/Dest:  Data to File
                                  Storage Grouping:  Single
>*  1) DATA to FILE               Restriction:  TRANSFER FUNCTION
    2) DATA to MEMORY             Acquisition Type:  SHAKER TEST
    3) PANEL to FILExx            Current File:
    4) PANEL to MEMORY            File Status:  CLOSED
                                  File Format:  MODAL
                                  Previous Action:  recall
                                  SUCCEEDED
```

1a)

```
ENTER RES COORD, REF COORD,   Type/Dest:  Data to File
and SEQ #                     Storage Grouping:  Single
* 2X+,     1Y+,     0         Restriction:  TRANSFER FUNCTION
                              Acquisition Type:  SHAKER TEST
>                             Current File:
                              File Status:  CLOSED
                              File Format:  MODAL
                              Previous Action:  recall
                              SUCCEEDED
```

1b)

```
ENTER RES COORD, REF COORD,   Type/Dest:  Data to File
and SEQ #                     Storage Grouping:  Single
* 2X+,     1Y+,     0         Restriction:  TRANSFER FUNCTION
                              Acquisition Type:  SHAKER TEST
>                             Current File:
                              File Status:  CLOSED
                              File Format:  MODAL
                              Previous Action:  store
                              FAILED
```

1c)

```
Attempting to store           Type/Dest:  Data to File
                              Storage Grouping:  Single
*                             Restriction:  TRANSFER FUNCTION
                              Acquisition Type:  SHAKER TEST
                              Current File:
                              File Status:  CLOSED
                              File Format:  MODAL
                              Previous Action:  store
                              FAILED
```

1d)

```
ACTION FAILED                       Type/Dest:  Data to File
Previous Action FAILED              Storage Grouping:  Single
                                    Restriction:  TRANSFER FUNCTION
*                                   Acquisition Type:  SHAKER TEST
                                    Current File:
                                    File Status:  CLOSED
                                    File Format:  MODAL
                                    Previous Action:  store
                                    FAILED
```

2)

```
 Storage Type/Destination           Type/Dest:  Panel to Memory
                                    Storage Grouping:  Multiple
 1) DATA to FILE                    Restriction:  ANY FUNCTION
>* 2) DATA to MEMORY                Acquisition Type:  IMPACT TEST
 3) PANEL to FILE**                 Current File:  LEGRAND
 4) PANEL to MEMORY                 File Status:  CLOSED
                                    File Format:  MODAL
                                    Previous Action:  store
                                    FAILED
```

2a)

```
ENTER RES COORD, REF COORD,         Type/Dest:  Panel to Memory
and SEQ #                           Storage Grouping:  Single
* 2X+,    1Y+,    0                 Restriction:  TRANSFER FUNCTION
                                    Acquisition Type:  SHAKER TEST
>                                   Current File:
                                    File Status:  CLOSED
                                    File Format:  MODAL
                                    Previous Action:  store
                                    FAILED
```

2b)

```
ENTER Memory Buffer #               Type/Dest:  Panel to Memory
(Press Next)                        Storage Grouping:  Single
* 0                                 Restriction:  TRANSFER FUNCTION
                                    Acquisition Type:  SHAKER TEST
>                                   Current File:
                                    File Status:  CLOSED
                                    File Format:  MODAL
                                    Previous Action:  store
                                    FAILED
```

2c)

```
Attempting to store

*

'
```

```
Type/Dest:  Panel to Memory
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  IMPACT TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  store
FAILED
```

2d)

```
ACTION FAILED
Previous Action FAILED

*

'
```

```
Type/Dest:  Panel to Memory
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  IMPACT TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  store
FAILED
```

3) **Not available in this version.**

```
    Storage Type/Destination

    1) DATA to FILE
    2) DATA to MEMORY
>*  3) PANEL to FILExx
    4) PANEL to MEMORY
```

```
Type/Dest:  Data to Memory
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  create
FAILED
```

4)

```
    Storage Type/Destination

    1) DATA to FILE
    2) DATA to MEMORY
    3) PANEL to FILExx
>*  4) PANEL to MEMORY

    '
```

```
Type/Dest:  Panel to File
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  create
FAILED
```

4a)

```
ENTER Memory Buffer #
(Press Next)
* 1

>
,
```

```
Type/Dest:  Panel to File
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  create
FAILED
```

4b)

```
Attempting to store

*

,
```

```
Type/Dest:  Panel to File
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  create
FAILED
```

4c)

```
ACTION SUCCEEDED
ENTER Memory Buffer #
(Press Next)
* 1

>1
,
```

```
Type/Dest:  Panel to File
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  store
SUCCEEDED
```

4d)

```
ACTION SUCCEEDED
Attempting to store

*
```

```
Type/Dest:  Panel to File
Storage Grouping:  Multiple
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:  LEGRAND
File Status:  CLOSED
File Format:  MODAL
Previous Action:  store
SUCCEEDED
```

D. RECALL Pushbutton

1)

```
     Recall Type/Source                 Type/Souce:  Data from Memory
                                        Restriction:  ANY FUNCTION
>*   1) DATA from FILE                  Acquisition Type:  SHAKER TEST
     2) DATA from MEMORY                Current File:
     3) PANEL from FILExx               File Status:  CLOSED
     4) PANEL from MEMORY               File Format:  MODAL
```

1a)

```
     ENTER REC #,SEQ #,RES COORD        Type/Souce:  Data from Memory
     and REF COORD                      Restriction:  ANY FUNCTION
     *                                  Acquisition Type:  SHAKER TEST
                                        Current File:
 >                                      File Status:  CLOSED
                                        File Format:  MODAL
```

2)

```
     Recall Type/Source                 Type/Souce:  Panel from Memory
                                        Restriction:  ANY FUNCTION
     1) DATA from FILE                  Acquisition Type:  SHAKER TEST
>*   2) DATA from MEMORY                Current File:
     3) PANEL from FILExx               File Status:  CLOSED
     4) PANEL from MEMORY               File Format:  MODAL
                                        Previous Action:  recall
                                        FAILED
```

2a)

```
     ENTER Memory Buffer #              Type/Souce:  Panel from Memory
     * 0                                Restriction:  ANY FUNCTION
                                        Acquisition Type:  SHAKER TEST
 >                                      Current File:
                                        File Status:  CLOSED
                                        File Format:  MODAL
                                        Previous Action:  recall
                                        FAILED
```

3) Not available in this version.

```
Recall Type/Source

   1) DATA from FILE
   2) DATA from MEMORY
>* 3) PANEL from FILExx
   4) PANEL from MEMORY
```

```
Type/Souce:  Data from Memory
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  recall
FAILED
```

3a)

```
ENTER Memory Buffer #
* 0

>
```

```
Type/Souce:  Data from Memory
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  recall
FAILED
```

3b)

```
Previous Action FAILED

*
```

```
Type/Souce:  Panel from Memory
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  recall
FAILED
```

4)

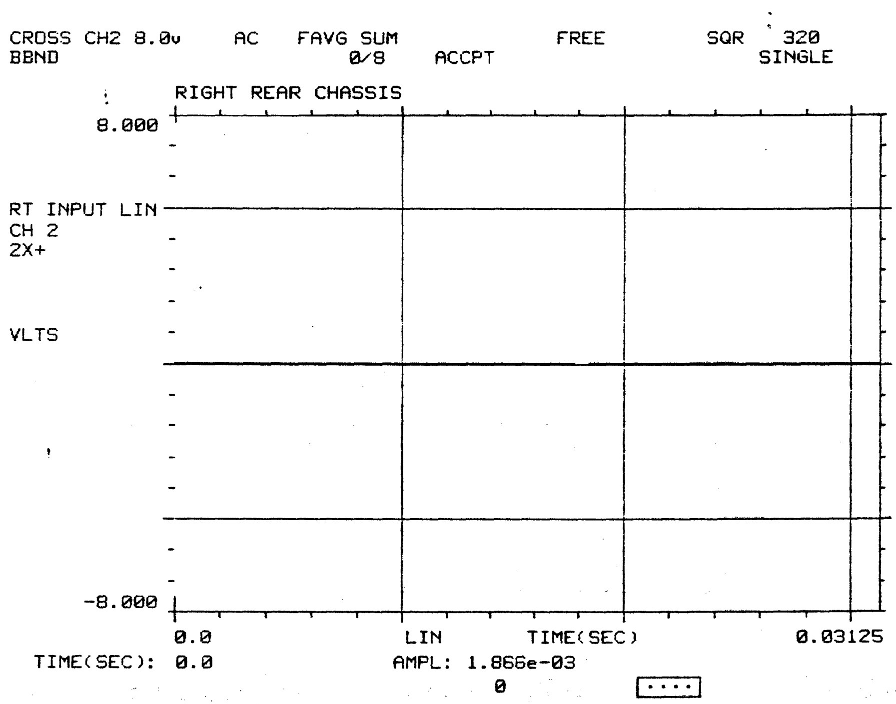
```
Recall Type/Source

   1) DATA from FILE
   2) DATA from MEMORY
   3) PANEL from FILExx
>* 4) PANEL from MEMORY
```

```
Type/Souce:  Panel from File
Restriction:  ANY FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  recall
FAILED
```

4a)

```
    Recall Type/Source              Type/Souce:  Panel from File
                                    Restriction:  ANY FUNCTION
    1) DATA from FILE               Acquisition Type:  SHAKER TEST
    2) DATA from MEMORY             Current File:
  ' 3) PANEL from FILExx            File Status:  CLOSED
>*  4) PANEL from MEMORY            File Format:  MODAL
                                    Previous Action:  recall
                                    FAILED
```

4b)



DISPLAY GROUP 5

MEASUREMENT SETUP Group Pushbuttons, Typical Menus and Displays

A. AVERAGE Pushbutton

1)

```
  Averaging Domain

>*  1) FREQUENCY
    2) TIMExx
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUMMATION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

1.1)

```
  Averaging Mode

>*  1) SUMMATION
    2) SUBTRACTION
    3) EXPONENTIAL
    4) PEAK HOLD
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUMMATION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

1.1a)

```
ENTER # of Averages
* 8

>
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUMMATION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

1.1.1)

```
  Pre-average Autorange

>*  1) OFF
    2) ON
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUMMATION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

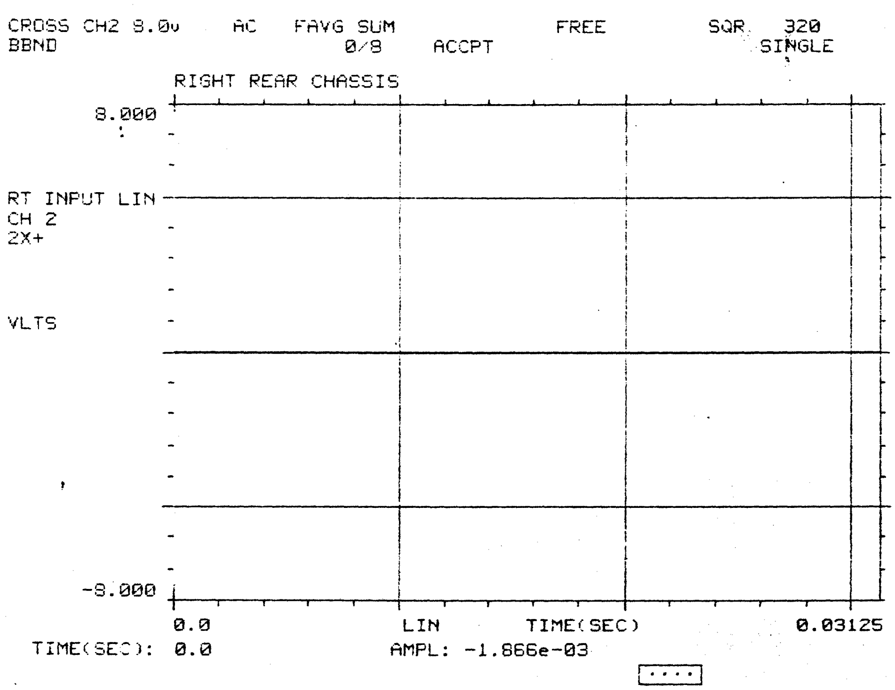
1.1.1.1)

```
Data Acceptance into Avg                 Averaging Domain:  FREQUENCY
                                         Averaging Mode:  SUMMATION
>* 1) ACCEPT EVERY FRAME                 # of Averages:  8
   2) MANUAL ACCEPT(CONTINUE)            Autorange:  OFF
   3) AUTO REJECT                        Accept:  EVERY FRAME
   4) AUTO REJECT w/ DBL HITS            Accept Min Peak %:  35
```

1.1.1.1a)

```
ENTER MINIMUM % FULL SCALE   Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL Averaging Mode:  SUMMATION
* 35                         # of Averages:  8
                             Autorange:  OFF
>                            Accept:  EVERY FRAME
                             Accept Min Peak %:  35
```

1.1.1.1b)



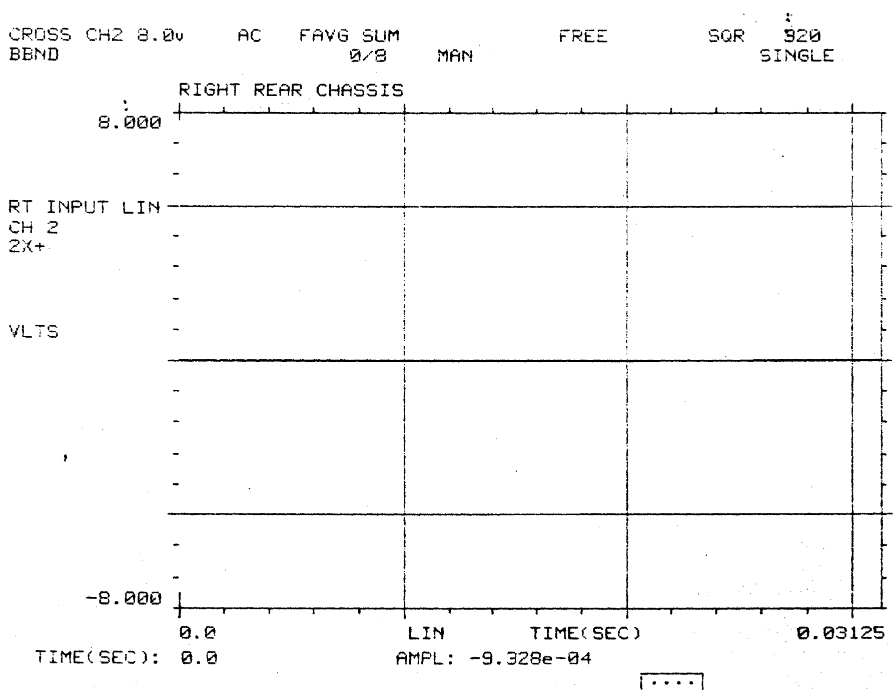
1.1.1.2)

```
    Data Acceptance into Avg          Averaging Domain:  FREQUENCY
                                      Averaging Mode:  SUMMATION
    1) ACCEPT EVERY FRAME             # of Averages:  8
>*  2) MANUAL ACCEPT(CONTINUE)        Autorange:  OFF
    3) AUTO REJECT                    Accept:  MANUAL
    4) AUTO REJECT w/ DBL HITS        Accept Min Peak %:  35
```

1.1.1.2a)

```
    ENTER MINIMUM % FULL SCALE        Averaging Domain:  FREQUENCY
    for an ACCEPTABLE SIGNAL LVL      Averaging Mode:  SUMMATION
    * 35                              # of Averages:  8
                                      Autorange:  OFF
>                                     Accept:  MANUAL
                                      Accept Min Peak %:  35
```

1.1.1.2b)



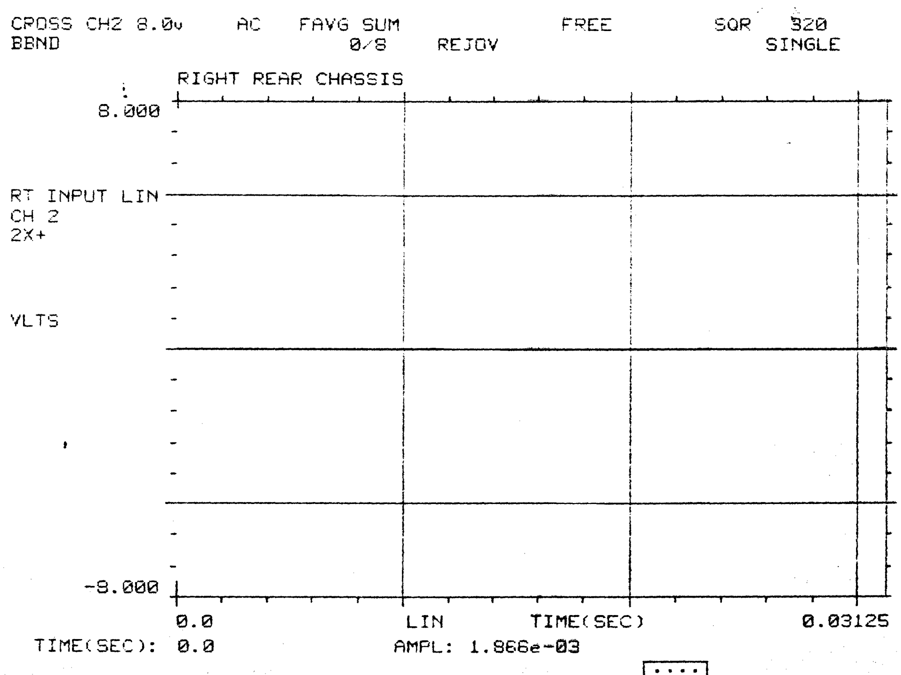
1.1.1.3)

```
   Data Acceptance into Avg           Averaging Domain:  FREQUENCY
                                      Averaging Mode:  SUMMATION
   1) ACCEPT EVERY FRAME              # of Averages:  8
   2) MANUAL ACCEPT(CONTINUE)         Autorange:  OFF
>* 3) AUTO REJECT                     Accept:  AUTO REJ O/L
   4) AUTO REJECT w/ DBL HITS         Accept Min Peak %:  35
```

1.1.1.3a)

```
ENTER MINIMUM % FULL SCALE     Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL   Averaging Mode:  SUMMATION
* 35                           # of Averages:  8
                               Autorange:  OFF
>                              Accept:  AUTO REJ O/L
                               Accept Min Peak %:  35
```

1.1.1.3b)



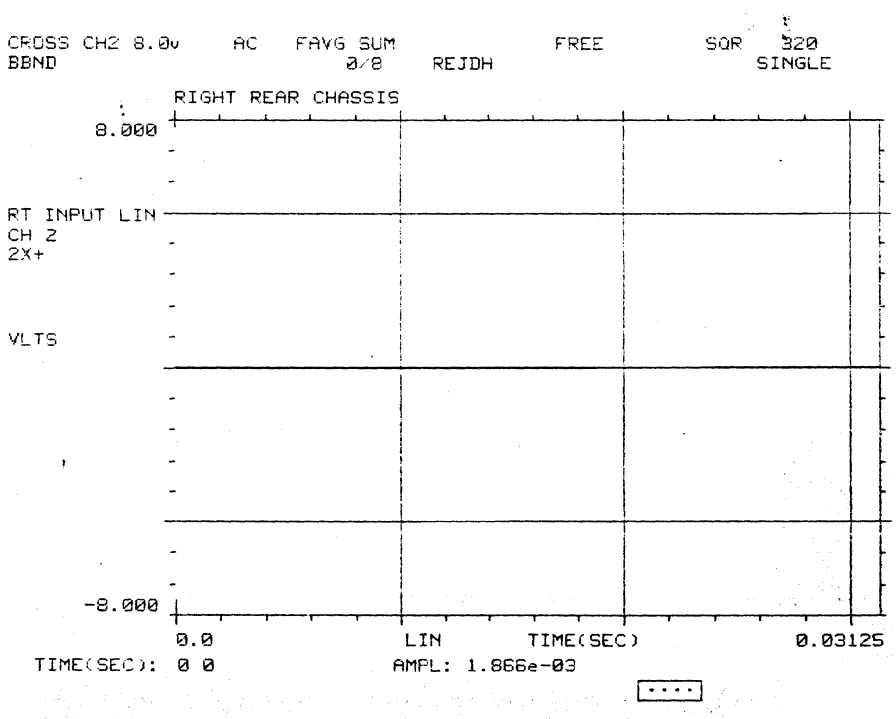
1.1.1.4)

```
Data Acceptance into Avg          Averaging Domain:  FREQUENCY
                                  Averaging Mode:  SUMMATION
 1) ACCEPT EVERY FRAME            # of Averages:  8
 2) MANUAL ACCEPT(CONTINUE)       Autorange:  OFF
 3) AUTO REJECT                   Accept:  AUTO REJ O/L & DBL HIT
>* 4) AUTO REJECT w/ DBL HITS     Accept Min Peak %:  35
```

1.1.1.4a)

```
ENTER MINIMUM % FULL SCALE    Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL  Averaging Mode:  SUMMATION
* 35                          # of Averages:  8
                              Autorange:  OFF
>                             Accept:  AUTO REJ O/L & DBL HIT
                              Accept Min Peak %:  35
```

1.1.1.4b)



1.1.2)

```
    Pre-average Autorange        Averaging Domain:  FREQUENCY
                                 Averaging Mode:  SUMMATION
    1) OFF                       # of Averages:  8
>*  2) ON                        Autorange:  ON
                                 Accept:  AUTO REJ O/L & DBL HIT
                                 Accept Min Peak %:  35
```

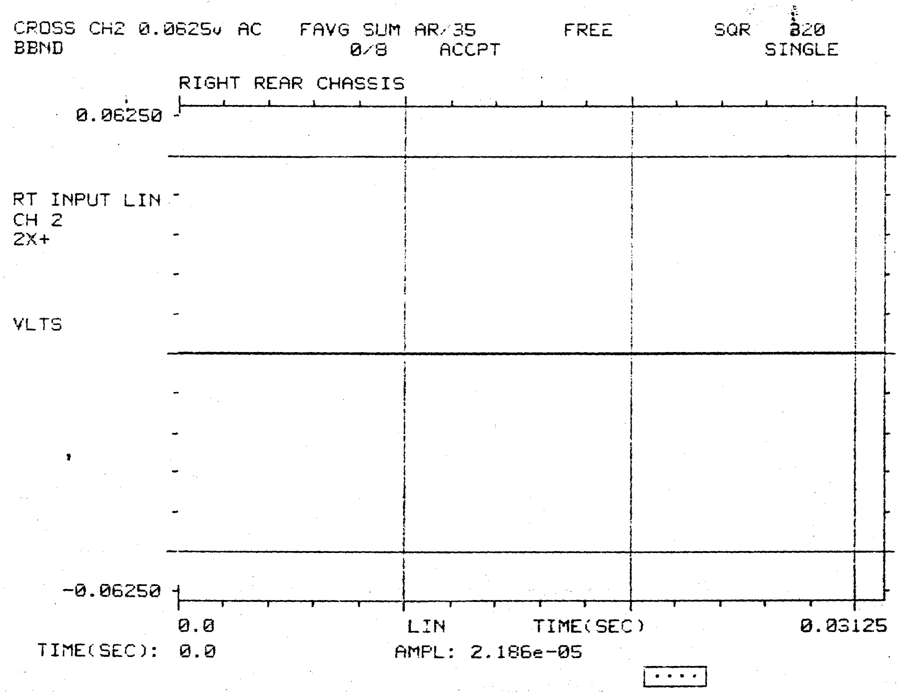
1.1.2.1)

```
    Data Acceptance into Avg     Averaging Domain:  FREQUENCY
                                 Averaging Mode:  SUMMATION
>*  1) ACCEPT EVERY FRAME        # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)   Autorange:  ON
    3) AUTO REJECT               Accept:  EVERY FRAME
    4) AUTO REJECT w/ DBL HITS   Accept Min Peak %:  35
```

1.1.2.1a)

```
ENTER MINIMUM % FULL SCALE   Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL Averaging Mode:  SUMMATION
* 35                         # of Averages:  8
                             Autorange:  ON
>                            Accept:  EVERY FRAME
                             Accept Min Peak %:  35
```

1.1.2.1b)



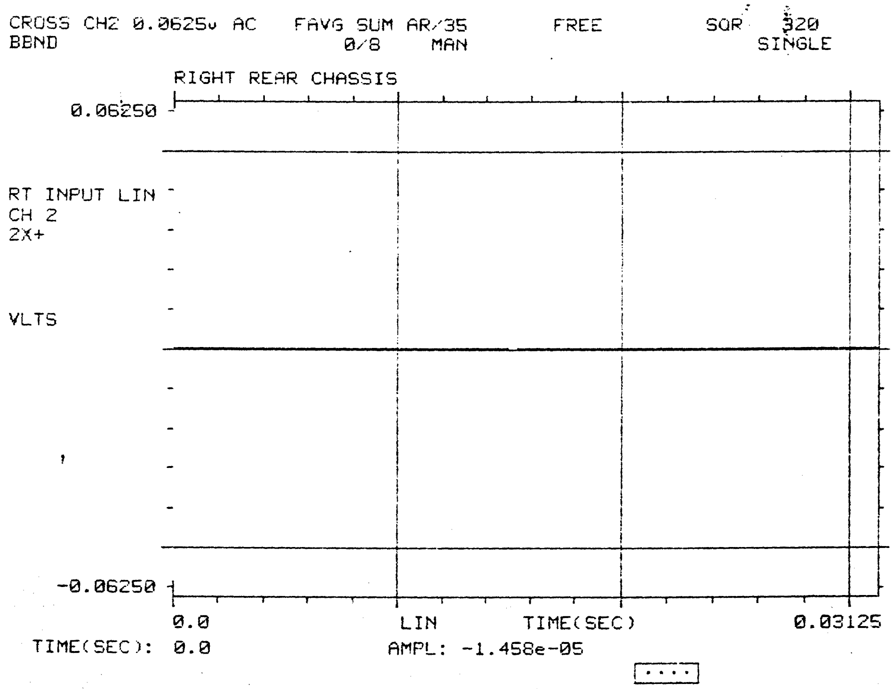
1.1.2.2)

```
    Data Acceptance into Avg         Averaging Domain:  FREQUENCY
                                     Averaging Mode:  SUMMATION
    1) ACCEPT EVERY FRAME            # of Averages:  8
>*  2) MANUAL ACCEPT(CONTINUE)       Autorange:  ON
    3) AUTO REJECT                   Accept:  MANUAL
    4) AUTO REJECT w/ DBL HITS       Accept Min Peak %:  35
```

1.1.2.2a)

```
  ENTER MINIMUM % FULL SCALE       Averaging Domain:  FREQUENCY
  for an ACCEPTABLE SIGNAL LVL     Averaging Mode:  SUMMATION
  * 35                             # of Averages:  8
                                   Autorange:  ON
  >                                Accept:  MANUAL
                                   Accept Min Peak %:  35
```

1.1.2.2b)



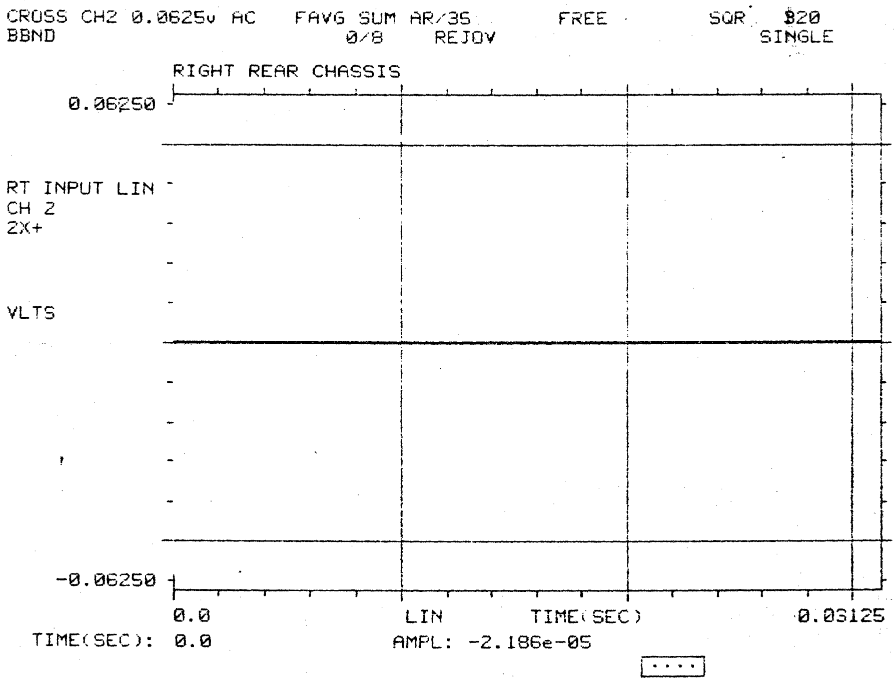
1.1.2.3)

```
   Data Acceptance into Avg          Averaging Domain:  FREQUENCY
                                     Averaging Mode:  SUMMATION
   1) ACCEPT EVERY FRAME             # of Averages:  8
   2) MANUAL ACCEPT(CONTINUE)        Autorange:  ON
>* 3) AUTO REJECT                    Accept:  AUTO REJ O/L
   4) AUTO REJECT w/ DBL HITS        Accept Min Peak %:  35
```

1.1.2.3a)

```
ENTER MINIMUM % FULL SCALE      Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL    Averaging Mode:  SUMMATION
* 35                            # of Averages:  8
                                Autorange:  ON
>                               Accept:  AUTO REJ O/L
                                Accept Min Peak %:  35
```

1.1.2.3a)



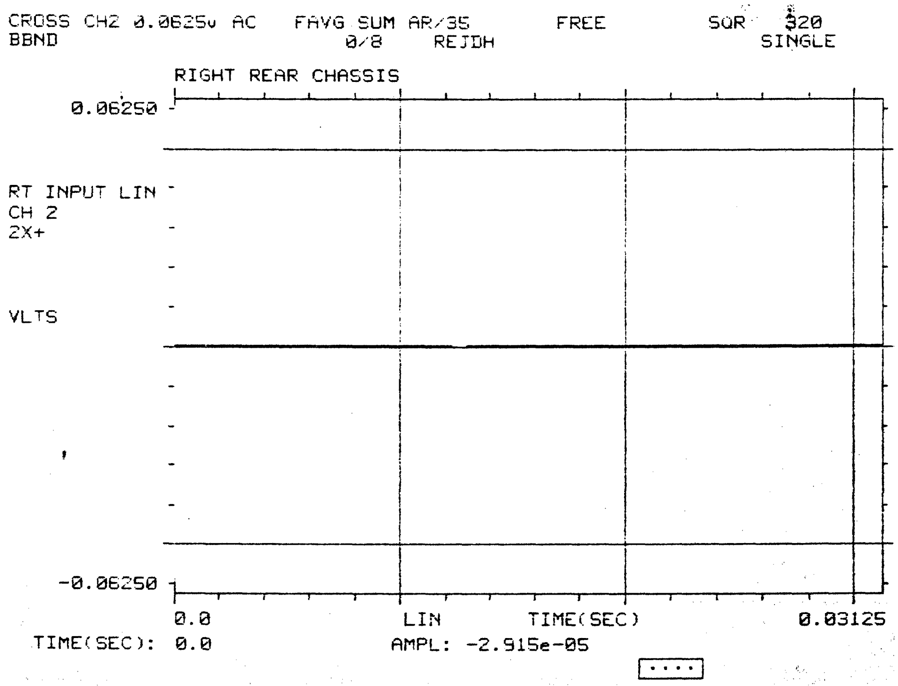
1.1.2.4)

```
   Data Acceptance into Avg        Averaging Domain:  FREQUENCY
                                   Averaging Mode:  SUMMATION
   1) ACCEPT EVERY FRAME           # of Averages:  8
   2) MANUAL ACCEPT(CONTINUE)      Autorange:  ON
   3) AUTO REJECT                  Accept:  AUTO REJ O/L & DBL HIT
>* 4) AUTO REJECT w/ DBL HITS      Accept Min Peak %:  35
```

1.1.2.4a)

```
ENTER MINIMUM % FULL SCALE         Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL       Averaging Mode:  SUMMATION
* 35                               # of Averages:  8
                                   Autorange:  ON
>                                  Accept:  AUTO REJ O/L & DBL HIT
                                   Accept Min Peak %:  35
```

1.1.2.4b)



1.2)

```
Averaging Mode

   1) SUMMATION
>* 2) SUBTRACTION
   3) EXPONENTIAL
   4) PEAK HOLD
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUBTRACTION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

1.2a)

```
ENTER # of Averages
* 8

>
```

```
Averaging Domain:  FREQUENCY
Averaging Mode:  SUBTRACTION
# of Averages:  8
Autorange:  OFF
Accept:  EVERY FRAME
Accept Min Peak %:  35
```

1.2.1)

```
    Pre-average Autorange          Averaging Domain:  FREQUENCY
                                   Averaging Mode:  SUBTRACTION
>*  1) OFF                         # of Averages:  8
    2) ON                          Autorange:  OFF
                                   Accept:  EVERY FRAME
                                   Accept Min Peak %:  35
```

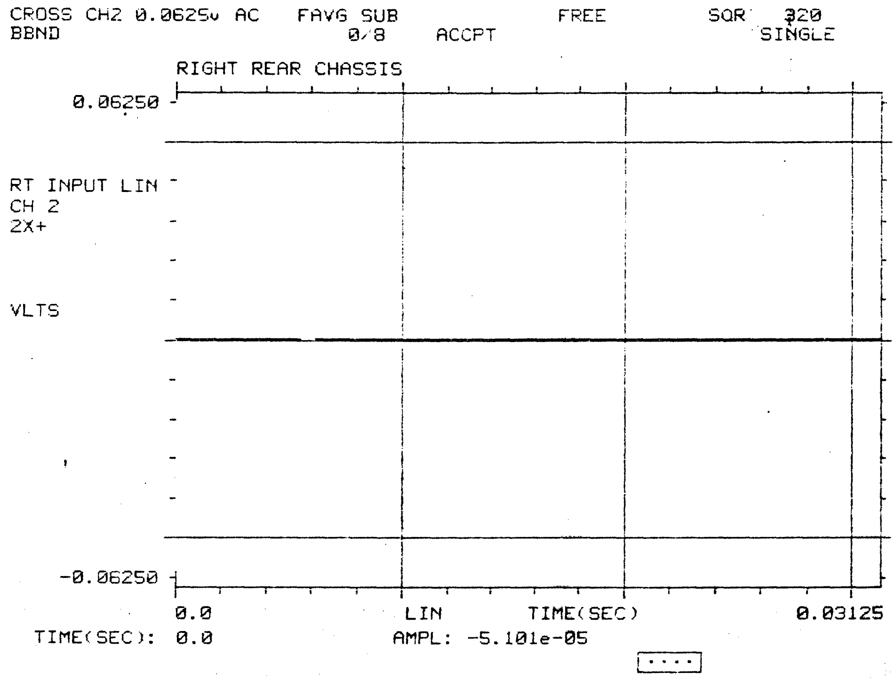
1.2.1.1)

```
    Data Acceptance into Avg       Averaging Domain:  FREQUENCY
                                   Averaging Mode:  SUBTRACTION
>*  1) ACCEPT EVERY FRAME          # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)     Autorange:  OFF
    3) AUTO REJECT                 Accept:  EVERY FRAME
    4) AUTO REJECT w/ DBL HITS     Accept Min Peak %:  35
```

1.2.1.1a)

```
    ENTER MINIMUM % FULL SCALE     Averaging Domain:  FREQUENCY
    for an ACCEPTABLE SIGNAL LVL   Averaging Mode:  SUBTRACTION
    * 35                           # of Averages:  8
                                   Autorange:  OFF
  >                                Accept:  EVERY FRAME
                                   Accept Min Peak %:  35
```

1.2.1.1b)



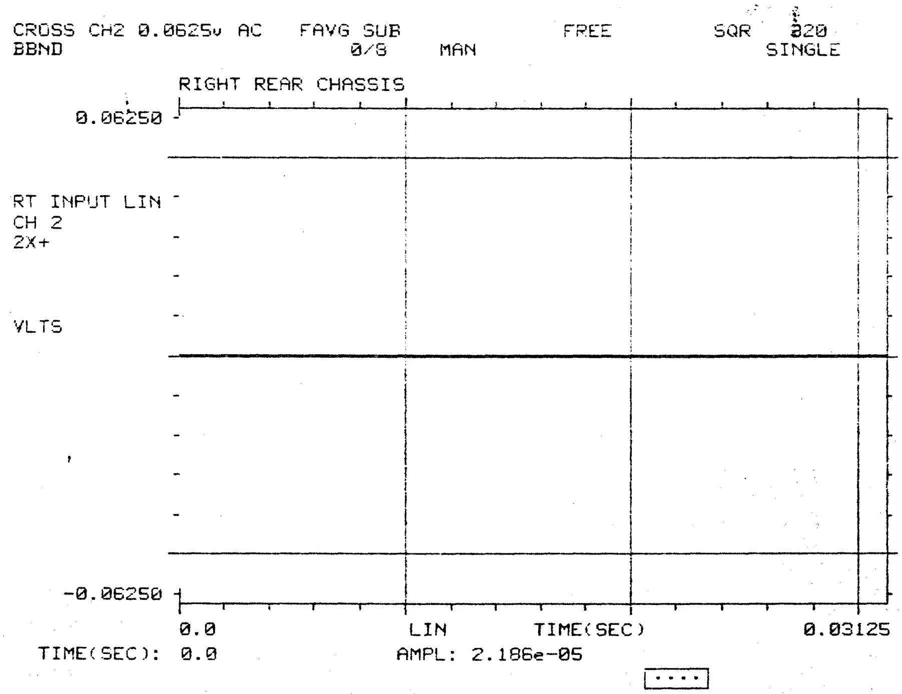
1.2.1.2)

```
   Data Acceptance into Avg        Averaging Domain:  FREQUENCY
                                   Averaging Mode:  SUBTRACTION
   1) ACCEPT EVERY FRAME           # of Averages:  8
>* 2) MANUAL ACCEPT(CONTINUE)      Autorange:  OFF
   3) AUTO REJECT                  Accept:  MANUAL
   4) AUTO REJECT w/ DBL HITS      Accept Min Peak %:  35
```

1.2.1.2a)

```
ENTER MINIMUM % FULL SCALE    Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL  Averaging Mode:  SUBTRACTION
* 35                          # of Averages:  8
                              Autorange:  OFF
>                             Accept:  MANUAL
                              Accept Min Peak %:  35
```

1.2.1.2b)



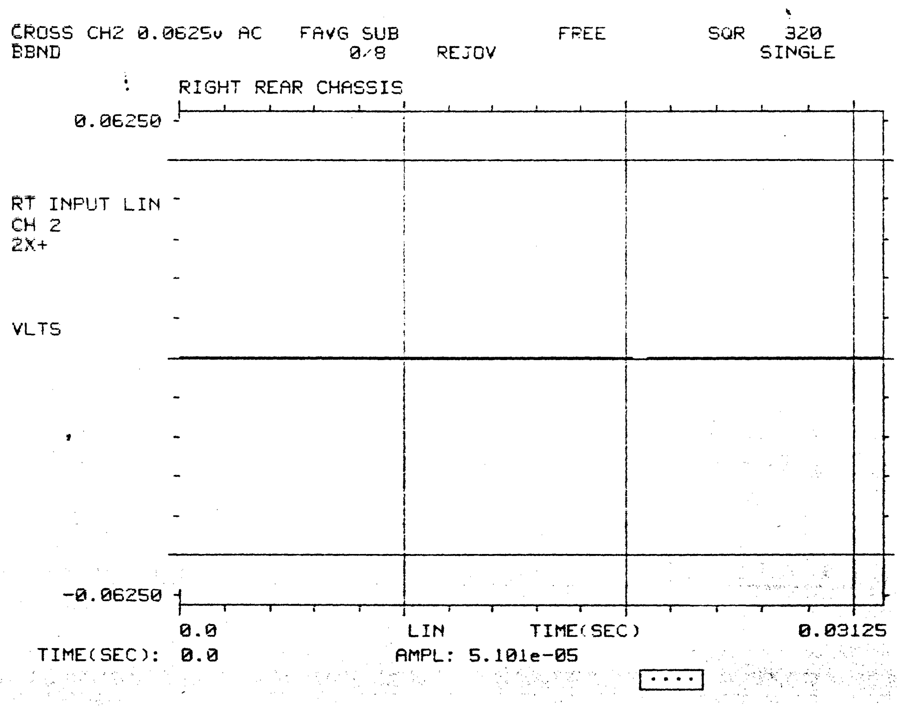
1.2.1.3)

```
    Data Acceptance into Avg         Averaging Domain:  FREQUENCY
                                     Averaging Mode:  SUBTRACTION
    1) ACCEPT EVERY FRAME            # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)       Autorange:  OFF
>*  3) AUTO REJECT                   Accept:  AUTO REJ O/L
    4) AUTO REJECT w/ DBL HITS       Accept Min Peak %:  35
```

1.2.1.3a)

```
ENTER MINIMUM % FULL SCALE      Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL    Averaging Mode:  SUBTRACTION
* 35                            # of Averages:  8
                                Autorange:  OFF
>                               Accept:  AUTO REJ O/L
                                Accept Min Peak %:  35
```

1.2.1.3b)



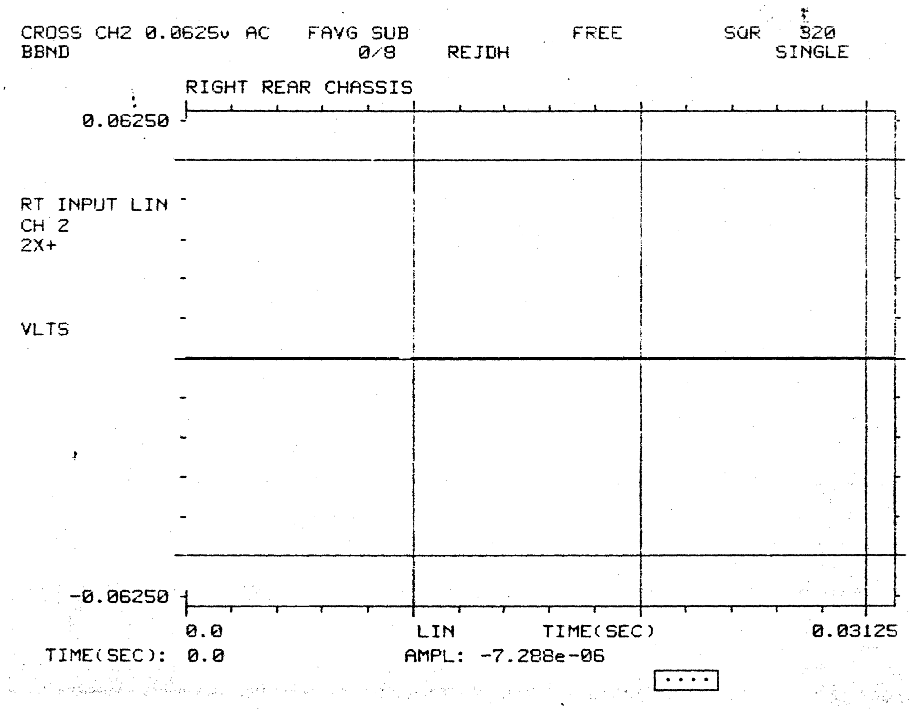
1.2.1.4)

```
Data Acceptance into Avg          Averaging Domain:  FREQUENCY
                                  Averaging Mode:  SUBTRACTION
  1) ACCEPT EVERY FRAME           # of Averages:  8
  2) MANUAL ACCEPT(CONTINUE)      Autorange:  OFF
  3) AUTO REJECT                  Accept:  AUTO REJ O/L & DBL HIT
>* 4) AUTO REJECT w/ DBL HITS     Accept Min Peak %:  35
```

1.2.1.4a)

```
ENTER MINIMUM % FULL SCALE        Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL      Averaging Mode:  SUBTRACTION
* 35                              # of Averages:  8
                                  Autorange:  OFF
>                                 Accept:  AUTO REJ O/L & DBL HIT
                                  Accept Min Peak %:  35
```

1.2.1.4b)



1.2.2)

```
   Pre-average Autorange                Averaging Domain:  FREQUENCY
                                        Averaging Mode:  SUBTRACTION
   1) OFF                               # of Averages:  8
>* 2) ON                                Autorange:  ON
                                        Accept:  EVERY FRAME
                                        Accept Min Peak %:  35
```

1.2.2.1)

```
   Data Acceptance into Avg             Averaging Domain:  FREQUENCY
                                        Averaging Mode:  SUBTRACTION
>* 1) ACCEPT EVERY FRAME                # of Averages:  8
   2) MANUAL ACCEPT(CONTINUE)           Autorange:  ON
   3) AUTO REJECT                       Accept:  EVERY FRAME
   4) AUTO REJECT w/ DBL HITS           Accept Min Peak %:  35
```

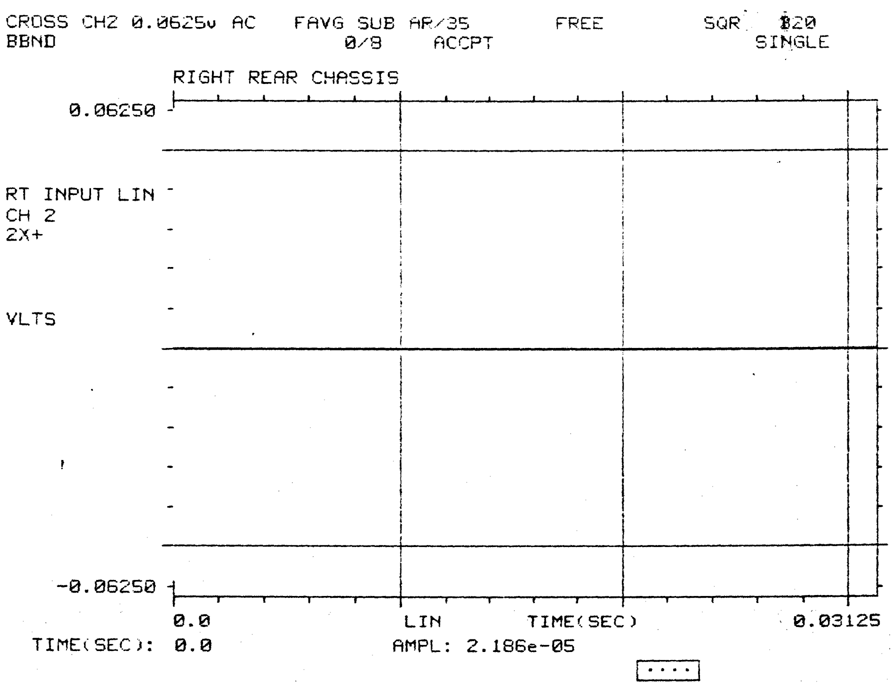
1.2.2.1a)

ENTER MINIMUM % FULL SCALE
for an ACCEPTABLE SIGNAL LVL
* 35

>,

Averaging Domain: FREQUENCY
Averaging Mode: SUBTRACTION
# of Averages: 8
Autorange: ON
Accept: EVERY FRAME
Accept Min Peak %: 35

1.2.2.1b)



1.2.2.2)

Data Acceptance into Avg

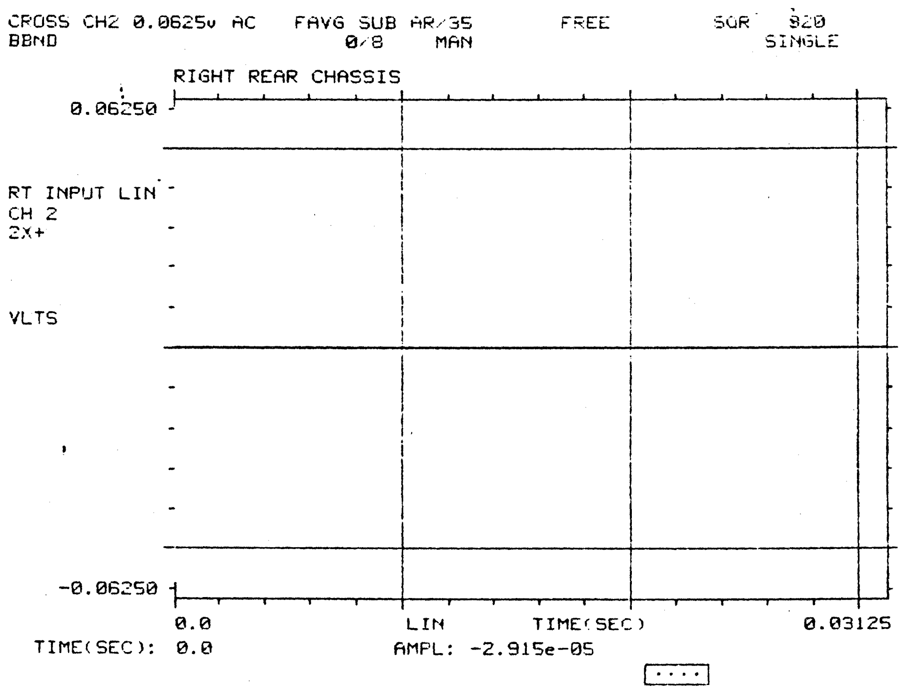
1) ACCEPT EVERY FRAME
>* 2) MANUAL ACCEPT(CONTINUE)
3) AUTO REJECT
4) AUTO REJECT w/ DBL HITS

Averaging Domain: FREQUENCY
Averaging Mode: SUBTRACTION
# of Averages: 8
Autorange: ON
Accept: MANUAL
Accept Min Peak %: 35

1.2.2.2a)

```
ENTER MINIMUM % FULL SCALE   Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL Averaging Mode:  SUBTRACTION
* 35                         # of Averages:  8
                             Autorange:  ON
>,                           Accept:  MANUAL
                             Accept Min Peak %:  35
```

1.2.2.2b)



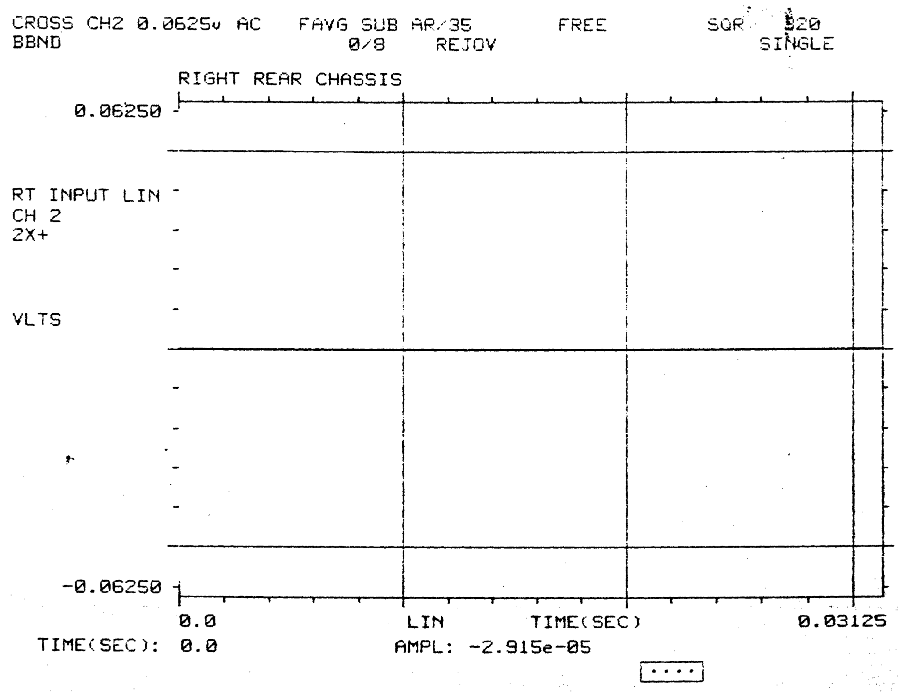
1.2.2.3)

```
 Data Acceptance into Avg     Averaging Domain:  FREQUENCY
                              Averaging Mode:  SUBTRACTION
 1) ACCEPT EVERY FRAME        # of Averages:  8
 2) MANUAL ACCEPT(CONTINUE)   Autorange:  ON
>* 3) AUTO REJECT             Accept:  AUTO REJ O/L
 4) AUTO REJECT w/ DBL HITS   Accept Min Peak %:  35
```

1.2.2.3a)

```
ENTER MINIMUM % FULL SCALE   Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL Averaging Mode:  SUBTRACTION
* 35                         # of Averages:  8
                             Autorange:  ON
>,                           Accept:  AUTO REJ O/L
                             Accept Min Peak %:  35
```

1.2.2.3b)



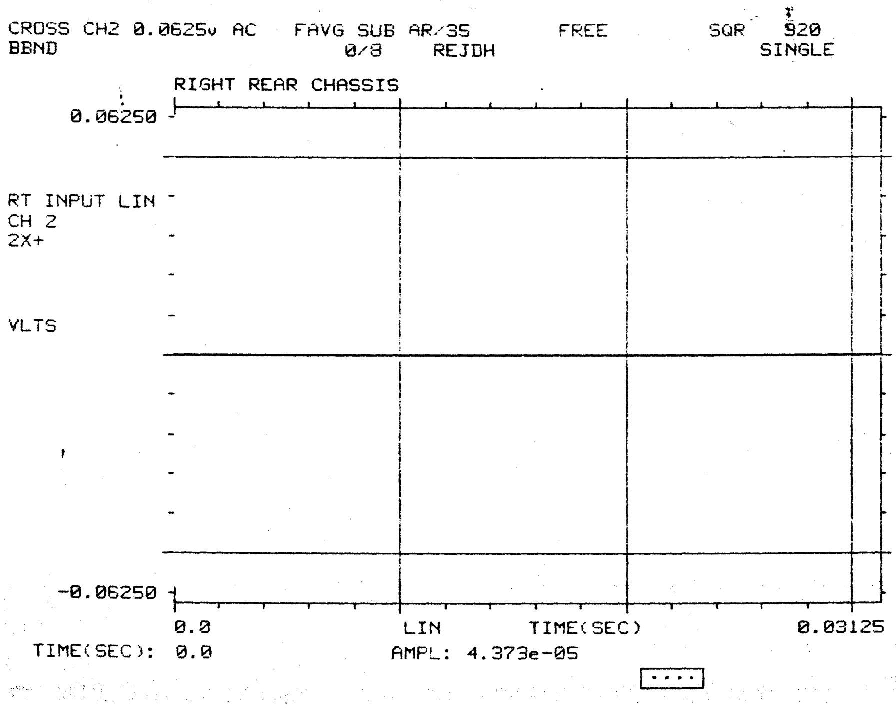
1.2.2.4)

```
    Data Acceptance into Avg           Averaging Domain:  FREQUENCY
                                       Averaging Mode:  SUBTRACTION
    1) ACCEPT EVERY FRAME              # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)         Autorange:  ON
    3) AUTO REJECT                     Accept:  AUTO REJ O/L & DBL HIT
>*  4) AUTO REJECT w/ DBL HITS         Accept Min Peak %:  35
```

1.2.2.4a)

```
ENTER MINIMUM % FULL SCALE         Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL       Averaging Mode:  SUBTRACTION
* 35                               # of Averages:  8
                                   Autorange:  ON
>                                  Accept:  AUTO REJ O/L & DBL HIT
                                   Accept Min Peak %:  35
```

1.2.2.4b)



1.3)

```
   Averaging Mode                 Averaging Domain:  FREQUENCY
                                  Averaging Mode:  EXPONENTIAL
   1) SUMMATION                   # of Averages:  8
   2) SUBTRACTION                 Autorange:  ON
>* 3) EXPONENTIAL                 Accept:  AUTO REJ O/L & DBL HIT
   4) PEAK HOLD                   Accept Min Peak %:  35
```

1.3a)

```
   ENTER # of Averages            Averaging Domain:  FREQUENCY
   * 8                            Averaging Mode:  EXPONENTIAL
                                  # of Averages:  8
  >                               Autorange:  ON
                                  Accept:  AUTO REJ O/L & DBL HIT
                                  Accept Min Peak %:  35
```

1.3.2)

```
    Pre-average Autorange          Averaging Domain:  FREQUENCY
                                   Averaging Mode:  EXPONENTIAL
    1) OFF                         # of Averages:  8
>*  2) ON                          Autorange:  ON
                                   Accept:  AUTO REJ O/L & DBL HIT
    ,                              Accept Min Peak %:  35
```

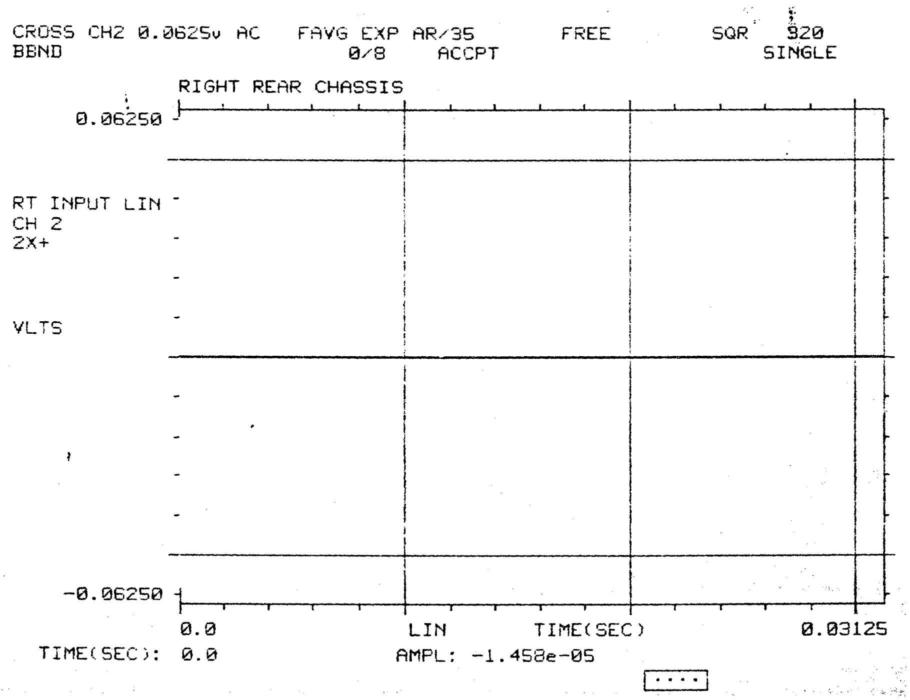
1.3.2.1)

```
    Data Acceptance into Avg       Averaging Domain:  FREQUENCY
                                   Averaging Mode:  EXPONENTIAL
>*  1) ACCEPT EVERY FRAME          # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)     Autorange:  ON
    3) AUTO REJECT                 Accept:  EVERY FRAME
    4) AUTO REJECT w/ DBL HITS     Accept Min Peak %:  35
```

1.3.2.1a)

```
    ENTER MINIMUM % FULL SCALE     Averaging Domain:  FREQUENCY
    for an ACCEPTABLE SIGNAL LVL   Averaging Mode:  EXPONENTIAL
    * 35                           # of Averages:  8
                                   Autorange:  ON
   >,                              Accept:  EVERY FRAME
                                   Accept Min Peak %:  35
```

1.3.2.1b)



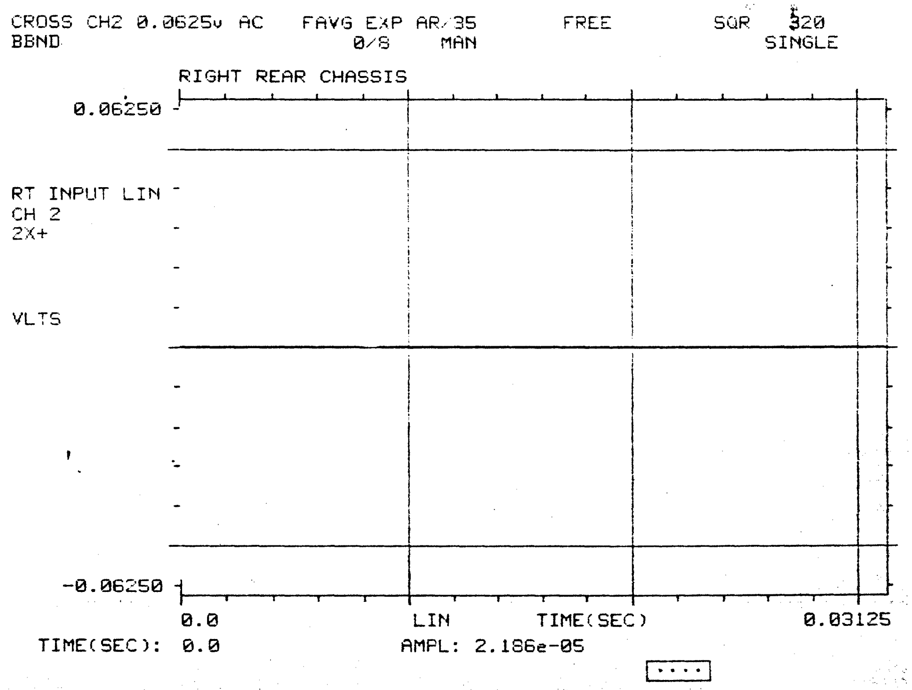
1.3.2.2)

```
   Data Acceptance into Avg          Averaging Domain:  FREQUENCY
                                     Averaging Mode:  EXPONENTIAL
   1) ACCEPT EVERY FRAME             # of Averages:  8
>* 2) MANUAL ACCEPT(CONTINUE)        Autorange:  ON
   3) AUTO REJECT                    Accept:  MANUAL
   4) AUTO REJECT w/ DBL HITS        Accept Min Peak %:  35
```

1.3.2.2a)

```
ENTER MINIMUM % FULL SCALE      Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL    Averaging Mode:  EXPONENTIAL
* 35                            # of Averages:  8
                                Autorange:  ON
>                               Accept:  MANUAL
                                Accept Min Peak %:  35
```

1.3.2.2b)



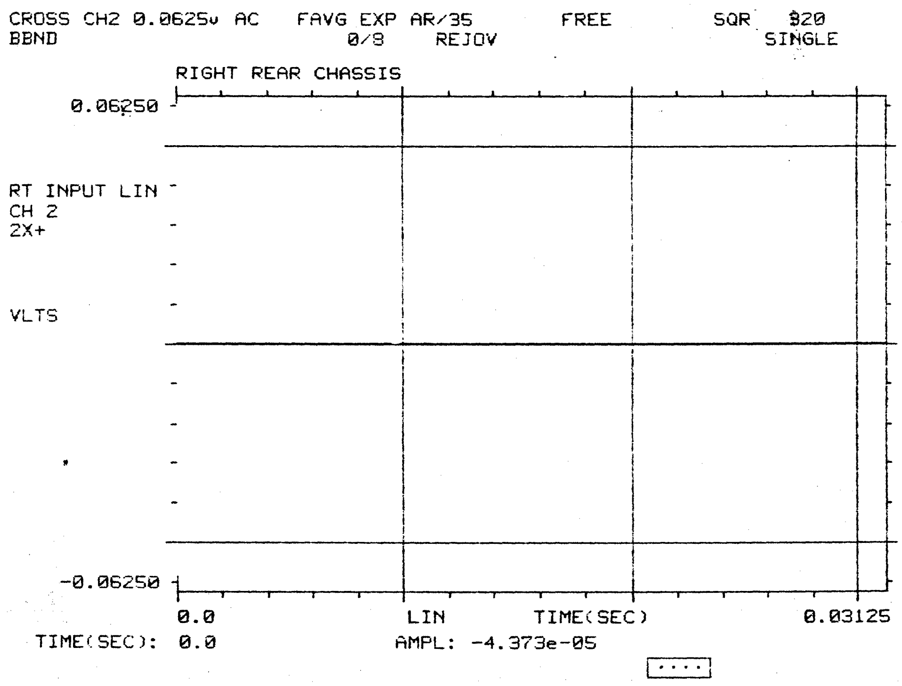
1.3.2.3)

```
    Data Acceptance into Avg        Averaging Domain:  FREQUENCY
                                    Averaging Mode:  EXPONENTIAL
    1) ACCEPT EVERY FRAME           # of Averages:  8
    2) MANUAL ACCEPT(CONTINUE)      Autorange:  ON
>*  3) AUTO REJECT                  Accept:  AUTO REJ O/L
    4) AUTO REJECT w/ DBL HITS      Accept Min Peak %:  35
```

1.3.2.3a)

```
ENTER MINIMUM % FULL SCALE    Averaging Domain:  FREQUENCY
for an ACCEPTABLE SIGNAL LVL  Averaging Mode:  EXPONENTIAL
* 35                          # of Averages:  8
                              Autorange:  ON
>                             Accept:  AUTO REJ O/L
                              Accept Min Peak %:  35
```

1.3.2.3b)



1.4) Not available in this version.

2) Not available in this version.

```
   Averaging Domain              Averaging Domain:  TIMExx
                                 Averaging Mode:  SUMMATION
   1) FREQUENCY                  # of Averages:  8
>* 2) TIMExx                     Autorange:  OFF
                                 Accept:  AUTO REJ O/L & DBL HIT
                                 Accept Min Peak %:  35
```

B. WINDOW Pushbutton

1)

```
    Window Type                          Window Type:  SQUARE
                                         Frame Overlap:  NONE
>*  1) SQUARE
    2) HANN
    3) FLAT TOP
    4) SPECIAL
    5) CORRELATION
    6) IMPACT
```

1a)

```
    Frame Overlap                        Window Type:  SQUARE
                                         Frame Overlap:  50%
    1) NONE
>*  2) 50%
    3) MAX
```

2)

```
    Window Type                          Window Type:  HANN
                                         Frame Overlap:  50%
    1) SQUARE
>*  2) HANN
    3) FLAT TOP
    4) SPECIAL
    5) CORRELATION
    6) IMPACT
```

2a)

```
    Frame Overlap                        Window Type:  HANN
                                         Frame Overlap:  50%
    1) NONE
>*  2) 50%
    3) MAX
```

3)

```
Window Type                       Window Type:  FLAT TOP
                                  Frame Overlap:  50%
   1) SQUARE
   2) HANN
>* 3) FLAT TOP
   4) SPECIAL
   5) CORRELATION
   6) IMPACT
```

3a)

```
Frame Overlap                     Window Type:  FLAT TOP
                                  Frame Overlap:  NONE
>* 1) NONE
   2) 50%
   3) MAX
```

4)

```
Window Type                       Window Type:  SPECIAL
                                  Frame Overlap:  NONE
   1) SQUARE
   2) HANN
   3) FLAT TOP
>* 4) SPECIAL
   5) CORRELATION
   6) IMPACT
```

4a)

```
Frame Overlap                     Window Type:  SPECIAL
                                  Frame Overlap:  MAX
   1) NONE
   2) 50%
>* 3) MAX
```

5)

```
    Window Type                    Window Type:  CORRELATION
                                   Frame Overlap:  MAX
    1) SQUARE
    2) HANN
    3) FLAT TOP
    4) SPECIAL
>*  5) CORRELATION
    6) IMPACT
```

5a)

```
    Frame Overlap                  Window Type:  CORRELATION
                                   Frame Overlap:  NONE
>*  1) NONE
    2) 50%
    3) MAX
```

6)

```
    Window Type                    Window Type:  IMPACT
                                   Refr Window strt:  0
    1) SQUARE                      # of Resp Windows:  0
    2) HANN                        Frame Overlap:  NONE
    3) FLAT TOP
    4) SPECIAL
    5) CORRELATION
>*  6) IMPACT
```

6a)

```
    ENTER % FULL FRAME UNTIL       Window Type:  IMPACT
    REFERENCE WINDOW TAPER         Refr Window strt:  0
    * 0                            # of Resp Windows:  0
                                   Frame Overlap:  NONE
   >
```

6b)

```
ENTER # OF EXPONENTIAL
RESP WINDOWS TO APPLY
* 0

>
```

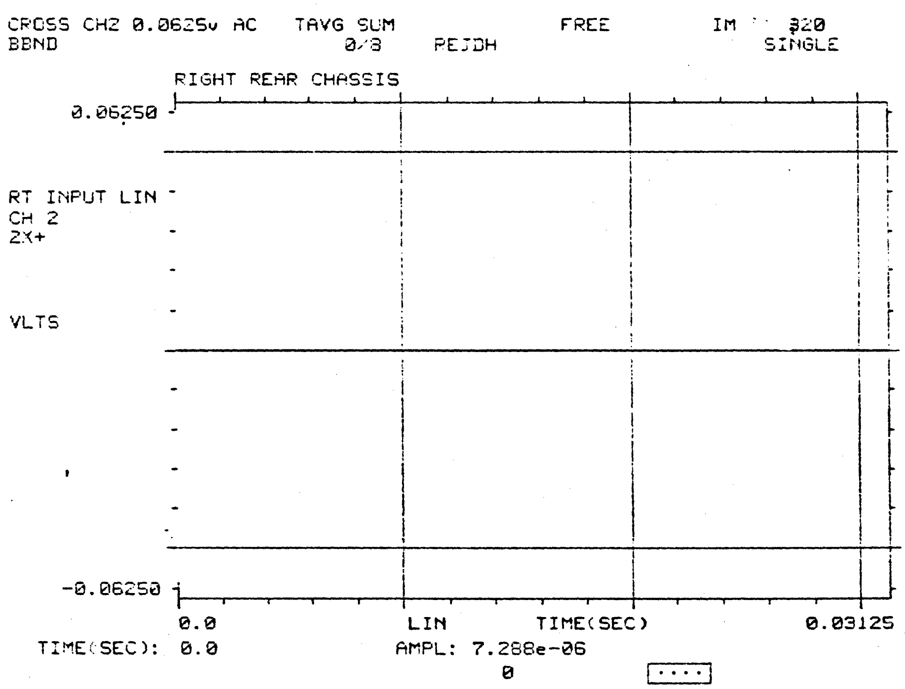
```
Window Type:  IMPACT
Refr Window strt:  0
# of Resp Windows:  0
Frame Overlap:  NONE
```

6c)

```
 Frame Overlap

>*  1) NONE
    2) 50%
    3) MAX
```

```
Window Type:  IMPACT
Refr Window strt:  0
# of Resp Windows:  0
Frame Overlap:  NONE
```

6d)



C. TRIG Pushbutton

1)

```
   Trigger                         Trigger:  FREE RUN
                                   Channel:  1
>*  1) FREE RUN                    Trigger Level:  0
    2) AUTO ARM 1st FRAME          Slope:  +
    3) AUTO ARM EVERY FRAME        Delay:  0
    4) TRIG-MAN ARM                Aux Delay:  0
```

1a)

```
ENTER Trigger Channel #        Trigger:  FREE RUN
(0 selects EXTERNAL TRIGGER)   Channel:  1
* 1                            Trigger Level:  0
                               Slope:  +
>                              Delay:  0
                               Aux Delay:  0
```

1b)

```
ENTER Trigger Level            Trigger:  FREE RUN
% of Full Scale                Channel:  1
* 0                            Trigger Level:  0
                               Slope:  +
>                              Delay:  0
                               Aux Delay:  0
```

1.1)

```
   Slope                       Trigger:  FREE RUN
                               Channel:  1
>*  1) +                       Trigger Level:  0
    2) -                       Slope:  +
                               Delay:  0
                               Aux Delay:  0
```

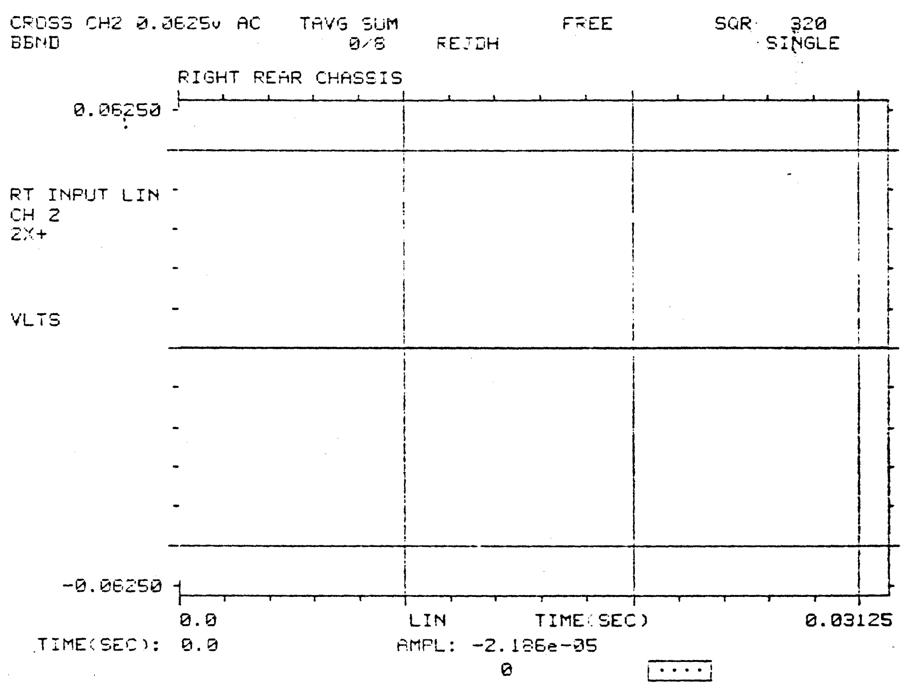
1.1a)

```
ENTER TRIGGER DELAY              Trigger:  FREE RUN
IN % of FRAME                    Channel:  1
(- Delay for Pre-Trig)           Trigger Level:  0
* 0                              Slope:  +
                                 Delay:  0
>                                Aux Delay:  0
```

1.1b)

```
ENTER AUXILIARY DELAY            Trigger:  FREE RUN
IN % of FRAME                    Channel:  1
* 0                              Trigger Level:  0
                                 Slope:  +
>                                Delay:  0
                                 Aux Delay:  0
```

1.1c)



2)

```
   Trigger

   1) FREE RUN
>* 2) AUTO ARM 1st FRAME
   3) AUTO ARM EVERY FRAME
   4) TRIG-MAN ARM
```

```
Trigger:  AUTO ARM 1st FRAME
Channel:  1
Trigger Level:  0
Slope:  +
Delay:  0
Aux Delay:  0
```

3)

```
   Trigger

   1) FREE RUN
   2) AUTO ARM 1st FRAME
>* 3) AUTO ARM EVERY FRAME
   4) TRIG-MAN ARM
```

```
Trigger:  AUTO ARM EVERY FRAME
Channel:  1
Trigger Level:  0
Slope:  +
Delay:  0
Aux Delay:  0
```

4)

```
   Trigger

   1) FREE RUN
   2) AUTO ARM 1st FRAME
   3) AUTO ARM EVERY FRAME
>* 4) TRIG-MAN ARM
```

```
Trigger:  TRIG-MAN ARM
Channel:  1
Trigger Level:  0
Slope:  +
Delay:  0
Aux Delay:  0
```

D. STATE Pushbutton

1)

```
Storage Setup

Storage Grouping:  Single
Restriction:  TRANSFER FUNCTION
Acquisition Type:  SHAKER TEST
Current File:
File Status:  CLOSED
File Format:  MODAL
Previous Action:  recall
SUCCEEDED
```

```
Output Signal Setup

Signal:  Off
Signal Level:     0.0
Frequency Type:  Baseband
```

```
Digital Plotter

Plotter Type:  SCREEN COPY
```

1a)

```
mode:  CROSS CHANNEL
Frequency Setup

Frequency Type:  BASEBAND
BASEBAND max freq:   10240
ZOOM min freq:          0.0
ZOOM max freq:       10240
# of Lines:  320
External Sample:  OFF
frame size:  1024
resolution:        32.00
sampling interval:   3.052e-05
```

```
Trigger Setup

Trigger:  TRIG-MAN ARM
Channel:  1
Trigger Level:  0
Slope:  +
Delay:  0
Aux Delay:  0
```

```
Averaging Setup

Averaging Domain:  TIMExx
Averaging Mode:  SUMMATION
# of Averages:  8
Autorange:  OFF
Accept:  AUTO REJ O/L & DBL HIT
Accept Min Peak %:  35
```

```
Window Setup

Window Type:  SQUARE
Frame Overlap:  NONE
```

1b)

UPPER DISPLAY

function: TIME

Source: REAL TIME
Chan: 2

X Scale: LIN AUTO SCALE
EXPAND Min X: 0.0
EXPAND Max X: 1.000

Y Scale: LIN AUTO SCALE
EXPAND Min Y: -8.000
EXPAND Max Y: 8.000

Ampl Units: V
Ampl Normalization: U
Freq Units: ORDERS
ORDER Reference: 0.0

LOWER DISPLAY

function: SPECTRUM

Source: REAL TIME
Chan: 2

X Scale: LIN AUTO SCALE
EXPAND Min X: 0.0
EXPAND Max X: 1.000
Y Scale: LIN AUTO SCALE
EXPAND Min Y: -8.000
EXPAND Max Y: 8.000

Ampl Units: V
Ampl Normalization: U
Freq Units: Hz

1c)

CHAN	VOLTS	COORD	CAL FACTOR	UNIT/VOLT	CPL	CHAN ID
1	8.0v	1X+	1.000	INCHES	AC	LEFT REAR CHASSIS
2	8.0v	2X+	1.000	INCHES	AC	RIGHT REAR CHASSIS
3	8.0v	3X-	1.000	INCHES	AC	LEFT MOTOR MOUNT
4	8.0v	4X-	1.000	INCHES	AC	RIGHT MOTOR MOUNT

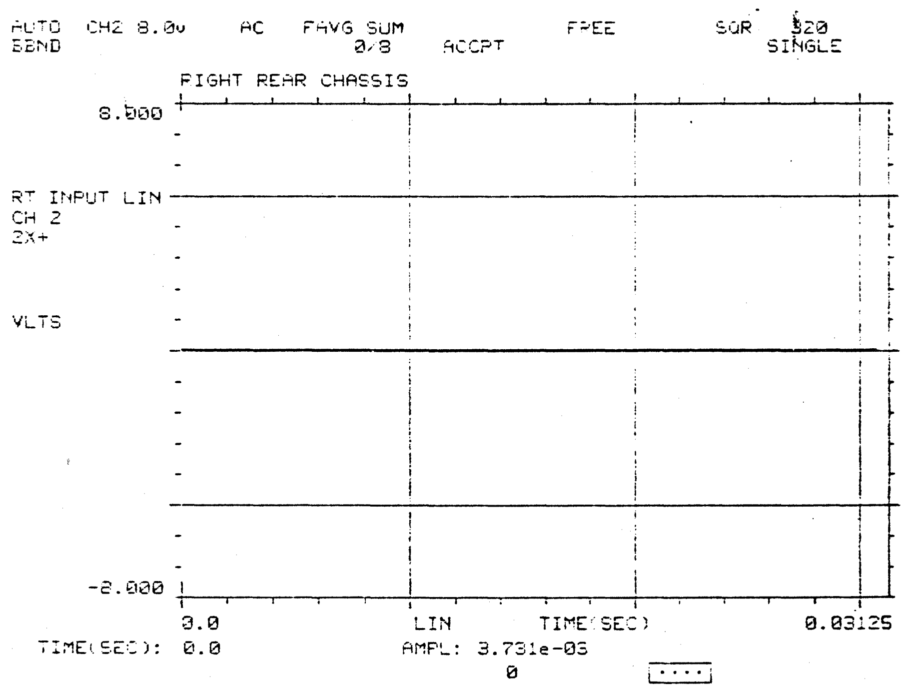
res chan	ref chan
8*2	*1
3	1
4	1
1	1

E. MODE Pushbutton

1)

```
   mode

>* 1) AUTO CHANNEL
   2) CROSS CHANNEL
   3) PROBABILITYxx
   4) EXIT TO MODAL ANALYSIS
   5) EXIT TO RT-11
```

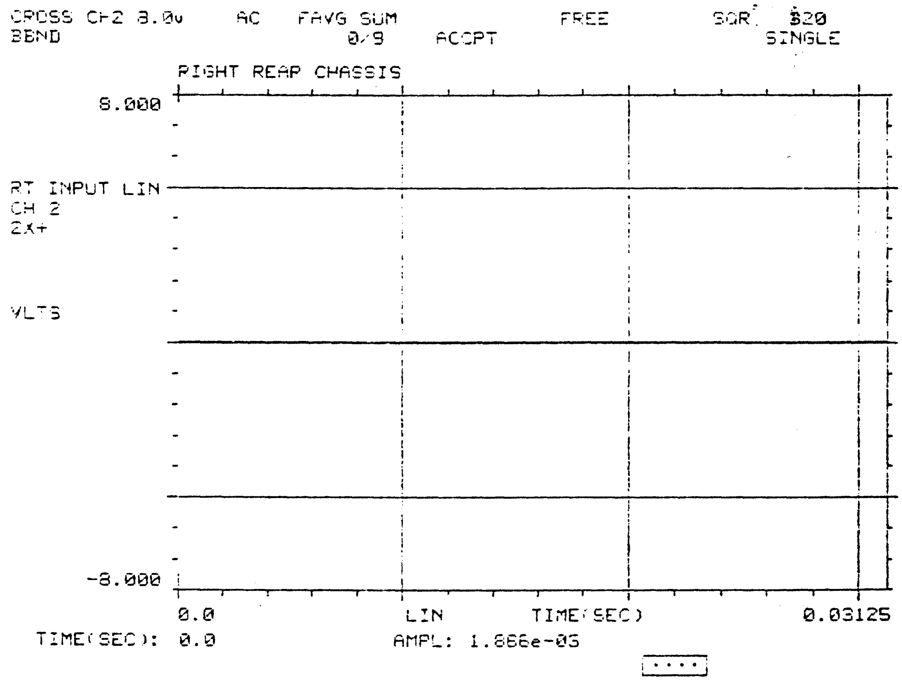
1a)



2)

```
   mode

   1) AUTO CHANNEL
>* 2) CROSS CHANNEL
   3) PROBABILITYxx
   4) EXIT TO MODAL ANALYSIS
   5) EXIT TO RT-11
```

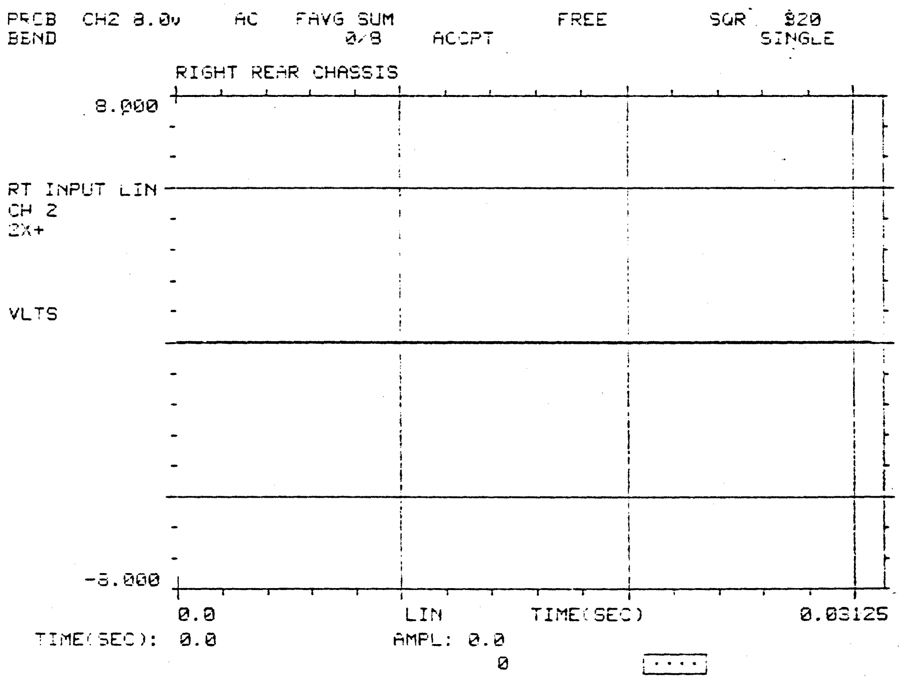
2a)



3)

```
mode

    1) AUTO CHANNEL
    2) CROSS CHANNEL
>*  3) PROBABILITYxx
    4) EXIT TO MODAL ANALYSIS
    5) EXIT TO RT-11
```

3a)



4) Exit RTA

5) Exit RTA

F. CHANS Pushbutton

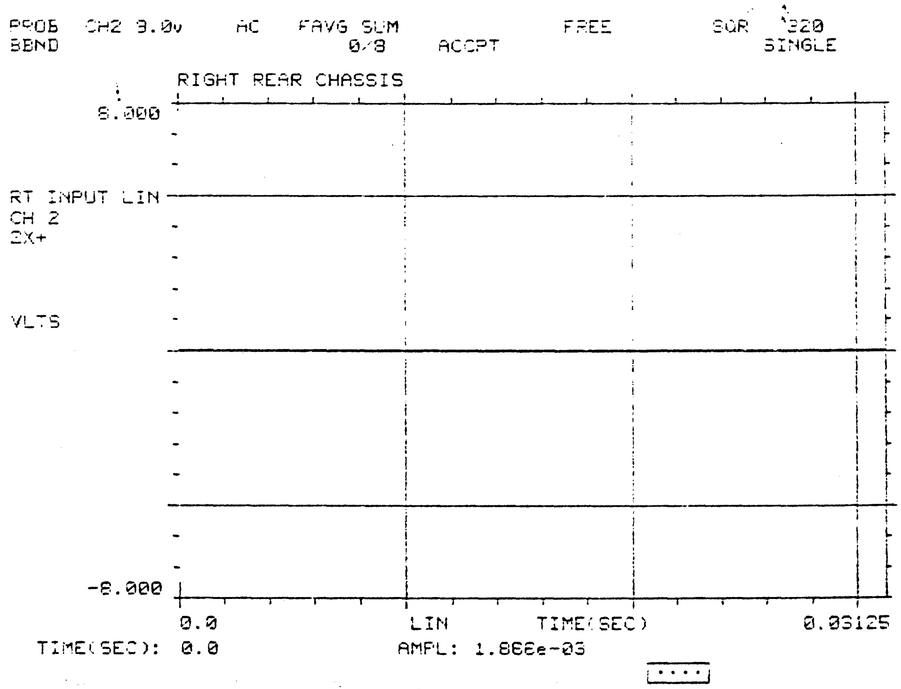
1)

```
Response channel assingments      res chan
                                  @*2
* designates active channel        3
                                   4
To modify, use arrows              1
to move @ and ENTER new
response channels

ENTER 0 to deactivate channels



 ENTER RESPONSE CHANNEL

 * 2

>
```

1a)

```
Active channels and their      CH #     COORD
Modal coordinate labels
                              @ 2        1X+
To modify, use arrows
to move @ to CH #, and
ENTER new label



 Move @ to Channel and
 ENTER the New Coord
 * 1X+

>
```

1b)



G. LEVEL Pushbutton

1)

```
ENTER CHANNEL #
to be SET UP
* 1

>
```

```
Setup Channel:  1
Volts Full Scale:  8.0v
MODAL coord:  1X+
Cal factor:        1.000
Cal units:  INCHES
                per 1.0 volt
Coupling:  AC
Chan ID:  LEFT REAR CHASSIS
```

1.1)

```
   Volts Full Scale

>*  1) 8.0v
    2) 4.0v
    3) 2.0v
    4) 1.0v
    5) 0.5v
    6) 0.25
    7) 0.125
    8) 0.0625
```

```
Setup Channel:  1
Volts Full Scale:  8.0v
MODAL coord:  1X+
Cal factor:        1.000
Cal units:  INCHES
                per 1.0 volt
Coupling:  AC
Chan ID:  LEFT REAR CHASSIS
```

1a)

```
ENTER MODAL COORDINATE
in form nnX+
* 1X+

>
```

```
Setup Channel:  1
Volts Full Scale:  8.0v
MODAL coord:  1X+
Cal factor:        1.000
Cal units:  INCHES
                per 1.0 volt
Coupling:  AC
Chan ID:  LEFT REAR CHASSIS
```

1b)

```
CAL FACTOR=<FACTOR> "UNITS"
                PER 1.0 VOLT
ENTER <FACTOR>
* 1.000

>
```

```
Setup Channel:  1
Volts Full Scale:  8.0v
MODAL coord:  1X+
Cal factor:        1.000
Cal units:  INCHES
                per 1.0 volt
Coupling:  AC
Chan ID:  LEFT REAR CHASSIS
```

1c)

```
CAL FACTOR=<FACTOR> "UNITS"   Setup Channel:  1
             PER 1.0 VOLT     Volts Full Scale:  8.0v
ENTER <UNITS>                 MODAL coord:  1X+
* INCHES                      Cal factor:       1.000
                              Cal units:  INCHES
>                                           per 1.0 volt
                              Coupling:  AC
                              Chan ID:  LEFT REAR CHASSIS
```

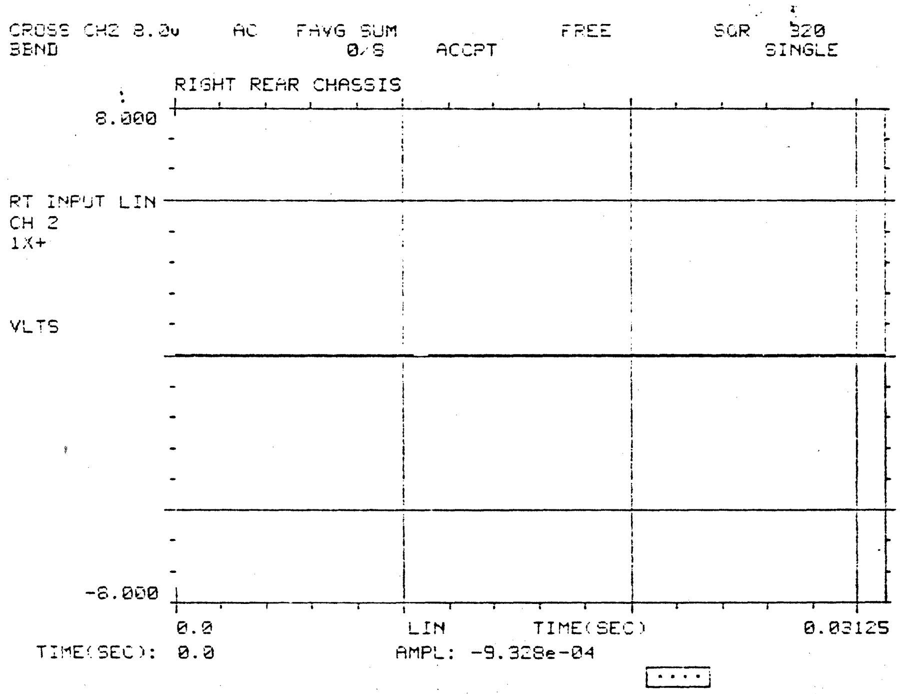
1.1.1)

```
   Coupling                   Setup Channel:  1
                              Volts Full Scale:  8.0v
>*  1) AC                     MODAL coord:  1X+
    2) DC                     Cal factor:       1.000
    3) ZERO                   Cal units:  INCHES
    4) BIAS SOURCE                          per 1.0 volt
    5) DCR:S/W DC REMOVAL     Coupling:  AC
                              Chan ID:  LEFT REAR CHASSIS
```

1.1.1a)

```
 ENTER CHANNEL I.D. LABEL     Setup Channel:  1
 * LEFT REAR CHASSIS          Volts Full Scale:  8.0v
                              MODAL coord:  1X+
>                             Cal factor:       1.000
                              Cal units:  INCHES
                                            per 1.0 volt
                              Coupling:  AC
                              Chan ID:  LEFT REAR CHASSIS
```

1.1.1b)



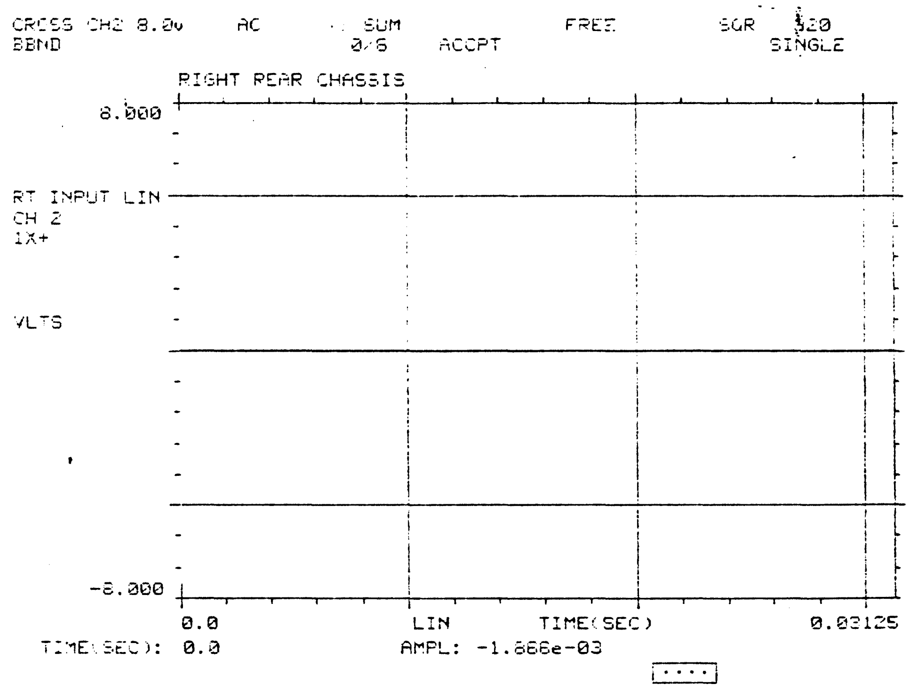
1.1.2)

```
Coupling                         Setup Channel:  1
                                 Volts Full Scale:  8.0v
   1) AC                         MODAL coord:  1X+
>* 2) DC                         Cal factor:        1.000
   3) ZERO                       Cal units:  INCHES
   4) BIAS SOURCE                        per 1.0 volt
   5) DCR:S/W DC REMOVAL         Coupling:  DC
                                 Chan ID:  LEFT REAR CHASSIS
```

1.1.2a)

```
ENTER CHANNEL I.D. LABEL         Setup Channel:  1
* LEFT REAR CHASSIS              Volts Full Scale:  8.0v
                                 MODAL coord:  1X+
>                                Cal factor:        1.000
                                 Cal units:  INCHES
                                         per 1.0 volt
                                 Coupling:  DC
                                 Chan ID:  LEFT REAR CHASSIS
```

1.1.2b)



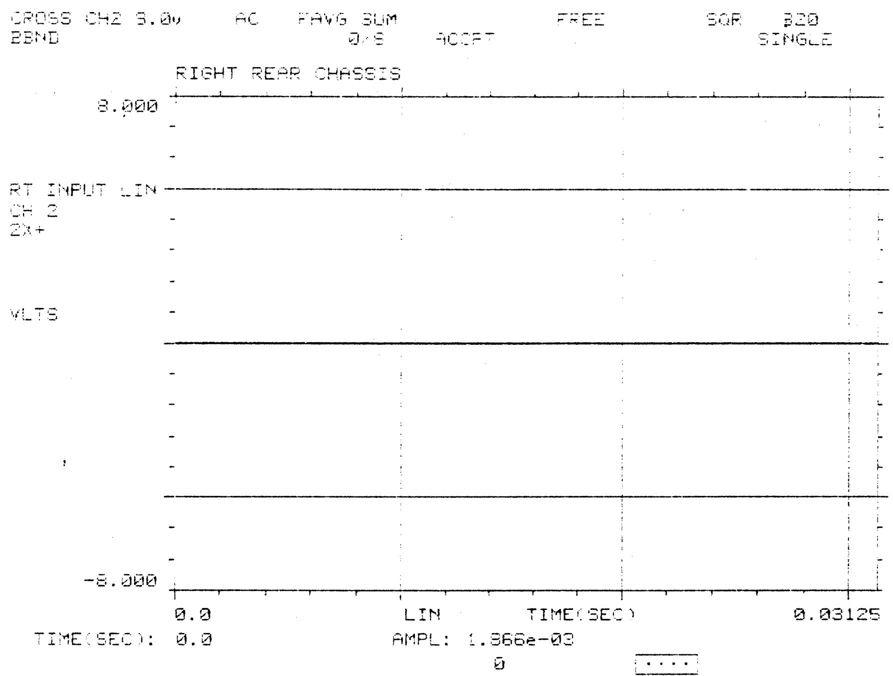
1.1.3)

```
Coupling                        Setup Channel:  1
                                Volts Full Scale:   8.0v
1) AC                           MODAL coord:  1X+
2) DC                           Cal factor:         1.000
>* 3) ZERO                      Cal units:  INCHES
4) BIAS SOURCE                                per 1.0 volt
5) DCR:S/W DC REMOVAL           Coupling:  ZERO
                                Chan ID:  LEFT REAR CHASSIS
```

1.1.3a)

```
ENTER CHANNEL I.D. LABEL        Setup Channel:  1
* LEFT REAR CHASSIS             Volts Full Scale:   8.0v
>                               MODAL coord:  1X+
                                Cal factor:         1.000
                                Cal units:  INCHES
                                              per 1.0 volt
                                Coupling:  ZERO
                                Chan ID:  LEFT REAR CHASSIS
```

1.1.3b)



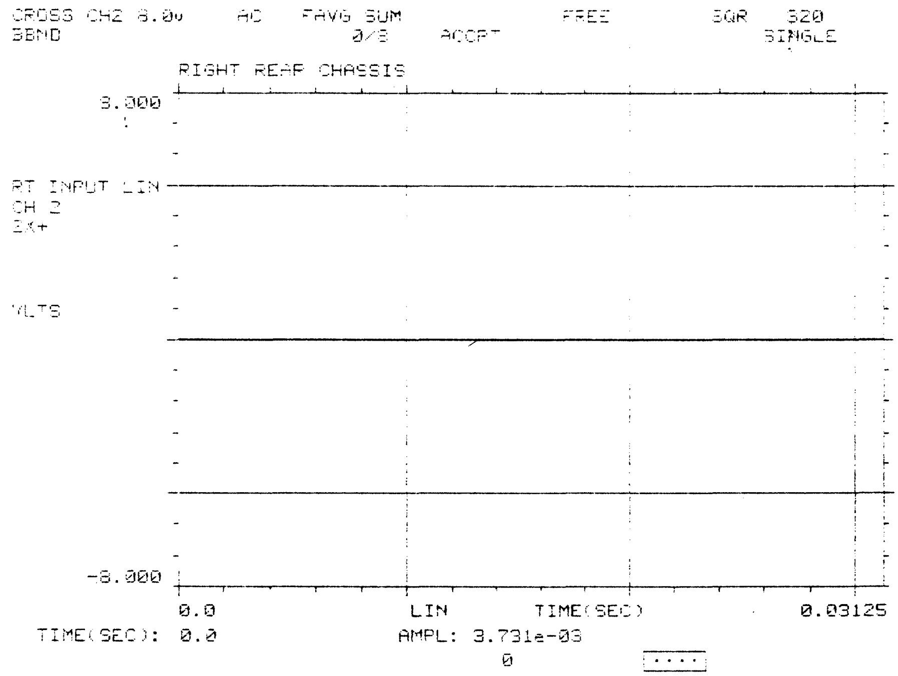
1.1.4a)

```
 Coupling                     Setup Channel:  1
                              Volts Full Scale:  8.0v
 1) AC                        MODAL coord:  1X+
 2) DC                        Cal factor:        1.000
 3) ZERO                      Cal units:  INCHES
>* 4) BIAS SOURCE                           per 1.0 volt
 5) DCR:S/W DC REMOVAL        Coupling:  BIAS SOURCE
                              Chan ID:  LEFT REAR CHASSIS
```

1.1.4b)

```
 ENTER CHANNEL I.D. LABEL     Setup Channel:  1
 * LEFT REAR CHASSIS          Volts Full Scale:  8.0v
                              MODAL coord:  1X+
>                             Cal factor:        1.000
                              Cal units:  INCHES
                                          per 1.0 volt
                              Coupling:  BIAS SOURCE
                              Chan ID:  LEFT REAR CHASSIS
```

1.1.4c)



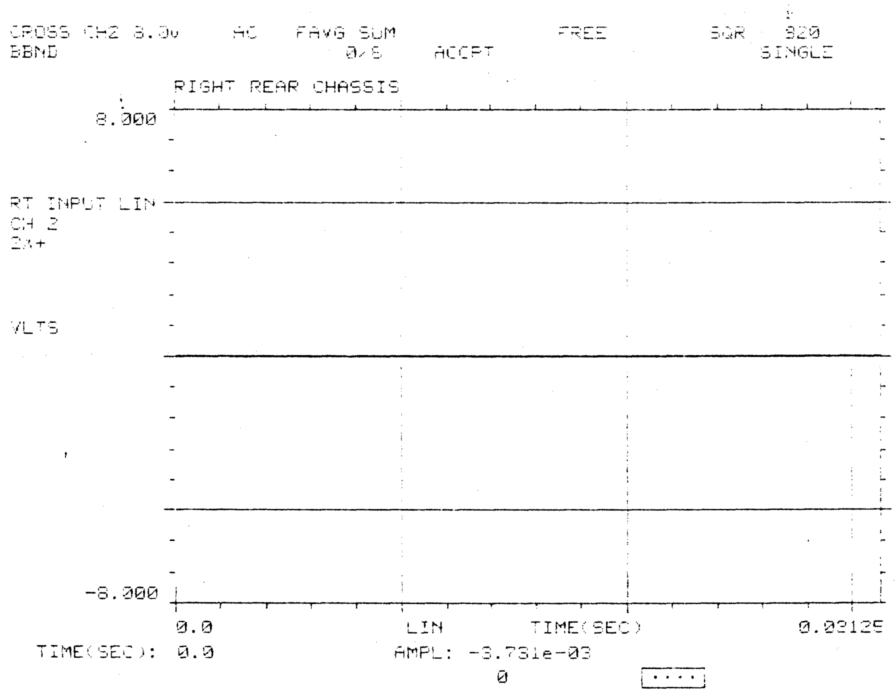
1.1.5)

```
   Coupling                          Setup Channel:  1
                                     Volts Full Scale:  8.0v
   1) AC                             MODAL coord:  1X+
   2) DC                             Cal factor:       1.000
   3) ZERO                           Cal units:   INCHES
   4) BIAS SOURCE                                per 1.0 volt
>* 5) DCR:S/W DC REMOVAL             Coupling:  DCR:S/W DC REMOVAL
                                     Chan ID:   LEFT REAR CHASSIS
```

1.1.5a)

```
ENTER CHANNEL I.D. LABEL          Setup Channel:  1
* LEFT REAR CHASSIS               Volts Full Scale:  8.0v
                                  MODAL coord:  1X+
>                                 Cal factor:       1.000
                                  Cal units:   INCHES
                                              per 1.0 volt
                                  Coupling:  DCR:S/W DC REMOVAL
                                  Chan ID:   LEFT REAR CHASSIS
```

1.1.5b)



H. FREQ Pushbutton

1)

```
    Frequency Type

>*  1) BASEBAND
    2) ZOOM
```

```
Frequency Type:  BASEBAND
BASEBAND max freq:    10240
ZOOM min freq:          0.0
ZOOM max freq:        10240
# of Lines:  320
External Sample:  OFF
frame size:  1024
resolution:          32.00
sampling interval:   3.052e-05
```

1a)

```
ENTER MAXIMUM FREQUENCY
* 10240
```

```
Frequency Type:  BASEBAND
BASEBAND max freq:    10240
ZOOM min freq:          0.0
ZOOM max freq:        10240
# of Lines:  320
External Sample:  OFF
frame size:  1024
resolution:          32.00
sampling interval:   3.052e-05
```

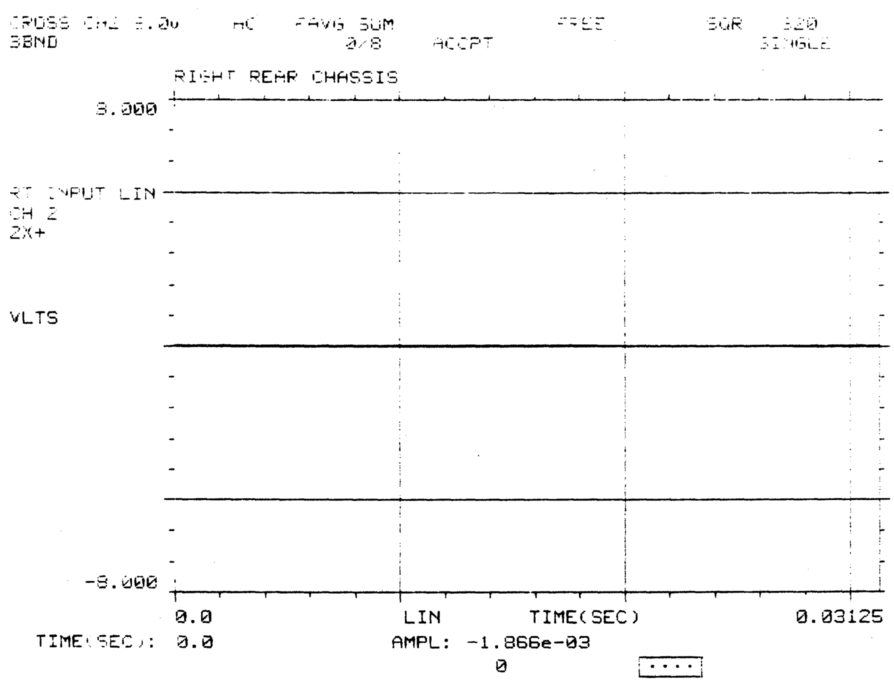
1b)

```
    # of Lines                       Frequency Type:  BASEBAND
                                     BASEBAND max freq:    10240
    1) 80                            ZOOM min freq:          0.0
    2) 160                           ZOOM max freq:        10240
>*  3) 320                           # of Lines:  320
    4) 512   *MODAL                  External Sample:  OFF
    5) 640                           frame size:  1024
    6) 1280                          resolution:          32.00
    7) 2560                          sampling interval:    3.052e-05
```

1c)

```
    External Sample                  Frequency Type:  BASEBAND
                                     BASEBAND max freq:    10240
>*  1) OFF                           ZOOM min freq:          0.0
    2) ON                            ZOOM max freq:        10240
                                     # of Lines:  320
                                     External Sample:  OFF
                                     frame size:  1024
                                     resolution:          32.00
                                     sampling interval:    3.052e-05
```

1d)



1f)

```
   External Sample                 Frequency Type:  BASEBAND
                                   BASEBAND max freq:   10240
   1) OFF                          ZOOM min freq:         0.0
>* 2) ON                           ZOOM max freq:       10240
                                   # of Lines:  320
                                   External Sample:  ON
                                   frame size:  1024
                                   resolution:        32.00
                                   sampling interval:  EXTERNAL
```

2)

```
   Frequency Type                  Frequency Type:  ZOOM
                                   BASEBAND max freq:   10240
   1) BASEBAND                     ZOOM min freq:         0.0
 * 2) ZOOM                         ZOOM max freq:       10240
                                   # of Lines:  320
                                   External Sample:  OFF
                                   frame size:  1024
                                   resolution:        32.00
                                   sampling interval:   3.052e-05
```

2a)

```
   ENTER ZOOM MINIMUM, MAXIMUM     Frequency Type:  ZOOM
   * 0.0,10240                     BASEBAND max freq:   10240
                                   ZOOM min freq:         0.0
                                   ZOOM max freq:       10240
                                   # of Lines:  320
                                   External Sample:  OFF
                                   frame size:  1024
                                   resolution:        32.00
                                   sampling interval:   3.052e-05
```

2b)

```
   # of Lines                      Frequency Type:  ZOOM
                                   BASEBAND max freq:   10240
   1) 80                           ZOOM min freq:         0.0
   2) 160                          ZOOM max freq:       10240
 * 3) 320                          # of Lines:  320
   4) 512   *MODAL                 External Sample:  OFF
   5) 640                          frame size:  1024
   6) 1280                         resolution:        32.00
   7) 2560                         sampling interval:   3.052e-05
```

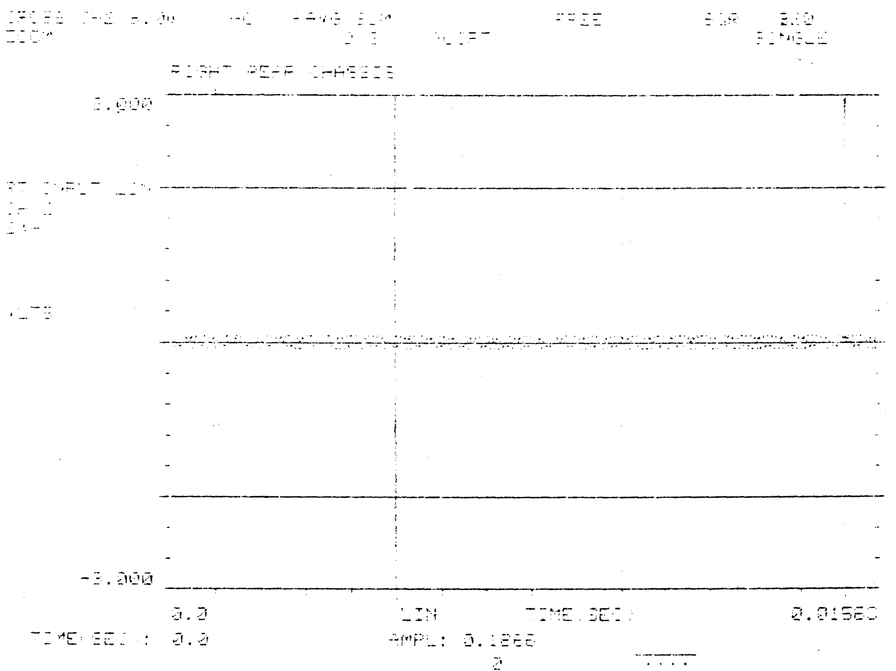
2c)

External Sample

* 1) OFF
2) ON

Frequency Type: ZOOM
BASEBAND max freq: 10240
ZOOM min freq: 0.0
ZOOM max freq: 10240
# of Lines: 320
External Sample: OFF
frame size: 1024
resolution: 32.00
sampling interval: 3.052e-05

2d)



DISPLAY GROUP 6

Miscellaneous Pushbuttons

A. OUTPUT SIGNAL

1)

```
   Output Signal                   Signal:  Off
                                   Signal Level:     0.0
>* 1) OFF                          Frequency Type:   Baseband
   2) SINE WAVE
   3) RANDOM NOISE
   4) BAND RANDOM
```

2)

```
   Output Signal                   Signal:  Sine Wave
                                   Signal Level:     0.0
   1) OFF                          SINE freq:  5000
>* 2) SINE WAVE                    Frequency Type:   Baseband
   3) RANDOM NOISE
   4) BAND RANDOM
```

2a)

```
   ENTER Sine Wave Frequency       Signal:  Sine Wave
   with 1 Hz Resolution            Signal Level:     0.0
   * 5000                          SINE freq:  5000
                                   Frequency Type:   Baseband
 >
```

2b)

```
   ENTER the RMS Level of          Signal:  Sine Wave
   Output Sine Wave (0-4.5V)       Signal Level:     0.0
   * 0.0                           SINE freq:  5000
                                   Frequency Type:   Baseband
 >
```

3)

```
    Output Signal                 Signal:  Random Noise
                                  Signal Level:    0.0
    1) OFF                        Frequency Type:  Baseband
    2) SINE WAVE
>*  3) RANDOM NOISE
    4) BAND RANDOM
```

3a)

```
    ENTER the RMS Level of        Signal:  Random Noise
    Output Noise (0-1.0V)         Signal Level:    0.0
    * 0.0                         Frequency Type:  Baseband

>
```

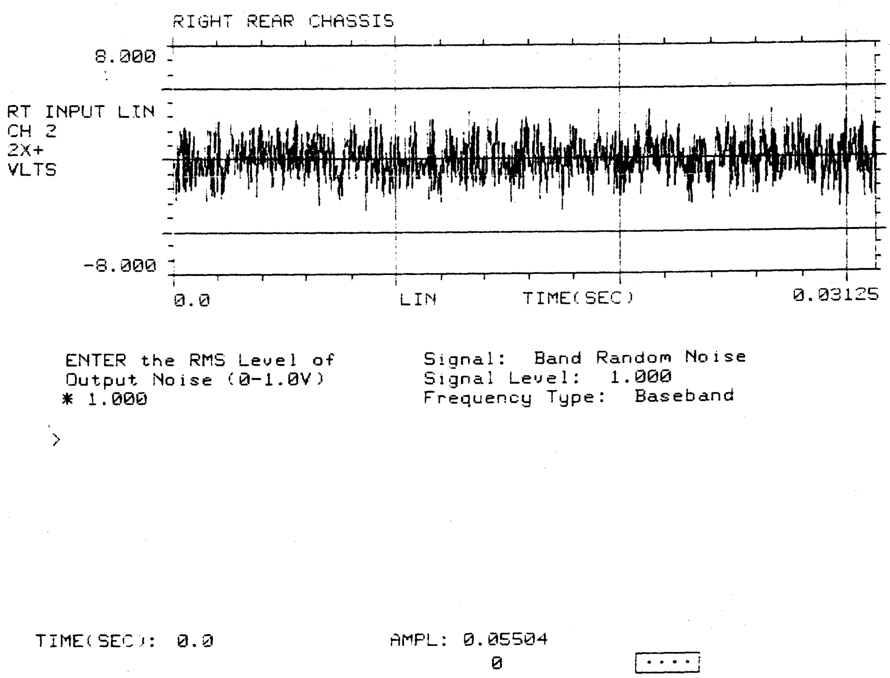
4)

```
    Output Signal                 Signal:  Band Random Noise
                                  Signal Level:    0.0
    1) OFF                        Frequency Type:  Baseband
    2) SINE WAVE
    3) RANDOM NOISE
>*  4) BAND RANDOM
```

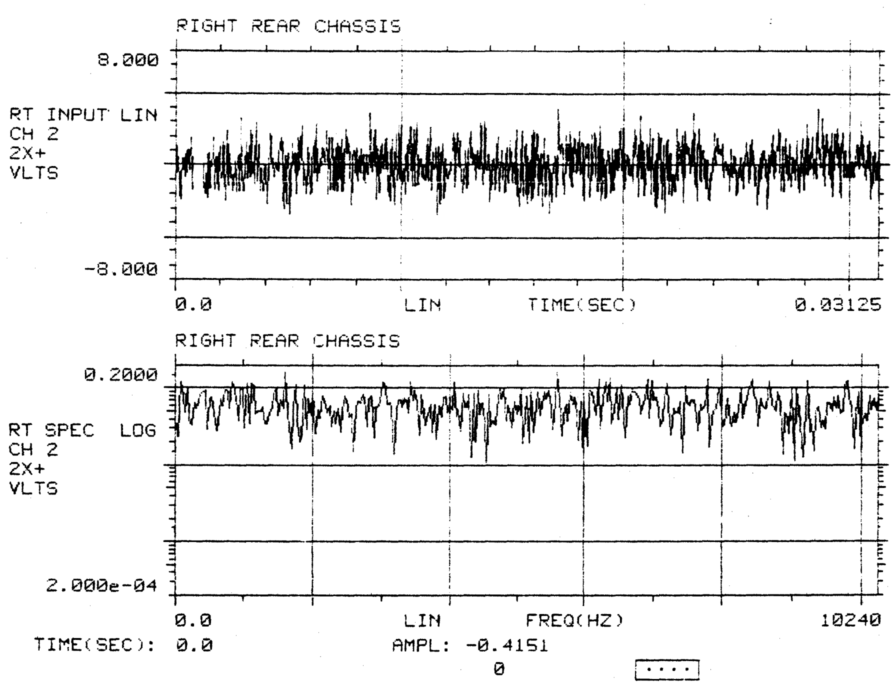
4a)

```
    ENTER the RMS Level of        Signal:  Band Random Noise
    Output Noise (0-1.0V)         Signal Level:    0.0
    * 0.0                         Frequency Type:  Baseband

>
```

4b)



4c) Dual Display of OUTPUT Signal



APPENDIX B

RTA FILE FORMAT

B.1 INTRODUCTION

Both the MODAL file format and the STANDARD file format used in the RTA program have a similar structure. Note that the MODAL file format is almost identical to the SDRC MODAL file. The differences are intergrated in such a way that data in the GenRad MODAL format is readable by the SDRC MODAL-PLUS program. Certain parameters in the header are used in such a way that added flexibility has been added to the use of the SDRC MODAL format in the RTA program.

This appendix provides a brief description of the SDRC MODAL format. For a detailed description of the SDRC MODAL format refer to the SDRC MODAL-PLUS Reference Manual, part number 5200.341 (GenRad part number 1765-7214). The important differences between the SDRC MODAL format and the RTA MODAL and STANDARD file formats are described in this appendix.

In terms of structure, both data bases consist of the following sections:

- o File Header section
- o Directory Entry section
- o Functional Header section
- o Data Section

B.2 FILE HEADER

The file header is one block in size, and designated by the name of the array A[ ] for compatibility with SDRC FORMAT descriptions. The contents of array A[ ] are as follows:

Array		Description
A[1]	0	Reserved in SDRC MODAL format.
	1	Reserved in RTA MODAL format.
A[2]	0	SDRC reserved.
A[3]		File type code, ASCII:
	'H'	MODAL format
	'S'	STANDARD format

Array		Description
A[4]	4	SDRC file type code.
A[5]	L	Length of the file label in bytes (maximum of 58).
A[6] thru A[34]		ASCII file label (null termimated).
A[35]		SDRC format date.
A[36]		SDRC format time.
A[37] thru A[43]		SDRC reserved.
A[44]	256	Number of words per block.
A[45]	D	Starting block number of data (counting from one) where: $D = N - 4n$
A[46]	N	File size in blocks where: $N = 1 + [(n+3)/128] + [n+4] + 4n$
A[47]	n	File size in the number of records (functions).
A[48]	1	Number of blocks per record.
A[49]	4	Number of Function Header entries per record.
A[50]	64	Function Header size in words.
A[51]	F	Function Header starting block number offset from start of file counting from one where: $F = 2 + [(n + 3)/128]$
A[52] thru A[64]		SDRC reserved.
A[65] thru A[104]		ADF filename (null terminated).
A[105] thru A[256]		SDRC reserved.
A[120]		STANDARD format file only. Next block to write function data; Physical block number counting from zero. Initialized to A[45] - 1

B.3 DIRECTORY OF RECORDS

The format of the directory entry section is as follows:

Word	Description
1 k1	Count of functions stored.
2 k2	Pointer (function number) to the last function sequentially stored.
3 k3	Pointer (record number) to last delete function.
4	SDRC reserved but not used. RTA stores the pointer to the Stored Panel data record.
5,6	SDRC reserved.
7,8	Reference coordinate, response coordinate for first function record in SDRC format. Followed by additional pairs of coordinates (two words each). Serves as the directory entries.
n	0, "hole" indicator.
n + 1	Relative entry to next "hole", 0 if none. If a record is deleted, its reference coordinate word is changed to zero, and its response coordinate is set to point to the record designated by k3. Then k3 is set to the record number of the deleted record. Note that record k3 is the first deleted record that is reused.

B.4 FUNCTION HEADER

Each record header is 64 words long. SDRC calls the record header the "C" array (C[ ]). The contents of the C array are as follows:

Array	Description
C[1]	SDRC reference coordinate code[1].
C[2]	SDRC response coordinate code[2].
C[3]	02003, signal code pair.

---

1. Note that the numeric part of the coordinate should be less than 8000, e.g. 123x+
2. Note that the numeric part of the coordinate should be less than 8000, e.g. 123x+

Array	Description
C[4]	Sequence number (<= 255) and priority (priority is not used).
C[5]	Function label length, maximum 58. Note that RTA allows a maximum of only 30.

NOTE: RTA uses C[6] thru C[34] differently than SDRC. The text area is restricted to the first 30 characters. The remainder (28) is used for GenRad specific information.

The following is a description of how the RTA program uses C[6] thru C[34]:

Array	Description
RTA C[6] thru C[20]	Label text (null terminated).
RTA C[21] thru C[25]	Response channel units text (null terminated.
RTA C[26] thru C[30]	Reference channel units text (null terminated).
RTA C[31]	Function type code (refer to paragraph B.6.2 for additional information). (MODLAC (TSL) uses a restricted number of types.)
RTA C[32]	Display units used when data is stored:

b0 = 1 If engineering units were used.
0 If engineering units were not used.

b1-b3 = Y-axis units normalized
0 - Volts
1 - V**2
2 - V**2/Hz
3 - V**2*Sec/Hz

b4-b6 = X-axis units
0 - Hz
1 - CPM

Array	Description
RTA C[33]	Number format and channel number('s) prior to RTA version 2.0 (5-25-84):

b0-b7 Reference channel number.

b8-b15 Response channel number.

NOTE: With RTA version 2.0 the following bits assignments have been used:

b0-b4 Reference channel number.

b5-b7 Number format code. (For additional information on the number format code refer to paragraph B.6.1).

b8-b12 Response channel number.

b13 Blockmath used on data prior to storage.

b14 Complex blockmath data block.

b15 RTA compatibility. If the function type and number format are not compatible (MODLAC standard format can generate incompatible data, e.g. complex time) RTA ignores this type data and issues an error message.

RTA C[34] Number of Averages and RTA/MODLAC flag.

b0-b14 Number of averages

b15 Flag indicating that a record is being generated by either RTA or MODLAC (standard file format).

NOTE: If b15 is set (1), C[5] through C[32] are interpreted by RTA as described above. However, if b15 is not set (0), the area from C[5] through C[33] is interpreted as label text, as in SDRC MODAL or MODAL+.

Array	Description
C[35]	Date. See SDRC format.
C[36]	Time. See SDRC format.
C[37]	Starting physical block number of data, not used by SDRC (the first physical block of this file is "0" not "1".
C[38]	Number of data values.
C[39]	SDRC format code (used by SDRC MODAL-PLUS to determine the number and format of data type). 0146502 Frequency Response Function (complex). 0106502 Frequency Spectrum (complex). 046101 Time History (real).
C[40]	Block exponent.
C[41] thru C[42]	Block resolution.
C[43] thru C[44]	Block minimum.
C[45] thru C[46]	Real part of maximum ordinate.
C[47] thru C[48]	Imaginary part of residual compliance.
C[49] thru C[50]	Real part of residual compliance.
C[51] thru C[52]	Imaginary part of residual compliance.
C[53] thru C[54]	Real part of residual compliance.
C[55] thru C[56]	Imaginary part of residual mobility.
C[57] thru C[58]	Real part of inertance.
C[59] thru C[60]	Imaginary part of inertance.
C[61]	Exponential window application count (IDECAY).
C[62] thru C[64]	SDRC reserved.

B.5 DATA

Regardless of function type, the data stored in RTA MODAL file format are all TSL block integers (SDRC terms it "block floating-point"). Therefore, data with a floating point number format has to be converted into TSL format. Before RTA data is stored, both a scale factor and a normalization factor are applied to the data. Both the conversion and the scaling are done in a local array. This leaves the averager buffer and display buffer untouched.

A record in MODAL format is restricted to 1024 words (four blocks on the disk). A 512 line transfer function fits into one record of 512 complex integers. A smaller function would be stored into the same four block record size. Larger functions are stored in a series as overlapping segments (with corresponding sequence numbers in the directory). This occurs for frequency functions larger than 512 elements and for time history functions larger than 1024 points.

Note that the MODAL format requires that a real frequency domain function must be stored as a complex function with the imaginary values (i.e. every other data value) equal to zero. This convention was not followed in earlier versions of the RTA program where real time and frequency functions were both stored as the same Time History real data type.

The scheme used for overlapping large records is described below. Note that the sequence number in the directory can start at any integer value. The following sequence numbers show the contents of the consecutive sequence numbers in the directory:

REAL OR COMPLEX FREQUENCY FUNCTION

Segment Number	**Ending Line Number**	**Beginning Line Number**
1	512	1
2	800	ending line # - 511
3	1200	ending line # - 511
..	(seg# * 400)	ending line # - 511

REAL TIME HISTORY FUNCTION

Segment Number	**Ending Line Number**	**Beginning Line Number**
1	1024	1
2	1600	ending line # - 1023
3	2400	ending line # - 1023
..	(seg# * 800)	ending line # - 1023

B.6 RTA STANDARD FORMAT FILE

The structure of the file is essentially the same as the MODAL file. The main differences are:

- o Standard file allows the floating point number format. It does not convert data into TSL integer format if the function is not time domain input functions.

- o Large data frames are not segmented into overlapping
- o Function size is variable.
- o Data storage relies on A[120] for the beginning block to write, and data recall relies on C[37] for the first block to read.

B.6.1 Number Format Codes

The number format codes are:

o	FPRBLK 0	floating real	2 words/data value
o	TSLIBLK 1	TSL integer	1 word/data value
o	FPCBLK 2	floating complex	4 words/data value
o	TSLICBLK 3	TSL complex	2 words/line

B.6.2 Function Type Codes

The RTA function type codes and their corresponding number formats are as follows:

Function Type		Number Format	Words/Line
TDFUNC 0	time domain	1 TSLIBLK	1
ORBITTFUNC 0	orbit diagram	0 FPRBLK	2
AHISTFUNC 2	amplitude histogram	1 TSLIBLK	1
AUXTFUNC 3	spare time type		
SPECFUNC 4	spectrum	0 FPRBLK,	2[3]
		2 FPCBLK	4
ACORFUNC 5	auto correlation	1 TSLIBLK	1
AUXSFUNC 6	spare		
CSPFUNC 7	cross spectrum	2 FPCBLK	4
TFFUNC 8	transfer function	2 FPCBLK	4
TFCBFUNC 9	transfer f with coherence blanking	2 FPCBLK	4
COHFUNC 10	coherence	0 FPRBLK	2
IMPRFUNC 11	impulse response	1 TSLIBLK	1
TRNMFUNC 12	transmissibility	0 FPRBLK	2
COHOFUNC 13	coherent output	0 FPRBLK	2
XCORFUNC 14	cross correlation	1 TSLIBLK	1
AUXCFUNC 15	spare		

3. A spectrum (SPECFUN) obtained through time domain averaging (linear spectrum) has complex valued data.

Function Type		**Number Format**	**Words/Line**
CIRCLEFUNC 16	circle fit	2 FPCBLK	4
CUMDISTFUNC 17	cumulative distr.	0 FPRBLK	2
PORBDENSFUNC 18	probability dens.	0 FPRBLK	2
RTHISTFUNC 23	real time histogram		

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