ADVANTEST®

ADVANTEST CORPORATION

R9211 Series

Digital Spectrum Analyzer

Guidebook (Operation)

MANUAL NUMBER FGE-8335019B01

First printing February 6, 1991
Printed in Japan

Safety Summary

To ensure thorough understanding of all functions and to ensure efficient use of this instrument, please read the manual carefully before using. Note that Advantest bears absolutely no responsibility for the result of operations caused due to incorrect or inappropriate use of this instrument.

If the equipment is used in a manner not specified by Advantest, the protection provided by the equipment may be impaired.

- **Warning Labels**

Warning labels are applied to Advantest products in locations where specific dangers exist. Pay careful attention to these labels during handling. Do not remove or tear these labels. If you have any questions regarding warning labels, please ask your nearest Advantest dealer. Our address and phone number are listed at the end of this manual.

Symbols of those warning labels are shown below together with their meaning.

DANGER: Indicates an imminently hazardous situation which will result in death or serious personal injury.

WARNING: Indicates a potentially hazardous situation which will result in death or serious personal injury.

CAUTION: Indicates a potentially hazardous situation which will result in personal injury or a damage to property including the product.

- **Basic Precautions**

Please observe the following precautions to prevent fire, burn, electric shock, and personal injury.

- Use a power cable rated for the voltage in question. Be sure however to use a power cable conforming to safety standards of your nation when using a product overseas.
- When inserting the plug into the electrical outlet, first turn the power switch OFF and then insert the plug as far as it will go.
- When removing the plug from the electrical outlet, first turn the power switch OFF and then pull it out by gripping the plug. Do not pull on the power cable itself. Make sure your hands are dry at this time.
- Before turning on the power, be sure to check that the supply voltage matches the voltage requirements of the instrument.
- Connect the power cable to a power outlet that is connected to a protected ground terminal. Grounding will be defeated if you use an extension cord which does not include a protected ground terminal.
- Be sure to use fuses rated for the voltage in question.
- Do not use this instrument with the case open.
- Do not place anything on the product and do not apply excessive pressure to the product. Also, do not place flower pots or other containers containing liquid such as chemicals near this

product.

- When the product has ventilation outlets, do not stick or drop metal or easily flammable objects into the ventilation outlets.
- When using the product on a cart, fix it with belts to avoid its drop.
- When connecting the product to peripheral equipment, turn the power off.

- **Caution Symbols Used Within this Manual**

Symbols indicating items requiring caution which are used in this manual are shown below together with their meaning.

DANGER: Indicates an item where there is a danger of serious personal injury (death or serious injury).

WARNING: Indicates an item relating to personal safety or health.

CAUTION: Indicates an item relating to possible damage to the product or instrument or relating to a restriction on operation.

- **Safety Marks on the Product**

The following safety marks can be found on Advantest products.

 : ATTENTION - Refer to manual.

 : Protective ground (earth) terminal.

 : DANGER - High voltage.

 : CAUTION - Risk of electric shock.

- **Replacing Parts with Limited Life**

The following parts used in the instrument are main parts with limited life.
Replace the parts listed below before their expected lifespan has expired to maintain the performance and function of the instrument.
Note that the estimated lifespan for the parts listed below may be shortened by factors such as the environment where the instrument is stored or used, and how often the instrument is used.
The parts inside are not user-replaceable. For a part replacement, please contact the Advantest sales office for servicing.

Each product may use parts with limited life.
For more information, refer to the section in this document where the parts with limited life are described.

Main Parts with Limited Life

Part name	Life
Unit power supply	5 years
Fan motor	5 years
Electrolytic capacitor	5 years
LCD display	6 years
LCD backlight	2.5 years
Floppy disk drive	5 years
Memory backup battery	5 years

- **Hard Disk Mounted Products**

The operational warnings are listed below.

- Do not move, shock and vibrate the product while the power is turned on.
  Reading or writing data in the hard disk unit is performed with the memory disk turning at a high speed. It is a very delicate process.

- Store and operate the products under the following environmental conditions.
  An area with no sudden temperature changes.
  An area away from shock or vibrations.
  An area free from moisture, dirt, or dust.
  An area away from magnets or an instrument which generates a magnetic field.

- Make back-ups of important data.
  The data stored in the disk may become damaged if the product is mishandled. The hard disc has a limited life span which depends on the operational conditions. Note that there is no guarantee for any loss of data.

- **Precautions when Disposing of this Instrument**

When disposing of harmful substances, be sure dispose of them properly with abiding by the state-provided law.

Harmful substances:
(1) PCB (polycarbon biphenyl)
(2) Mercury
(3) Ni-Cd (nickel cadmium)
(4) Other
Items possessing cyan, organic phosphorous and hexadic chromium and items which may leak cadmium or arsenic (excluding lead in solder).

Example: fluorescent tubes, batteries

Environmental Conditions

This instrument should be only be used in an area which satisfies the following conditions:

- An area free from corrosive gas
- An area away from direct sunlight
- A dust-free area
- An area free from vibrations
- Altitude of up to 2000 m

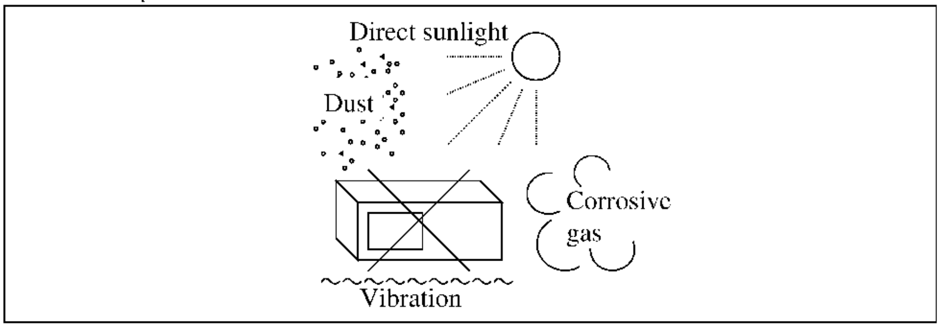
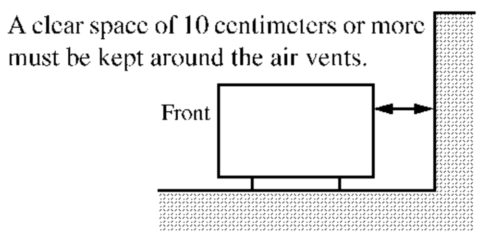


Figure-1 Environmental Conditions

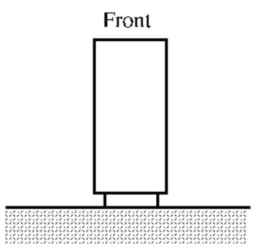
- Operating position



The instrument must be used in a horizontal position.
A cooling fan, which prevents the internal temperature from rising, is equipped with the instrument.
The air vents on the case must be unblocked.

Figure-2 Operating Position

- Storage position



This instrument should be stored in a horizontal position.
When placed in a vertical (upright) position for storage or transportation, ensure the instrument is stable and secure.

-Ensure the instrument is stable.
-Pay special attention not to fall.

Figure-3 Storage Position

- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

  Impulse withstand voltage (over-voltage) category II defined by IEC60364-4-443

  Pollution Degree 2

Types of Power Cable

Replace any references to the power cable type, according to the following table, with the appropriate power cable type for your country.

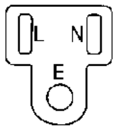
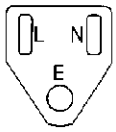
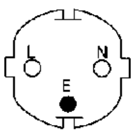
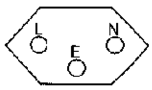
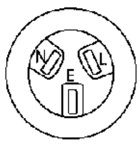
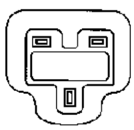
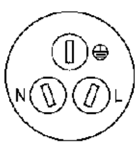
Plug configuration	Standards	Rating, color and length	Model number (Option number)
	PSE: Japan Electrical Appliance and Material Safety Law	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
	CEE: Europe DEMKO: Denmark NEMKO: Norway VDE: Germany KEMA: The Netherlands CEBEC: Belgium OVE: Austria FIMKO: Finland SEMKO: Sweden	250 V at 6 A Gray 2 m (6 ft)	Straight: A01404 (Option 96) Angled: A01414
	SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
	SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
	BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417
	CCC:China	250 V at 10 A Black 2 m (6 ft)	Straight: A114009 (Option 94) Angled: A114109

Table of Contents

Introduction

The R9211 series spectrum analyzer is a powerful instrument with many capabilities. This tutorial manual provides a quick and easy introduction to the R9211 so that you can get started using the instrument right away. This manual applies to each of the R9211 models: the R9211A, R9211B, R9211C, R9211E and R9211F. Once you have mastered the concepts in this manual, refer to the *Instruction Manual* for your particular model for a complete description of every feature. If you will be using the instrument as part of a GPIB (General Purpose Interface Bus) system, refer to the *R9211 Series GPIB Handbook.*

To use this manual effectively, read chapters 1, 2, and 3 to become familiar with the instrument's controls. Then perform the tutorials in chapter 4. If you will be using an R9211B, C or F for servo system design, order the instructional video tape by calling the technical assistance number below. Read Chapter 5 in conjunction with the tape.

This manual is organized as follows:

- **chapter 1** describes the applications, features, and options of the R9211 series
- **chapter 2** describes the controls, inputs, and outputs of the R9211 and describes the various displays
- **chapter 3** describes the basic uses of the front panel keys
- **chapter 4** gives detailed tutorials for typical uses of the R9211, including waveform measurement, spectrum measurement, time-frequency measurement and frequency response function measurement
- **chapter 5** supplements the instructional video tape (sold separately), which gives instructions for servo measurements and describes the curve-fit and scaling functions of the R9211C
- the **appendix** contains a reference chart of menu items
- the **glossary** defines abbreviations and terms that may be unfamiliar to you

Notational Conventions

Key concepts in this manual are marked with this skeleton key symbol. **For a quick introduction to the R9211, skim this manual reading the parts marked with this symbol.**

This caution symbol marks a note about something that could harm you or the instrument.

FUNCTION

X SOFT KEY

Y SOFT KEY

These key symbols indicate key presses in the tutorial section of this manual. In the text keys are marked with [square brackets].

For Technical Assistance

For technical assistance or service information, or to order the video tape, call Advantest Sales & Support Offices.

Chapter 1
The R9211 Series Features

The R9211 series of digital spectrum analyzers use FFT (fast Fourier transform) techniques that are computational in nature rather than hardware based. This gives the R9211 series much more flexibility for analysis than swept-tuned spectrum analyzers. The R9211 combines an analog-to-digital converter and a powerful computer in one compact package. Numerous options and accessories complement the series, making the R9211 ideal for many applications.

R9211 Series Applications

The R9211 is an effective tool for applications in the following fields:

Automotive

- engine, chassis, and interior vibration and noise analysis
- braking performance tests
- spark plug performance evaluation
- door sound analysis
- knock sensor evaluation
- ride analysis

Audio-Visual Equipment

- tracking and focus servo analysis
- chassis vibration analysis
- optical actuator DC gain and harmonic vibration analysis
- audio circuit frequency characteristics and distortion measurement
- wow, flutter, and jitter analysis
- data signal-to-noise measurement
- LCD flicker analysis
- microphone and speaker performance evaluation
- flyback transformer and deflection circuit analysis
- analysis of power line current distortion due to TV use
- optical disk flutter analysis
- frequency characteristic analysis of recordings

Musical Instruments

- spectrum analysis
- sound decay analysis
- electronic instrument circuit analysis
- tuning

Household Appliances

- washing machine, air conditioner, and vacuum cleaner vibration and noise analysis
- electric fan 1/*f* spectrum analysis
- lighting equipment noise and spectrum analysis

Semiconductors and Electronics

- ADC and DAC dynamic testing
- DSP evaluation
- CODEC transmission characteristic evaluation
- semiconductor manufacturing equipment vibration analysis
- power supply design

Materials Science

- evaluating attenuation characteristics of vibration control materials
- harmonic frequency vibration analysis of materials
- corrosive reaction analysis (chemical impedance) of stainless steel and similar materials
- furnace reaction conditions analysis

Communications

- sonar characteristic evaluation
- modular phone base band signal and circuit evaluation
- SSB phase noise analysis
- acoustic condensation circuit evaluation
- PLL control circuit loop characteristic evaluation
- telephone, cordless phone, fax, and modem transmission power measurements and noise analysis
- telephone line frequency characteristics and group delay measurement
- echo canceler evaluation

Computer Equipment

- laser printer polygon mirror noise and spectrum analysis
- hard disk swing arm vibration mode analysis
- floppy disk, CD, and optical-magnetic disk drive servo analysis
- printer vibration and noise analysis
- ultrasound bath analysis
- superconductor DC-SQUID noise analysis

Medical Engineering

- brain wave analysis
- heart pulse and blood circulation analysis
- pacemaker vibration spectrum analysis
- palate analysis
- hearing analysis

Civil Engineering and Architecture

- acoustic hall sound decay evaluation
- floor vibration analysis
- seismic wave analysis

R9211 Series Features

Common Features

The different R9211 models are specialized for different applications and price considerations. Note the features of your particular model described in this chapter. Chapter 4 gives you hands-on experience with each of these features.

All of the R9211 models have the following features:

- two input channels each with direct or differential input
- a built-in accelerometer power supply
- flexible triggering settings
- viewing of up to four display windows at a time
- an internal floppy disk for saving data (optional for the R9211E)
- output to an optional internal printer or a standard plotter
- waveform averaging to improve signal-to-noise ratios
- many output formats, including real and imaginary frequency spectrum diagrams, phase diagrams, Nyquist diagrams, Bode plots, Cole-Cole diagrams, Nichols diagrams, impulse response diagrams, and coherence function diagrams
- advanced math functions for processing data
- horizontal, vertical, and band markers for making accurate waveform measurements, including automatic peak and harmonic tracking functions

All of the R9211 models have the following four measurement modes:

- **waveform measurement mode** to analyze a signal in the time domain
- **spectrum measurement mode** to analyze a signal in the frequency domain
- **FRF** (frequency response function) **measurement mode** to analyze a device or structure's response to a generated signal
- **time-frequency measurement mode** to track amplitude changes at specific frequencies (or frequency ranges) over time

The R9211B, R9211C and R9211F have an additional **servo measurement mode** to measure a servo mechanism's response to various signals.

R9211A Features

The R9211A is best suited for acoustical, noise, and voice analysis. Its features include:

- simultaneous octave analysis of data
- a running zoom feature to expand frequency resolution for precision measurements

R9211B Features

The R9211B is geared towards servo analysis or other types of analysis for which an internal signal generator is helpful. It's features include:

- an internal signal generator
- a summing amplifier for both closed loop and open loop measurements of servo circuits

R9211C Features

The R9211C is the top-of-the-line model particularly suited for servo analysis but capable of the functions of all the other models. It's features include those of the R9211B plus:

- a running zoom feature to expand frequency resolution
- a curve-fit and FRF synthesis function for the internal signal generator
- a comparator function for GO/NOGO analysis, useful for assembly line testing
- a high-speed processor

R9211E Features

The R9211E is the economy model of the series, and is best suited for analysis of mechanical vibrations, noise, and acoustical signals.

The R9211E has one accessory card slot which can hold either a floppy disk drive, a CMOS 2 Mbyte memory card, or an I/O + Memory Board.

R9211F Features

The R9211F has the same features as the R9211B plus:

- a floating signal generator (the ground is not referenced to the mainframe)
- a pink noise generator for signal-to-noise ratio measurements

R9211 Series Options

The following options are available for the R9211 series:

- internal 3.5 inch floppy disk drive (MS-DOS format), standard for all but the R9211E
- internal thermal printer
- I/O + Memory Board for special digital input and output functions and an extra 2 Mbytes of memory
- CMOS Memory Board with 2 Mbytes of battery backed up memory

Many accessories are available for the R9211 series, such as cables, impulse hammers, acceleration sensors, rack mounting hardware, and carrying cases. Consult your dealer for details.

Chapter 2
Control Panels and Display

Familiarize yourself with the R9211's controls by reading the following descriptions and referring to the illustrations of the R9211 front and rear panel. The numbers in the illustrations correspond to the descriptions in the text.

Front Panel

I Measurement Keys

1. START key: Starts waveform averaging, FRF/servo measurement, or T-F analysis depending on the mode and view selected
2. STOP/C key: Stop/continue waveform averaging, stop FRF/servo measurement, or stop/continue T-F analysis
3. AUTO key: Not used
4. PRESET key: Resets the instrument to default settings if pressed during the self-test cycle following power-on; also sets servo mode mathematical computation functions on the R9211C

II Function Keys

5. MODE key: Sets either Waveform, Spectrum, T-F, FRF or Servo measurement mode
6. SETUP key: Sets measurement parameters
7. SG CONT key: Controls the signal generator output
8. COPY key: Causes an external GPIB plotter to start plotting
9. VIEW key: Controls display parameters
10. MKR key: Sets marker parameters
11. MATH key: Selects mathematical computation functions
12. DEVICE key: Sets external device control parameters (floppy disk drive, external GPIB plotter, GPIB address)

III GPIB

13. SRQ (service request) lamp: Indicates the R9211 is transmitting a GPIB service request to the controller
14. TALK lamp: Indicates the R9211 is transmitting data to an external device
15. LISTEN lamp: Indicates the R9211 is receiving data from an external device
16. REMOTE lamp: Indicates the R9211 is remotely controlled by an external device
17. LCL (local) key: Releases GPIB remote control so that you can operate the R9211 from the front panel

IV Data Entry

18. Data knob: Rotate for setting parameter values and moving the markers
19. Down (∨) key: Use for setting parameter values and moving the markers
20. Up (∧) key: Use for setting parameter values and moving the markers
21. Numeric keys (0-9): Numeric value keys
22. Decimal (.) key: Decimal point
23. Minus (-) key: Minus sign
24. Comma (,) key: Comma for multiple entries
25. ENT (enter) key: Enters numeric key input
26. MK (marker) key: Not used
27. BS (back space) key: Back space and delete one character

V Input

28. CH A lamp: Indicates channel A is operating
29. CH B lamp: Indicates channel B is operating
30. OVER lamps: Indicate the input signal is over limits
31. NORM lamps: Indicate the input signal is within normal limits
32. ICP lamps: Indicate power for acceleration sensors is on
33. + Input Terminals: Lamps indicate the terminal is grounded
34. - Input Terminals: Lamps indicate the terminal is grounded
35. AUTO ARM lamp: Indicates automatic trigger data capture mode
36. ARM lamp: lights when waiting for trigger
37. HOLD lamp: Indicates data capture on hold

VI Signal Generator Output (R9211B, C, and F Only)

38. OPR (operation) key: Toggles between signal generator operation and standby status
39. Signal overload lamp: Indicates an output signal overload or a summing amplifier overload
40. Summing amplifier operating lamp: Indicates the summing amplifier is operating
41. Signal output terminal: Signal generator output

VII Power and Intensity

42. Power switch
43. Intensity knob: Sets the screen intensity to a comfortable level

VIII Floppy Drive

44. Floppy disk drive: Use double-sided double-density 3.5 inch floppy disks

IX Soft Keys and Menus

45. Y (vertical) soft keys: For setting parameters
46. X (horizontal) soft keys: For selecting classes of parameters

I MEASUREMENT

1. START
2. STOP/C
3. AUTO
4. PRESET

II FUNCTION

5. MODE
6. SETUP
7. SG CONT
8. COPY
9. VIEW
10. MKR
11. MATH
12. DEVICE

III GPIB

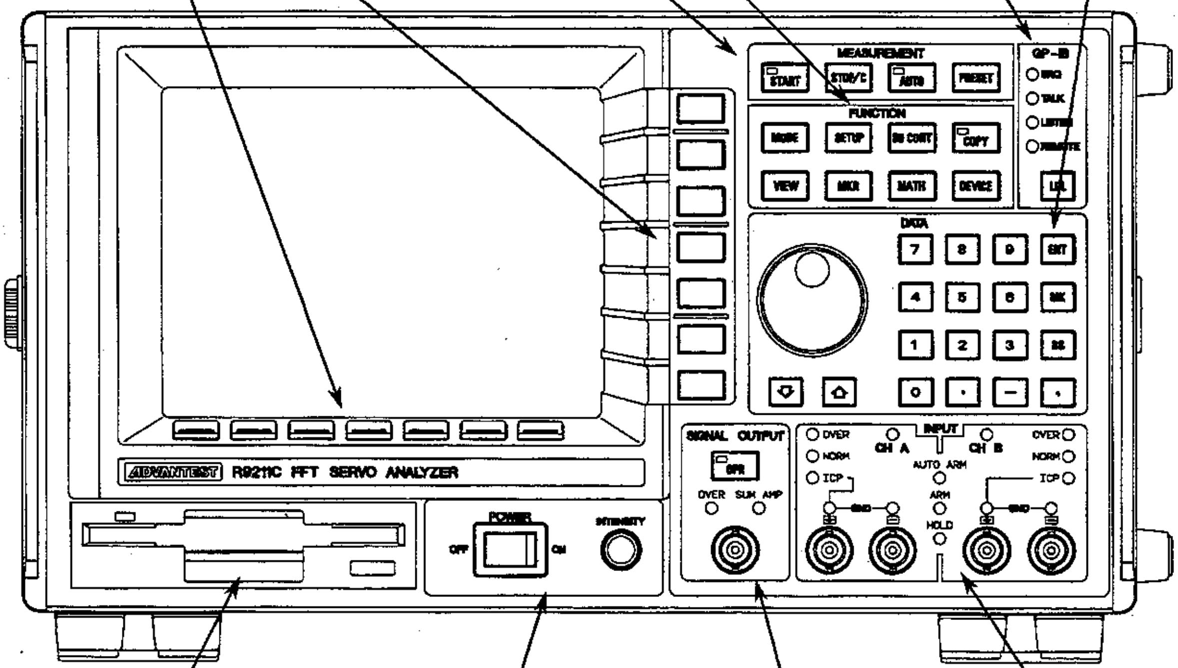
13. SRQ
14. TALK
15. LISTEN
16. REMOTE
17. LOCAL

IV DATA ENTRY

18. KNOB
19. ↓ KEY
20. ↑ KEY
21. 0-9 KEYS
22. DEC PT
23. MINUS SN
24. COMMA
25. ENTER
26. MARKER
27. BACK SP

IX SOFT KEYS

45. Y SOFT KEYS
46. X SOFT KEYS



VIII FLOPPY DRIVE

44. FLOPPY DRIVE

VII PWR & INTENS

42. POWER
43. INTENSITY

VI OUTPUT

38. OPR
39. OVER
40. SUM AMP
41. SG TERM

V INPUT

28. CH A
29. CH B
30. OVER
31. NORM
32. ICP
33. + TERM
34. – TERM
35. AUTO ARM
36. ARM
37. HOLD

Rear Panel

I Digital Input/Output (Optional; Standard on R9211C)

1. DIGITAL input/output connector: Provides output from the instrument's A/D stage or input to the instrument's FFT stage; useful for testing A/D converters or if using an external digitizer

II Video Output

2. VIDEO OUTPUT Connector: Video or printer output connection

III GPIB Terminal

3. GPIB Connector: See the *GPIB Handbook* for more information

IV Data Control Input and Output

4. TRIG output terminal: Outputs a pulse when a signal triggers the instrument
5. SMPLG CLK output terminal: Outputs a clock signal at the internal sampling clock rate
6. External TRIG input terminal: Accepts an input to trigger data capture
7. External SMPLG CLK input terminal: Accepts an input to clock data sampling

V Signal Generator I/O (R9211B, C and F Only)

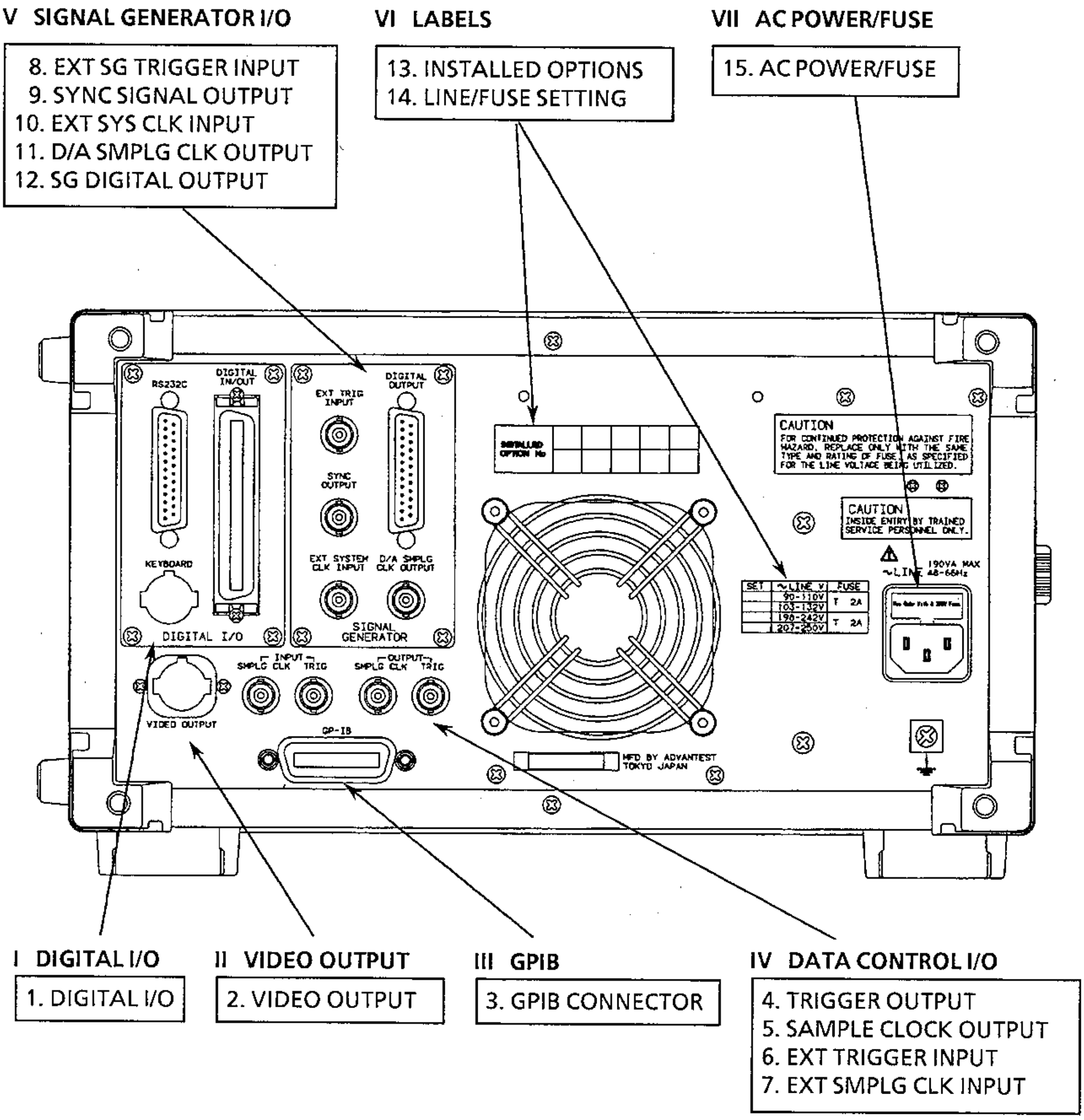
8. External trigger input: Accepts an input to trigger the signal generator
9. Synchronization signal output: Outputs a signal generator synchronization signal (set by SG CONT, SYNC OUT)
10. External SYS CLK input: Not used
11. Digital sampling clock output: Outputs a sampling clock for the digital data from the signal generator
12. Digital signal output: Digital data output from the signal generator

VI Labels

13. INSTALLED OPTION No.: The options installed internally in this model are marked
14. Set, Line V, Fuse: The power voltage settings and required fuse type for this model are marked in the SET column

VII AC Power

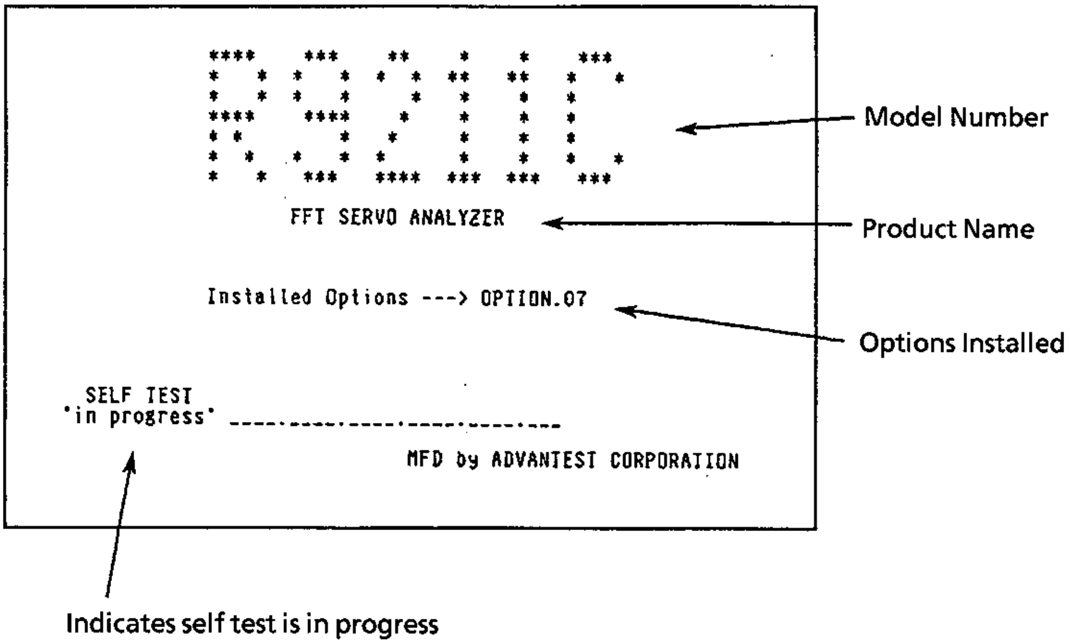
15. AC power input: Power cable jack; also contains the fuse


V SIGNAL GENERATOR I/O
8. EXT SG TRIGGER INPUT
9. SYNC SIGNAL OUTPUT
10. EXT SYS CLK INPUT
11. D/A SMPLG CLK OUTPUT
12. SG DIGITAL OUTPUT
VI LABELS
13. INSTALLED OPTIONS
14. LINE/FUSE SETTING
VII AC POWER/FUSE
15. AC POWER/FUSE
RS232C
DIGITAL IN/OUT
KEYBOARD
DIGITAL I/O
EXT TRIG INPUT
SYNC OUTPUT
EXT SYSTEM CLK INPUT
D/A SMPLG CLK OUTPUT
DIGITAL OUTPUT
SIGNAL GENERATOR
VIDEO OUTPUT
INPUT SMPLG CLK TRIG
OUTPUT SMPLG CLK TRIG
GP-IB
MFD BY ADVANTEST TOKYO JAPAN
CAUTION
FOR CONTINUED PROTECTION AGAINST FIRE HAZARD, REPLACE ONLY WITH THE SAME TYPE AND RATING OF FUSE AS SPECIFIED FOR THE LINE VOLTAGE BEING UTILIZED.
CAUTION
INSIDE ENTRY BY TRAINED SERVICE PERSONNEL ONLY.
190VA MAX
~LINE 48-66Hz
SET
~LINE V
FUSE
90-110V
103-132V
T 2A
198-242V
207-250V
T 2A
I DIGITAL I/O
1. DIGITAL I/O
II VIDEO OUTPUT
2. VIDEO OUTPUT
III GPIB
3. GPIB CONNECTOR
IV DATA CONTROL I/O
4. TRIGGER OUTPUT
5. SAMPLE CLOCK OUTPUT
6. EXT TRIGGER INPUT
7. EXT SMPLG CLK INPUT

Display

Initial Display

When the power is switched on, the R9211 performs a self test and displays the following screen:



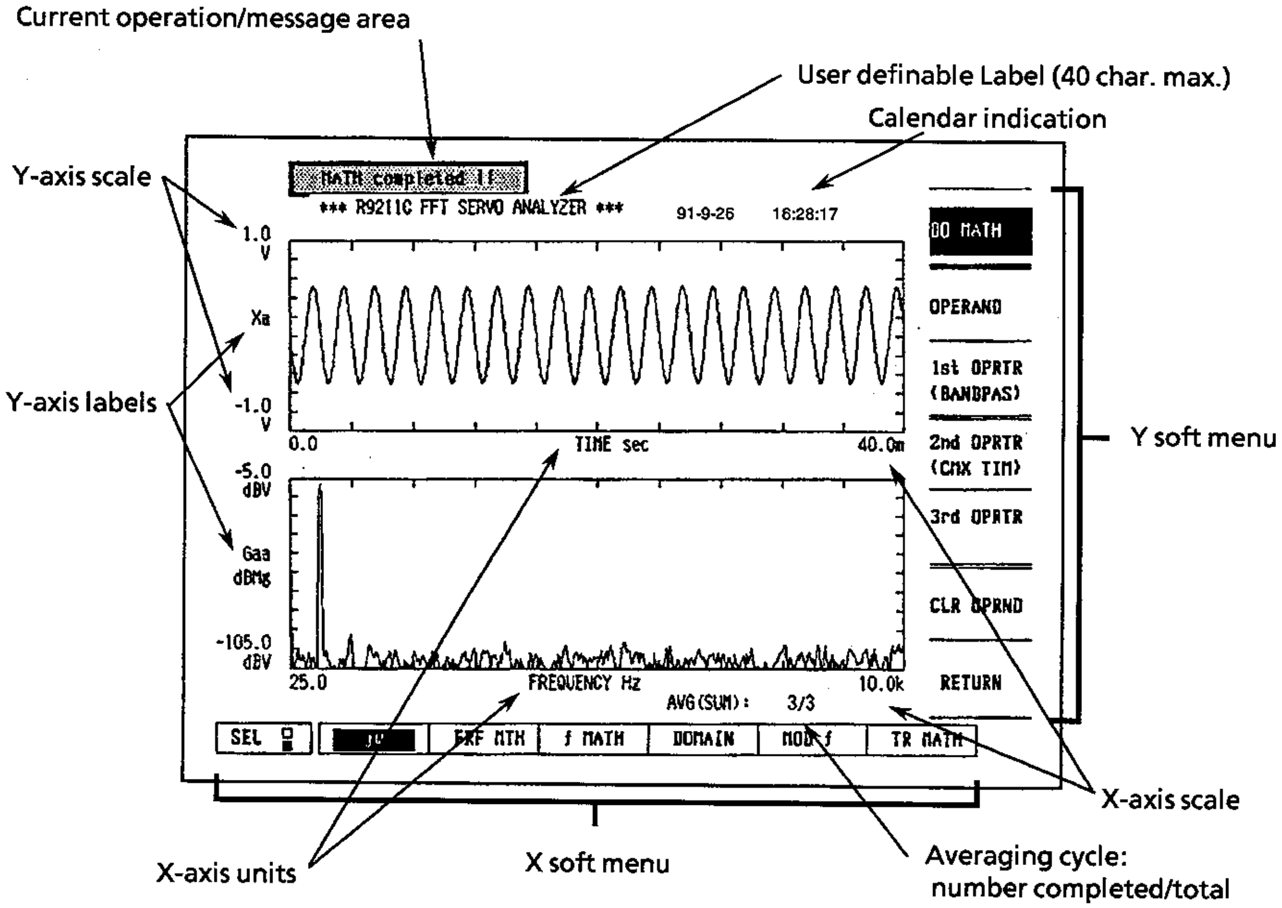
The words 'in progress' blink to indicate that the self test is operating.

When all self test routines have resulted in a PASS, the main program automatically begins, and the measurement screen is displayed.

If an error occurs in a self-test routine, there is a pause and a description of the error appears on the screen. Note the error when you make a service call to Advantest. To forcibly start the main program after an error, press any key on the front panel.

Display Labels

The following figure shows the types of labels that appear on the display:



Y-Axis Labels

The following labels appear for the Y-axis depending on the view setting. The < > brackets indicate averaged data. For a more detailed description refer to the *Instruction Manual.*

Xa: Channel A instantaneous time data

Xb: Channel B instantaneous time data

<Xa> Channel A average time data

<Xb> Channel B average time data

<Sa>: Channel A complex spectrum

Gaa: Channel A power spectrum

Gab: Cross-spectrum

<Hab>: Frequency-response function

<Coh>: Coherence function

<SNR>: Signal-to-noise ratio

<COP>: Coherent output power

<IMPLS>: Impulse response

Raa: Autocorrelation of Xa

Rab: Cross correlation

Pa: Histogram or probability density function of Xa

Chapter 3
Front Panel Keys

The front panel has function keys, data keys, and X and Y soft (software defined) keys. This chapter explains how to use these keys.

The R9211 has more than 400 soft keys to support its many features. The soft keys are organized in a logical manner, and the basic sequence of key presses is the same for most operations. To accomplish a task, you first press a function key, then press an X soft key to choose a class of parameters, and then set specific parameters using the Y soft keys and data entry keys. This chapter describes each function key and then describes common key sequences. More specific descriptions of the soft keys are given in chapter 4.

Using the Function Keys

You can make basic measurements using only the [MODE], [SETUP] and [VIEW] function keys.

MODE Key

The [MODE] key selects one of the following measurement modes:

- **waveform:** for viewing time versus amplitude, auto and cross correlation, and histogram displays
- **spectrum:** for viewing time versus amplitude, power spectrum, complex spectrum, and cross-correlated spectrum displays
- **time-frequency:** for viewing time versus amplitude, power spectrum, complex spectrum, cross-correlated spectrum, time versus amplitude for specific frequencies, and three dimensional frequency-amplitude-time displays
- **frequency response function:** for viewing time versus amplitude, power spectrum, complex spectrum, cross-correlated spectrum, and frequency response function displays
- **servo:** for viewing time versus amplitude, power spectrum, cross-correlated spectrum, and frequency-response function displays

SETUP Key

The [SETUP] key begins the process for setting input and output parameters for each measurement mode. Different parameters are available depending on the measurement mode.

SG CONT Key

The [SG CONT] key begins the process for setting the signal generator output.

COPY Key

The [COPY] key directs an external plotter to plot the displayed data.

VIEW Key

The [VIEW] key begins the process for specifying the type of display and display scaling.

MKR Key

The [MKR] key begins the process for positioning the various on-screen markers on displayed data.

MATH Key

The [MATH] key begins the process for performing mathematical computations on the displayed data.

DEVICE Key

The [DEVICE] key is used for floppy disk control settings, external plotter settings, and setting the R9211's GPIB address.

Using The Soft Keys

The R9211 series has two sets of soft keys, one along the X-axis and one along the Y-axis. Menus displayed next to the X soft keys and Y soft keys let you select modes and functions and set parameters.

In general, the X soft keys call up specific Y soft key menus, and the Y soft keys are used for parameter setting and toggling selected functions. Usually you select an item with an X soft key, then set a parameter related to that item with a Y soft key.

Sometimes the X soft key menus fill more than one screen and it is necessary to press NEXT or RETURN to find the key you are looking for.

Using the Data Keys

There are three ways to enter parameter values: by turning the data knob, by pressing the up and down arrow keys, or by entering a value on the keypad. Not all methods work for all parameter entry operations.

When using the keypad, press ENT (enter) after typing a value. You can enter consecutive parameters by typing commas between them. Press BS to backspace over mistakes.

For some parameters, only discrete values are available. If you try to set a value in-between the allowed values, the setting jumps to the nearest available value. For example, certain memory settings are available only in powers of two. If you tried to set one of these parameters to 63k, it would jump to 64k.

Basic Key Sequences

Most R9211 operations follow this sequence:

1. Select a measurement mode using the [MODE] key.
2. Set the measurement parameters using the [SETUP] key.
3. Set the view parameters using the [VIEW] key.

Selecting a Measurement Mode

1. Press the MODE key.
2. Press the MEAS key.
3. Select a measurement mode.

Setting Measurement Parameters

1. Press the SETUP key.
2. Press the FUNC key.
3. Use the Y Soft keys to select the desired function.
4. Press the RANGE key.
5. Use the Y Soft keys to select the desired range.
6. Press the INPUT key.
7. Use the Y Soft keys to set the input parameters.

Setting View Parameters

1. Press the VIEW key.
2. Press INST VW (to set the instantaneous view).
3. Select the type of display.

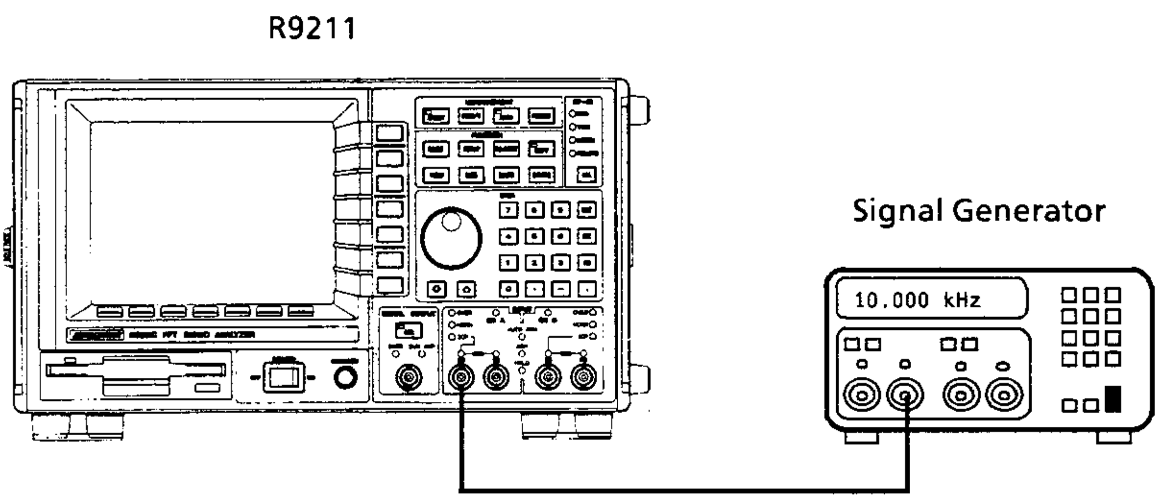
Chapter 4
Tutorials

This chapter consists of four tutorials for Waveform Measurement, Spectrum Measurement, Time-Frequency Measurement, and FRF Measurement. These tutorials cover most of the features of the R9211 series and should take you less than three hours to complete. Even experienced users can benefit from the tips in these tutorials. Perform these tutorials in the order given, since later tutorials build upon information given in the first tutorials. If you have an R9211 model B, C, or F, also perform the Servo Measurement tutorial in chapter 5.

Setting Up

These tutorials require a signal generator to reproduce the examples in this manual. The R9211 models B, C, and F have a built-in signal generator that you can use; if you don't have one of these models, it is helpful to have an external signal generator capable of producing a 10 kHz sine wave.

The built-in signal generator doesn't require any cable connections. If you are using an external signal generator, connect its output to the R9211's channel A +input as shown:



As you read, press the keys shown in the left margin of the tutorial. Almost all of the soft keys are described, and you are encouraged to explore their functions.

The tutorials follow the general pattern of pressing a function key, pressing an X soft key, exploring each of the Y soft key settings, then pressing the next X soft key. The three types of keys are shown as follows:

FUNCTION   X SOFT KEY   Y SOFT KEY

Waveform Measurement Tutorial

This tutorial describes how to use the R9211 as a digital oscilloscope.

Calibrating the Instrument

PRESET

Turn the instrument on (or cycle the power if it's already on). Wait until the self-test starts, then press [PRESET]. This skips the self-test and resets the instrument to its preset (default) settings. The instrument is preset to waveform measurement mode.

CAL | SINGLE DC CAL

Select [CAL] and press [SINGLE DC CAL] to calibrate the R9211. Wait until the screen displays [SINGLE DC CAL...end] in the upper left corner before continuing.

In actual practice, it is best to calibrate the instrument after it has warmed up for 30 minutes. This zeros the input amplifiers to improve accuracy.

Setting Up the Signal Generator

If you are using an external signal generator, set it to produce a 1 kHz sine wave with a 10 V amplitude. If you are using the internal signal generator, set it up as follows:

SG CONT

Press the [SG CONT] function key to set the signal generator parameters. The signal generator is preset to produce a 1 kHz sine wave.

SG VLT | AMPLITUDE 10.0V

Press the [SG VLT] X soft key and press the [AMPLITUDE] Y soft key.

1 | 0 | ENT

Set the amplitude to 10 V by pressing the [1], [0], and [ENT] data keys.

CONNECT | CH A

Select [CONNECT] and set [to ChA].

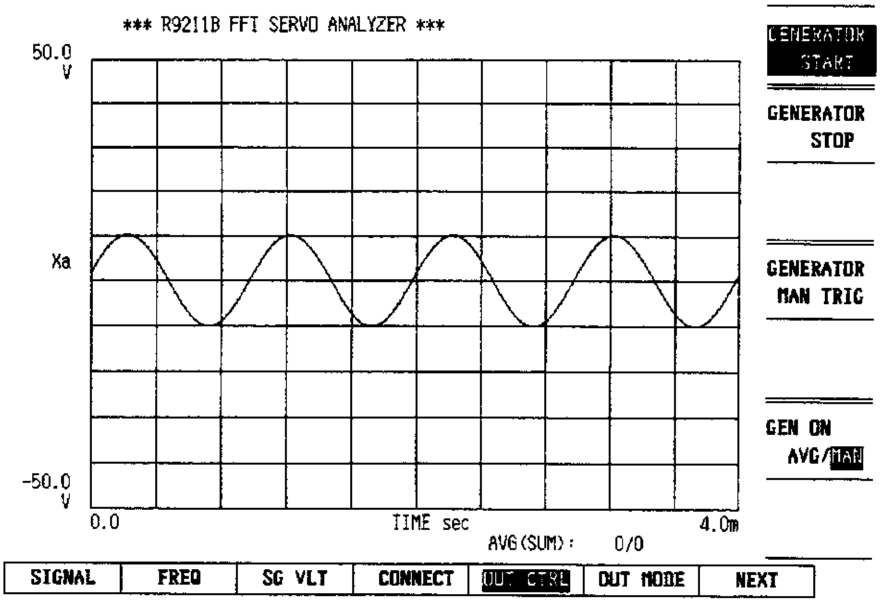
OUT CTRL

GENERATOR START

Select [OUT CTRL] and set to [GENERATOR START].

OPR

Press the [OPR] key on the signal output section of the front panel. You should see the following (untriggered) display:



signal generator output

Setting Measurement Parameters Under SETUP

SETUP

Press [SETUP] to set the measurement parameters. Note that the X soft key menu now displays FUNC, RANGE, SENS, INPUT, TRIG, ARM/HLD and NEXT. We will explore each of these parameter groups in turn.

Setting FUNC Parameters

FUNC

Press [FUNC] on the X soft key menu. Try exploring each of the Y soft key functions as described next.

TIME

Press [TIME]. The instrument is preset to display the TIME waveform measurement function, which displays time versus amplitude.

AUTOCORR

Press [AUTOCORR]. This setting measures the degree of randomness of a signal or detects periodic components of a noisy signal on a scale of -1 to 1.

CROSS-CORR

Press [CROSS-CORR]. This setting measures the time delay between two signals, which is useful for calculating distance in time delay tests.

HISTOGRAM

Press [HISTOGRAM]. This setting plots the probability density function (histogram) of a signal for statistical analysis.

TIME

Press [TIME] to return to the TIME function when you are done.

Setting RANGE Parameters

RANGE

Press [RANGE].

If you know the time length of the signal you want to capture, set the range. That way the instrument has the maximum number of sample points to work with for improved accuracy. The range (in seconds) equals SAMPL RAT (the sample rate) times FRAME TIM (the number of sample points).

SAMPL RAT 3.91msec

Press [SAMPL RAT] to try different sample rate settings (using the direction keys). The display automatically adjusts to show the full range. Return [SAMPL RAT] to 3.91 msec.

FRAME TIM 1024spl

Press [FRAME TIM] to try different frame time settings (using the direction keys). Note that the display (and any calculations) are slower but more accurate if more sample points are acquired. Return [FRAME TIM] to 1024 samples.

Setting SENS Parameters

SENS

Press [SENS] to set the sensitivity of the inputs.

CH-A AUTO/MAN

Set [CH-A] to AUTO. Note that the input sensitivity automatically increases one level to ±20 V. Use auto-sensitivity for untriggered (free run) acquisitions. ⌈When AUTO SENS is used, it is important to have run the calibration procedure described at the beginning of this tutorial.⌋

There are two types of automatic sensitivity. UP&D automatically increases or decreases the input sensitivity to signal amplitudes of -60 to +30dBV. Use this setting for periodic signals with more than one cycle per frame time. UP only decreases the input sensitivity. Use this setting for repeated pulses. Set to UP&D before proceeding.

Setting INPUT Parameters

INPUT

Press [INPUT] to see the input connection settings.

CHANNEL CH-A/CH-B

The input connection parameters can be set differently for channel A and channel B using [CHANNEL]. Leave set to CH-A.

COUPLING AC/DC

The [COUPLING] setting determines the input coupling. Leave set to AC.

+INPUT IN/GND

The [+INPUT] and [-INPUT] settings allow you to switch input connection terminals, or use both for a differential input. The front panel indicator lights if the terminal is grounded. Leave +INPUT set to IN and -INPUT set to GND.

Note the [FILTER] input setting. When on, this low-pass anti-aliasing filter prevents spurious frequency components in the spectrum. However, square waves may be distorted if their higher harmonics are filtered out. It is important to *turn off* the anti-aliasing filter when working with square wave (digital) signals. Leave this filter on for normal use.

⚠ **Do not turn on the ICP power unless an accelerometer is connected to the + input terminal.** Up to 24 VDC can exist between the + terminal and ground when the ICP is on, creating a hazard if test leads are attached.

The [ICP] setting provides an internal current source (4 mA) through the + input terminal to power an external accelerometer. The front panel indicator lights when ICP power is on. Leave set to OFF.

When ON, the [TEST] setting generates a test signal at a frequency that depends on the current frequency range setting. The test signal doesn't operate when the signal generator is running. Leave set to OFF.

Setting TRIG Parameters

TRIG

Press [TRIG] to explore the R9211's triggering functions.

SOURCE (CH-A)

With the [SOURCE] key, the trigger source can be set to channel A, channel B, or an external source through the rear panel terminal. Press [SOURCE] to see these options, and press [RETURN] to return to the previous Y soft menu. Leave set to CH-A.

SLOPE (+)

With the [SLOPE] key, the triggering slope can be set to +, -, bi-slope inside, or bi-slope outside. Press [SLOPE] to see these options. Bi-slope inside triggers when the signal enters the triggering range, and bi-slope outside triggers when the signal leaves the range. Leave set to (+) and press [RETURN].

LEVEL 0.0V

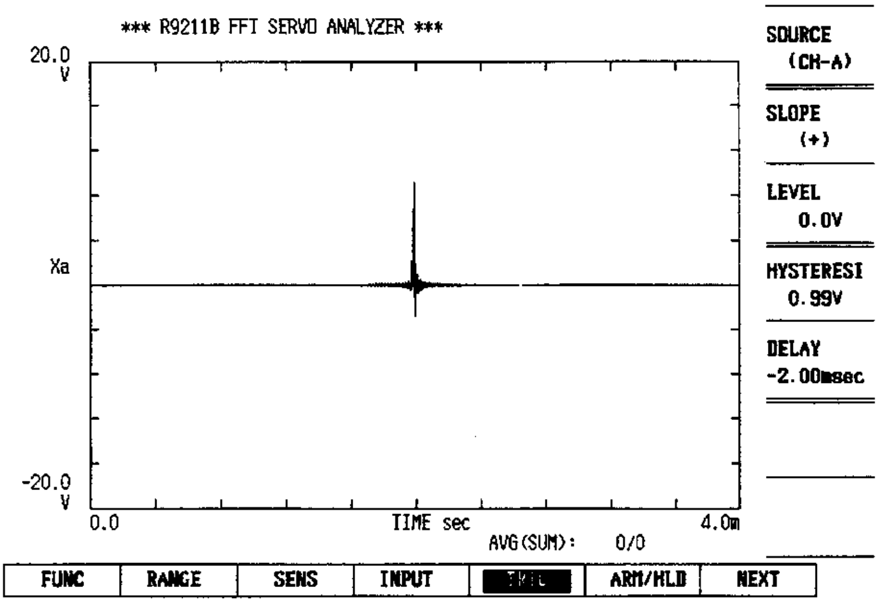
Press [LEVEL] and set to 0 V using the keypad. The trigger level may be set in increments of 1/256 of the input level range.

HYSTERESI 0.99V

Press [HYSTERESI] and set to 1 V. (Note that the instrument jumps to the nearest available setting, which is 0.99 V.) The hysteresis width sets the triggering range around the triggering level. A higher hysteresis setting ensures that noise doesn't falsely trigger the instrument.

DELAY -2.00msec

The [DELAY] setting determines the delay interval between the trigger point and beginning of data capture. For example, if the frame time is 4 msec, a setting of -2 msec places the trigger point in the center of the X-axis, as shown by the triggered pulse below. Leave set to -2 msec.



triggered pulse

Setting ARM/HLD Parameters

ARM/HLD

AUTO ARM

Press [ARM/HLD] and set to [AUTO ARM] to start triggering. This setting continuously arms the instrument and displays the signal data if the trigger is activated. The sine wave you have been capturing should stabilize. The front panel ARM and HOLD indicators light to show each arm/hold cycle.

ARM

Press [ARM]. This setting arms the signal once; if the instrument triggers, measurement stops and the signal data is displayed.

HOLD

Press [HOLD]. This setting displays the last signal data captured (regardless of triggering) and stops.

FREE RUN

Press [FREE RUN]. This setting continuously displays the input signal. Set to FREE RUN after you have tried the other functions.

Setting the Display Parameters Under VIEW

VIEW

Press the [VIEW] function key to explore the display parameters. Note that the X menu changes to display new parameter groups.

Setting TYPE Parameters

TYPE | DUAL

Press [TYPE]. Four display types let you display up to four screens.

TRIPLE

Set to [DUAL] to show the two screen display.

QUAD

Set to [TRIPLE] to show the three screen display.

Set to [QUAD] to show the four screen display.

SEL

Press [SEL] to select each screen for setting display parameters. The filled-in box in the [SEL] key indicates the current screen.

SINGLE

Set to [SINGLE] to return to the single screen display when you are done.

Setting the INST VW

INST VW | CH-A TIME

Press [INST VW] to set the instantaneous view for a screen.

Press [CH-A TIME] to display the signal generator waveform.

CH-B TIME

Press [CH-B TIME]. This setting displays a signal input to channel B.

ORBITAL

Press [ORBITAL]. This setting displays the channel A signal amplitude on the X-axis and the channel B signal amplitude on the Y-axis. (If both signals are sine waves, this creates 'Lissajous' or orbital figures.)

CH-A TIME

Press [CH-A TIME] to return to the instantaneous view of the waveform.

NEXT

Press [NEXT] to go to the next page of the X-axis menu.

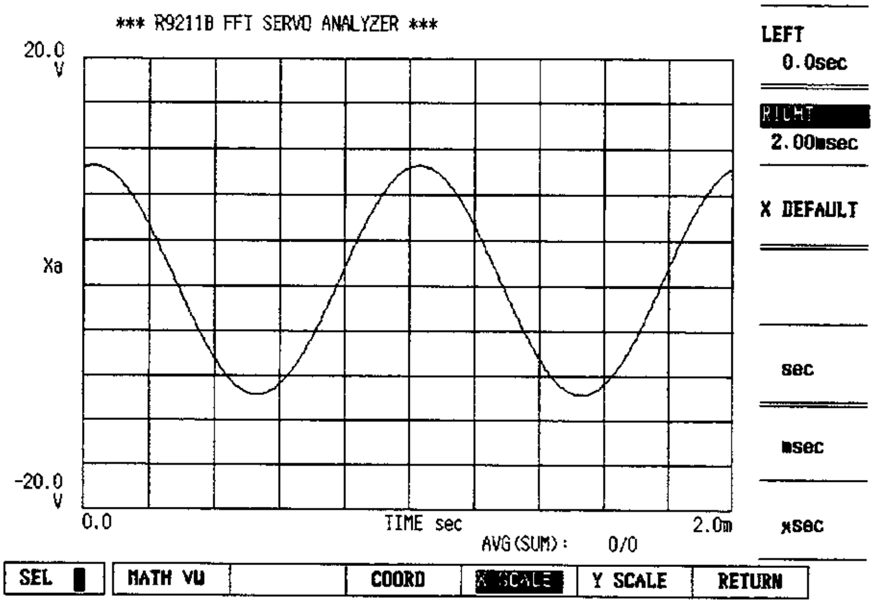
Changing the X-SCALE

X-SCALE

Press [X SCALE].

RIGHT
0.002sec

Select [RIGHT] and set the right end of the X-axis scale to .002 seconds. (Press [2] then press [msec].) The display should appear as shown below. Note that the R9211 still acquires 4 msec of data but only displays half of the data.



changing the x-scale

X DEFAULT

Press [X DEFAULT] to return the left and right ends of the X-axis scale to their full-scale values.

Changing the Y-SCALE

Y-SCALE

Press [Y SCALE]. The options are similar to the X-scale options.

[UPPER] sets the upper end of Y-axis scale. [LOWER] sets the lower end of Y-axis scale. [Y DEFAULT] returns the upper and lower ends of the Y-axis scale to their default values. [Y AUTO SCALE] automatically determines the Y-axis scale from the data.

Using Markers to Take Measurements

The R9211 has versatile markers for reading data values. In general, you use the rotary knob to position cursors, and then read the values displayed on-screen. The R9211 also has functions for positioning the cursors automatically. Note that the screen markers do not operate for the QUAD display type.

MKR

Press the [MKR] function key.

Setting the MKR VAL

MKR VAL

SINGLE X X1 Y1

Press [SINGLE X] to display a vertical cursor with time and voltage values at the point of intersection with the display data. Rotate the knob to see the effect.

X1 Y1 X2 Y2

Press [X1 Y1 X2 Y2] to display two vertical cursors labeled LC (left cursor) and RC (right cursor) with time and voltage values at the two points of intersection with the display data. Only one cursor is visible until you change the FIX X settings and rotate the knob as described next.

FIX X

Press [FIX X] and try the following options for moving the cursors relative to each other.

X FIXED CENTER

[X FIXED CENTER] fixes the midpoint of the two vertical cursors.

X FIXED RIGHT

[X FIXED RIGHT] fixes the right cursor of the two vertical cursors.

X FIXED LEFT

[X FIXED LEFT] fixes the left cursor of the two vertical cursors.

X FIXED WIDTH

[X FIXED WIDTH] fixes the horizontal interval between the two vertical cursors.

MKR VAL

Press [MKR VAL] to try other marker settings.

X1 Y1 X2 ΔY

Press [X1 Y1 X2 ΔY] to display two vertical cursors at points of intersection with the display data, showing time and voltage values for the left cursor (LC) and time and differential voltage values for the right cursor (RC).

Y1 Y2

Press [Y1 Y2] to display two horizontal cursors with voltage values. Only one cursor is visible until you make a setting under [FIX Y] and rotate the knob.

Y1 ΔY

Press [Y1 ΔY] to display two horizontal cursors, the lower cursor with a voltage value and the upper cursor with the voltage difference.

Setting the X MKR Function

X MKR

PK MKR (OFF)

Press the [X MKR] X soft key to try the peak automatic cursor positioning function.

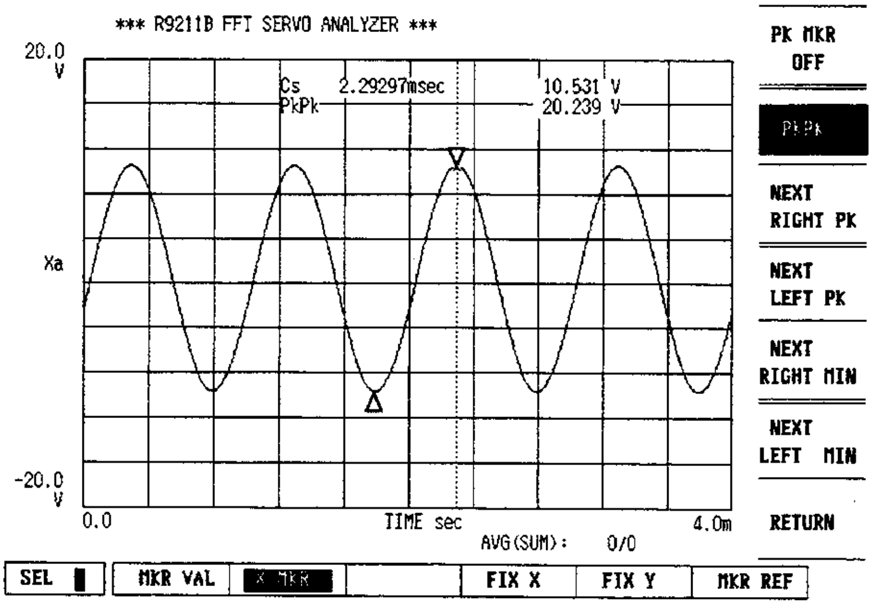
PKPK

RETURN

Press [PK MKR]. The peak marker computes the value of a wave peak. You can choose from peak-to-peak, next right peak, next left peak, next right minimum, or next left minimum. Set to [PKPK] (peak-to-peak) and press [RETURN].

X MARKER DO ESTIM

Press [X MARKER DO ESTIM]. In general you must press this key after making a selection under [PULSE PAR], [PK MKR] or [BAND MKR]. The figure below shows the peak markers in action.



peak-to-peak markers

BAND MKR (OFF) — The band marker function computes the maximum and minimum values within a designated range. You can choose from the peak-to-peak voltage or the rms voltage within a range.

PULSE PAR (OFF) — The pulse parameter function computes pulse parameters from the leading edge to the trailing edge. You can choose from finding the rise time, fall time, or width of the pulse.

REAL TIME ON/OFF — When on, REAL TIME displays new X MKR values each time the waveform display changes.

MKR VAL — MKR OFF — Press [MKR VAL] and set [MKR OFF] to turn off the markers.

Using External Devices

The R9211 has commands and settings under the DEVICE menu for saving data to or recalling data from a floppy disk, and for setting plotter and GPIB parameters. Obtain a 3.5 inch floppy disk (two-sided and either double density or high density) to practice using the disk drive.

Recalling a file from the floppy disk causes most of the R9211 settings to change to the settings set when the file was created. A good strategy for setting up the R9211 quickly is to recall a file with the settings you want.

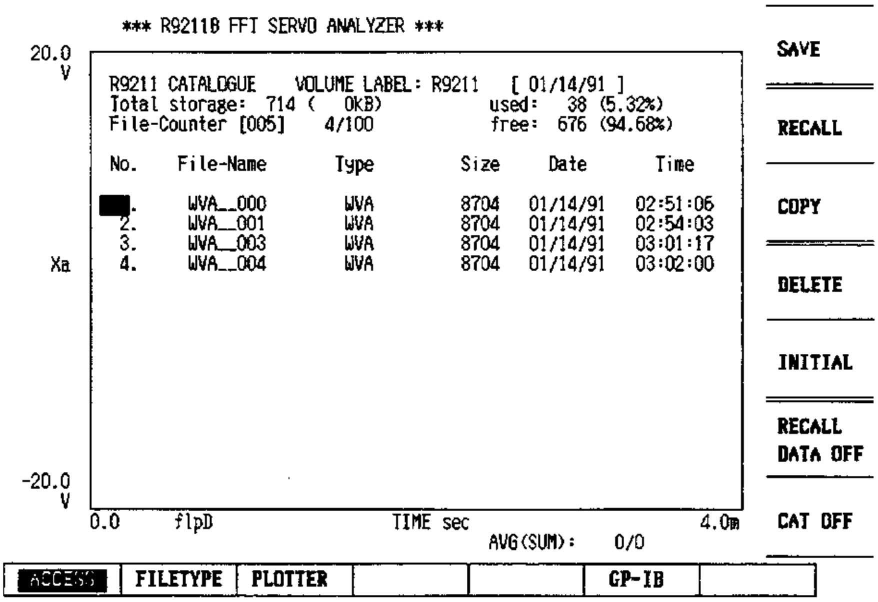
DEVICE — Press the [DEVICE] function key.

Accessing the Floppy Disk Drive

ACCESS — Press [ACCESS] to see the commands for controlling the floppy disk.

First initialize (format) a blank floppy disk as follows. **Initializing a disk destroys any data that may be on the disk!**

INITIAL — EXECUTE INITIAL — Insert the floppy disk in the drive, then press [INITIAL]. The R9211 checks the format of the disk. Press [EXECUTE INITIAL] to initialize the disk in MS-DOS format. The R9211 replaces the current screen with a catalog of the disk label, amount of memory used, and contents.



floppy disk catalog

SAVE	EXECUTE SAVE	Press [RETURN], press [SAVE], and press [EXECUTE SAVE] to save the current data to the floppy disk. (The R9211 saves data from both input channels A and B if present.)
RECALL	EXECUTE RECALL	Press [RETURN], press [RECALL], and press [EXECUTE RECALL] to recall and display a file from the floppy disk. Note that the signal generator automatically stops.
	RECALL DATA OFF	Press [RETURN] and press [RECALL DATA OFF] to return the instrument to displaying the input signal. To restart the signal generator, press [SG CONT], select [OUT CTRL], and set [GENERATOR START]. Press [DEVICE] again to continue.
COPY	EXECUTE COPY	Press [COPY], and press [EXECUTE COPY] to create a copy of the data file on the same floppy disk.
DELETE	EXECUTE DELETE	Use the knob to select one of the data files from the disk catalog. Press [RETURN], press [DELETE], and press [EXECUTE DELETE] to delete the file.
	CAT OFF	Press [RETURN] and press [CAT OFF] to return from the disk catalog to the waveform measurement screen.

DONE — Close the alphabetic input window.

FILE NAME NO_NAME — To input the file name, press the [FILE NAME] key and open the alphabetic input window. Press the [ENT] key with the knob.

DEL CHAR — Delete one-left-character.

DEL NAME — Delete the file name.

Setting the FILETYPE

FILETYPE

MEAS FILE (DATA) — Press [FILETYPE], then press [MEAS FILE]. Note the types of files that can be saved:

A DATA file contains unprocessed time data and some setup information. For example, if the instantaneous spectrum was saved while in spectrum mode, the time data is recalled and converted into a spectrum.

A VIEW file contains processed data (after FFT processing or mathematical calculations).

The TBL FILE option is displayed only on the R9211C. The R9211C uses the TBL file to store GO/NOGO limit parameters, curve-fit data, and synthesis pole/zero data.

PANELFILE — A PANEL file contains front panel condition.

Setting PLOTTER Parameters

If you are using a plotter with the R9211, plug it into the GPIB port. Set the plotter to LISTEN ONLY and make sure there are no other devices on the bus. Set the R9211 [TALK ONLY] to ON under [GPIB] as described below.

PLOTTER

Press [PLOTTER] and set the following options.

PLOT WHAT (ALL)

Set [PLOT WHAT] to ALL to plot the waveform, scale and labels; set to FRAME to plot the scale only; set to SIGNAL to plot the waveform only; and set to LABEL to plot labels only.

PEN MODE (AUTO)

Set the [PEN MODE] to AUTO if you are using a multi-pen plotter for automatic pen changes during color plotting.

PEN SELECT

Under [PEN SELECT] select pens 1 to 6 the for scale, annotation, waveform, and readout plots.

PAPER SIZ (OFF)

Set the [PAPER SIZ] to A3 (for 8.5" x 11" paper), set to A4 (for 8.25" x 11.66" European standard paper), or set to OFF. When set to OFF, the plotter's paper size setting is used.

SCALE PLT

Set the paper size when the [PAPER SIZ] selects the USER SIZE.

MACRO PLT (OFF)

Under [MACRO PLT] set a two digit code that determines the number of plots on one page as follows: n = the number of plots on the page, and m = the plot's position on the page. For example, 31 indicates the top plot of three plots on a page; 32 indicates the middle plot, and 33 indicates the bottom plot. An exception to this rule is the code 12, which produces a single side-ways plot.

PLOT TYPE AT/HP

Set the [PLOT TYPE] to AT for Advantest plotters or HP for Hewlett Packard plotters.

COPY

To output a drawing to the plotter, press the [COPY] function key on the front panel. (The optional internal printer uses the [COPY] key on the printer.)

Setting GPIB Parameters

GPIB

If you are using the R9211 as part of a GPIB system, press [GPIB] and set the following parameters.

TALK ONLY ON/OFF

Set [TALK ONLY] to ON when a plotter is connected. The plotter should be set to LISTEN ONLY. Set the R9211 [TALK ONLY] to OFF when using a controller.

HEADER ON/OFF

Set [HEADER] to ON to attach a header to the output data. The header contains descriptive information and is used for error checking in some GPIB systems.

SET ADDRESS

Set the GPIB address under [SET ADDRESS] so that the R9211 has a unique address on the bus. The preset address is 8.

Turning off the Beep

MODE

EXTEND

BUZZER (OFF)

By the way, if you don't want the instrument to beep every time you press a key, press [MODE], press [EXTEND], select [BUZZER], and set to OFF.

Spectrum Measurement Tutorial

This tutorial describes how to use the R9211 as a spectrum analyzer.

If it's not already running, set up the internal or external signal generator to produce a 10 V sine wave as described before. Increase the frequency to 10 kHz. If you are using the built-in signal generator, increase the frequency as follows.

SG CONT

Press [SG CONT] and select [FREQ].

FREQ | f 10.00kHz

Press [*f*] and set to 10 kHz with the keypad.

Setting Spectrum Mode

MODE

Press the [MODE] function key.

MEAS | SPECTRUM

Select [MEAS] and set to [SPECTRUM].

VIEW

In spectrum mode you can display both a waveform and its frequency spectrum. To try this, press [VIEW].

TYPE | DUAL

Select [TYPE] and set to [DUAL].

SEL

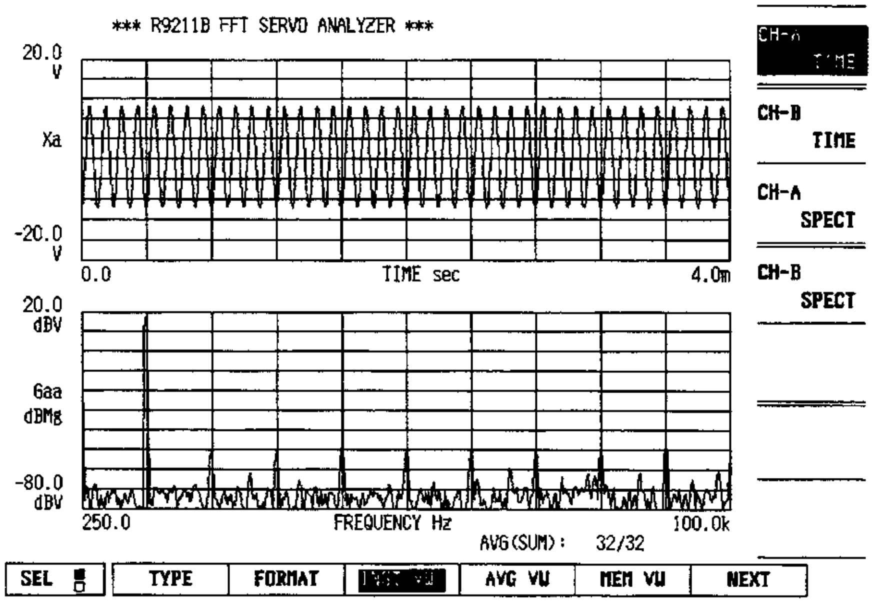
Press [SEL] to select the top display.

INST VW | CH-A TIME

Press [INST VW] and set to [CH-A TIME]. The display appears as shown on the next page.

TYPE | SINGLE

Press [TYPE] and set to [SINGLE] to return to a single screen display of the spectrum.



dual display

Setting the Spectrum Display

[SETUP]

When you switch to spectrum mode, additional functions appear in the X and Y soft key menus. Press [SETUP] and select [FUNC] to explore the spectrum measurement functions.

[FUNC] [POWER SPECT]

Press [POWER SPECT] to display the power spectrum.

[CROSS SPECT]

Press [CROSS SPECT] to display the cross spectrum between channels A and B. The cross spectrum is useful for highlighting common frequency components in the two signals or for calculating time delays from their phase shift.

[COMPLEX SPECT]

Press [COMPLEX SPECT]. The power spectrum is displayed by default since the complex spectrum display requires averaging. Press [START] to display the complex spectrum.

[START]

[POWER SPECT]

Press [POWER SPECT] to return to the power spectrum measurement function.

VIEW NEXT — Press [VIEW], press [NEXT], and select [COORD]. Try the following menu choices.

COORD

Mag — Press [Mag] to display the Y-axis in linear magnitude.

Mag^2 — Press [Mag^2] to display the Y-axis in linear magnitude squared.

PHASE — Press [PHASE] to display the phase of the complex spectrum.

REAL — Press [REAL] to display the real component of the complex spectrum.

IMAG — Press [IMAG] to display the imaginary component of the complex spectrum.

NYQUIST — Press [NYQUIST] to display the real component versus the imaginary component of the complex spectrum.

dBMag — Press [dBMag] to return to the original logarithmic display.

Setting the Spectrum RANGE

SETUP RANGE — Press [SETUP] and select [RANGE].

f RESOLN (LIN f) — By default the R9211 uses a linear algorithm to calculate the spectrum (*f* RESOLN is set to LIN). Press [*f* RESOLN] to try the other choices.

LOG f — Press [LOG *f*]. This setting calculates and displays the spectrum logarithmically. Note that you can also set the VIEW to display a log scale, but setting the [RANGE] calculates logarithmic data more accurately.

1/3 OCT f — Press [1/3 OCT *f*]. This setting displays the results of a 1/3 synchronous octave analysis calculation for acoustical applications. (Refer to the *Instruction Manual* for details.)

1/1 OCT f — Press [1/1 OCT *f*]. This setting displays the results of a 1/1 synchronous octave analysis calculation for acoustical applications.

LIN f — Press [LIN *f*] to return to a linear display.

LINE/SPAN 400 line — Select [LINE/SPAN]. This setting dictates the number of frequency points calculated for the frequency range. As with increasing the number of samples in waveform mode, increasing the lines/span slows down calculations but improves accuracy. Try setting to a higher value to see how resolution improves.

RETURN — Press [RETURN]. By default the R9211 is set to its maximum frequency range of 100 kHz. The R9211 models A and C have a zoom feature, which allows you to set the start and stop frequency of the spectrum calculation. Pressing either the [START *f*] or [STOP *f*] key automatically begins the frequency zoom mode. The * symbol displayed on the screen indicates you are in zoom mode. To return from zoom mode, press the [FREQ RNG] key.

Setting Spectrum Mode Weighting

The spectrum mode weighting determines how the R9211 reduces errors caused by the fact that only a finite portion of the input signal can be sampled. Several different mathematical methods are possible, each with tradeoffs in frequency resolution and amplitude accuracy.

NEXT — Press [NEXT] and press [WEIGHT] to explore the different weighting functions.

WEIGHT — MINIMUM — The weighting is preset to [MINIMUM]. This setting has poor frequency resolution but fair amplitude accuracy. Use this setting to detect sidebands or notches.

HANNING — Press [HANNING]. This setting has fair frequency resolution, but poor amplitude accuracy. Use this setting for periodic waveforms.

FLAT-PASS — Press [FLAT-PASS]. This setting has the best amplitude accuracy but the worst frequency resolution. Use this setting for harmonic analysis.

RECT — Press [RECT]. This setting has the best frequency resolution but the worst amplitude accuracy. Use this setting for transient and impulse signals.

FORCE/ RESPONSE — Press [FORCE / RESPONSE]. Use this setting for measurement with an impulse hammer. Press [RETURN].

MINIMUM — Press [MINIMUM] to return to the original weighting setting.

Controlling Averaging

AVG — The [SETUP] [AVG] menu lets you control the averaging process. Press [AVG] to explore this function. After making changes to the averaging settings, press the [START] measurement key to display the results. Press [STOP/C] to interrupt the averaging.

AVG MODE (SUM) — Press [AVG MODE].

SUM, START — Press [SUM] and press [START]. This setting uses summation averaging.

Notice how averaging has reduced the level of noise, making the harmonics of this signal more clearly visible.

EXP, START, STOP/C — Press [EXP] and press [START]. Press [STOP/C] to stop. This setting uses an exponential moving average (the average is weighted over time).

PEAK, START — Press [PEAK] and press [START]. This setting does not average the peaks. Use this setting to highlight spectrum peaks.

SUB, START — Press [SUB] and press [START]. This setting uses subtraction averaging.

SUM, RETURN — Press [SUM] to return to the original setting. Press [RETURN].

AVG NO 4, START — Press [AVG NO] and set to 4. Press [START]. Use this key to set the number of averaging iterations from 1 to 32767.

PROCESS (NORMAL) — Press [PROCESS] to explore the different settings for controlling the averaging process.

FAST, START — Set to [FAST] and press [START]. This setting displays the averaging results only after all iterations are complete.

+1 AVG | START | STOP/C

Press [+1 AVG] and press [START]. With this setting, one averaging cycle is completed each time you press [STOP/C]. Use this setting for vibration measurements with an impulse hammer.

STOP +1

Press [STOP +1] to interrupt the +1 averaging process.

NORMAL | RETURN

Press [NORMAL] to return to the original setting. This setting displays the results of each averaging iteration. Press [RETURN].

VIEW | INST VW

Return to the instantaneous view of the spectrum by pressing [VIEW] and selecting [INST VW].

CH-A SPECT

Set to [CH-A SPECT].

Saving Data In Memory

The R9211 has internal memory locations where you can store data. This feature is useful if you want to display two different measurements side-by-side. The number of locations depends on the R9211 model and the amount of optional memory installed. This memory is erased when you turn off the instrument.

VIEW | MEM VW

To explore this feature, press [VIEW] and select [MEM VW].

DATA SAVE 1

Press [DATA SAVE 1] to store the currently displayed data in the first memory location.

DATA RECALL 1

Press [DATA RECALL 1] to recall the data from the first memory location.

VIEW | INST VW

Return to the instantaneous view of the spectrum by pressing [VIEW] and selecting [INST VW].

CH-A SPECT

Set to [CH-A SPECT].

Other VIEW Functions

VIEW

Press [VIEW] and select [FORMAT] to explore other display features.

The [NUMERIC LIST] feature is described later.

FORMAT

3D DISPLAY

Press [3D DISPLAY] to show a three-dimensional display. Adjust the 3D display as described below under [3D SETUP]. The T-F mode provides more complete control of the 3D display. Press [GRAPH].

X-AXIS LIN/LOG

Set [X-AXIS] to LOG. This setting switches the X-axis of the display between linear and logarithmic scales. (As previously noted, the logarithmic display is more accurate if you change the [RANGE] setting under [SETUP] to logarithmic frequency resolution.) Set the [X-AXIS] back to LIN.

Use the [OVERLAY] feature in T-F mode to display multiple T-F traces on one screen as described later.

GRATICULE ON/OFF

Set [GRATICULE] to OFF. When on, the R9211 displays a graticule (grid).

3D SETUP

Press [3D SETUP] to set three-dimensional display parameters.

3D ANGLE 75deg

Press [3D ANGLE] and set to 75deg. Press [RETURN].

3D DISPLAY

Press [3D DISPLAY]. Note how the display has changed to a sharper angle.

GRAPH

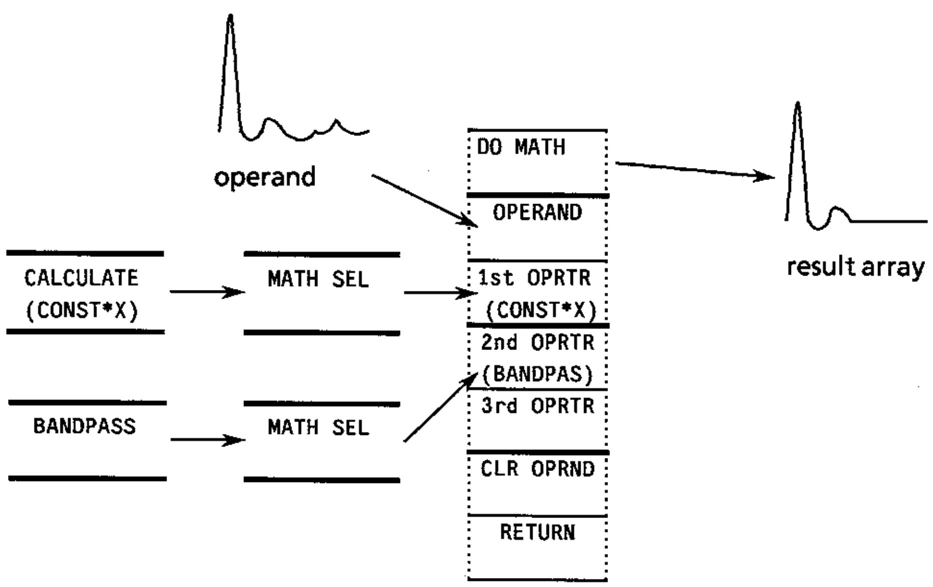
Press [GRAPH] to return from the 3D display to a two axis display.

Using the MATH Functions

The R9211 has a variety of mathematical functions for processing captured data. Each measurement mode has different math functions. For the sake of brevity, only a few math functions are described here. Refer to the *Instruction Manual* for a complete description.

In general, perform computations by assigning an *operand* (the data set), assigning up to three *operators* (the mathematical functions), and pressing [DO MATH]. To view the results of the calculation, you then press [VIEW], select [MATH VW], and set to [RESULT ARRAY]. (Note that you cannot perform additional computations on the result array. You can perform additional calculations on data stored on disk or in the memory locations.)

Operand and operator assignments are made under the [MATH SEL] menu. [MATH SEL] is laid out differently from the other Y soft key menus: it is available from each of the five math function X soft key menus. This way, you select a function you need, then press [MATH SEL] and press an [OPRTR] key to assign the function to the operator list. Pressing [OPERAND] assigns the currently displayed data as the operand. Pressing [DO MATH] begins the computation.



math select menu

The five math function X soft keys in spectrum mode are:

[jω] Select from pseudo differentiation and pseudo integration operators.

[CEPSTRUM] Select from inverse Fourier transform operators.

[*f* MATH] Select from algebraic operators.

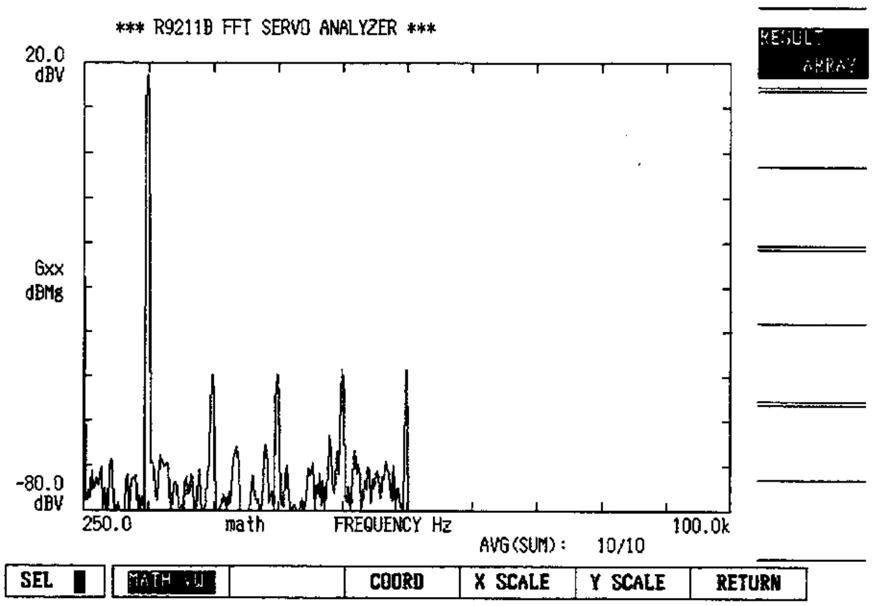
[DOMAIN] Select from transformation operators.

[MOD *f*] Select from frequency filtering operators.

MATH Functions Example

For practice using the math functions, mathematically filter out the high end of the signal generator output as follows. It is assumed that the power spectrum of the 10 V, 10 kHz signal generator output is currently displayed.

Keys	Procedure
MATH / MOD f	Press the [MATH] function key and select [MOD *f*].
BANDPASS / UPPER f 50.00kHz	Press [BANDPASS] and set [UPPER *f*] to 50 kHz.
FILTERING ON/OFF / RETURN	Set [FILTERING] to ON and press [RETURN].
MATH SEL / OPERAND	Press [MATH SEL]. Press [OPERAND] to assign the currently displayed data as the operand. (You must assign an operand before assigning operators.)
1st OPRTR (BANDPAS)	Press [1st OPRTR] to assign the bandpass function as the first operator. (BANDPAS) appears under [1st OPRTR].
DO MATH	Press [DO MATH].
VIEW / MATH VW / RESULT ARRAY	Press [VIEW], select [MATH VW] (on the second menu), and set to [RESULT ARRAY]. The result should appear as shown on the next page.



result array

RETURN

INST VW | CH-A SPECT

To return to the instantaneous view, press [RETURN], select [INST VW], and set to [CH-A SPECT].

Additional Markers for Spectrum Mode

MKR

Press [MKR] to see some of the additional marker functions available in spectrum mode.

X MKR | HARMONIC (OFF)

For example, press [X MKR] and select [HARMONIC].

FUND FREQ 10.00kHz

Set the [FUND FREQ] to 10 kHz.

HARMONIC ON/OFF | RETURN

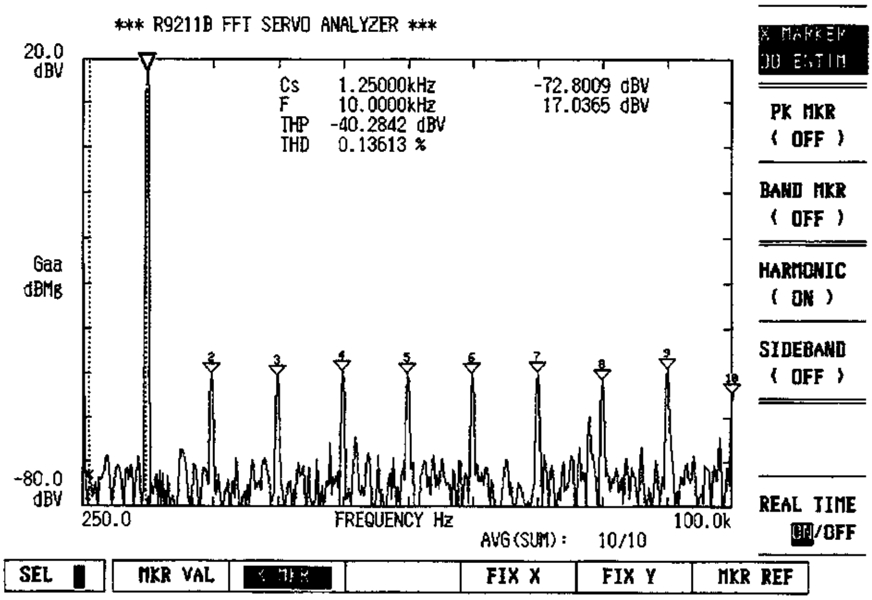
Set [HARMONIC] to ON and press [RETURN]. The display appears as shown below.

FUND SET PEAK/MAN

Select to set the manual mode of FUNDAMENTAL FREQUENCY or to set PEAK SEARCH FREQUENCY.

MAX ORDER 20

Set to 2nd operand of calculated HARMONIC.



harmonic markers

VIEW

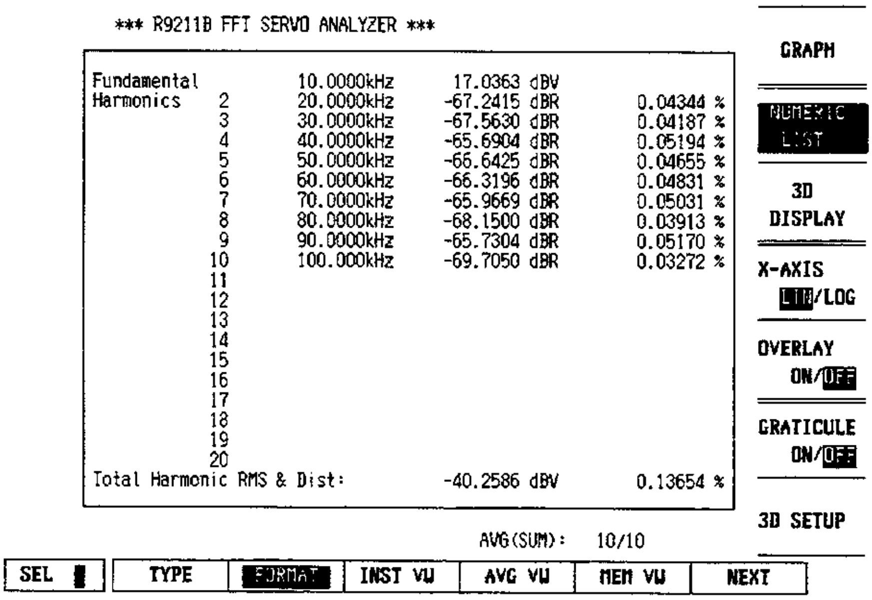
FORMAT

NUMERIC LIST

To display the harmonics' signal strengths as a list, press the [VIEW] key, select [FORMAT], and set to [NUMERIC LIST]. The display appears as shown below.

GRAPH

Set to [GRAPH] to return to the normal view.



harmonic markers numeric list

Setting Custom Labels and Scaling

SETUP

UNIT

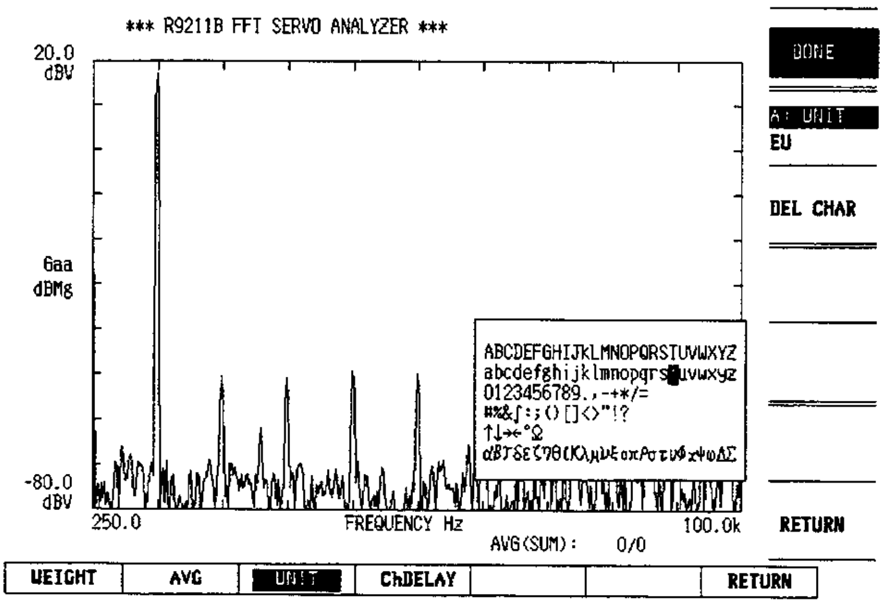
The R9211 lets you set custom labels and scaling for the Y-axis of the spectrum plot called *engineering units*. You could use this feature, for example, to show the power spectrum gain relative to some reference other than dBVolts. To explore this feature, press [SETUP] and press [UNIT].

A: VALUE
10.00dBEU

Press [A: VALUE] and set to 10 dBEU. This key sets the scaling value. If the data currently displayed has logarithmic Y-axis units, scaling is done according to the equation 0 dBV = XXXX dBEU. If the data currently displayed has linear Y-axis units, scaling is done according to the equation 1 V_{rms} = XXXX EU.

A: UNIT
tu

Press [A: UNIT]. This key sets the two letter engineering unit abbreviation that appears on-screen for the Y-axis. Select the letter 't' with the knob and press [ENT]. Select the letter 'u' with the knob and press [ENT]. (Here *tu* stands for tutorial units.) Press [DONE] and press [RETURN].



setting the engineering units label

EU or Vlt
(EU)

Now turn on the engineering units. Press [EU or Vlt] and set to [EU]. (The [Vrms] setting turns the scaling function off, and dBV values are computed from V_{rms}. The [Vlt] setting turns the scaling function off, and dBV values are computed from V_{peak}.) Note how the spectrum is stretched vertically by 10% and the Y-axis units change to dBtu.

(Note that the PSD function on the Y menu is not strictly part of the scaling functions. When PSD is on, the R9211 displays the power spectrum density, which is the conversion level per 1 Hz. This function is useful for noise measurements.)

Time-Frequency Measurement Tutorial

This tutorial describes how to use the R9211 to measure changes in frequency amplitudes over time. This type of analysis could be used, for example, to reduce noise and vibration in the sound of an automobile door opening and closing. You can trace new frequencies after the T-F data has been acquired. If you have optional memory installed, you can trace frequencies for a longer period of time.

There are two ways that the R9211 can display time-frequency information: as a two dimensional trace of the change in amplitude versus time of a particular frequency or frequency range, or as a three dimensional plot of the spectrum using the Z-axis for time.

Note that the MATH computation functions do not operate with T-F data. Also note that the T-F analysis functions do not operate if the frequency zoom feature is on.

Setting Up and Displaying T-F Traces

The T-F trace feature can display up to four traces on one screen. To use the trace feature, first assign to each trace a frequency or frequency range that you want the R9211 to monitor. Then set the length of time for monitoring. Then press [START].

Practice using the T-F trace feature to monitor the signal generator output and its first three harmonics as follows.

PRESET

Restart the R9211 and press [PRESET] to clear the settings from the previous tutorial.

MODE

Set up the signal generator to produce a 10 V sine wave at 10 kHz as you did for the previous tutorial.

MEAS | TIME-FREQ

Press [MODE], select [MEAS], and set to [TIME-FREQ] to enter T-F measurement mode.

EXTEND | TRACEonST ON/OFF

Select [EXTEND] and set [TRACEonST] (trace on start) to ON. This setting automatically sets the trace display when a trace measurement starts.

SETUP

Press [SETUP] and press [TRIG] to set the amount of data memory allocated to the trace function.

TRIG

ARM LEN
64 K

Press [ARM LEN] and set to the maximum amount of memory. The maximum amount is determined by the R9211 model, the amount of optional memory installed, and single or dual channel operation. If your application only requires one channel, you can double the amount of memory available as follows.

FUNC

ACTIVE CH
(CH-A)

Select [FUNC], select [ACTIVE CH], and set to [CH-A]. Press [RETURN].

Another way to increase the amount of T-F measurement time is to reduce the frequency range of the instrument. The maximum amount of time (in seconds) can be determined according to the following formula:

$$\frac{\text{(ARM LENGTH in Kbytes x 1024)}}{\text{(frequency range in Hertz x 2.56)}}$$

For example, 1024k ARM LEN data captured in the 5 kHz range can record for approximately 82 seconds.

NEXT

T-F

Press [NEXT] to go to the next page of the X-axis menu, and press [T-F]. The general procedure is to set the trace range, set the trace frequencies under [t-*f* MODE] and check the trace settings under [t-*f* STATUS]. Then set [INST t-*f*] to ON and press [START]. Viewing all four traces on one screen takes additional key presses as described below.

Turn [INST t-*f*] OFF when setting the trace parameters.

t RANGE

Press [t RANGE] and set the start time to 0 sec, the stop time to 4 msec, and the step time to .5 msec. Press [RETURN].

t-f MODE

SPOT f
10.00kHz

Press [t-*f* MODE]. With the ID set to 1, set the [SPOT *f*] to 10 kHz. (Note that a trace can also cover a frequency range and that the trace can use units other than the power spectrum units.)

Change the trace ID to 2 and set the [SPOT *f*] to 20 kHz.

Similarly, set the SPOT frequency for traces 3 and 4 to 30 kHz and 40 kHz.

t-f STATUS

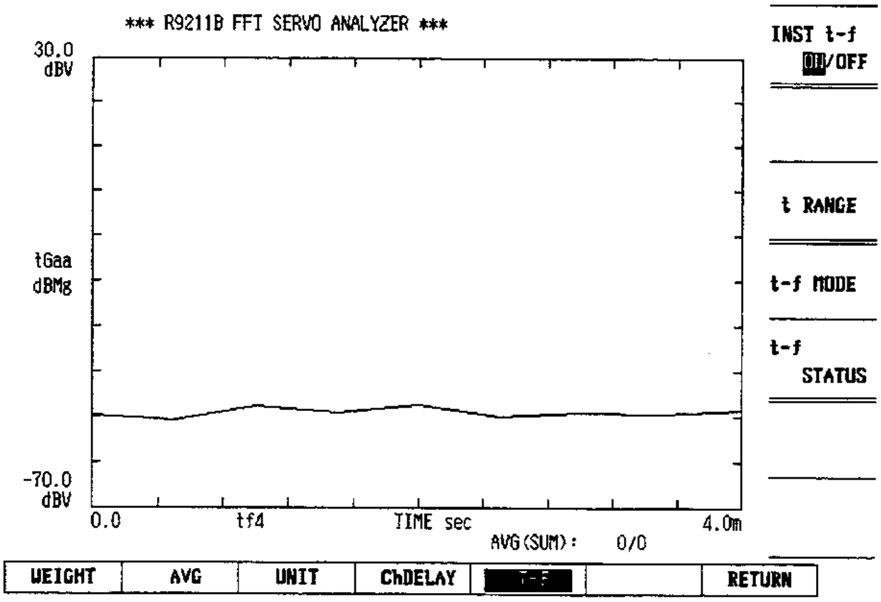
Check your settings using [t-*f* STATUS] (the settings are read-only when read from the status key).

INST t-f ON/OFF

Set [INST t-*f*] to ON. (If [INST t-*f*] is not on, the R9211 assumes you want to perform averaging when you press [START].)

START

Press [START]. The R9211 displays one trace in eight steps from 0 to 4 msec as shown below.



a single T-F trace

To display all four traces simultaneously, first assign one trace to each of the four screens in [QUAD] display mode, then turn on the overlay function as follows.

VIEW

TYPE — QUAD — Press [VIEW], select [TYPE], and set to [QUAD].

Press [NEXT] to go to the next X-axis menu.

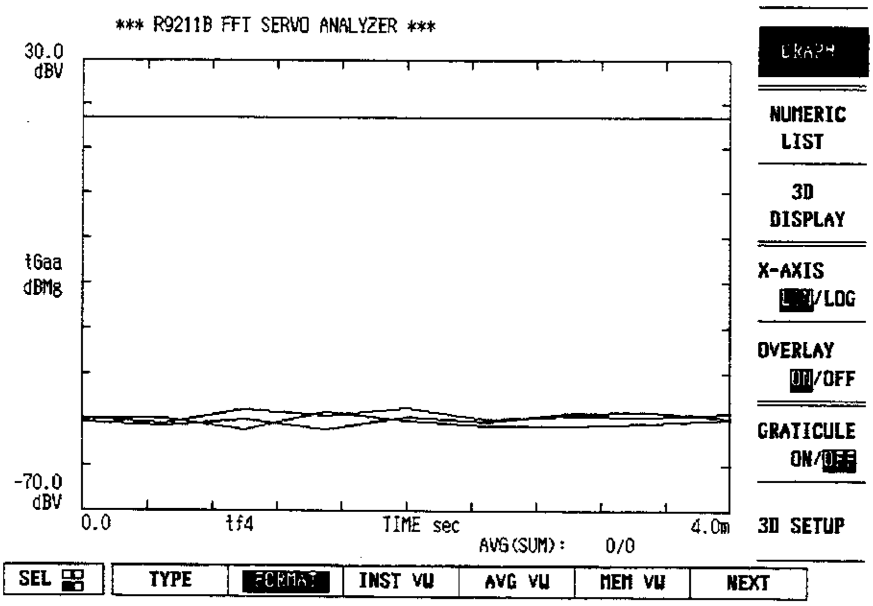
T-F VW — Press [T-F VW].

SEL — t-f TRACE 1 — Press [SEL] to select the upper left screen and press [t-*f* TRACE 1] to assign trace one to that screen.

Similarly assign each of the other traces to the other screens.

RETURN — Press [RETURN] to return to the previous page of the X-axis menu.

FORMAT — OVERLAY ON/OFF — Press [FORMAT] and set [OVERLAY] to ON. The display appears as shown below.



overlayed T-F traces

Setting Up and Displaying T-F in 3D

T-F data can also be displayed in three dimensions with time as the Z-axis. To explore this function, first return to a normal spectrum display.

OVERLAY ON/OFF — Set [OVERLAY] to OFF.

TYPE — SINGLE — Press [TYPE] and set to [SINGLE].

INST VW — CH-A SPECT — Press [INST VW] and set to [CH-A SPECT].

DATA VIEW ON/OFF — Set [DATA VIEW] to ON. (Note that the T-F trace function turns off automatically.)

VIEW STEP — STEP TIME 0.50msec — Press [VIEW STEP]. Set the [STEP TIME] to 0.5 msec.

FORMAT — 3D SETUP — Press [FORMAT] and select [3D SETUP].

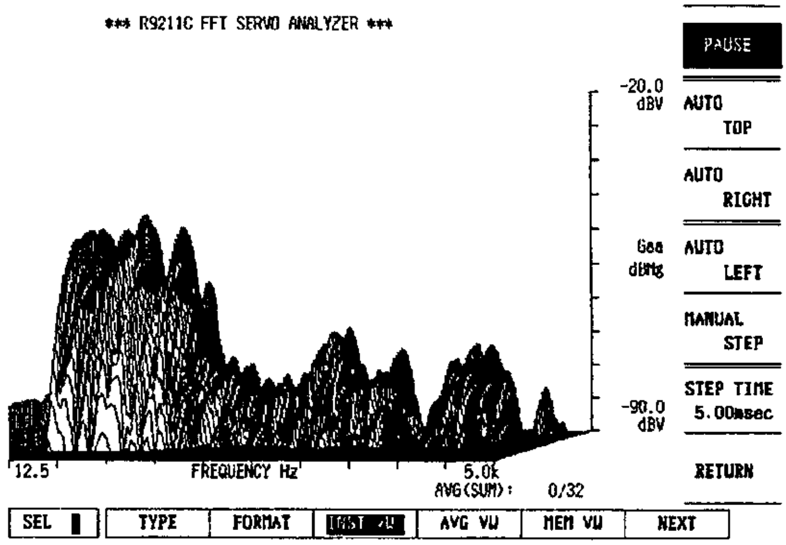
3D CTRL (VW STEP) — Press [3D CTRL] and set to [VIEW STEP].

3D DISPLAY — Press [RETURN] twice and press [3D DISPLAY]. The display is activated but the instrument is paused by default.

INST VW — VIEW STEP — Press [INST VW], press [VIEW STEP], and select [AUTO RIGHT]. The R9211 shows the spectrum changing in time.

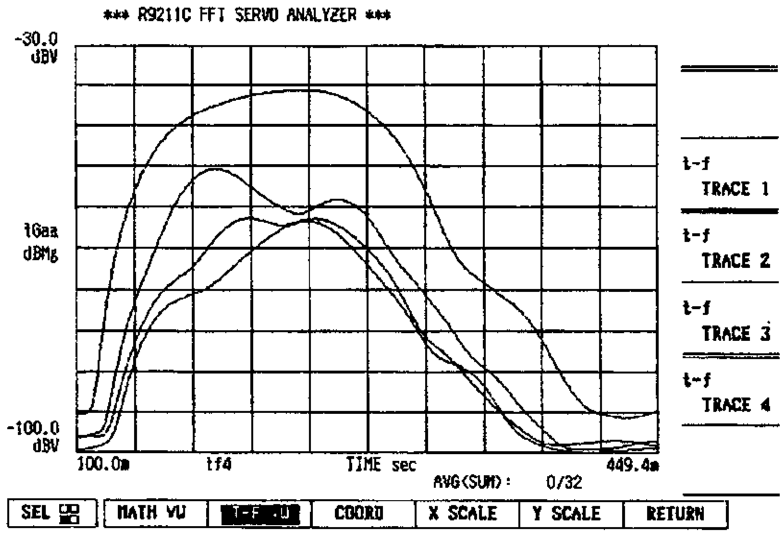
AUTO RIGHT — [PAUSE] stops movement of the [DATA VIEW] display.

The figure below shows an example of the 3D T-F display used to capture the vocal syllable "ah" spoken into a microphone.



3D T-F display

This figure (below) shows the same data using the trace function to trace four selected frequency ranges.



T-F trace of vocal data

FRF Measurement Tutorial

This section describes how to use the R9211 to measure the frequency response function (FRF) of a device — how an input spectrum differs from the output spectrum.

FRF measurement mode is similar to servo measurement mode. (Servo measurement mode is only available with R9211 models B, C, or F.) Servo mode is specialized for measuring the FRF of a servo system with a filter and actuator. If you have a model with servo mode, also go through the tutorial in chapter 5.

In FRF mode, the general procedure is to set up the signal generator output, start the signal generator, press [START], and view the coherence and FRF measurement. FRF mode has additional VIEW and MKR functions to explore.

Setting Up

To make FRF measurements, connect the signal generator output to the Device Under Test (DUT), and connect the same signal generator output to channel A using a 'tee' connector. Connect the DUT output to channel B. For the purposes of this tutorial, any DUT will do, such as a filter or an amplifier. For example, try using a simple RC low-pass filter. If you are using an external signal generator, connect it as shown on the next page. For best results the external signal generator should be capable of producing a multi-sine or swept sine signal.

PRESET

Reset the instrument by turning it off, turning it on, and pressing [PRESET] while the self-test is running.

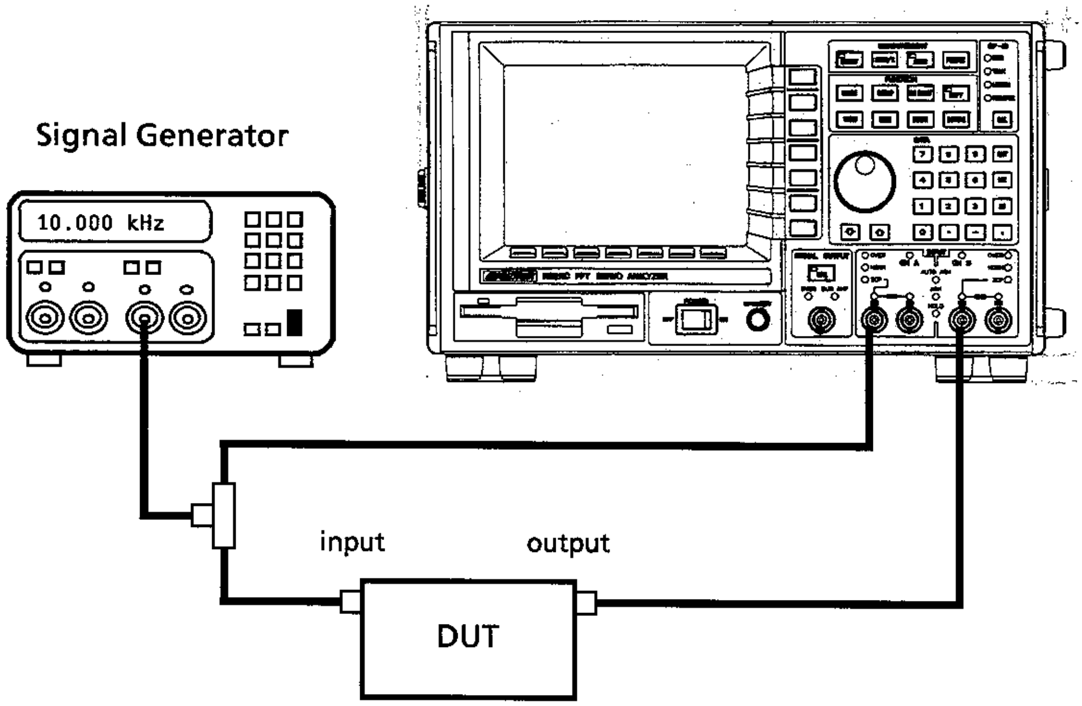
MODE

MEAS | FRF

Press [MODE] and select [FRF] measurement mode.

EXTEND | TRACEonST ON/OFF

Press [EXTEND] and set [TRACEonST] to ON. This automatically sets the FRF display when an FRF measurement begins. The FRF display has an upper screen displaying coherence and a lower screen displaying gain.



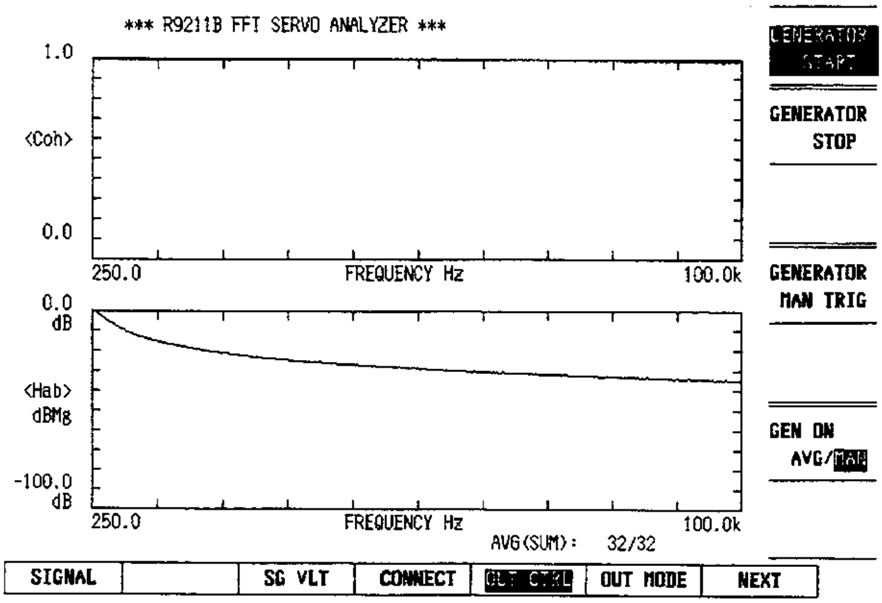
Setting Signal Generator Parameters

If you have an external signal generator, set it to produce a multi-sine or swept sine signal for the range 0 to 100 kHz.

SG CONT		If you are using the internal signal generator, set it as follows:
SIGNAL	M-SINE	Press [SG CONT]. Press [SIGNAL] and select [M-SINE].
SG VOLT	AMPLITUDE 10.00V	Press [SG VLT] and set [AMPLITUDE] to 10 V.
OUT CTRL	GENERATOR START	Press [OUT CTRL] and press [GENERATOR START].
OPR		Press [OPR] on the front panel to start the signal generator.

Start FRF Measurement

Press [START]. The R9211 averages several FRF measurements and displays the results as shown below. The example given here shows the FRF of a low pass RC filter.



FRF of a low pass RC filter

Check the coherence. The coherence should be close to one for an acceptable measurement. You can improve coherence by narrowing the frequency range of the measurement or by increasing the number of averaging cycles.

Viewing FRF Results

Hardkey	Softkey	
VIEW TYPE	SINGLE	There are several ways to display measurements made in the FRF measurement mode. Some of these are available under [VIEW] [AVG VW] and some are under [VIEW] [FRF CORD].
		Press [VIEW], select [TYPE], and set to [SINGLE].
		Press [AVG VW].
AVG VW	COHERENCE	Press [COHERENCE] to display the coherence function. Use this to evaluate the reliability of FRF measurements.
	IMPULSE RESPONSE	Press [IMPULSE RESPONSE]. This shows how the DUT changes the input signal in the time domain . It is derived from the reverse Fourier transform of the FRF data.
	FRF	Press [FRF] to return to a display of the frequency response function.
NEXT		Press [NEXT] to go to the second [VIEW] X-axis menu.
FRF CORD		Press [FRF CORD] to explore other FRF display options.
	BODE	Press [BODE] to display a Bode plot (a dual display of the phase and gain characteristics).
	CO-QUAD	Press [CO-QUAD] to simultaneously display the real and imaginary portions of the frequency response function.
	NYQUIST	Press [NYQUIST] to display a Nyquist diagram, which shows real versus imaginary FRF data.
	Cole-Cole	Press [Cole-Cole] to display a Cole-Cole diagram, which shows real versus negative imaginary FRF data. This diagram is used for chemical impedance measurements.
	NICHOLS	Press [NICHOLS] to display a Nichols diagram, which shows phase versus gain FRF data. This diagram is used for evaluation of the phase margin and gain margin.
	BODE	Press [BODE] to return to the Bode plot.

Using FRF Markers

MKR

FRF mode enables markers additional to the ones you have explored in the other modes. Press [MKR] to explore one of these new markers.

CTRL SYS

Press [CTRL SYS].

BODE MKR ON/OFF

Set [BODE MKR] to ON. (The view coordinates must be set to Bode plot.) The Bode marker computes the phase margin and gain margin of the open-loop frequency response function. This information is useful for amplifier and filter design.

Congratulations

Congratulations. You have completed the tutorial for the R9211 models A and E. If you have a model B, C, or F, proceed to chapter 5 to learn about the servo mode features.

Chapter 5
Servo Mode Tutorial

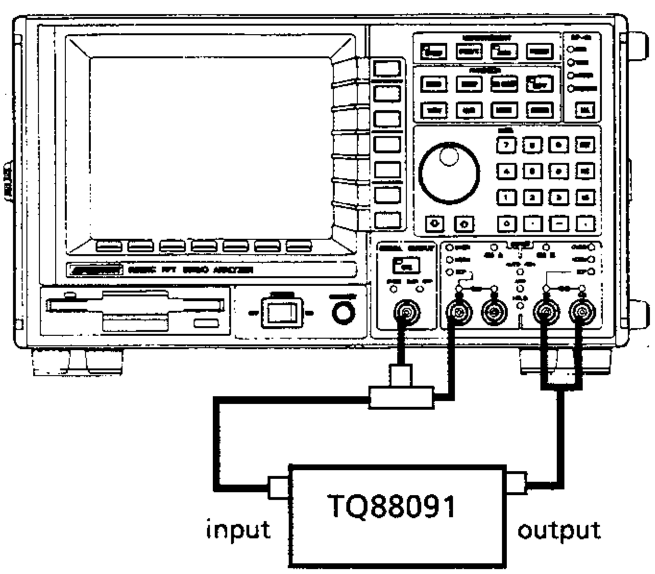
This tutorial describes how to use the R9211B, C, or F to analyze servo mechanisms. It closely follows the video tape *Servo Analyzer for You* (available from Advantest) and uses the TQ88091 Optical Actuator Test Head in the examples. However, you can perform the tutorial without the video or the test head. Some of the features already covered in the previous tutorials are reviewed. The last part of this tutorial describes features available only on the R9211C.

This tutorial uses the focus servo pickup and drive amplifier of a CD player as an example. There are two methods for analyzing such a servo unit: the laser doppler method (the head displacement is measured as speed) and the actuator test head method (the head displacement is measured directly). The actuator test head method is studied first.

Begin the video now if you have it. Pause the video after each section and perform the steps in the text.

Setting Up

Connect the TQ88091 Optical Actuator Test Head or an equivalent DUT to the R9211 as shown below. Attach an actuator to the TQ88091 (refer to the *TQ88091 Instruction Manual*).



PRESET

Turn the instrument on (or cycle the power if it's already on). Wait until the self-test starts, then press [PRESET]. This skips the self-test and resets the instrument to its preset (default) settings. Adjust the screen intensity (brightness) to a comfortable level.

MODE

Press [MODE] and select [MEAS].

MEAS | SERVO

Press [SERVO] to set the R9211 to servo measurement mode. The display changes to a dual screen display.

CAL | SINGLE DC CAL

Select [CAL] and press [SINGLE DC CAL] to calibrate the R9211. Wait until the screen displays [SINGLE DC CAL...end] before continuing.

Setting Measurement Conditions

Setting Input Parameters

SETUP

Press [SETUP] and select [SWEEP].

SWEEP | LOG MSIN

Set to [LOG MSIN] for a logarithmic multi-sine sweep.

RANGE

Press [RANGE] and select [FREQ RNG].

FREQ RNG* 20 kHz

Set the frequency range to 20 kHz.

f RESOLN | Line/Dec 100

Press [*f* RESOLN]. Leave the Line/Dec (lines per decade) at 100.

Decade 4

Set the number of decades to 4.

Set the sweep to [SWEEP UP] and press [RETURN].

SWEEP UP

Press [SENS] to set the input sensitivity.

SENS | CH-A AUTO/MAN | CH-B AUTO/MAN

Set both channel A and B to AUTO.

Setting Output Parameters

Note that in servo mode, you set the signal generator output using the [SETUP] key. (In other modes, you set the signal generator output using the [SG CONT] key.)

SG VLT — AMPLITUDE 0.05V

Select [SG VLT] and set the [AMPLITUDE] to 0.05 V. (The maximum setting is 18 V.)

PRESET — OFFSET 0.0V

Select [OFFSET] and set the offset to 0.0 V. You can set the offset independently of the amplitude to a maximum of 10 V. The offset voltage is present at the signal generator output terminal even if [SG COM] is set to [GENERATOR STOP] and [OPR] is on. This is done so that you can position a servo between its mechanical stops using the offset voltage.

SG COM — GEN ON AVG/MAN

Select [SG COM] and set [GEN ON] to [AVG]. (When set to AVG, the signal generator does not output a signal until you press the [START] key, as described later in the tutorial.)

AVG — AVG NO 2

Select [AVG] and set the number of averaging cycles under [AVG NO] to 2. Leave the averaging process set to [NORMAL].

NEXT

Press [NEXT] to move to the next X soft menu.

INPUT — CHANNEL CH-A/CH-B

Press [INPUT]. If you are using the TQ88091 Test Head, set channel B for a differential input as follows:

+INPUT IN/GND — -INPUT IN/GND

Press [CHANNEL] so that CH-B is selected (highlighted). Press [-INPUT] so that IN is selected. Both [+INPUT] and [-INPUT] should be set to IN for a differential input.

Measurement and Analysis

Measurement

OPR

Press [OPR] to switch on the signal generator from standby status. The [OPR] key should be lit.

START

Press [START] to initiate the measurement. The [START] key lights during the measurement.

The screen changes to show the coherence on the upper screen and the DUT's open loop FRF on the lower screen.

VIEW

NEXT

To get a clearer look at the FRF, press [VIEW] and press [NEXT].

Y SCALE

Y AUTO SCALE

Select [Y SCALE] and set to [Y AUTO SCALE]. The R9211 automatically sets the most appropriate viewing range.

Frequency Table

Using the servo mode's frequency table, you can set up to 20 frequency bands for the signal generator to sweep. This feature makes the R9211 effective for analyzing complex specific features of the DUT.

SETUP

RETURN

Press [SETUP]. Press [RETURN] to return to the first setup menu.

SWEEP

LOG F-Tab

Press [SWEEP] and set to [LOG F-Tab].

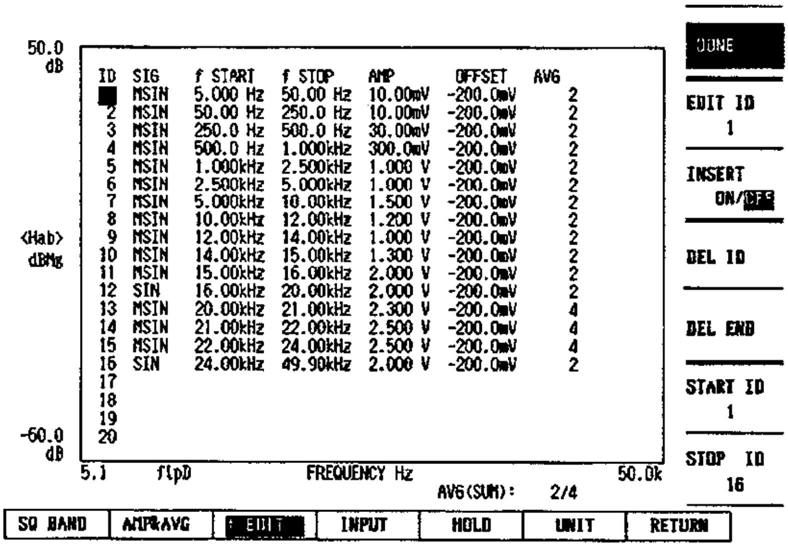
NEXT

SQ BAND

Press [NEXT] and press [SQ BAND]. The screen changes to to display the frequency table.

Enter the frequency table information shown in the figure below. Use the Y soft keys to set SINE or M-SINE and the sweep's start and stop frequency. The Y soft menu then changes so that you can set the signal's amplitude, offset voltage, and number of averaging cycles. After setting those values the cursor automatically moves to the next ID number.

If the Y soft menu already displays the value you want, press [ENT] for that setting. If you make a mistake, you can edit the table with the functions under the [*f* EDIT] menu.



ID	SIG	f START	f STOP	AMP	OFFSET	AVG
[illegible]	MSIN	5.000 Hz	50.00 Hz	10.00mV	-200.0mV	2
2	MSIN	50.00 Hz	250.0 Hz	10.00mV	-200.0mV	2
3	MSIN	250.0 Hz	500.0 Hz	30.00mV	-200.0mV	2
4	MSIN	500.0 Hz	1.000kHz	300.0mV	-200.0mV	2
5	MSIN	1.000kHz	2.500kHz	1.000 V	-200.0mV	2
6	MSIN	2.500kHz	5.000kHz	1.000 V	-200.0mV	2
7	MSIN	5.000kHz	10.00kHz	1.500 V	-200.0mV	2
8	MSIN	10.00kHz	12.00kHz	1.200 V	-200.0mV	2
9	MSIN	12.00kHz	14.00kHz	1.000 V	-200.0mV	2
10	MSIN	14.00kHz	15.00kHz	1.300 V	-200.0mV	2
11	MSIN	15.00kHz	16.00kHz	2.000 V	-200.0mV	2
12	SIN	16.00kHz	20.00kHz	2.000 V	-200.0mV	2
13	MSIN	20.00kHz	21.00kHz	2.300 V	-200.0mV	4
14	MSIN	21.00kHz	22.00kHz	2.500 V	-200.0mV	4
15	MSIN	22.00kHz	24.00kHz	2.500 V	-200.0mV	4
16	SIN	24.00kHz	49.90kHz	2.000 V	-200.0mV	2
17						
18						
19						
20						

frequency table

f EDIT | STOP ID 16

Press [*f* EDIT] and set [STOP ID] to 16 (or the maximum ID you entered). Note that it is possible to sweep a portion of the frequency table bands by setting [START ID] and [STOP ID].

DONE

Press [DONE]. The screen returns from the frequency table display.

START

Press [START] to make a measurement using the frequency table to control the sweep.

Screen Operations

Key	Softkey	
VIEW		Next explore the different display options in servo mode. Press [VIEW] and select [FRF CORD].
FRF CORD	BODE	Set to [BODE]. The FRF phase is displayed on the upper screen and the FRF magnitude is displayed on the lower.
SEL		To make the phase easier to see, use the auto scale function. Press [SEL] to select the upper screen.
Y SCALE	Y AUTO SCALE	Press [Y SCALE] and set to [Y AUTO SCALE].
RETURN TYPE	SINGLE	Now set the display to a single screen to get a better look at the phase. Press [RETURN], press [TYPE], and set to [SINGLE].
NEXT COORD	PHASE	Press [NEXT], press [COORD], and set to [PHASE].
RETURN TYPE	DUAL	Return to dual screen display. Press [RETURN], press [TYPE], and set to [DUAL].
RETURN FORMAT	GRATICULE ON/OFF	Now, turn off the graticule. Press [RETURN], press [FORMAT], and set [GRATICULE] to OFF.

Reading Data With Markers

MKR

Now explore the servo mode marker functions. Press [MKR].

MKR VAL

SINGLE X X1 Y1

Press [MKR VAL] and set to the [SINGLE X X1 Y1] marker. Rotate the knob to see the marker.

CTRL SYS

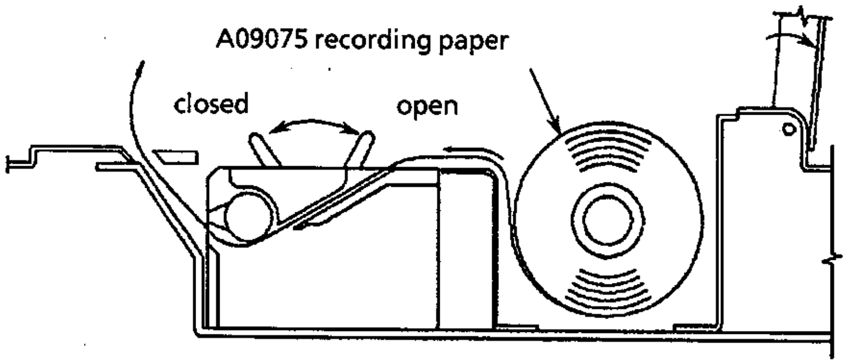
BODE MKR ON/OFF

Calculate the DUT's open loop phase and gain margin using the Bode marker. Select [CTRL SYS] and set [BODE MKR] to ON. Two markers appear and the screen shows the gain margins of the first pole.

Saving the Data

Printing on the Internal Printer

Now set up the optional printer to make a hard copy (if installed). Open the printer lid and move the printing head lever to the open position as shown below.



loading the printer

Insert a roll of AO9075 paper as shown. Close the printing head lever and shut the lid. Hold the feed button for a moment and tear off the excess paper.

When the paper is installed properly, press the [COPY] key on the printer. (The front panel [COPY] key is for an external plotter.) The printer produces an exact copy of the display.

Storing Data on a Floppy Disk

DEVICE

ACCESS

Insert a floppy disk into the disk drive. Press [DEVICE] and select [ACCESS] to access the disk.

INITIAL | EXECUTE INITIAL

If the disk is unformatted, press [INITIAL] and [EXECUTE INITIAL] to initialize (format) the disk. Press [RETURN] when done.

SAVE | EXECUTE SAVE

To save the currently displayed data, press [SAVE] and [EXECUTE SAVE]. The R9211 saves the data and most of the parameter settings. Press [RETURN].

RECALL | EXECUTE RECALL

To recall the data, select the file with the knob. Press [RECALL] and press [EXECUTE RECALL].

DONE

Close the alphabetic input window.

FILE NAME NO_NAME

To input the file name, press the [FILE NAME] key and open the alphabetic input window. Press the [ENT] key with the knob.

DEL CHAR

Delete one-left-character.

DEL NAME

Delete the file name.

Advanced Analysis (R9211C Only)

Curve Fit and Synthesis Functions

The R9211C's *curve fit* function calculates the poles and zeros (Laplace parameters) that characterize a servo's FRF. The *synthesis function* is the reverse; it uses Laplace parameters to generate an FRF. By editing the pole/zero table from a curve fit, you can use the synthesis function to simulate the servo's frequency response to new poles and zeros.

These two functions simplify the task of servo design. The synthesis function lets you evaluate the servo's response to a simulated feedback compensation circuit. After you find the optimal response, you can use the Laplace parameters to design the actual compensation circuit.

Performing the Curve Fit

PRESET		To begin, press [PRESET] and press [MATH KEY].
MATH KEY	CurveFit MENU	Select [CurveFit MENU]. This changes the menus available under the [MATH] key so that you can work with the curve fit function.
MATH		Press [MATH] and select [FIT].
FIT	FIT INPUT AVG/MATH	Set [FIT INPUT] to [AVG].
sWeight	AUTO WGT	Select [sWeight] and set to [AUTO WGT].
FIT	CREATE FIT	Select [FIT] and press [CREATE FIT] to begin the curve fit calculation. The display shows [Curve fit...end] when the calculations are done.

Viewing the Curve Fit

Now set up the display with two screens so that the original FRF is on the top screen and the fitted FRF is on the bottom screen as follows.

VIEW

TYPE — DUAL

Press [VIEW] and select [TYPE].

Set to [DUAL].

SEL

Use [SEL] to select the top screen.

AVG VW — FRF

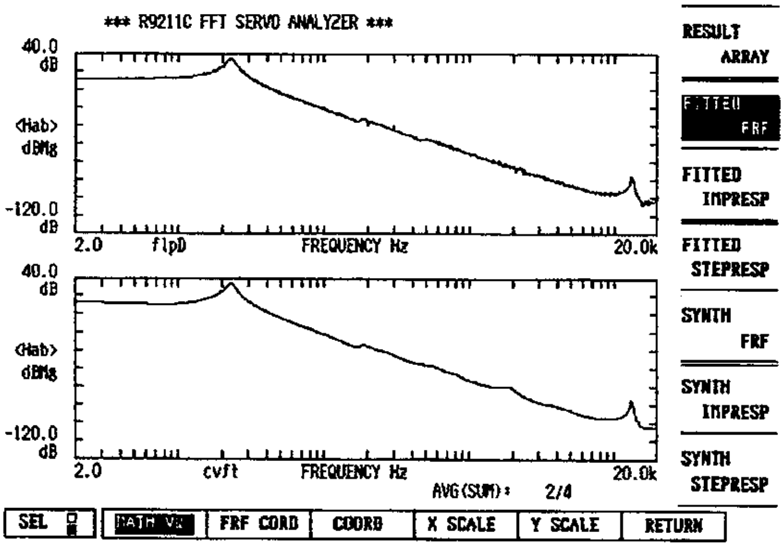
Select [AVG VW] and set to [FRF].

SEL

Use [SEL] to select the bottom screen.

MATH VW — FITTED FRF

Select [MATH VW] and set to [FITTED FRF]. The display should look similar to the one below. This figure shows data obtained from a CD player focus servo.



curve-fit

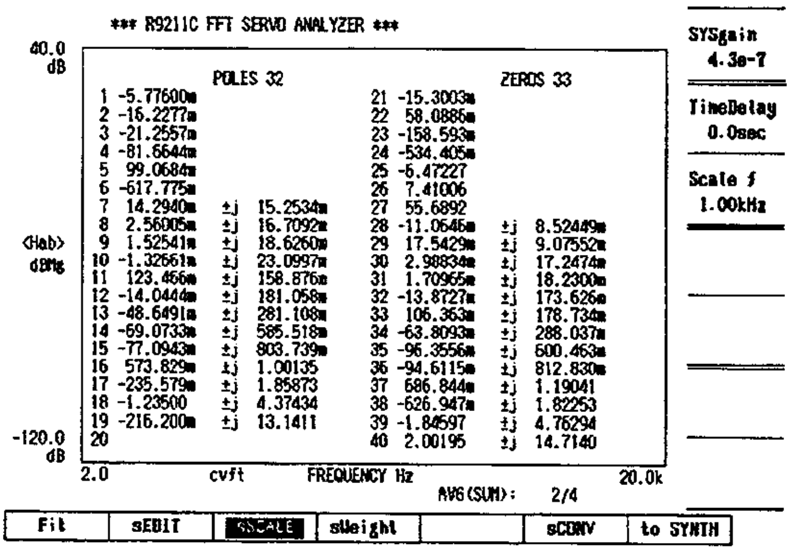
Editing the Pole/Zero Table

Now simulate a change in circuitry by editing the pole/zero table and using the synthesis function. After editing the pole/zero table, you must compensate for the changes by adjusting the system gain.

First transfer the pole zero data into the synthesis function as follows.

Press [MATH] and select [sEDIT].

The pole/zero table appears as shown below, with one column for poles and another column for zeros. Note that the poles and zeros are complex numbers, although some only have a real portion. The poles' imaginary portion represents a peak frequency of the FRF and the real portion represents the width of the peak. The zeros' imaginary portion represents a valley frequency of the FRF and the real portion represents the width of the valley.



	POLES 32				ZEROS 33		
1	-5.77600m			21	-15.3003m		
2	-16.2277m			22	58.0886m		
3	-21.2557m			23	-158.593m		
4	-81.6644m			24	-534.405m		
5	99.0684m			25	-6.47227		
6	-617.775m			26	7.41006		
7	14.2940m	±j	15.2534m	27	55.6892		
8	2.56005m	±j	16.7092m	28	-11.0646m	±j	8.52449m
9	1.52541m	±j	18.6260m	29	17.5429m	±j	9.07552m
10	-1.32661m	±j	23.0997m	30	2.98834m	±j	17.2474m
11	123.466m	±j	158.876m	31	1.70965m	±j	18.2300m
12	-14.0444m	±j	181.058m	32	-13.8727m	±j	173.626m
13	-48.6491m	±j	281.108m	33	106.363m	±j	178.734m
14	-69.0733m	±j	585.518m	34	-63.8093m	±j	288.037m
15	-77.0943m	±j	803.739m	35	-96.3556m	±j	600.463m
16	573.829m	±j	1.00135	36	-94.6115m	±j	812.830m
17	-235.579m	±j	1.85873	37	686.844m	±j	1.19041
18	-1.23500	±j	4.37434	38	-626.947m	±j	1.82253
19	-216.200m	±j	13.1411	39	-1.84597	±j	4.76294
20				40	2.00195	±j	14.7140

pole/zero table

sSCALE

Press [sSCALE]. This menu has settings that let you adjust the curve fit scale.

sEDIT | DONE

Press [sEDIT] and press [DONE].

to SYNTH | FIT to SYNTH

Select [to SYNTH] and press [FIT to SYNTH] to transfer the pole/zero data.

Next edit the pole/zero table as follows.

PRESET

Press [PRESET].

MATH KEY | FRF Synth MENU

Select [MATH KEY] and set to [FRFSynth MENU]. This changes the math menus to make the synthesis functions available.

MATH

Press [MATH].

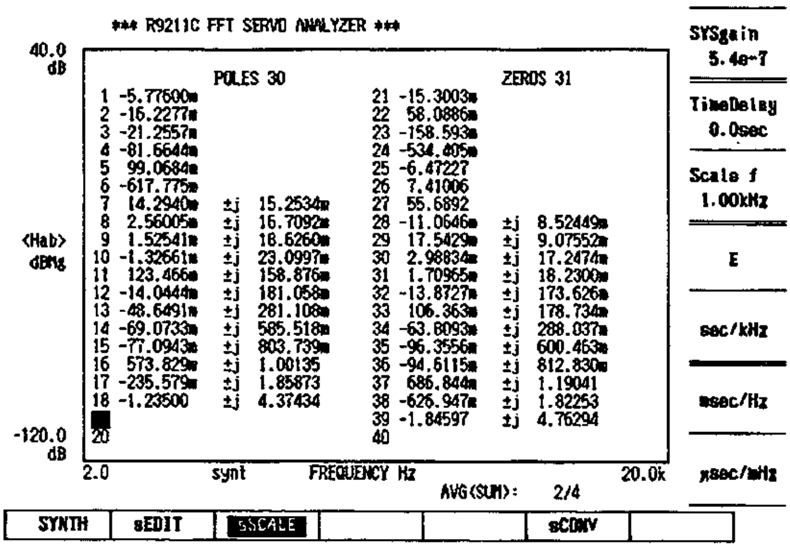
sEDIT | EDIT ID 19

Select [sEDIT] and set [EDIT ID] to the last pole line number of the table.

DEL ID

Press [DEL ID] to delete the last pole.

Similarly delete the last zero entry in the table as shown on the next page.



revised pole/zero table

After deleting poles and zeros from the table, you must adjust the system gain slightly higher to compensate. In general, set the system gain according to the following rules:

1. If you delete a pole, set new SYSgain = $(1/|POLE|^2)$ x old SYSgain.
2. If you delete a zero, set new SYSgain = $(|ZERO|^2)$ x old SYSgain.
3. If you change the value of a pole, set new SYSgain = $(|new\ POLE|^2/|old\ POLE|^2)$ x old SYSgain.
4. If you change the value of a zero, set new SYSgain = $(|old\ ZERO|^2/|new\ ZERO|^2)$ x old SYSgain.
5. If the pole or zero only has a real portion, substitute $|POLE|^2$ and $|ZERO|^2$ in the equations above with $|POLE|$ and $|ZERO|$.

In our example pole/zero table, we deleted both a pole and a zero. We calculate the system gain adjustment as follows:

$$\text{new SYSgain} = (|ZERO|^2/|POLE|^2) \times \text{old SYSgain}$$

$$= [(2.00195^2 + 14.714^2)/(0.2162^2 + 13.1411^2)] \times 4.3\text{e-}7$$

$$= 5.49\text{e-}7$$

sSCALE | SYSgain 5.49e-7 — Select [sSCALE] and set the [SYSgain] slightly higher.

sEDIT | DONE — Select [sEDIT] and press [DONE].

SYNTH | CREATE SYNTH — Select [SYNTH] and press [CREATE SYNTH] to begin the synthesis calculation. The instrument displays [Synth...end] when it is finished.

Viewing the Synthesized FRF

VIEW — Press [VIEW].

TYPE | DUAL — Select [TYPE] and set to [DUAL].

Press [SEL] to select the top screen.

SEL

Press [MATH VW] and set to [FITTED FRF].

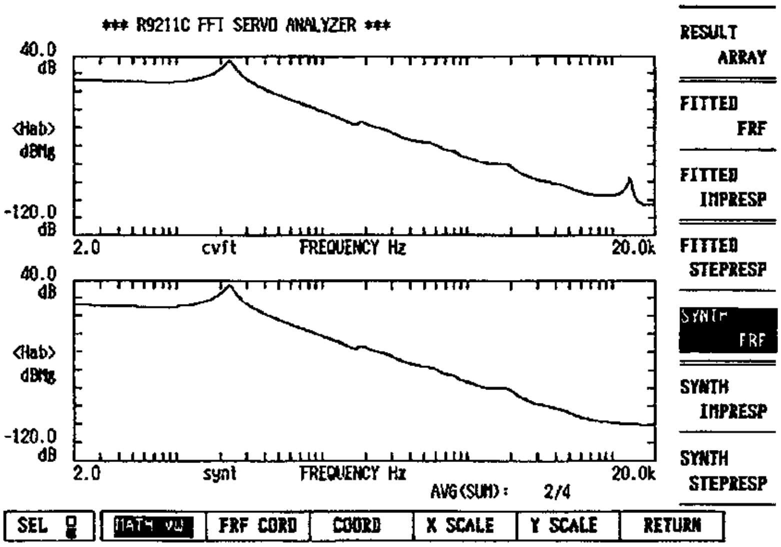
MATH VW — FITTED FRF

Press [SEL] to select the bottom screen.

SEL

MATH VW — SYNTH FRF

Press [MATH VW] and set to [SYNTH FRF]. The screen should appear similar to the display shown below. This figure shows how the data obtained from a CD player focus servo has changed. Notice how the secondary resonance point has been eliminated.



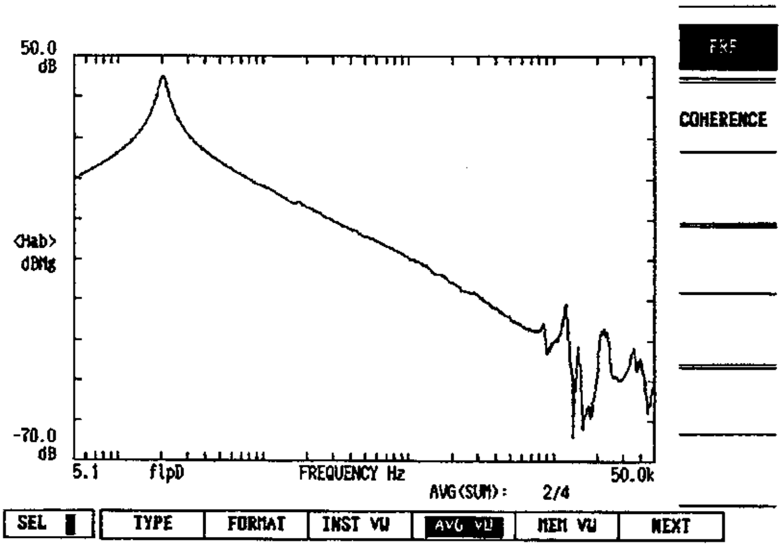
fitted and synthesized FRF

Scaling and Math Functions

Now explore the scaling and math functions. You need these functions when using the laser doppler method to test a servo unit. For this method, you use a laser doppler gauge to measure the *speed* of a servo head. You then integrate the data from the gauge to obtain the *displacement* current.

The example in this tutorial uses data from a CD focus servo taken with a laser doppler gauge as shown below. First it is necessary to scale the data using the R9211's scaling function. Then integrate the data with the math function.

The amount of scaling depends on the laser doppler gauge's sensitivity, which is measured in units of (cm/sec)/volt. For the data shown below, it was determined that the laser doppler gauge has a sensitivity of 2.365 μm/sec per volt. Therefore, use a scaling factor of
1 V_{rms} = 2.365 μm/sec



laser doppler gauge data

Changing the Scaling

VIEW

Begin by setting the display to show linear coordinates for the FRF.

COORD | Mag

Press [VIEW]. Select [COORD] and set to [Mag].

Now change the Y-axis units and label as follows.

SETUP

Press [SETUP].

UNIT | SELECT CH (CH-A)

Select [UNIT]. Set [SELECT CH] to [CH-A] and press [RETURN].

A: VALUE 1.00EU

Set [A: VALUE] to 1.00.

SELECT CH
(CH-B)

Set [SELECT CH] to [CH-B] and press [RETURN].

B: VALUE
2.356EU

Set [B: VALUE] to 2.365.

SELECT CH
(CROSS)

Set [SELECT CH] to [CROSS] and press [RETURN].

CRS: UNIT
μm

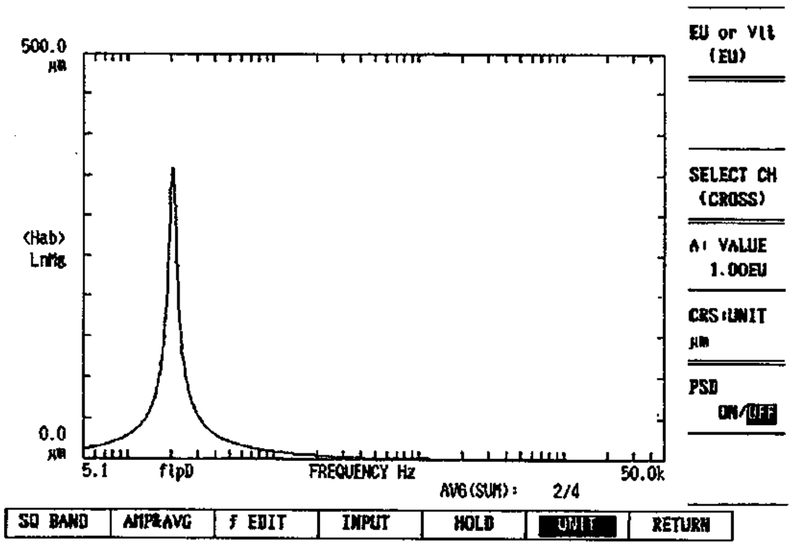
Now set the label. Press [CRS:UNIT]. Use the knob to select 'μ' and press [ENT]. Next select 'm' and press [ENT].

DONE

Press [DONE] and press [RETURN].

EU or Vlt
(EU)

Press [EU or Vlt], set to [EU], and press [RETURN]. The display changes to the custom units you've set as shown below. This figure shows laser doppler gauge data with custom units.



scaled laser doppler gauge data

Using the Math Functions

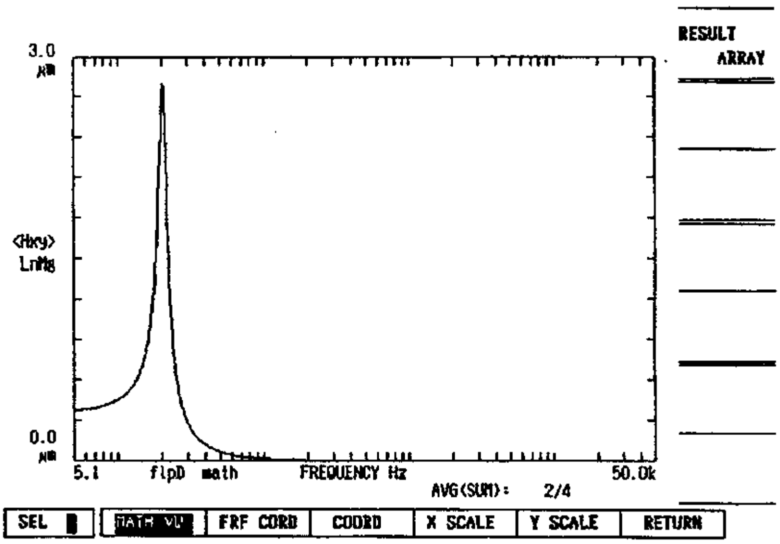
PRESET		Now practice integrating data as follows. Press [PRESET].
MATH KEY	MATH MENU	Select [MATH KEY] and set to [MATH MENU] to make the normal math menus available.
MATH		Press [MATH].
jω	jω RANGE	Select [jω] and select [jω RANGE].
	THRESHOLD -100dBV	Set [THRESHOLD] to -100 dBV.
	LOWER f 50.00kHz	Set [LOWER f] to 50 kHz.
	UPPER f 75.00kHz	Set [UPPER f] to 75 kHz. Press [RETURN].
	jω? (1/jω)	Select [jω ?] and set to [1/jω] for integration. Press [RETURN].
	MATH SEL	Press [MATH SEL].
	OPERAND	Press [OPERAND] to assign the currently displayed data as the operand.
	1st OPRTR (1/jω)	Press [1st OPRTR] to assign the integration function as the first operator.
	DO MATH	Press [DO MATH] to begin the calculations.

VIEW

MATH VW

RESULT ARRAY

To view the results, press [VIEW], select [MATH VW], and set to [RESULT ARRAY]. The figure below shows the results of integration on the previously shown laser doppler gauge data.

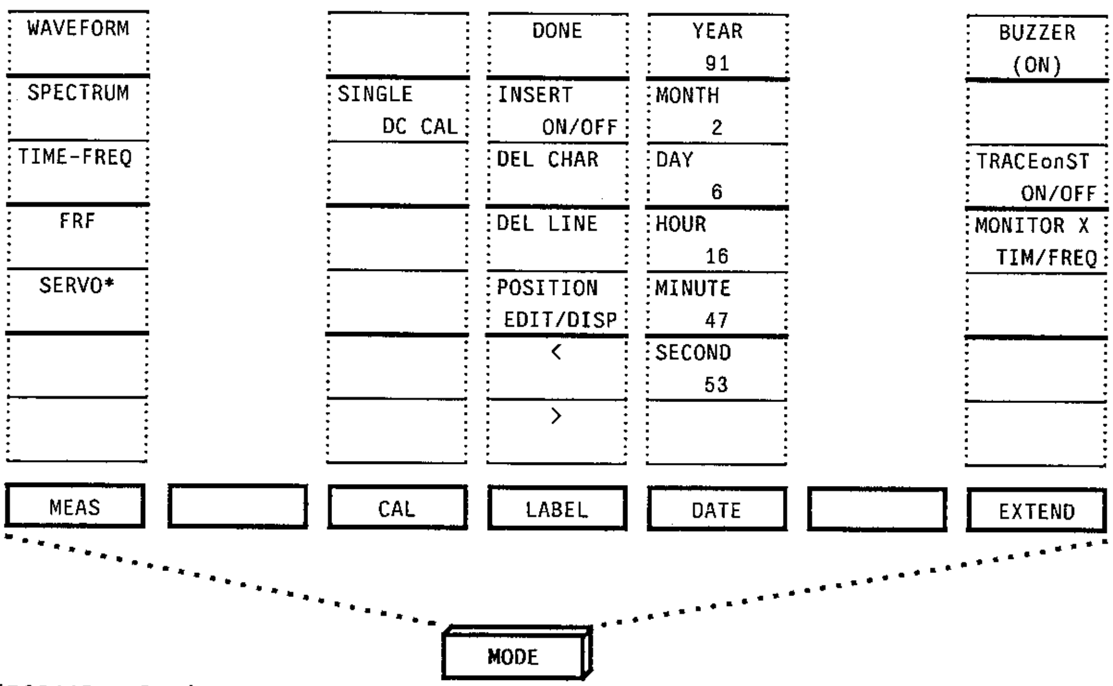


integrated laser doppler gauge data

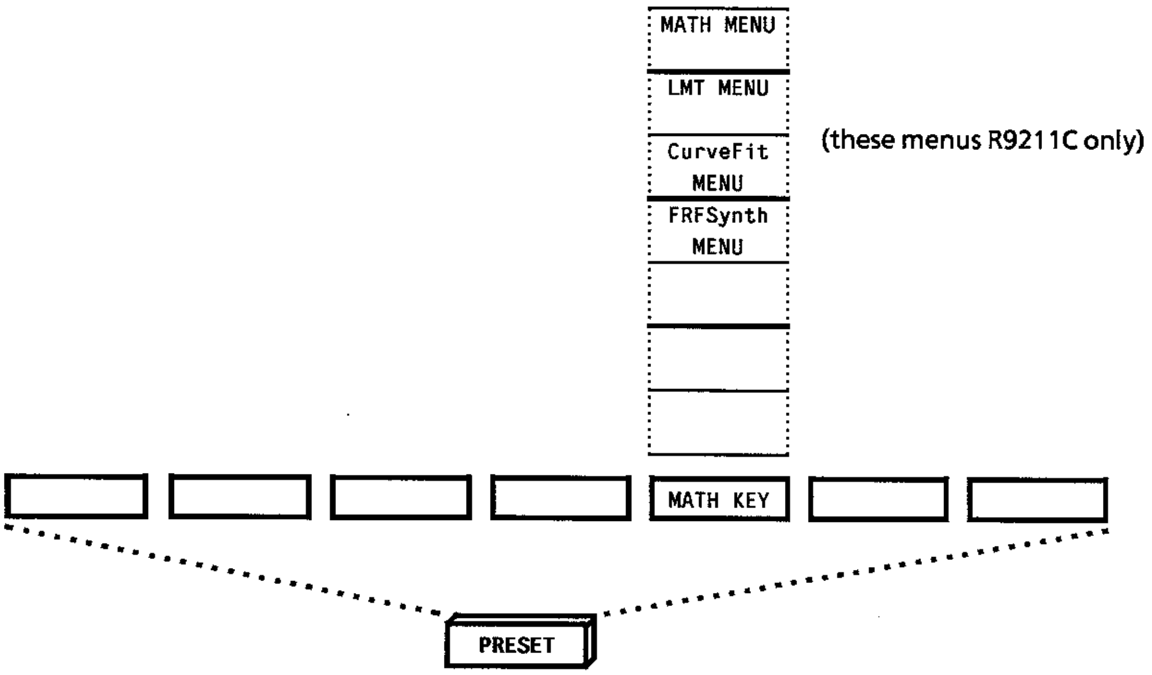
Appendix

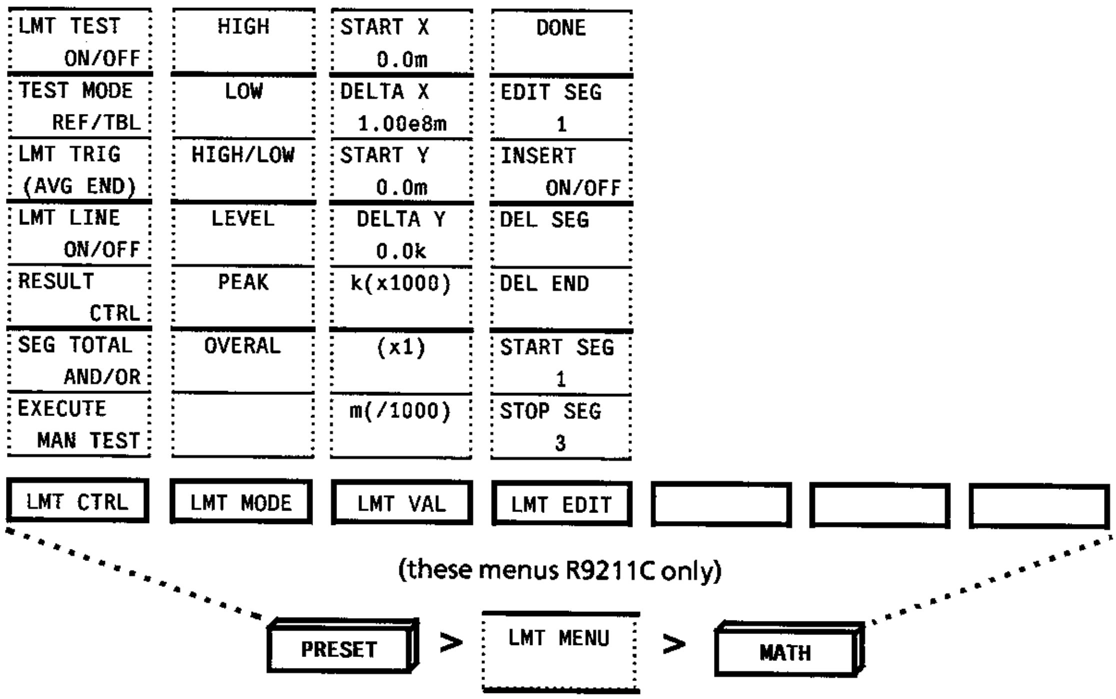
This appendix shows the different X and Y soft menus. By perusing this chart, you can get an idea of some of the R9211 functions that weren't discussed in the tutorials. For example, to set the R9211 clock's hour, note that you press [MODE], [DATE], and [HOUR] as shown below.

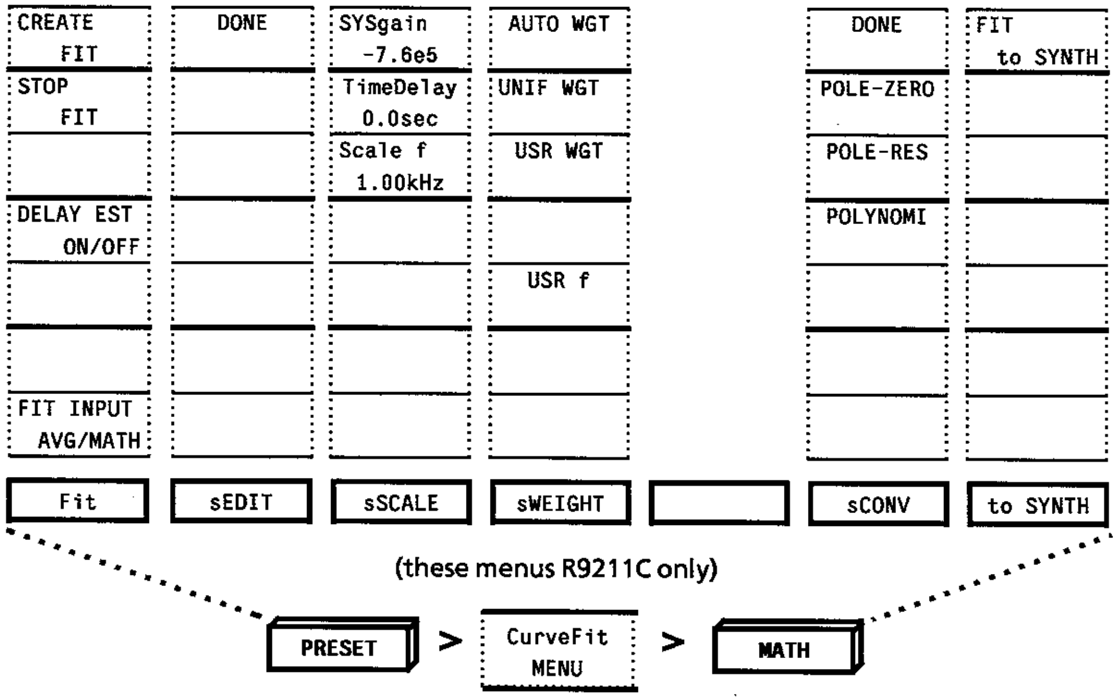
The chart is roughly divided into different sections for different measurement modes. Second-level Y menus aren't shown. Some soft keys only appear for certain settings or R9211 models as indicated.

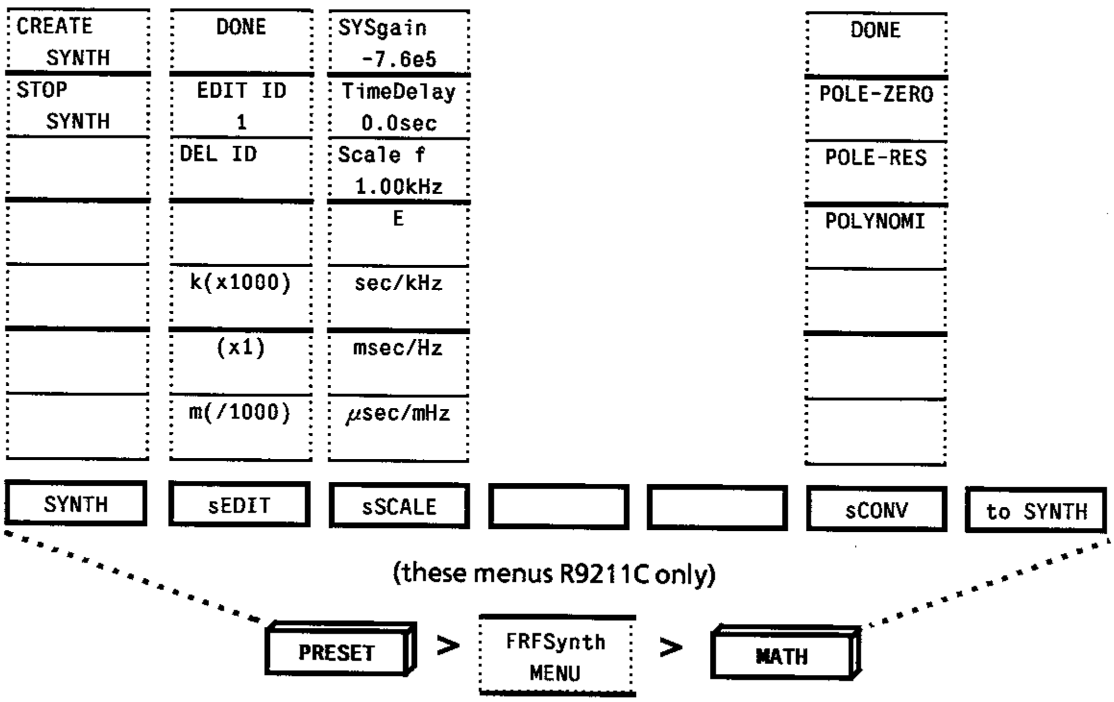


*R9211B or C only


MATH MENU
LMT MENU
CurveFit MENU
FRFSynth MENU
(these menus R9211C only)
MATH KEY
PRESET


LMT TEST ON/OFF
TEST MODE REF/TBL
LMT TRIG (AVG END)
LMT LINE ON/OFF
RESULT CTRL
SEG TOTAL AND/OR
EXECUTE MAN TEST
HIGH
LOW
HIGH/LOW
LEVEL
PEAK
OVERAL
START X 0.0m
DELTA X 1.00e8m
START Y 0.0m
DELTA Y 0.0k
k(x1000)
(x1)
m(/1000)
DONE
EDIT SEG 1
INSERT ON/OFF
DEL SEG
DEL END
START SEG 1
STOP SEG 3
LMT CTRL
LMT MODE
LMT VAL
LMT EDIT
(these menus R9211C only)
PRESET
>
LMT MENU
>
MATH


CREATE FIT
STOP FIT
DELAY EST ON/OFF
FIT INPUT AVG/MATH
DONE
SYSgain -7.6e5
TimeDelay 0.0sec
Scale f 1.00kHz
AUTO WGT
UNIF WGT
USR WGT
USR f
DONE
POLE-ZERO
POLE-RES
POLYNOMI
FIT to SYNTH
Fit
sEDIT
sSCALE
sWEIGHT
sCONV
to SYNTH
(these menus R9211C only)
PRESET
>
CurveFit MENU
>
MATH

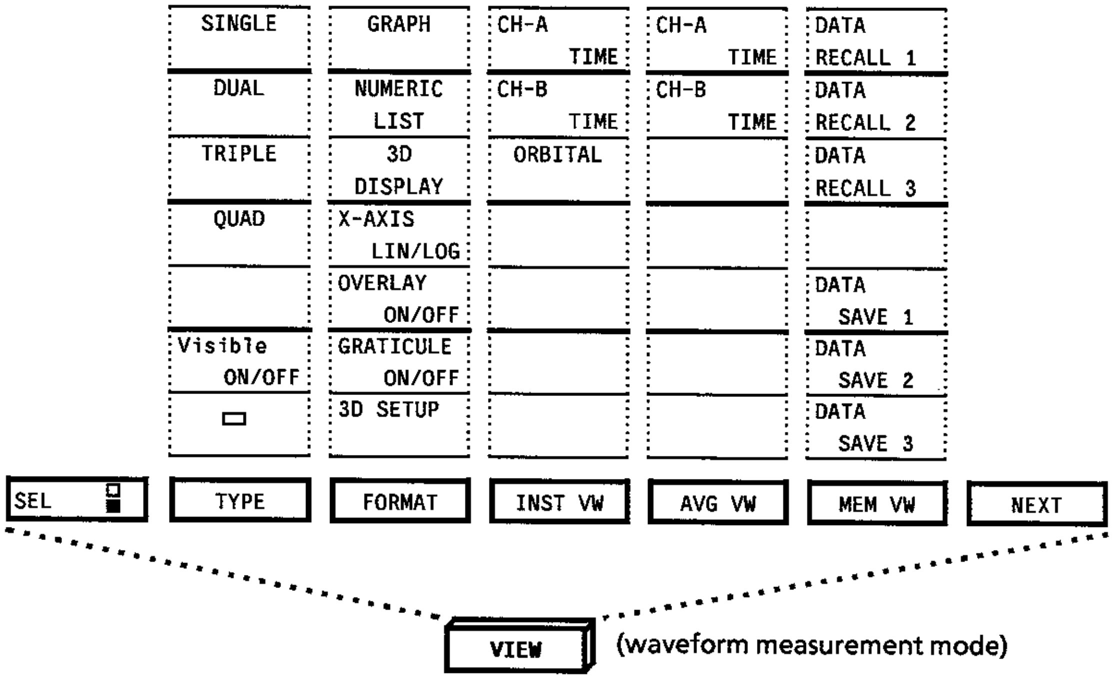

CREATE SYNTH
STOP SYNTH
DONE
EDIT ID 1
DEL ID
k(x1000)
(x1)
m(/1000)
SYSgain -7.6e5
TimeDelay 0.0sec
Scale f 1.00kHz
E
sec/kHz
msec/Hz
µsec/mHz
DONE
POLE-ZERO
POLE-RES
POLYNOMI
SYNTH
sEDIT
sSCALE
sCONV
to SYNTH
(these menus R9211C only)
PRESET
>
FRFSynth MENU
>
MATH

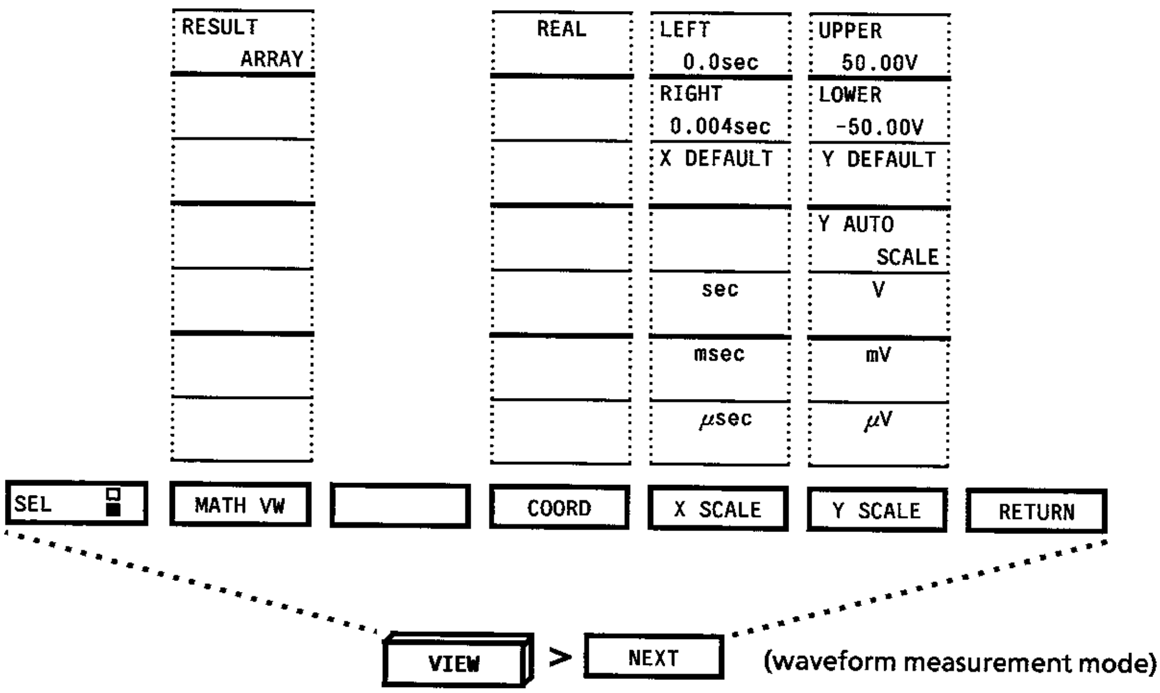
TIME	SAMPL RAT 3.91 µsec	CH-A AUTO/MAN	CHANNEL CH-A/CH-B	SOURCE (CH-A)	AUTO ARM	
AUTOCORR	FRAME TIM 1024 spl	SET CH-A 0dBV	COUPLING AC/DC	SLOPE (+)	ARM	
CROSS- CORR	HIST POIN 256 bin	CH-B AUTO/MAN	+INPUT IN/GND	LEVEL 0.5V	HOLD	
HISTOGRAM		SET CH-B 0dBV	-INPUT IN/GND	HYSTERESI -0.01V	FREE RUN	
			FILTER ON/OFF	DELAY 10 µsec		
DIGITALin CH-A/OFF	SAMPL CLK INT/EXT		ICP ON/OFF			
ACTIVE CH (CH-A&B)			TEST ON/OFF			
FUNC	RANGE	SENS	INPUT	TRIG	ARM/HOLD	NEXT

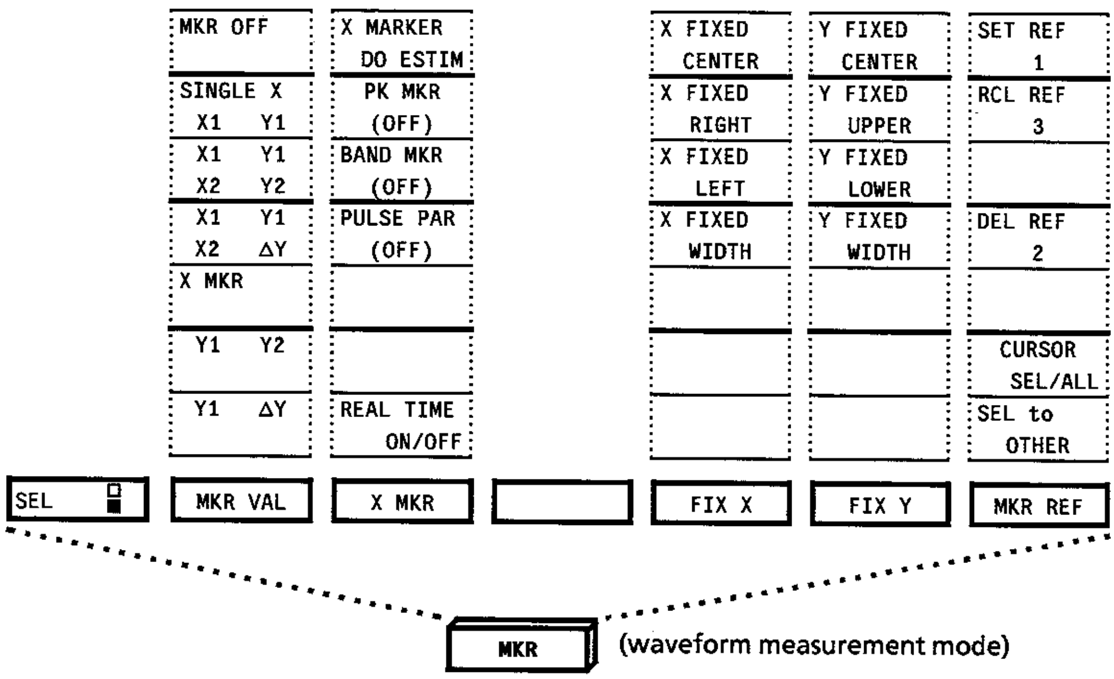
SETUP (waveform measurement mode)

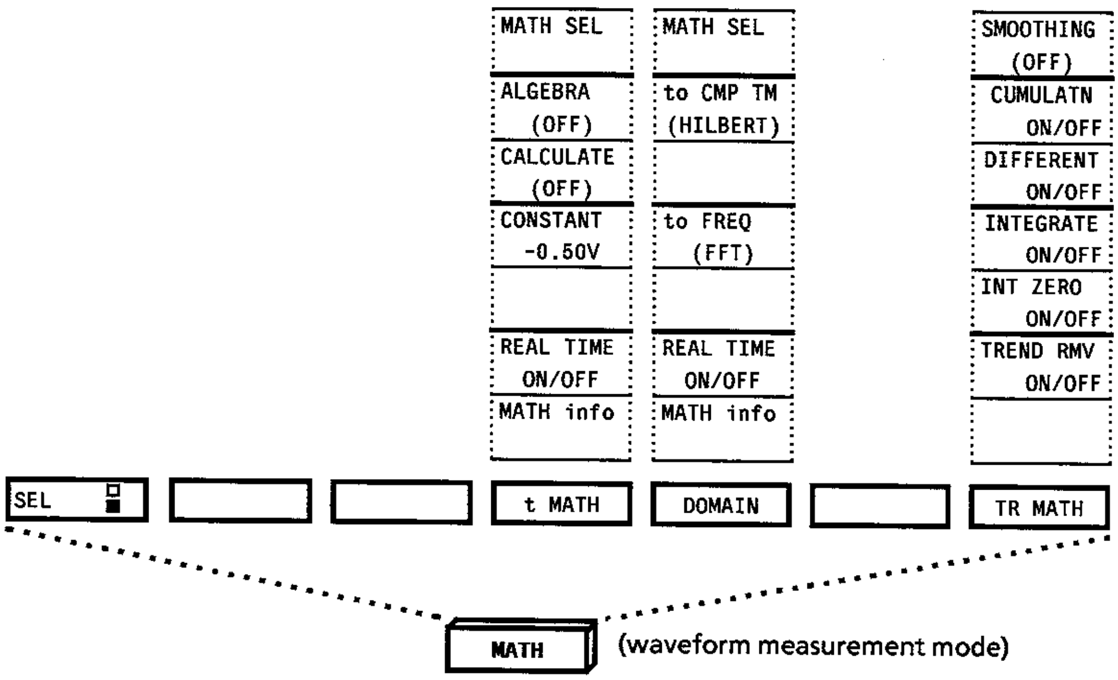
STATIONAR (HANN)	AVG MODE (SUM)	EU or Vlt (Vlt)	ICH DELAY ON/OFF			
TRANSIENT (RECT)	AVG NO 32		DELAY T 0.0msec			
	LIMIT NO 2000	SELECT CH (CH-A)				
	PROCESS (NORMAL)	A: VALUE 100.0EU				
	REJECT ON/OFF	A: UNIT EU				
LAG WND	AVG	UNIT	ChDELAY			RETURN

SETUP > NEXT (waveform measurement mode)


SINGLE
DUAL
TRIPLE
QUAD
Visible ON/OFF
GRAPH
NUMERIC LIST
3D DISPLAY
X-AXIS LIN/LOG
OVERLAY ON/OFF
GRATICULE ON/OFF
3D SETUP
CH-A TIME
CH-B TIME
ORBITAL
CH-A TIME
CH-B TIME
DATA RECALL 1
DATA RECALL 2
DATA RECALL 3
DATA SAVE 1
DATA SAVE 2
DATA SAVE 3
SEL
TYPE
FORMAT
INST VW
AVG VW
MEM VW
NEXT
VIEW
(waveform measurement mode)


RESULT ARRAY
REAL
LEFT 0.0sec
RIGHT 0.004sec
X DEFAULT
sec
msec
µsec
UPPER 50.00V
LOWER -50.00V
Y DEFAULT
Y AUTO SCALE
V
mV
µV
SEL
MATH VW
COORD
X SCALE
Y SCALE
RETURN
VIEW
>
NEXT
(waveform measurement mode)


MKR OFF
SINGLE X
X1 Y1
X1 Y1
X2 Y2
X1 Y1
X2 ΔY
X MKR
Y1 Y2
Y1 ΔY
X MARKER
DO ESTIM
PK MKR
(OFF)
BAND MKR
(OFF)
PULSE PAR
(OFF)
REAL TIME
ON/OFF
X FIXED
CENTER
X FIXED
RIGHT
X FIXED
LEFT
X FIXED
WIDTH
Y FIXED
CENTER
Y FIXED
UPPER
Y FIXED
LOWER
Y FIXED
WIDTH
SET REF
1
RCL REF
3
DEL REF
2
CURSOR
SEL/ALL
SEL to
OTHER
SEL
MKR VAL
X MKR
FIX X
FIX Y
MKR REF
MKR
(waveform measurement mode)


MATH SEL
ALGEBRA
(OFF)
CALCULATE
(OFF)
CONSTANT
-0.50V
REAL TIME
ON/OFF
MATH info
MATH SEL
to CMP TM
(HILBERT)
to FREQ
(FFT)
REAL TIME
ON/OFF
MATH info
SMOOTHING
(OFF)
CUMULATN
ON/OFF
DIFFERENT
ON/OFF
INTEGRATE
ON/OFF
INT ZERO
ON/OFF
TREND RMV
ON/OFF
SEL
t MATH
DOMAIN
TR MATH
MATH
(waveform measurement mode)

SIGNAL	FREQ	SG VLT	CONNECT	OUT CTRL	OUT MODE	NEXT
SINE	f 1.00kHz	AMPLITUDE 0.0V	SG OUTPUT	GENERATOR START	CONTINUE	
SWEPT		OFFSET 0.0V	SUM AMP	GENERATOR STOP	INTERNAL	
M-SINE	RESOLN ON/OFF		to ChA		EXTERNAL	
IMPULSE		LIMIT VLT 20.0V	to ChB	GENERATOR MAN TRIG	EXT GATE	
RANDOM	kHz	V			MANUAL	
ARBITRARY	Hz	mV		GEN ON AVG/MAN		
(XFER)	mHz	μV				

SG CONT (all measurement modes except servo)

IMPEDANC	SYNC OUT	TAPER				RETURN
0 Ω	SYNC OUT 1 FRM	TAPER ON/OFF				
50 Ω		TAPER t 0.0001sec				
600 Ω						
		sec				
		msec				
		μsec				

SG CONT > NEXT

(all measurement modes except servo)

FUNC	RANGE	SENS	INPUT	TRIG	ARM/HOLD	NEXT
FRF*	f RESOLN (LIN f)	CH-A AUTO/MAN	CHANNEL CH-A/CH-B	SOURCE (CH-A)	AUTO ARM	
POWER SPECT	FREQ RNG 100 kHz	SET CH-A 0dBV	COUPLING AC/DC	SLOPE (+)	ARM	
CROSS SPECT	START f** 0.0 kHz	CH-B AUTO/MAN	+INPUT IN/GND	LEVEL 0.5V	HOLD	
COMPLEX SPECT	STOP f** 100 kHz	SET CH-B 0dBV	-INPUT IN/GND	HYSTERESI -0.01V	FREE RUN	
	kHz		FILTER ON/OFF	DELAY 10 µsec		
DIGITALin CH-A/OFF	Hz		ICP ON/OFF	ARMLEN*** 64 k		
ACTIVE CH (CH-A&B)	mHz		TEST ON/OFF			

*T-F mode only

**models A and C only

***T-F mode only

SETUP (spectrum, time-frequency, and FRF measurement modes)

this menu appears for T-F mode only (INST t-f)

WEIGHT	AVG	UNIT	ChDELAY	T-F		RETURN
MINIMUM	AVG MODE (SUM)	EU or Vlt (Vlt)	ICH DELAY ON/OFF	INST t-f ON/OFF		
HANNING	AVG NO 32		DELAY T 0.0msec			
FLAT-PASS	LIMIT NO 2000	SELECT CH (CH-A)		t RANGE		
RECT	PROCESS (NORMAL)	A: VALUE 100.0EU		t-f MODE		
FORCE/ RESPONSE	REJECT ON/OFF	A: UNIT EU		t-f STATUS		
	OVERLAP (0%)	PSD ON/OFF				
WEIGHT(f) (OFF)						

SETUP > NEXT (spectrum, time-frequency, and FRF measurement modes)

TYPE	FORMAT	INST VW	AVG VW	MEM VW
SINGLE	GRAPH	CH-A TIME	CH-A PWR SPECT	DATA RECALL 1
DUAL	NUMERIC LIST	CH-B TIME	CH-B PWR SPECT	DATA RECALL 2
TRIPLE	3D DISPLAY	CH-A SPECT		DATA RECALL 3
QUAD	X-AXIS LIN/LOG	CH-B SPECT		
	OVERLAY ON/OFF	CROSS-SPECT*		DATA SAVE 1
Visible ON/OFF	GRATICULE ON/OFF	DATA VIEW ON/OFF*		DATA SAVE 2
▭	3D SETUP	VIEW STEP*		DATA SAVE 3

SEL | TYPE | FORMAT | INST VW | AVG VW | MEM VW | NEXT

*T-F mode only

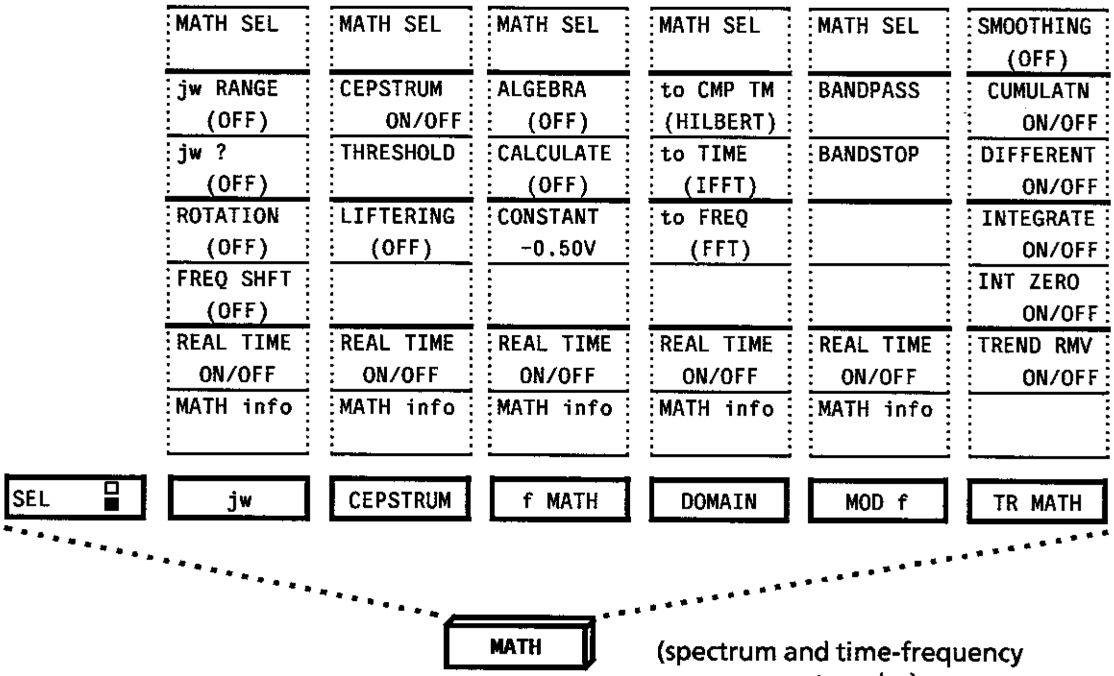
VIEW (spectrum and time-frequency measurement modes)

this menu appears for T-F mode only

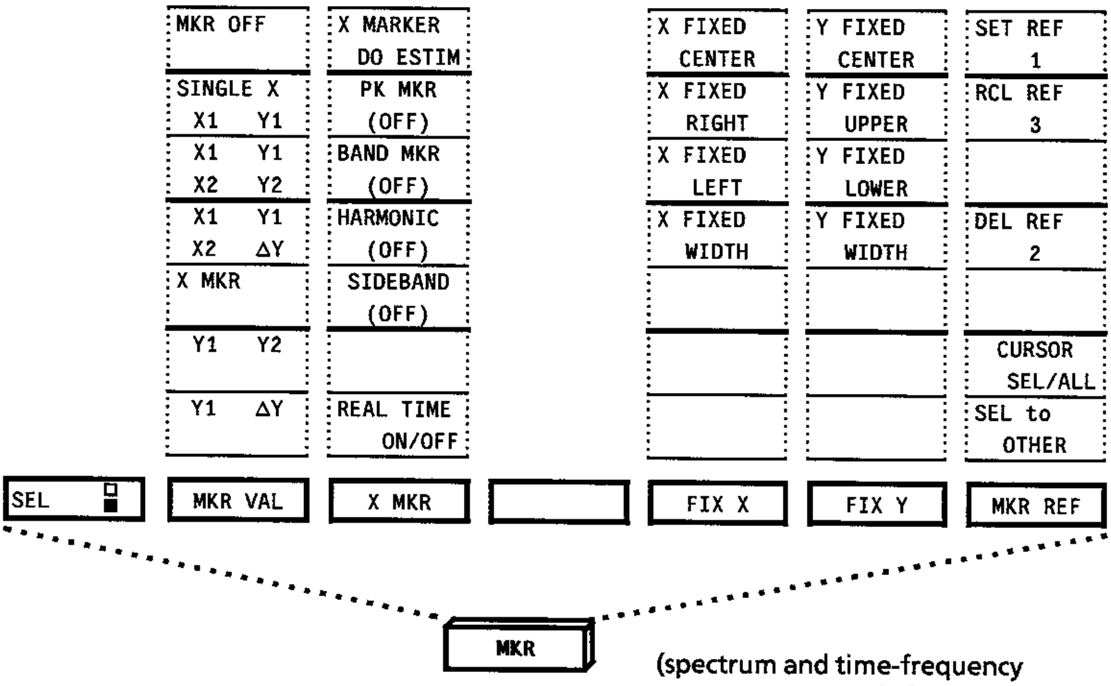
MATH VW	T-F VW	COORD	X SCALE	Y SCALE
RESULT ARRAY		dBMag	LEFT 0.24kHz	UPPER 30.00dBV
		Mag	RIGHT 100.00kHz	LOWER -70.00dBV
	t-f TRACE 1	Mag2	X DEFAULT	Y DEFAULT
	t-f TRACE 2	PHASE		Y AUTO SCALE
	t-f TRACE 3	REAL	kHz	
	t-f TRACE 4	IMAG	Hz	
		NYQUIST	mHz	

SEL | MATH VW | T-F VW | COORD | X SCALE | Y SCALE | RETURN

VIEW > NEXT (spectrum and time-frequency measurement modes)



(spectrum and time-frequency measurement modes)



(spectrum and time-frequency measurement modes)

SEL	TYPE	FORMAT	INST VW	AVG VW	MEM VW	NEXT
	SINGLE	GRAPH	CH-A TIME	FRF	DATA RECALL 1	
	DUAL	NUMERIC LIST	CH-B TIME	COHERENCE	DATA RECALL 2	
	TRIPLE	3D DISPLAY	CH-A SPECT	IMPULSE RESPONSE	DATA RECALL 3	
	QUAD	X-AXIS LIN/LOG	CH-B SPECT	CH-A PWR SPECT		
	+ MONITOR DO/UNDO	OVERLAY ON/OFF	CROSS-SPECT	CH-B PWR SPECT	DATA SAVE 1	
	Visible ON/OFF	GRATICULE ON/OFF		CROSS-SPECT	DATA SAVE 2	
	▭	3D SETUP			DATA SAVE 3	

VIEW (FRF and servo measurement modes)

SEL	MATH VW	FRF CORD	COORD	X SCALE	Y SCALE	RETURN
	RESULT ARRAY	BODE	dBMag	LEFT 0.24kHz	UPPER 30.00dBV	
		CO-QUAD	Mag	RIGHT 100.00kHz	LOWER -70.00dBV	
		NYQUIST	PHASE	X DEFAULT	Y DEFAULT	
		Cole-Cole	-PHASE		Y AUTO SCALE	
		NICHOLS	GROUP DELAY	kHz		
			REAL	Hz		
			IMAG	mHz		

VIEW > NEXT

(FRF and servo measurement modes)

jw	FRF MTH	f MATH	DOMAIN	MOD f	TR MATH
MATH SEL	MATH SEL	MATH SEL	MATH SEL	MATH SEL	SMOOTHING (OFF)
jw RANGE (OFF)	OpenClose (OFF)	ALGEBRA (OFF)	to CMP TM (HILBERT)	BANDPASS	CUMULATN ON/OFF
jw ? (OFF)	CloseOpen (OFF)	CALCULATE (OFF)	to TIME (IFFT)	BANDSTOP	DIFFERENT ON/OFF
ROTATION (OFF)	EQUALIZE ON/OFF	CONSTANT -0.50V	to FREQ (FFT)		INTEGRATE ON/OFF
FREQ SHFT (OFF)	SNR (OFF)				INT ZERO ON/OFF
REAL TIME ON/OFF	REAL TIME ON/OFF	REAL TIME ON/OFF	REAL TIME ON/OFF	REAL TIME ON/OFF	TREND RMV ON/OFF
MATH info	MATH info	MATH info	MATH info	MATH info	

SEL

MATH (FRF and servo measurement modes)

MKR VAL	X MKR	CTRL SYS	FIX X	FIX Y	MKR REF
MKR OFF	X MARKER DO ESTIM	CTRL SYS DO ESTIM	X FIXED CENTER	Y FIXED CENTER	SET REF 1
SINGLE X X1 Y1	PK MKR (OFF)	BODE MKR ON/OFF	X FIXED RIGHT	Y FIXED UPPER	RCL REF 3
X1 Y1 X2 Y2	X dB BWD (OFF)	CLOSE LOP ON/OFF	X FIXED LEFT	Y FIXED LOWER	
X1 Y1 X2 ΔY	SHAPE (OFF)	DC GAIN 10.00dB	X FIXED WIDTH	Y FIXED WIDTH	DEL REF 2
X MKR	RIPPLE ON/OFF				
Y1 Y2					CURSOR SEL/ALL
Y1 ΔY	REAL TIME ON/OFF				SEL to OTHER

SEL

MKR (FRF and servo measurement modes)

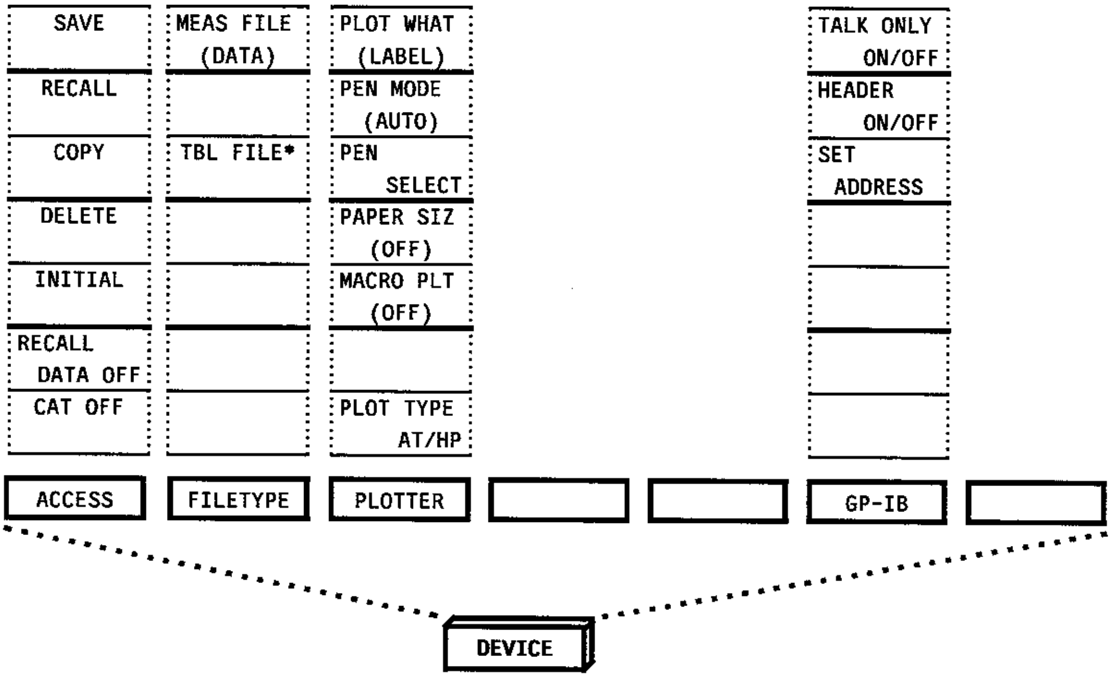
SWEEP	RANGE	SENS	SG VLT	SG COM	AVG	NEXT
LIN MSIN	f RESOLN (LIN f)	CH-A AUTO/MAN	AMPLITUDE 0.50V	GANERATOR START	AVG NO 16	
LOG MSIN	FREQ RNG 100 kHz	SET CH-A 0dBV	OFFSET 0.01V	GENERATOR STOP	LIMIT NO 30	
LIN SIN	START f 0.0 kHz	CH-B AUTO/MAN				
LOG SIN	STOP f 100 kHz	SET CH-B 0dBV	LIMIT VLT 20.0V		PROCESS (NORMAL)	
LIN F-Tab	kHz		V	INVL TIME (OFF)		
LOG F-Tab	Hz		mV	GEN ON AVG/MAN	AUTO AVG ON/OFF	
Meas Time (SHORT)	mHz		µV	SUM AMP ON/OFF	COH LIM 0.95	

SETUP (servo measurement mode)

SQ BAND	AMP&AVG	f EDIT	INPUT	HOLD	UNIT	RETURN
SINE	AMPLITUDE 0.01V	DONE	CHANNEL CH-A/CH-B	HOLD	EU or Vlt (Vlt)	
M-SINE	OFFSET 0.10V	EDIT ID 1	COUPLING AC/DC	FREE RUN		
f START 0.002kHz	AVG NO 4	INSERT ON/OFF	+INPUT IN/GND		SELECT CH (CH-A)	
f STOP 0.02kHz		DEL ID	-INPUT IN/GND		A: VALUE 40.00dBEU	
kHz	V	DEL END			A: UNIT EU	
Hz	mV	START ID 1	ICP ON/OFF		PSD ON/OFF	
mHz	µV	STOP ID 20				

SETUP > NEXT (servo measurement mode)

*R9211C only


SAVE
RECALL
COPY
DELETE
INITIAL
RECALL DATA OFF
CAT OFF
MEAS FILE (DATA)
TBL FILE*
PLOT WHAT (LABEL)
PEN MODE (AUTO)
PEN SELECT
PAPER SIZ (OFF)
MACRO PLT (OFF)
PLOT TYPE AT/HP
TALK ONLY ON/OFF
HEADER ON/OFF
SET ADDRESS
ACCESS
FILETYPE
PLOTTER
GP-IB
DEVICE

Glossary

accelerometer: a vibration sensor; often used with an impulse hammer, which measures the vibrations created by striking a structure

autocorrelation: a measure of a signal's randomness; it is produced by measuring the relatedness of points on a signal at time delays τ between the points; a periodic component in the signal shows as a spike when τ equals the period

Bode plot: a plot of both the gain versus frequency and the phase shift versus frequency between two signals

cepstrum: the 'inverse spectrum'; that is, the result of applying the inverse FFT to a dBMag spectrum

closed-loop characteristic: the FRF of a system with its feedback loop closed (connected)

coherence: a measure of the linear cause-effect relationship between two signals; also indicates the accuracy of their FRF

Cole-Cole diagram: a plot of the real FRF component versus the negative imaginary FRF component between two signals

complex spectrum: the spectrum obtained by applying the FFT to a signal; it has both real and imaginary components which can be interpreted as amplitude and phase information

Co-quad diagram: a plot of both the real FRF component versus frequency and the imaginary FRF component versus frequency between two signals

cross-correlation: a measure of the similarity between two signals; the same signal shifted in time shows a spike when τ equals the time delay (impulse response also indicates time delays but with greater sensitivity)

cross-spectrum: the product of two spectrums, which is part of the FRF calculation; it can also be used to calculate the time delay between two signals

curve-fit: a calculation that generates the poles and zeros (Laplace parameters) that characterize the FRF of two signals

decade: in a logarithmic display, one octave with ten divisions

differential input: also known as balanced input; a three wire input (+, -, and ground) that passes the difference in voltage between two signals to reject 'pickup' and other noise

DUT (Device Under Test): a generic term for any device or structure being tested

FFT (Fast Fourier Transform): a computational method for obtaining the spectrum of a digitally sampled signal

FRF (Frequency Response Function): also called the transfer function; a measure of how a device or structure responds to an input signal; that is, how an input spectrum differs from an output spectrum

GO/NOGO: function: a comparator function (on the R9211C only) that evaluates whether an input signal meets criteria that you determine

GPIB (General Purpose Interface Bus): the IEEE 488 standard for interfacing test and measurement instruments and their peripherals

histogram: also known as the probability density function; a function of a signal's amplitude versus the probability that a randomly chosen point on the signal has that amplitude

hysteresis: a range about the triggering level to prevent multiple triggering of a noisy signal; the instrument triggers only if the input signal passes through both the upper and lower threshold

ICP (Integrated Circuit Piezoelectric accelerometers): a current source (4 mA) for powering accelerometers that have internal amplifiers

IFFT (Inverse Fast Fourier Transform): a computational method for obtaining a waveform from a frequency spectrum

impulse response: the inverse FFT of the FRF that shows how a device or structure responds to an input signal in the time domain

Laplace parameters: the poles and zeros used to characterize an FRF

liftering: 'inverse filtering'; that is, mathematically filtering a signal by applying the inverse FFT to its spectrum, filtering the resulting cepstrum in frequency domain, and then applying the FFT again

loop gain: the ratio of open-loop gain to closed loop gain

Nichols diagram: a plot of the FRF phase versus the FRF gain between two signals

Nyquist diagram: a plot of the real FRF component versus the imaginary FRF component between two signals

octave analysis: an ANSI standard for analyzing noises and echoes by transforming a spectrum into a number of discrete bandwidth-filter outputs

open-loop characteristic: the FRF of a system with its feedback loop open (not connected)

operand: the data set upon which a mathematical operator operates

operator: a mathematical function or transform applied to an operand

pole: a complex number with the imaginary portion representing an FRF's peak and the real portion representing the width of the peak

power spectrum: also known as the auto power spectrum; a real variable function (amplitude information only) obtained by multiplying a complex spectrum by its complex conjugate

power spectrum density: the conversion level per hertz of the power spectrum

quefrency domain: the 'inverse frequency domain'; that is, the domain (analogous to the time domain) created by applying the inverse FFT to a dBMag spectrum

step response: a system's response to a step signal, which can be synthesized from the FRF using the R9211's synthesis function

summation amplifier: an internal amplifier that allows you to easily change from closed loop to open loop measurements

synthesis function: a computation that uses the pole/zero table (Laplace parameters) to generate an FRF

weighting: a computational method to reduce FFT errors caused by the fact that only a finite portion of the signal can be sampled

zero: a complex number with the imaginary portion representing an FRF's valley and the real portion representing the width of the valley

Index

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   (b) any improper or inadequate handling, carriage or storage of the Product by the Purchaser or any third party (other than Advantest or its agents);

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   (f) Advantest's incorporation or use of any specifications or designs supplied by Purchaser;

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Advantest's maintenance agreement provides the Purchaser on-site and off-site maintenance, parts, maintenance machinery, regular inspections, and telephone support and will last a maximum of ten years from the date the delivery of the Product. For specific details of the services provided under the maintenance agreement, please contact the nearest Advantest office listed at the end of this Operation Manual or Advantest 's sales representatives.

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