ADVANTEST
ADVANTEST CORPORATION

R9211B/C

FFT Servo Analyzer

Operation Manual

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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

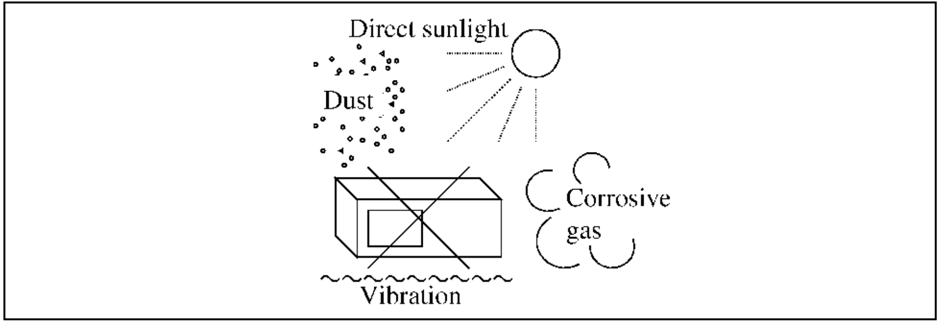
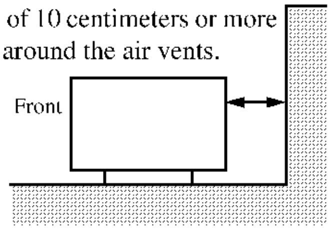


Figure-1 Environmental Conditions

- Operating position

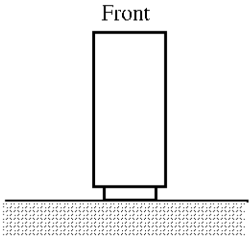
A clear space of 10 centimeters or more must be kept around the air vents.



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.

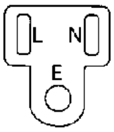
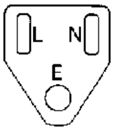
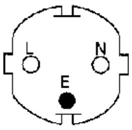
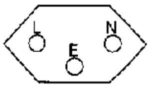
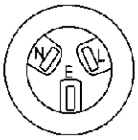
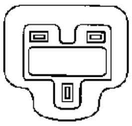
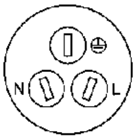
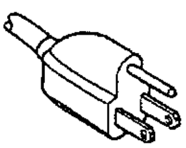
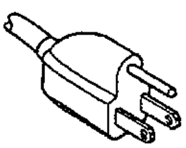
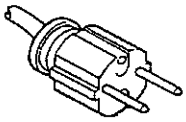
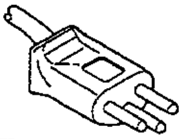
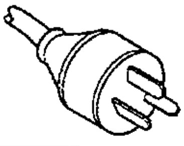
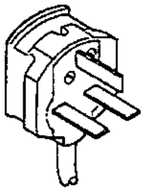
Plug configuration	Standards	Rating, color and length	Model number (Option number)
	PSE: Japan Electrical Appliance and Material Safety Law	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) 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 Power Cable Options

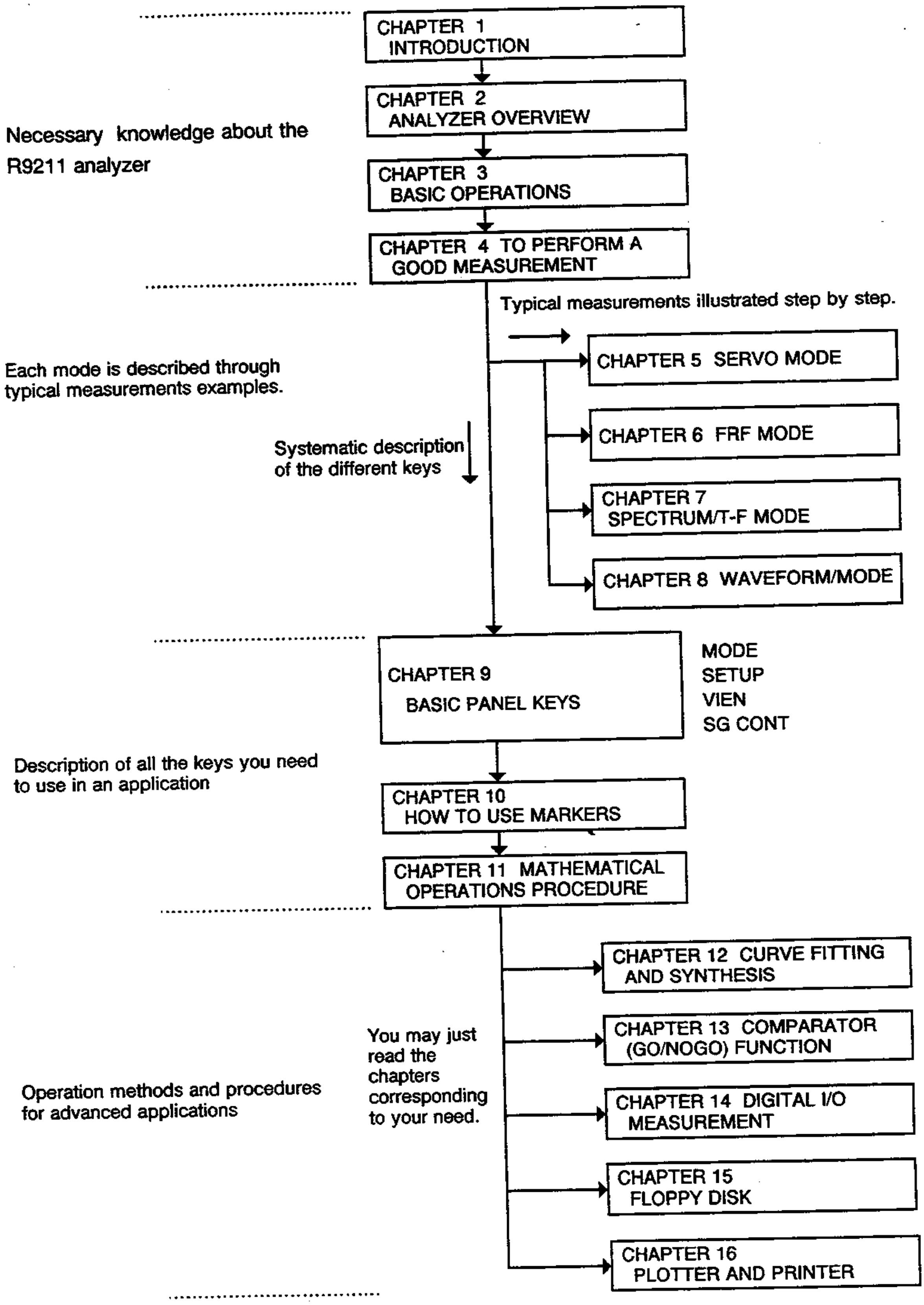
There are six power cable options (refer to following table).

Order power cable options by Model number.

	Plug configuration	Standards	Rating, color and length	Model number (Option number)
1		JIS: Japan Law on Electrical Appliances	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
2		UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
3		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
4		SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
5		SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
6		BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417

BEFORE READING THIS MANUAL

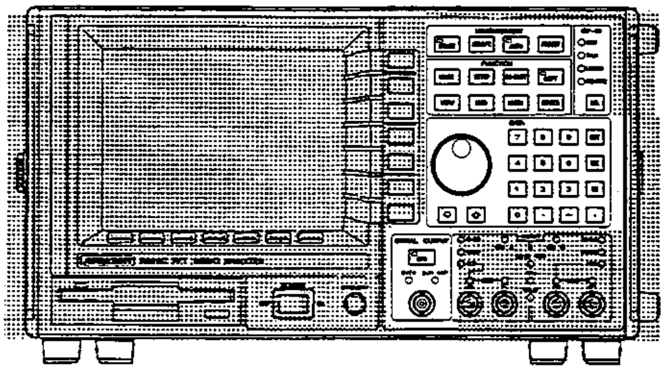
■ How to Use This Manual



Symbolic Notation of the Different Types of Keys throughout This Manual

In this manual, the keys are symbolized so that you can quite easily understand what type they belong to, and what key sequences are proper.

Notation of the Panel Keys



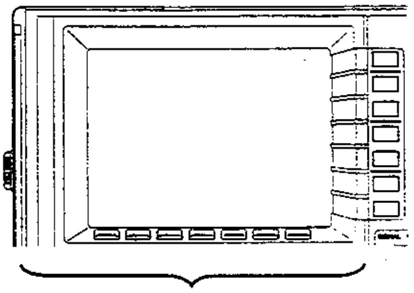
Most panel keys are represented by their name enclosed in a double ledged box.

Example: $\boxed{\boxed{\text{SETUP}}}$

But a numeric key is only underlined.

Example: $\underline{10}$ means "Sequentially press the $\boxed{1}$ and $\boxed{0}$ keys"

Symbolic Notation of Soft Keys



A Y soft key is symbolized by its name overlined and underlined.

Example: $\begin{array}{c}\overline{\text{FREQ RNG}}\\ \underline{\text{100kHz}}\end{array}$

An X soft key is designed by its name enclosed in a ledged box.

Example: $\boxed{\text{RANGE}}$

Symbolic Notation of Key Sequences

The keys succession is indicated by arrows(⇒).

Example: $\boxed{\boxed{\text{SETUP}}} \Rightarrow \boxed{\text{RANGE}} \Rightarrow \begin{array}{c}\overline{\text{FREQ RNG}}\\ \underline{\text{100kHz}}\end{array}$

Notation of Model Names

R9211: Represents the R9211B and R9211C.
R9211B: Represents the R9211B only.
R9211C: Represents the R9211C only.

■ Appearance and Accessories Check

When this unit is delivered, make sure that it was not damaged during transportation. If it is damaged or if any standard accessory is missing, contact your nearest sales office or agent.

Addresses and telephone numbers are listed at the end of this manual.

Standard Accessories

Product name	Type	Stock No.	Quantity
Power cable	A01402	DCB-DD2428X01-1	1
Input cable	MI-77	DCB-FM0904-1	2
T-type connector (BNC)	UG274/U	JCF-AB001EX04	1
Fuse	EAWK2A	DFT-AA2A	2
Instruction manual	Procedures	ER9211B/C (P)	1
Guidebook	Operations	ER9211SERIES (G)	1
GPIB HAND Book	——	ER9211SERIES (H)	1

Note: When ordering an additional accessory, please inform us of its type and stock No.

TABLE OF CONTENTS

Chapter 1 INTRODUCTION

Chapter 2 ANALYZER OVERVIEW

Chapter 3 BASIC OPERATIONS

Chapter 4 TO PERFORM A GOOD MEASUREMENT

Chapter 5 SERVO MODE

Chapter 6 FRF MODE

Chapter 7 SPECTRUMT-F MODE

Chapter 8 WAVEFORM MODE

Chapter 9 BASIC PANEL KEYS

Chapter 10 HOW TO USE MARKERS

Chapter 11 MATHEMATICAL OPERATIONS PROCEDURES

Chapter 12 CURVE FITTING AND SYNTHESIS (R9211C ONLY)

Chapter 13 COMPARATOR (GO/NOGO) FUNCTION (R9211C ONLY)

Chapter 14 DIGITAL I/O AND MEASUREMENT

Chapter 15 FLOPPY DISK

Chapter 16 PLOTTER AND PRINTER

APPENDIX

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

This chapter gives general advices about the use of the R9211 FFT Servo Analyzer.

CONTENTS

1. Safety Requirements

■ Power Supply

The power supply voltage is set before delivery and is indicated on the rear panel. (See Table 1-1.)
Before connecting the power cable, check the outlet voltage and make sure that the POWER switch is set to OFF.

Table 1-1 Voltage

Option No.	Standard	Option 32	Option 42	Option 44
Power supply voltage	90-110 VAC	103-132 VAC	198-242 VAC	207-250 VAC
Power supply frequency	48-66Hz			

■ Grounding

The power cable plug has three pins. The round pin in the middle is for grounding.
Whenever possible, insert the power cable plug into an outlet provided with a protective grounding socket.
When connecting an adapter to the plug, be sure to connect to the external ground, the ground wire (Figure 1-2 (a)) of the adapter or the ground output (Figure 1-1) at the rear panel of the main body.
The R9211 being designed for wide band and high sensitivity measurements, improper grounding may generate noise during measurement and consequently inaccurate results. Thus, please, ground the R9211 before using it at the high sensitivity input level.
The included A09034 (KPR-18) adapter conforms to the Electrical Appliance Law.
As shown in Figure 1-2, the A09034 has two different sized pins. When inserting the plug into the outlet, check its proper orientation. If the A09034 do not fit the socket, please separately purchase a suitable adapter.

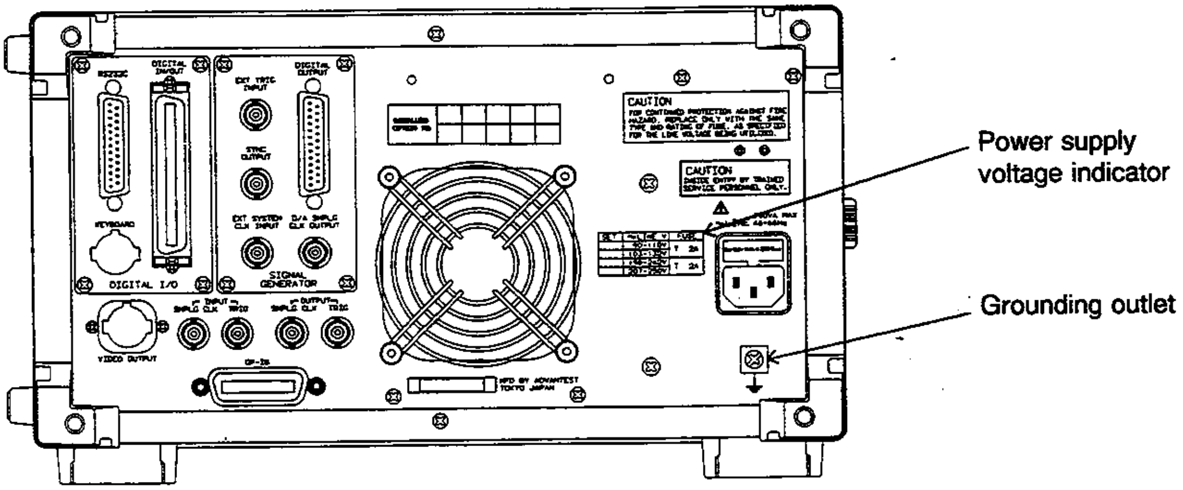


Figure 1-1 Power Supply Voltage Indicator and Grounding Outlet

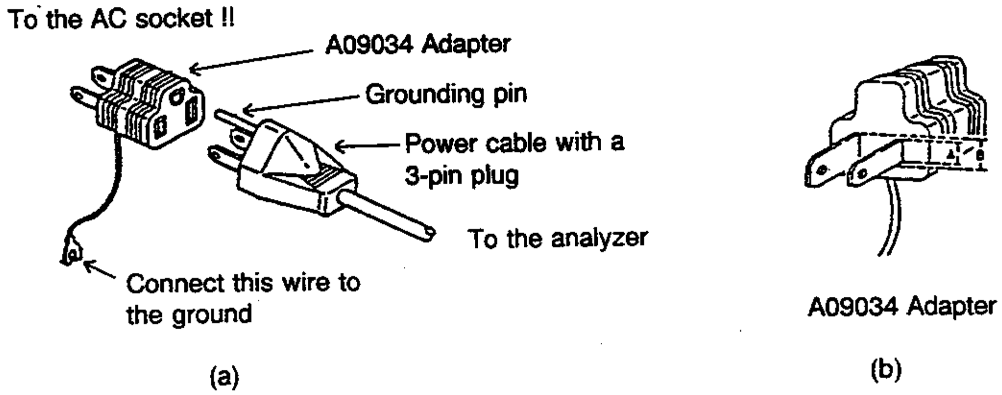


Figure 1-2 Power Cable Plug and Adapter

■ Replacing a Fuse

The power fuse is in the fuse holder at the rear panel. To check or replace the fuse, disconnect the power plug, pull out the fuse holder cap toward you, then remove the fuse.
Always use a 24 A fuse (DFT-AA2A), no matter the voltage, because a switching power supply unit is included.

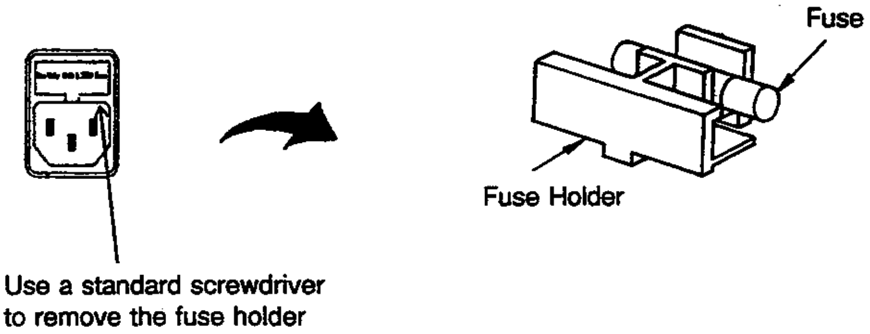


Figure 1-3 Fuse Holder

CAUTION !
Before replacing the fuse, set the POWER switch to OFF and remove the power plug from the socket.

2. Use under Normal Conditions

■ Operating Environment

(1) Do not use this unit in a heavy-dusted local, or in places subject to direct sunlight, or corrosive gas exposure.
The ambient temperature should lay between +5 and +35°C and the relative humidity must equal 80% at most.

(2) This unit is designed to resist the noise generated by the AC power supply. However, it is recommended that this unit be used in a place where the noise is reduced to a minimum. If required, use a noise filter.

(3) When connecting this unit to other measuring units through the interface, please thoroughly read the other units manuals in advance.

(4) Avoid using this unit in locations subject to heavy vibration.

■ Cooling and Ventilation

This unit is equipped with a cooling fan to prevent its overheating. Cooling air enters and exhausts the analyzer through the rear panel. For this reason, be careful to install the unit to allow free circulation of cooling air, do not use it in a standing up position.

■ Display (CRT) Intensity and Life Span

The CRT's color is umber. Using the CRT with a high intensity level for a long period of time will generate burnt spots on the screen. To use the CRT for a long period of time, reduce the intensity as much as possible.

■ Cleaning the CRT screen

Periodically clean the CRT screen with a soft cloth dampened with alcohol. Do not use other chemicals.

CAUTION !
During maintenance or cleaning, DO NOT USE any solvent such as benzene, toluene, or acetone, which may damage plastic parts.

■ Destruction of Circuit Elements by CMV Looping of the Power Supply

(1) Peripheral devices such as a desk-top computer or a plotter can be connected to this unit. To protect circuit elements, pay attention to CMV (Common Mode noise Voltage) generation caused by improper grounding.

(2) When a power supply line is not grounded, the loop formed as shown in Figure 1-4 approximately generates a 50 VAC voltage (CMV) between outlets a1 and a2 and between b1 and b2. If the circuit between grounding plugs b1 and b2 is opened and the circuit between signal outlets a1 and a2 is closed, input/output circuit elements of circuits 1 and 2 may be destroyed or damaged. To prevent this, use a properly grounded power supply line. Switching on/off the unit by inserting or removing the power supply plug will generate the similar CMV. Use the POWER switch to power on/off the unit.

(3) If it is unavoidable to use an ungrounded power supply line, insert the power cable plug after connecting the ground outlet and signal cable. Then, set the POWER switch to ON.

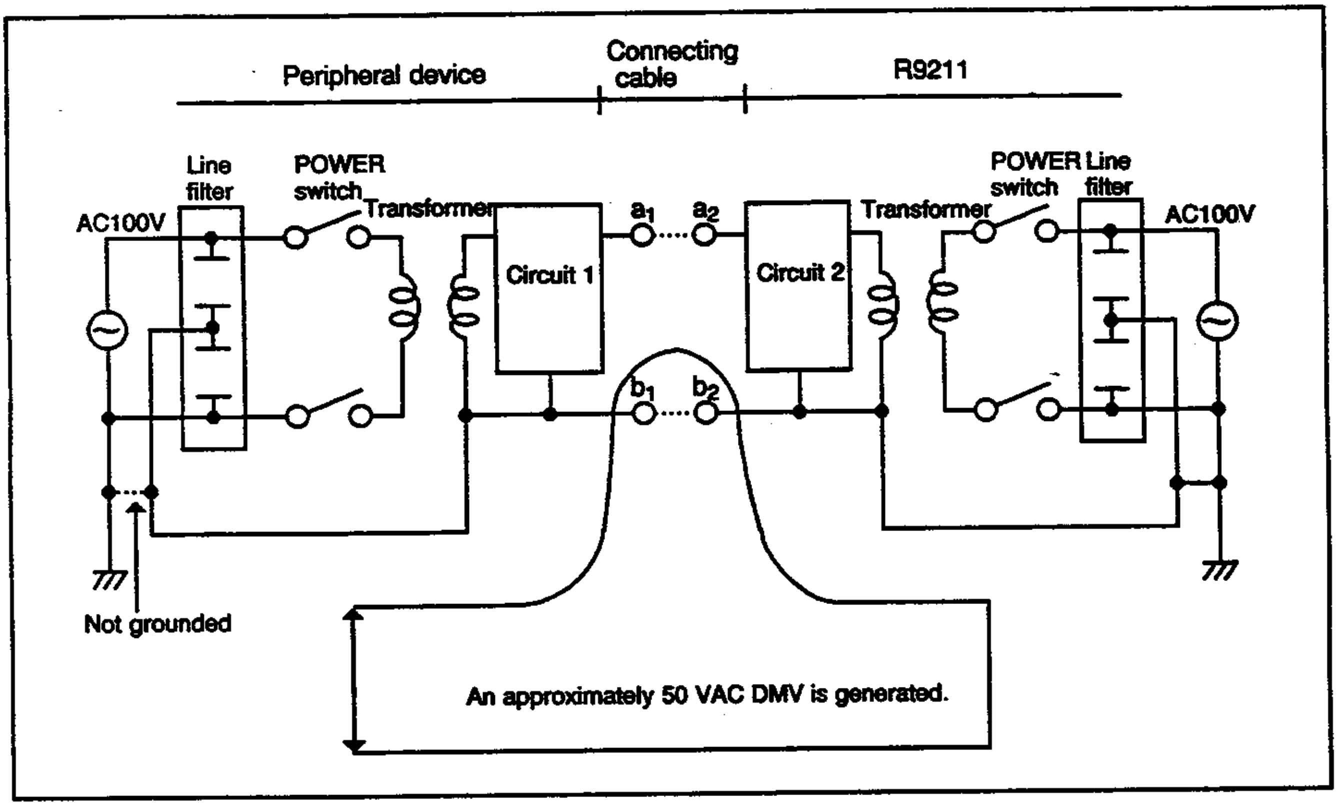


Figure 1-4 CMV Looping of the Power Supply Line

■ NiCd (Nickel Cadmium) Battery

R9211 includes NiCd battery, which backs up a watch of built-in calendar and a setting condition. When the time and date of calendar watch gets out of order, electric discharge or life of NiCd battery is considered to be shortage. After NiCd battery comes to full electric discharge, electric power supply needs to remain "on" as to charge with electricity for approx. 60 hours. When the time and date of calendar watch gets out of order for enough time-electric power supply, and [DEFAULT] is set in the start of electric power supply, life of NiCd battery is considered to be shortage. Inform to Advantest Sales & Support Offices for the exchange of battery.

3. Transportation and Storage

■ Transportation

Use the original package or the equivalent to transport this unit.

■ Storage

The storage temperature ranges between -20 to +60°C. If this unit is not used over a long period, cover it with a vinyl sheet or put it in a cardboard box. Store it in a dry place not directly exposed to the sunlight.

4. Troubleshooting

■ Before Ordering Repair

Before ordering repair, check the following points:

● No data is displayed when the unit is switched on.

Check 1
- Check the power supply line.

Check 2
- Check whether the fuse is blown.
  Switch off, unplug the unit and check whether the proper fuse is used and not blown.

● The self-diagnosis indicates failure when the power is switched on.

No Check
- The internal hardware is defective.

● No input signal is displayed or the "OVER" lamp does not go off.

Check 1
- Perform a check in the test mode.

Conditions
Input range: 0dB
Frequency range: 100kHz
Time- or frequency-axis waveform

Displays
About -4dB (8kHz frequency)

If an input signal is not displayed under the above conditions, the hardware is defective.

Check 2
- Check the input coupling. SETUP ⇒ INPUT

Check 3
- Check the input range setting. SETUP ⇒ RANGE

Reset the unit if the setup conditions are unknown.

CHAPTER 2

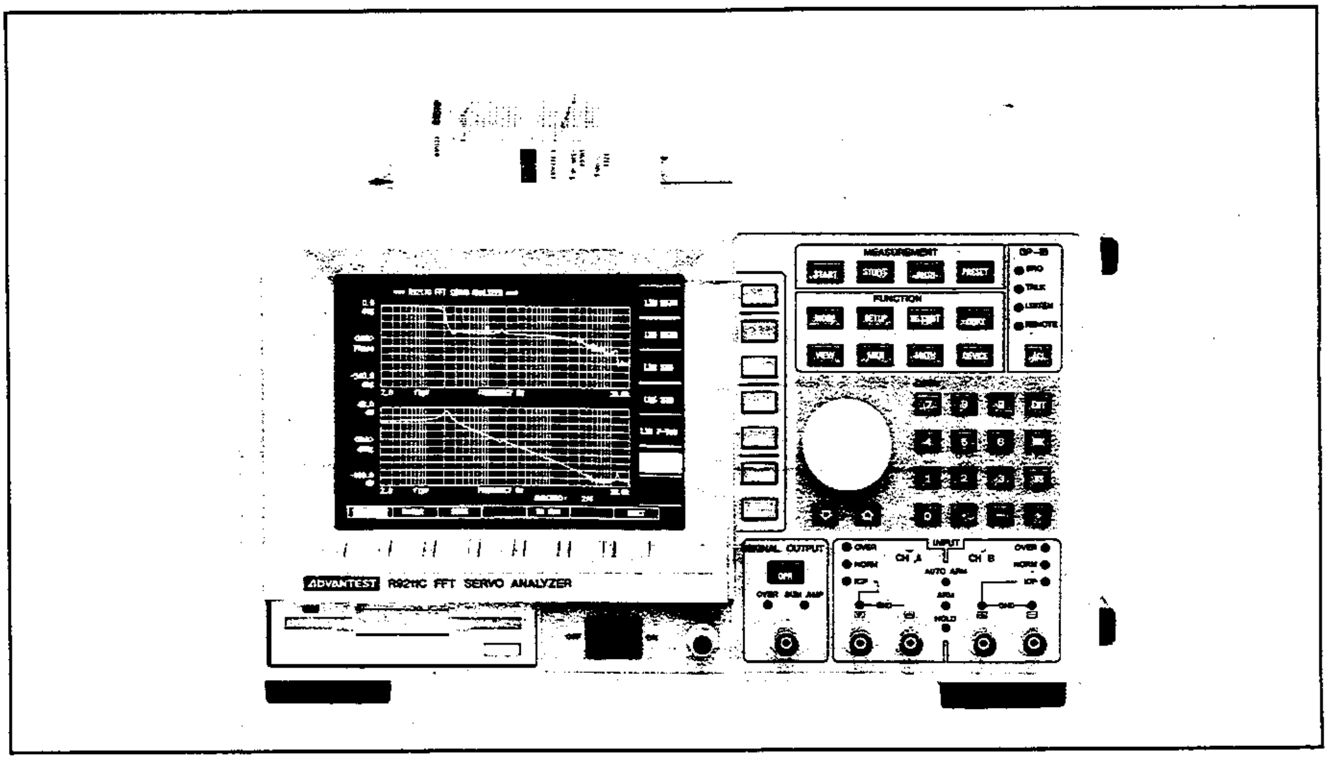
ANALYZER OVERVIEW

This chapter outlines the analyzer and its five measurement modes.

CONTENTS

1. Outline

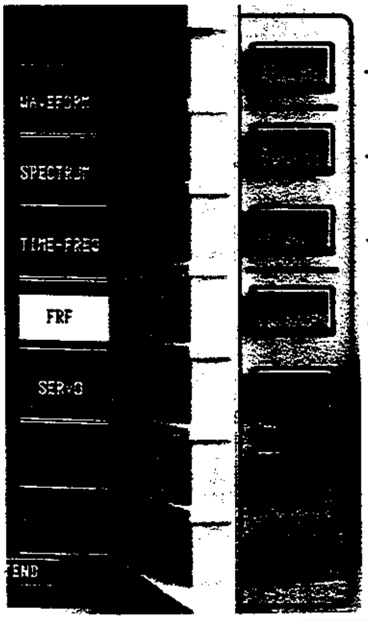
The R9211 is a 2 channels, 16 bits, spectrum analyzer whose analysis method is based on the Fast Fourier Transformation (FFT). Its maximum analysis frequency reaches 100kHz. It is designed for high speed, high precision, wide dynamic range measurement. It is furthermore equipped with 2 unique built-in features : a servo analysis function and a summing amplifier. Not only providing all the basic functions available on traditional FFT spectrum analyzers, it also offers the best performances to be found on analyzers of the same category.
The R9211C, in addition to the functions of the R9211B, is a first class servo analyzer that enables high precision curve-fitting and synthesis.



The illustration above shows the R9211C with an optional built-in printer.

■ The Five Measurement Modes

The R9211 FFT servo analyzer possesses five measurement modes that serve different purposes.



In this mode the unit behaves as a high resolution (16 bits) digital oscilloscope .

Select this mode to use the unit as a 90dB dynamic range spectrum analyzer.

This mode allows you, from a survey of the waveform over a long time period, to analyze the time evolution of the spectrum.

In this mode, frequency response functions are obtained over all the analyzed frequencies, simultaneously, through the application of an impulse or a random waveform.

This mode is designed for the measurement of wide-dynamic-range (100dB or more) frequency response functions, using built-in swept multi-sine wave or swept sine wave.

2. The Measurement Modes

■ Servo Mode

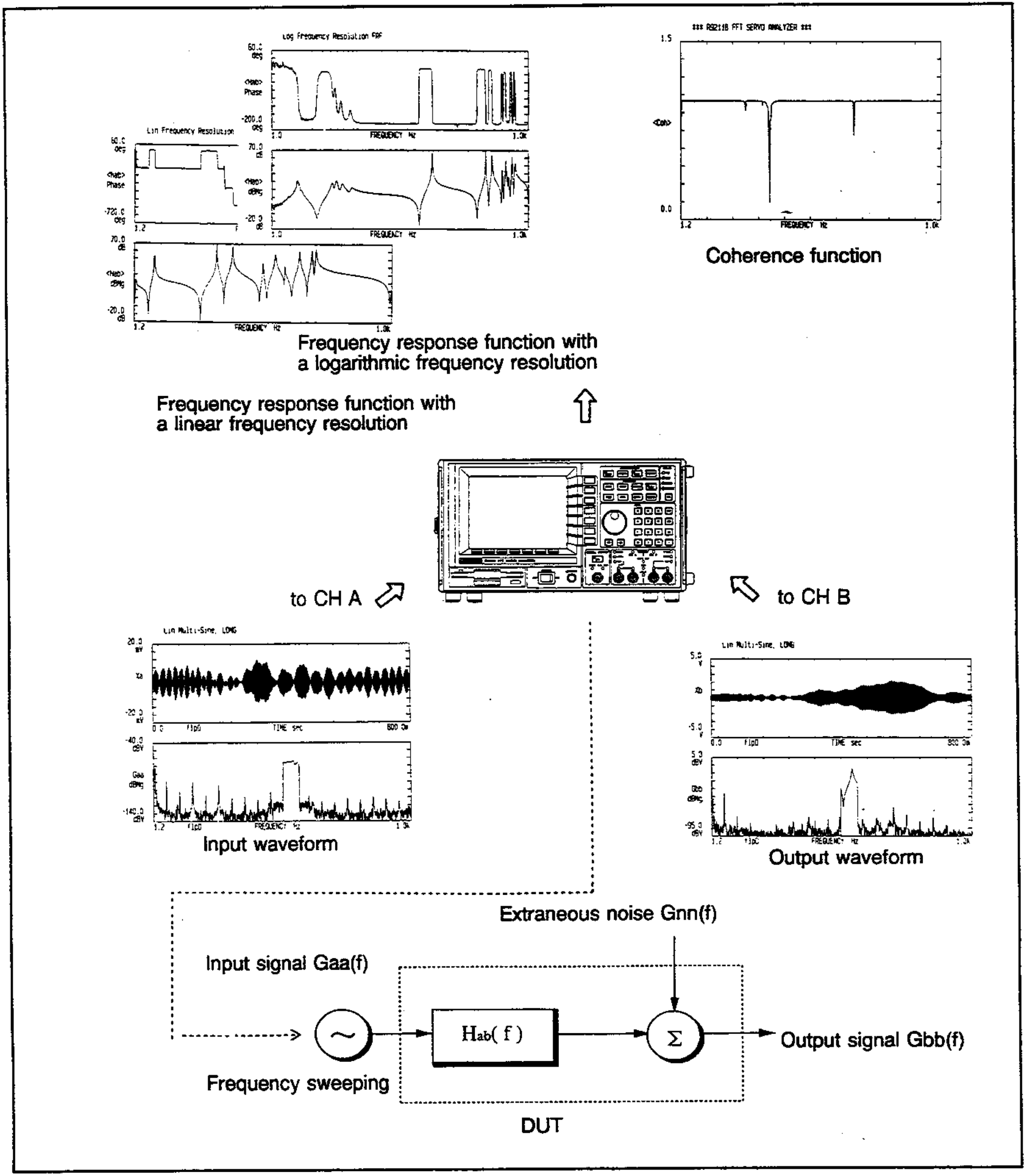


Figure 2-1 Concept of Measurement System in Servo Mode

In the servo mode, frequency response functions can be obtained through the application of linear/logarithmic swept multi-sine or swept sine wave generated by the built-in SG (Signal Generator). At this time, the coherence function which indicates the influence of the extraneous noise can be obtained.
You should select this mode in the following cases:

- When the dynamic range of the DUT is wider than 70dB
- When a good frequency resolution at the low frequencies of the analysed frequency band is required.

Measurement resolution:
Linear frequency analysis: 25-800 lines (Impulse response function: 64-2048 points)
Logarithmic frequency analysis:
* 10-100 lines/decade (1-6 decades)
* 200 lines/decade (1-5 decades)

Sweeping method:

- Linear multi-sine
- Linear sine
- Linear frequency table
- Logarithmic multi-sine
- Logarithmic sine
- Logarithmic frequency table

■ FRF Mode

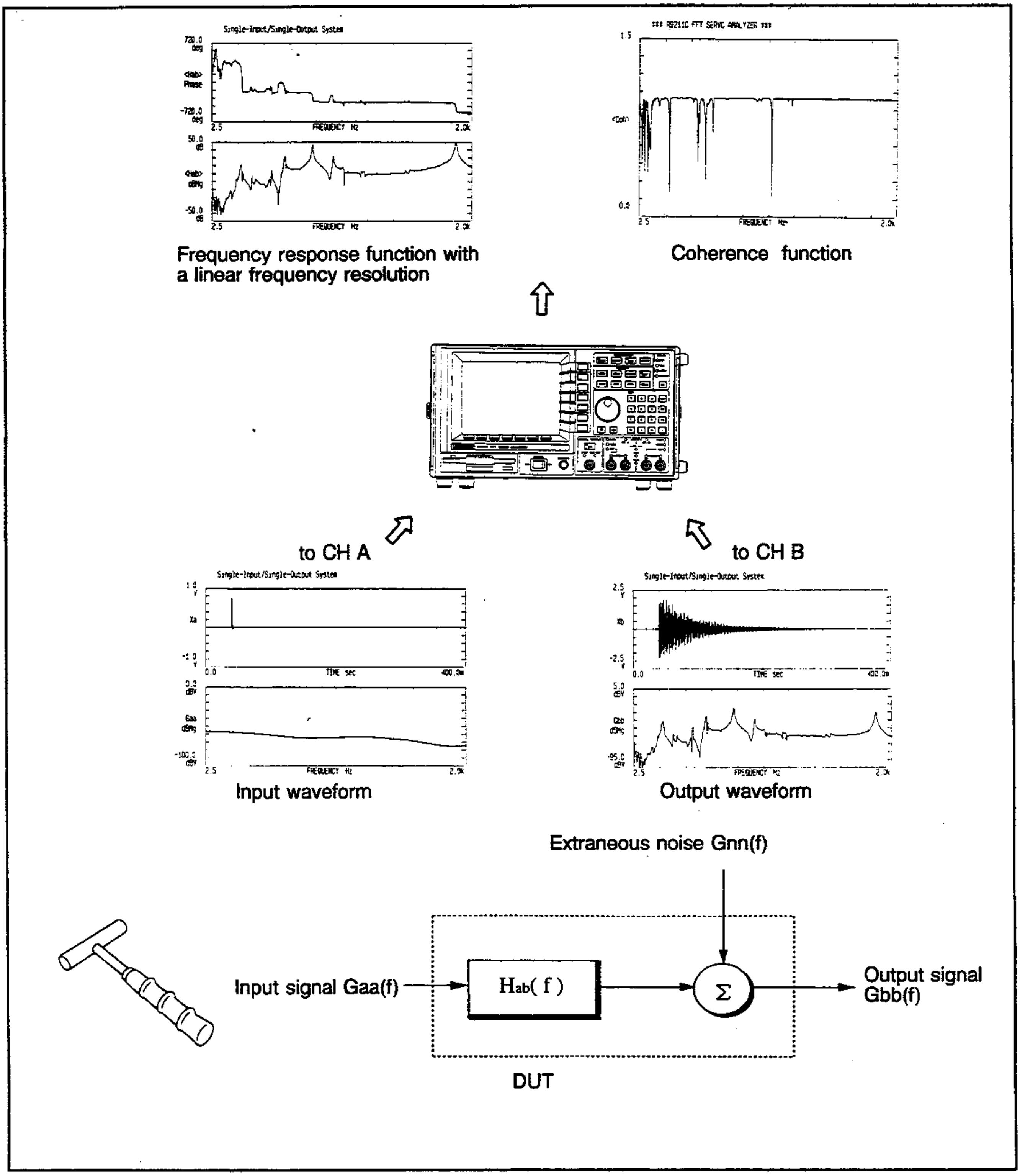


Figure 2-2 Concept of Measurement System in FRF Mode

In the FRF mode, linear frequency response functions can be computed only if the excitation signal has a frequency band larger than the frequency band of the analysis. The signal source is an impulse wave generated by the impulse hammer or a random wave, a multi-sine wave, or a swept sine wave generated by the built-in Signal Generator (often noted SG). At this time, the coherence function indicating the influence of the extraneous noise can be measured.

A large delay between the input and output can be compensated with an interchannel delay compensation feature.

Measurement resolution:	25-800 lines (Linear frequency response function) 64-2048 points (Impulse response function)
Zoom analysis function:	Between the start and stop frequencies, chosen by the user, the maximum line span is 800 lines. This function cannot be applied to transient signal analysis when you use the trigger.

■ Spectrum Mode

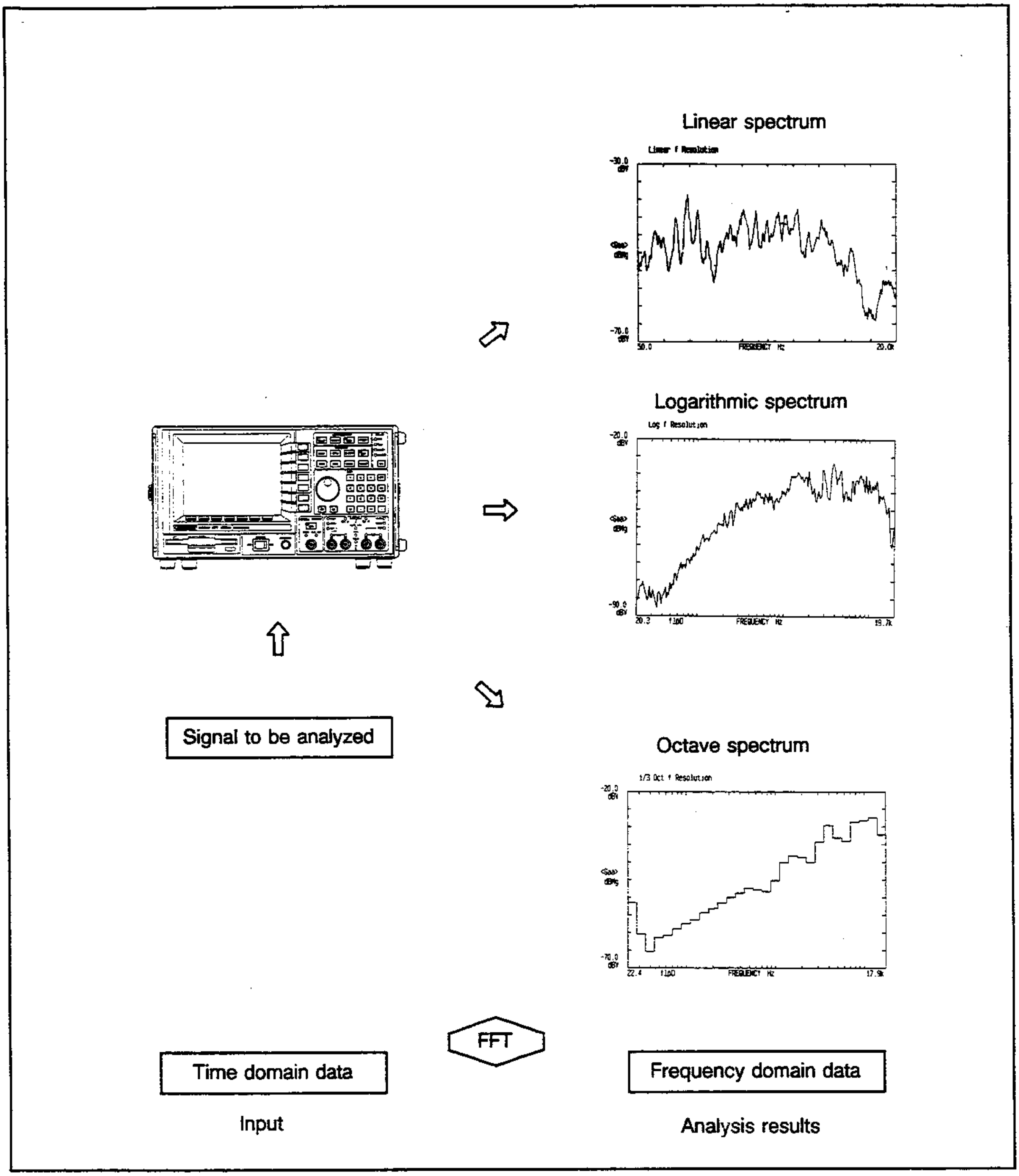


Figure 2-3 Concept of Measurement System in the Spectrum Mode

In the spectrum mode, several spectrum representations of the frequency domain data, resulting from the analysis of the input signal, are possible, no matter which channel is selected. One should choose the representation that suits best the analysed data :

- The linear frequency resolution spectrum is best suited to stationary signals analysis (harmonic analysis...)
  Analysis resolution: 25-1600 lines (Single channel: 3200 lines)
- The logarithmic frequency resolution spectrum is best suited to non-stationary signals analysis (noise analysis)
  Analysis resolution: 80 lines/decade, 1-3 decades
- The octave spectrum is best suited to sound or audio signals analysis.
  1/3 octave, 1/1 octave analysis

If a zoom analysis function (provided only on the R9211C) is used, high-resolution spectrum analysis is possible, the minimum span being 10mHz.(For a start frequency higher than 10kHz, the minimum span becomes 100mHz.)
See Figure 2-4.

ADVICE

1. The frequency resolution is enhanced and the noise floor of the measurement system including the measuring equipment is reduced when the number of lines increases. (See Figure 2-4.)
2. Depending on the type of the averaged spectrum data, different applications are possible: (See Figure 2-5.)
   - ▶ Power spectrum average
     The spectrum can be smoothed without synchronization by a trigger.
   - ▶ Complex spectrum average
     A target signal can be extracted from a noisy signal, by using the synchronization signal of the target signal as a trigger, thus reducing the noise components from the signal when averaging (synchronous averaging).
3. You should use a linear frequency resolution spectrum to measure a continuous wave such as a sine wave. (The logarithmic frequency resolution spectrum does not fit this type of measurement.)

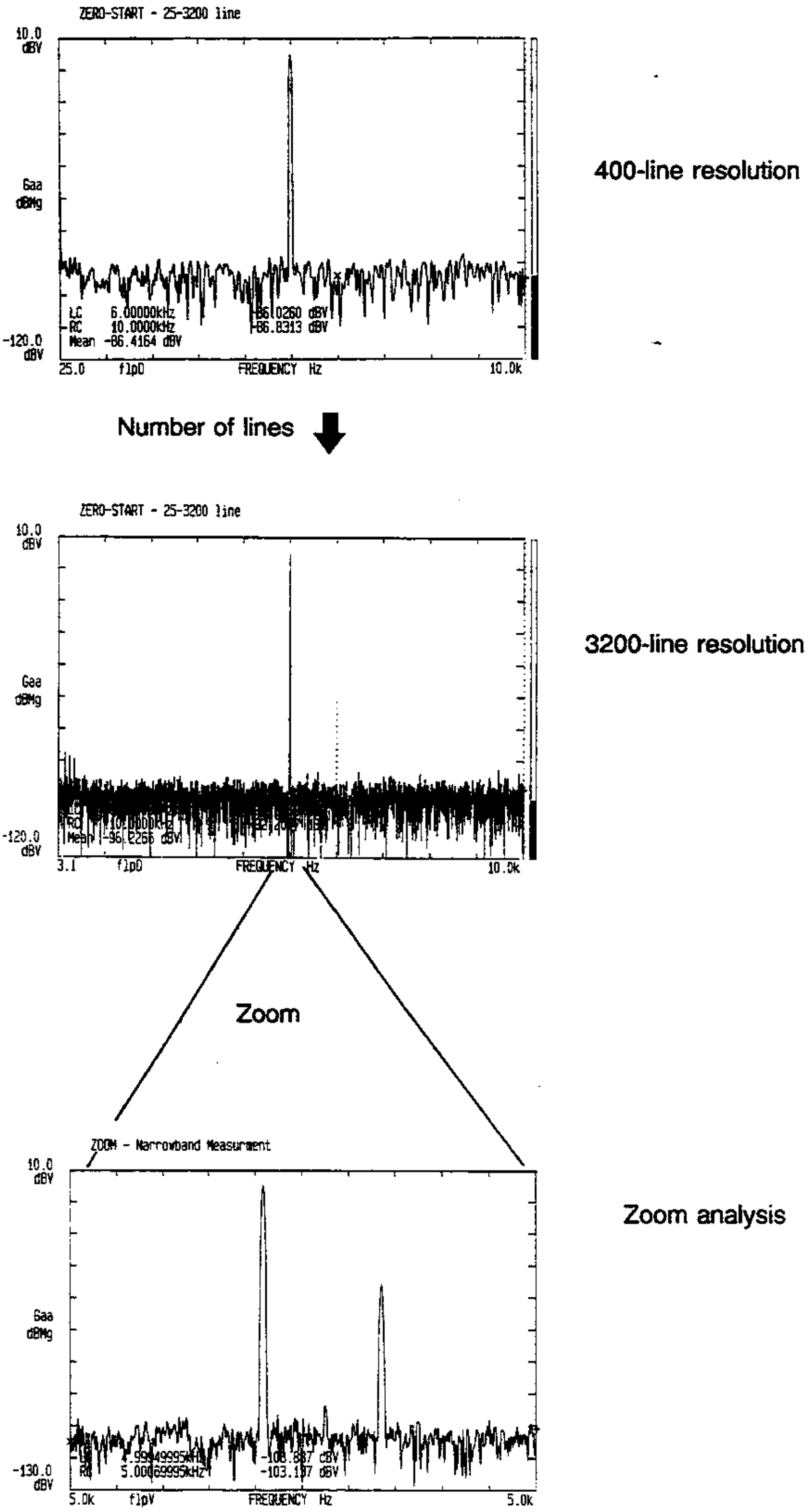
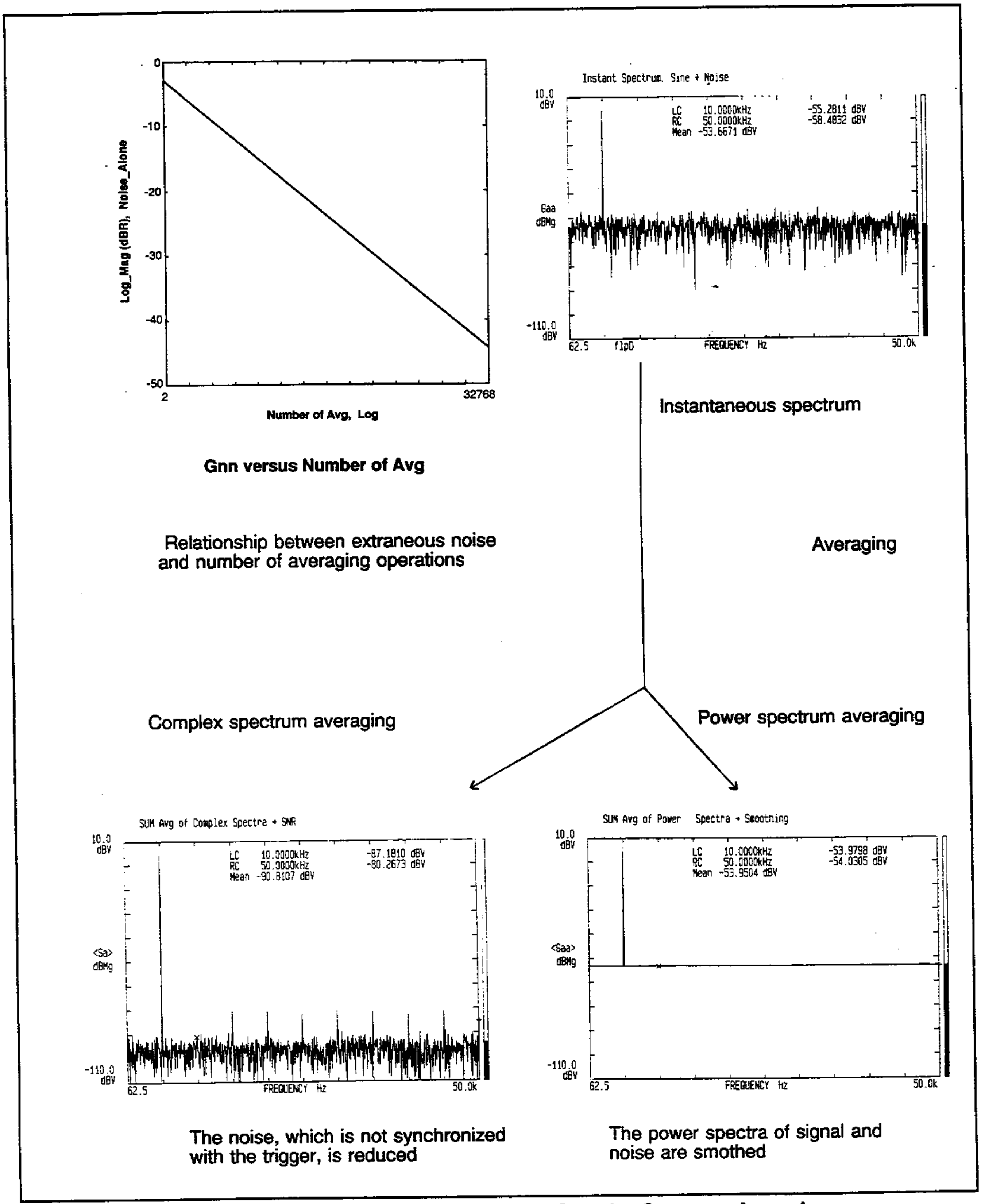


Figure 2-4 Number of Lines and Zoom Effect



Gnn versus Number of Avg

Relationship between extraneous noise and number of averaging operations

Instantaneous spectrum

Averaging

Complex spectrum averaging

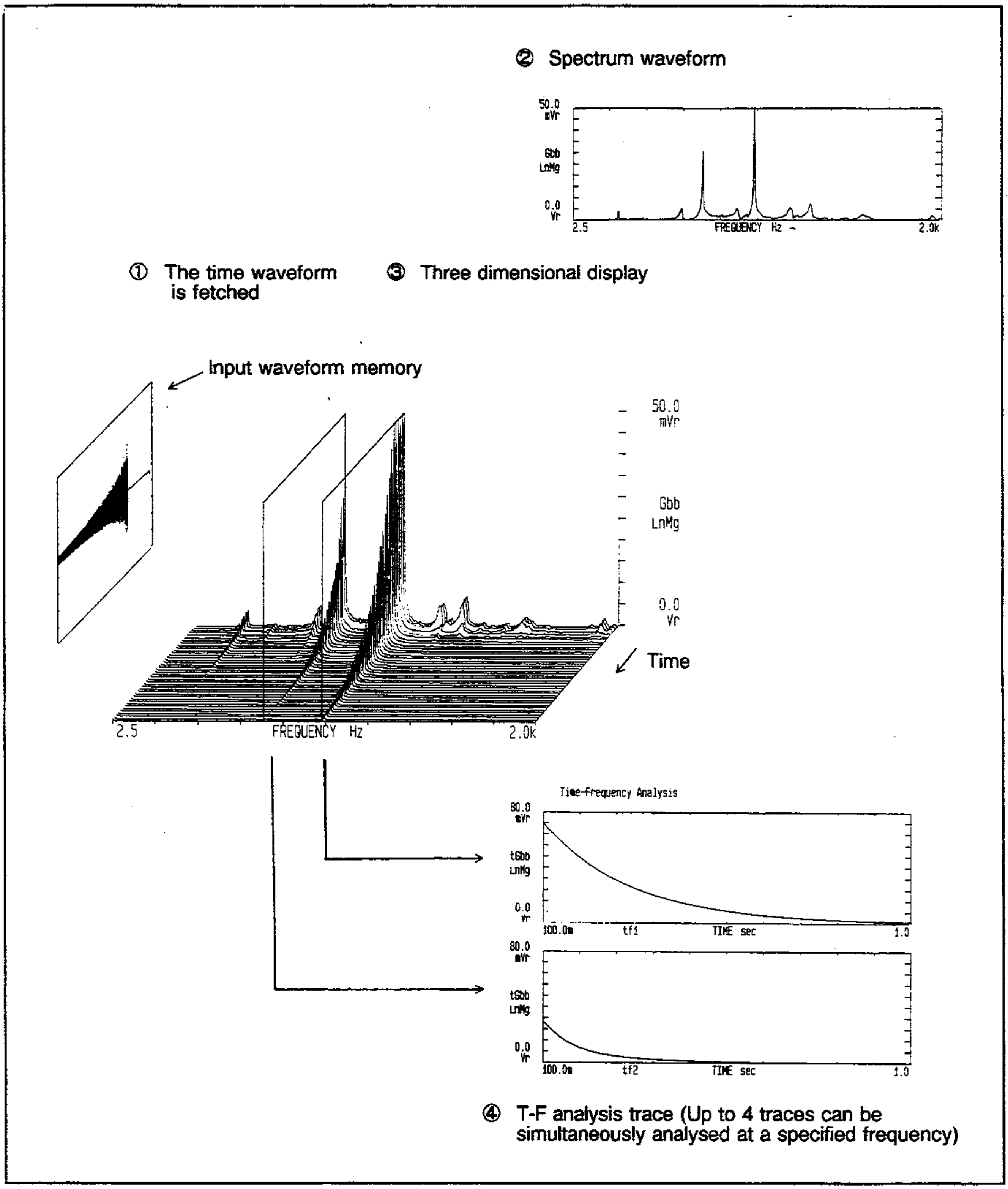
Power spectrum averaging

The noise, which is not synchronized with the trigger, is reduced

The power spectra of signal and noise are smothed

Figure 2-5 Effect of Power Spectrum and Complex Spectrum Averaging

■ Time-Frequency Analysis Mode (T-F Mode)



② Spectrum waveform

① The time waveform is fetched

③ Three dimensional display

Input waveform memory

Time

④ T-F analysis trace (Up to 4 traces can be simultaneously analysed at a specified frequency)

Figure 2-6 Concept of Measurement In the Time-frequency Analysis Mode

In the TF mode, a transient signal is recorded in the input waveform memory by using a trigger signal. (① in Figure 2-6)
The following analyses can be performed, depending on the recorded waveform:

(1) One can observe the instantaneous spectrum of any portion chosen from the recorded waveform. (② in Figure 2-6)
(2) Spectra can be displayed in three dimensions depending on the recorded waveforms. (③ in Figure 2-6)
(3) The relationship between a specified frequency and time can be analyzed to obtain a transient signal damping characteristic (T-F analysis). (④ in Figure 2-6)

Input Waveform Memory Sizes

R9211B		
	Standard	64K words (Single channel: 128K words)
	Standard + CMOS memory (option 10)	512K words (Single channel: 1024K words)
	Standard + I/O + Memory (option 11)	512K words (Single channel: 1024K words)
	Standard + CMOS memory (option 10) + I/O + Memory (option 11)	1024K words (Single channel: 2048K words)
R9211C		
	Standard	512K words (Single channel: 1024K words)
	Standard + CMOS memory (option 10)	1024K words (Single channel: 2048K words)

■ Waveform Mode

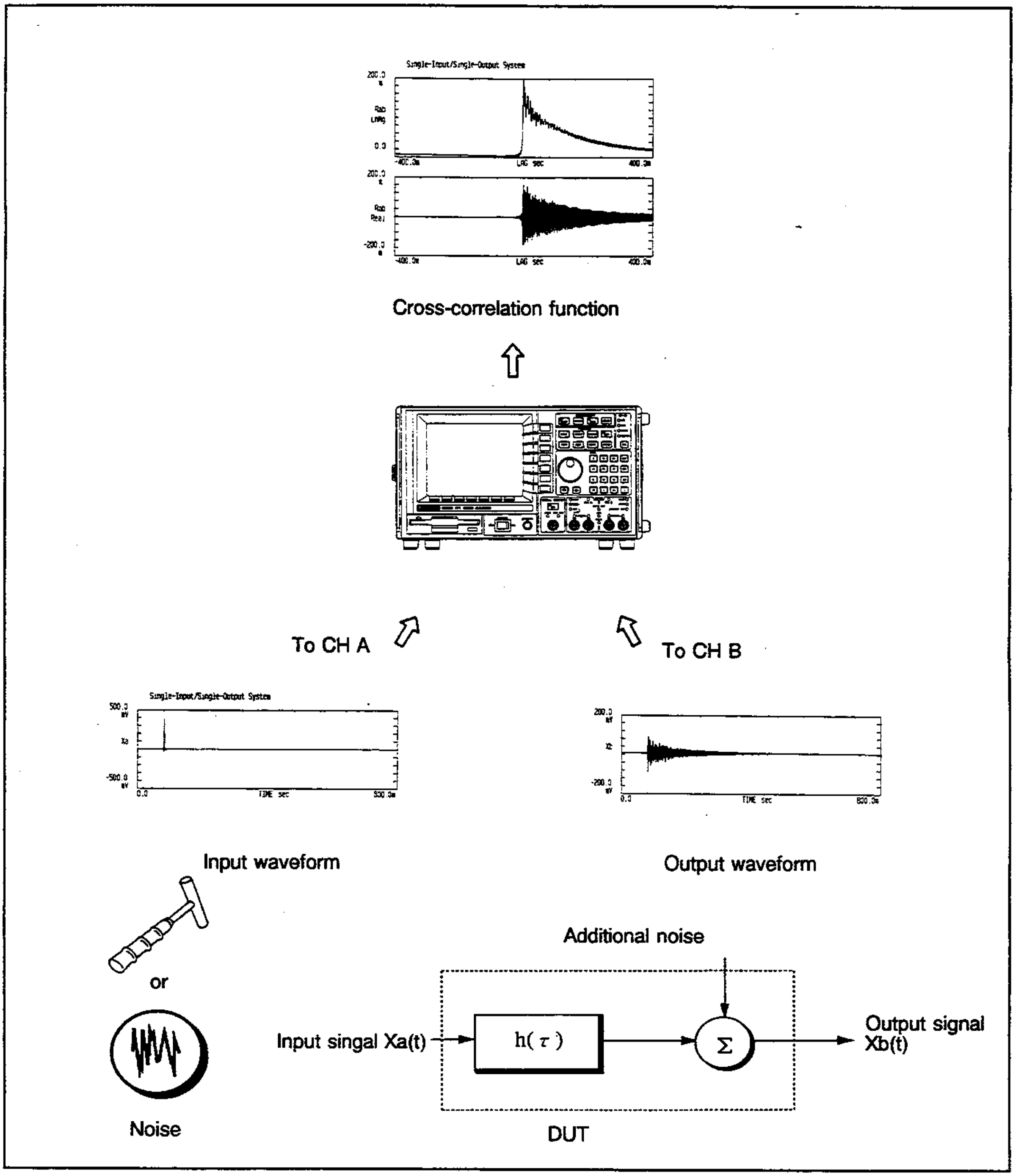


Figure 2-7 Concept of Measurement in Waveform Mode

The waveform mode is used for the time domain analysis : the time waveform, the correlation function, and the histogram can be obtained.

(1) A time waveform can be displayed, repeatedly, at a higher speed than in the other modes.
(2) An autocorrelation function can be used to evaluate the periodicity of the input signal.
(3) A cross-correlation function can be used to evaluate the time lag between input signals.
(4) An amplitude probability density function can be used for statistical signal processing.

3. Comparison between the Different Measurement Modes

■ From the Point of View of the Analysed and Displayed Data

The data currently being acquired can be displayed as an instantaneous trace by selecting the

VIEW ⇒ INST VW operation.

Average measurement is required to remove or smooth the extraneous noise which is being measured. The averaging result can be displayed by selecting the

VIEW ⇒ AVG VW operation.

The types of these instantaneous data and averaging data depend on the analysis mode and on the selected function as summarized in Table 2-1.

■ From the Point of View of the Averaging Modes

There are four averaging mode : sum averaging (SUM), exponential averaging (EXP), peak detection averaging (PEAK), and subtract averaging (SUB) modes.
The averaging mode that can be selected depends on the selected measurement mode as summarized in Table 2-2.
Besides, Table 2-2 lists the averaging operations that require triggering for synchronous averaging.

■ From the Point of View of the Trigger Operation

There are four modes for input data triggering: auto-arm, arm, hold, and free run modes.
Table 2-3 indicates the relationships between these modes and measurement modes.
Furthermore, the number of input traces to be acquired can be set only in the T-F mode (arm length).

■ From the Point of View of the Signal Generation Control

In the servo mode, you can control the built-in signal generator (SG) with the SETUP key.

In other modes, you can control it with the SG CONT key.
Table 2-4 summarizes the relationships between measurement modes and signal generator operations.

Table 2-1 Instantaneous Analysable Data / Average Data Types

Analysis mode	Function	Instantaneous data		Average data	
MODE	SETUP	VIEW	INST VW	VIEW	AVG VW
	Function	CHA & CHB	CHA or CHB	CHA & CHB	CHA or CHB
Waveform	Time	CH-A TIME CH-B TIME ORBITAL	CH-X TIME	CH-A TIME CH-B TIME	CH-X TIME
	AUTOCORR	CH-A TIME CH-B TIME CH-A AUTOCORR CH-B AUTOCORR		CH-A AUTOCORR CH-B AUTOCORR	
	CROSS-CORR	CH-A TIME CH-B TIME CH-A AUTOCORR CH-B AUTOCORR CROSS-CORR		CROSS-CORR	
	HISTOGRAM	CH-A TIME CH-B TIME CH-A HIST CH-B HIST	CH-X TIME CH-X HIST	CH-A HIST CH-B HIST	CH-X HIST
SPECTRUM or TIME-FREQ	POWER SPECT or COMPLEX SPECT	CH-A TIME CH-B TIME CH-A SPECT CH-B SPECT	CH-X TIME CH-X SPECT	CH-A PWR SPECT CH-B PWR SPECT	CH-X PWR SPECT
				CH-A CMP SPECT CH-B CMP SPECT	CH-X CMP SPECT
	CROSS-SPECT	CH-A TIME CH-B TIME CH-A SPECT CH-B SPECT CROSS-SPECT		CROSS-SPECT	
FRF	FRF			FRF COHERENCE IMPULSE RESPONSE CH-A PWR SPECT CH-B PWR SPECT CROSS-SPECT	
SERVO	–			FRF COHERENCE IMPULSE RESPONSE	

CH-X: Active channel signal
CH-A: A channel signal
CH-B: B channel signal
TIME: Time waveform
AUTOCORR: Auto correlation function
CROSS-CORR: Cross-correlation function
HIST: Histogram

SPECT: Spectrum
CMP SPECT: Complex spectrum
PWR SPECT: Power spectrum
CROSS-SPECT: Cross-spectrum
FRF: Frequency response function
COHERENCE: Coherence function
IMPULSE RESPONSE: Impulse response function

3. Comparison between the Different Measurement Modes

Table 2-2 Measurement Modes and Averaging Modes

Analysis mode	Function	Averaging mode	Data subject to averaging
Waveform	Time < Trigger required >	SUM	Time waveform X_a, X_b
	Auto Corr.	SUM EXP	Auto correlation function R_{aa}, R_{bb}
	Cross-Corr.	SUM EXP	Cross-correlation function R_{ab}
	Histogram	SUM	Histogram P_a, P_b
Spectrum or Time-Frequency	Power Spect	SUM, EXP, PEAK, SUB	Power spectrum G_{aa}, G_{bb}
	Cross Spect	SUM, EXP, PEAK, SUB	Cross-spectrum G_{ab}
	Complex Spect < Trigger required >	SUM, EXP, PEAK, SUB	Complex spectrum S_a, S_b
FRF	FRF	SUM, EXP, PEAK	Power/Cross-spectrum G_{aa}, G_{bb}, G_{ab}
Servo	–	SUM	Power/Cross-spectrum G_{aa}, G_{bb}, G_{ab} *

* : This spectrum is used internally : it cannot be displayed.

Table 2-3 Measurement Modes and Trigger

MODE	SETUP ARM/HLD	SETUP TRIG ARM LENGTH
WAVEFORM	possible	impossible
SPECTRUM	possible	impossible
TIME-FREQ	possible	possible
FRF	possible	impossible
SERVO	Free run only	impossible

Table 2-4 Measurement Modes and Signal Generator Operation

Analysis mode	Setup	Generation starting method	
WAVEFORM	SG CONT	SG CONT OUT CTRL Generator Start	OPR
SPECTRUM			
TIME-FREQ			
FRF			
SERVO	SETUP	SETUP SG COM Generator Start	

4. Measurement Blocks

■ Ordinary Measurement Blocks

Figure 2-8 shows the measurement block-diagram of the R9211.

● **Lowpass Filter (2kHz, 5kHz, ..., 100kHz)**
The analog input signal is amplified and passed through the low pass filter so that the signal components outside the measurement band are eliminated (in order to prevent frequency aliasing).

● **16-bit A/D Converter**
After filtering, the signal is digitized, and the resulting 16 bit digital signal is recorded in the input buffer.

● **Zoom Processor**
When the analysis frequency range is lower than 1kHz or when a narrow-band is measured in the zoom measurement mode, the input signal is processed by the zoom processor before it is stored in the input buffer.

● **Input Waveform Buffer**
Generally, only the latest recorded data are read from the buffer to be displayed or processed.
In the T-F mode, an arbitrary portion of data recorded in the input buffer can be read for analysis and display.

You can select the position in the buffer of the data you wish to analyse with the data view function.

(VIEW ⇒ INST VW ⇒ DATA VIEW ON /OFF)

Data view "mode" is selected. The frame selection procedure is described p.9-74.
Furthermore, when a T-F analysis is conducted, the data stored in the input waveform buffer are processed one by one to analyze the relationship between the frequency and time.

(SETUP ⇒ T-F ⇒ INST T-F ON /OFF T-F analysis is enabled. Please refer to p.9-41.

START starts the analysis)

● **Fast Fourier Transform (FFT)**
The waveform Xa is transformed from the time-domain to the frequency domain (Fourier transform) to obtain the complex spectrum Sa.
The original waveform Xa is multiplied by a window function (Hanning,...), before FFT processing, to reduce the leakage in the frequency domain, due to the discontinuities introduced, in the time domain, by the truncation.

- **Power and Cross-spectrum Estimation**

The power spectrum and cross spectrum are obtained from the complex spectrum.

- **FRF Estimation**

In the servo or FRF mode, the frequency response function and the coherence function are computed from the averaged input/output power spectra and cross-spectrum.

- **Built-in Curve Fitting Block (R9211C only)**

Laplace parameters (pole, zero, etc.) are extracted from the measured frequency response function. These Laplace parameters are used to synthesize the frequency response function, the impulse response function, and the step response function.

Logarithmic Frequency Resolution Spectrum Analysis and Octave Spectrum Analysis

In the spectrum or in the T-F mode, a logarithmic frequency resolution spectrum analysis and octave spectrum analysis can be performed in addition to the ordinary linear frequency spectrum analysis. The measurement block is shown in Figure 2-9.

- **Highest Frequency Range's Spectrum**

The last recorded signal frame (1024 points), stored in the input buffer, is analyzed by the FFT method to obtain the spectrum of the highest frequency range (e.g., 20kHz range).

- **1/10 Lowpass Digital Filter**

Ten signal frames, stored in the input buffer, are passed through this filter before FFT analysis to obtain the spectrum of the middle frequency range (2kHz).

- **1/100 Lowpass Digital Filter**

One hundred signal frames, stored in the input buffer, are passed through this filter, before FFT analysis, to obtain the spectrum of the lowest frequency range (200Hz).

- **Constant Ratio Band Filter**

The spectra in these three frequency ranges (20kHz, 2kHz, and 200Hz) are passed through this filter to obtain a logarithmic frequency resolution spectrum.

- **Octave Band Filter**

The logarithmic frequency spectrum is passed through this filter to be transformed to the octave spectrum.

- **Log/octave analysis**

Log filter is operated for the result which Log analysis performed linear FFT each decade. For 400 line-FFT each decade, the filtered result for frequency resolution each decade differs ten times. In order to correct the difference of frequency resolution, R9211 sets a noise floor to the decade of the worst frequency resolution and displays. Octave filter is used for the result of this Log analysis and octave spectrum is measured.
Therefore, Log octave analysis is suitable for the measurement of signal regulation movement. (When enter continuous waveform such as sign wave and triangle wave, the level don't go to a true value.) Input signal, for the use of filter, doesn't make energy gather to the specified level band, but is supposed to distribute equally such as noise in analysis frequency bound.

For PSD value in Log analysis, equivalent noise bandwidth (ENBW) is not revised.
For the ENBW revise, the following calculation is performed.

PSD(ENBW consideration) = PSD(R9211 display)/ENBW

ENBW is changed by weighting function. Use the following value.

Weighting function	ENBW(Equivalent Noise Bandwidth)
Rectangular	1.00
Harring	1.50
Minimum	1.98
Flat pass	6.77

Advantages of the method applied in the R9211

The R9211 does neither switch analog filters nor switch analysis frequency ranges for each octave as time goes by. But it stores all data to be analyzed in the input buffer.
These waveforms are transformed to the logarithmic frequency spectrum or octave spectrum through digital signal processing. Therefore, several data can be analysed simultaneously, enhancing the reproducibility and reliability of octave spectra over multiple ranges.

Note on how to use the R9211

Specify "one decade" if you want to compute the logarithmic frequency resolution spectrum, or the octave spectrum of a transient signal.

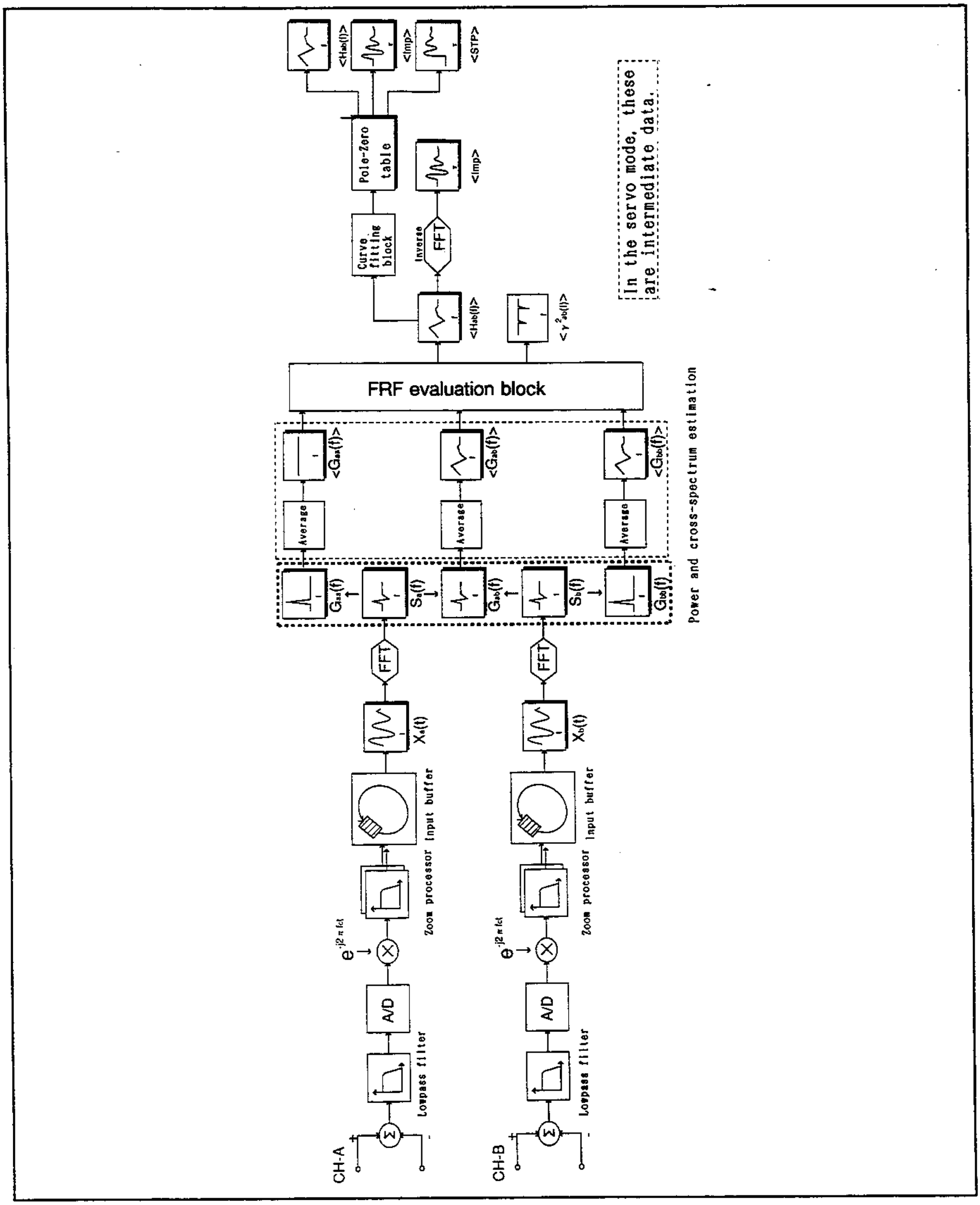


Figure 2-8 Measurement Block Diagram

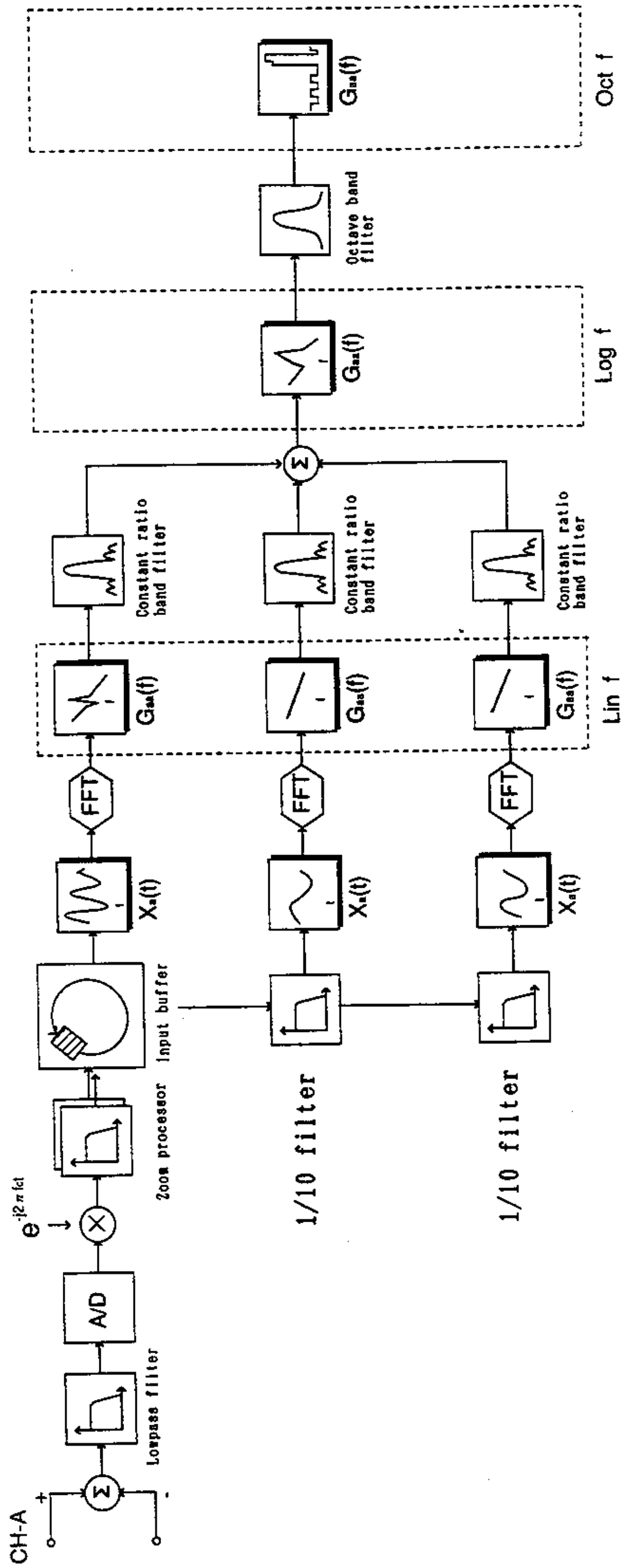


Figure 2-9 Logarithmic Frequency Spectrum Measurement Block Diagram

CHAPTER 3

BASIC OPERATIONS

First, this chapter explains basic key operation rules.
Next, it describes the operations which must be performed after switching the power on.
Lastly, this chapter introduces the front and rear panel.

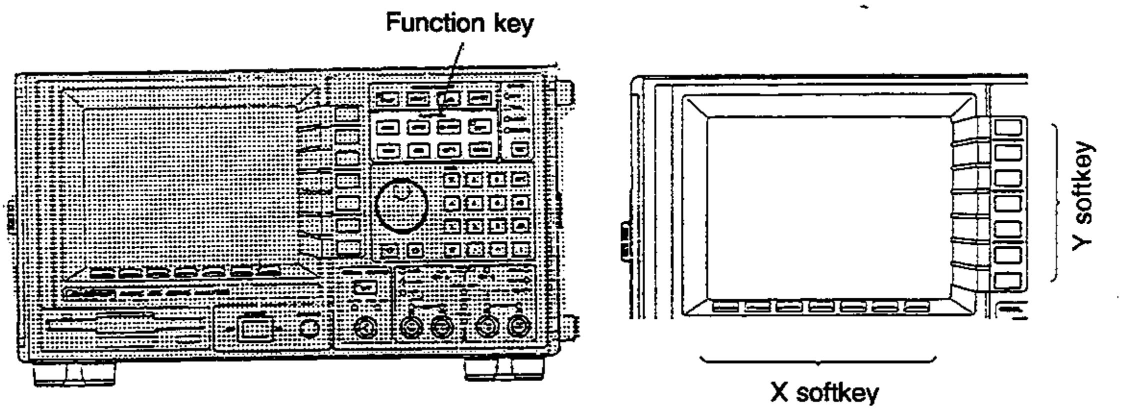
CONTENTS

1. Mastering Key Operations

To use the R9211 effectively, and to master the operation method quickly, as well as the measurement flow, it is important to understand the order in which the keys must be pressed.

■ Key Order (Hierarchical Structure)

There are two types of keys : the panel keys and the X and Y softkeys, which are displayed on the CRT screen.



Press the keys in the following order :

Function key ⇒ X softkey ⇒ Y softkey

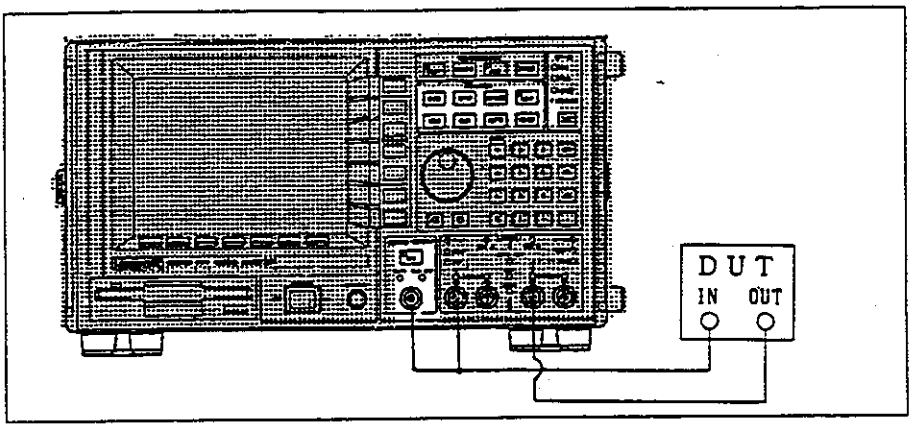
- Function key: Press the function keys in accordance to the measurement flow.
- X softkey: X softkeys are ordered from left to right according to their frequency of use. When setting these keys
- Y softkey: Set Y softkeys from top to bottom.

CAUTION !
The X or Y keys you have previously set are displayed in reverse video mode on the screen. You need not press these keys if you do not want to change their settings.

■ Measurement Flow

The sequence of panel key operations indicates the measurement flow. A basic measurement flow is as follows:

1 **Connect the DUT to the R9211.**



2 **Press the MODE key.**

Select a measurement mode (according to the type of measurement you intend to perform).

3 **Press the CAL key.**

The DC calibration is then carried out

4 **Press the SETUP key.**

Set the divers measurement parameters according to the measurement conditions.

5 **Press the SG CONT key.**

Set the Signal Generation. (This key cannot be used in the servo mode.)

6 **Press the OPR key.**

This, internally, connects the output terminal of the SG's output amplifier to the output connector.

7 **Press the START key.**

Starts an averaging process or a servo measurement.

8 **Press the VIEW key.**

Allows to display the results of both measurements and mathematical computations, and to set the desired display form.

9 **Press the MATH key.**

Execute the necessary arithmetic computations. (Of course, if you need not use this feature, step directly to the next point.)

10 **Press the MKR key.**

Thanks to the variety of markers, you can retrieve and display different numerical values from both measurement and mathematical computations results.

11 **Press the DEVICE key.**

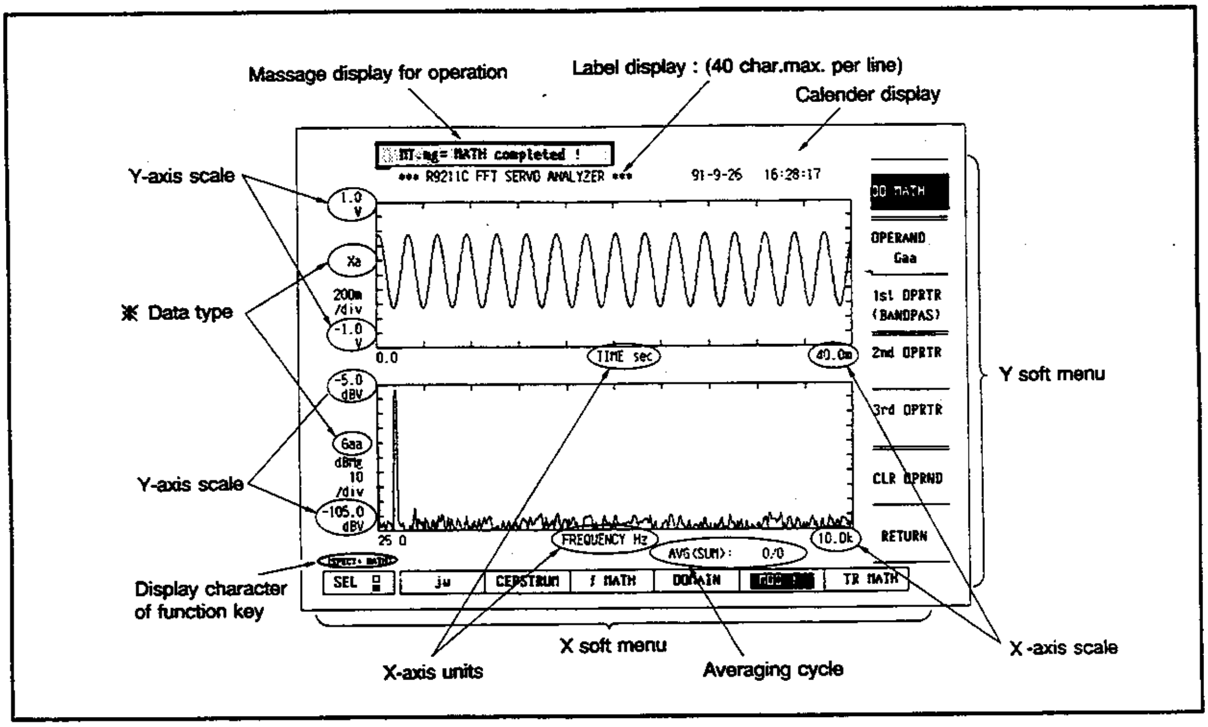
Set the plotter or the floppy disk drive, either for data saving or for data retrieving.

12 **Press the COPY key.**

Start plotting the measurement data.

2. CRT Introduction

■ CRT Display Explanation



※ indicates as following.

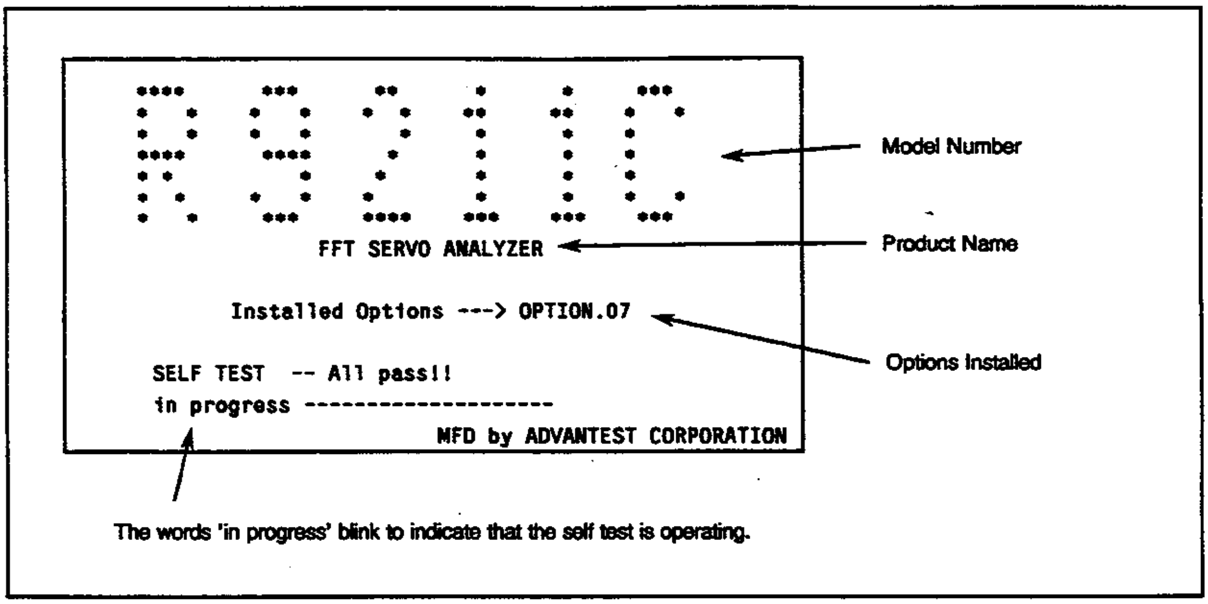
Xa:	Channel A instantaneous time data
Xb:	Channel B instantaneous time data
<Xa>	Channel A average time data
<Xb>	Channel B average time data
Gaa:	Channel A power spectrum
Gbb:	Cross-spectrum
<Sa>	Channel A complex spectrum
<Sb>	Channel B complex spectrum
<Hab>	Frequency-response function
<Coh>	Coherence function

NOTE

The < > brackets indicate averaged data.

Initial Display

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



```
                  FFT SERVO ANALYZER

           Installed Options ---> OPTION.07

  SELF TEST  -- All pass!!
  in progress --------------------
                         MFD by ADVANTEST CORPORATION
```

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

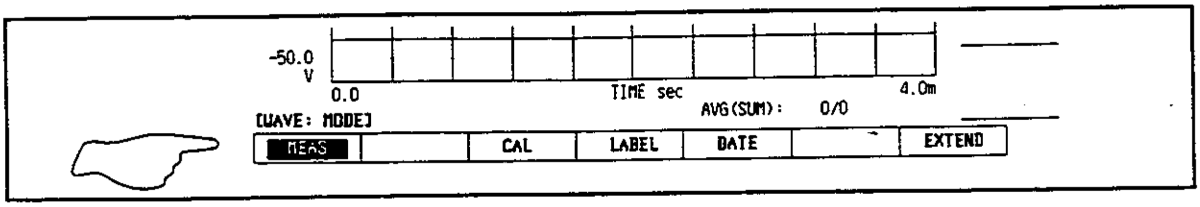
When all self test routines have resulted in a PASS, the main program automatically begins, and the measurement screen is displayed.

If an error occurs in a self-test routine, the screen comes to a temporary stop with an error displayed. 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 Character of Function Key

The name of measurement mode and select function key on CRT is displayed as to indicate that a displayed soft menu is evolved from which function key.

(1) Output point——Upper left on X1 soft menu



(2) Retations of selected function Keys and display characters

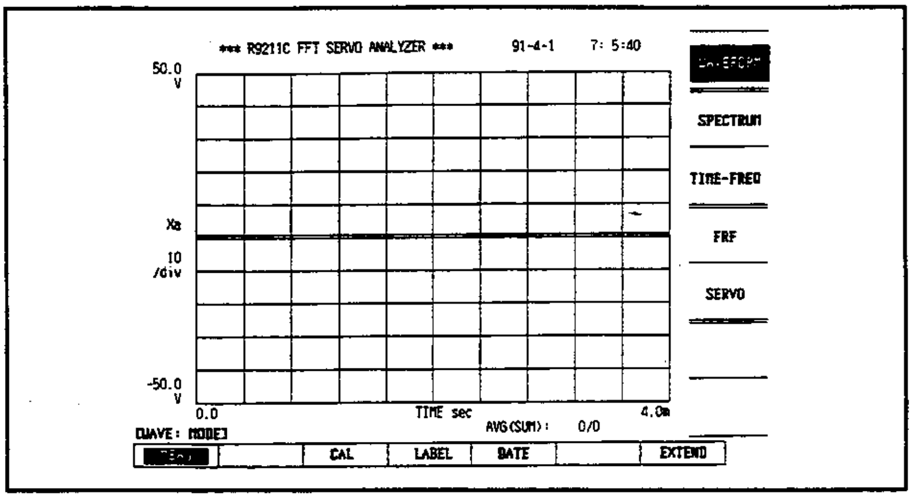
		Measurement mode				
'Function Key'		WAVEFORM	SPECTRUM	TIME-FREQ	FRF	SERVO (Note 1)
MODE Key		[WAVE: MODE]	[SPECT: MODE]	[TF: MODE]	[FRF: MODE]	[SERVO: MODE]
SETUP Key		[WAVE: SETUP]	[SPECT: SETUP]	[TF: SETUP]	[FRF: SETUP]	[SERVO: SETUP]
SG CONT Key (Note 2)		[WAVE: SG CONT]	[SPECT: SG CONT]	[TF: SG CONT]	[FRF: SG CONT]	[SERVO: SG CONT]
VIEW Key		[WAVE: VIEW]	[SPECT: VIEW]	[TF: VIEW]	[FRF: VIEW]	[SERVO: VIEW]
MKR Key		[WAVE: MARKER]	[SPECT: MARKER]	[TF: MARKER]	[FRF: MARKER]	[SERVO: MARKER]
MATH Key	'MATH'	[WAVE: MATH]	[SPECT: MATH]	[TF: MATH]	[FRF: MATH]	[SERVO: MATH]
	'LIMIT' (Note 3)		[SPECT: LIMIT]	[TF: LIMIT]	[FRF: LIMIT]	[SERVO: LIMIT]
	'CFIT' (Note 4)				[FRF: sCVFIT]	[SERVO: sCVFIT]
	'SYNTH' (Note 5)				[FRF: sSYNTH]	[SERVO: sSYNTH]
DEVICE Key		[WAVE: DEVICE]	[SPECT: DEVICE]	[TF: DEVICE]	[FRF: DEVICE]	[SERVO: DEVICE]
PRESET Key		[WAVE: PRESET]	[SPECT: PRESET]	[TF: PRESET]	[FRF: PRESET]	[SERVO: PRESET]

(Note 1) SERVO mode is only available for R9211B/C.
(Note 2) ’SG CONT’ Key mode is only available for R9211B/C.
(Note 3) ’MATH’ Key ’LIMIT’ is only available for R9211C.
(Note 4) ’MATH’ Key ’CFIT’ is only available for R9211C.
(Note 5) ’MATH’ Key ’SYNTH’ is only available for R9211C.

∗ The blank of the table indicates that a specified measurement mode is unable to use.

Calender Display

The time at which a data selected by the selector left lower on the screen is created, is displayed.



The displayed time and date is different according to kinds of data.

- **Data selected by INST VIEW menu**
Display the time and date at which data is installed by aralyzer.

- **Data selected by SUG VIEW**
Display the time and date which starts average.

- **Data selected by MATH VIEW**
Display the time specified in operand 1 when execute operation.

- **Data selected by MEM VIEW**
Display the display time of the previous saved data.

Caution !

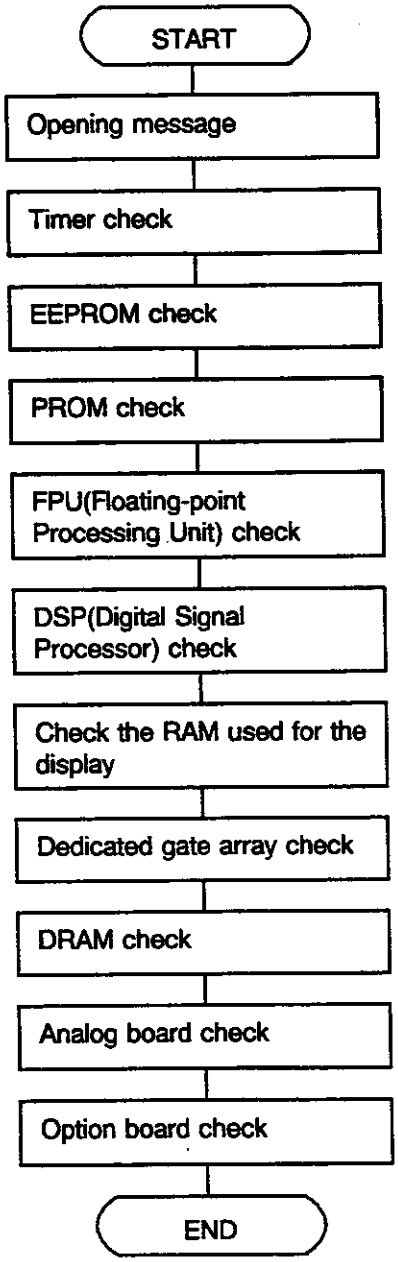
When floppy disk recorded by the unit without the calendar displaym, is replayed, the calendar display is not perfrmed for the replayed data in some cases.

3. After Turning the Power ON

■ Self-diagnostic Function

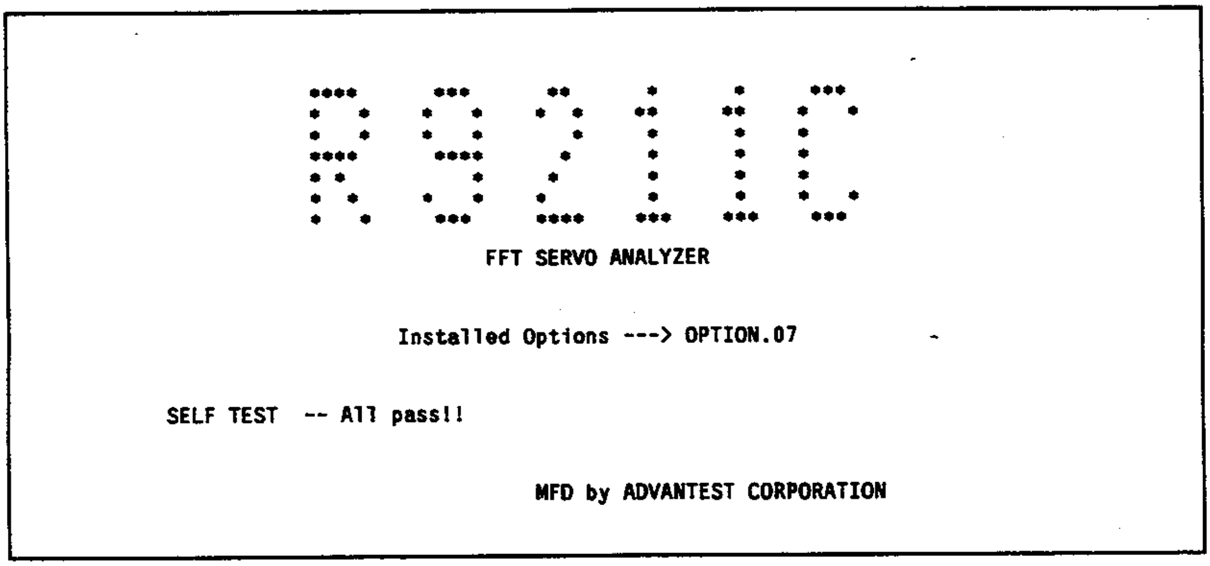
The R9211 executes its internal self-diagnostic program each time, it is switched on. The self-diagnosis process takes 30 to 60 seconds. To stop self-diagnosis and begin measurement immediately, press any panel key other than PRESET.

(Use the PRESET key only if you want to preset the R9211. For the presetting method, see Chapter 9, Section 1 "How to use the PRESET key".



- Information about eventually installed options

Upon the self-diagnosis completion, the result is displayed on the CRT.



```
                ****     ***      **       *        *       ***
                *  *    *   *    *  *     **       **      *   *
                *  *    *   *       *      *        *      *
                ****     ****      *       *        *      *
                * *         *     *        *        *      *
                *  *    *   *    *         *        *      *   *
                *   *    ***     ****     ***      ***      ***
                               FFT SERVO ANALYZER

                         Installed Options ---> OPTION.07

     SELF TEST  -- All pass!!

                                   MFD by ADVANTEST CORPORATION
```

If any fault is detected, the corresponding fail code is displayed, meaning that the analyzer is defective. Contact your nearest sales office or agent.

CAUTION !
Even if you never detect any failure from the R9211 while using it, you should execute the self-diagnostic program monthly for a complete checkup.

Initialization

When you are not certain of the setting conditions, or when you want to reset the initial status, proceed as follows :

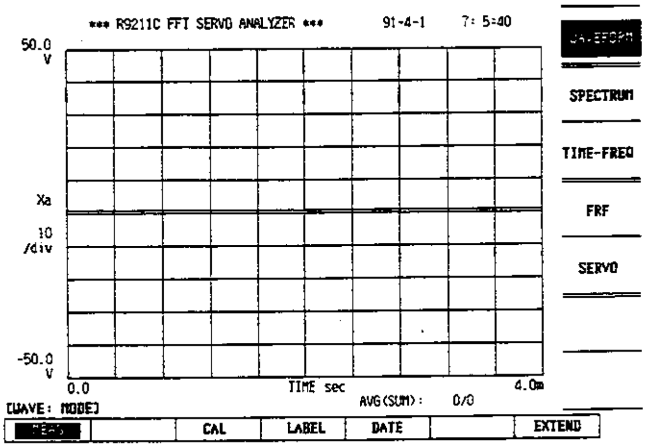
1. **Turn the power on.**

2. **The self-diagnostic program starts.**

3. **Press the PRESET key in the MEASUREMENT section during execution of the self-diagnostic program ("In Progress" is blinking). (Do not press other keys before "WL.mg = Default Configuration" is displayed.)**

4. **"WL.mg = Default Configuration" is being displayed for 1 second.**

5. **WAVEFORM mode is selected and the default values are set.**



CAUTION !

If the PRESET key is pressed after completion of the self-diagnosis program, (that is to say in the measurement mode), it is used to change the function assigned to the MATH key. For further details, see Chapter 9, Section 1 " PRESET key OPERATION".

4. Panels Description

■ Front Panel

☐ MEASUREMENT

① START key : Starts average measurement, servo measurement, or T-F analysis.
② STOP/C key : Stops/continues average measurement, servo measurement, or T-F analysis.
③ AUTO key : Unused
④ PRESET key : Presets the units when pressed during the execution of the self-diagnosis program, after the power is turned on. Otherwise, this key is used to change the function to be assigned to the [MATH] key.

☐ GPIB

⑤ SRQ lamp : Service request. Notifies that there is a service request sent to an external device.
⑥ TALK lamp : Talker. It is lighted during transmission to an external device.
⑦ LISTEN lamp : Listener. It is lighted during reception from an external device.
⑧ REMOTE lamp : It is lighted when the analyzer is controlled from an external device.
⑨ LCL key : Clears the remote controlled state.

☐ FUNCTION

⑩ MODE key : Sets a measurement mode.
⑪ SETUP key : Sets the measurement conditions.
⑫ SG CONT key : Sets the signal generation conditions. (This key cannot be used in the servo mode.)
⑬ COPY key : Controls the GPIB commanded external plotter.
⑭ VIEW key : Sets the display conditions.
⑮ MKR key : Sets the marker control parameters.
⑯ MATH key : Selects different mathematical computations.
⑰ DEVICE key : Sets the operating conditions of an eventual external device (floppy disk drive/GPIB plotter/GPIB).

☐ DATA

⑱ Data knob : Sets the value for a measurement condition or moves the marker.

⑲ DOWN [⇩] key : Sets the value for a measurement condition or moves the marker.

⑳ UP [⇧] key : Sets the value of a measurement condition or moves the marker.

㉑ [0] to [9] : Numeric keys

㉒ [·] : Decimal point

㉓ [–] : Minus sign

㉔ [,] : Delimiter between numbers

㉕ ENT key : Validation of numbers
㉖ MK key : Unused
㉗ BS key : Backspace. Deletes one character.

☐ INPUT

㉘ CH A lamp : is lighted while channel A is under use.
㉙ CH B lamp : is lighted while channel B is under use.
㉚ OVER lamp : is lighted when an input channel is overloaded.
㉛ NORM lamp : is lighted when the input conditions are normal.
㉜ ICP lamp : is lighted when the power of the integrated circuit piezoelectric accelerometer is on.
㉝ + connector, + lamp : Plus-side input connector. The lamp is lighted when the + side is grounded.
㉞ – connector, – lamp : Minus-side input connector. The lamp is lighted when the – side is grounded.
㉟ AUTO ARM lamp : is lighted when trigger data are automatically acquired.
㊱ ARM lamp : is lighted when the trigger is in the wait state.
㊲ HOLD lamp : is lighted when the data acquiring process stops.

☐ POWER/INTENSITY

㊳ POWER switch : Turns on/off the power.
㊴ INTENSITY : Controls the screen intensity.

☐ Floppy Disk Drive

㊵ Floppy disk drive : Disk insertion opening

☐ Softkeys/Softmenus

㊶ Y softmenu
㊷ Y softkeys : Sets a parameter or selects one value among two (toggle).
㊸ X softmenu
㊹ X softkeys : Selects a submenu (i.e. a Y softmenu).

☐ SG OUT

㊺ OPERATE key (OPERATE/STANDBY key)
: Used for switching between OPERATE and STANDBY status.
㊻ OPERATE lamp : is lighted while the R9211 is operating.
㊼ SIGNAL OVERLOAD lamp
: is lighted in case of saturation of the signal output or of the summing amplifier.
㊽ Summing amplifier lamp
: is lighted when the summing amplifier is functioning.
㊾ Signal output connector
: Outputs the specified signals.

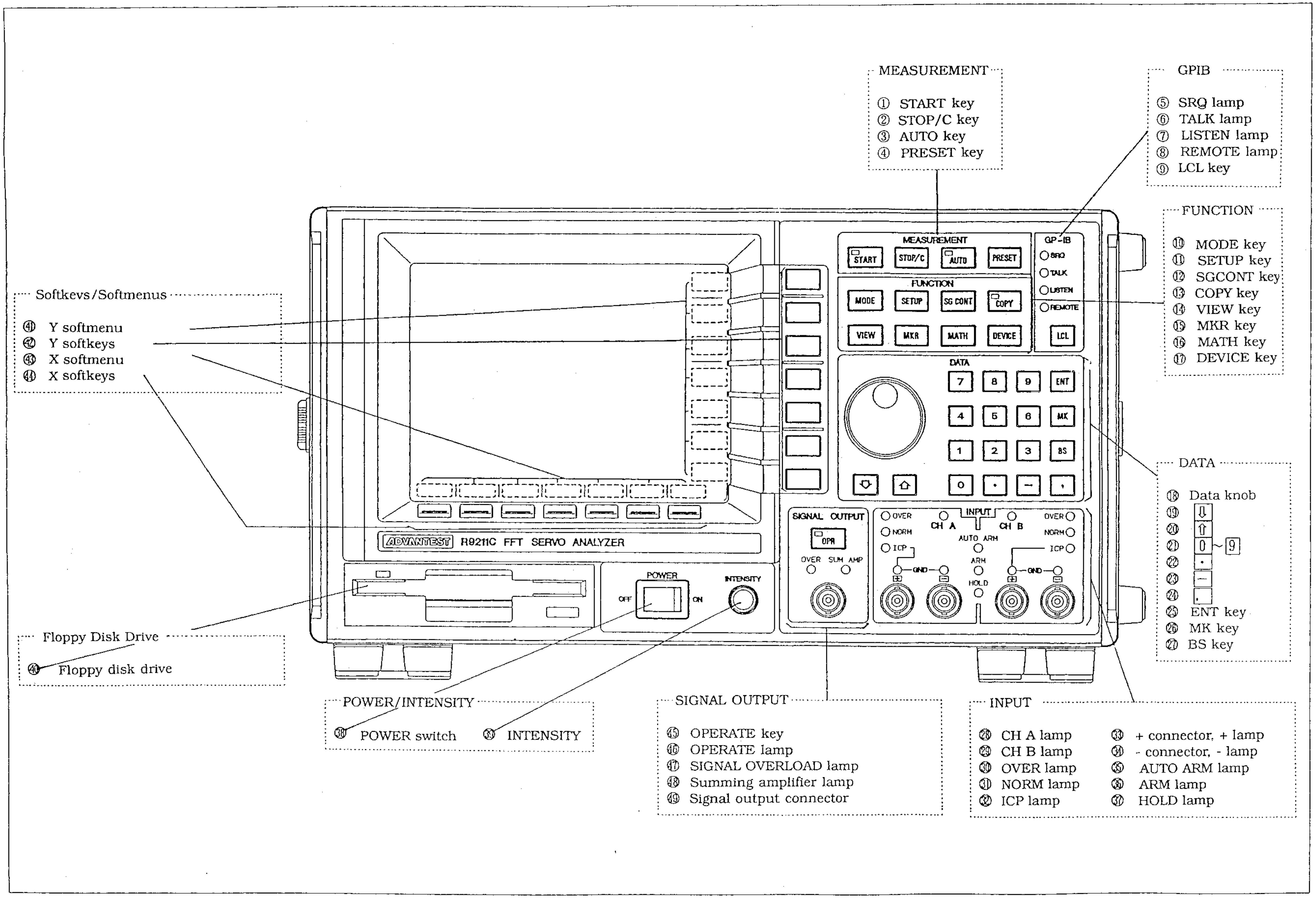


Figure 3-1 Description of the Front Panel

■ Rear Panel

☐ DIGITAL I/O

① DIGITAL IN/OUT connector
: Digital input/output connector

☐ VIDEO OUTPUT

② VIDEO OUTPUT connector
: Output connector for a video printer or a TV monitor.
Output type : Separate TTL-level
Clock frequency : 16MHz

☐ GPIB

③ GPIB connector : Connector for GPIB

☐ INPUT, OUTPUT

④ TRIG output connector
: Trigger's output connector
⑤ SMPLG CLK output connector
: Internal sampling clock output connector
⑥ External TRIG input connector
: External trigger input connector
⑦ External SMPLG CLK input connector
: Internal sampling clock input connector

☐ AC Power Socket

⑧ AC power socket : A fuse is installed in the socket.

☐ Indications

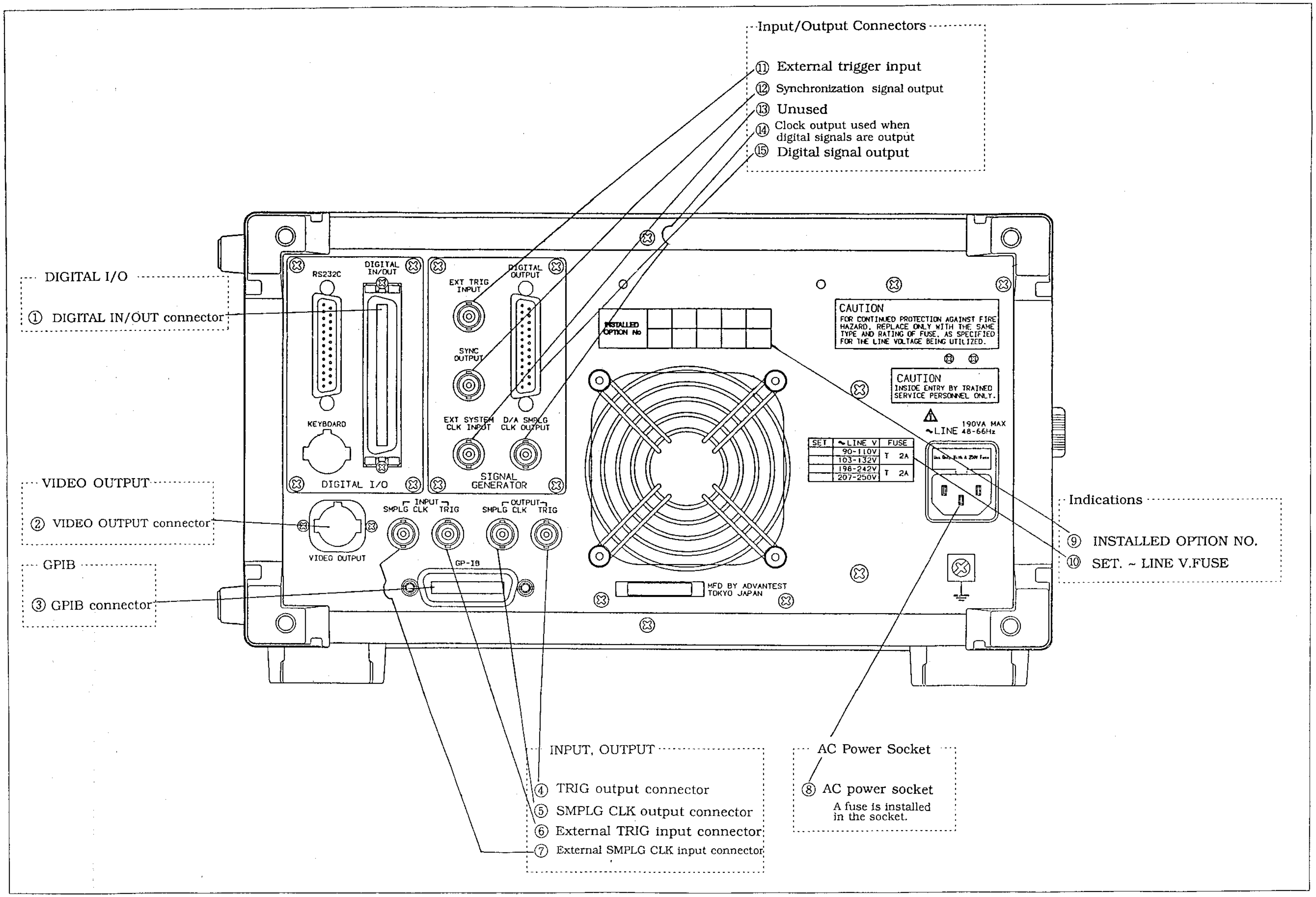
⑨ INSTALLED OPTION NO.
: Indicates the type of an eventual option installed in the unit.
⑩ SET. ~ LINE V.FUSE : Indicates the supply voltage and fuse status.

☐ Input/Output Connectors

⑪ External trigger input : External trigger signal for SG (Signal Generator)
⑫ Synchronization signal output
: SG synchronization output (Set with : $\boxed{\text{SG CONT}}$ of $\boxed{\text{SYNC OUT}}$.)
⑬ Unused
⑭ Clock output used when digital signals are output
: SG digital data output sampling clock
⑮ Digital signal output : SG digital data output

CAUTIONS !

1. ***The fuse holder is on the rear panel. Before replacing the fuse, switch the R9211 off and disconnect the power cable from the AC outlet.***
   The standard, type, and voltage of the new fuse must be the same as those of the old one, otherwise, there is fire-hazard.
2. ***Any person other than ADVANTEST CEs should not open the panel for inspection.***



Input/Output Connectors

⑪ External trigger input
⑫ Synchronization signal output
⑬ Unused
⑭ Clock output used when digital signals are output
⑮ Digital signal output

DIGITAL I/O

① DIGITAL IN/OUT connector

VIDEO OUTPUT

② VIDEO OUTPUT connector

GPIB

③ GPIB connector

Indications

⑨ INSTALLED OPTION NO.
⑩ SET. ~ LINE V.FUSE

INPUT, OUTPUT

④ TRIG output connector
⑤ SMPLG CLK output connector
⑥ External TRIG input connector
⑦ External SMPLG CLK input connector

AC Power Socket

⑧ AC power socket
A fuse is installed in the socket.

Figure 3-2 Description of the Rear Panel

CHAPTER 4

TO PERFORM A GOOD MEASUREMENT

This chapter deals with the preliminary knowledge, related to the basic connections, the input sensitivity, necessary to a good measurement. It also explains how to reduce the effects of noise on a measurement.

CONTENTS

1. Input Connection

■ Input Circuit

The R9211 is provided with two input methods: Differential input and single ended. The input method can be set separately, for each input channel, by selecting the appropriate input condition. Figure 4-1 shows the input circuits.

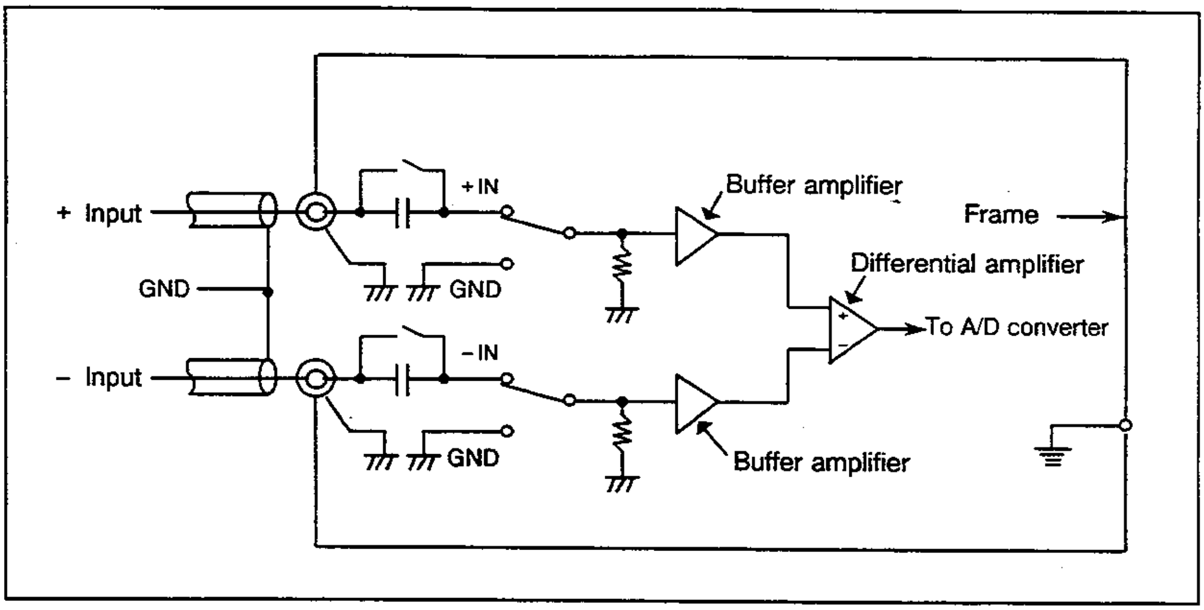


Figure 4-1 R9211 Input Circuits

● Input Cable

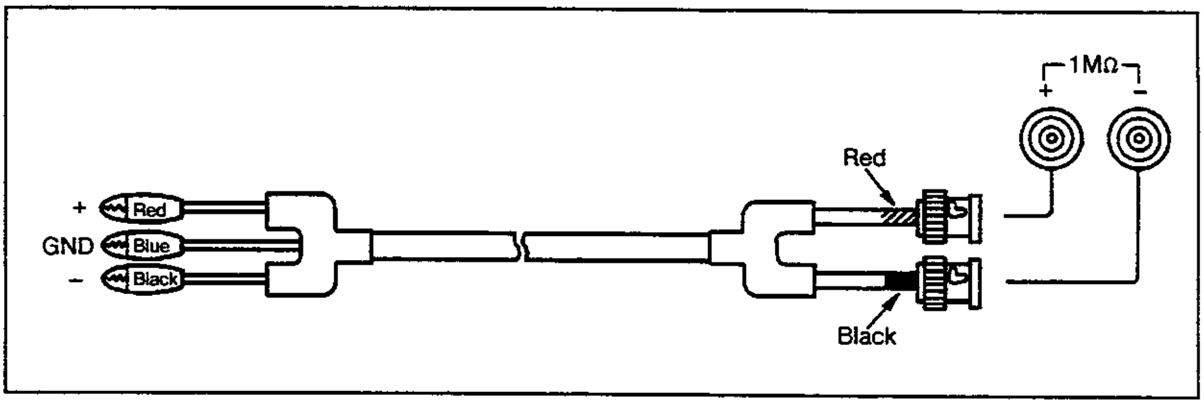


Figure 4-2 Input Cable

The input cable (MI-77) has three input clips (red, black, and blue alligator clips) and two BNC plugs. Connecting the red and black BNC terminals to the + and – inputs allows the following connections:

Red alligator clip → + input terminal
Black alligator clip → – input terminal
Blue alligator clip → GND terminal

- **Impedance and Maximum Applied Voltage between the Input Outlets**

The GND input outlet (blue alligator clip) is connected to the frame. If there is a difference between frame and GND voltages, the system cannot be measured. (The outer conductor of the BNC is connected to the frame.) Table 4-1 lists the impedances between the input sockets (including the frame) and the maximum voltages that may be applied to them.

Table 4-1 Impedances and Maximum Applicable Voltages between the Input Sockets

Maximum applicable voltage Impedance	+ Input	− Input	GND	Frame
+ Input		400V peak	200V peak	200V peak
− Input	2MΩ		200V peak	200V peak
GND	1MΩ	1MΩ		0V
Frame	1MΩ	1MΩ	Short (0Ω)	

■ Selecting an Input Method and Setting a Menu

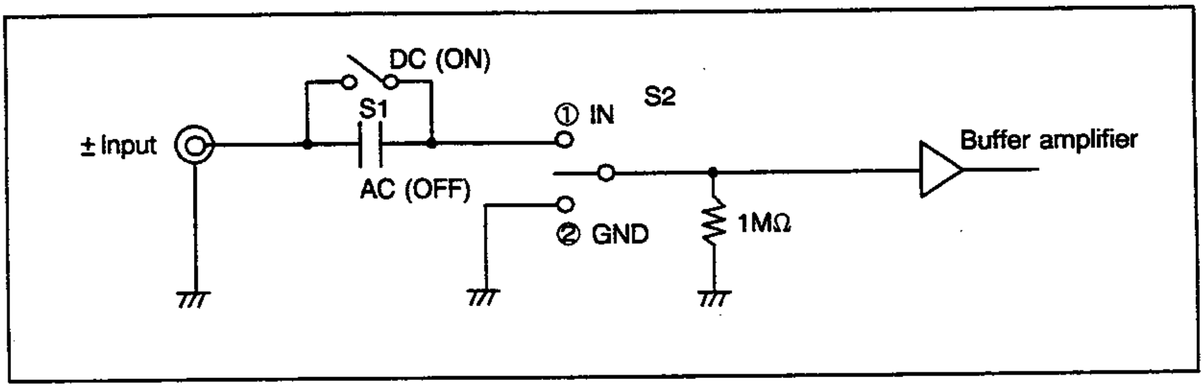


Figure 4-3 Selecting an Input Method

You can choose, for the + or − input, between AC and DC coupling, and between IN and GND. Internally, according to what has been selected for AC/DC at the menu level, S1 is switched to OFF (AC coupling) or to ON (DC coupling). Similarly, S2 switched to 1 selects the IN position while S2 switched to 2 selects the GND position.

To set these parameters, first press the function key **SETUP**,

then the X softkey **INPUT** and finally the appropriate Y softkey.

1. Input Connection

Table 4-2 Input Mode versus Menu Setting

Input mode \ Menu setting		AC / DC	+ GND / IN	− GND / IN
Differential	AC coupling	AC	IN	IN
	DC coupling	DC		
Single ended + input	AC coupling	AC	IN	GND
	DC coupling	DC		
Single ended − input	AC coupling	AC	GND	IN
	DC coupling	DC		

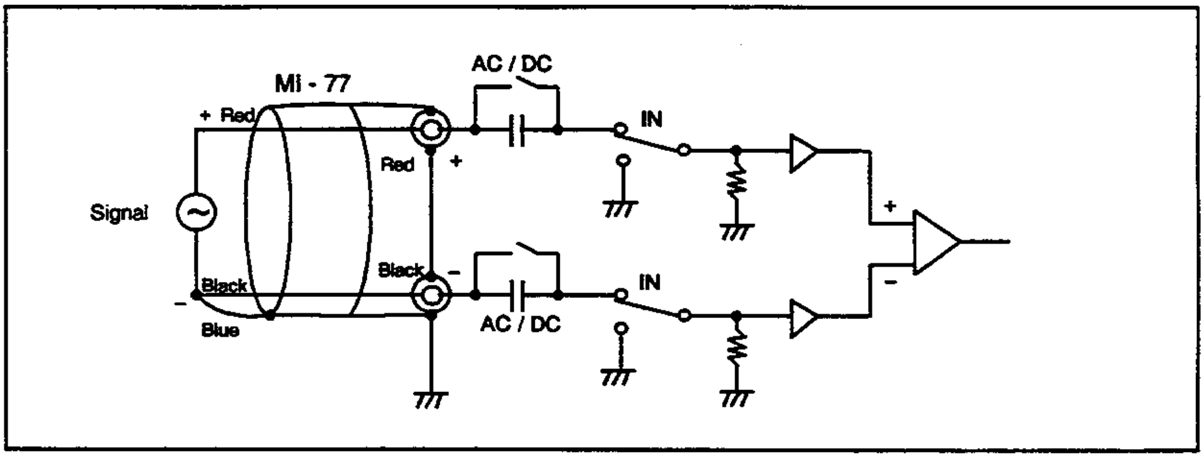


Figure 4-4 Differential Input Connection

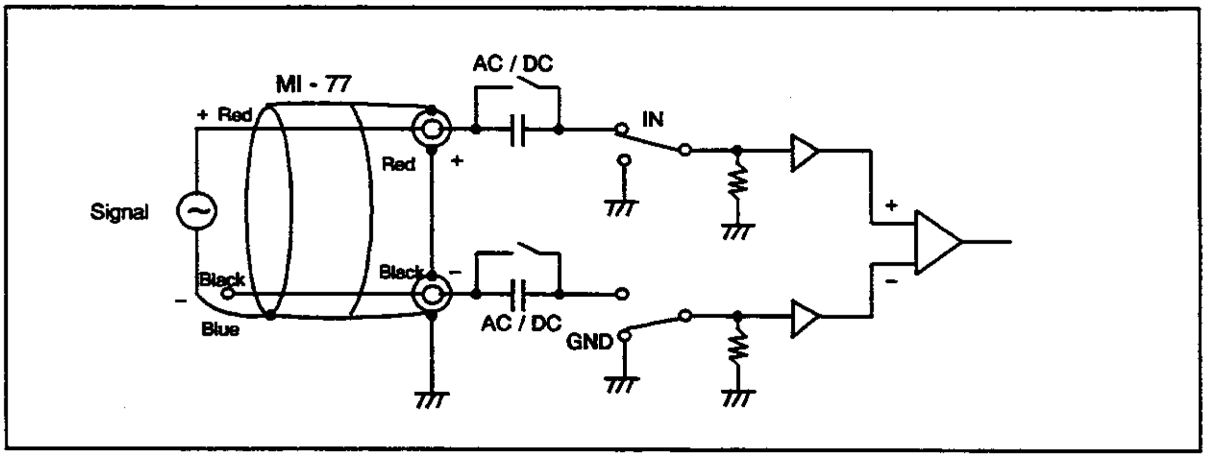


Figure 4-5 + Input Single Ended Connection

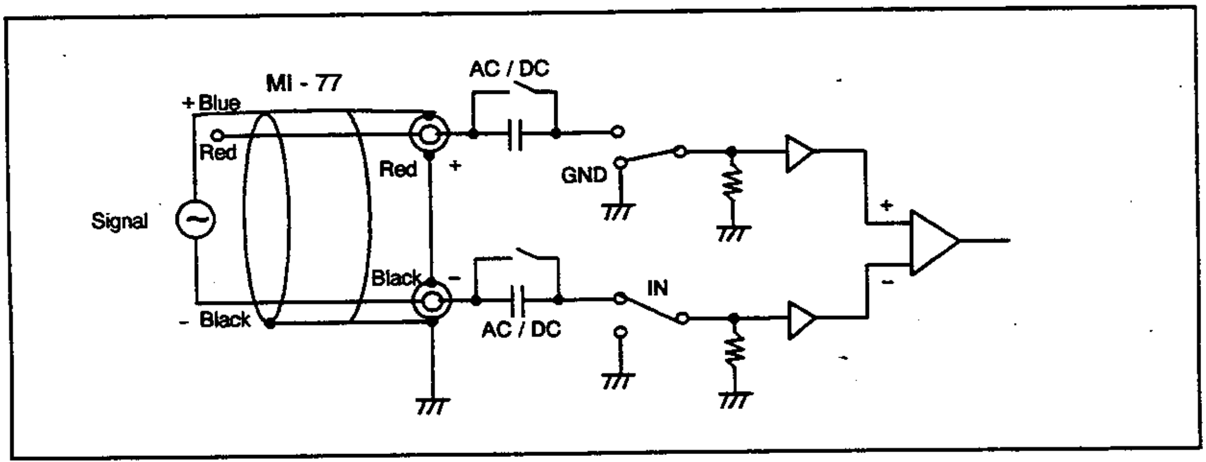


Figure 4-6 - Input Single Ended Connection

■ Internal Connection of the Signal Generator's (SG) Output to the Inputs

● Internal Connection Circuit

The internal connections depend on the Y softkeys and their settings. Table 4-3 and Figure 4-7 summarize the relationships between the Y softkeys and the internal connections.

Table 4-3 Y Softkey and Switch Positioning

	S1	S2	S3	S4	S5	S6	S7	S8	Remarks
SUM AMP ON / OFF	ON / OFF	a	b	IN	GND	a	IN	GND	Servo mode
SG OUTPUT	ON / OFF	b	a	IN / GND	IN / GND	a	IN / GND	IN / GND	Other modes
SUM AMP	ON / OFF	a	b	IN	GND	a	IN	GND	
to ChA	ON / OFF	b	b	IN	GND	a	IN / GND	IN / GND	
to ChB	ON / OFF	b	a	IN / GND	IN / GND	b	IN	GND	

S1: Switched by the panel key "□OPR".
S2: Switched according to the "CONNECT" menu setting.
S3: Switched according to the "CONNECT" menu setting.
S4: Switched according to the "SETUP" → "INPUT" menu setting.
S5: Switched according to the "SETUP" → "INPUT" menu setting.
S6: Switched according to the "CONNECT" menu setting.
S7: Switched according to the "SETUP" → "INPUT" menu setting.
S8: Switched according to the "SETUP" → "INPUT" menu setting.

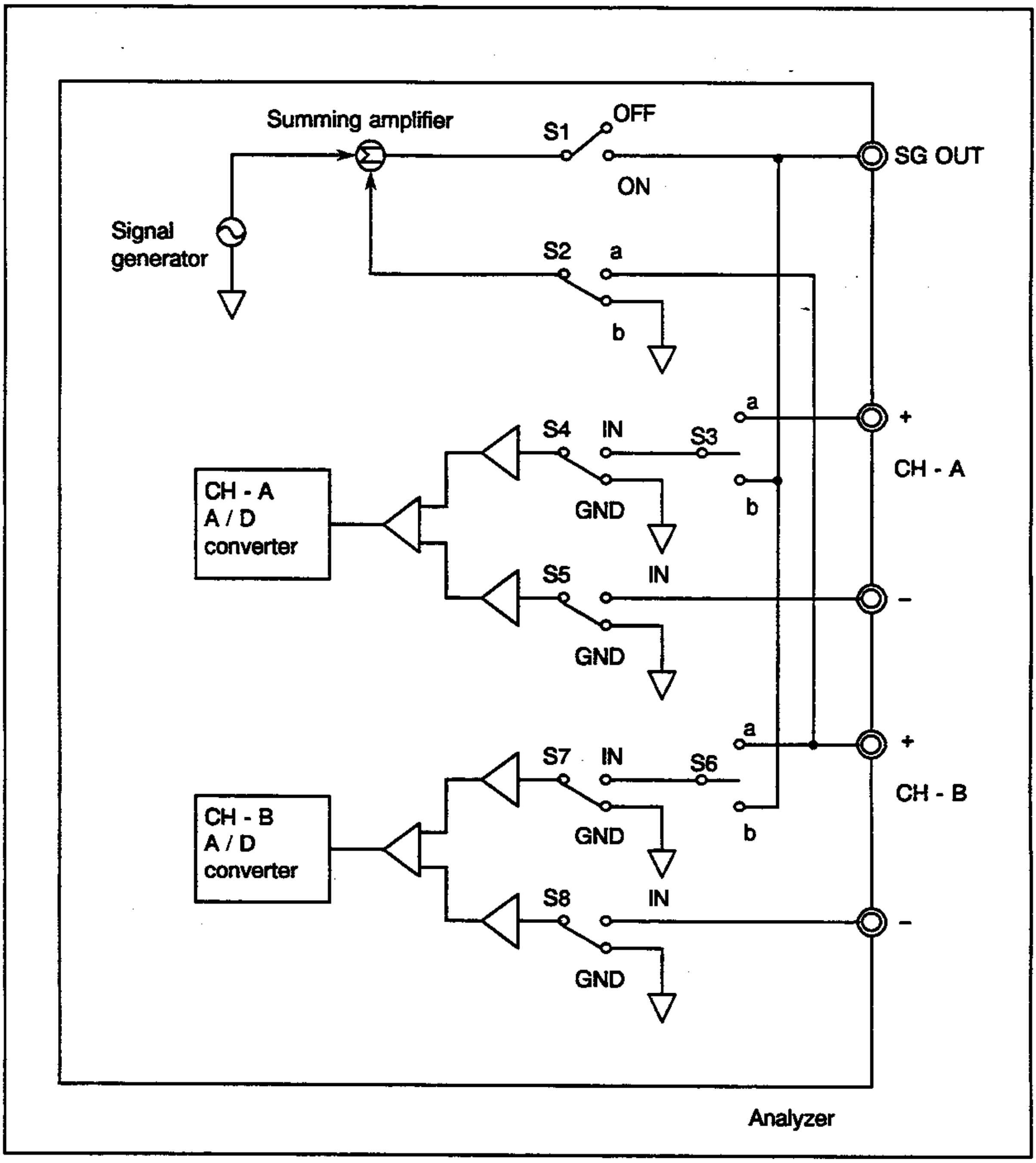


Figure 4-7 Internal Connection Circuits of the R9211

● Connecting a Summing Amplifier in the Servo Mode

○ When the Summing Amplifier of the R9211 is not Used

SETUP ⇒ SG COM ⇒ SUM AMP ON / OFF

Please set to OFF.

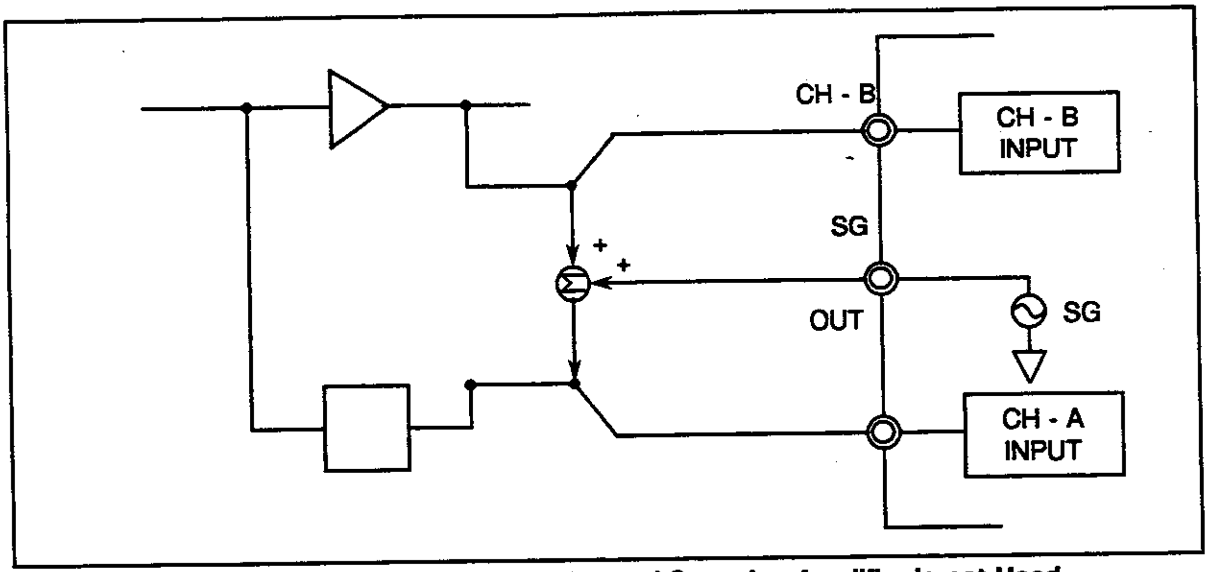


Figure 4-8 Connection when the Internal Summing Amplifier is not Used

○ When the Summing Amplifier of the R9211 is Used

SETUP ⇒ SG COM ⇒ SUM AMP ON / OFF

Please set to ON.

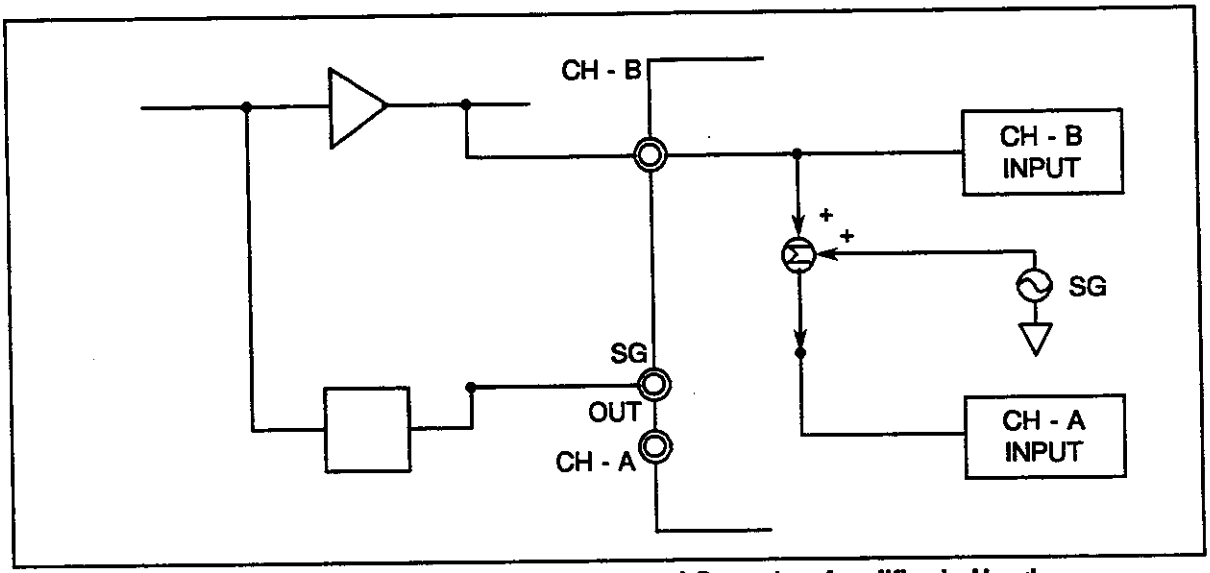


Figure 4-9 Connection when the Internal Summing Amplifier is Used

When ON/OFF is set to ON, the waveform input to CH-B is added to the waveform generated by the SG and the resulting signal is output from the SIGNAL OUTPUT.

- **Internal Connection in the Other Modes**

There are three connection modes: "to ChA", "to ChB", and "SUM AMP". Both "to ChA" (ChA monitor) and "to ChB" (ChB monitor) are single channel modes.

○ Example of Connection in the "to ChA" Mode

(SG CONT ⇒ CONNECT ⇒ to ChA)

In this mode, SG and CH-A are internally connected.

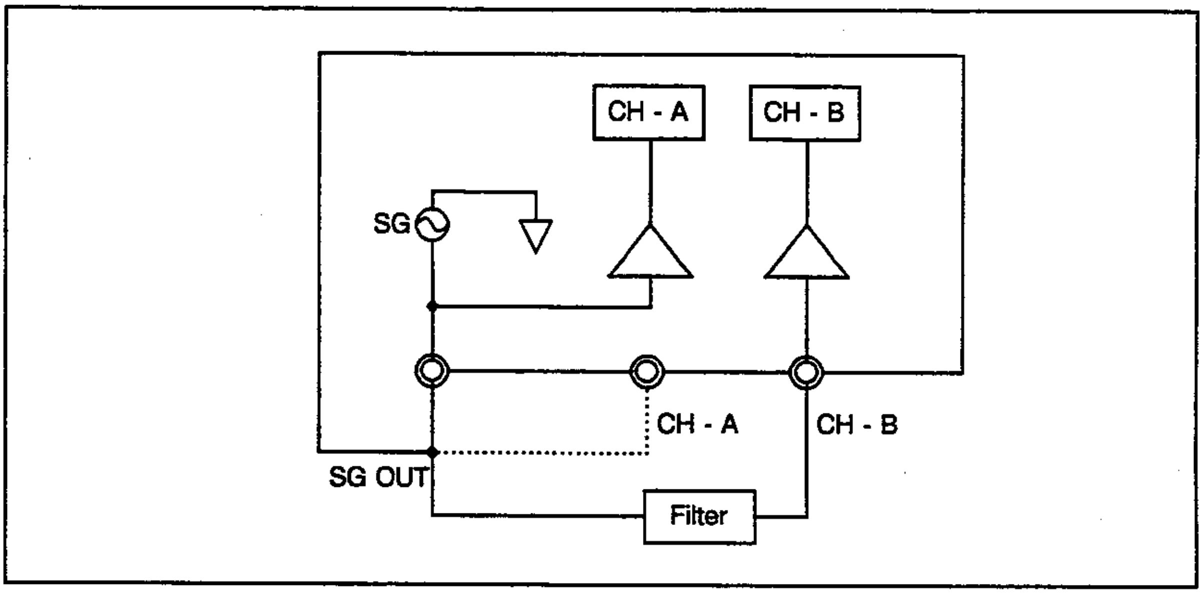


Figure 4-10 Connection in the "to ChA" Mode

○ **Example of Connection in the "to ChB" Mode**

(SG CONT ⇒ CONNECT ⇒ to ChB)

Since the selection of the frequency response function measurement mode is disabled, the START panel key in the MEASUREMENT block must not be used when this connection is selected.

○ **Example of connection in the "SUM AMP" mode**

(SG CONT ⇒ CONNECT ⇒ SUM AMP)

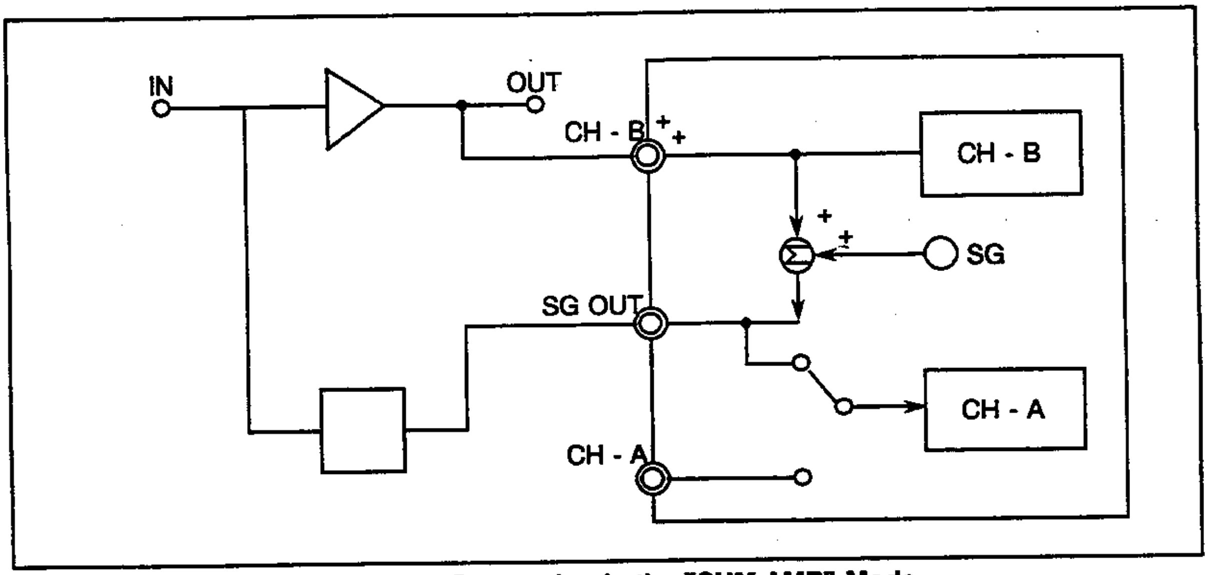


Figure 4-11 Connection in the "SUM AMP" Mode

■ Power Supply for Integrated Circuit Piezoelectric Accelerometers (ICP)

The positive input outlet provides the accelerometer with a constant current of approximately 4mA. It can be used to drive the ICP accelerometer.

● **Equivalent Circuit of Accelerometer Power Input Unit**
The power for the accelerometer is supplied from the positive input terminals of two input channels (A and B).

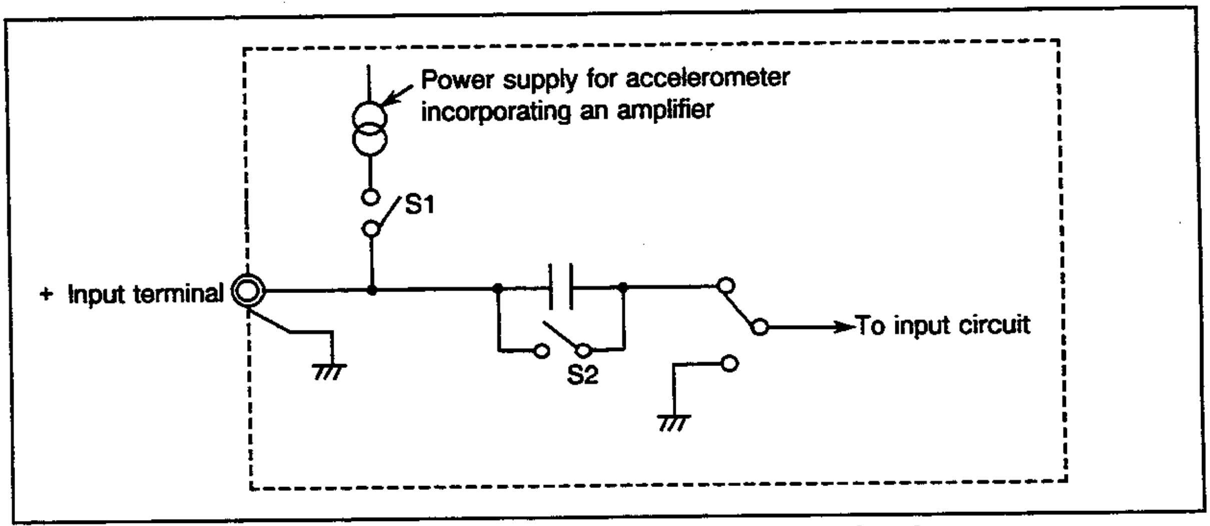


Figure 4-12 Balanced Circuit of Power Input Unit for Accelerometer

- **Setting Procedure**

SETUP ⇒ INPUT ⇒ CHANNEL CHA / CHB — Specify the selected channel.

⇒ ICP ON / OFF — Switch on the power of the ICP accelerometer.

(1) If the ICP power is ON, the input coupling automatically becomes an AC coupling.
(2) When the ICP power is ON, the "ICP" LED (red) is lit.

- **Caution**

(1) When the ICP power is ON, S2 (Figure 4-12) is switched off for AC coupling. In this case, the frequency at the -3 dB point is 0.2Hz.

(2) The maximum operating voltage is +18V. If the peak value of the accelerometer exceeds +18V, the DC voltage at the + input terminal does not follow the waveform and the measurement is not correctly performed. Therefore, the DC voltage level must be checked.

Check the DC voltage level assuming that DC coupling is selected for the other channel. (See Figure 4-13.)

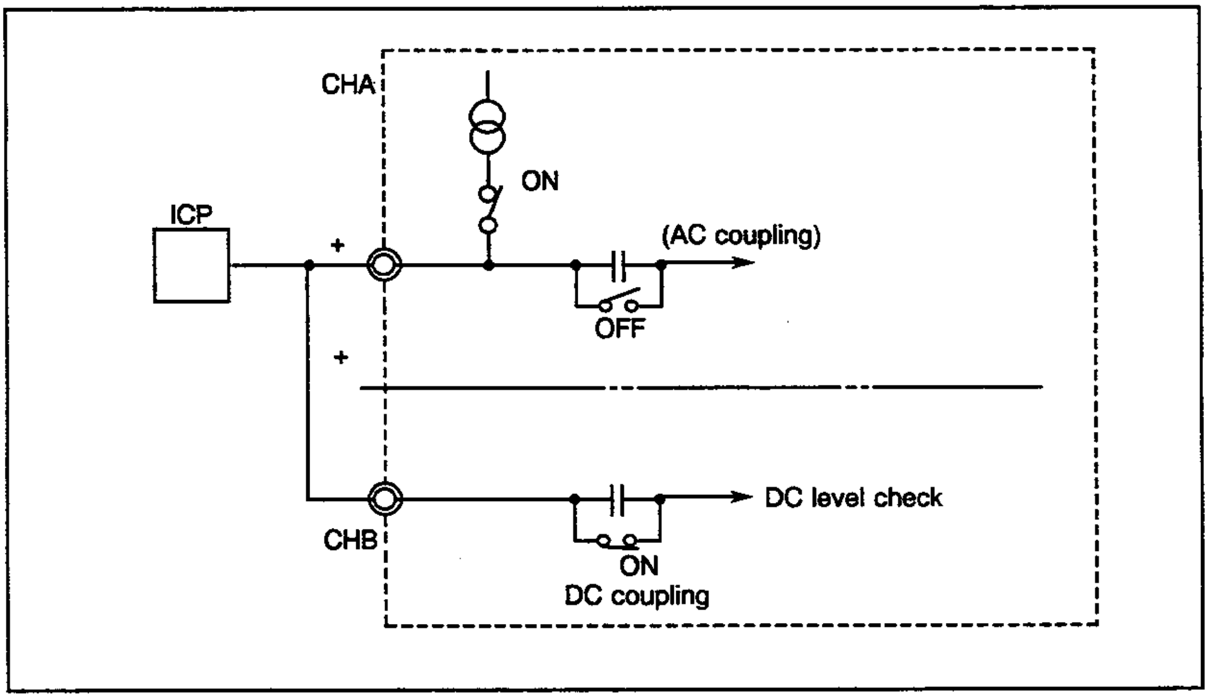


Figure 4-13 Checking Method at the Operation Level

WARNING

If the ICP power is switched ON, without connecting the acceleration sensor to the positive input socket, up to 24 VDC voltage is generated between the positive input socket and the ground (GND). If a device (e.g. an amplifier) other than the acceleration sensor is connected to the positive input terminal, do not switch the ICP power on.

■ Using an External Trigger Circuit

If an external trigger is used and the external trigger line impedance is high, errors will occur. The control circuit must keep the impedance at less than 10kW .

Figure 4-14 shows an application example of the external trigger circuit using a relay or switch.

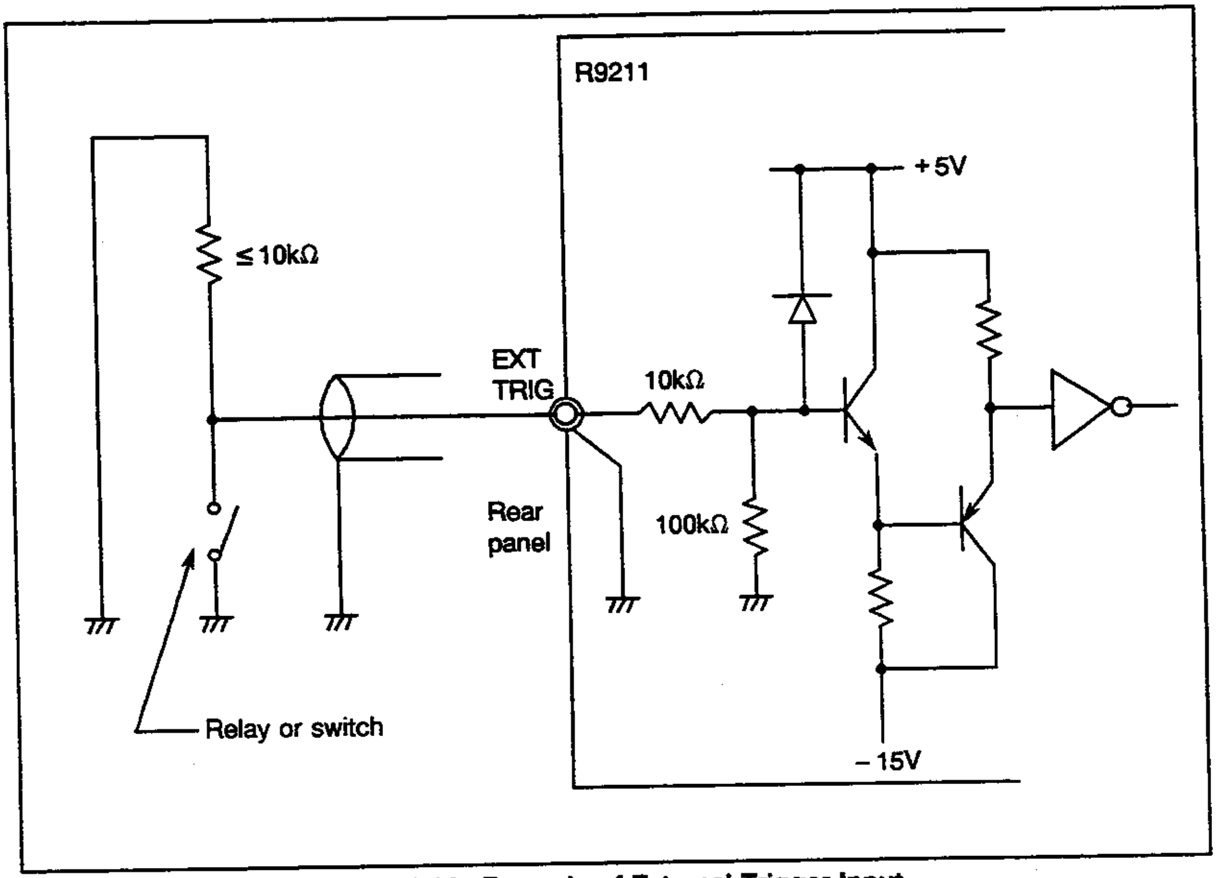


Figure 4-14 Example of External Trigger Input

CAUTION !

Since the external trigger circuit is operated at the TTL level, setting the trigger level, or the hysteresis in the menu is meaningless.

2. Input Sensitivity

■ Input Sensitivity Auto-range Function

● **Setting of Input Sensitivity Range**

To select one of the 3 input sensitivity range setting methods, offered by the R9211, first select the SENS menu by pressing :

(1) Manual Setting

CH - A
AUTO / MAN

(2) Auto Range Setting (Up and Down)

CH - A	⇒	A:UP&D / UP
AUTO / MAN		+30dBV

(3) Auto Range Setting (Up Only)

CH - A	⇒	A:UP&D / UP
AUTO / MAN		+30dBV

(a) You must select a range setting method suited to the input waveform type.

(b) The data measured during sensitivity range setting are not properly analyzed. For example, if the auto-range up&down function is used when analyzing a transient signal, since it takes time to evaluate a transient signal and to change the range, the waveform to be analyzed may have died away when the range is finally decided.

(c) If the Autorange up&down function is used when analyzing a periodic signal, whose period is larger than the frame time (thus the frame time contains less than one period), the sensitivity range will keep on going up and down, thus yielding incorrect measurement results.

(d) In the auto range mode, the range also depends on the signals which are not included in the measurement frequency range, and on the time variation of the common-mode voltage applied to the + and - inputs in the same phase. In this case, select the auto range setting (up only) method or the manual setting method.

When AUTO ARM or ARM has been selected with the ARM/HLD key of SETUP , change the input sensitivity by the manual setting method.

(e) Note that the input sensitivity function is automatically changed under certain conditions : if you are in the Autorange mode, and press the ARM/HOLD key, the input sensitivity range setting mode becomes manual.

(f) The auto range setting method cannot be used for logarithmic frequency resolution analysis, octave analysis, and zoom analysis (spectrum mode /T-F mode).

Example:

SETUP ⇒ SENS ⇒ Ch - A AUTO .... Auto range

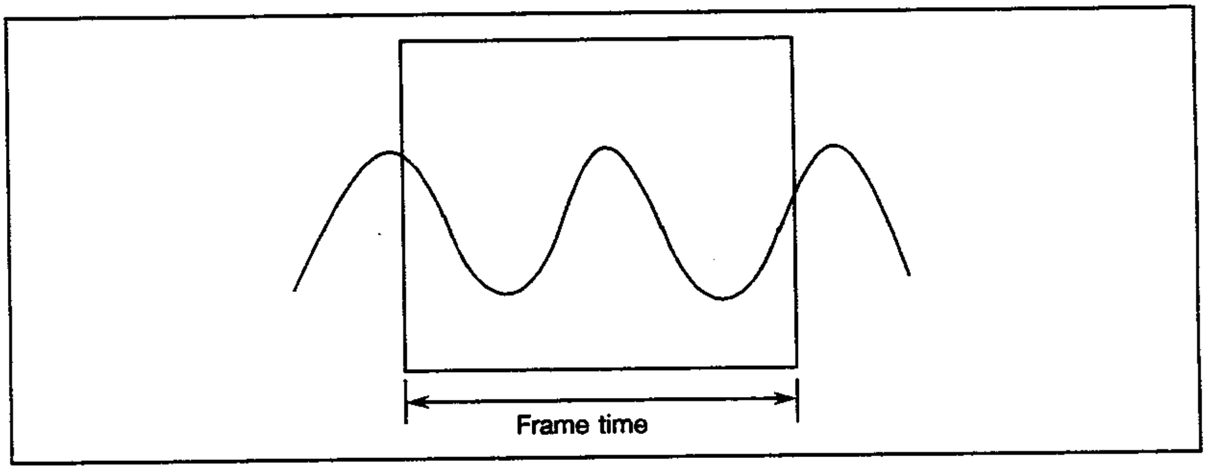
ARM/HLD ⇒ FREE RUN

⇒ AUTO ARM .... Change from free run to auto arm or arm
or
ARM

(SENS ⇒ CH - A MAN) .... Internal change from auto range to manual

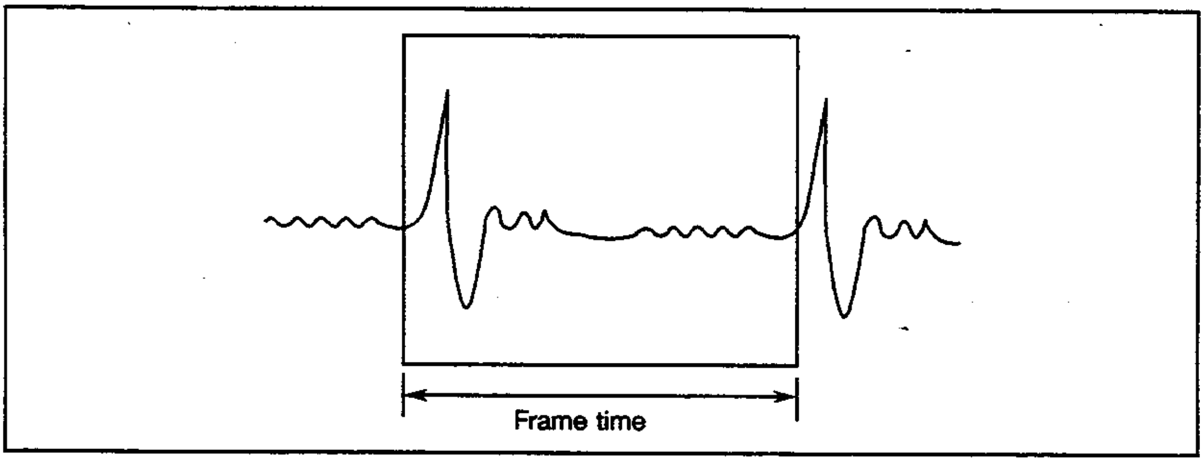
- **Range Setting Methods Appropriate to the Waveform Type**

(1) The frame time represents a small number of periods of the input signal.



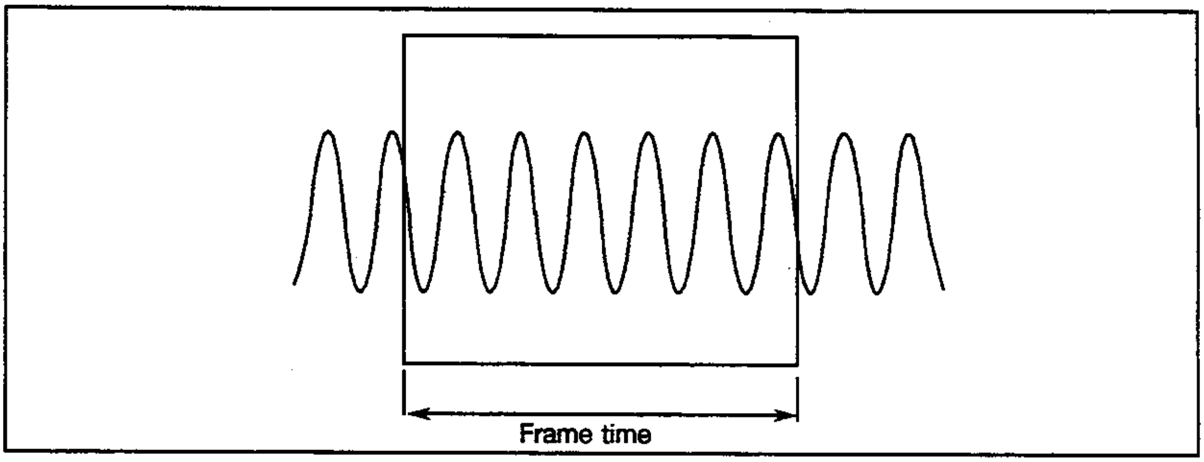
CH - A
AUTO / MAN ⇒ A:UP&D / UP
+30dBV .... Auto range setting (up only)
or
CH - A
AUTO / MAN .... Manual setting

(2) The input signal is a transient signal, generated periodically.



CH - A
AUTO / MAN ⇒ A:UP&D / UP
+30dBV .... Auto range setting (up only)
or
CH - A
AUTO / MAN .... Manual setting

(3) The frame time represents a large number of the input signal periods.



CH - A
AUTO / MAN ⇒ A:UP&D / UP
+30dBV .... Auto range setting
(up and down)

■ Input Sensitivity versus Y Scale

- **Y scale Default Value for Spectra**

Figure 4-15 shows the relationship between the input sensitivity (x dBV) and the Y scale default value.

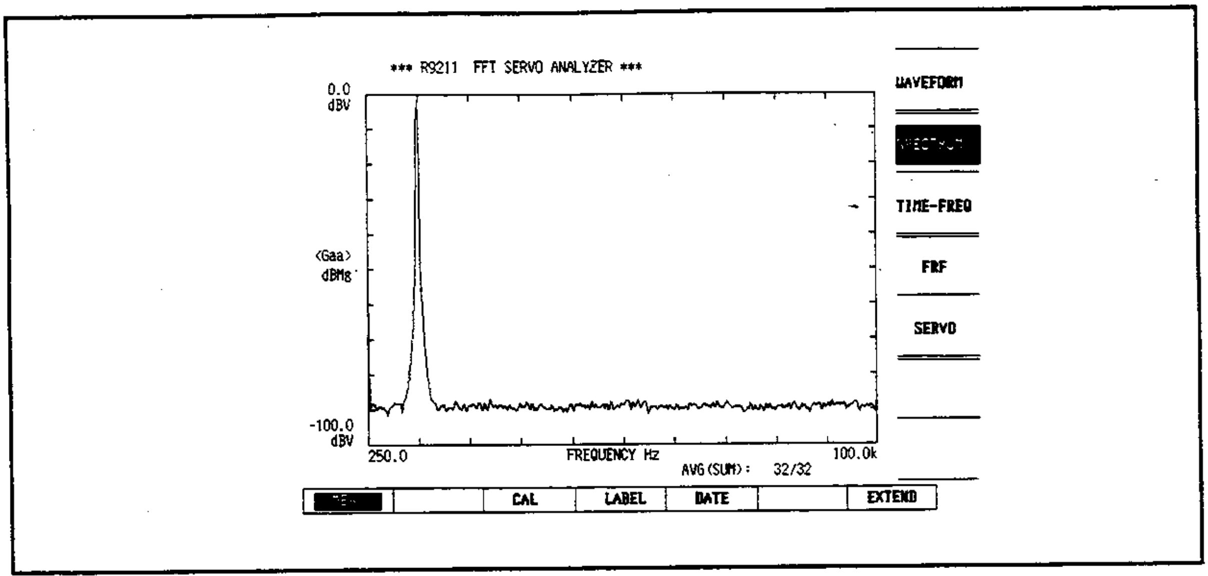


Figure 4-15 Display of the Y Scale Default Value of a Spectrum Waveform

For example, when the input sensitivity is set to 10dBV, the Y scale default value is 10dBV through -90dBV.

- **Display of Spectra in Volts rms (Vrms) or Volts (Vlt)**

As for spectra displaying, setting the unit to Vrms or Vlt

$\boxed{\text{SETUP}} \Rightarrow \boxed{\text{UNIT}}$, results in such displays as are shown in Figure 4-16, 4-17, and 4-18. Figure 4-18 represents the input signal used in this example, Figure 4-17 and 4-18 represent the resulting spectrum in Vrms and Vlt units respectively.

For further details on unit setting, see "■ Setting of the Unit" in Chapter 9.

When sine waves are input in the spectrum mode, the relational expression is as follows:

Vrms : 20log $\underbrace{\text{1Vrms}}_{\text{Effective value of voltage}}$ = 0dBV

Vlt : 20log $\underbrace{\text{1.41V peak}}_{\text{Peak value of voltage}}$ = 2.98dBV

2. Input Sensitivity

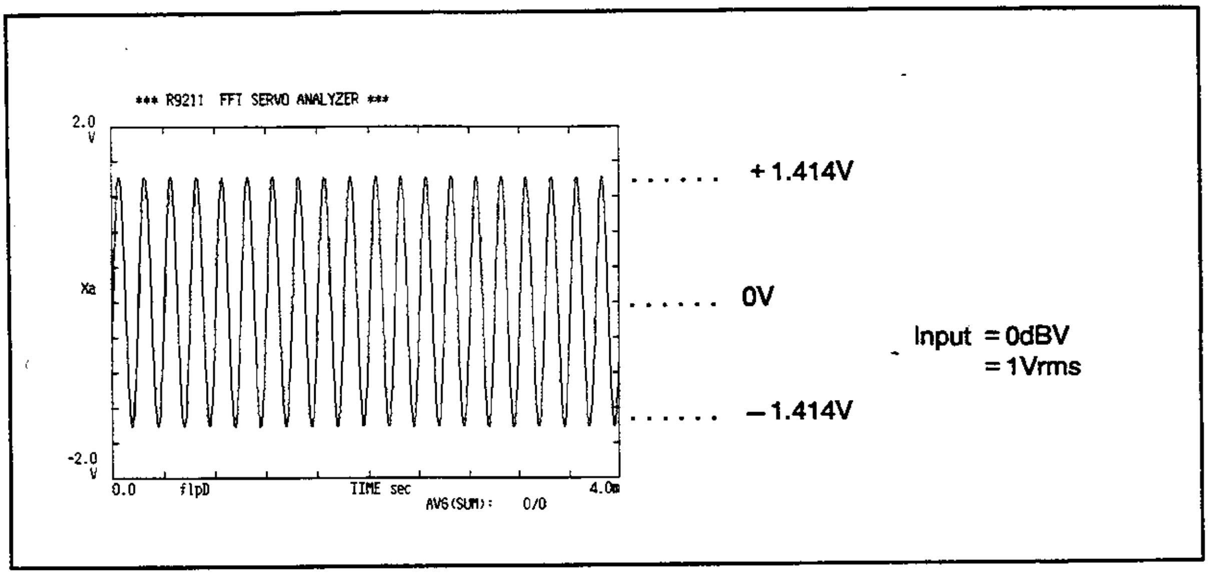


Figure 4-16 Input Waveform

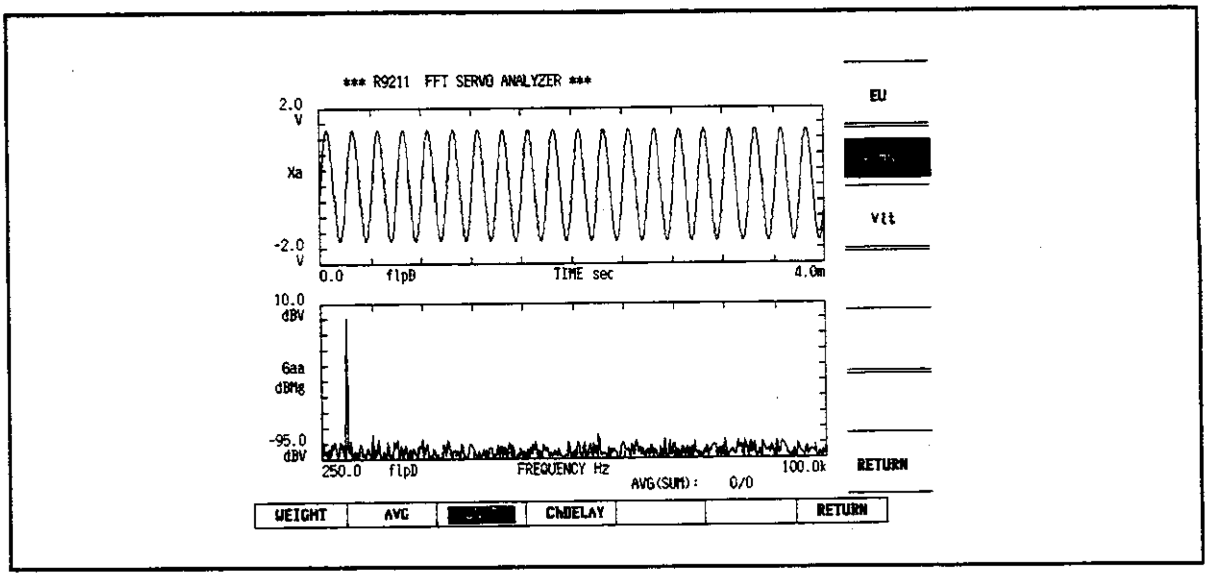
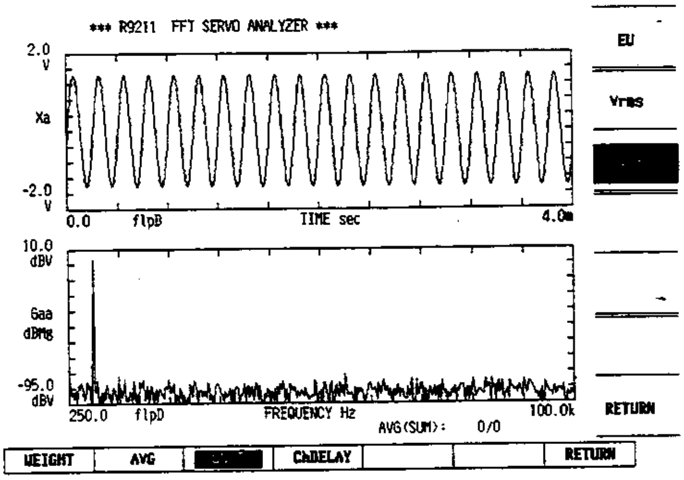


Figure 4-17 Waveform Displayed in Vrms Units



1 Volt peak in input corresponds to 0dBV on the spectrum

Figure 4-18 Waveform Displayed in Volts (Vlt)

- **Maximum Input Voltage and Y Scale of Time Waveform**

he maximum input voltage and the default value of the Y scale depend on the set input sensitivity. (See Table 4-4.)
You can display the default value by executing the following procedure :

VIEW ⇒ (NEXT)

⇒ Y SCALE ⇒ Y DEFAULT

- **Input Sensitivty and Maximum Input Voltage**

When the input sensitivity is 0 dBV, the maximum input value (P-P value ie Peak-Peak value) is as follows:

$$\boxed{0\text{dBV} = 1\text{Vrms} = (1.414 \times 2)\ V_{P\text{-}P}}$$

In this case, the maximum value of the A/D converter ranges from +1.414 V to −1.414V. Moreover, if an input value lays outside this range, the OVER lamp (red) on the front panel lights and the measurement data is not reliable. Furthermore, if an input value represents 93% or more of the maximum input value, the OVER lamp lights.
When an input value represents from 50% to 93% of the maximum input value, the NORM lamp (green) lights to indicate that the input sensitivity is normal. If neither the NORM lamp nor the OVER lamp lights, the input value represents less than 50% of the set input sensitivity. In this case, you must lower the input sensitivity so that it becomes normal.

For further details about the input sensitivity setting, see "■ Setting of the Input Sensitivity" in Chapter 9.

When the input sensitivity is 10dBV, the P-P value is as follows:

$$\boxed{10\text{dBV} = 3.16\text{Vrms} = (4.471 \times 2)\ _{P\text{-}P}}$$

In this case, the maximum value of the A/D converter ranges from +4.471 to −4.471V.

Table 4-4 Maximum Input Values and Y Scale Default Values Corresponding to the Set Input Sensitivity (In the Case of Voltage versus Time Displays)

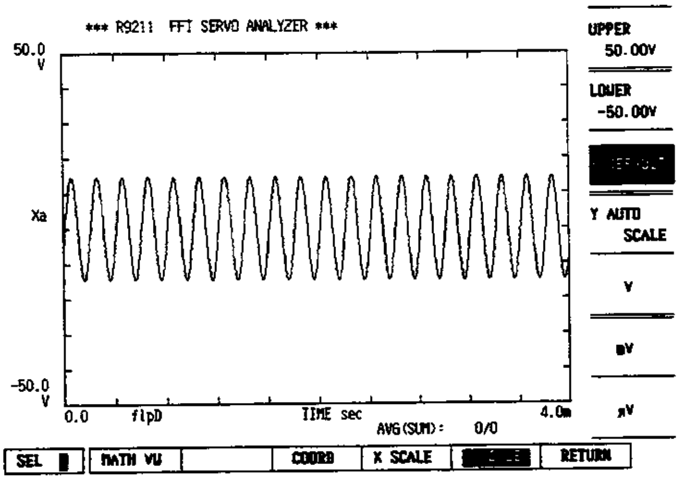
Input sensitivity (dBV)	Maximum input voltage		Y scale default value	Input sensitivity (dBV)	Maximum input voltage		Y scale default value
	Vrms	Vlt			Vrms	Vlt	
30	31.62 V	± 44.72 V	±50V	-17	0.141 V	± 199.8mV	±200mV
29	28.18 V	± 39.86 V		-18	0.126 V	± 178.0mV	
28	25.12 V	± 35.52 V		-19	0.112 V	± 158.7mV	
27	22.39 V	± 31.66 V		-20	0.100 V	± 141.4mV	
26	19.95 V	± 28.22 V		-21	89.13mV	± 126.0mV	
25	17.78 V	± 25.15 V		-22	79.43mV	± 112.3mV	
24	15.85 V	± 22.41 V		-23	70.79mV	± 100.1mV	
23	14.13 V	± 19.98 V	±20V	-24	63.10mV	± 89.23mV	±100mV
22	12.59 V	± 17.80 V		-25	56.23mV	± 79.53mV	
21	11.22 V	± 15.87 V		-26	50.12mV	± 70.88mV	
20	10.00 V	± 14.14 V		-27	44.67mV	± 63.17mV	
19	8.913 V	± 12.60 V		-28	39.81mV	± 56.30mV	
18	7.943 V	± 11.23 V		-29	35.48mV	± 50.18mV	
17	7.079 V	± 10.01 V		-30	31.62mV	± 44.72mV	
16	6.310 V	± 8.923V	±10V	-31	28.18mV	± 39.86mV	±50mV
15	5.623 V	± 7.953V		-32	25.12mV	± 35.52mV	
14	5.012 V	± 7.088V		-33	22.39mV	± 31.66mV	
13	4.467 V	± 6.317V		-34	19.95mV	± 28.22mV	
12	3.981 V	± 5.630V		-35	17.78mV	± 25.15mV	
11	3.548 V	± 5.018V		-36	15.85mV	± 22.41mV	
10	3.162 V	± 4.442V	± 5V	-37	14.13mV	± 19.98mV	±20mV
9	2.818 V	± 3.986V		-38	12.59mV	± 17.80mV	
8	2.512 V	± 3.552V		-39	11.22mV	± 15.87mV	
7	2.239 V	± 3.166V		-40	10.00mV	± 14.14mV	
6	1.995 V	± 2.822V		-41	8.913mV	± 12.60mV	
5	1.778 V	± 2.515V		-42	7.943mV	± 11.23mV	
4	1.585 V	± 2.241V		-43	7.079mV	± 10.01mV	
3	1.413 V	± 1.998V	± 2V	-44	6.310mV	± 8.923mV	±10mV
2	1.259 V	± 1.780V		-45	5.623mV	± 7.953mV	
1	1.122 V	± 1.587V		-46	5.012mV	± 7.088mV	
0	1.000 V	± 1.414V		-47	4.467mV	± 6.317mV	
-1	0.891 V	± 1.260V		-48	3.981mV	± 5.630mV	
-2	0.794 V	± 1.123V		-49	3.548mV	± 5.018mV	
-3	0.708 V	± 1.001V		-50	3.162mV	± 4.472mV	
-4	0.631 V	± 892.3mV	± 1V	-51	2.818mV	± 3.986mV	± 5mV
-5	0.562 V	± 795.3mV		-52	2.512mV	± 3.552mV	
-6	0.501 V	± 708.8mV		-53	2.239mV	± 3.166mV	
-7	0.447 V	± 631.7mV		-54	1.995mV	± 2.822mV	
-8	0.398 V	± 563.0mV		-55	1.778mV	± 2.515mV	
-9	0.355 V	± 501.8mV		-56	1.585mV	± 2.241mV	
-10	0.316 V	± 447.2mV	±500mV	-57	1.413mV	± 1.998mV	± 2mV
-11	0.282 V	± 398.6mV		-58	1.259mV	± 1.780mV	
-12	0.251 V	± 355.2mV		-59	1.122mV	± 1.587mV	
-13	0.224 V	± 316.6mV		-60	1.000mV	± 1.414mV	
-14	0.200 V	± 282.2mV					
-15	0.178 V	± 251.5mV					
-16	0.158 V	± 224.1mV					

- **Optimizing the Y Scale of Time Waveforms**

When the default of the Y scale is used, the maximum input voltage is limited and consequently the amplitude may be reduced (see Figure 4-19). In this case, by selecting the auto scale method for the Y scale, one can optimize the display (see Figure 4-20). The display obtained by selecting the autoscale method is as follows :

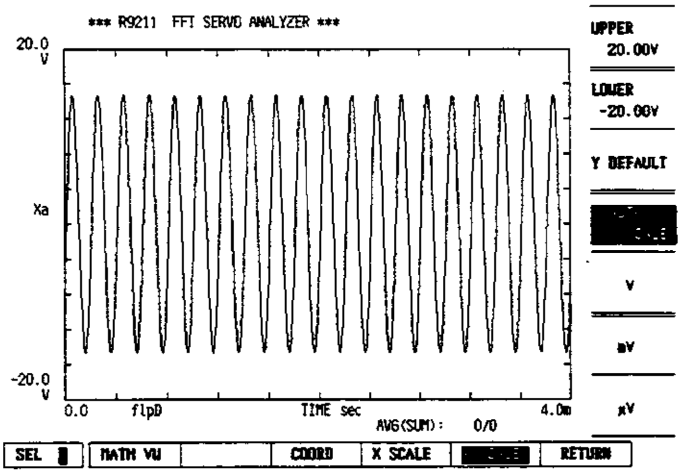
VIEW ⇒(**NEXT**)

⇒ **Y SCALE** ⇒ Y AUTO SCALE



The input sensitivity is 25dBV and the waveform is displayed with the default Y scale value.

Figure 4-19 Display in Default Mode



The waveform is displayed with autoscale selected.

Figure 4-20 Display in Auto Scale Mode

3. Reducing The Noise Effects

■ Differential Input Method

When the differential input method is applied (Figure 4-21), the noise input to the positive input and that to the negative input, in the same phase, cancel each other, when going through the differential amplifier. When the single-ended method is applied (Figure 4-22), since the noise voltage is output by the amplifier without any transformation, the input sensitivity cannot be enhanced. As for the differential input method, the optimum range can be set irrespective of noise because the induction noise can be annihilated.

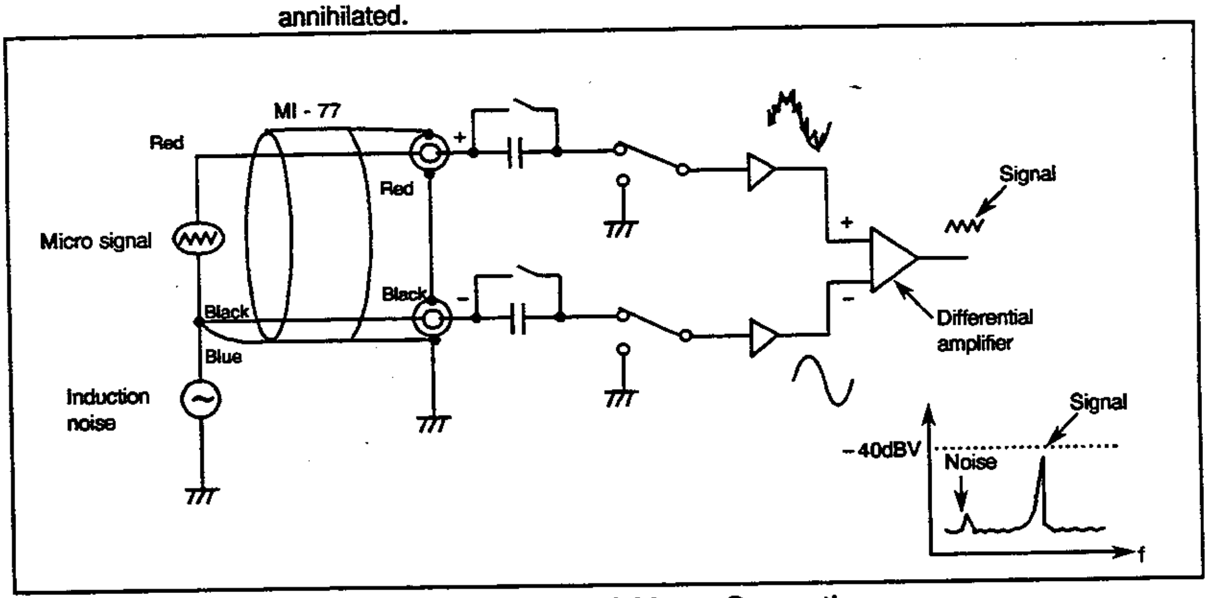


Figure 4-21 Differential Input Connection

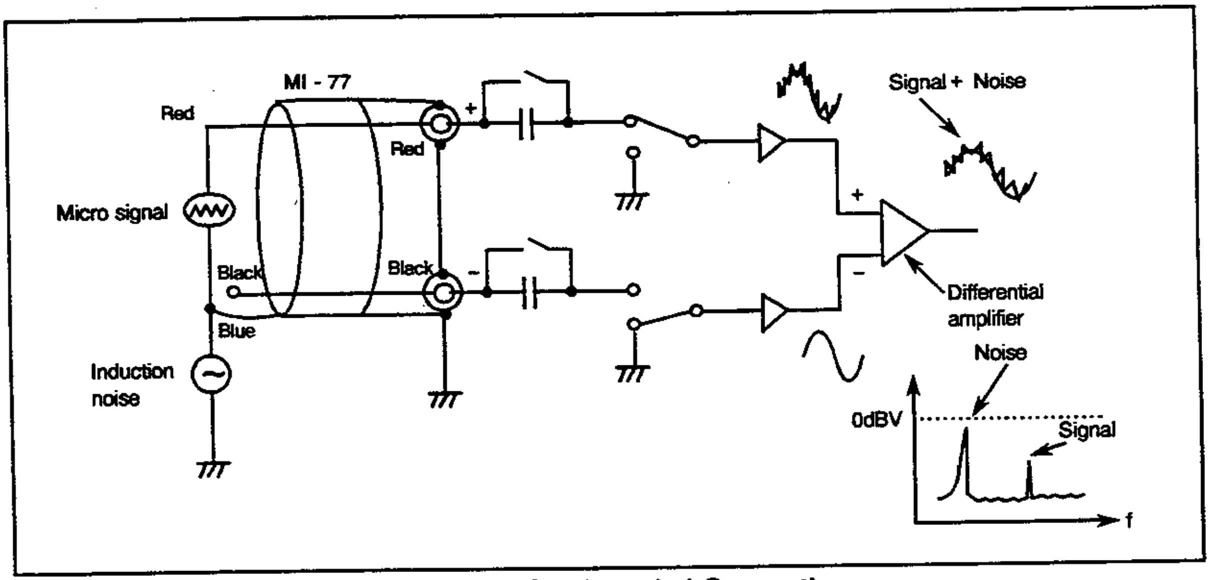
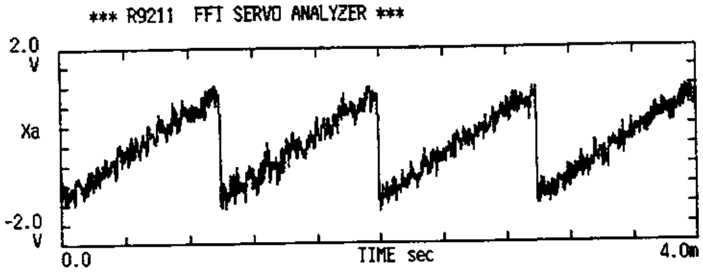


Figure 4-22 Single-ended Connection

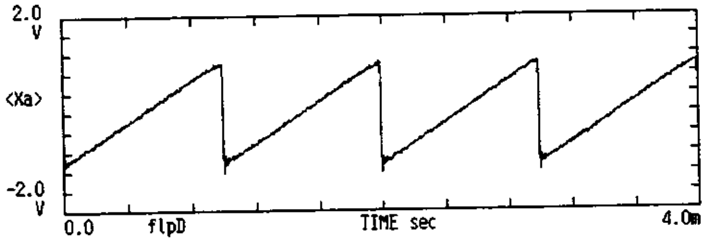
■ Synchronous Averaging Method

In the domain, one method to extract a signal from a periodic signal buried in noise (cf. Figure 4-23), is to perform a synchronous averaging of the noisy signal (cf. Figure 4-24).



Noise is superimposed with the signal.

Figure 4-23 Signal Buried in Noise



Extraction of signal through synchronous summing averaging.

Figure 4-24 Signal Extracted through Synchronous Averaging

The signal to be measured must be synchronized and then averaged. Different synchronization methods are available :

(1) The signal to be measured is used as a trigger source.
(2) The synchronization signal (TTL level) of the target signal is input to the R9211 as an external trigger signal. This method is effective when the noise is greater than the signal to be measured.

ADVICE

Select a complex spectrum analysis mode to perform synchronous averaging in the frequency domain. For further details, see "■ Averaging" in Section 3 "Toward Better Measurement" in Chapter 7.

■ Synchronous Averaging Setup Example

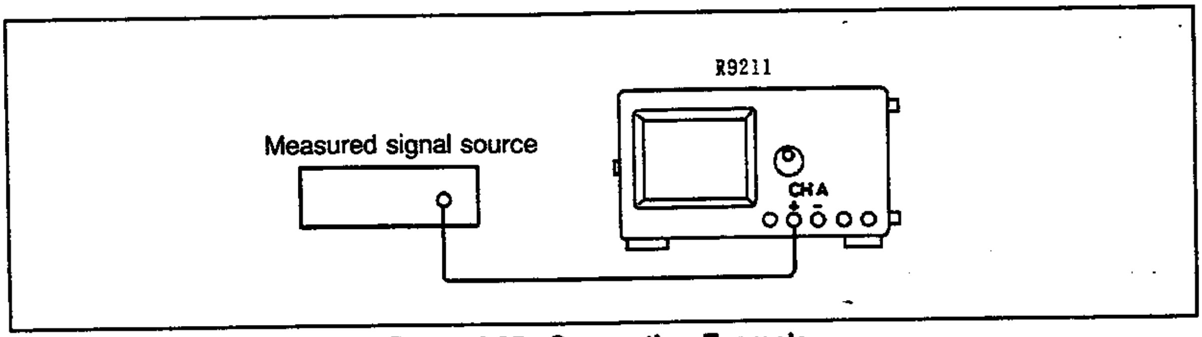


Figure 4-25 Connection Example

What follows now, explains the procedure to be executed in order to measure the waveform represented in Figure 4-25 (saw-toothed waveform buried in noise).
In this setup example, the signal to be measured is input to channel A and is itself used as a trigger source.

1 Preparation

1 Connect the signal source to the R9211 as shown in Figure 4-25.

2 Mode selection

2 Select the waveform mode as the measurement mode.

MODE ⇒ MEAS ⇒ WAVEFORM .... Set the measurement mode to the time domain mode.

3 Measurement conditions setup

3 Select the time axis waveform function as the mesaurement function.

SETUP ⇒ FUNC ⇒ TIME .... Select the time axis waveform function.

ACTIVE CH ⇒ CH - A&B ...... Here, specify that channel A and channel B are to be active.

4 Set the time axis resolution.

⇒ RANGE ⇒ SAMPL RAT	Set the time axis resolution with the ↑↓ keys.

5 Set the input sensitivity.

⇒ SENS ⇒ CHA - A MAN	Select the manual mode as input sensitivity mode. (In the case of a transient signal the manual mode is compulsory)
⇒ SET CH - A	Then set the input sensitivity of channel A with the numeric keys followed by the ENT key, or with the knob.
⇒ CHA - B MAN	
⇒ SET CH - B	Then set the input sensitivity of channel A with the numeric keys followed by the ENT key, or with the knob.

6 Set the inputs coupling.

⇒ INPUT ⇒ CHANNEL CH - A/CH - B	First select either CH-A or CH-B.
⇒ COUPLING AC/DC	For the specified channel, select a coupling method (AC or DC).
⇒ + INPUT IN/GND	Select the + input socket status (active or GND).
⇒ - INPUT IN/GND	Select the - input socket status (active or GND).
⇒ FILTER ON/OFF	Select the filter status (ON or OFF).

In the case of a time analysis, the filter must be switched off. Indeed, if it is switched on, ringing effects are generated on the waveform, because the antialiazing filter, by limiting the signal frequency band width, eliminates signal harmonics.

CAUTION !
You must of course switch on the filter when proceeding to a spectrum analysis.

⇒ ICP ON/OFF .... The ICP must be switched OFF.

⇒ TEST ON/OFF .... TEST must be set to OFF.

7 Setting of the trigger.

⇒ TRIG ⇒ SOURCE ⇒ ChA .... Specify here that the signal input to channel A is the trigger signal.
RETURN

⇒ SLOPE ⇒ +SLOPE .... Choose to trigger along the positive slope of the trigger signal.
RETURN

⇒ LEVEL .... Set the trigger level.

⇒ HYSTERESI .... Set the hysteresis width.

⇒ DELAY .... Here control the delay between the trigger point and the memorization point.

8 Set the ARM status.

⇒ ARM/HLD ⇒ AUTO ARM .... When a trigger is used, data fetching is stopped repeatedly. When no trigger is used, a trigger level is set again.

9 Set the averaging conditions.

⇒ NEXT

⇒ AVG ⇒ AVG MODE ······ Set the averaging mode.
SUN ··· Average

⇒ RETURN

⇒ AVG NO ······ Specify the number of averages to be performed.

⇒ PROCESS ⇒ NORMAL ······ Opt for displaying the result of each averaging (intermediate results display).

10 Start the measurement.

START ······ The measurement is performed.

11 Set the display conditions.

VIEW ⇒ TYPE ⇒ DUAL ······ Specify a dual display.

⇒ SEL ······ 2/1 First select screen 1 (lower).

⇒ FORMAT ⇒ GRAPH ······ Set it to the graphic display mode.

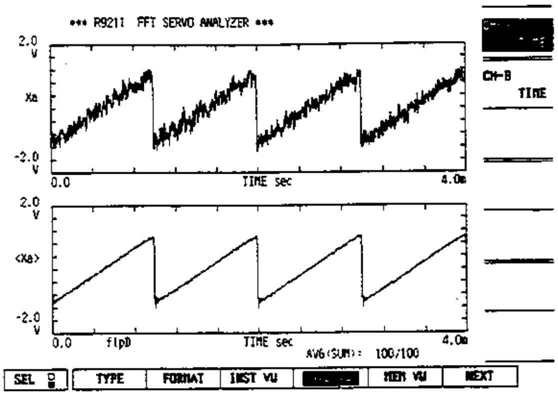
⇒ AVG VW ⇒ CH-A TIME ······ Choose to display here the averaged time waveform.

⇒ SEL ······ 2/1 Then select screen 2 (upper).

⇒ FORMAT ⇒ GRAPH ······ Set it to the graphic display mode.

⇒ INST VW ⇒ CH-A TIME ······ Choose to display here the instantaneous time waveform.

The averaged time waveform of channel A is displayed on screen 1 (lower) and the instantaneous time waveform of channel A is displayed on screen 2 (upper). (See Figure 4-26.)



Screen 2 (upper): Instantaneous time waveform

Screen 1 (lower): Time waveform averaged 100 times

Figure 4-26 Averaging Example in the Time Domain (here, the input signal is a saw-tooth signal buried in noise)

CHAPTER 5

SERVO MODE

This chapter explains the analysis procedure in the servo mode, gives the necessary information about the measurements in the servo mode, and, through examples, concretely illustrates how to use the servo mode.

CONTENTS

1. An Introduction to the Servo Mode

The R9211 servo analyzer measures the frequency response function of the Device Under Test (DUT), by applying the FFT method and by making use of the built-in Signal Generator.

In the servo analysis mode, in order to gather the frequency response function, the total measurement frequency range is partitioned. The SG generates the proper signals in each frequency partition and sweeps them, so that the FRF is obtained over the entire frequency range.

■ A Classification of the Six Sweeping Methods

(1) LIN MSIN : A linear resolution frequency analysis, within the corresponding frequency division, is performed by sweeping a multi-sine wave suitable for the analysis resolution.

(2) LOG MSIN : A logarithmic resolution frequency analysis, within the corresponding frequency division, is performed by sweeping a multi-sine wave suitable for the analysis resolution.

(3) LIN SIN : A linear frequency analysis is performed by sweeping a sine wave. The frequency division, here, is only composed of one point : the sine wave frequency line.

(4) LOG SIN : A logarithmic frequency analysis is performed by sweeping a sine wave. The frequency division, here, is only composed of one point : the sine wave frequency line.

(5) LIN F-Table : The various frequency divisions are specified in a sequence table, the f-table. At the same time, the waveform types (multi-sine or sine wave), the signal levels, and the number of averages are specified to characterize the sweeping mode in each frequency division for a linear resolution frequency analysis.

(6) LOG F-Table: The various frequency divisions are specified in a sequence table, the f-table. At the same time, the waveform types (multi-sine or sine wave), the signal levels, and the number of averages are specified to characterize the sweeping mode in each frequency division for a logarithmic resolution frequency analysis.

REFERENCE→
- ***egarding the selection of the appropriate sweeping method, see Section 3 "Toward Better Measurement".***
- ***For details on the linear resolution frequency analysis and on the logarithmic resolution frequency analysis, see Section 3 "Toward Better Measurement".***

■ Major Features of the Servo Analysis Mode

(1) According to the choice of measurement time (SHORT/MIDDLE/LONG), the Signal Generation block automatically decides the frequency partition, and while acquiring and synchronizing the data, within the analysis frequency range, it performs the measurement by sweeping.

→This measurement method is characterized by a wide dynamic range. (See Figure 5-1.)

(2) When a logarithmic resolution frequency analysis is selected, the frequency response function can be computed over 1 to 6 decades.
→The resolution at the low frequencies is enhanced by a logarithmic frequency sweeping. (See Figure 5-2.)

(3) A frequency table can be used to characterize the sweeping method, in order to achieve high-speed and high-accuracy. (See Figure 5-3.)

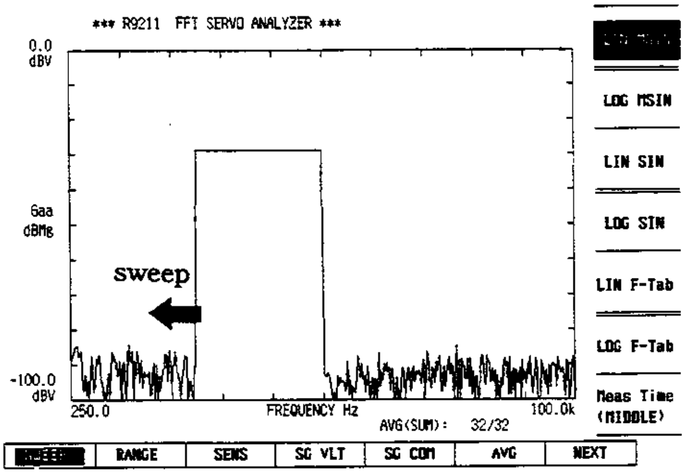


Figure 5-1 Example of a Linear Multi-sine Wave Output

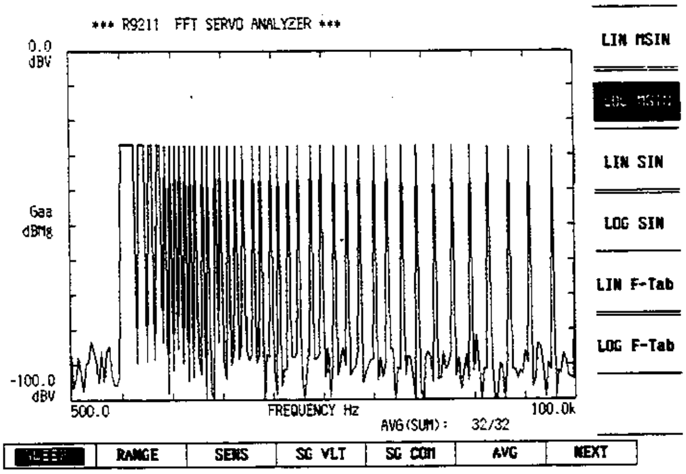
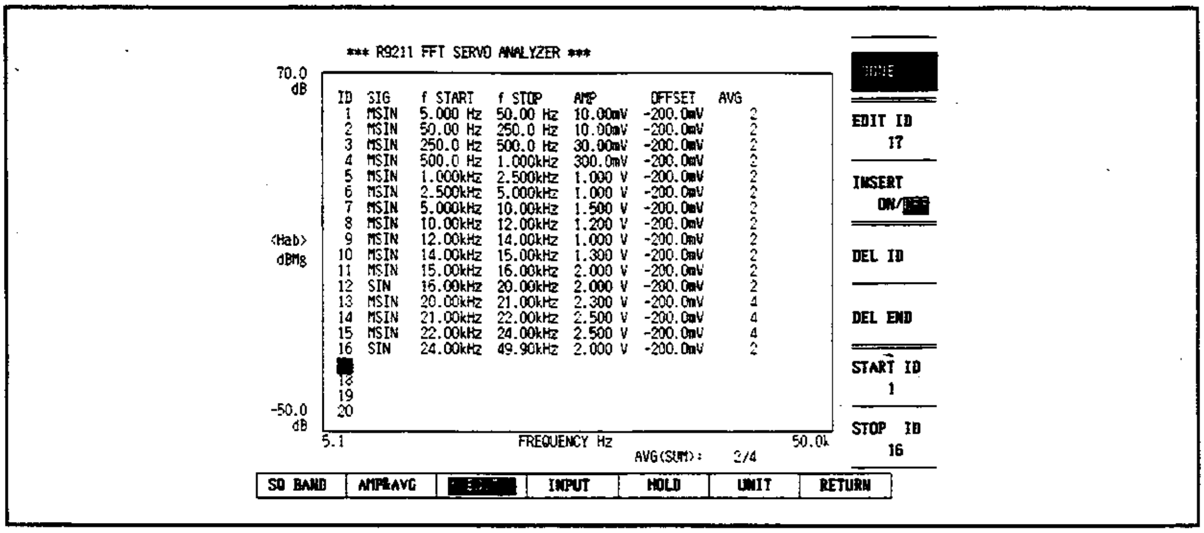


Figure 5-2 Example of a Logarithmic Multi-sine Wave Output



ID	SIG	f START	f STOP	AMP	OFFSET	AVG
1	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
18						
19						
20						

AVG(SUM): 2/4

Figure 5-3 Example of a Frequency Table Setting Screen

2. Basic Setting Procedure

■ Measurement Procedure of the Frequency Response Function of a Mechanical Filter

This section describes the procedure to follow in order to compute the transfer function of a mechanical filter by the LOG MSIN sweep method.

1 **Switch the power on.**

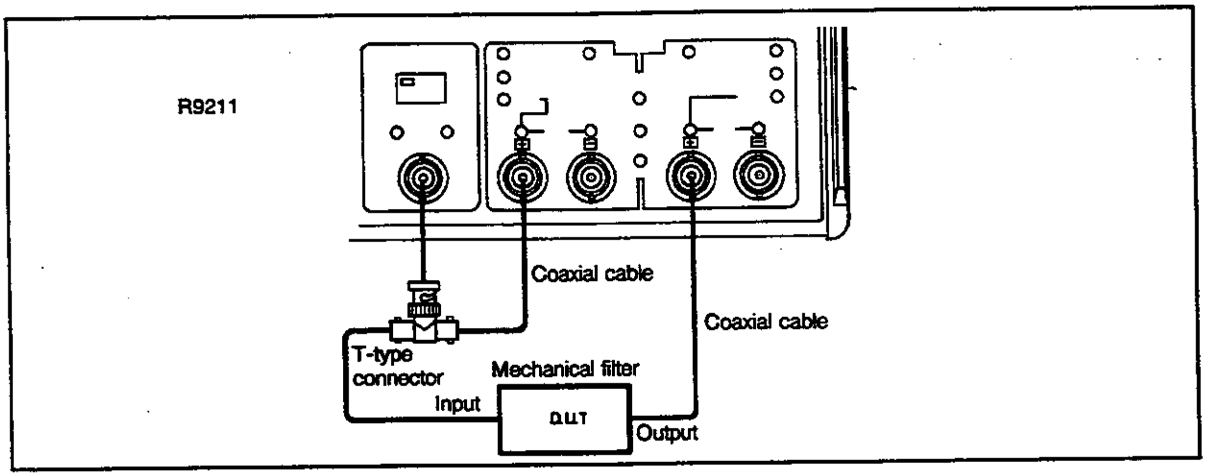


Figure 5-4 Connection Method

2 **Select the servo mode.**

MODE ⇒ MEAS ⇒ SERVO

In this case, the display mode becomes a dual one, and Gaa and Gbb are displayed.

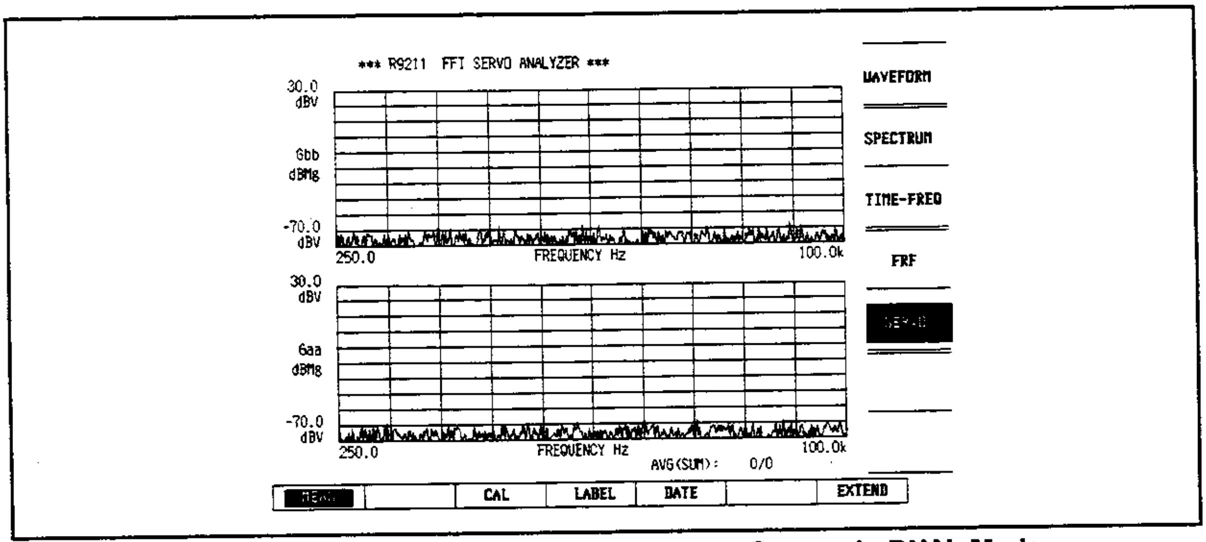


Figure 5-5 Display of the Input/Output Power Spectra in DUAL Mode

3 Select LOG MSIN as the signal sweep method.

SETUP ⇒ SWEEP ⇒ LOG MSIN	Select the LOG MSIN sweep method.

4 Set the measuring frequency range.

⇒ RANGE ⇒ FREQ RNG 100kHz	Set the maximum frequency range for the measurement.
50 ⇒ kHz	Here, choose 50kHz.

5 Set the analysis resolution.

⇒ f RESOLN (LIN f)	Select the logarithmic resolution frequency analysis.
⇒ LOG f	
⇒ Line/Dec	Now, choose the number of lines per decade either 10, 25, 50, 100, or 200.
50 ⇒ ENT	Here, choose 50.

6 Set the number of decades.

⇒ Decade	Set the number of decades.
3 ⇒ ENT	One to six decades can be selected. In this case, three decades are appropriate.

Note

Six decades can be selected only when the analysis resolution is at most 100 lines / decade.

7 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO

⇒ CH-B AUTO

Choose AUTO for channel A as well as for channel B, so that the input sensitivity changes automatically according to the input signal amplitude.

8 Set the signal amplitude of the Signal Generator.

⇒ SG VLT ⇒ AMPLITUDE

Do not forget that this amplitude corresponds to the peak value, instead of the peak-peak value as you might be used to.

150 ⇒ mV

Here, set ±150mV(300mV$_{P-P}$).

Note

1. Set a voltage offset when it is required for the filter input.

⇒ OFFSET

2. When OPR in the SIGNAL OUT section is ON (the OPERATE key lamp is lit), changing the offset voltage will output the DC component without any transformation.

3. Set a voltage so that the sum of the signal amplitude and of the offset value does not exceed the limit, eventually, required for the DUT protection.

⇒ LIMIT VLT

5 ⇒ V

Here, choose ±5V.

9 Set the signal generation timing.

⇒ SG COM ⇒ GEN ON AVG

Choose here to synchronize the signal generation start with the averaging start.

10 Set the number of averages.

⇒ AVG ⇒ AVG NO 32 — The number of averages may be any integer between 1 and 32767.

5 ⇒ ENT — Enter 5 here.

11 Set the inputs coupling.

⇒ NEXT

⇒ INPUT ⇒ CHANNEL CH-A/CH-B — At first, in order to set the input coupling of channel A, specify channel A.

⇒ COUPLING AC/DC — Choose a DC coupling.

⇒ + INPUT IN/GND — Since the input mode is of the single-ended type, the positive input must be set to IN. (The lamp dies off.)

⇒ - INPUT IN/GND — For the same reason, the negative input has to be set to GND. (The lamp lights.)

⇒ FILTER CH-A/CH-B — Switch now to channel B. As for channel A, choose a DC coupling, and a single-ended configuration.

12 Switch on the OPR key.

The OPR key's LED lights.

Note

When an offset is set, do not forget that an offset voltage is output from the output socket.When setting the operating point of a DUT by cut and tries, first, switch the OPR key on, then change the offset voltage to adjust it.

13 Measurement

Press the START key.

The START key's LED lights.

In this case, the coherence function <Coh> and the frequency response function <Hab> are displayed in the dual display mode. After completion of the measurement, a Bode diagram is displayed.

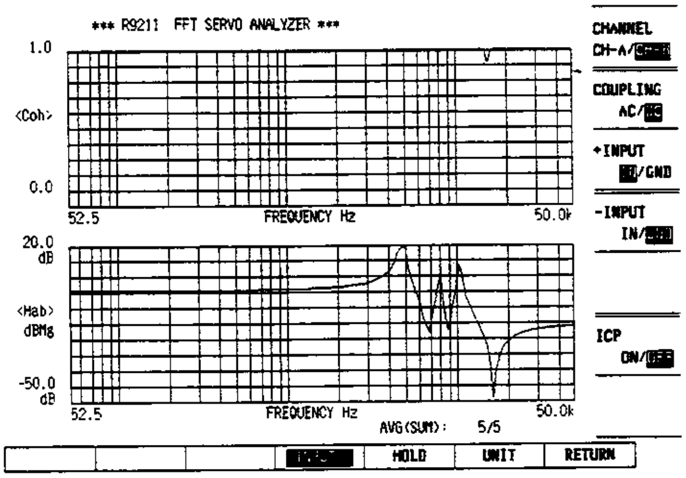


Figure 5-6 Example of Average Data Display

14 Selection of the type of display

Select display of average data.

VIEW ⇒ AVG VW ⇒ FRF Choose to visualize the FRF.

Note

A DUAL screen mode was previously selected when the servo analysis mode was set up. It is assumed here, that the lower screen is selected.

⇒ NEXT

⇒ FRF CORD ⇒ BODE A Bode diagram (phase and amplitude characteristics) is displayed. Two screens are displayed at the same time.

Note

A DUAL screen mode was previously selected when the servo analysis mode was set up. It is assumed here, that the lower screen is selected.

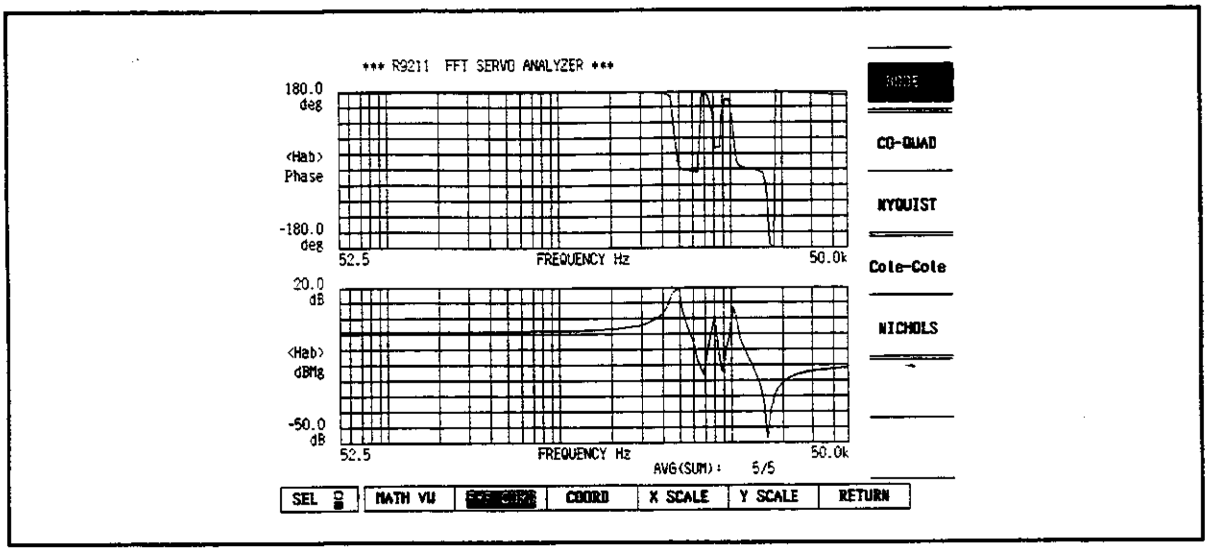


Figure 5-7 Example of Bode Diagram Display

15 Use the marker.

Read the amplitude peak and the corresponding phase with a marker.

MKR ⇒ SEL ⬒ ⇒ SINGLE X X1 Y1	Make the cursor appear on the screen where the phase is represented, that is to say the upper screen.
⇒ SEL ⬓	Now select the lower screen, which is where the amplitude is represented.
⇒ X MKR	Specify "X MKR" so that the marker will automatically be positioned along the X axis to point to the peak value.
⇒ PK MKR	To search for only one peak, select "SINGLE PK".
⇒ SINGLE PK	
⇒ MKR REF ⇒ SEL to OTHER	On the phase screen (upper), place the cursor at the same position as on the amplitude screen (lower).

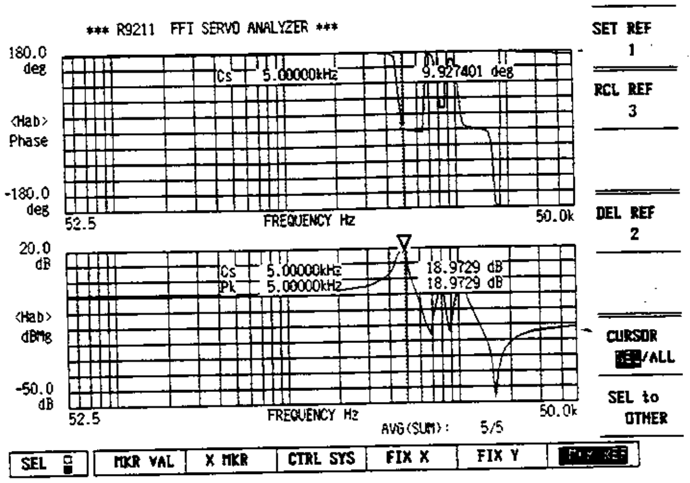


Figure 5-8 Example of Marker Display

3. Toward Better Measurement

■ Signal Source Sweeping in the Servo Analysis Mode

In the servo analysis mode, the signal sweeping methods may be classified in 6 categories. The different features of these methods are gathered in the following table.

Sweep method	Low frequencies resolution	Dynamic range of the DUT	Measurement time	
LIN MSIN	Disabled	Narrow	Short	A short, middle, or long measurement time must be selected depending on the DUT's dynamic range.
LOG MSIN	Enabled	Narrow	Relatively short	Frequencies are swept for each decade in the specified sweep direction from low to high frequency (or reciprocally).
LIN SIN	Disabled	Relatively wide	Relatively long	A short, middle, or long measurement time must be selected depending on the DUT's dynamic range.
LOG SIN	Enabled	Relatively wide	Long	A sine wave is swept over analyzed frequency span. The step of this sweep is variable and depends on the frequency resolution.
LIN F-Table	Disabled	Wide ≥ 70dB	—	The measurement frequency is divided into frequency divisions in the frequency table and SIN or MSIN is specified for each of these. These frequency divisions are swept one by one (a linear resolution sweeping method is applied here).
LOG F-Table	Enabled	Wide ≥ 70dB	—	The measurement frequency is divided into frequency divisions in the frequency table and SIN or MSIN is specified for each of these. These frequency divisions are swept one by one (a logarithmic resolution sweeping method is applied).

DUT: Device Under Test

Choose the method that will give the best frequency resolution at the low frequencies, but will nonetheless remain consistent with the dynamic range of the DUT.
If the DUT is unknown, select the sweep method after obtaining approximate measurement data by specifying MSIN.

Linear Resolution Frequency Analysis and Logarithmic Resolution Frequency Analysis

The linear frequency analysis is the method by which a time data sampled at specified intervals is converted to a regular frequency resolution spectrum to obtain the FRF.
In the case of an analysis based on a regular frequency resolution, since the ratio of the frequency resolution to the measured frequency, increases as the frequency decreases, the resolution concretely decreases, thus the results lack in precision. When the logarithmic resolution analysis method is applied, the FFT speed can be used effectively and a good frequency resolution can be obtained over the whole frequency range.
Select either the linear or logarithmic resolution analysis method according to whether a high resolution at the low frequencies is necessary when computing the frequency response function.

Setting the Frequency Range and the Resolution of the Measurement

● Setting the Frequency Range

When setting the frequency range, select a frequency (that is to say the upper limit of the span to be studied) higher than the maximum frequency of interest.

● Setting the Resolution and the Number of Decades

The resolution setting is different for a linear sweep and for a logarithmic sweep.
For a linear sweep, the resolution is characterized by the number of lines constituting the total frequency range to be studied. You can choose this number of lines from : 25, 50, 100, 200, 400, or 800. For a logarithmic sweep, the resolution is characterized by the number of lines constituting one decade. This number must be selected from : 10, 25, 50, 100 or 200. Then, the frequency range is determined by the number of decades you now specify you want to use. You can choose from 1 to 6 decades. However, note that, for a resolution of 200 lines per decade, the maximum number of decades you can specify is only 5. Since no decade corresponds to the less than 10mHz range when the maximum frequency of the measured range is inferior to 100Hz, the number of decades is therefore limited. If the number of decades, somehow, exceeds the limit, the message "SM.er = Servo Upper Limit Exceeded:Check Settings" is displayed and the maximum possible value is adopted.

Setting the Input Sensitivity

In the servo analysis mode, it is very rare that the frequency characteristic curve of the DUT becomes flat. For this reason, select the AUTO range, rather than a fixed range.

■ Setting the SG's Signal Amplitude

In the servo analysis mode, set the source signal amplitude with the following two points in mind :

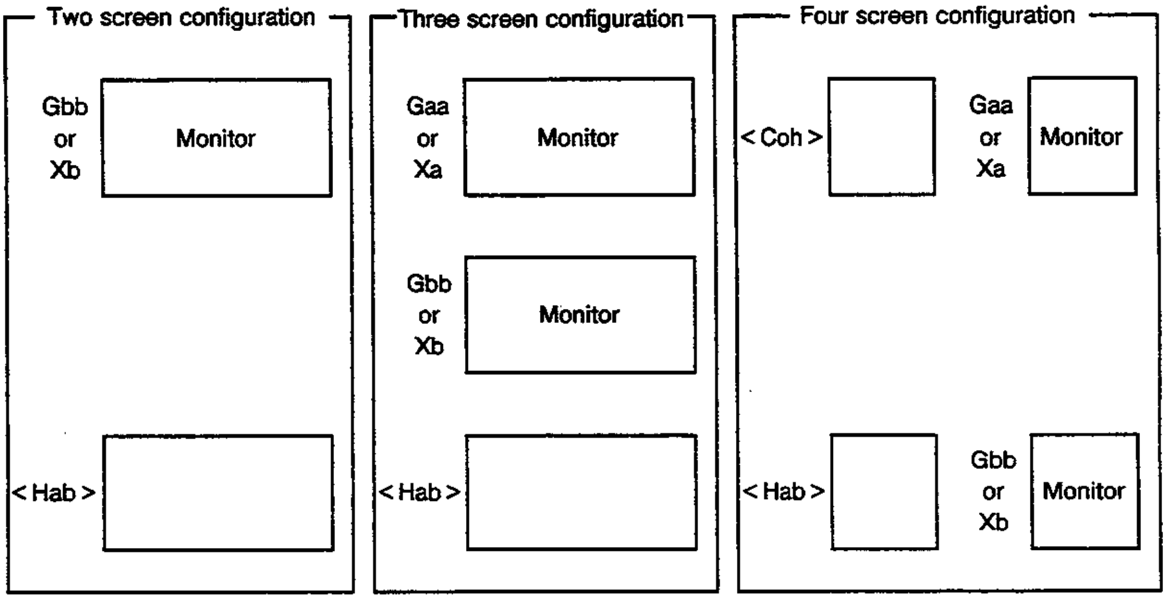
(1) The DUT must not be saturated.
(2) The Signal Generator's signal amplitude must be higher than the noise level.

These two points can be checked during the masurement by using the monitor function.

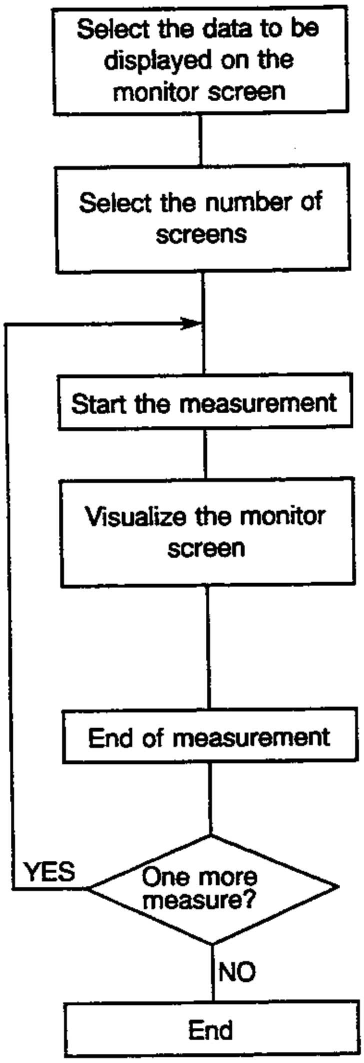
REFERENCE →
For details on the monitor function, see " ■ Display Related Modifications" and " ■ Extended Functions' Setting" in Chapter 9.

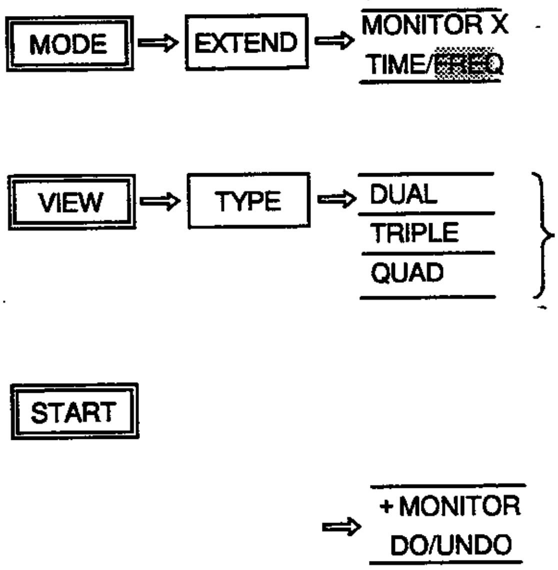
■ Monitor Function

In the servo mode, by specifying a multiscreen display, one can visualize the instantaneous time waveform or the instantaneous power spectrum, at the desired position, and while the servo analysis is being performed.



Monitor Setup





Select either a time or a spectrum waveform.

Select a screen configuration.

Select either a time or a spectrum waveform.

If TRACE on START is set to ON at the time of restart, you must specify DO again.

4. Typical Measurement Examples

Measurement of the Characteristics of a Switching Power Loop

This section illustrates the procedure followed for the measurement of a feedback loop characteristics, through the example of a switching power loop's characteristics measurement.
The LOG SIN sweep method is used in this example.

1 Switch the power on.

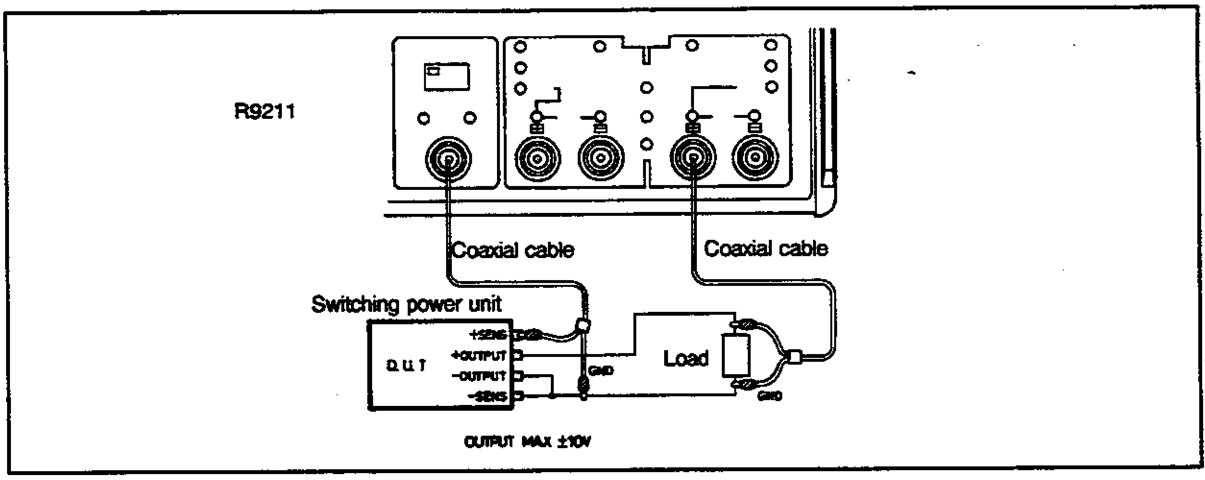


Figure 5-9 Connection Method

2 Select the servo mode.

MODE ⇒ MEAS ⇒ SERVO

In this case, the display mode becomes a dual one, and Gaa and Gbb are displayed.

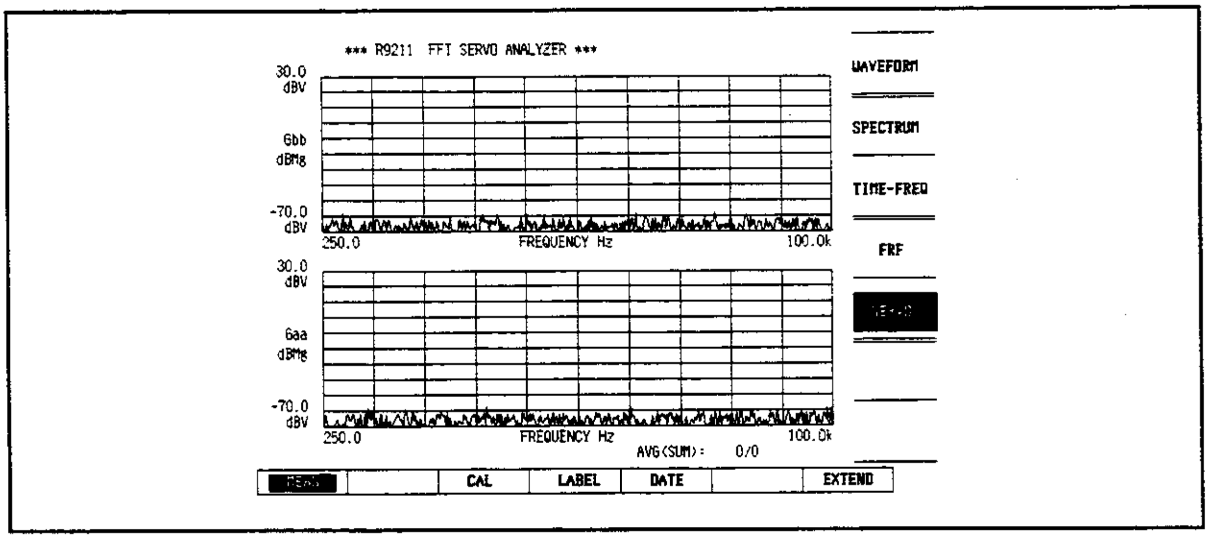


Figure 5-10 Display of the Input/Output Power Spectra in DUAL Mode

3 Select the proper sweep method.

SETUP ⇒ SWEEP ⇒ LOG SIN	Select the LOG SIN sweep method.

4 Set the frequency range of the measurement.

⇒ RANGE ⇒ FREQ RNG 100kHz	Set the maximum frequency of the range.
10 ⇒ kHz	10kHz is appropriate here.

5 Set the analysis resolution.

⇒ f RESOLN	Select the logarithmic resolution frequency analysis.
⇒ LOG f	
⇒ Line/Dec	Select the number of lines per decade from 10, 25, 50, 100, or 200.
10 ⇒ ENT	Select 10 here.

6 Set the number of decades.

⇒ Decade	Set the number of decades over which the analysis is to be performed.
4 ⇒ ENT	From one to six decades can be selected. Select four decades here.

Note

Six decades can be selected only when the analysis resolution is less than 100 lines/decade.

7 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO

⇒ CH-B AUTO

Set AUTO for both channel A and channel B, so that the input sensitivity changes automatically according to the input signal amplitude.

8 Set the signal amplitude of the Signal Generator.

⇒ SG VLT ⇒ AMPLITUDE

Do not forget that this amplitude corresponds to a peak amplitude (from 0 to the peak) instead of a peak-peak value.

10 ⇒ mV

Set ±10mV (20mV$_{P-P}$) here.

Note:

1. If the DUT requires the application of an offset, set its value at this stage of the procedure.

⇒ OFFSET

*2 When **OPR** in the SIGNAL OUT section is ON (the OPERATE key lamp is lit), changing the offset voltage will output the DC component without any transformation.*

3. Set a voltage so that the sum of the signal amplitude and of the offset value does not exceed the limit, eventually, required for the DUT protection.

⇒ LIMIT VLT

5 ⇒ V

Set ±5V here.

9 Select a signal generation timing.

⇒ SG COM ⇒ GEN ON AVG

Choose to start the signal generation at the same time as the averaging process.

10 Connect the built-in summing amplifier.

⇒ SUM AMP ON/OFF	Switch the summing amplifier on, thus connecting internally the SG to channel A.

11 Set the number of averages.

⇒ AVG ⇒ AVG NO	Choose the number of averages between 1 and 32767.
3 ⇒ ENT	Enter 3 here.

12 Input coupling conditions setup.

⇒ NEXT	
⇒ INPUT ⇒ CHANNEL CH-A/CH-B	At first, in order to set the input coupling of channel A, specify channel A.
⇒ COUPLING AC/DC	Choose the AC coupling.
⇒ + INPUT IN/GND	Since the input mode is of the single-ended type, the positive input must be set to IN.
⇒ – INPUT IN/GND	For the same reason, the negative input has to be set to GND.
⇒ CHANNEL CH-A/CH-B	Switch now to channel B. As for channel A, choose a AC coupling, and a single-ended configuration.

↓

13 Switch on the [OPR] key.

The [OPR] key's LED lights.

Note

When an offset is set, do not forget that an offset voltage is output from the output socket. When setting the operating point of a DUT by cut and tries, first, switch the [OPR] key on, then change the offset voltage to adjust it.

14 Press the [START] key.

The [START] key's LED lights.

In this case, the coherence function <Coh> and the frequency response function <Hab> are displayed in the double screen configuration.

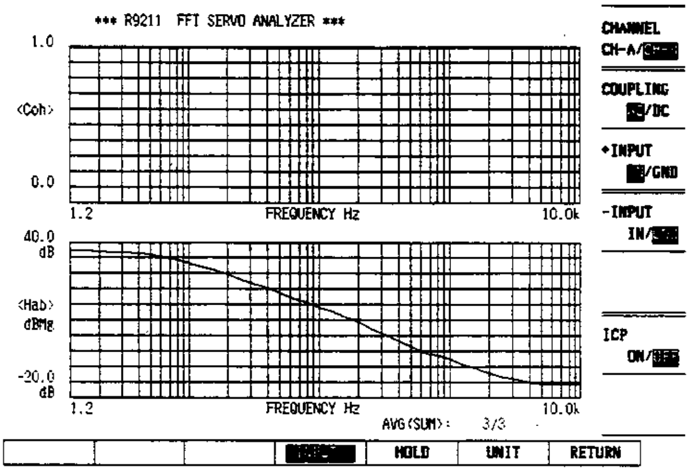


Figure 5-11 Example of Average Data Display

15 Visualize the averaged data.

VIEW ⇒ AVG VW ⇒ FRF

Display the FRF.

Note

This operation may be omitted since the < Hab > data (lower screen) was previously selected when you started averaging.

⇒ NEXT

⇒ FRF CORD ⇒ BODE

A Bode diagram (phase and amplitude characteristics) is displayed. Two screens are displayed at the same time.

Note

A double screen configuration was previously selected when the servo analysis mode was set up. It is assumed here, that the lower screen is selected.

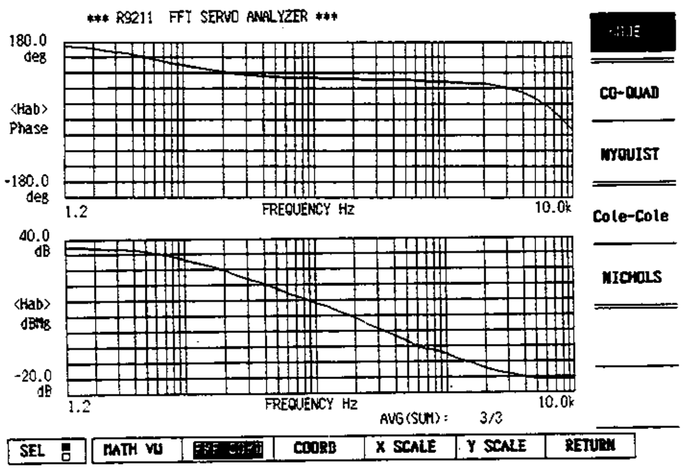


Figure 5-12 Bode Diagram

16 Shift the phase by 180° .

⇒ SEL

Select the upper screen (phase characteristic).

When the open loop characteristic is measured using a summing amplifier, the resulting data shifted by 180°. Thus, you must shift it by 180° to obtain the correct characteristic.

MATH	⇒ f MATH	⇒ CALCULATE (OFF)	Select a 180° shift operation.
		⇒ NEGATE	
		⇒ RETURN	
		⇒ MATH SEL	
		⇒ OPERAND	Select the data to be submitted to this operation (here the FRF).
		⇒ 1st OPRTR	Set the selected operation (phase shift) as the first operator.
		⇒ DO MATH	Perform the phase shift.
	⇒ MKR REF	⇒ SEL to OTHER	The cursor of the amplitude display (lower screen also non selected screen) is automatically aligned with the phase display cursor (upper screen also selected screen)

17 Display the operation result.

VIEW	⇒ MATH VW	⇒ RESULT ARRAY	Display the operation result.
	COORD	⇒ PHASE	Display the phase of the resulting FRF.
	⇒ Y SCALE	⇒ Y AUTO SCALE	Unwrap the phase.

⇒ **SEL** ▤ Now, select the lower screen.

⇒ **MATH VW** ⇒ RESULT ARRAY

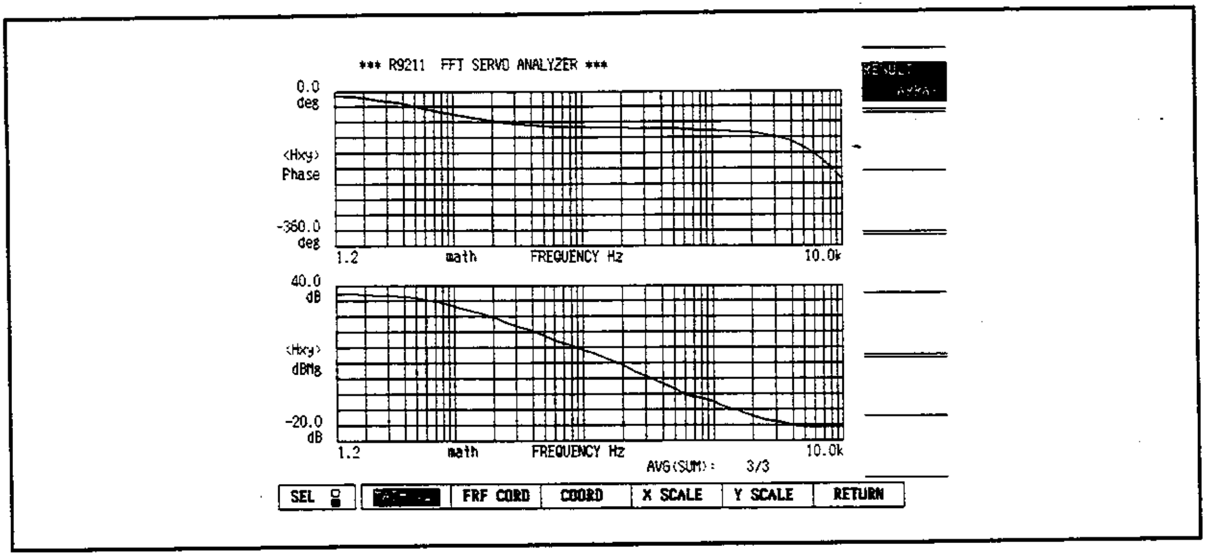


Figure 5-13 180° Shifted Phase Display

18 **Nyquist and Nichols diagrams are now going to be plotted, to judge the system's stability.**

VIEW ⇒ **FRF CORD** ⇒ NYQUIST Display a Nyquist diagram.

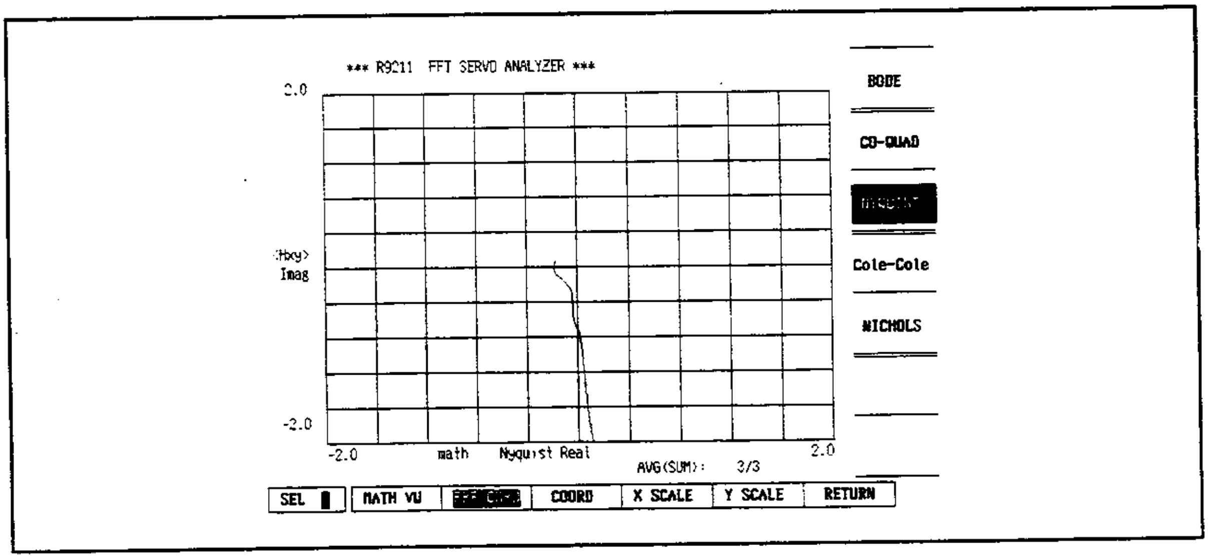


Figure 5-14 Nyquist Diagram

⇒ NICHOLS — Display a Nichols diagram.

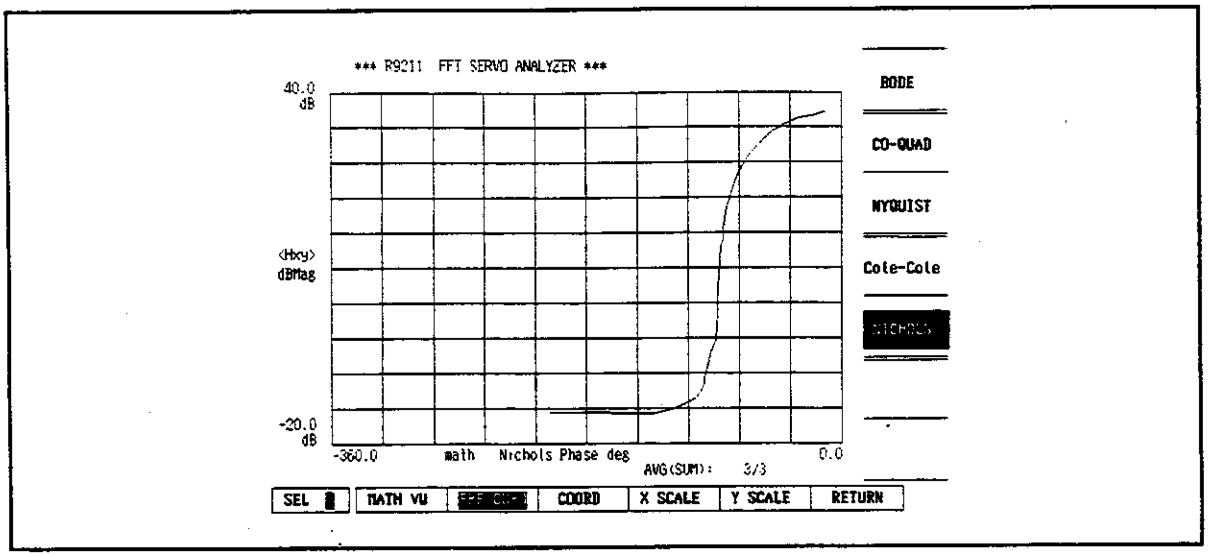


Figure 5-15 Nichols Diagram

⇒ BODE — Display a Bode diagram.

Read the gain margin and phase margin.

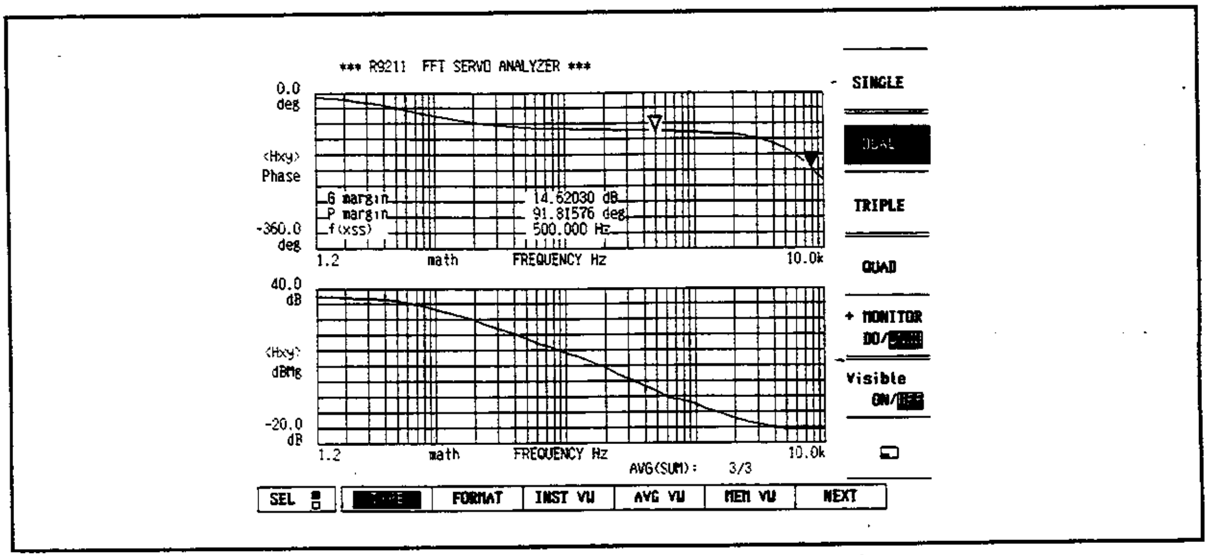
⇒ SEL ☰ — Select the upper screen (to display a Bode marker on the upper screen).

MKR ⇒ CTRL SYS ⇒ BODE MKR ON/OFF — Switch on the Bode marker.

If there exists no frequency where the gain characteristic cuts the 0dB axis or where the phase characteristic cuts the 180° axis, then the message "Bode Marker Undefined" appears on the CRT.

VIEW ⇒ TYPE ⇒ ▨
⇩
▨

To ease the visualization of the results, change its display position to the lower left corner.



G margin 14.62030 dB
P margin 91.81576 deg
f(xss) 500.000 Hz
AVG(SUM): 3/3

Figure 5-16 Open Loop Characteristic Display

Deduce the closed loop characteristics from the open loop measured results.

⇒ AVG VW   FRF — Display the measured data on the upper screen.

MATH ⇒ FRF MATH ⇒ Open Close

⇒ H / (1 + H) — Select the open loop to closed loop conversion operation.

⇒ RETURN

⇒ MATH SEL

⇒ 2nd OPRTR — Since you previously gave a value to the first operator, define this conversion operation as the second operator.

DO MATH — Perform the conversion.

21 Selection of the type of display

Visualize the operation results.

VIEW ⇒ MATH VW ⇒ RESULT ARRAY — Display the results on the upper screen.

⇒ COORD ⇒ PHASE — Visualize the phase.

⇒ SEL — Select the lower screen.

⇒ MATH VW ⇒ RESULT ARRAY — Display the logarithmic amplitude.

⇒ Y SCALE ⇒ Y AUTO SCALE — Choose the auto scale representation.

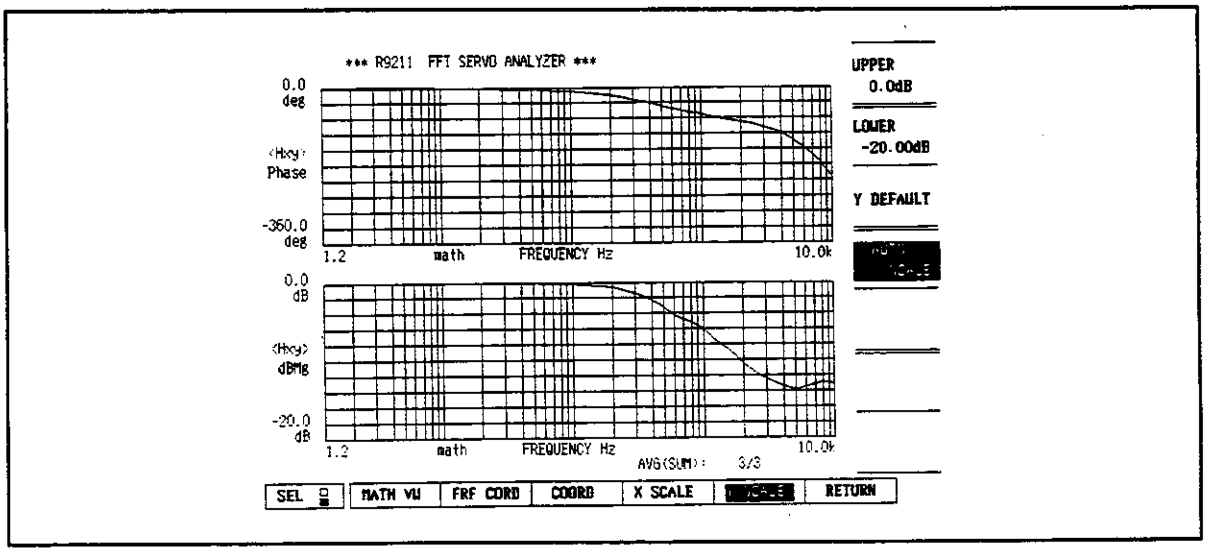


Figure 5-17 Closed Loop Characteristics

■ Advanced Measurement: How to Use the f-table

If the dynamic range of the DUT is wider than 70dB, the signal's power is partially reduced, and the measurement results are inaccurate.
If the f-table is used, since the generated signal can be finely defined, high-speed and high-accuracy measurements are enabled.
Here the use of this table is illustrated through the example of the measurement of the frequency response function of the focus servo system of a CD actuator.

1 Switch the power on.

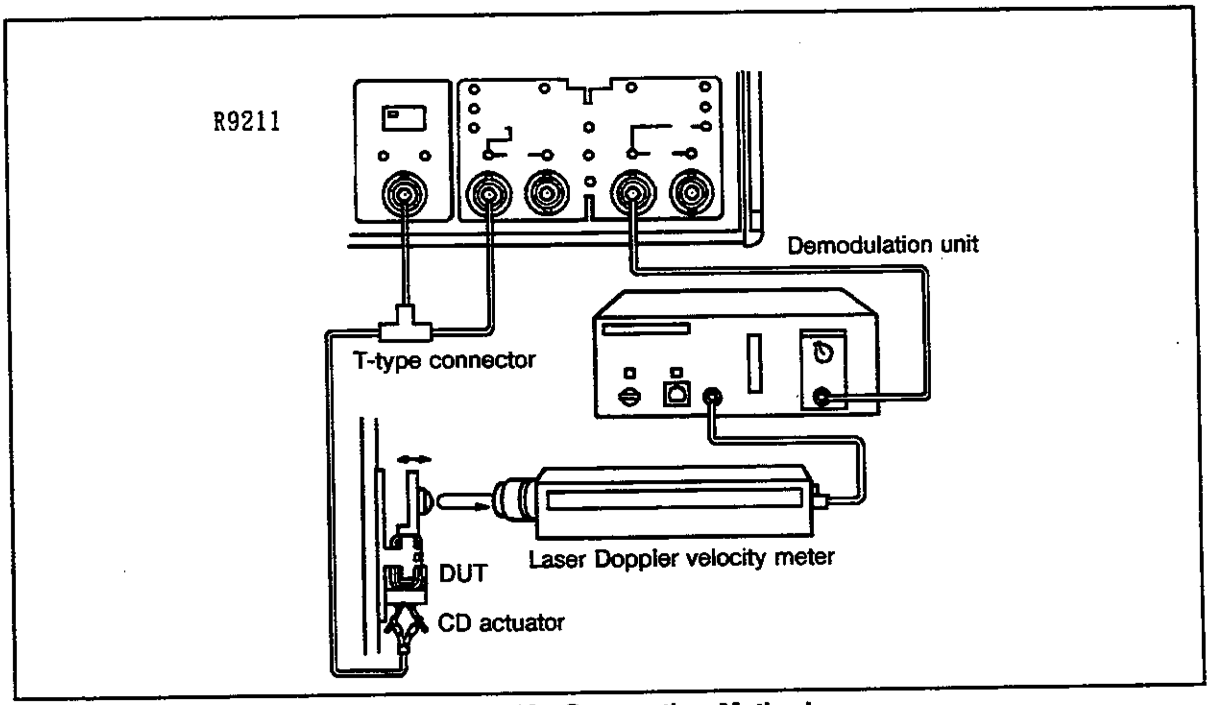


Figure 5-18 Connection Method

2 Obtain approximate measurement data by the LOG MSIN sweep method in the servo analysis mode.

The approximate measurement results will enable you to decide the table setting. About measuring with the LOG MSIN sweep method, please refer to the example "Measurement Procedure of the Frequency Response Function of a Mechanical Filter", in this chapter.

3 Choose LOG F-Tab as the signal sweep method.

SETUP ⇒ SWEEP ⇒ LOG F-Tab

4 Set the frequency range of the measurement.

⇒ RANGE ⇒ FREQ RNG 100kHz	Set the maximum frequency of the range.
50 ⇒ kHz	50kHz is appropriate here.

5 Set the analysis resolution.

⇒ f RESON	Having selected the logarithmic resolution frequency analysis, select the number of lines per decade.
⇒ LOG f	
⇒ Line/Dec	Select the number of lines per decade from 10, 25, 50, 100, or 200.
200 ⇒ ENT	Select 200 here.

6 Set the number of decades.

⇒ Decade	Set the number of decades over which you want the analysis to be performed.
4 ⇒ ENT	From one to six decades can be selected. Select four decades here.

Note

Six decades can be selected only when the analysis resolution is less than 100 lines/decade.

7 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO ⇒ CH-B AUTO	Set AUTO for both channel A and channel B, so that the input sensitivity changes automatically according to the input signal amplitude.

8 Set the signal generation timing.

⇒ **SG COM** ⇒ GEN ON / AVG

Set the signal generation timing so that the signal generation starts at the same time as the averaging process.

Note

If the preceding steps were previously set to obtain the approximate measurement data, they need not be set again.

9 Set up the frequency table.

⇒ **NEXT**

⇒ **SQ BAND**

Display the frequency table.

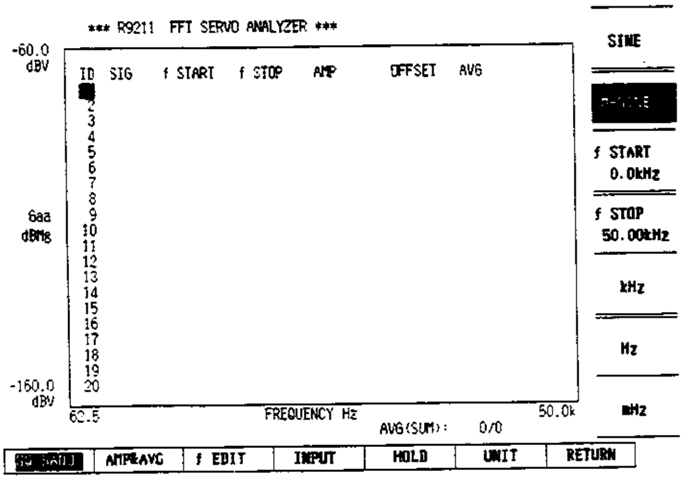


Figure 5-19 Frequency Table

Partition the measurement frequency range according to the approximate measurement data.
Set the waveform type, the start frequency, the stop frequency, the signal level, the offset, and the number of averages for each frequency division. Each frequency division is assigned an ID number.
In this example, partition the measurement frequency range in 16 divisions and set the above mentioned quantities as follows:

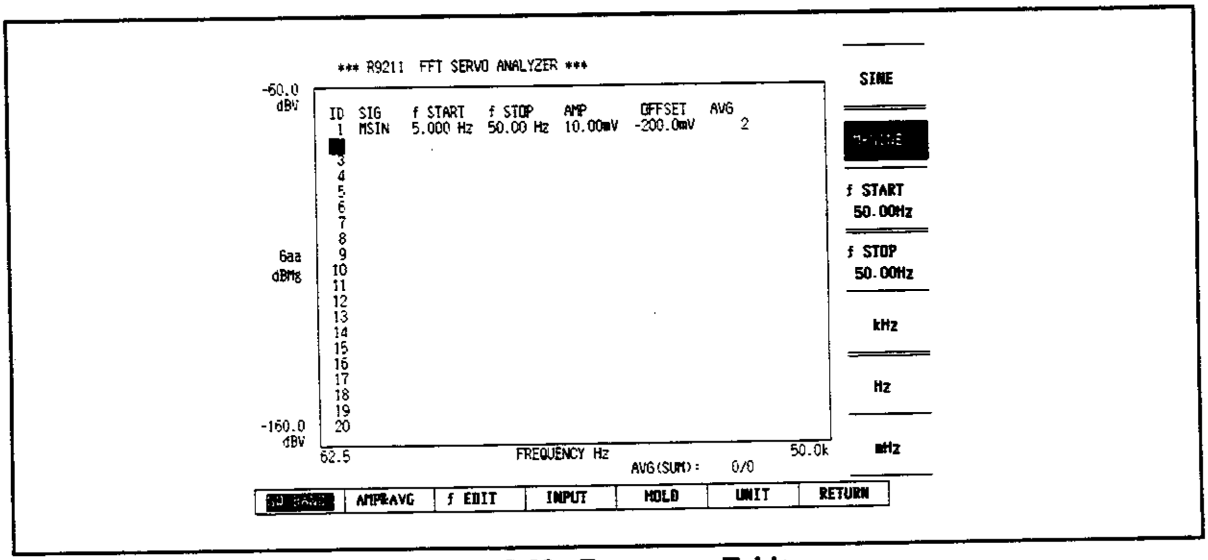
ID	SIG	f START	f STOP	AMP	OFFSET	AVG
1	MSIN	5.000 Hz	50.00 Hz	10.00 mV	−200.0mV	2
2	MSIN	50.00 Hz	250.0 Hz	10.00 mV	−200.0mV	2
3	MSIN	250.0 Hz	500.0 Hz	30.00 mV	−200.0mV	2
4	MSIN	500.0 Hz	1.000 kHz	300.0 mV	−200.0mV	2
5	MSIN	1.000 kHz	2.500 kHz	1.000 V	−200.0mV	2
6	MSIN	2.500 kHz	5.000 kHz	1.000 V	−200.0mV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

Regarding the partitioning method and the value setting method, refer to Section 3 "Toward Better Measurement".

⇒ MSIN	For the division referred to as ID1, select a multisine wave.
⇒ f START	The start frequency must now be set.
5 ⇒ Hz	Enter 5Hz.
⇒ f STOP	The stop frequency must now be set.
50 ⇒ Hz	Enter 50Hz.
⇒ AMP&AVG ⇒ AMPLITUDE	The signal amplitude must now be set.
10 ⇒ mV	Enter 10mV.

⇒ **OFFSET**	The offset must now be set.
-200 ⇒ mV	Enter -200mV.
⇒ **AVG No**	The number of averages must now be set.
2 ⇒ **ENT**	

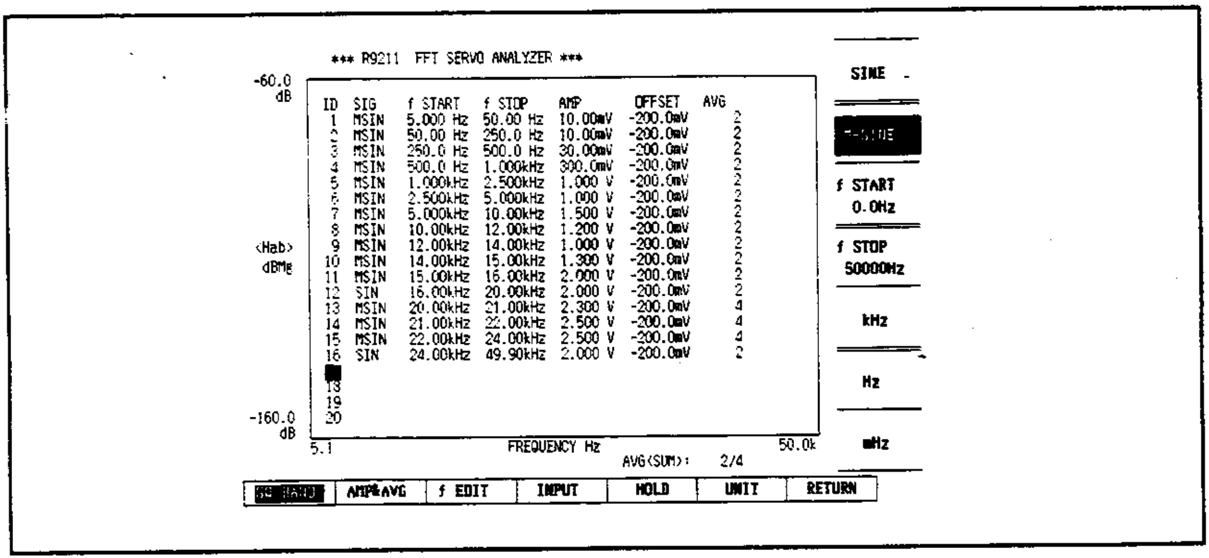
Press now the **ENT** key to start setting up the frequency division referred to as ID2.



```
*** R9211  FFT SERVO ANALYZER ***
ID  SIG    f START    f STOP    AMP       OFFSET   AVG
 1  MSIN   5.000 Hz   50.00 Hz  10.00mV  -200.0mV    2
 2
 3
 4
 5
 6
 7
 8
 9
10
11
12
13
14
15
16
17
18
19
20
                                          AVG(SUM):   0/0
```

Figure 5-20 Frequency Table

Set each frequency division up to the one referred to as ID 16. In the same way when a frequency division setup is completed, you must step to the setup of the following one.



ID	SIG	f START	f STOP	AMP	OFFSET	AVG
1	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
■						
18						
19						
20						

AVG(SUM): 2/4

Figure 5-21 Frequency Table

10 Set a sweep sequence.

In order to perform sweeping according to what was defined in the table, specify the start and stop IDs.

⇒ f EDIT ⇒ START ID

Here, set 1 as the start ID and 16 as the stop ID.

1 ⇒ ENT

⇒ STOP ID

16 ⇒ ENT

11 Change mode from table setup to measurement.

⇒ DONE

Before pressing the DONE key, any operation other than table setting operations are forbidden and the message "XX.er = Invalid Key !" is displayed. After setting up the table, press the DONE key to be able to set other parameters.

12 Input coupling conditions setup.

⇒ NEXT		
⇒ INPUT ⇒	CHANNEL **CH-A**/CH-B	At first, in order to set the input coupling of channel A, specify channel A.
⇒	COUPLING AC/**DC**	Choose the DC coupling.
⇒	+ INPUT **IN**/GND	Since the input mode is of the single-ended type, the positive input must be set to IN.
⇒	- INPUT IN/**GND**	For the same reason, the negative input has to be set to GND.
⇒	CHANNEL CH-A/**CH-B**	Switch now to channel B. As for channel A, choose a DC coupling, and a single-ended configuration.

13 Switch on the OPR key.

The OPR key's LED lights.

Note

When an offset is set, do not forget that an offset voltage is output from the output socket. When setting the operating point of a DUT by cut- and- tries, first, switch the OPR key on, then change the offset voltage to adjust it.

14 Press the START key.

The START key's LED lights.

In this case, the coherence function <Coh> and the frequency response function <Hab> are displayed in the double screen configuration.

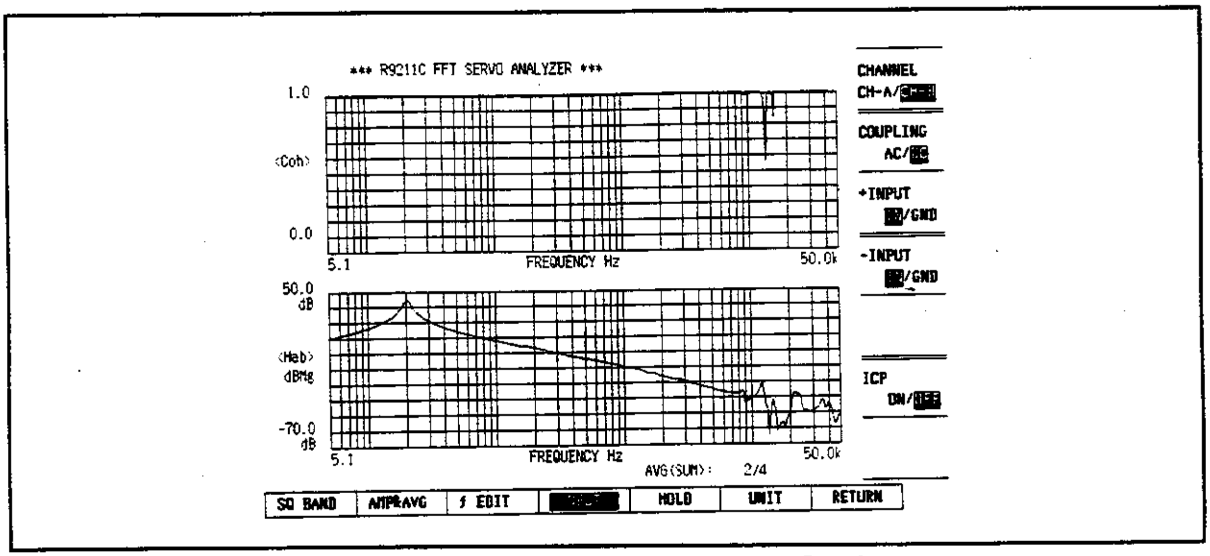


Figure 5-22 Example of Average Data Display

15 Visualize the averaged data.

VIEW ⇒ AVG VW ⇒ FRF — Display the FRF.

Note

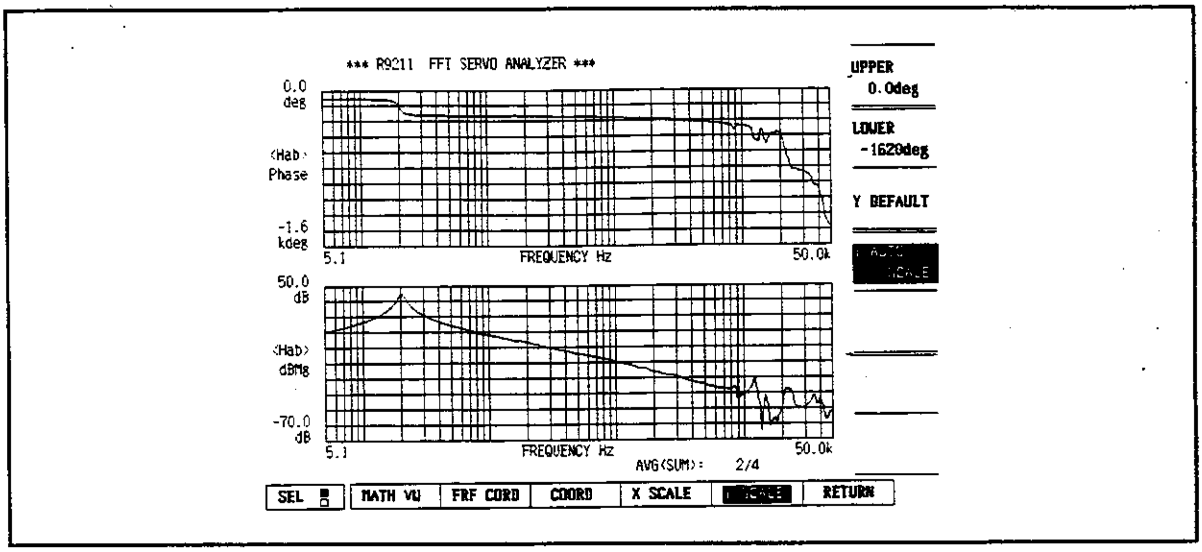
This operation may be omitted since the <Hab> data (lower screen) was previously selected when you started averaging.

⇒ NEXT

⇒ FRF CORD ⇒ BODE — A Bode diagram (phase and amplitude characteristics) is displayed. Two screens are displayed at the same time.

Note

A double screen configuration was previously selected when the servo analysis mode was set up. It is assumed here, that the lower screen is selected.



UPPER 0.0deg

LOWER -1620deg

AVG(SUM): 2/4

Figure 5-23 Bode Diagram

CHAPTER 6

FRF MODE

In this chapter, the analysis procedure in the FRF mode is explained, and all the necessary information about this mode is given. Finally, the FRF is illustrated through several examples.

CONTENTS

1. The FRF Mode

The FRF mode is used to measure the frequency response function of filters, structure etc. The input signal to the DUT is connected to channel A while the output signal is connected to channel B to measure the relationship between the input and output. The Coherence function will enable you to verify the reliability of the measurement. And, if you need, you can compute the impulse response function by applying an Inverse Fourier Transform to the Frequency Response Function.

Note
Since the input signal is not a swept signal, a signal generator other than the built-in SG can be used for the input.

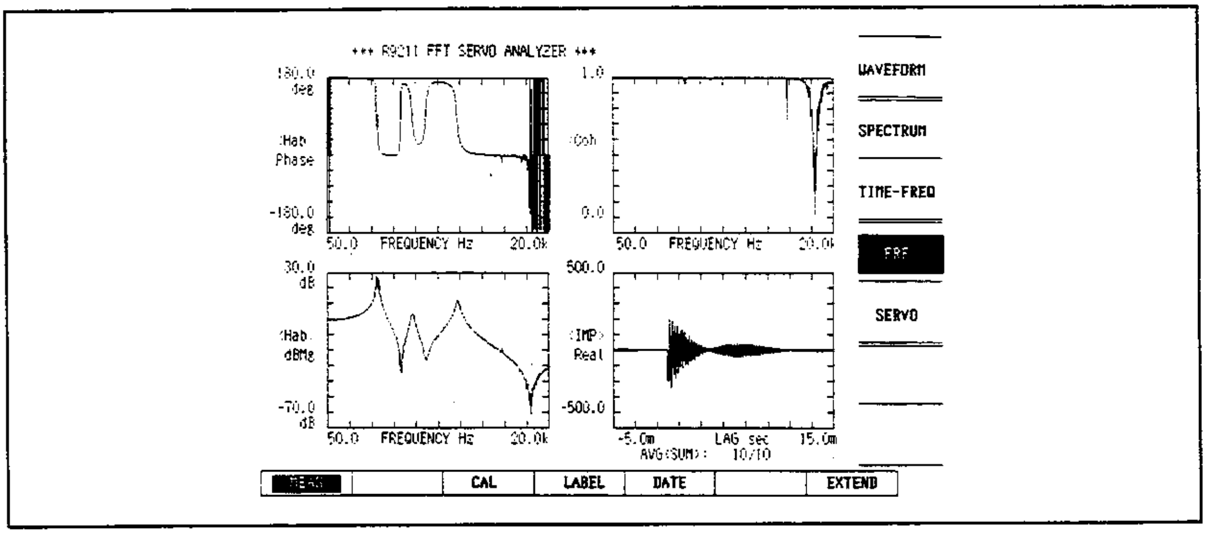


Figure 6-1 Typical Example of Display in the FRF Mode

2. Basic Setup Procedure

When measuring the frequency response function of a device (filter ...), you need a signal generator that can generate a signal at every frequency of the frequency span over which you want to know the FRF. Since white noise or maximum length sequence noise are made of frequency components distributed over a wide frequency range, either of these signals can be used as an input signal.
Following is a description of the measurement procedure of a filter, using a white noise generator.

1 Preparation

Connect the DUT (filter) and signal generator to the R9211.

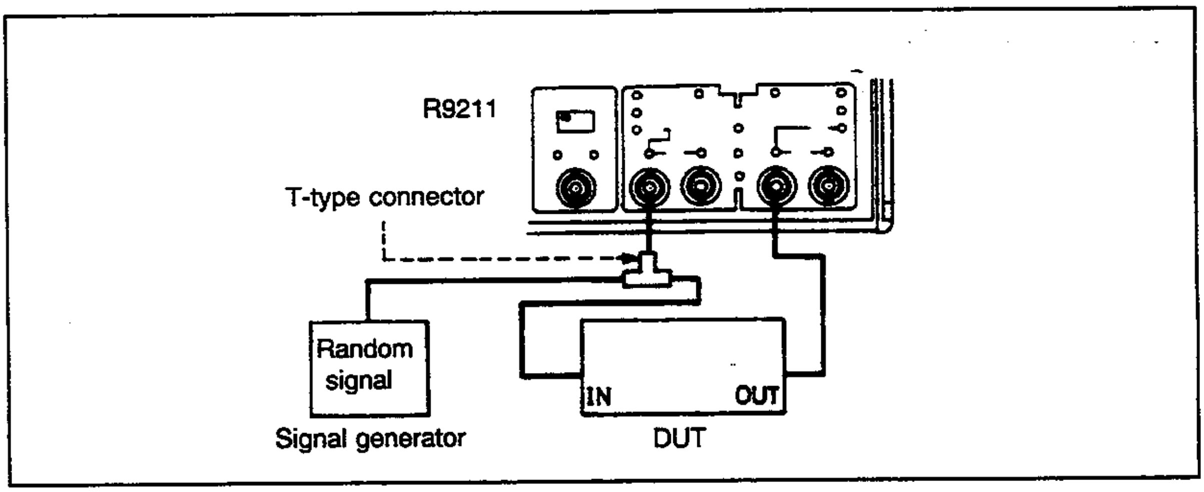


Figure 6-2 Connection Method

2 Mode selection

Select the FRF mode.

MODE ⇒ MEAS ⇒ FRF

3 Measurement conditions setup

Set the input sensitivity.

SETUP ⇒ SENS ⇒ CH-A AUTO/MAN — Choose the AUTO mode for channel A

⇒ CH-B AUTO/MAN — Choose the AUTO mode for channel B

4 Set the frequency range.

⇒ RANGE ⇒ FREQ RNG	Set the upper limit of the frequency range of the measurement. (If you know the FRF of the DUT, choose 100kHz)
20 ⇒ kHz	This is how you would enter 20kHz.

5 Set the input coupling conditions.

⇒ INPUT ⇒ CHANNEL	Select the channel for which the input conditions are to be set up.
⇒ CH-A/CH-B	
⇒ +INPUT IN/GND	Set the + INPUT to IN.
⇒ −INPUT IN/GND	Set the − INPUT to GND.
⇒ COUPLING AC/DC	Set the input coupling method (AC or DC).
	Set up the INPUT menu for both channels.

6 Select the Hanning window.

⇒ NEXT	Call the second page of the X soft menu.
⇒ WEIGHT ⇒ HANNING	

7 Set the averaging conditions.

⇒ [AVG] ⇒ AVG NO	Set the number of averages.
32 ⇒ [ENT]	This is how you would average 32 times.
[MODE] ⇒ [EXTEND] ⇒ TRACEonST ON/OFF	To display the FRF and the coherence function as the averaging is being processed, in the double screen configuration, set TRACEonST ON. If you set it to OFF, the current screen is displayed with no transformation from the beginning of the averaging process until its end : you don't see the evolution averaging induces on the FRF and coherence function.
[VIEW] ⇒ [TYPE] ⇒ DUAL	

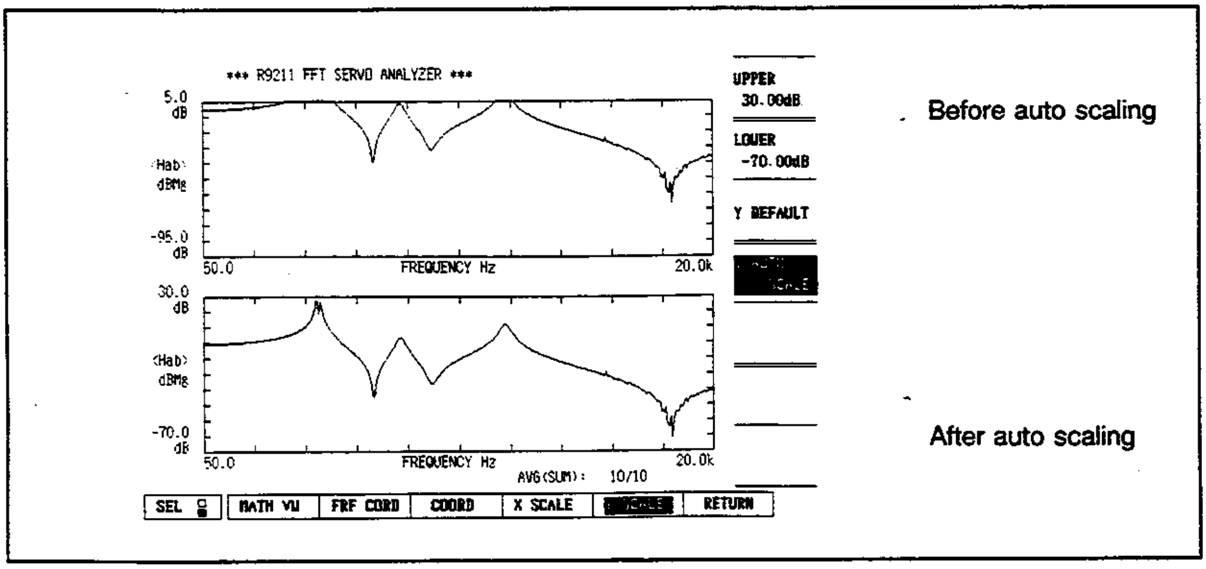
8 Switch the [START] key ON.

The averaging process starts.

When the [START] key LED goes off, indicating that the averaging process is completed, check the measurement results.

9 Visualize the measurement results.

[VIEW] ⇒ [AVG VW] ⇒ FRF	
⇒ [NEXT]	
⇒ [FRF CORD] ⇒ BODE	Display a Bode diagram.
⇒ [Y SCALE] ⇒ Y AUTO SCALE	Adjust the Y scale of the lower screen.
⇒ [SEL ▀] ⇒ Y AUTO SCALE	Select the upper screen to adjust its Y scale.



Before auto scaling

After auto scaling

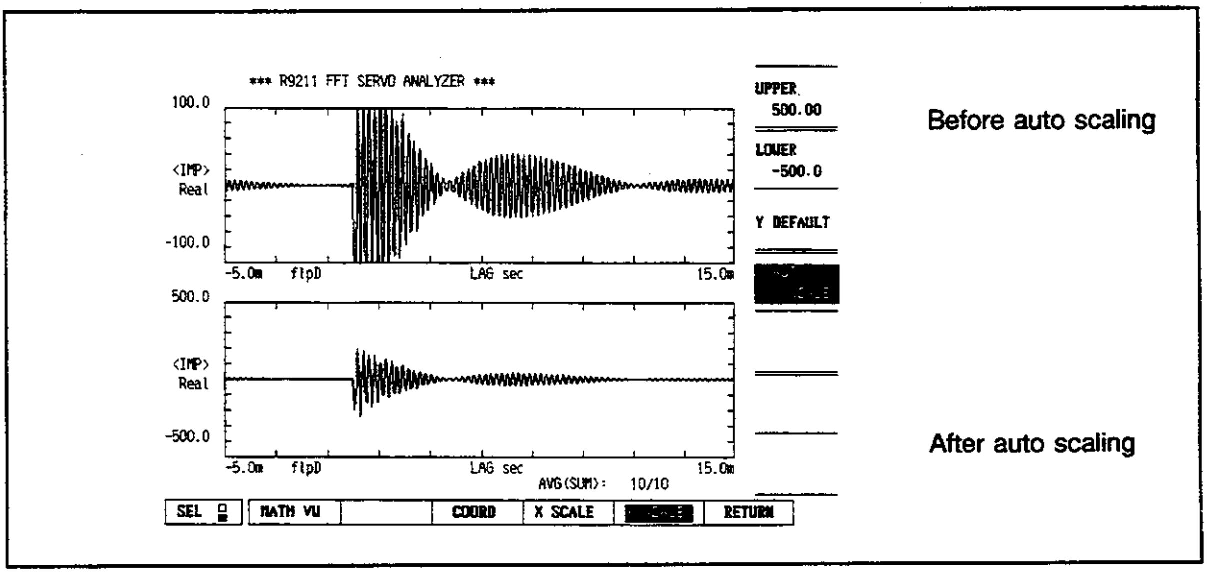
Figure 6-3 Bode Diagram

⇒ NEXT — Visualize the impulse response.

⇒ AVG VW ⇒ IMPULSE RESPONSE

⇒ NEXT

⇒ Y SCALE ⇒ Y AUTO SCALE — Adjust the Y-axis scale.



Before auto scaling

After auto scaling

Figure 6-4 Impulse Response Function's Graph

3. Toward Better Measurement

Force and Response Windows

Since the impulse wave is generated during a short period of time, the signal power is low and it is easily affected by noise elements. To prevent this, non-signal portions are replaced with zeros to cancel the influence of the noise components. This is performed by multiplying the signal by a so-called force window.
If the impulse response is not damped within the frame time, a clipping error is caused by the time window. In this case, the response waveform is multiplied by the exponential function to damp the impulse response within the frame time, thus recovering the clipping error.
If it is so specified in the setup, channel A's waveform is automatically multiplied by a force window, while channel B's waveform is multiplied by a response window, and then the results are displayed.

- **Settig the Force Window**

SETUP ⇒ WEIGHT ⇒ FORCE/ RESPONSE

⇒ SET CHANN CH-A/CH-B — Select CH-A to multiply it by a force window.

⇒ SET WND FORC/RESP — Select FORC.

⇒ START TIM — Set the force window's start time.

20 ⇒ ENT — For the unit, see the table below.

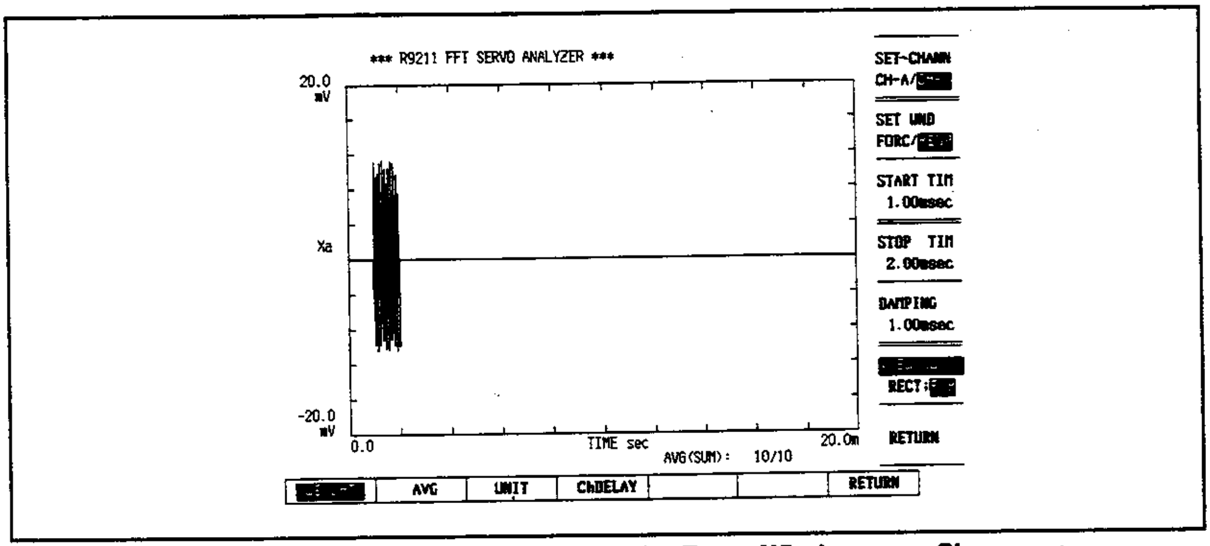
⇒ STOP TIM — Set the force window's end time.

30 ⇒ ENT — For the unit, see the table below.

- **Setting the Force/Response Windows' Start and End Times**

A value greater than the end time value cannot be specified as the start time value. When the start time value, which you want to set, is bigger than the end time value actually set (from the preceding setup), you must first set the new end time value, and only then can you set the new start time value. In the same way, a value smaller than the start time cannot be specified as the end time. When the new end time value is smaller than the previously set start time value, the new start time value must be set before the end time value is changed.
The unit of time is determined depending on the frequency range as follows:

Frequency range	Unit
100kHz to 500Hz	μsec
200Hz to 500mHz	msec
200mHz to 10mHz	sec



SET-CHANN CH-A/

SET WND FORC/

START TIM 1.00msec

STOP TIM 2.00msec

DAMPING 1.00msec

RECT:

Figure 6-5 Effect of the Application of the Force Window on a Sine-wave

⇒ SET CHANN CH-A/CH-B	Select CH-B to multiply it by a response window.
⇒ SET WND FORC/RESP	Select RESP.
⇒ START TIM	Set the response window's start time.
⇒ STOP TIM	The end time value of the response window has no meaning ; however, it must be greater than the start time value.
⇒ DAMPING	Set the response window damping time.

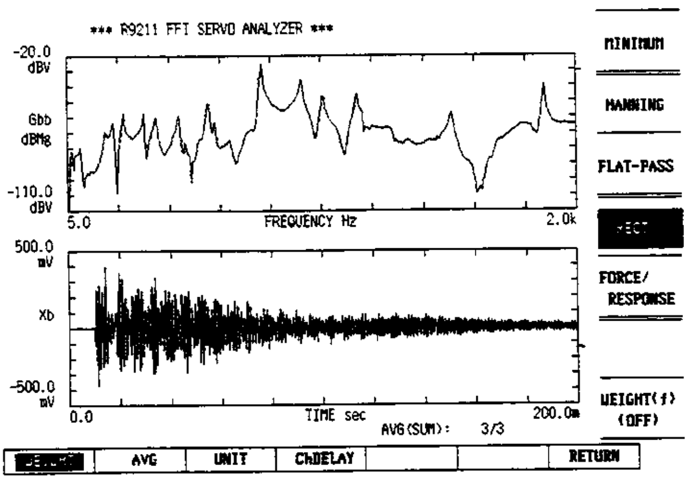


Figure 6-6 A Response Waveform which is not Damped within the Frame Time

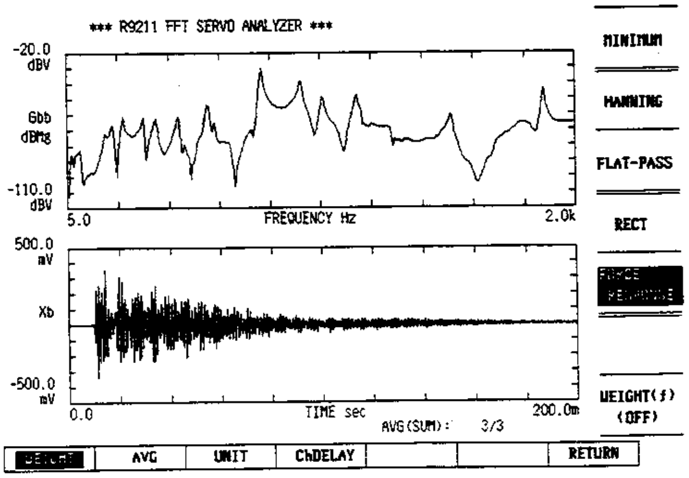


Figure 6-7 A Response Waveform Artificially Damped within the Frame Time

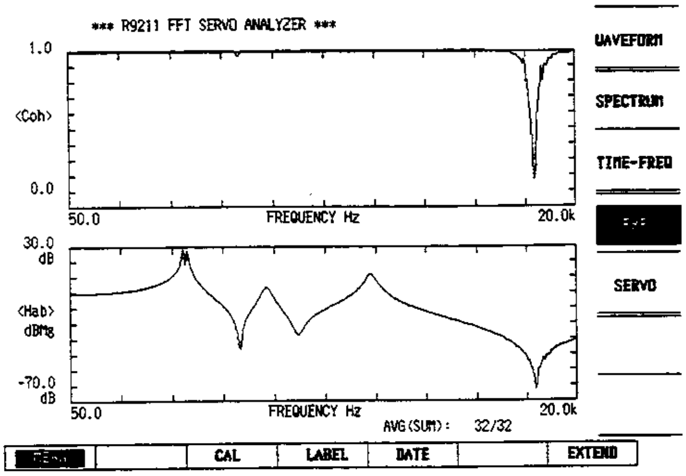
How to Check the Measurement Results

When you measure a FRF, it is important that you check the coherence function. Indeed, if the DUT seems to function non-linearly, or if some extraneous noise perturbs the measurement, or if there is another source of signal, measurement reliability cannot be checked using only the FRF. For this reason, the cause-effect relationship between the input signal and the output signal must be checked with the coherence function.
The coherence function takes its values between 0 and 1. The closer the coherence function is to 1, the stronger the cause-effect relationship between the input and the output, therefore meaning that the FRF results are reliable.
Conversely, the closer the coherence function comes to 0, the weaker the cause-effect relationship between input and output : the FRF results are not reliable and do not characterize the system's behavior.
Thus, whether the measurement method and point are suitable can be verified by analyzing the coherence function.

How to Visualize the Coherence Function

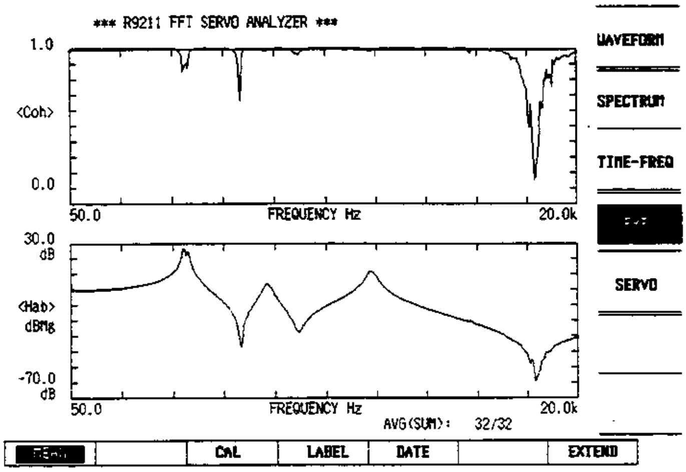
VIEW ⇒ TYPE ⇒ DUAL	Select the double screen configuration. If both the coherence function and FRF are displayed simultaneously, the frequency at which the reliability is low can be easily identified.
⇒ SEL ⬒	
⇒ AVG VW ⇒ COHERENCE	Display the coherence function on the upper screen.
⇒ SEL ⬓ ⇒ FRF	Display the FRF on the upper screen.

Figures 6-8 and 6-9 show the results obtained when the same filter is analyzed with a multi-sine waveform and a pseudo random waveform.



The coherence is high, thus implying that the reliability of the measurement is also high.

Figure 6-8 Frequency Response Function Obtained with a Multi-sine Wave



The coherence is low at some points. We therefore know that the reliability of the measurement is low at these antiresonance and resonance points.

Figure 6-9 Frequency Response Function Obtained with a Pseudo Random Wave

Delayed Systems Analysis (Interchannel Delay)

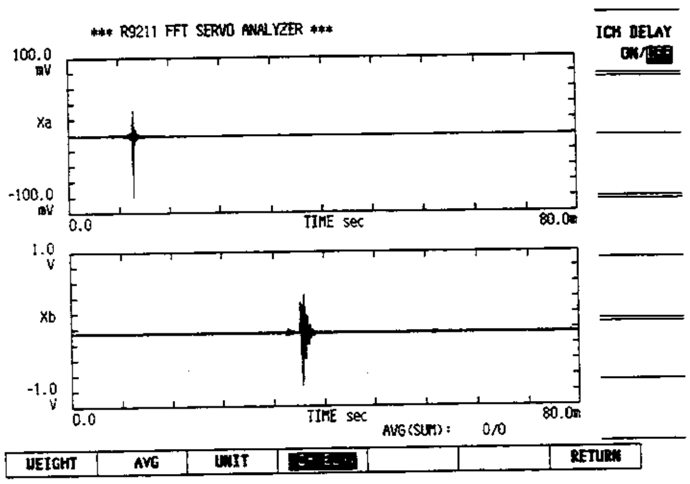
If there is a delay between the input and the output, the output signal is affected by sources of signal other than the input signal, which reduces the coherence and increases the frequency response function error. By using the interchannel delay function, you can compensate the delay between the input and the output signals inside the R9211. Thus, you can measure the frequency response function accurately.

SETUP ⇒ NEXT

⇒ ChDELAY ⇒ ICH DELAY ON/OFF — Switch on ICH DELAY.

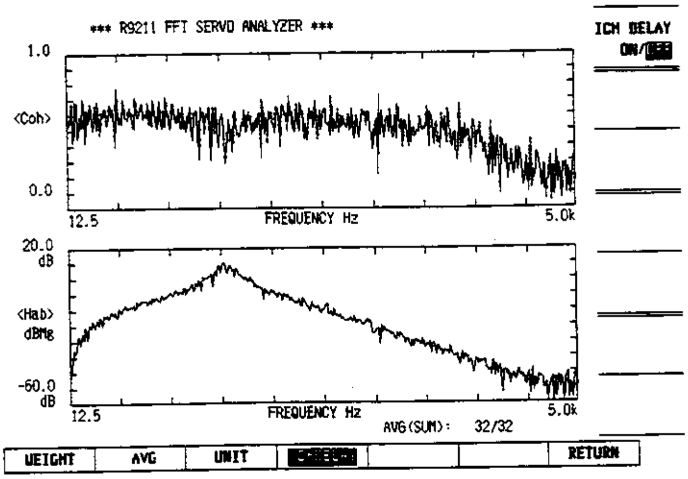
⇒ DELAY T XXX msec — Take Channel B as reference : if channel A's signal is late compared to channel B's, set a positive delay, if channel A's signal is earlier than channel B's, set a negative delay. (Resolution: sampling interval)

Say you want to measure a system whose input and output are similar to those represented in Figure 6-10. Since channel B's signal is 26ms late compared to channel A's, if you undertake the measure as you would for a normal system, the reliability of the FRF would be low, which is indicated by a small coherence function.



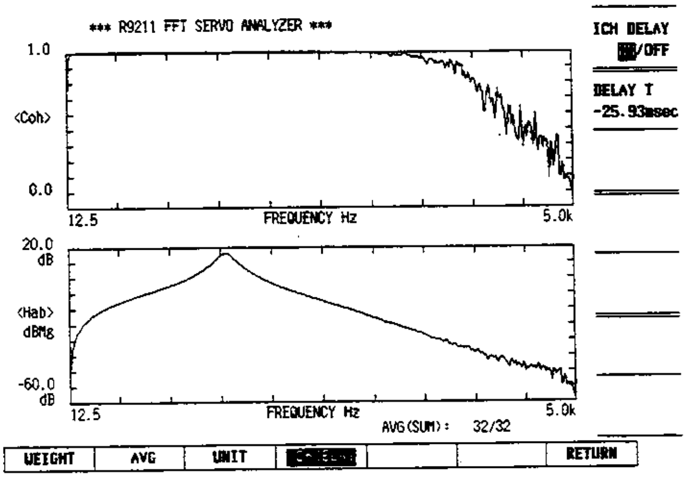
Response of a delayed system to an impulse :
Xa : Input waveform
Xb : Output waveform
CH-B is about 26ms late compared to channel A.

Figure 6-10 Input and Output Signals of a Delayed System



The very small coherence function demonstrates the poorness of the measurement if no precaution is taken.

Figure 6-11 FRF Measurement of a Delayed System



Since channel A's signal is in advance of channel B's, if we set a −25.93ms interchannel delay, we will increase the reliability of the FRF measurement which is clearly shown by the coherence function.

Figure 6-12 FRF Measurement of a Delayed System after Compensating the Delay between Input and Output Signals

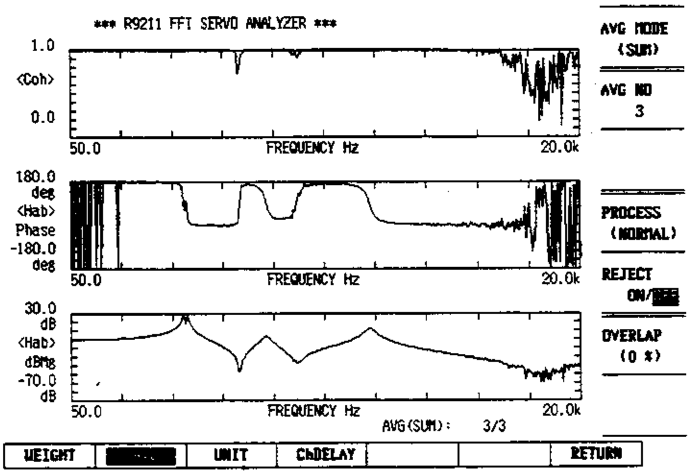
Averaging

To measure a FRF, you must average the signal. By averaging, both the FRF measurement's reliability and state can be guaranteed. When some extraneous noise perturbs the measurement, averaging improves the Signal-to-Noise Ratio.

SETUP ⇒ **NEXT**

⇒ **AVG** ⇒ AVG NO

30 ⇒ **ENT** To average 30 times



AVG MODE (SUM)

AVG NO 3

PROCESS (NORMAL)

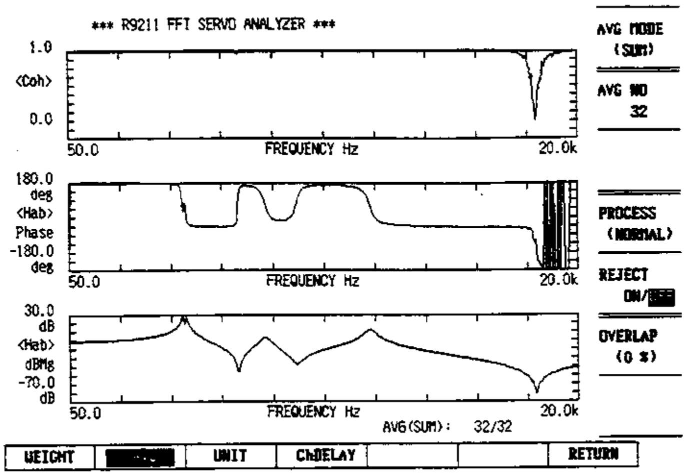
REJECT ON/OFF

OVERLAP (0 %)

AVG(SUM): 3/3

Averaging is done only three times :
The coherence is small and the phase is inaccurate.

Figure 6-13 Average Example 1



AVG MODE (SUM)

AVG NO 32

PROCESS (NORMAL)

REJECT ON/OFF

OVERLAP (0 %)

AVG(SUM): 32/32

Averaging is done 32 times. The coherence becomes larger and the phase is more accurate.

Figure 6-14 Average Example 2

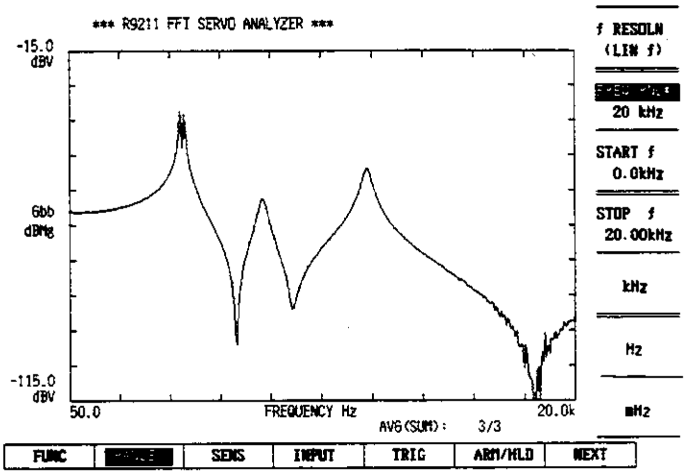
Frequency Range, Number of Lines, and Zoom

To obtain a highly reliable measurement result, it is essential to select the measurement frequency range and resolution according to the characteristics of the DUT.

How to Set the Frequency Range

SETUP ⇒ RANGE ⇒ FREQ RNG

20 ⇒ kHz To set a frequency range of [0 ; 20kHz], type this sequence.



START f 0.0kHz

STOP f 20.00kHz

AVG(SUM): 3/3

Figure 6-15 Setting the Frequency Range

How to Set the Frequency Resolution

SETUP ⇒ RANGE ⇒ f RESOLN (LIN f)

⇒ LINE/SPAN

800 ⇒ ENT To set a frequency resolution of 800 lines.

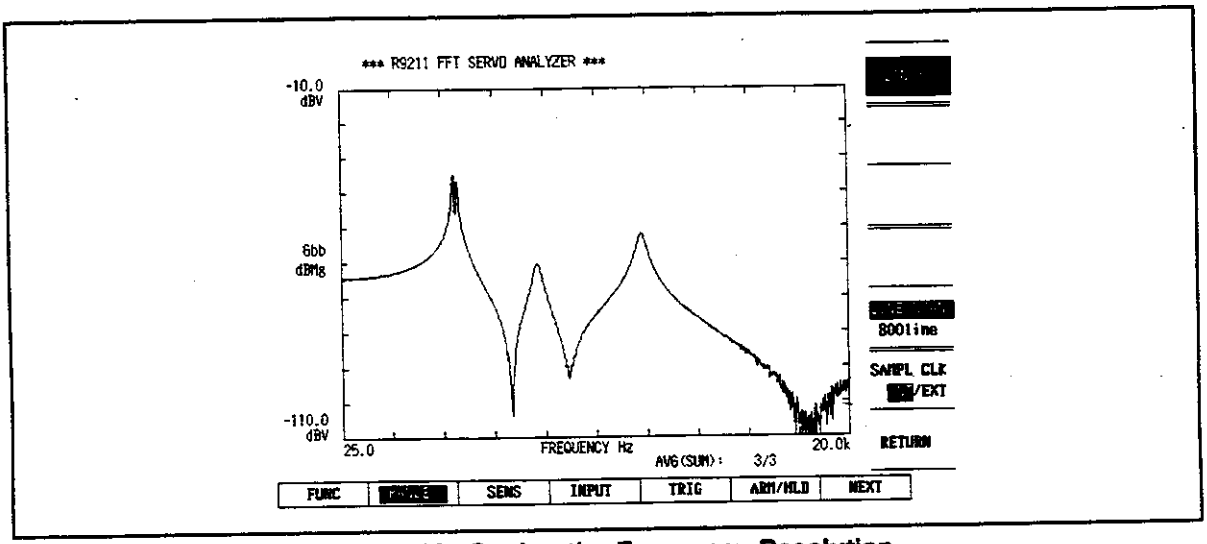


Figure 6-16 Setting the Frequency Resolution

- **Zoom**

When you want to analyze, in detail, only a specific frequency domain, you can use the frequency zoom. A complex characteristics filter possesses several poles and zero. First, obtain the FRF over the entire frequency range, then analyze each pole and zero (resonance points), in detail, with the frequency zoom.
In the menu, specify the start and end frequencies of the domain to be zoomed in.

Note

The zoom function is provided only on the R9211C.

SETUP ⇒ RANGE ⇒ START f Set the start frequency.

10 ⇒ kHz

⇒ STOP f Set the end frequency.

20 ⇒ kHz

If you press the START f or STOP f , a * mark appears to show that the specified domain is being zoomed in.

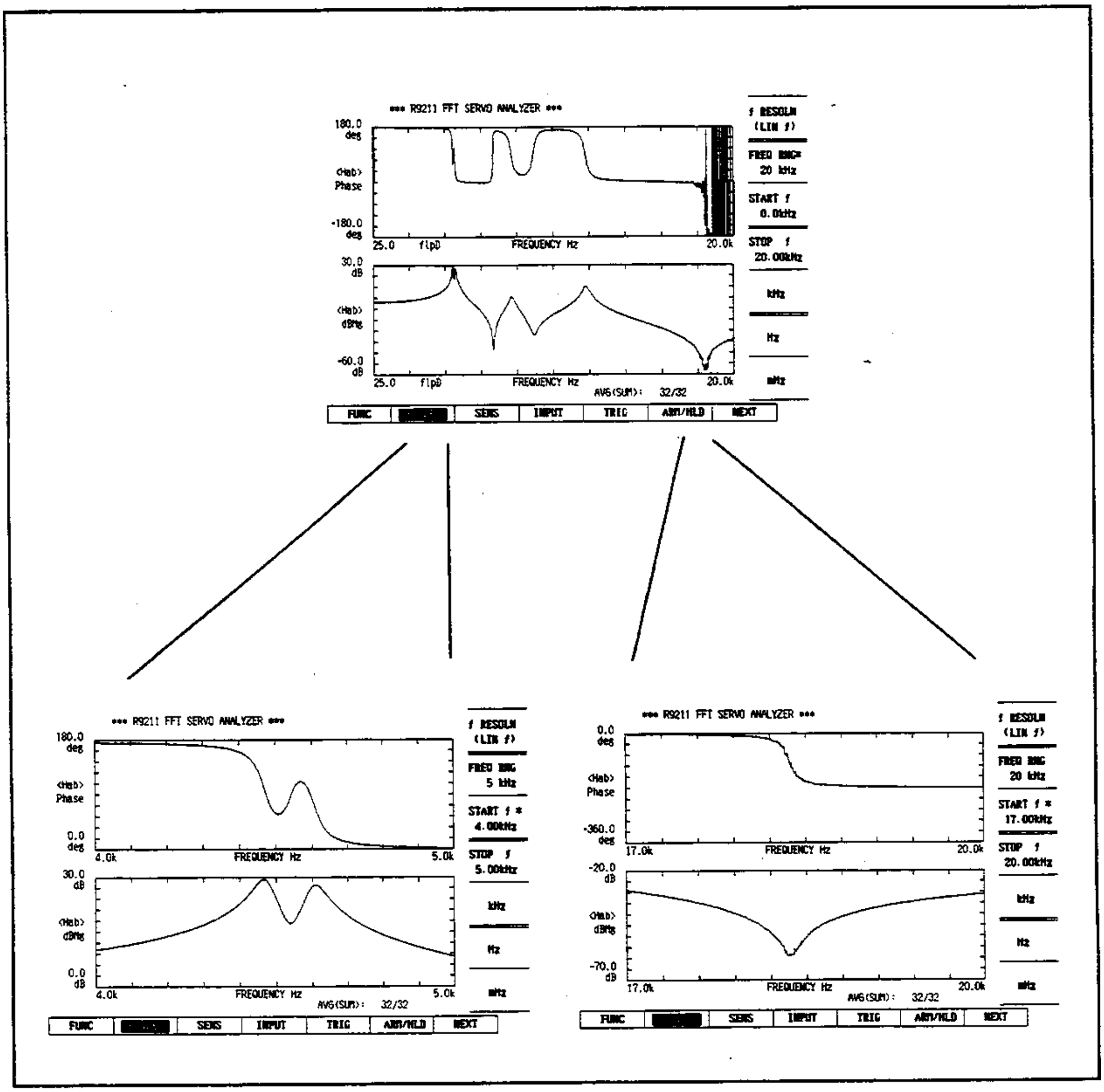


Figure 6-17 Zoom

Measuring the SNR (Signal-to-Noise Ratio)

The SNR (signal-to-noise ratio) is defined as the ratio of the power spectrum of the signal to that of the noise. It can be calculated with the coherence function.

$$<SNR> = \frac{<Gss(f)>}{<Gnn(f)>} = \frac{<COP>}{<In\ COP>} = \frac{<COH><Gbb>}{(1-<COH>)<Gbb>}$$

<Gss(f)> : Power spectrum of the signal
<Gnn(f)> : Power spectrum of the noise
<COP> : Coherent output power spectrum (generated only when an input signal is applied to the DUT)
<In COP> : Power spectrum of the noise
<COH> : Coherence function
<Gbb> : Power spectrum of the DUT's output

VIEW ⇒ AVG VW ⇒ COHERENCE ------------------ Display the coherence function.

MATH ⇒ FRF MTH ⇒ MATH SEL ⇒ OPERAND --- Register the displayed coherence function as an operand.

⇒ RETURN

⇒ SNR ⇒ SNR --- Select the SNR computation.

⇒ RETURN

⇒ MATH SEL ⇒ 1st OPRTR --- Register the selected SNR computation as a first operator.

⇒ DO MATH --- Execute the SNR computation (SNR).

VIEW ⇒ NEXT ⇒ MATH VW

⇒ MATH VW ⇒ RESULT ARRAY --- Display the SNR.

4. Typical Measurement Examples

Measurement with an Impulse Hammer

The impulse hammer is used to rapidly analyze the frequency response function of a structure.
The fact that a pulse possesses frequency components over a wide range, enables a complete analysis in a very short time. To analyze the mechanical vibration modes of a structure, provide the head of the hammer with a pickup and measure the frequency response function between this pickup and a second pickup located on the DUT. This method requires only simple measurement equipment and it can be used readily for analyzing vibrations of a large structure such as an engine block.
A power supply unit for accelerometers is built into the R9211. If you use an accelerometer provided with a built-in amplifier, you can readily measure the vibration modes of the DUT without the necessity of using an extraneous power supply unit or an amplifier.

REFERENCE
For more detailed information about the built-in power supply unit for accelerometers, refer to what concerns the ICP (Integrated Circuit Piezoelectric) : p4-9, 4-10, 9-19.

1 Be sure to fix the accelerometer on the structure so that it will not move.

The following measurement procedure's description assumes that the accelerometer, which is used, is provided with a built-in amplifier.

2 Connect the accelerometer to the R9211. (See Figure 6-18.)

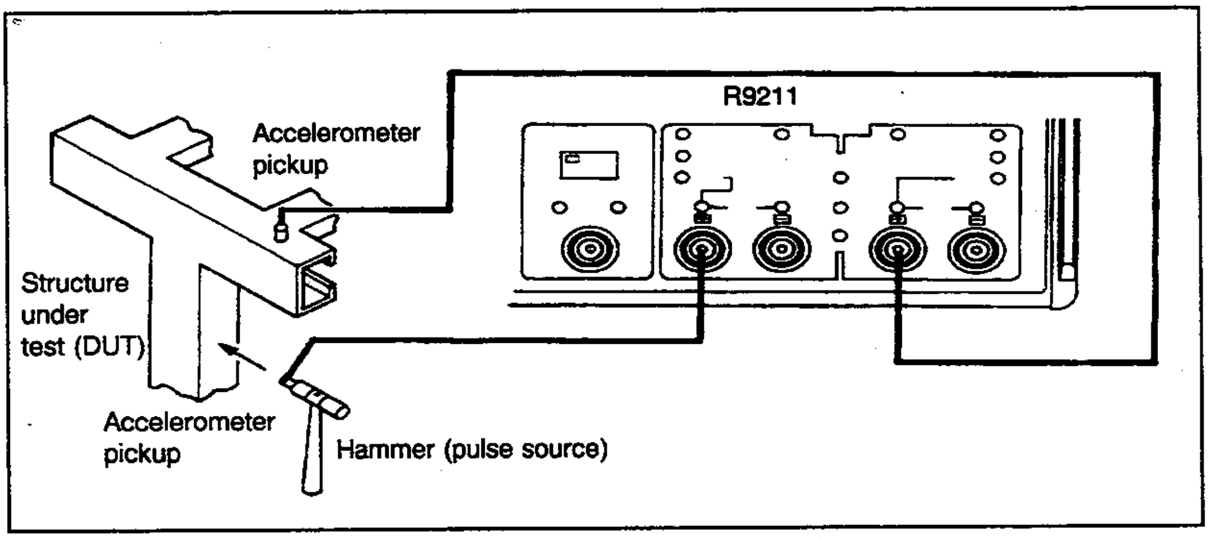


Figure 6-18 Connection of the Impulse Hammer

Note
Connect the pickups to the + sockets of channels A and B.

3 Select the FRF mode.

MODE ⇒ MEAS ⇒ FRF

4 Select the rectangular window (RECT).

SETUP ⇒ NEXT

⇒ WEIGHT ⇒ RECT

5 Set the input coupling conditions.

⇒ NEXT	
⇒ INPUT ⇒ CHANNEL CH-A/CH-B	Select the channel you are now going to set up.
⇒ ICP ON/OFF	When ICP is switched on, the input coupling automatically becomes AC.

6 Set the input sensitivity.

⇒ SENS ⇒ SET CH-A	Set the input sensitivity of channel A.
−5 ⇒ ENT	To enter −5 dBV.
⇒ SET CH-B	Set channel B in the same way.

7 Set the frequency range.

⇒ RANGE ⇒ FREQ RNG	Set the maximum frequency of the range.
200 ⇒ Hz	To enter 200Hz.

8 Measurement conditions setup

Set the trigger conditions.

⇒	TRIG ⇒ SOURCE	Select channel A as the trigger source.
⇒	CH-A	
⇒	RETURN	
⇒	SLOPE	
⇒	+SLOPE	Trigger along the positive slope.
⇒	RETURN	
⇒	LEVEL	The displayed unit is then adopted.
100 ⇒	ENT	Enter 100 to set 0.1V when the unit is mV.
⇒	HYSTERESI	Set the hysteresis level.
5 ⇒	ENT	Enter 5 to set 5mV when the unit is mV.
⇒	DELAY	Set the triggering position.
1 ⇒	msec	Enter 1 to set 1ms.
⇒	RETURN	

Set the averaging conditions.

⇒ AVG ⇒ PROCESS	
⇒ +1 AVG	Set +1 AVG.
⇒ RETURN	
⇒ AVG NO	Set the averaging count.
10 ⇒ ENT	Enter 10 to average 10times.

With the +1 AVG mode, data are acquired in the arm or auto arm mode and are checked while averaging is being performed.

⇒ ARM/HLD ⇒ AUTO ARM	Select the auto arm mode.
VIEW ⇒ TYPE ⇒ DUAL	To allow the acquired data to be checked, select the double screen configuration.
⇒ INST VW ⇒ CH-A TIME	Display the time waveform input to channel A.
⇒ SEL ⬒ ⇒ CH-B TIME	Display the time waveform input to channel B.

Generate vibrations with the impulse hammer to adjust the trigger level so that the HOLD lamp between the connectors of channels A and B lights. If the OVER lamp of each channel lights, cancel the auto arm mode (FREE RUN) and adjust the input sensitivity.

MODE ⇒ EXTEND ⇒ TRACEonST ON/OFF	Set TRACEonST to OFF to forbid screen evolution according to the averaging process.

10 Switch the START key ON.

11 Generate vibrations with the impulse hammer.

Observe the data acquired at both channels. If what you observe is correct, press the STOP/C key to start averaging.

Again, generate vibrations with the hammer and press the STOP/C key if the data are correct, until the START key's lamp dies out, thus indicating the completion of averaging.

12 Visually check the measurement results.

VIEW ⇒ AVG VW ⇒ FRF Display a Bode diagram.

NEXT

FRF CORD ⇒ BODE

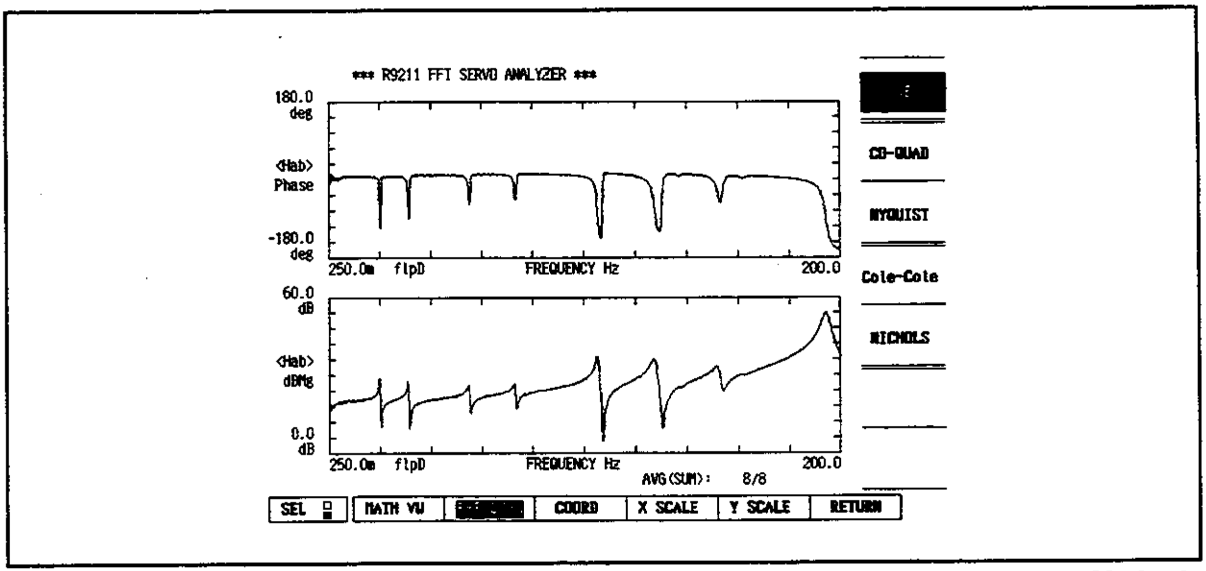


Figure 6-19 Bode Diagram Obtained for a Measurement using the Impulse Hammer Method

Example of Measurement Using the Built-in SG (Multi-Sine Wave)

In the following example, a multi-sine wave generated by the built-in SG is used to test a filter.

1 Connect the DUT (filter) to the R9211.

When you use the built-in SG, connect the DUT to the R9211 as shown in Figure 6-20. When you use an external SG, connect it and the DUT as shown in Figure 6-2.

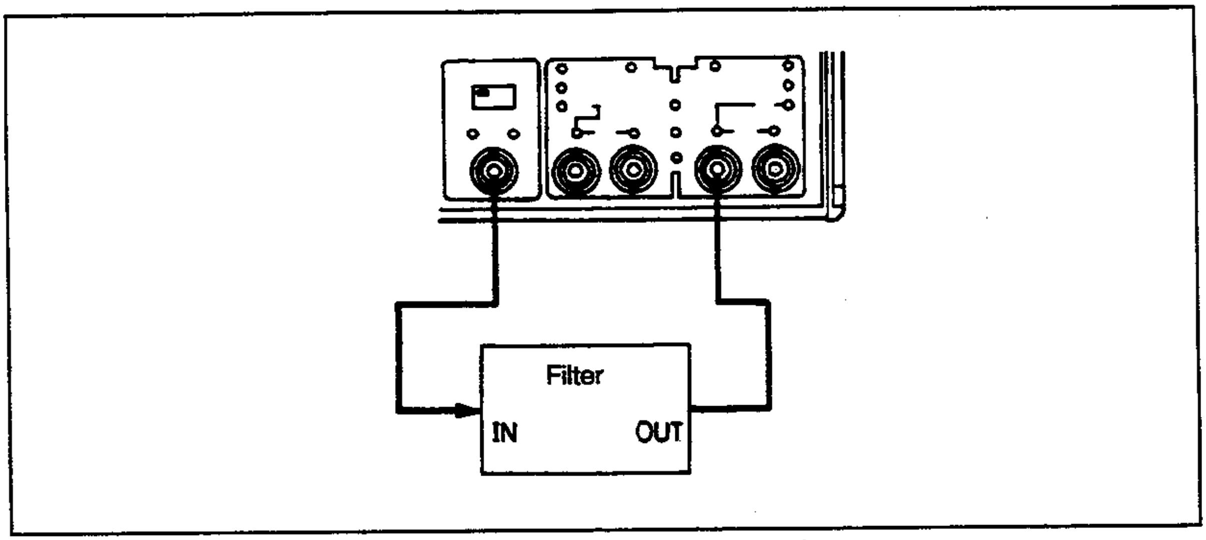


Figure 6-20 Connection Method

2 Select the FRF mode.

MODE ⇒ MEAS ⇒ FRF

3 Set the input sensitivity.

SETUP ⇒ SENS ⇒ CH-A AUTO	Choose the AUTO mode for CH-A.
⇒ CH-B AUTO	Choose the AUTO mode for CH-B.

4 Set the frequency range.

⇒ RANGE ⇒ FREQ RNG	Set the upper limit of the frequency range. (If the FRF of the DUT is unknown, set 100kHz.)
50 ⇒ kHz	To set 50kHz.

5 Set the input coupling conditions.

⇒ INPUT ⇒ CHANNEL CH-A/CH-B	Select the channel you are now going to set up.
⇒ +INPUT IN/GND	Set the + INPUT to IN.
⇒ −INPUT IN/GND	Set the − INPUT to GND.
⇒ COUPLING AC/DC	Set the input coupling method. Set AC here.

Set such conditions for both channels.

6 Select the rectangular window (RECT).

⇒ NEXT	Call the second page of the X softmenu.
⇒ WEIGHT ⇒ RECT	

7 Set the signal generation control parameters.

SG CONT ⇒ SIGNAL ⇒ M-SINE	Select a multi-sine wave.
⇒ SG VLT ⇒ AMPLITUDE	Set the output voltage of the signal generator.
0.5 ⇒ V	Set ±0.5V.

↓

⇒ CONNECT ⇒	to ChA	Internally connect the SG's output to CH-A.
⇒ OUT CTRL ⇒	GENERATOR START	Start the signal generation.
OPR		From now on, the generated signal is actually output from the SG's output socket.

Thus, you can check the DUT's input and output signals on the screen. You will adjust the frequency range and signal amplitude while observing the spectrum of channel B's signal.

8 Adjust the settings according to the characteristics of the DUT.

Reset the frequency range according to your observation of the spectrum of Channel B's signal.

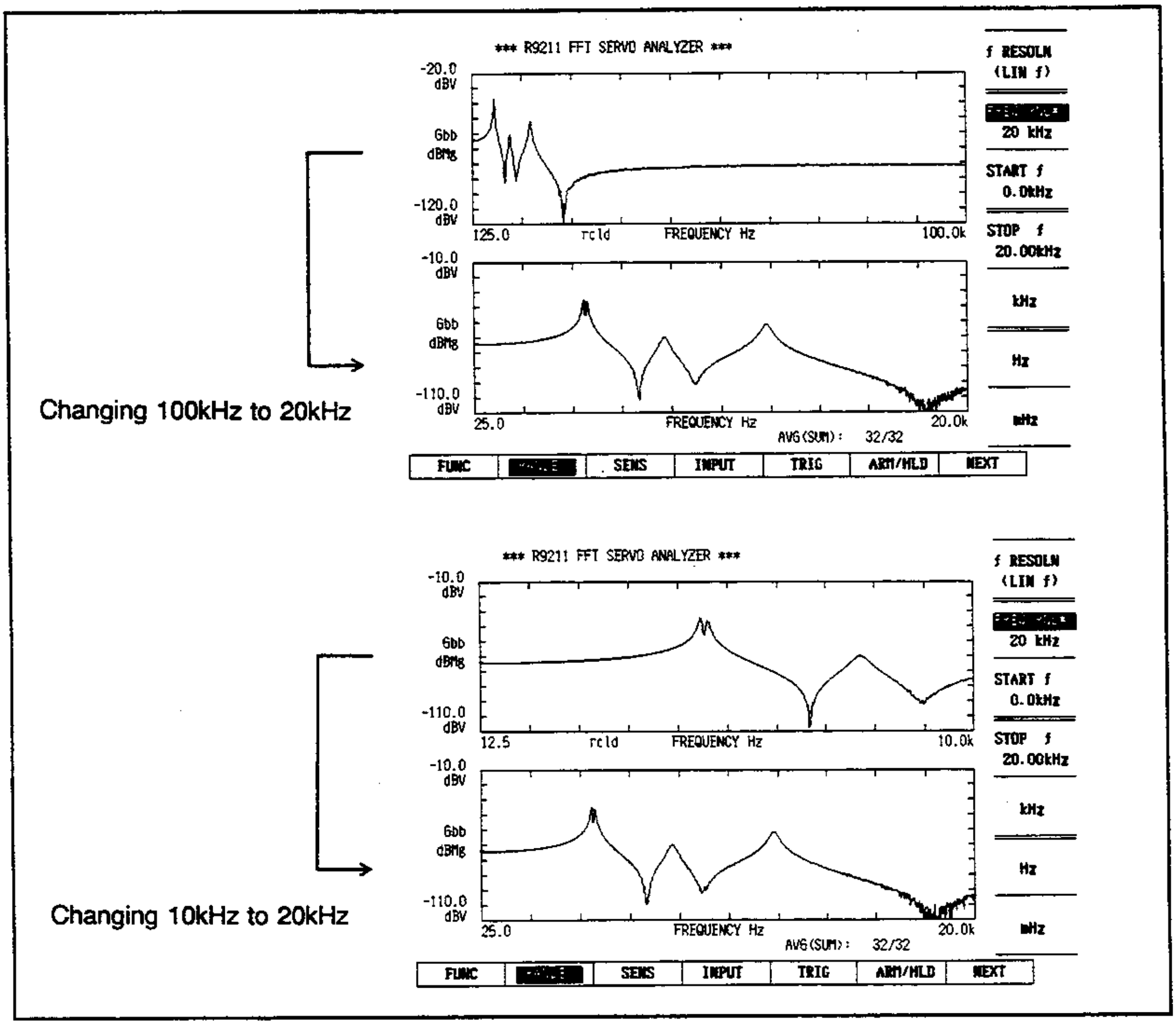


Figure 6-21 Resetting the Frequency Range

9 Adjust the signal generator's control parameters.

When the signal is distorted, make the following adjustments:

Linear system : Reduce the SG's signal amplitude.
Nonlinear system : Use the RANDOM or servo mode.

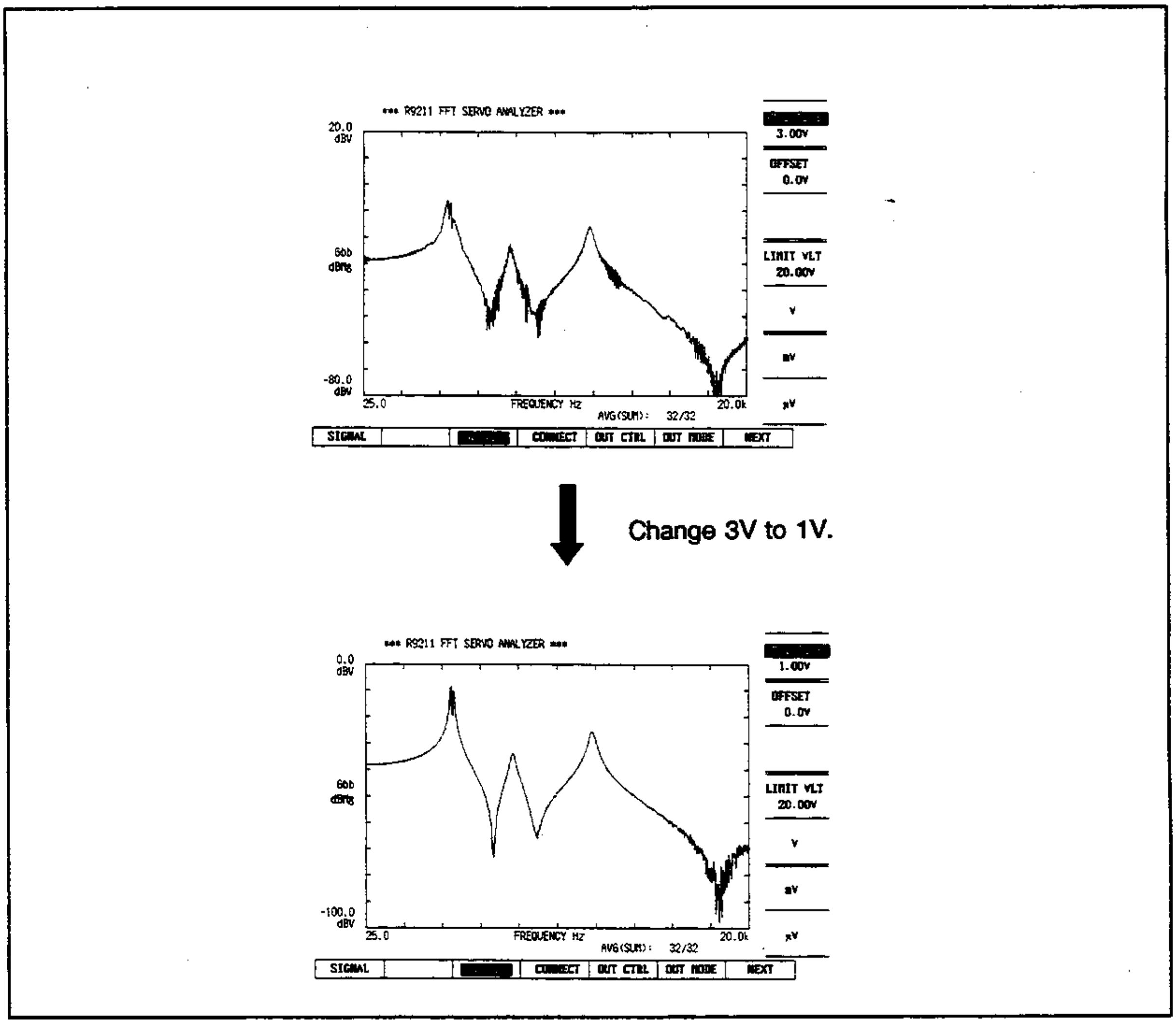


Figure 6-22 Signal Amplitude Adjustment

10 Set the averaging conditions.

SETUP ⇒ NEXT	Call the second page of the X soft menu.
⇒ AVG ⇒ AVG NO	Set the number of averages.
10 ⇒ ENT	To enter 10.

MODE ⇒ EXTEND ⇒ TRACEonST ON/OFF — Switch on TRACEonST to display, on the CRT, the coherence and FRF evolution as averaging progresses.

VIEW ⇒ TYPE ⇒ DUAL

11 Switch the START key on.

Start averaging.

When the START key's lamp dies out indicating the completion of the averaging process, check the measurement results.

12 Visualize the measurement results.

VIEW ⇒ AVG VW ⇒ FRF — Display a Bode diagram.

⇒ NEXT

⇒ FRF CORD ⇒ BODE

⇒ Y SCALE ⇒ Y AUTO SCALE — Adjust the Y scale on the upper and lower screens.

⇒ SEL ⊟ ⇒ Y AUTO SCALE

⇒ NEXT — Display the impulse response.

⇒ AVG VW ⇒ IMPULSE RESPONSE

⇒ NEXT

⇒ Y SCALE ⇒ Y AUTO SCALE — Adjust the Y scale.

Example of Measurement Using the Built-in SG (Pseudo Random Wave)

In the following example, a pseudo random wave generated by the built-in SG is used to test a filter.

1 Connect the DUT (filter) to the R9211.

When using the built-in SG, connect the DUT to the R9211 as shown in Figure 6-22. When using an external SG, connect it and the DUT as shown in Figure 6-2.

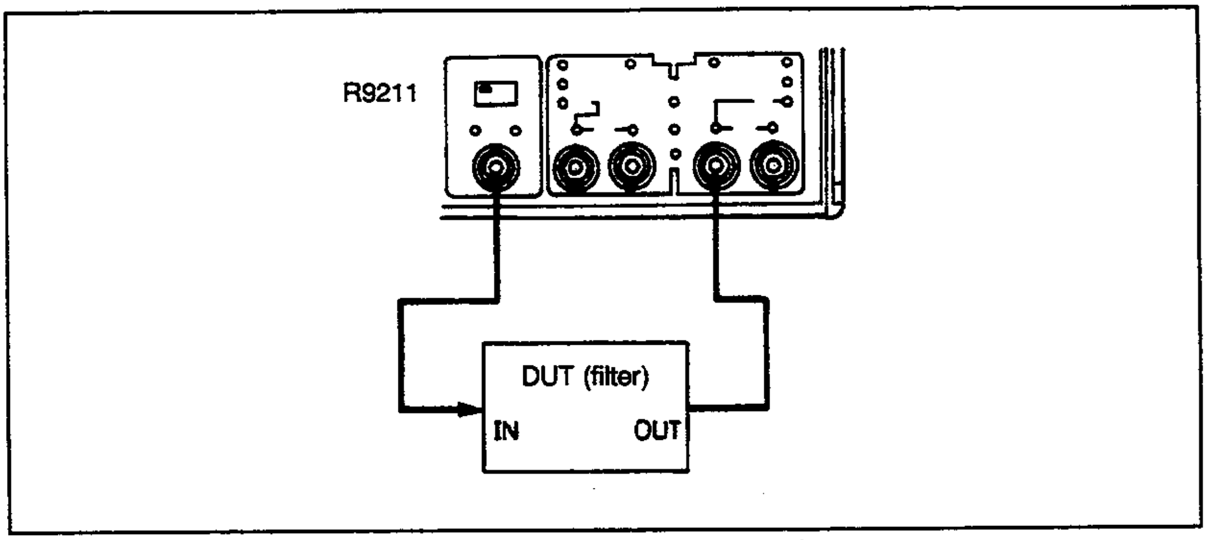


Figure 6-23 Connection Method

2 Select the FRF mode.

MODE ⇒ MEAS ⇒ FRF

3 Set the input sensitivity.

SETUP ⇒ SENS ⇒ CH-A AUTO Choose the AUTO mode for CH-A.

⇒ CH-B AUTO Choose the AUTO mode for CH-B.

4 Set the frequency range.

⇒ RANGE ⇒ FREQ RNG	Set the upper limit of the frequency range. (If the FRF of the DUT is unknown, set 100kHz.)
50 ⇒ kHz	To set 50kHz.

5 Set the input coupling conditions.

⇒ INPUT ⇒ CHANNEL CH-A/CH-B	Select the channel you are now going to set up.
⇒ +INPUT IN/GND	Set the + INPUT to IN.
⇒ −INPUT IN/GND	Set the − INPUT to GND.
⇒ COUPLING AC/DC	Set the input coupling method. Set AC here.
	Set such conditions for both channels.

6 Select the Hanning window.

⇒ NEXT	Call the second page of the X softmenu.
⇒ WEIGHT ⇒ HANNING	Select the Hanning window.

7 Set the signal generation control parameters.

SG CONT ⇒ SIGNAL ⇒ RANDOM	Select a pseudo random wave.
⇒ SG VLT ⇒ AMPLITUDE	Set the output voltage of the signal generator.
0.5 ⇒ V	Set ±0.5V.

↓

⇒ CONNECT ⇒ to ChA	Internally connect the SG's output to CH-A.
⇒ OUT CTRL ⇒ GENERATOR START	Start the signal generation.
OPR	From now on, the generated signal is actually output from the SG's output socket.

8 Set the averaging conditions.

SETUP ⇒ NEXT	Call the second page of the X soft menu.
⇒ AVG ⇒ AVG NO	Set the number of averages.
10 ⇒ ENT	To enter 10.
MODE ⇒ EXTEND ⇒ TRACEonST ON/OFF	Switch on TRACEonST to visualize the coherence and FRF evolution as averaging is progressing.
VIEW ⇒ TYPE ⇒ DUAL	Then select a double screen configuration.

9 Switch on the START key.

Start averaging.

When the START key's lamp dies out, thus indicating the averaging completion, check the measurement results.

10 Visualize the measurement results.

VIEW ⇒ AVG VW ⇒ FRF	Display a Bode diagram.
⇒ NEXT	
⇒ FRF CORD ⇒ BODE	

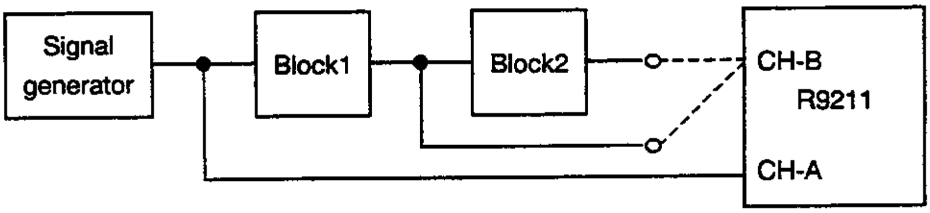
⇒	Y SCALE	⇒	Y AUTO SCALE	Adjust the Y scale on the upper and lower screens.
⇒	SEL ⬒	⇒	Y AUTO SCALE	
⇒	NEXT			Display the impulse response.
⇒	AVG VW	⇒	IMPULSE RESPONSE	
⇒	NEXT			
⇒	Y SCALE	⇒	Y AUTO SCALE	Adjust the Y scale.

Example of Utilization of the Equalizer

In some cases, the use of sensors such as pickups, to measure the frequency response function of a system, induces perturbations in the system's behavior. To compensate for the error due to this perturbation, and obtain the actual frequency response function, one can make use of the equalizer. In fact, if a system is constituted of 2 blocks serially connected, the equalizer permits you to obtain the characteristics of the first block only.

Hab : FRF of the serial system : Block1 + Block2
Hab1 : FRF of Block1
Hab2 : FRF of Block2

$$\mathrm{Hab1} = \frac{\mathrm{Hab}}{\mathrm{Hab2}}$$



1 Before equalization

Record the characteristics of Block2 in the memory.

Measure the FRF of Block2 and display it on the screen.

VIEW ⇒ NEXT

⇒ MEM VIEW ⇒ DATA SAVE1 Save Block2's FRF in memory1.

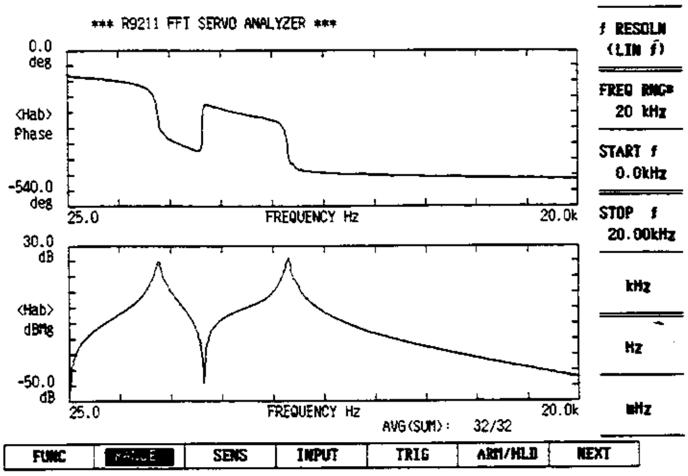
2 Equalization

Measure the characteristics of the global system.

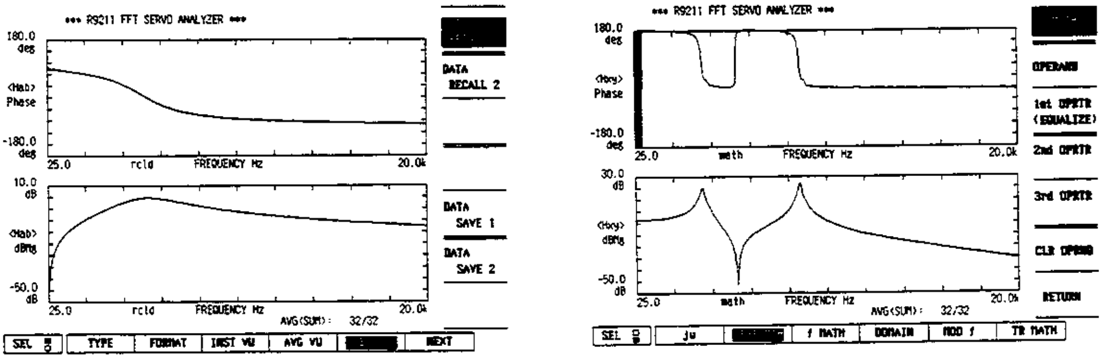
VIEW ⇒ AVG VW ⇒ FRF Display the FRF of the global system (Block1 + Block2).

Use the Equalizer.

MATH ⇒ FRF MTH ⇒ MATH SEL	
⇒ OPERAND	Register the displayed FRF as operand of the equalizing operation. (This operand is the numerator (Hab) of the above mentioned quotient.)
VIEW ⇒ MEM VW ⇒ DATA RECALL 1	Display the previously recorded FRF.
MATH ⇒ FRF MTH ⇒ EQUALIZE ON	Switch on EQUALIZE.
⇒ MATH SEL ⇒ 1st OPRTR	Now the displayed FRF is registered as the denominator of the quotient (Hab2).
⇒ DO MATH	Equalize.
VIEW ⇒ MATH VW ⇒ NEXT	
⇒ RESULT ARRAY	Display the equalized FRF.



FRF of the global system (Block1 + Block2)



FRF of Block2

FRF of Block1 obtained by equalizing

Figure 6-24 Example FRF Equalization

CHAPTER 7

SPECTRUM T-F MODE

This chapter describes the analysis procedure in the spectrum and T-F modes, provides the necessary knowledge about the conduction of a measurement in these modes, and illustrates the above mentioned items through several examples.

CONTENTS

1. Spectrum and T-F Modes

■ The Spectrum Mode

The spectrum mode is designed to analyze, in the frequency domain, signals input to channel A, channel B, or to the digital I/O. The T-F mode, the servo mode and the FRF mode are also used to analyze a signal in the frequency domain, however the spectrum mode is provided with the following features :

(1) Linear frequency resolution analysis and zoom analysis are enabled.
(2) Logarithmic frequency resolution analysis is enabled.
(3) Octave analysis is enabled.
(4) Spectrum data averaging is enabled.
(5) The frequency resolution can be set more finely than in the other modes.

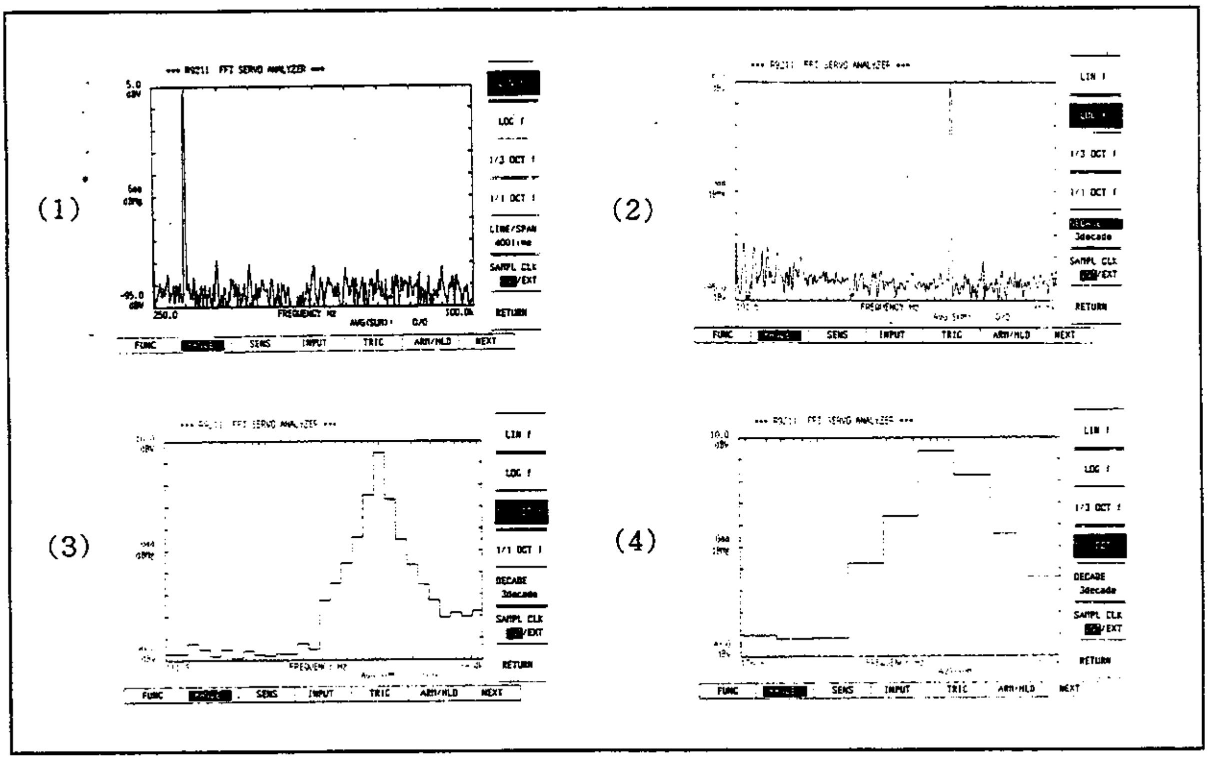


Figure 7-1 Analysis in the Spectrum Mode

The spectrum mode can also be used to study signals in the time domain. However, it does not offer the same powerful features for time domain analysis (time resolution, ...) as the waveform mode.
The spectrum mode is partitioned in 3 functions :
- Power spectrum function
- Cross spectrum function
- Complex spectrum function

Two main differences between the power spectrum function and the complex spectrum function can be found :

- Firstly, they do not use the same averaging method.
- Secondly, with the power spectrum function, octave and logarithmic resolution analysis are enabled, whereas, with the complex spectrum function, they are not.

See the following table:

	Octave analysis	Logarithmic analysis	Averaging method
Power spectrum	○	○	Power averaging
Complex spectrum	×	×	Complex averaging

*: For more details about the averaging method, see "■ Averaging".

■ The T-F Mode (Extended Spectrum Mode)

The T-F mode is provided with a longer input buffer than the other modes. Thus, the input data are stored as one block in this input buffer, and the frequency analysis is performed on these data, frame by frame.
The T-F mode is particularly suitable for long duration signals (vibration, noise, etc.)

The T-F mode has the five following features:

(1) After the Fast Fourier Transform has been performed on each frame of the data stored in the input buffer, the curve representing the relationship between the amplitude of the spectrum at a fixed frequency and the time, can be plotted, for any frequency (T-F analysis).

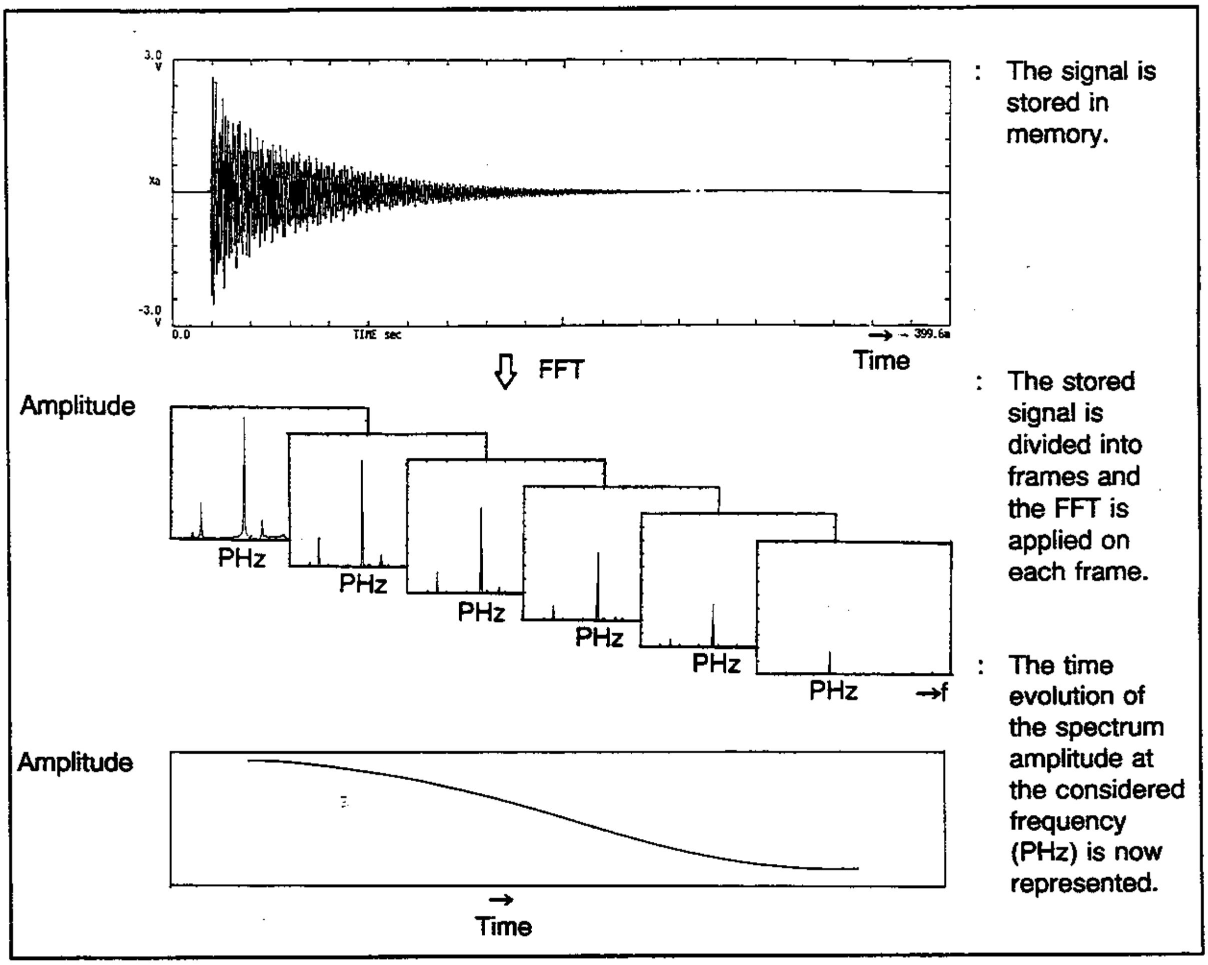
(2) The data stored in the input buffer can be analyzed frame by frame in the time or in the frequency domain (Data View).

(3) Logarithmic resolution frequency analysis can be performed.

(4) Octave analysis can be made.

(5) The spectrum data can be averaged.

This figure illustrates point (1).



: The signal is stored in memory.

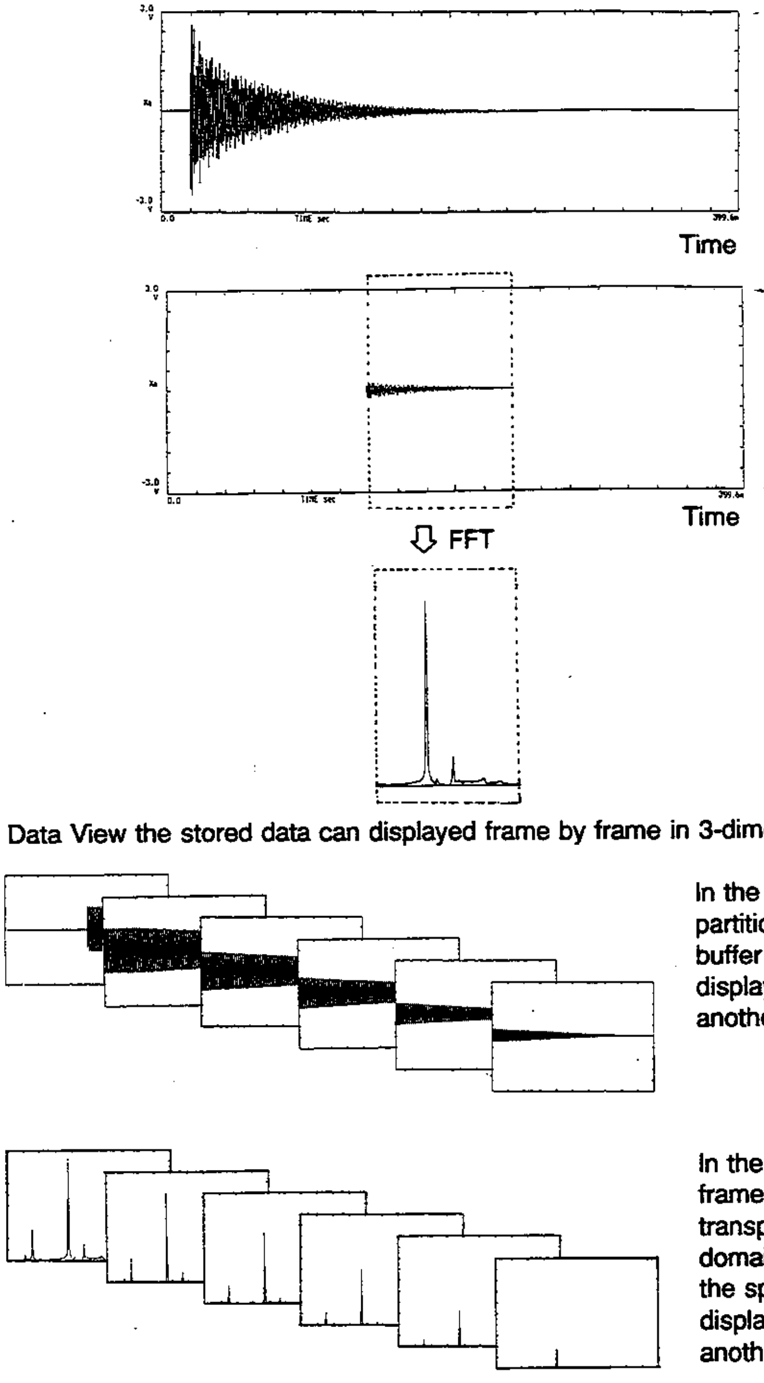
: The stored signal is divided into frames and the FFT is applied on each frame.

: The time evolution of the spectrum amplitude at the considered frequency (PHz) is now represented.

Figure 7-2 Analysis in the T-F Mode

In this example, was represented the relationship between the spectrum amplitude at a fixed frequency and the time. But it is also possible to plot the time evolution of the spectrum phase at a fixed frequency, or the time evolution of the frequency corresponding to the spectrum amplitude peak.

This figure illustrates point (2).



: Signals are stored in the input buffer.

: A particular portion of the stored data can be read from the buffer and analyzed.

: Then by the FFT method, the selected data can be transposed to the frequency domain and analyzed.

With Data View the stored data can displayed frame by frame in 3-dimensions.

In the time domain, after partitioning the data stored in the buffer into frames, each frame is displayed piled up upon one another.

In the frequency domain, the frame partitioned data is transposed to the frequency domain by the FFT method, and the spectra, thus obtained, are displayed piled up upon one another.

Figure 7-3 Analysis Using Data View

CAUTION!

When logarithmic resolution frequency analysis or octave analysis are performed in the T-F mode, T-F analysis and Data View functions cannot be used.

T-F analysis (feature (1)) and Data View (feature (2)) have been separately described. However, the same buffer is used for both. Figure 7-4 graphically represents (block diagram) the analysis of the time evolution of a long duration signal in the T-F mode.

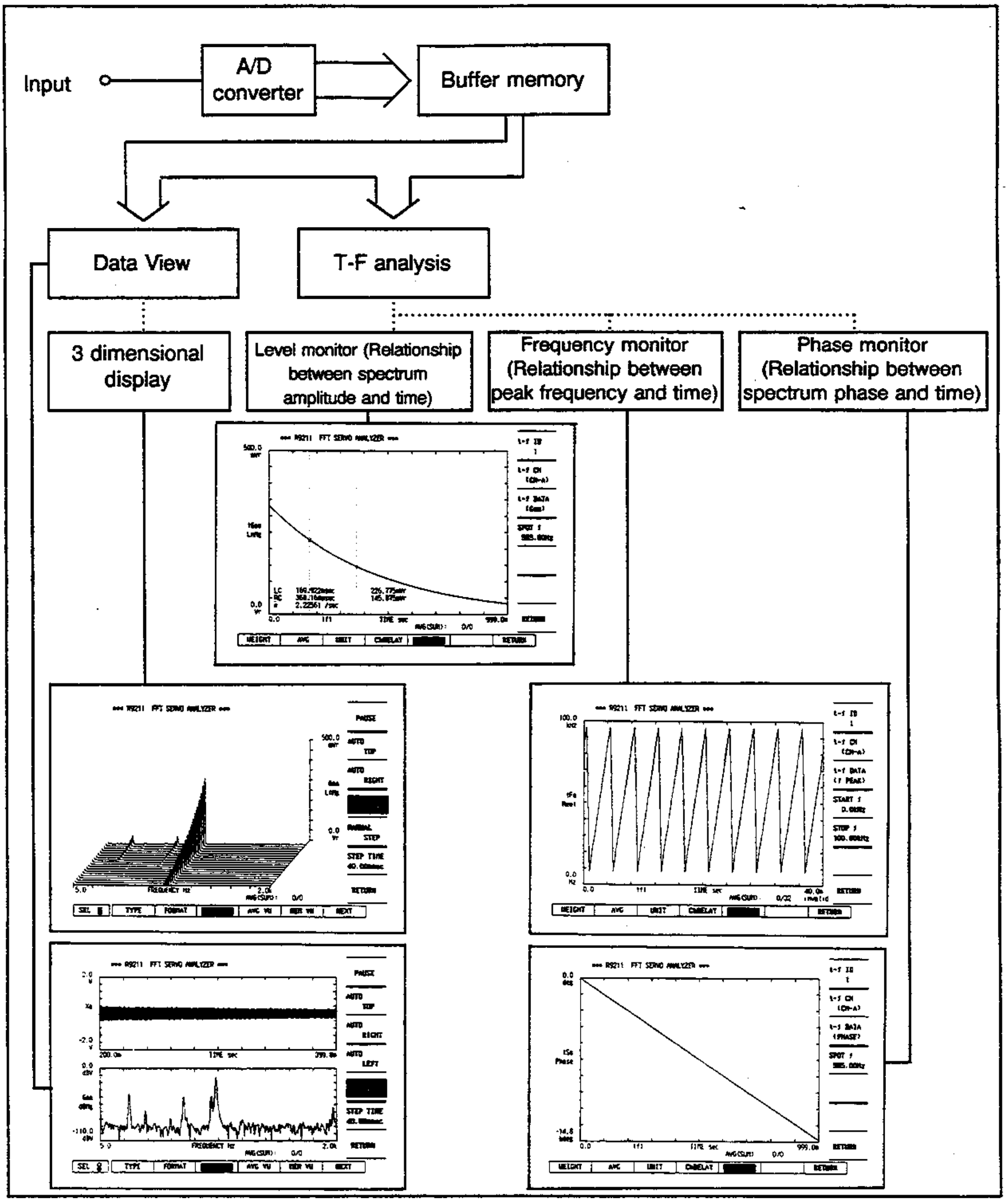


Figure 7-4 Block Diagram Representing the Analysis of a Long Duration Signal in the T-F Mode

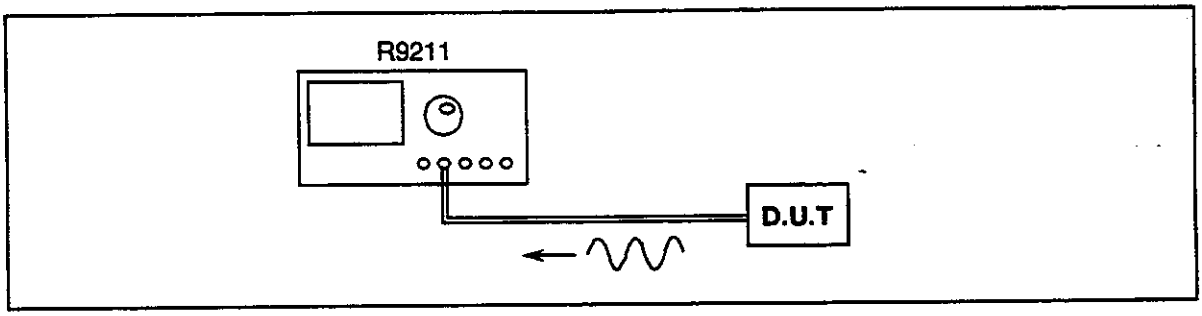
2. Basic Setup Procedure

■ Setup Procedure for Linear Resolution Frequency Analysis

To conduct a spectrum analysis in the spectrum mode, proceed as follows :

1 Preparation

Connect the input signal to channel A.



2 Mode selection

Select the spectrum mode.

MODE ⇒ MEAS ⇒ SPECTRUM ....You may select the T-F mode.

3 Measurement conditions setup

Select the power spectrum function.

SETUP ⇒ FUNC ⇒ POWER SPECT

4

Set the frequency range and the number of lines.

⇒ RANG ⇒ f RESOLN

⇒ LIN f ....Select the linear resolution frequency analysis mode.

⇒ LINE/SPAN

(When 800 is specified as the number of lines and 20kHz is specified as the frequency range, the frequency resolution becomes 25Hz (20kHz divided by 800).)

⇒ 800 ⇒ ENT ……………Set the number of lines to 800.

⇒ RETURN

⇒ FREQ RNG

⇒ 20 ……………………Set the frequency range to 20kHz.

⇒ KHz

5 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO/MAN ……………………Select the auto range mode. (Select the manual mode to analyze a transient signal.)

⇒ UP&D/UP ……………………Prefer the "up and down" range adjustment mode.

6 Set the inputs coupling conditions.

⇒ INPUT ⇒ CHANNEL CH - A/CH - B ……………………Select the channel you are now going to setup.

⇒ COUPLING AC/DC ……………………Choose the proper input coupling.

⇒ + INPUT IN/GND ……………………Select IN for the + input, so that the signal is input through the + input.

⇒ – INPUT IN/GND ……………………Select GND for the – input to connect it to ground.

7 Choose the proper window.

(When an input is connected to ground, the LED above the input connector lights.)

⇒ NEXT

⇒ WEIGHT ⇒ HANNING ……………………Select the Hanning window.

Set the averaging conditions.

⇒ AVG ⇒ SUM ························Choose the arithmetic average method (SUM).

⇒ RETURN

⇒ AVG NO

⇒ 20 ⇒ ENT ···············Set a 20 time average.

Start the measurement.

START ··Perform the measurement. (The screen shown in Figure 7-5 is displayed.)

Set the display conditions.

Select the double screen configuration, and display the time waveform on the upper screen and the averaged spectrum on the lower screen.

VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ▀ ··Specify the screen to be set.

⇒ INST VW ⇒ CH-A TIME ······················Display the instantaneous time waveform.

⇒ SEL ▄

⇒ AVG VW ⇒ CH-A PWR-SPECT ···················Display the averaged power spectrum.

11 Set the marker's control parameters.

Display a single cursor on the lower screen and read out the coordinates of the cursor : spectrum amplitude and frequency.

MKR ⇒ MKR VAL ⇒ SINGLEX X1 Y1 ....Select a single cursor type marker.

......................With the knob, move the cursor to the point you are interested in and read its coordinates on the screen.

12 Set TRACEonST to OFF.

In this case, if you press the START key again, since the default screen of the R9211 will be automatically displayed, you will not be able to change it to the type of screen you want.

MODE ⇒ EXTEND ⇒ TRACEonST ON/OFF

13 Start averaging.

START ....The new data are averaged. (See Figure 7-6.)

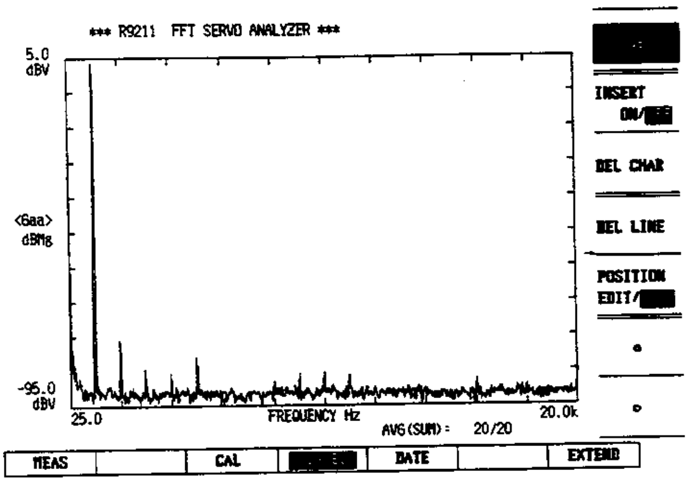
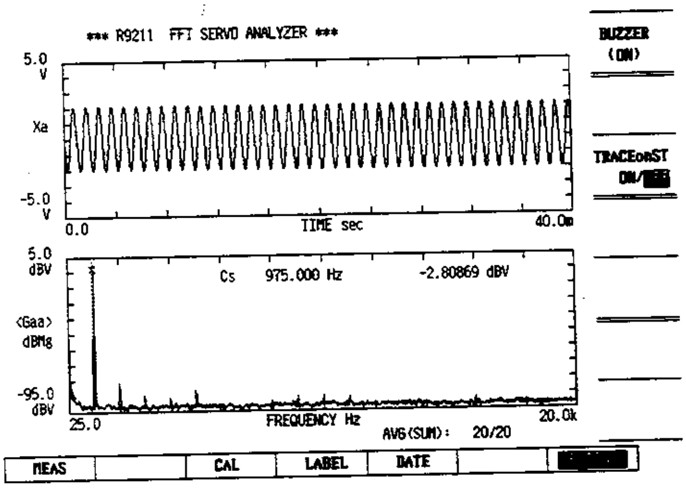


Figure 7-5 The Screen During the Measurement



Instantaneous time waveform

Averaged power spectrum

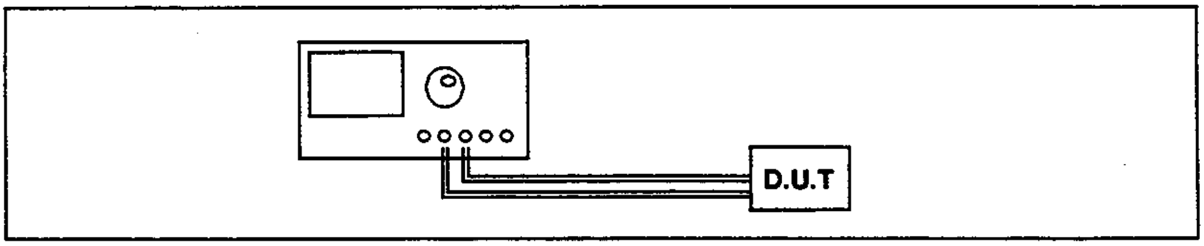
Figure 7-6 Display of the Measurement Results

Setup Procedure for Octave and Logarithmic Resolution Frequency Analysis

To conduct a logarithmic resolution frequency analysis in the T-F mode, proceed as follows :

Connect the input signals (DUT) to channel A.

In this example, we use the differential input method, but this choice is in no way related to the logarithmic resolution analysis.



Select the spectrum mode.

MODE ⇒ MEAS ⇒ SPECTRUM

Select the power spectrum function.

SETUP ⇒ FUNC ⇒ POWER SPECT

Set the frequency range and the number of lines.

⇒ RANG ⇒ f RESOLN

⇒ LOG f ························Logarithm
(For an octave analysis, select 1/3 OCTf or 1/1 OCTf.)

⇒ DECADE

⇒ 2 ⇒ ENT ··············Set two decades for instance.

(The frequency resolution is independent of the frequency range and of the number of decades. It is always equal to 80 lines/decade.)

⇒ RETURN

⇒ FREQ RNG

⇒ 20 ……Set the frequency range to 20kHz

⇒ KHz

5 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO/MAN ……You cannot use the auto range mode when performing a logarithmic resolution frequency analysis or an octave analysis.

⇒ SET CH-A ……Set the input sensitivity according to the signal amplitude.

⇒ 0 ⇒ ENT

6 Set the inputs coupling conditions.

⇒ INPUT ⇒ CHANNEL CH - A/CH - B

⇒ COUPLING AC/DC

⇒ + INPUT IN/GND

⇒ – INPUT IN/GND

……Since we chose the differential input method, both the + and – inputs of channel A must be set to IN.

7 Set an audio weighting filter (only if necessary).

⇒ NEXT

⇒ WEIGHT ⇒ WEIGHT(f)

⇒ A WGT ……………………Here, we chose audio weighting filter A.

⇒ RETURN

Select the form of display suited to your application.

VIEW ⇒ **TYPE** ⇒ DUAL

⇒ **SEL ▀**

⇒ **INST VW** ⇒ CH-A TIME ……………………Display channel A's instantaneous time waveform on the upper screen in the double screen configuration.

⇒ **SEL ▄**

⇒ **INST VW** ⇒ CH-A POWER-SPECT ………………Display the instantaneous power spectrum on the lower screen.

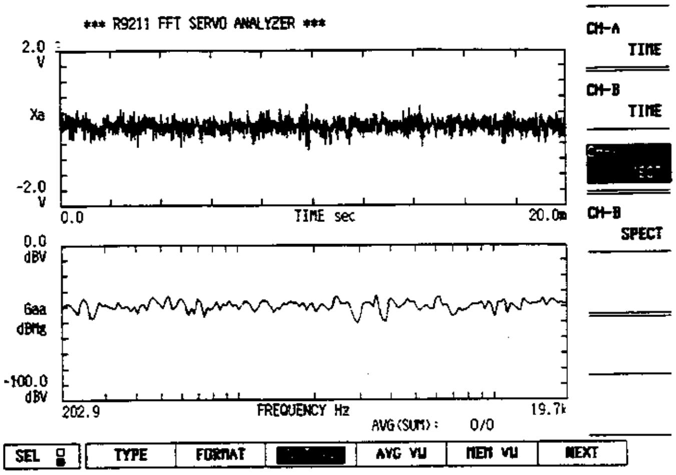


Figure 7-7 Logarithmic Resolution Frequency Analysis (lower)

CAUTION !

The linear resolution frequency analysis is best suited to the measurement of the amplitude of a signal such as a sine wave. If octave or logarithmic resolution frequency analysis is applied to such signals the measurement results are inaccurate.

3.Toward Better Measurement

■ Frequency Range and Number of Lines

● Linear Frequency Resolution

The linear frequency resolution of the FFT analyzer is calculated with the following formula :

Linear frequency resolution = Frequency range/Number of lines

Select the frequency range and the number of lines according to the frequency resolution you need for the analysis of your signal. For instance, if the frequency range is set to 100kHz and the number of analysis lines is set to 800, the frequency resolution becomes 100kHz/800 = 125Hz.

[How to select the linear resolution frequency analysis]

SETUP ⇒ RANG ⇒ f RESOLN
⇒ LIN f

[How to change the number of lines]

SETUP ⇒ RANG ⇒ f RESOLN
⇒ LINE/SPAN
⇒ 800 ⇒ ENT

[How to change the frequency range]

SETUP ⇒ RANG ⇒ FREQ RNG
⇒ 100 ⇒ ENT

The maximum number of lines depends on the number of active channels as summarized in Table 7-1.

Table 7-1 Numbers of Lines Versus Number of Active Channels

Mode / Number of active channels	Maximum number of lines	
	Spectrum mode	T-F mode
1 channel	3200lines	800lines
2 channels	1600lines	800lines

[How to change the active channel]

SETUP ⇒ FUNC ⇒ ACTIVE CH

⇒ CH-A&B ·········Select the active channel(s).

⇒ CH-A

⇒ CH-B

- **Logarithmic Frequency Resolution**

When a logarithmic resolution frequency analysis is conducted (only when the power spectrum function of the spectrum mode is used), the frequency resolution is 80 lines/decade.

[How to select the logarithmic frequency analysis]

SETUP ⇒ RANG ⇒ f RESOLN

⇒ LOG f

[How to set the number of decades]

SETUP ⇒ RANG ⇒ f RESOLN

⇒ DECADE

⇒ 2 ⇒ ENT

The number of decades depends on the number of active channels as summarized in Table 7-2.

Table 7-2 Number of Decades Versus Number of Active Channels

Number of active channels	Maximum number of decades
1 channel	3
2 channels	2*

* For the R9211C, up to three decades may be specified.

■ Applying a Window

The FFT is processed only on a portion of the continuous input signal, portion whose length corresponds to the frame time.

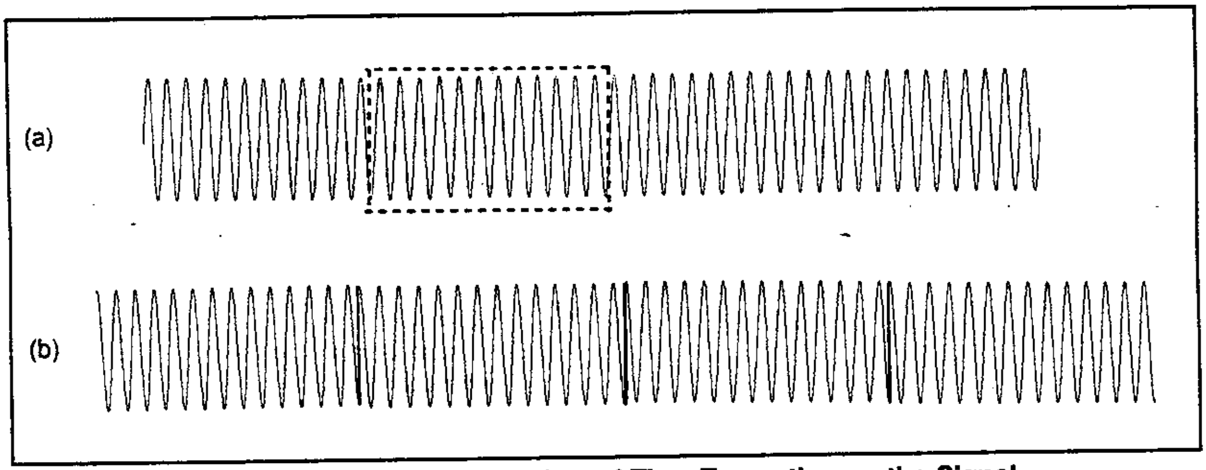


Figure 7-8 Illustrates the Effect of Time Truncation on the Signal

If the signal portion enclosed in the dotted line (cf. Figure 7-8 (a)), is extracted from the continuous input signal, and is transposed to the frequency domain by FFT, the result we actually obtain in the frequency domain corresponds to the discontinuous time signal represented on Figure 7-8 (b), instead of corresponding to the studied signal, because the Fast Fourier Transform, naturally considers the time limited signal it receives in input, as a period of a time infinite periodic signal ((b) is obtained by infinitely repeating the signal portion outlined on Figure 7-8 (a)). In order to reduce the influence of the time truncation, the truncated signal portion is multiplied by a weighting function, so that the signal input to the FFT may be considered as a period of an infinite continuous periodic signal. This weighting function is called a window.
The R9211 is provided with the minimum, Hanning, flat pass, rectangular, and force/response windows. The differences and application domains of each of these are described in Table 7-3.

Table 7-3 Selection of the Best Suited Window ("WEIGHTING")

	Advantage	Disadvantage	Application
Rectangular window	○ The energy of the sampled data does not change during the frame time. ○ It offers the best frequency resolution.	○ Its amplitude accuracy is poor. ○ Generates discontinuities on continuous waveforms that do not satisfy the periodicity condition.	○ It proves optimum for the analysis of transient signals or impulse signals.
Hanning	○ It does not generate discontinuities for continuous aperiodic waveforms.	○ Its frequency resolution is slightly lower than that of the rectangular window. ○ Its amplitude accuracy is relatively poor.	○ Generally used to study continuous waveforms. ○ Spectrum analysis up to 70dB.
Flat pass	○ It offers the best amplitude accuracy.	○ Its frequency resolution is poor.	○ Effective for harmonics analysis
Minimum window function	○ It shows the best side-band shape. ○ Its frequency resolution is higher than that of the flat pass window. ○ Its amplitude accuracy is higher than that of the Hanning window.	○ Its frequency resolution is lower than that of the Hanning window. ○ Its amplitude accuracy is lower than that of the flat pass window.	○ Effective for the study of small adjacent spectral lines(e.g., notches). ○ Spectrum analysis beyond 70dB.

CAUTION!

The force/response windows are rarely used for spectrum analysis.

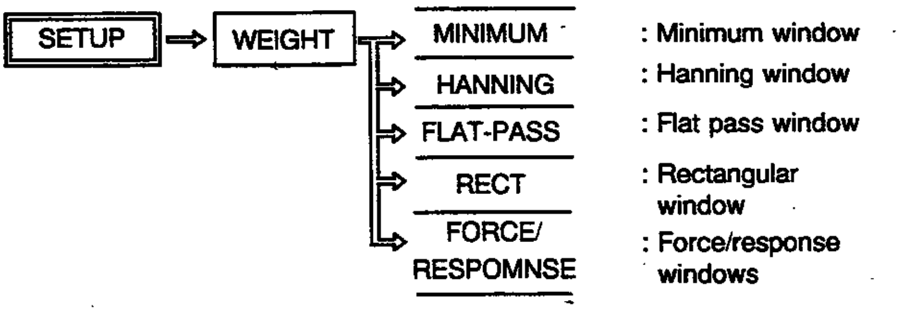
ADVICE

Usually, the force/response windows are used to obtain a frequency response function with an impulse hammer in the FRF mode.

The force window is used when sampling an impulse waveform to improve the signal-to-noise ratio, while the response window is used to damp the output waveform within the frame time. In the spectrum/T-F mode, the force window is used to perform partial FFT if it is necessary. A waveform is sampled from the input time waveform by setting the values of START TIM and STOP TIM, which correspond to the start and end times of the force window. Note that the truncation error is the same as the one obtained when applying the rectangular window.

Partial FFT: One portion only (a frame) of the sampled and stored data is transposed to the frequency domain by FFT.

[How to select a window]

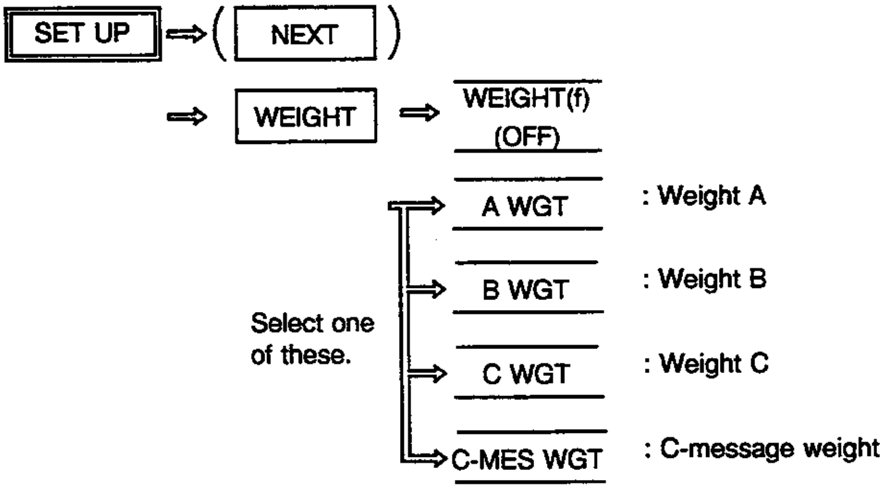


■ Audio Weighting Filter

The R9211 is provided with 3 audio weighting filters presenting characteristic A, B, and C respectively, and with a weighting filter for telephone lines named C-message weighting filter.
A-, B-, and C-characteristic filters conform to the Standard of Noise Level Measurement (IEC651).
The C-message weighting filter conforms to the Standard for Analog Devices used for Voice Propagation (IEEE std 743).

REFERENCE➜
Regarding these filter characteristics, see "Audio Weights Characteristics" in Appendix 2 "Glossary" page A-19 and A-20.

[How to set an audio weighting filter]



■ Switching ON/OFF the Antialiasing Filter

For a spectrum analysis, in order to prevent from spectrum aliasing (this term is used when spectrum lines whose frequency does not belong to the analysis range, appear nonetheless inside the range), you must switch the antialiasing filter on. For a time analysis, you must, of course, switch it off.

SETUP ⇒ INPUT ⇒ FILTER ON/OFF : Switches on or off the antialiasing filter.

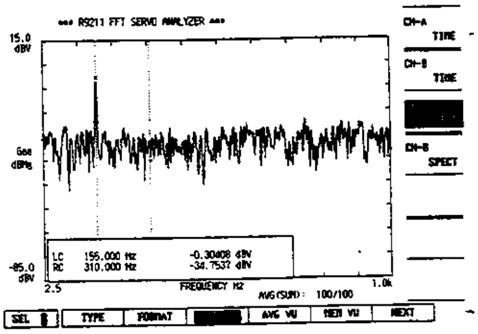
The filter setting is common to channel A and channel B.

■ Averaging

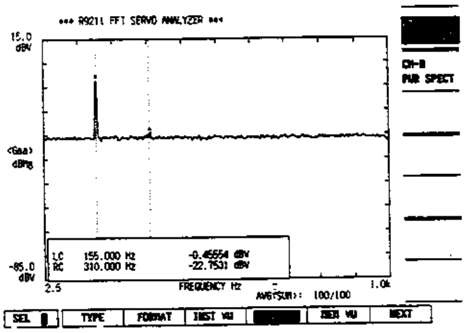
● **Power Spectrum Averaging and Complex Spectrum Averaging**
To average spectrum data, you have the choice between 2 methods : the power spectrum averaging method and the complex spectrum averaging method.

○ **Power Spectrum Averaging**
Both target signal and noise are smoothed.

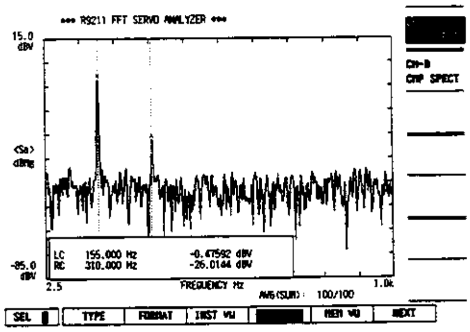
○ **Complex Averaging**
Synchronous averaging is performed according to a trigger signal synchronized with the target signal, thus the target signal can be extracted from the noise.



Instantaneous spectrum of the target signal buried in noise.



Power spectrum averaging



Synchronous complex spectrum averaging

(The noise level is smoothed to its mean level.)

(The noise level is reduced because the noise is not synchronized with the trigger signal. A secondary harmonic is revealed while it was impossible to detect it on the instantaneous power spectrum.)

[Setup procedure]
Select the power spectrum function or the complex spectrum function in the spectrum or T-F mode.

SETUP ⇒ FUNC ⇒ POWER SPECT / COMPLEX SPECT

Selects power or complex spectrum averaging.

● Averaging Method

Four averaging methods are available : arithmetic averaging, exponential averaging, peak hold averaging and subtraction averaging. The arithmetic and exponential averaging methods are now described.

○ Arithmetic Averaging

When the power spectrum function is used, arithmetic averaging is expressed as follows:

$$<Gaa> = 1/N\{Gaa_1 + Gaa_2 + \cdots\cdots Gaa_N\}$$

N : Number of averages
Gaai : ith power spectrum point (i = 1, ..., N)

When the complex spectrum function is used, arithmetic averaging is expressed as follows:

$$<Sa> = 1/N \cdot \{Sa_1 + Sa_2 + \cdots\cdots Sa_N\}$$

N : Number of averages
Sai : Complex spectrum

If <Sa> is expressed in Mag or in dBMg, the previous equation becomes :

$$dBMg = 10 \cdot \log \{(Real<Sa>)^2 + (Imag<Sa>)^2\}$$

$$Mag = \sqrt{(Real<Sa>)^2 + (Imag<Sa>)^2}$$

[How to set an averaging method and a number of averages]

SETUP ⇒ NEXT
⇒ AVG ⇒ SUM ....Select the arithmetic averaging method.
⇒ RETURN
⇒ AVG NO
⇒ 20 ⇒ ENT .....Set 20 as the number of averages.

START ....Start averaging.

○ **Exponential Averaging**

Exponential averaging is expressed as follows:

$$Aj = (1 - \frac{1}{K}) A_{j-1} + \frac{1}{K} D_j$$

A_j : Average result number j (now)
A_{j-1} : Previous average result
D_j : Data fetched this time
K : Weight

When setting exponential averaging, the weight value (K) and the maximum number of averages (maximum value of j) must be specified.

$\boxed{\text{SETUP}}$ ⇒ ($\boxed{\text{NEXT}}$)
⇒ $\boxed{\text{AVG}}$ ⇒ AVG MODE (SUM)
⇒ EXP : Select the exponential averaging method.
⇒ RETURN
⇒ AVG NO : Set the weight value.

Caution !

When the exponential averaging (EXP) method is selected, AVG NO is used to set weight value.

⇒ 4 ⇒ $\boxed{\text{ENT}}$
⇒ LIMIT NO 200 : Set the maximum number of averages.
⇒ 10 ⇒ $\boxed{\text{ENT}}$

● Other Functions Related to Averaging

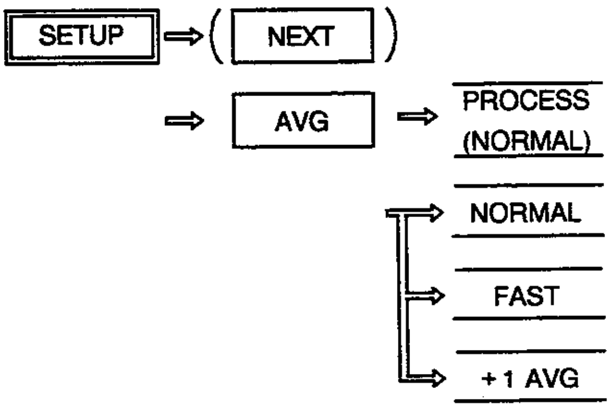
○ PROCESS

This function is used to specify the timing of the display of averaged data and execution of averaging.

NORMAL : Data is displayed each time averaging is performed (the intermediate results are displayed).
FAST : The averaging result is displayed only after completion of the total averaging process.
+1AVG : One averaging step is performed each time the STOP/C key is pressed.

(1) Fast averaging is faster than normal averaging. Select this mode to quickly obtain the averaging result.

(2) The +1AVG mode is suitable to the impulse hammer measurement method (for example), because you can decide after each data acquisition whether you want to take the acquired data into account for your average process.
If the +1AVG mode is selected, and you want to quit averaging in the middle of the process, press the STOP+1 key.



○ **REJECT**

By switching REJECT ON or OFF you can choose whether to take into account in the averaging process, the data which have saturated the analyzer's input block.

SETUP ⇒ (NEXT)

⇒ AVG ⇒ REJECT ON/OFF

○ **Overlap**

If we overlap the data frames, the number of averages during a specified period of time increases, thus the difference between consecutive data frames decreases.

However at high frequencies, overlapping is sometimes impossible because of treatment constraints. The averaging operation is in no way affected. The four available overlap types are hereunder described.

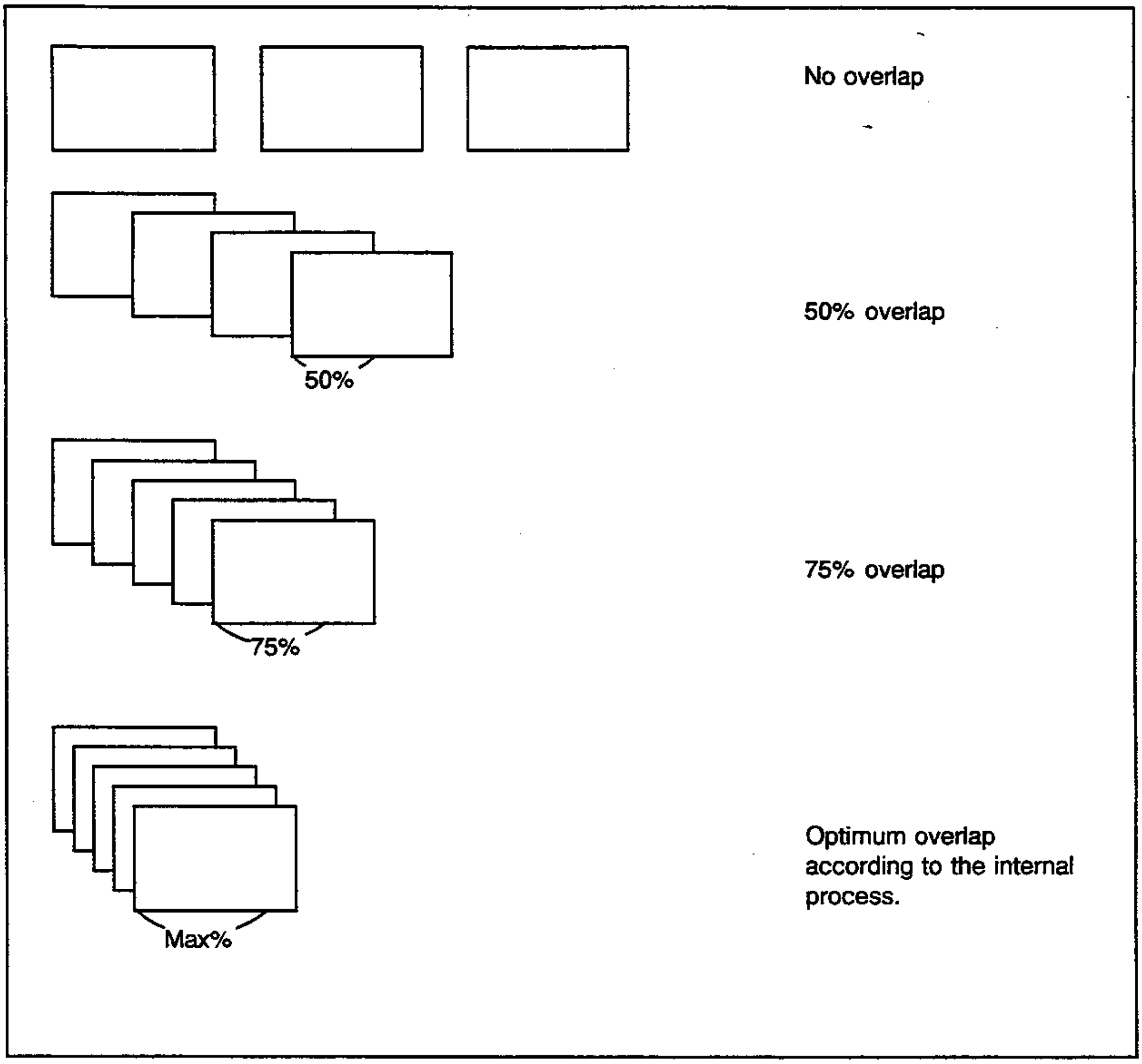
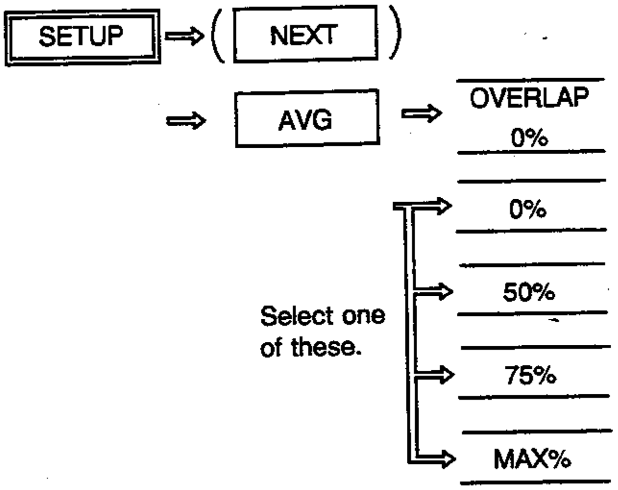


Figure 7-9 Average Data Overlap Types

[How to set the overlap]

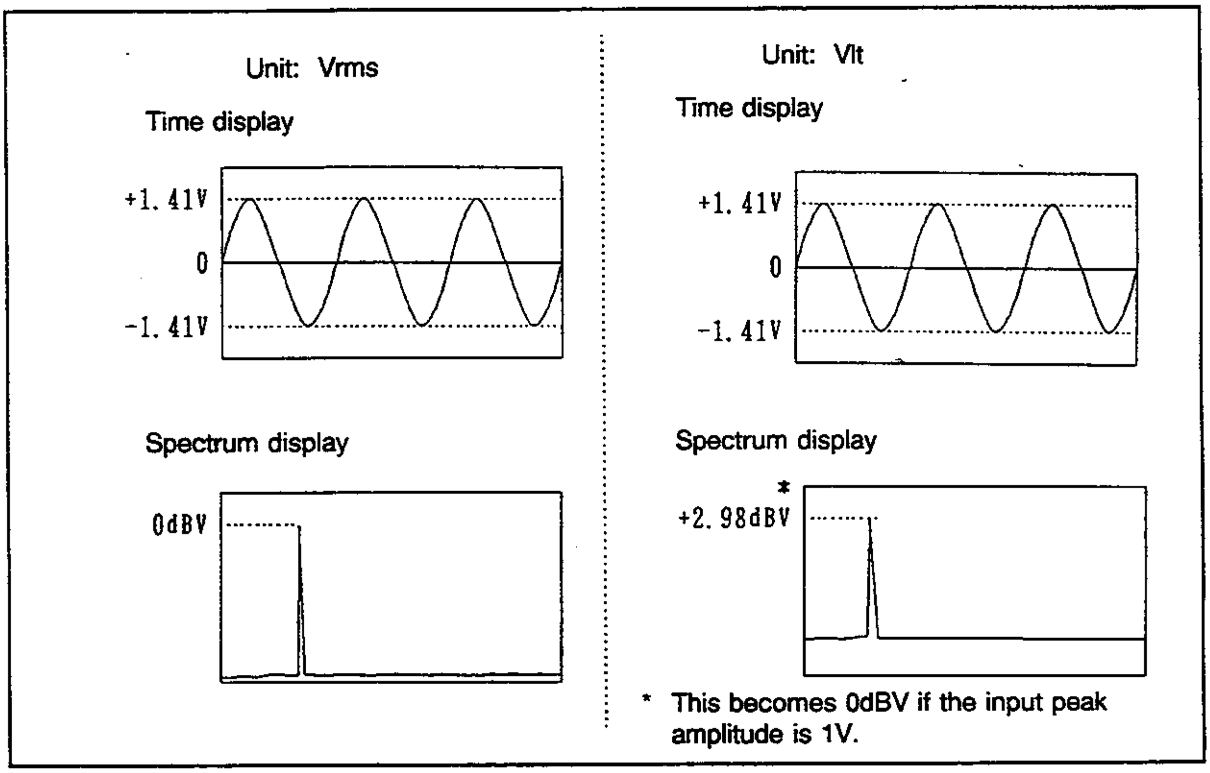


■ Vlt, Vrms, Engineering Unit, and PSD

● Vlt and Vrms

The input sensitivity setting unit is Vrms, but the display unit can be Vlt. When a sine wave is input in the spectrum mode, the relationship between Vrms and Vlt is described by the following formulas:

Vrms : 20log 1 Vrms = 0 dBV
Vlt : 20log 1.41 Vpp = 2.98 dBV



* This becomes 0dBV if the input peak amplitude is 1V.

Figure 7-10 Displayed Waveforms

[How to set the unit]

SETUP ⇒ **UNIT** ⇒ EU or Vlt

Select one of these.
- Vrms
- Vlt

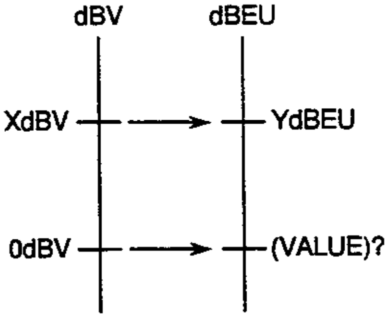
● Engineering Unit

You can define a new unit for each channel : you then define the relationship between your unit and 1 Volt (Vlt), for example, and the 2 digit maximum name of the unit. The scale setting depends on the type of display (time waveform/dB scale spectrum /linear scale spectrum).

○ For a dB Scale Spectrum

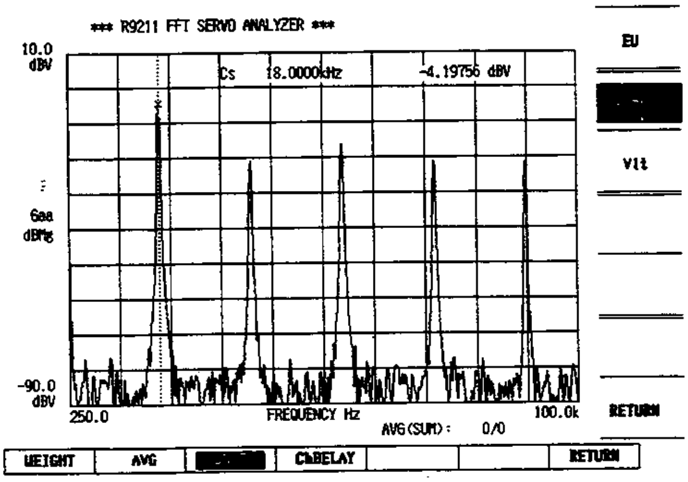
Set the scale correspondence factor (VALUE) of each channel. This factor is defined as the value in dBEU (dB Engineering Unit) corresponding to 0dBV.

When you want XdBV to correspond to YdBEU, the correspondence factor (VALUE) is :



$$(X-0)_{dB} = [Y-(VALUE)]_{dB}$$
$$\therefore (VALUE) = (Y-X)_{dBEU}$$

[Concrete setup procedure]
To set the engineering unit, named "A", on channel A, so that, for example, −4.2dBV corresponds to −30dBEU, the correspondence factor must be −25.80dBEU.



SETUP ⇒ (NEXT)

⇒ UNIT ⇒ SELECT CH

⇒ CH-A : Select channel A.

⇒ RETURN

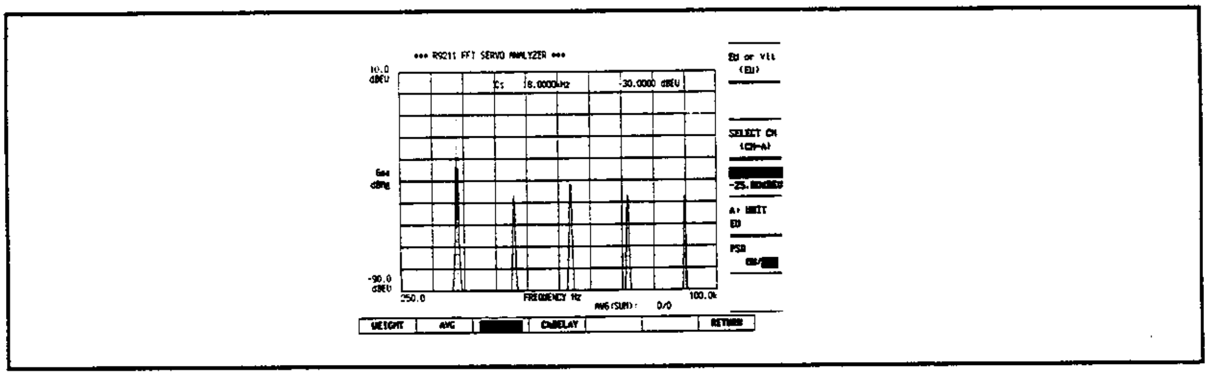
CAUTION !

When CROSS is selected, a unit name of 2 characters can be defined but no correspondence can be defined.

⇨ VALUE

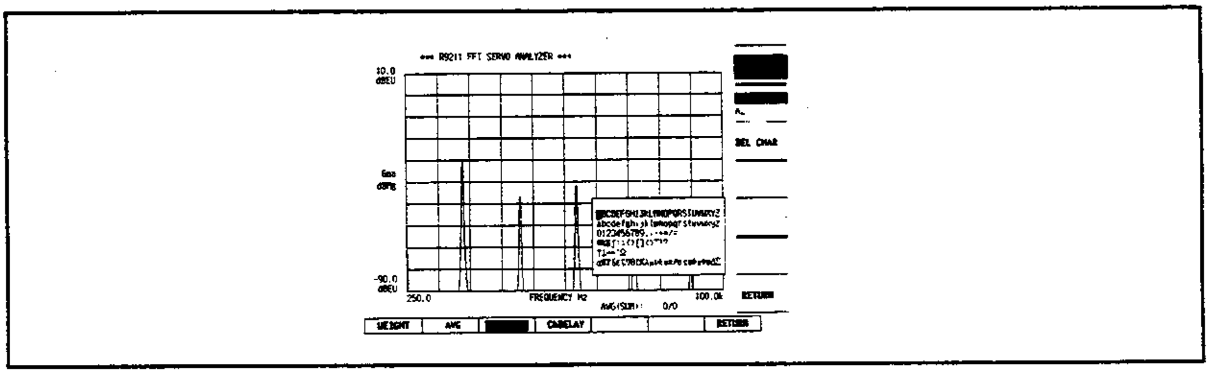
⇨ −25.8 ⇨ ENT

Enter the value of the correspondence factor with the knob or with the numeric keys. The knob is graduated in steps of 1dB.



⇨ UNIT

Enables you to set the engineering unit name.



A label list is displayed on the screen. Up to two characters can be selected from it with the knob ⇧ and ⇩ keys.

Press the ENT key after selecting each character.

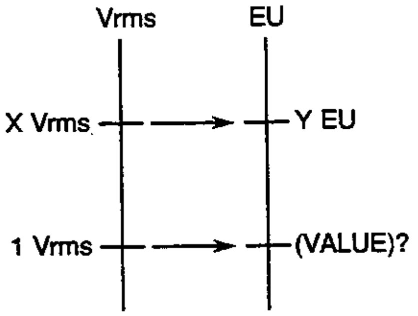
⇨ DONE

Validates the engineering unit setting.

○ For a Linear Scale Spectrum

Set the scale correspondence factor (VALUE) of each channel. This factor is defined as the value in EU corresponding to 1Vrms.

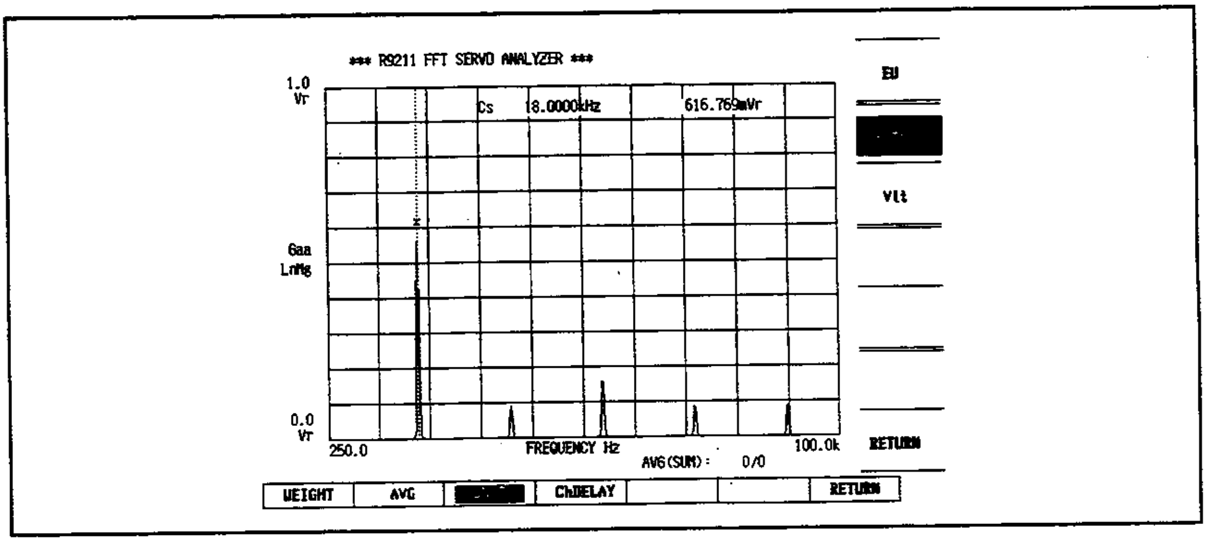
When you want XVrms to correspond to YEU, the correspondence factor is:



$$X:1 = Y:(\text{VALUE})$$

$$\therefore (\text{VALUE}) = Y/X$$

[Concrete setup procedure]
To set an engineering unit on channel A's linear data, so that 616.769mVrms corresponds to 1EU, the correspondence factor must be $1/616.769 \times 10^{-3} \fallingdotseq 1.62136$EU.



SETUP ⇒ (NEXT)

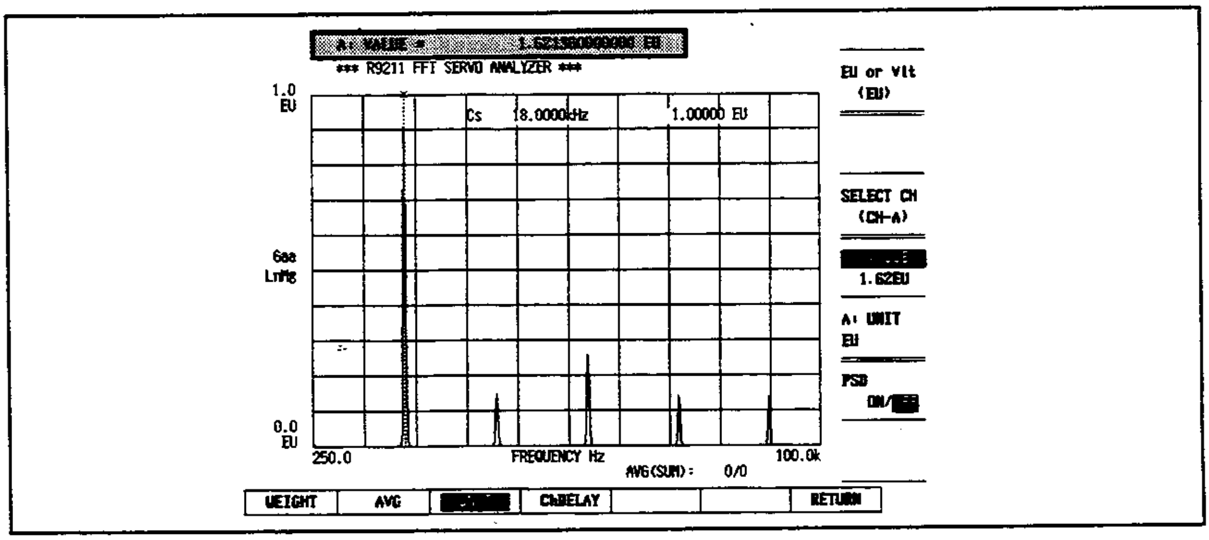
⇒ UNIT ⇒ SELECT CH

⇒ CH-A Select channel A.

⇒ RETURN

⇒ VALUE - Set the correspondence factor, here 1.62136.

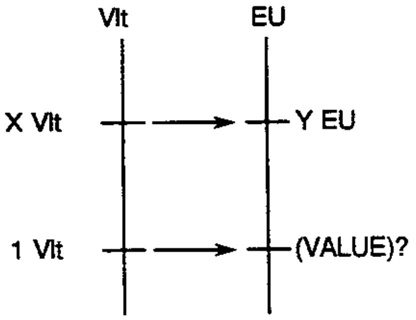
1.62136 ⇒ ENT



○ For a Time Waveform

Set the scale correspondence factor (VALUE) of each channel. This factor is defined as the value in EU corresponding to 1Vlt.

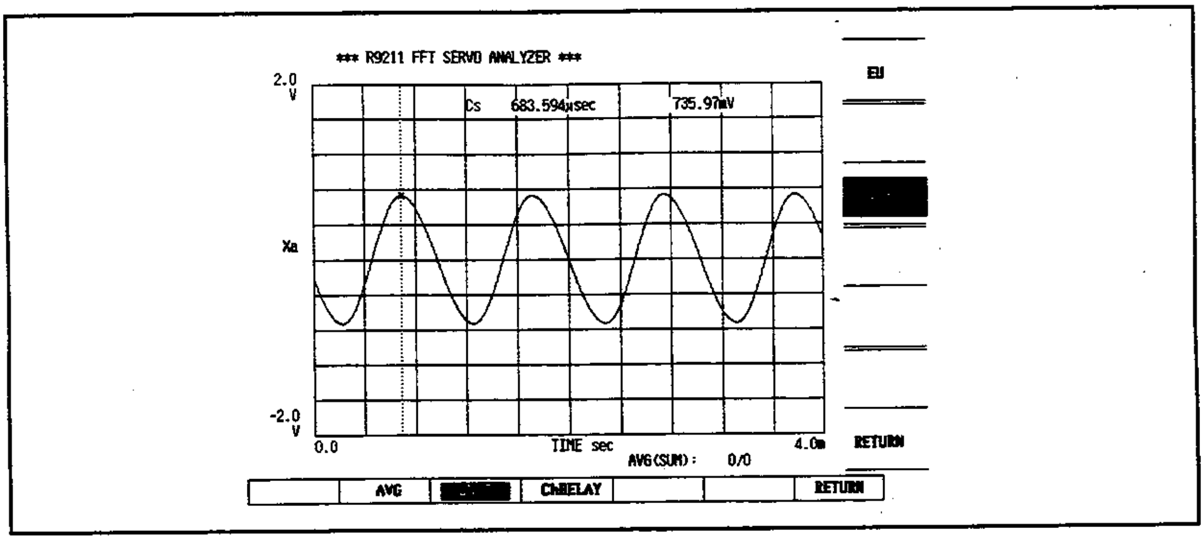
When you want XVlt to correspond to YEU, the correspondence factor (VALUE) is:



X:1 = Y:(VALUE)

∴ (VALUE) = Y/X

[Concrete setup procedure]
735.97mVlt corresponds to 1EU for channel A's time waveforms.



In this case, the correspondence factor becomes :
$1/735.97 \times 10^{-3} \fallingdotseq 1.35876$EU.

SETUP ⇒ (NEXT)

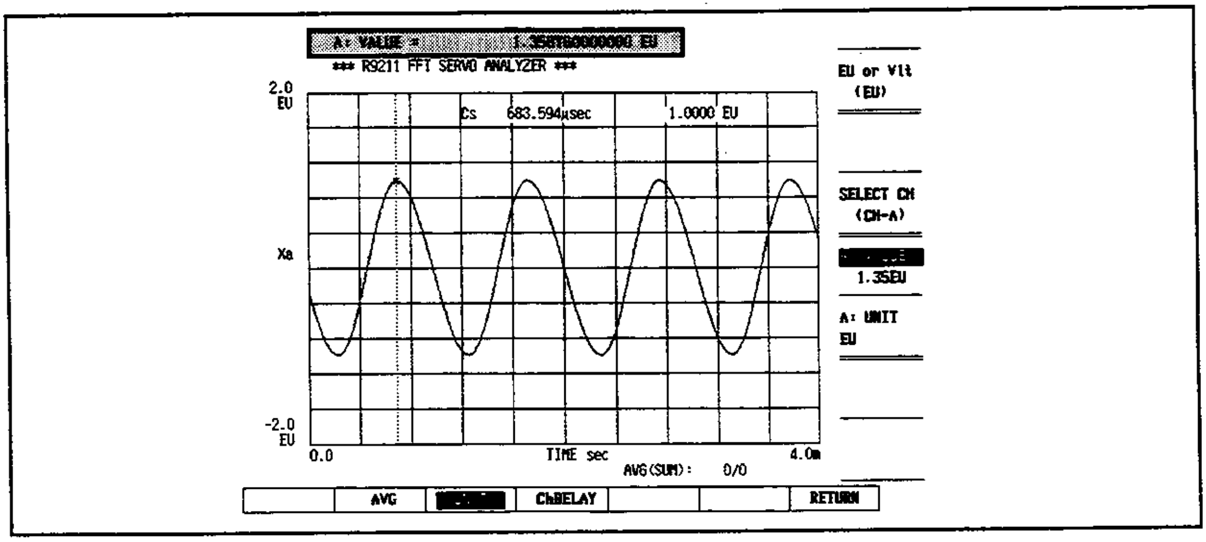
⇒ UNIT ⇒ SELECT CH

⇒ CH-A Select channel A.

⇒ RETURN

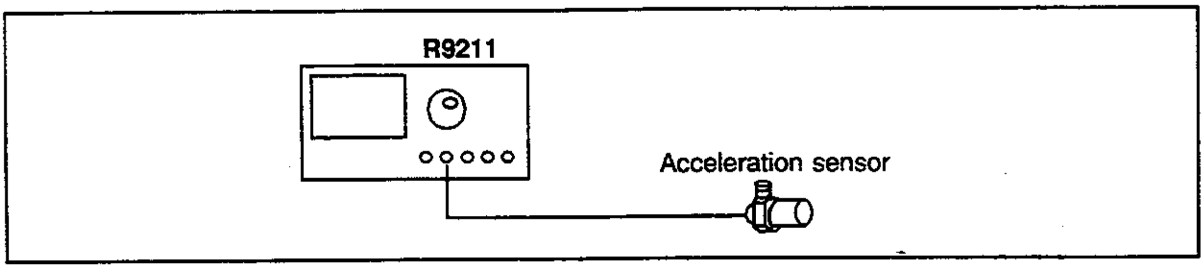
⇒ VALUE Set the correspondence factor, here1.35876EU.

1.35876 ⇒ ENT


A: VALUE = 1.35876000000 EU

● Acceleration Sensor Scaling

When the output of an acceleration sensor is connected to an input of the R9211, you must change the scale to be able to read directly the acceleration values.



When the sensitivity of the acceleration sensor is S mV/g, it means that S mV corresponds to 1g (or 1EU). Scaling can be carried out easily by displaying a linear spectrum. In this case, the correspondence factor is $1/(S \times 10^{-3})$. After scaling, the gravitational acceleration (g) can be directly read. The gravitational acceleration unit is converted to the MKS unit system as follows:

$$1g = 9.8 \text{ m/sec}^2$$

When scaling is carried out in the MKS unit system, the correspondence factor is the following one :

$$\{1/(S \times 10^{-3})\} \times 9.8 \times \sqrt{2}$$

The velocity and displacement can then be obtained by multiplying the acceleration by $1/j\omega$ and $1/(j\omega)^2$ respectively. (these operations are available in the math menu).

CAUTION !

Here displacements were expressed in meters, (MKS unit system),but practically displacements are often expressed in millimeters. In such cases the correspondence factor is $\{1/(S \times 10^{-3})\} \times 9800\sqrt{2}$.

In this case, acceleration is expressed in mm/sec^2 ***while velocity is expressed in mm/sec.***

● PSD

When measuring the noise level generated by, for example, a semi-conductor, it happens that, for the same measurement, different noise values are displayed depending on the frequency range set. This is because the frequency resolution depends on the analysis range and window type.

When measuring the PSD (power spectrum density), the measurement result is converted to the power per Hz, thus, the same result is displayed whatever the analysis range may be. Moreover, the equivalent noise band width, different for each window, is compensated. The unit as well is displayed as must be: if Mag, Mag^2 or dBMag is selected, then the unit displayed is $V/\sqrt{Hz}$, V^2/Hz and $dBV/\sqrt{Hz}$ respectively.

[Setup Procedure]

SETUP ⇒ UNIT ⇒ PSD ON/OFF .... Channel A and channel B share the same PSD setting.

■ Post Measurement Computations (Typical Examples)

In this section, several often used post computations examples are described: Derivation and integration operations (jω operations) through which it is possible to convert an acceleration to a velocity or to a displacement, Hilbert transform which enables to measure the envelope of a modulated signal are described below.

● jω Operations

For example, the signal output from the acceleration sensor is a voltage proportional to the acceleration measured by the sensor. The relationships between acceleration, velocity, and displacement are the following ones:

$$\begin{tikzcd}
\text{Acceleration} \arrow[r, shift right, "\substack{\text{Integration}\\ \int dt}"'] & \text{Velocity} \arrow[l, shift right, "\substack{\frac{d}{dt}\\ \text{Derivation}}"'] \arrow[r, shift right, "\substack{\text{Integration}\\ \int dt}"'] & \text{Displacement} \arrow[l, shift right, "\substack{\frac{d}{dt}\\ \text{Derivation}}"']
\end{tikzcd}$$

An integration in the time domain corresponds to a multiplication by $(\frac{1}{j\omega})$ in the spectrum domain. A derivation in the time domain corresponds to a multiplication by $(j\omega)$ in the spectrum domain. In the spectrum domain, the relationships between acceleration, velocity, and displacement are the following ones:

$$\begin{tikzcd}
\text{Acceleration} \arrow[r, shift right, "\times(\frac{1}{j\omega})"'] \arrow[rr, bend right=40, "\times(\frac{1}{j\omega})^2"'] & \text{Velocity} \arrow[l, shift right, "\times(j\omega)"'] \arrow[r, shift right, "\times(\frac{1}{j\omega})"'] & \text{Displacement} \arrow[l, shift right, "\times(j\omega)"'] \arrow[ll, bend right=40, "\times(j\omega)^2"']
\end{tikzcd}$$

As for R9211's "jω operations", you can set the working frequency domain's limits and an operation threshold. Data smaller than the specified threshold are not processed.

[How to multiply data by $(1/j\omega)^2$]
Display the spectrum you want to multiply by $(1/j\omega)^2$ on the R9211's screen.

In the double screen configuration, specify the waveform to be subjected to the operation by pressing the following keys:
MATH ⇒ SEL ▤
The waveform to be subjected to this operation must be frequency domain data. The time domain data cannot be specified for this operation.

MATH ⇒ jω ⇒ jω RANG

⇒ THRESHOLD
⇒ −120 ⇒ ENT

Set the threshold value. In this example, −120 dBV is set.

⇒ LOWER f
⇒ 0
⇒ KHz
⇒ UPPER f
⇒ 100
⇒ KHz

Set the frequency working domain limits. Here the range 0 to 100kHz is specified.

⇒ RETURN

⇒ jω ?
⇒ $\left(\frac{1}{j\omega}\right)^2$

Set the operation type.
× $(1/j\omega)^2$

⇒ RETURN

⇒ MATHSEL

⇒ OPERAND

⇒ 1st OPERATR

⇒ DO MATH

VIEW ⇒ MATH VW ⇒ RESULT ARRAY

Thus, the operation result can be displayed.
If the function subjected to this operation is the output of the acceleration sensor, the operation result is the corresponding displacement.
Set an engineering unit in order to display the displacement expressed in millimeters (mm). For further details, see the explanation about the engineering unit (p. 7-27 to 7-33).

- **Hilbert Transform**

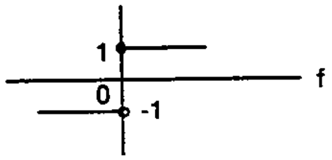


Figure 7-11 Rectangular Filter Transfer Function

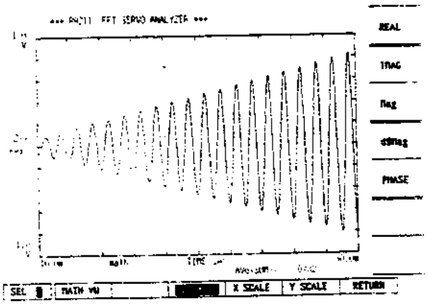
Devices presenting a frequency response function such as shown in Figure 7-11 (including the negative frequencies) are called. Let X(t) stand for the time series data.

If X(t) is input to a rectangular filter and if we call $\hat{X}(t)$ the series output from it, then $\hat{X}(t)$ is called Hilbert transform of X(t).

Suppose $Za(t) = X(t) + j\,\hat{X}(t)$,

where, $j = \sqrt{-1}$,

then, Za(t) is called the pre-envelope of X(t). And the absolute value of Za(t), $|Za(t)|$, is called the envelope of Xa(t). $|Za(t)|$ describes the envelope of the modulated signal.



Computation of the envelope ⇒

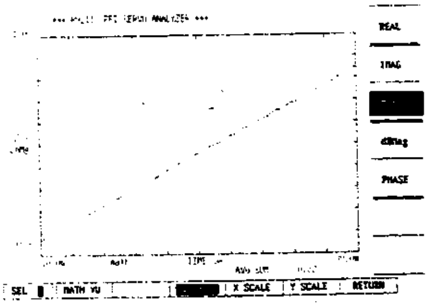


Figure 7-12 Modulated Signal

Figure 7-13 Envelope of the Modulated Signal

To compute the envelope of a signal, you must proceed as is now explained:
Display the real part, the imaginary part, or phase of the signal's spectrum on the R9211's screen.
If you are working with a multiple screens configuration, select the proper data with the VIEW ⇒ SEL keys.

Specify the data to be subjected to the operation (real part, imaginary part, or phase of the spectrum).

Note
To display the real part, the imaginary part, or the phase of the spectrum data, execute the following procedure (select the spectrum screen by pressing the VIEW ⇒ SEL keys in the multiple screen configuration, then execute the following procedure):

VIEW ⇒ COORD ⇒
- *REAL : Displays the real part of the selected function (specified with the SEL key).*
- *IMAG : Displays the imaginary part of the selected function (specified with the SEL key).*
- *PHASE : Displays the phase of the selected function (specified with the SEL key).*

Select one of these.

MATH ⇒ DOMAIN ⇒ to CMP TM : To COMPLEX TIME: Hilbert transformation

⇒ MATH SEL

⇒ OPERAND

⇒ 1st OPPTR

⇒ DO MATH

In a multiple screen configuration, press VIEW ⇒ SEL to specify the position where to display the results.

VIEW ⇒ MATH VW ⇒ RESULT ARRAY : Indicate that the computation results must be displayed.

COORD ⇒ Mag : Specify that the absolute value of the displayed function (Mag) must be displayed along the Y-axis.

Y SCALE ⇒ Y AUTO SCALE : Set Y-axis auto scaling.

■ Zoom (R9211C only)

● Function

The zoom function is designed to zoom in a frequency domain defined by its lower (start f) and upper (stop f) limits. The zoom spectrum is computed on 800 lines, representing the smallest span among those listed in the following table,which contains the span you specified.

Zoom span
50 kHz
20 kHz
10 kHz
5 kHz
2 kHz
1 kHz
500 Hz
200 Hz
100 Hz
50 Hz
20 Hz
10 Hz
5 Hz
2 Hz
1 Hz
500mHz
200mHz
100mHz
50mHz
20mHz
10mHz

If the start frequency is set to 3kHz and the end frequency is set to 7kHz, the span is equal to 4KHz. According to the table to the left, the minimum span containing 4kHz is 5kHz. It means that a 5kHz, 800line analysis is performed.

In this case, the analysis resolution is equal to:

$$\frac{5\text{kHz}}{800\text{lines}} = 6.25\text{Hz /line}$$

The displayed domain has nonetheless 3kHz and 7kHz as limits.

● Zoom's Limitations

When the zoom function is running, there are some functions you may not use at the same time, as well as other restrictions. The table hereunder describes the zoom's limitations:

Table 7-4 Zoom's Limitations

Function	Restriction type
Zoom analysis in the waveform mode	Prohibited
Switching mode while zooming	Enabled but stops the zoom procedure
Trigger mode switching to AUTO ARM while zooming	Prohibited
Trigger mode switching to ARM while zooming	Prohibited
Zoom analysis in AUTO ARM mode	Prohibited
Zoom analysis with f-RESOLN set to LOG f	Prohibited
Zoom analysis with f-RESOLN set to 1/3 OCT f	Prohibited
Zoom analysis with f-RESOLN set to 1/1 OCT f	Prohibited
Modifying f-RESOLN while zooming	Prohibited
Switching active-channel while zooming	Prohibited
Modifying LINE/SPAN while zooming	Prohibited
DATA VIEW while zooming	Prohibited
T-F analysis while zooming	Prohibited
Changing the zoom parameters while using DATA VIEW	DATA VIEW switches from ON to OFF
Changing the zoom parameters during T-F analysis	The T-F analysis switches from ON to OFF

● General Notes

(1) When the zoom function is used, the antialiasing filter cannot be turned off.

(2) When the zoom function is used, select a manual mode to adjust the sensitivity range.

● Zoom Analysis Setup

If you press the key sequence: SETUP ⇒ RANGE, you will obtain the following Y soft menu:

f RESOLN (LIN f)	Select the linear frequency resolution (LIN f) when you want to perform a zoom analysis.
FREQRNG ※ 100kHz START f 0.0kHz STOP f 100.00kHz	Pressing the FREQRNG or STARTf key will move the * mark. FREQRNG※ : Zero start analysis. START f * : Zoom analysis.
kHz	
Hz	
mHz	

SETUP ⇒ RANGE ⇒ START f *	: * moves.
⇒ 10 ⇒ Hz	Input the analysis start frequency.
⇒ STOP f * ⇒ 30 ⇒ Hz	Input the analysis end frequency.

4. Typical Measurement Examples

■ Calibration of a Noise Meter

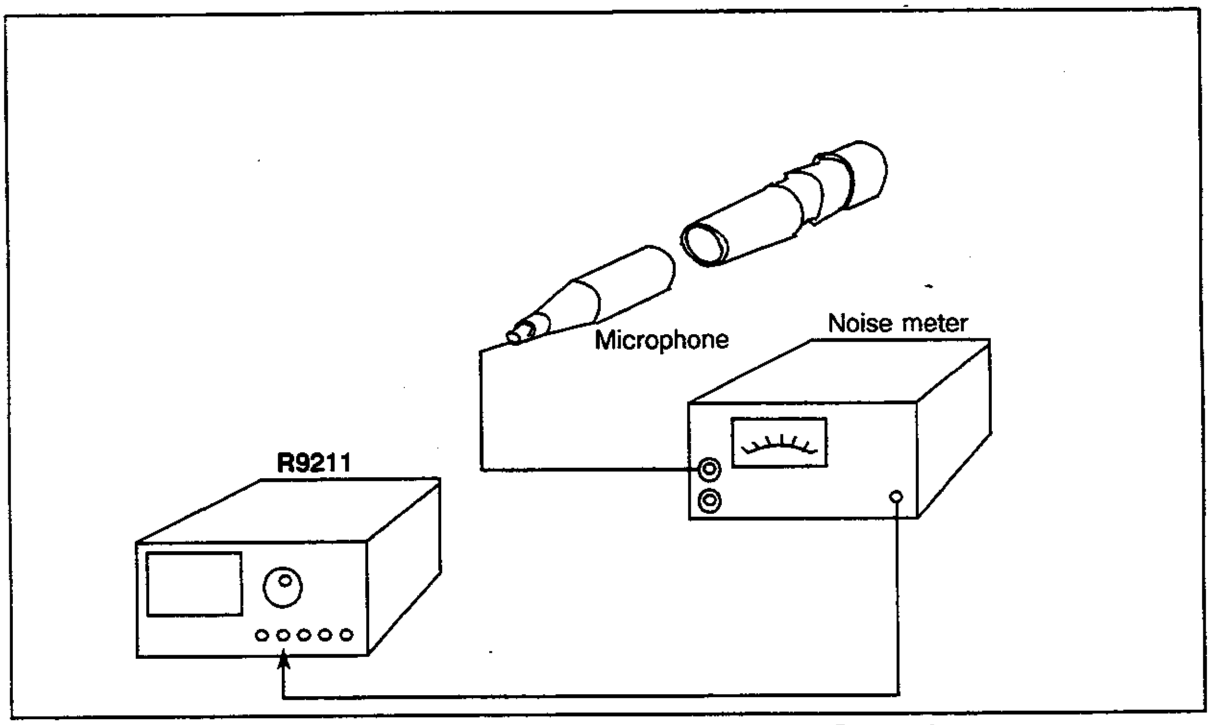


Figure 7-14 Calibration of a Noise Meter with a Pistonphone

We use a pistonphone to calibrate a noise meter. Since the calibration value of the pistonphone is 114dB, we adjust the noise meter so that the noise generated from the pistonphone becomes 114dB. We select the overall marker of the R9211 and define an engineering unit so that the marker value becomes 114dB.

1 Preparation
2 Mode selection
3 Measurement conditions setup
4

1 Connect a pistonphone as shown in Figure 7-14 and apply the calibration sound pressure to the microphone.

2 Select the SPECTRUM mode.

MODE ⇒ MEAS ⇒ SPECTRUM .... TIME-FREQ

You may also select TIME-FREQ.

3 Set octave analysis conditions.

SETUP ⇒ FUNC ⇒ POWER SPECT

⇒ RANGE ⇒ FREQ RNG 20kHz ....Set the frequency range to 20kHz.

⇒ f RESOLN (LIN f)

⇒ 1/3 OCT f ....Select 1/3 octave analysis.

⇒ DECADE 3decade ....Set 3 decades to measure the noise level from 20Hz to 20kHz.

4 Set the input sensitivity.

Set the input sensitivity so that the NORM lamp (green) on the front panel lights.

SETUP ⇒ SENS ⇒ SET CHA 0 dBV ....The auto range cannot be selected when performing an octave analysis.

5 Set the markers.

MKR ⇒ **MKR VAL** ⇒ X1 Y1 / X2 Y2 ……………………Display two markers.

Using the knob, move the first marker to the screen's right boundary.

⇒ **FIX X** ⇒ X FIXED / RIGHT

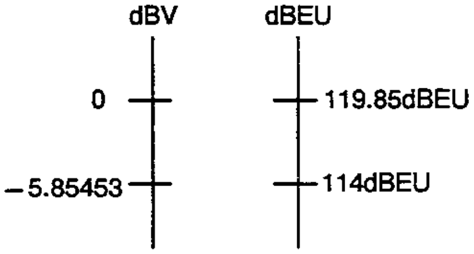
Using the knob, move the second marker to the screen's left boundary.

⇒ **X MKR** ⇒ BAND MKR / (OFF)

⇒ OVERALL ……………………See Figure 7-15.

6 Define an engineering unit.

Define a new scale, so that the values displayed on the screen indicate noise levels.
Since the overall marker's reading is −5.85453dBV, define the engineering unit so that this value corresponds to 114dBEU.



SETUP ⇒ (**NEXT**)

⇒ **UNIT** ⇒ SELECT CH / CH-A

⇒ A:VALUE / 119.85dBEU ……………………Specify the input channel on which this unit definition applies.

⇒ A:UNIT ………………… Select 1/3 octave analysis.

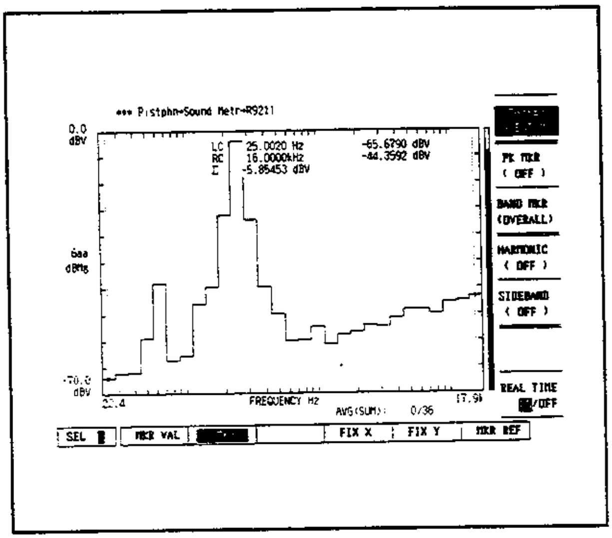
Using the knob and ENT key, define the name of this engineering unit.

⇒ EU or Vlt (Vrms)

⇒ EU

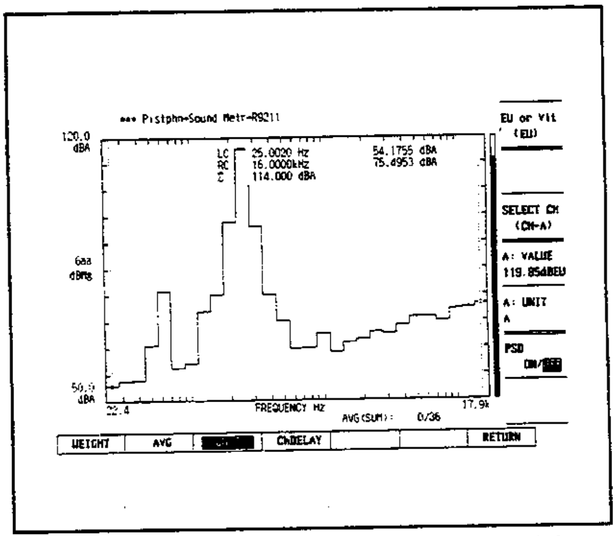
⇒ RETURN

} Indicate that the display is expressed with this engineering unit.



```
LC  25.0020 Hz     -65.6790 dBV
RC  16.0000kHz     -44.3592 dBV
Σ   -5.85453 dBV
```

Figure 7-15 Display of the Overall Marker



```
LC  25.0020 Hz     54.1755 dBA
RC  16.0000kHz     75.4953 dBA
Σ   114.000 dBA
```

Figure 7-16 Display of the Calibration Value

■ Measurement of the Characteristics of an Unevenly Rotating Device

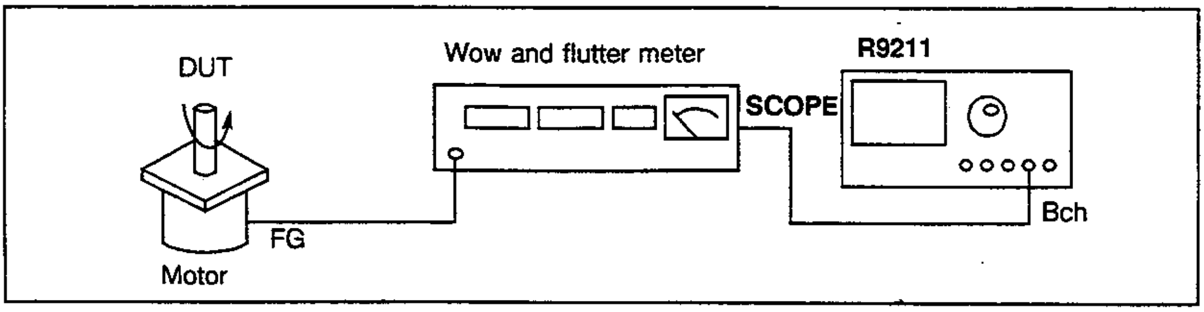


Figure 7-17 Measurement of Irregular Rotations

When the motor is rotating, frequency generator (FG) pulses are generated according to the magnetic field. To measure the motor rotation irregularities, these pulses are transmitted via the wow and flutter meter to the FFT analyzer which will analyze the frequency components of this irregular rotation.
The SCOPE socket of the wow and flutter meter outputs only the irregular elements contained in the FG pulses as an analog signal.
In this example, 240pulses per rotation of a motor, rotating at 250rpm, are electrically picked out and sent to the wow and flutter meter's input.

● Wow and Flutter Meter's Setup

W & F : ON
INPUT : L.P.F
FUNCTION : UNWEIGHTED
INDICATION : RMS
C. FREQ : AUTO ON
MEMORY : OFF
REPEAT : ON
F. FREQ : 1/4. 3
RANGE : f. S 3.0%

- **R9211's setup**

1 **Connect the DUT and the wow and flutter meter as shown in Figure 7-17.**

2 **Select the mode.**

MODE ⇒ MEAS ⇒ SPECTRUM

3 **Set the frequency range.**

⇒ RANG ⇒ FREQ RNG 10Hz

⇒ f RESOLN (LIN f)

4 **Set the input sensitivity.**

SETUP ⇒ SENS ⇒ CH-B AUTO/MAN

5 **Set the window.**

SETUP ⇒ (NEXT)

⇒ WEIGHT ⇒ MINIMUM

6 Set the number of averages.

⇒ AVG ⇒ AVG NO 8 ....Average 8 times.

7 Start averaging.

START ....Perform the measurement.

8 Select the data to be displayed.

VIEW ⇒ AVG VW ⇒ CH-B PWR SPECT

When you reach this point, you will visualize the same display as the one shown on the upper diagram, Figure 7-18.

9 Set the marker's type and position.

MKR ⇒ MKR VAL ⇒ SINGLE X X1 Y1

Using the ◎ knob, points the marker to the data you are interested in.

10 Set the zoom control parameters.

Since the averaged results indicate that the peak frequency is located at 462.5mHz, zoom this area.

VIEW ⇒ INST VW ⇒ CH-B SPECT

SETUP ⇒ RANGE ⇒ START f ∗ 200mHz ....Define the frequency domain to be zoomed in.

⇒ STOP f 2.2Hz

When you reach this point, you will visualize the same display as the one shown on the lower diagram, Figure 7-18.

7 Measurement
8 Selection of the type of display
9 Markers setup
10 Zoom setup

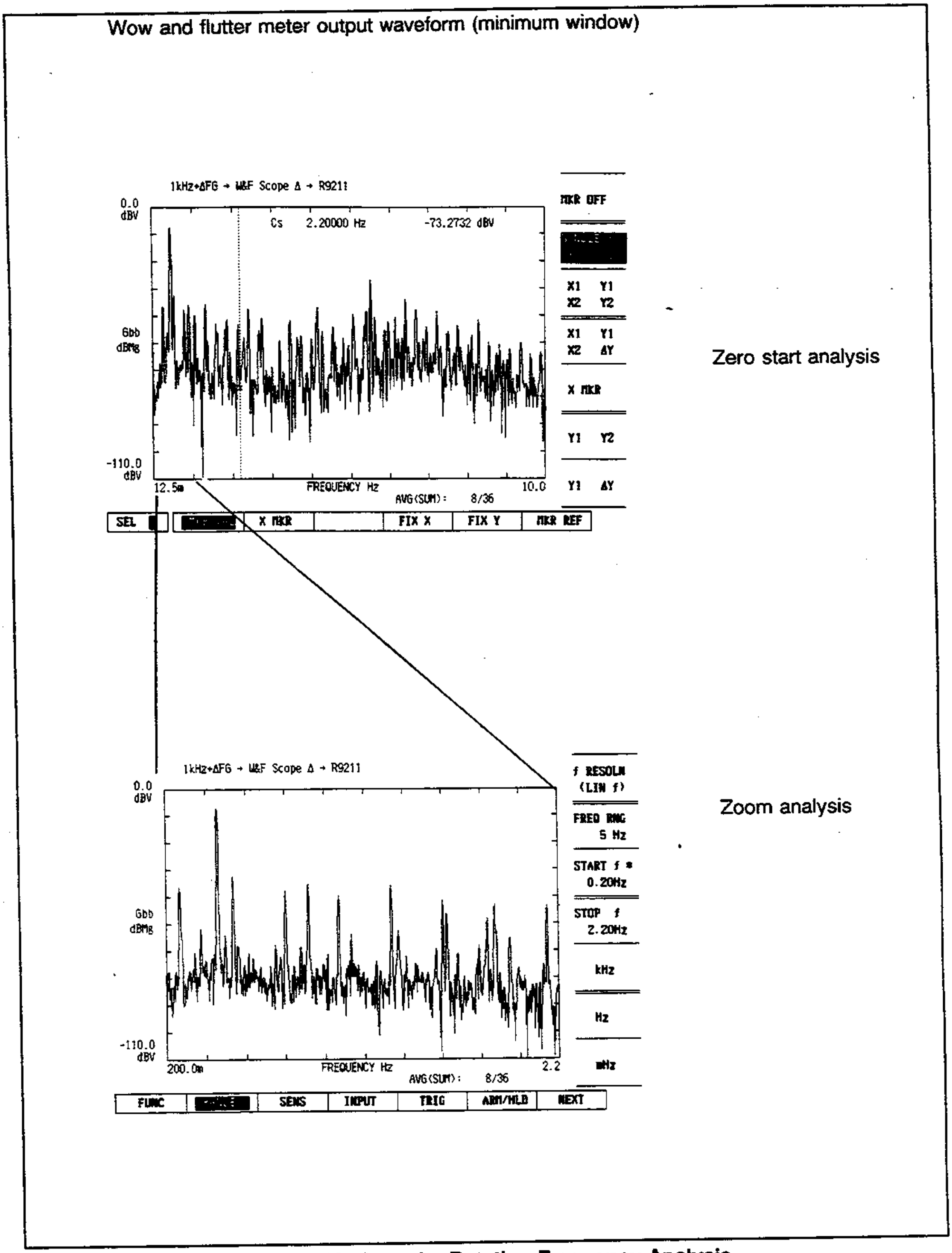


Figure 7-18 Irregular Rotation Frequency Analysis

■ Measurement of the Damping Characteristic of a Speaker

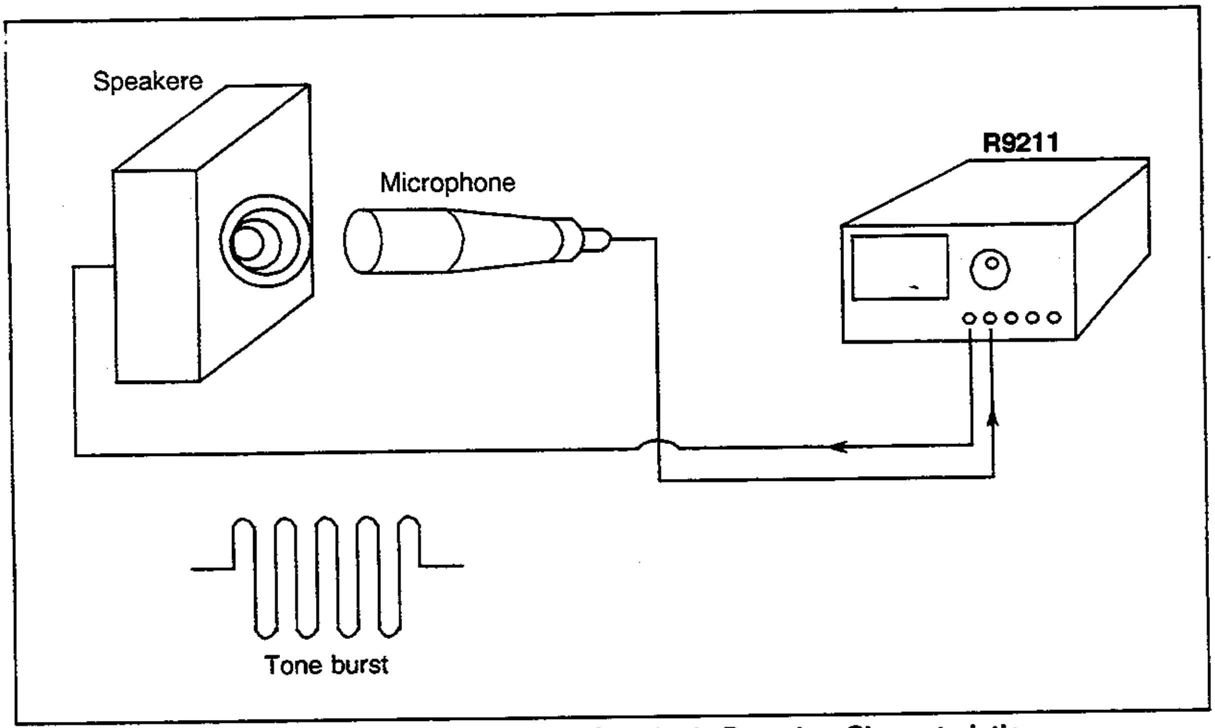


Figure 7-19 Measurement of a Speaker's Damping Characteristic

A tone burst signal is input to the speaker and the sound issued from the speaker is acquired via a microphone. The Hilbert transform of the microphone's output is computed by the R9211, to obtain the pre-envelope of the microphone's output signal. The speaker's damping characteristic can be deduced from the damping value of the pre-envelope.

- **Setup Procedure**

Connect the speaker to the signal generator's output of the R9211 and connect the microphone to channel A.

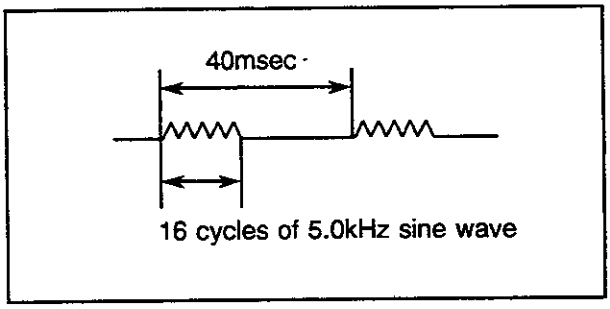
Setup the SG(Signal Generator)

Output a tone burst signal from the SG.

SG CONT ⇒ SIGNAL ⇒ SINE
⇒ FREQ ⇒ f 5.00kHz
SG VLT ⇒ AMPLITUDE 1.00V
CONNECT ⇒ SG OUTPUT
OUT MODE ⇒ INTERNAL
⇒ (PERIOD)
⇒ PERIOD t 40msec
⇒ RETURN
⇒ n CYCLE 16
⇒ OUT CTRL ⇒ GENERATOR START

SIGNAL OUTPUT

OPR



When you reach this point, you will visualize the same display as the one shown on the right.

3 Select the mode.

MODE ⇒ MEAS ⇒ SPECT

4 Set the frequency range.

SETUP ⇒ RANGE ⇒ f RESOLN (LIN f) .... Select the linear frequency analysis.

⇒ FREQ RNG 10kHz

5 Set the input sensitivity.

SETUP ⇒ SENS ⇒ CH-A AUTO/MAN .... Select the manual mode because triggering will be used.

⇒ SET CH-A 0 dBV

Adjust the input sensitivity so that the NORM lamp on the front panel lights.

6 Set the trigger.

SETUP ⇒ TRIG ⇒ SOURCE (CH-A) .... Specify channel A as the trigger source.

⇒ SLOPE (+) .... Trigger according to the positive slope of the signal.

⇒ LEVEL 0.03mV

⇒ HYSTERESI 0.06mV

⇒ DELAY −20.00msec

If the frequency range is set to 10kHz, the frame time will be 40ms for 400-line FFT.
If the trigger delay time is set to −20.00ms, the trigger is activated at the time displayed at the center of the screen.

Select the appropriate form of representation.

Select a double screen configuration to display the time waveform on the upper screen and the spectrum on the lower screen.

VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ⬒

⇒ INST VW ⇒ CH-A TIME

⇒ SEL ⬓

⇒ INST VW ⇒ CH-A SPECT

8 Measurement conditions setup

8 ARM.

ARM and read the data from the buffer.

SETUP ⇒ ARM/HLD ⇒ ARM

9 Selection of the type of display

9 Select the appropriate form of representation.

Perform a Hilbert transform on the sampled data to obtain the pre-envelope.
Since the Hilbert transform must be applied on complex spectra, you must display the spectrum on the screen.

VIEW ⇒ SEL ☰

⇒ INST VW ⇒ CH-A SPECT

⇒ NEXT

⇒ COORD ⇒ REAL

10 Post-measurement computation

10 Perform a Hilbert transform.

MATH ⇒ DOMAIN ⇒ to CMP TM (HILBERT)

⇒ MATH SEL

⇒ OPERAND

⇒ 1st OPRTR

⇒ DO MATH

When the computations are completed, the message "MATH completed!!" is displayed.

11 Modify the axis.

VIEW ⇒ MATH VW ⇒ RESULT ARRAY

⇒ COORD ⇒ Mag

Adjust the time axis of the measured data (upper screen) to the time axis of the resulting data.

VIEW ⇒ SEL ⬒

⇒ X SCALE ⇒ LEFT 10.00msec

⇒ RIGHT 30.00msec

When you reach this point, you will visualize the same display as the one shown Figure 7-20.

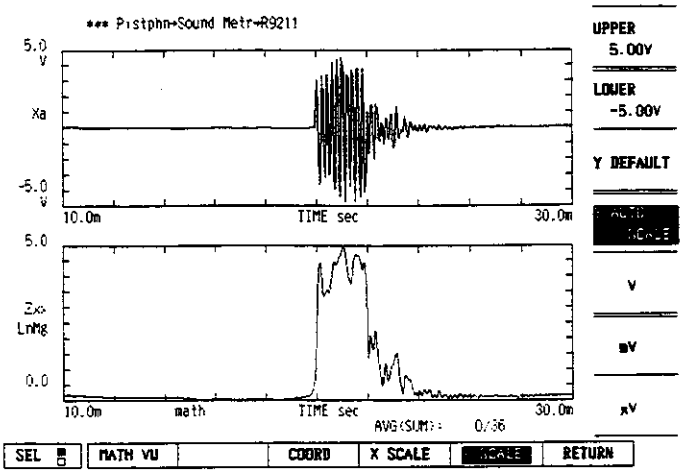
12 Lay one screen over the other to observe how they correspond.

Adjust the Y-axis.

VIEW ⇒ Y SCALE ⇒ LOWER 0.0V

⇒ FORMAT ⇒ OVERLAY [✓ ON]/OFF .... Display the result of the overlaying operation.

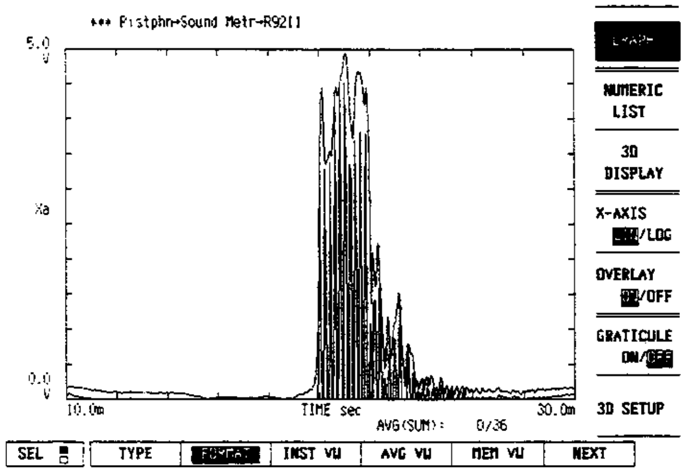
When you reach this point, you will visualize the same display as the one shown Figure 7-21.



Microphone's output signal

Hilbert transform of the microphone's output

Figure 7-20 Damping Characteristic of a Speaker



Lay the microphone output over the Hilbert transform result

Figure 7-21 Overlaid Waveforms

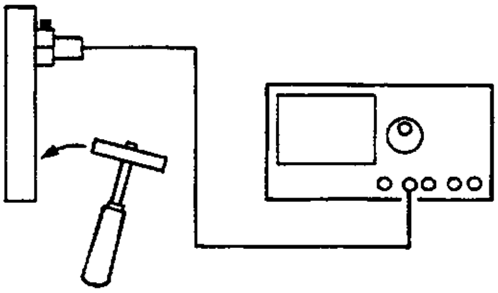
■ Advanced Measurement (T-F Mode)

● Measurement of the Damping Factor of a Metal Plate (Acquiring Data in T-F Mode)

We shall describe here an example of an application of the T-F mode : measurement of the damping factor of a steel plate under vibrations. An acceleration sensor is fixed on the steel plate, then vibrations are induced to the plate with a hammer, so that the damping factor of the plate can be measured. The measurement procedure up to the storage of the data in the input buffer is described here. How to display the acquired data in 3-dimensions, and how to gather the damping factor through T-F tracing, are explained in the next section.

1 Preparation

Connect the metal plate as follows:



Fix an acceleration sensor on the metal plate.

Connect the acceleration sensor to channel A.

2 Mode selection

Select the T-F mode.

MODE ⇒ MEAS ⇒ TIME FREQ

3 Measurement conditions setup

Set the frequency range.

SETUP ⇒ RANGE ⇒ FREQ RNG 100kHz
⇒ 10
⇒ kHz

Set the frequency range to 10kHz.

4 Switch the acceleration sensor.

⇒ INPUT ⇒ CHANNEL CH-A/CH-B

⇒ ICP ON/OFF

Select channel A and switch the acceleration sensor's power on.

5 Set a window.

⇒ NEXT

⇒ WEIGHT ⇒ RECT ....Since more than one frame is acquired in T-F analysis, select a rectangular window in order not to perturb each data individually.

6 Set the input sensitivity.

Strike the metal plate and adjust the input sensitivity so that the NORM lamp on the front panel lights.
Always try to strike the metal plate with the same strength.

⇒ RETURN

⇒ SENS ⇒ CH-A AUTO/MAN ....Select the manual mode for channel A, since you are going to perform strike tests.

⇒ SET CH-A

–5 ⇒ ENT ....To set –5dBV

7 Set up the trigger.

⇒ TRIG ⇒ SOURCE

⇒ CH-A ....Set channel A as the trigger source.

⇒ RETURN

⇒ SLOPE ·············Trigger along the positive slope of the signal.

⇒ +SLOPE

⇒ RETURN

⇒ LEVEL

⇒ 100 ⇒ ENT ········Set a trigger level (mV) so that noise will not perturb triggering. The unit is the mV.

⇒ HYSTERESI ·············3 bis Usually, this level is set to 0V. This setting is required only when the noise is very important.

⇒ 0 ⇒ ENT

⇒ DELAY ·············A second Y menu page is displayed.

⇒ DELAY ·············Press this key again.

⇒ −20 ·············Set −20 ms.

⇒ msec

Since one frame length is 40ms, and the frequency range 10KHz, triggering is done at the center of the frame.

⇒ ARMLEN ·············Set the length of the data frame.

⇒ 8 ⇒ ENT ········By setting 8 kilowords here, 8 data frames shall be analyzed.

8 Arm.

ARM/HLD ⇒ ARM

9 Strike the metal plate.

Strike the metal plate with the same strength as when you were performing the tests (input sensitivity).
If the NORM lamp lights, the input sensitivity is correct.
If the OVER lamp lights, press :

⇒ FREE RUN

⇒ ARM

then, strike the metal plate again.

10 Data acquisition's completion.

The lighting of the front panel's HOLD lamp indicates the completion of the data acquisition process.

11 Select the appropriate form of display.

Check the data with DATA VIEW.

VIEW ⇒ INST VW ⇒ CH-A TIME ....Display the time waveform of channel A.

⇒ DATA VIEW **ON**/OFF ....Switch DATA VIEW on.

⇒ VIEW STEP

⇒ AUTO TOP ....Display the beginning of the input buffer.

⇒ AUTO RIGHT ....Progressively display the input buffer contents by shifts equal to the set STEP TIME.

Thus, the input buffer contents are displayed gradually. How to display the input buffer contents in 3-dimensions, and how to gather the damping factor through T-F tracing, is explained in the following section.

● **Three-dimensional Display in T-F Mode**

You can display the data sampled in the T-F mode on the 3-dimensional screen in the following procedure :

1 Display the spectrum data.

Selection of the type of display

VIEW ⇒ INST VW ⇒ CH-A SPECT ……To display the time waveform in 3-dimensions, display the waveform here.

⇒ Data View ON/OFF

⇒ VIEW STEP

⇒ AUTO TOP

⇒ Y SCALE ⇒ Y AUTO SCALE

2 3-dimensional display's setup.

⇒ FORMAT ⇒ 3D STEP

⇒ 3D CTRL

⇒ VIEW STEP

(3D STEP, 3D CTRL, VIEW STEP:) Set the 3-dimensional display timing to the data window timing.

⇒ RETURN

⇒ RETURN

⇒ 3D DISPLAY

⇒ INST VW ⇒ VIEW STEP

⇒ AUTO RIGHT

3-dimensional display starts. However, since the amplitude of the front data is larger than that of the rear data, it is very difficult to read the graph.
To improve this, first press AUTO RIGHT to display the data up to an appropriate place, then press:

⇒ AUTO LEFT

Then, the data of smallest amplitude are displayed at the front of the screen, and the data of the beginning of the buffer are display at the back of the screen.

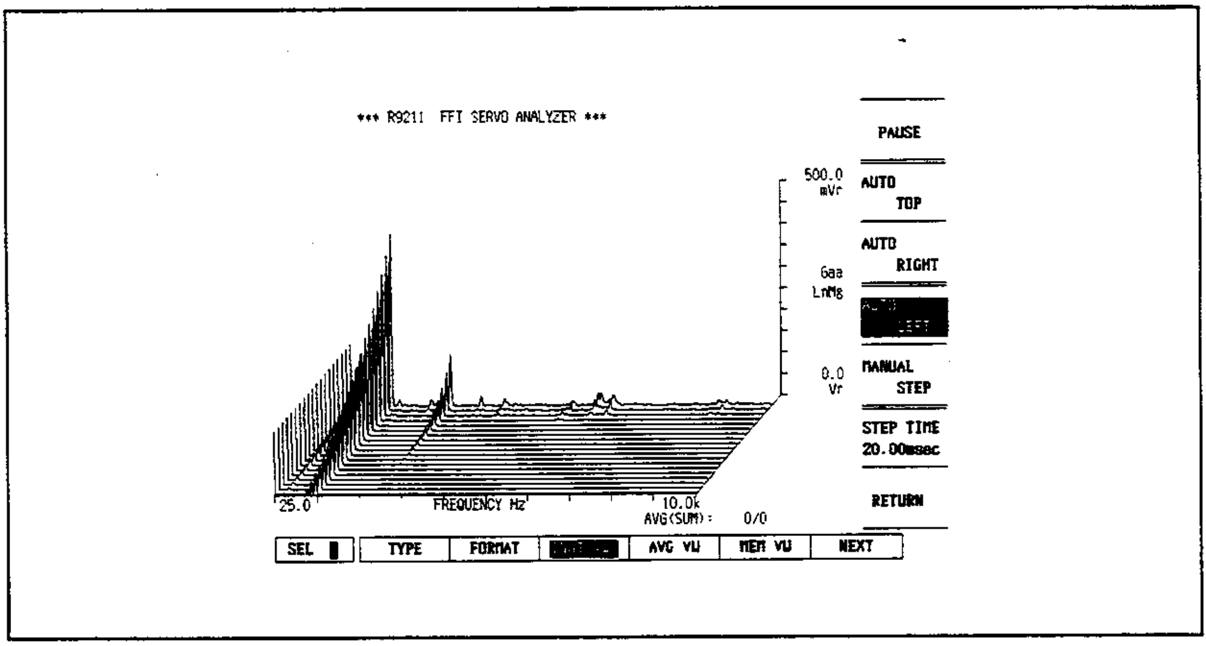


Figure 7-22 3-dimensional Display in T-F Mode

● **Measuring a Damping Factor through T-F Tracing**

We explained in a previous section how to acquire data for the T-F mode. We shall describe now how to proceed to measure a damping factor using T-F tracing (Time-Frequency) and the marker.

1 Markers setup

Looking for the resonance frequency.

VIEW ⇒ INST VW ⇒ CH-A SPECT

⇒ DATA VIEW ON/OFF

⇒ VIEW STEP

⇒ AUTO TOP

MKR ⇒ MKR VAL ⇒ SINGLE X X1 Y1

Using the ◯ knob, move the marker to find the resonance frequency.

(Suppose that the resonance frequency is found at 1kHz.)

2 Measurement conditions setup

T-F trace setup.

SETUP ⇒ (NEXT)

⇒ T-F ⇒ t RANGE

⇒ STOP t 1 sec

⇒ STEP t 1 msec

⇒ RETURN

Measurement conditions setup

⇒ t-f MODE

⇒ t-f ID 1

⇒ t-f CH (CH-A)

⇒ t-f DATA (Gxx)

⇒ STOP f 1kHz

⇒ RETURN

⇒ INST t-f ON/OFF

3 Start T-F tracing.

START .... Start T-F tracing.

Analysis start

4 Select the appropriate form of display.

VIEW ⇒ (NEXT)

⇒ TF-VW ⇒ t-f TRACE 1

The time-frequency characteristics are drawn up.

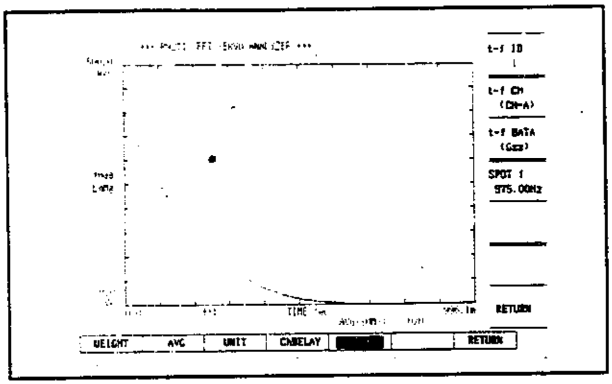


Figure 7-23 Time-frequency characteristic

5 Set the damping markers.

MKR ⇒ **MKR VAL** ⇒ X1 Y1 / X2 Y2

Enclose the portion subject to damping factor measurement with two markers.

⇒ **FIX X** ⇒ X FIXD LEFT

⇒ X FIXD RIGHT

⇒ **X MKR** ⇒ DAMP PWR ON/OFF

⇒ X MARKER DO ESTIM

The damping factor is displayed.

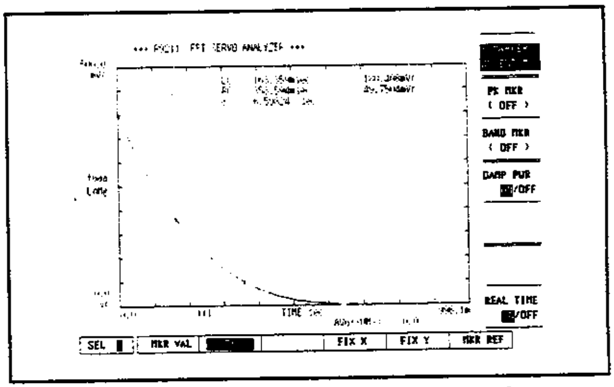


Figure 7-24 Display of the Damping Factor of a Metal Plate

CHAPTER 8

WAVEFORM MODE

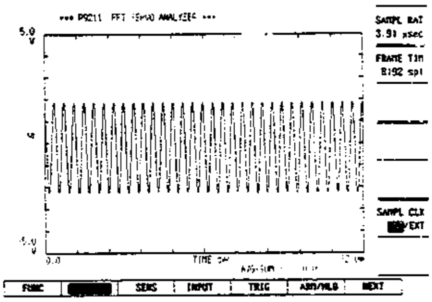
This chapter describes the analysis procedure in the waveform mode, provides the necessary information about such measurements, and illustrates this mode through examples.

CONTENTS

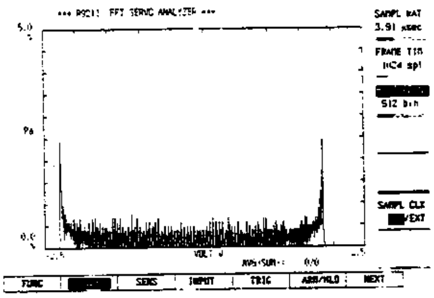
1. An Introduction To The Waveform Mode

The waveform mode is designed for the analysis in the time domain of signals input to channel A, channel B, or the digital I/O connector. No frequency domain analysis is possible, but the following features are provided.

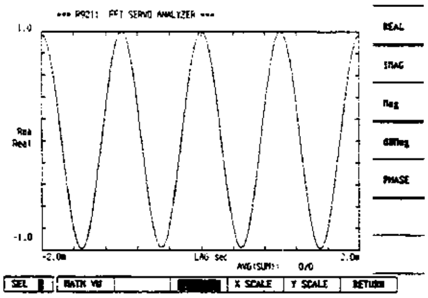
(1) High resolution observations can be made on time waveforms.
(2) Histogram measurements are enabled.
(3) Correlation measurements are enabled.



Time waveform



Histogram



Autocorrelation function

Histograms and correlation functions can be measured only in the waveform mode.

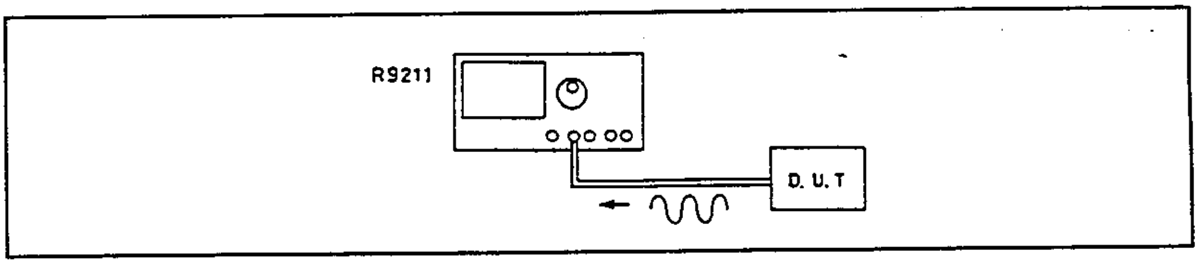
2. Basic Setup Procedure

■ Waveform Observation Setup Procedure

Hereunder, is described the setup procedure followed for studying a time waveform.

1 Input the signal to be measured to channel A or channel B.

Suppose that a 2 V_{P-P} sine wave is input from the DUT to the R9211.



2 Select the waveform mode.

MODE ⇒ MEAS ⇒ WAVEFORM : Select the time domain measurement mode.

3 Select the time waveform function.

SETUP ⇒ FUNC ⇒ TIME : Select the time axis waveform function.

4 Set the sampling period and the number of points.

⇒ RANGE ⇒ SAMPL RAT 3.91μsec : Set with the ⇧ key or the ⇩ key.

FRAME TIME 1024spl

5 Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO/MAN : Select AUTO as the input sensitivity mode.

6 Switch off the antialiasing filter.

⇒ INPUT ⇒ FILTER ON/OFF

7 Set the trigger control parameters.

⇒ TRIG ⇒ SOURCE CH-A : Specify channel A as the trigger source.

⇒ SLOPE (+) : Trigger along the positive slope of the signal.

⇒ LEVEL 0.0mV : Set the trigger level to 0V.

⇒ HYSTERESI 22.09mV

8 Set the averaging conditions.

⇒ (NEXT)

⇒ AVG ⇒ AVG NO 8 : Set 8 as the number of averages.

9 Select the AUTO ARM mode.

⇒ ARM/HLD ⇒ AUTO ARM : Arms automatically.

10 Start averaging.

START : Start averaging.

Averaging Start

11 Selection of the type of display

11 Select the double screen configuration.

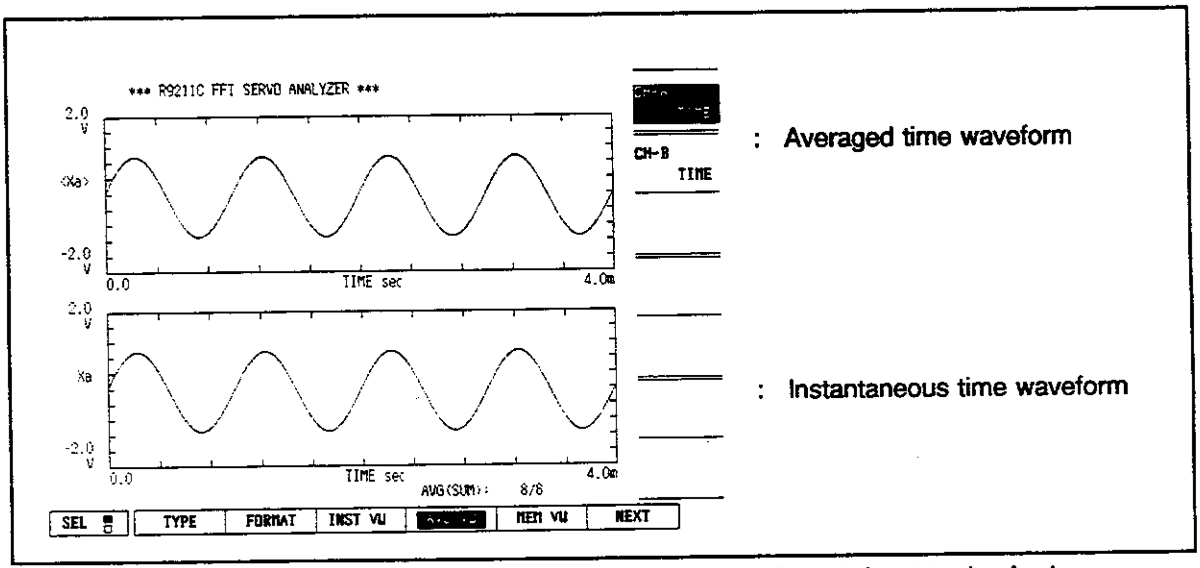
VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ▤ : Select the lower screen.

⇒ INST VW ⇒ CH-A TIME : Display the instantaneous time data on the lower screen.

⇒ SEL ▤ : Select the upper screen.

⇒ AVG VW ⇒ CH-A TIME : Display the averaged time data on the upper screen.



: Averaged time waveform

: Instantaneous time waveform

Figure 8-1 Time Waveforms Generated when a Sine Waveform is Input to the Analyzer

■ Histogram Measurement Setup Procedure

Hereunder is described the procedure followed for the measurement of a histogram.

1 Mode selection

Select the waveform mode.

MODE ⇒ MEAS ⇒ WAVEFORM

2 Measurement conditions setup

Select the histogram analysis function.

SETUP ⇒ FUNC ⇒ HISTOGRAM

3

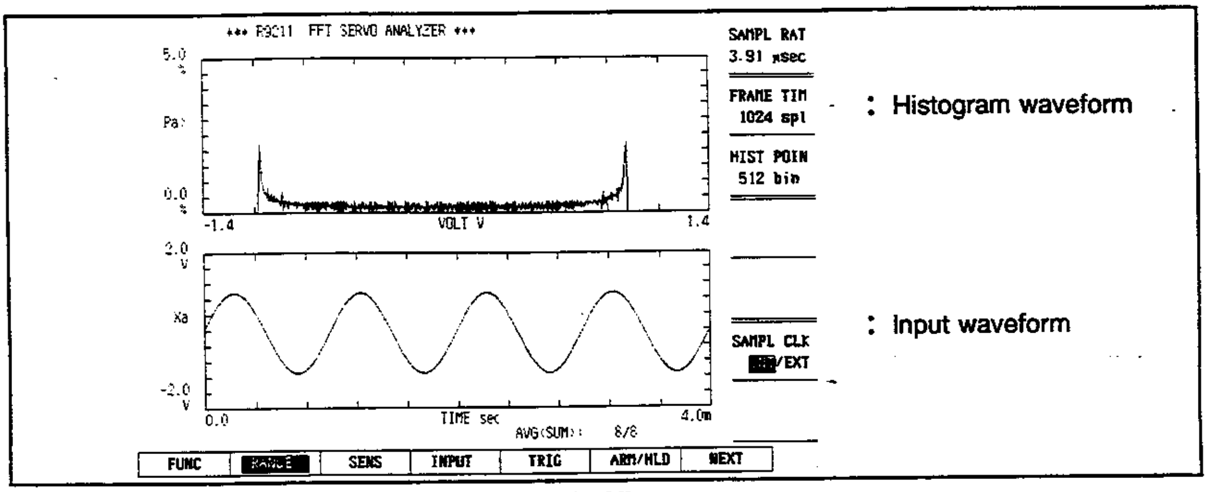
Set the sampling rate and the number of points.

⇒ RANG ⇒ SAMPL RAT 3.91μsec : Set the sampling period.

⇒ FRAME TIME 1024spl : Set the number of time samples.

⇒ HIST POIN 512bin : Set the number of histogram points.

The procedure you must now follow is the same as the one used for time waveforms observations. Since this procedure has already been described, it is not described again here. You should refer to the previous section. (p.8-3, ...)



SAMPL RAT 3.91 µsec
FRAME TIM 1024 spl
HIST POIN 512 bin
SAMPL CLK ■/EXT

: Histogram waveform

: Input waveform

Figure 8-2 Histogram

■ Correlation Function Measurement Setup Procedure

Hereunder is described the procedure followed for the measurement of correlations functions.

1 Mode selection

Select the waveform mode.

MODE ⇨ MEAS ⇨ WAVEFORM

2 Measurement conditions setup

Select the appropriate analysis function.

SETUP ⇨ FUNC ⇨ AUTO CORR : Autocorrelation function

Select one of these. ⇨ CROSS-CORR : Cross-correlation function

3

Set the sampling rate and the number of points.

⇨ RANGE ⇨ SAMPL RAT 3.91µsec

⇨ FRAME 1024spl

4 Set the input sensitivity.

⇒ **SENS** ⇒ CH-A AUTO/MAN

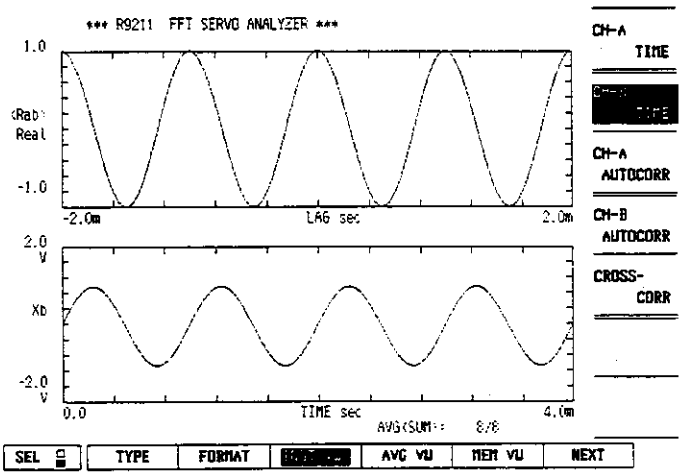
This is an example of input sensitivity setting. Set the input sensitivity according to your own input signal.

⇒ SET CH-A 0dBV

⇒ CH-B AUTO/MAN

⇒ SET CH-B 5dBV

The procedure afterwards is the same as the one described from page 8-3 for the time waveform observation.



: Cross-correlation function

: Input waveform

Figure 8-3 Cross-correlation Function

3. Toward Better Measurement

■ Sampling Rate and Number of Points

● Sampling Rate

You can specify the A/D conversion sampling rate. Only the sampling rates listed in Table 8-1 may be specified.
If the anti-aliasing filter is on, changing the sampling rate modifies the anti-aliasing filter's cutting frequency accordingly.

Table 8-1 Possible Sampling Rates

Possible sampling rate	Antialiasing filter's cutting frequency.
3.91 μsec	100kHZ
7.81 μsec	50kHZ
19.5 μsec	20kHZ
39.1 μsec	10kHZ
78.1 μsec	5kHZ
195 μsec	2kHZ
391 μsec	1kHZ
781 μsec	500 HZ
1.95 msec	200 HZ
3.91 msec	100 HZ
7.81 msec	50 HZ
19.5 msec	20 HZ
39.1 msec	10 HZ
78.1 msec	5 HZ
195 msec	2 HZ
391 msec	1 HZ
781 msec	500mHZ
1.95 sec	200mHZ
3.91 sec	100mHZ
7.81 sec	50mHZ
19.5 sec	20mHZ
39.1 sec	10mHZ

SETUP ⇒ RANG ⇒ SAMPL RAT

Enter the sampling rate with the ⇩ or ⇧ keys.

● Number of Display Points

The number of points per frame to be displayed can be set. Table 8-2 lists the values that the parameter "number of points per frame" can take.

Table 8-2 Possible Number of Points Per Frame

Number of points per frame which can be displayed
64
128
256
513
1024
2048
4096
8192 (*)

(*) This number of points is available when one channel only is active.

SETUP ⇒ RANG ⇒ FRAME TIM

⇒ Use the numeric keys, the ⇧ and ⇩ keys, or the ◔ knob to set the number of points.

When a value is input with the numeric keys, the value closest to one of the values listed in the above table is set.

● Histogram Voltage Amplitude

When measuring a histogram, you define the voltage resolution by specifying the number of points which will describe the total voltage amplitude.
You can consider these points as voltage intervals, whose width is related to the number of points (bin) by the following relationship:

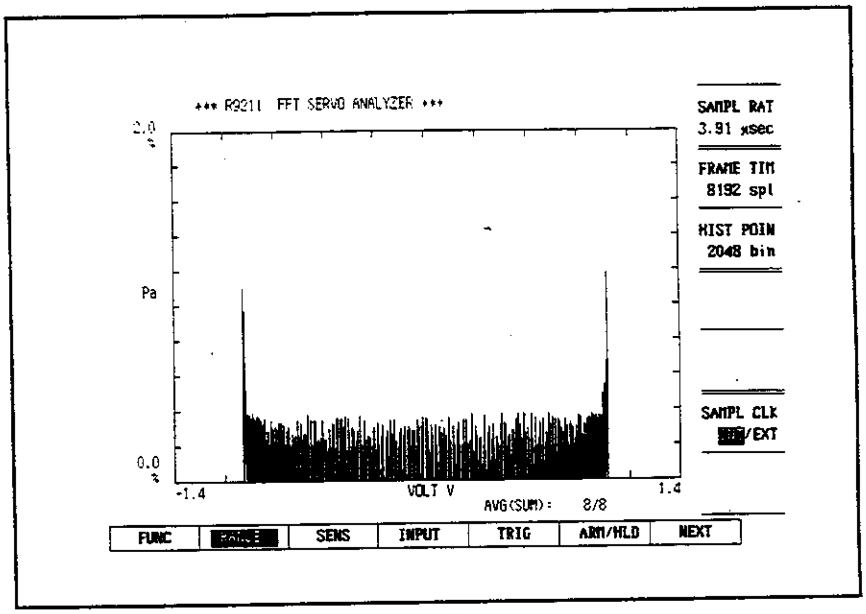
$$\text{Voltage resolution (or width of a voltage interval)} = \frac{2 \cdot \sqrt{2} \cdot 10^{\frac{dBV}{20}}}{\text{Number of points}}$$

For example, if the input sensitivity is 0 dBV and the number of histogram points is 64 bins, the voltage amplitude is:

$$\text{Voltage resolution} = \frac{2 \cdot \sqrt{2} \cdot 10^{0}}{64} \fallingdotseq 0.44\text{V}$$

SETUP ⇒ RANG ⇒ HIST POIN 64bin : Selects 64 bins.

Since a histogram measurement is performed on 1 data frame (an average is calculated over each frame), you can modify the total number of histo-points by changing the number of points per frame.


*** R9211 FFT SERVO ANALYZER ***

SAMPL RAT 3.91 μsec

FRAME TIM 8192 spl

HIST POIN 2048 bin

SAMPL CLK INT/EXT

AVG(SUM): 8/8

Figure 8-4 Histogram

■ Trigger

Triggering is used when you want to acquire your data at the moment when a signal reaches a certain level, or when you want to perform synchronous averaging.
The trigger setup flow is the following one :

Set a trigger source.

↓

Set the trigger type and level.

↓

Set a trigger point (delay).

↓

Arm or choose the automatically arming mode.

● Trigger Types

The R9211 has two trigger types: for the first one, called LEVEL trigger, you choose a trigger threshold value, and triggering is executed when the trigger signal becomes larger (or smaller) than this threshold; for the second one, called BI-SLOPE trigger, you choose a zone, triggering is then executed when the trigger signal enters (or exits) this zone.

- Trigger
  - LEVEL Trigger
    - Rise (Trigger when the trigger signal becomes larger than the threshold.)
    - Fall (Trigger when the input signal becomes smaller than the threshold.)
  - BI-SLOPE Trigger
    - IN (Triggers when the trigger signal enters the specified voltage zone.)
    - OUT (Triggers when the trigger signal exits the specified voltage zone.)

● Selection of a Trigger Source

When you select an external trigger signal, input the external trigger signal to the TRIG connector at the rear panel of the R9211.

SETUP ⇒ TRIG ⇒ SOURCE

Select one of these.

- ⇒ CH-A : Selects channel A as the trigger source.
- ⇒ CH-B : Selects channel B as the trigger source.
- ⇒ EXT : Selects an external trigger signal as the trigger source.

● LEVEL Trigger

First, for a LEVEL trigger, you must specify whether the triggering is to be executed along the rising edge or along the falling edge of the signal.

SETUP ⇒ TRIG ⇒ SLOPE

Select one of these.
- ⇒ +SLOPE
- ⇒ −SLOPE

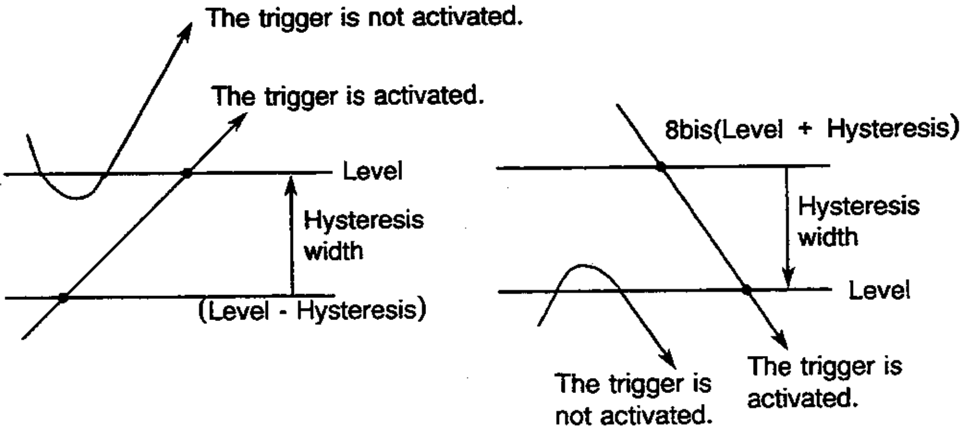
RETURN

Then, choose the triggering level (threshold).

⇒ LEVEL

⇒ 12 ⇒ ENT

Finally, define the hysteresis.



Trigger activated along a rising edge. Trigger activated along a falling edge.

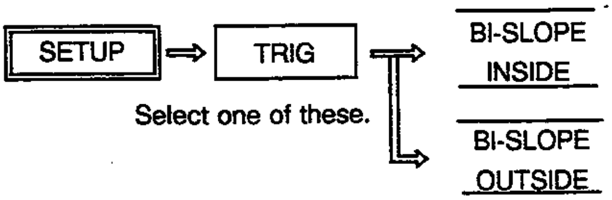
As shown on the above figure, the hysteresis direction is determined by the trigger slope (rising edge or falling edge).

TRIG ⇒ HYSTERESI

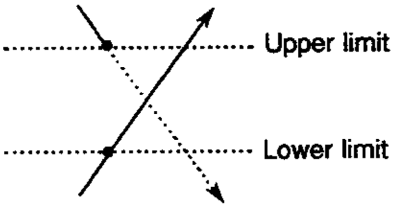
⇒ 22 ⇒ ENT

● BI-SLOPE Trigger

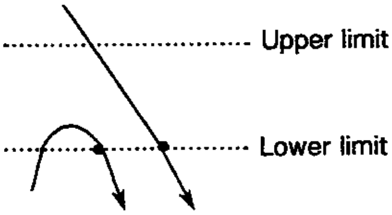
First, determine whether the trigger is to be activated when the trigger signal enters into or exists from the specified voltage zone.



Then specify the voltage zone (upper and lower limits).



BI-SLOPE IN trigger

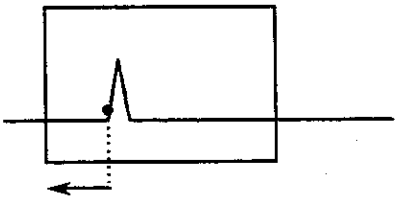


BI-SLOPE OUT trigger

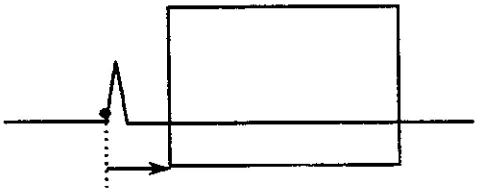
● Trigger Delay

The trigger delay represents the relative time between the trigger activation point and the left end of the screen.

For example, when the trigger delay is set to −2ms, the following screen is displayed :



Furthermore, when the trigger delay is set to 2ms, the following screen is displayed:



[Setup procedure]

TRIG ⇒ DELAY
⇒ DELAY
⇒ −2
⇒ msec
⇒ RETURN

- **ARM/AUTO ARM**

We just described the trigger conditions setup procedure.
Now, to perform a measurement while using the trigger you must manually, or automatically arm it. In the ARM mode, the trigger is activated and the data thus acquired are held. In the AUTO ARM mode, the data are updated whenever the trigger is activated.
When, in the ARM or AUTO ARM mode, data acquisition is completed after the trigger's activation, the HOLD lamp (red) lights.

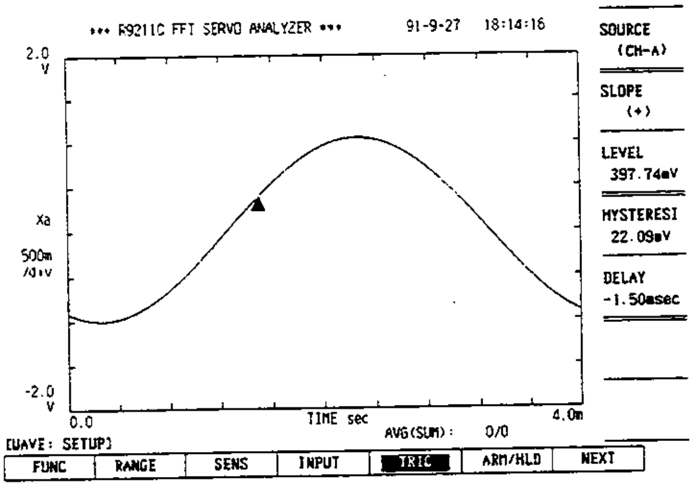
[Setup procedure]

SETUP ⇒ ARM/HLD ⇒ AUTO ARM
⇒ ARM

Select one of these.

■ Trigger Position Marker

Display the marker at the point where the trigger is activated.



*** R9211C FFT SERVO ANALYZER *** 91-9-27 18:14:16

SOURCE (CH-A)
SLOPE (+)
LEVEL 397.74mV
HYSTERESI 22.09mV
DELAY -1.50msec

AVG(SUM): 0/0

[WAVE: SETUP]

Caution !

When the data held in the ARM mode operation is recorded on the floppy disk and is reproduced, the trigger position marker is not displayed.

■ Lag Window

The cross-correlation function and auto-correlation function are calculated using the FFT.
To redûce the truncation error introduced then, a window function is applied.
In the R9211, this window function is called a lag window.
To obtain the correlation function of a continuous signal, use a Hanning window (HANN). To obtain the correlation function of a transient signal, use a Rectangular (RECT) window.
[Setup procedure]

SETUP ⇨ NEXT

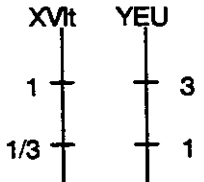
⇨ LAG WND ⇨ STATIONAR (HANN) Hanning window

⇨ TRANSIENT (RECT) Rectangular window

Select one of these.

■ Engineering Unit

You can define an engineering unit to change the scale, displayed on the screen of the R9211.
For example, if you connect to the R9211 a sensor which outputs 2V when it measures 1G, by defining an appropriate engineering unit, you can directly read on the screen, the measurement results in unit "G".
For instance, to make 1Vlt corresponds to 3EU, proceed as follows :



Y(EU) = (Correspondence factor) × X(Vlt)
In this example, the correspondence factor is 3.

SETUP ⇨ NEXT

⇨ UNIT ⇨ SELECTCH CH-A

⇨ A:VALUE 3.00EU

⇨ A:UNIT EU

Using the ◎ knob and ENT key, enter the characters (maximum 2) of the engineering unit's name.

⇨ DONE

⇨ RETURN

⇨ EU or Vlt EU : Display the engineering unit.

4. Typical Measurement Examples

■ Sound Propagation Delay Measurement (Using a Tone Burst Signal)

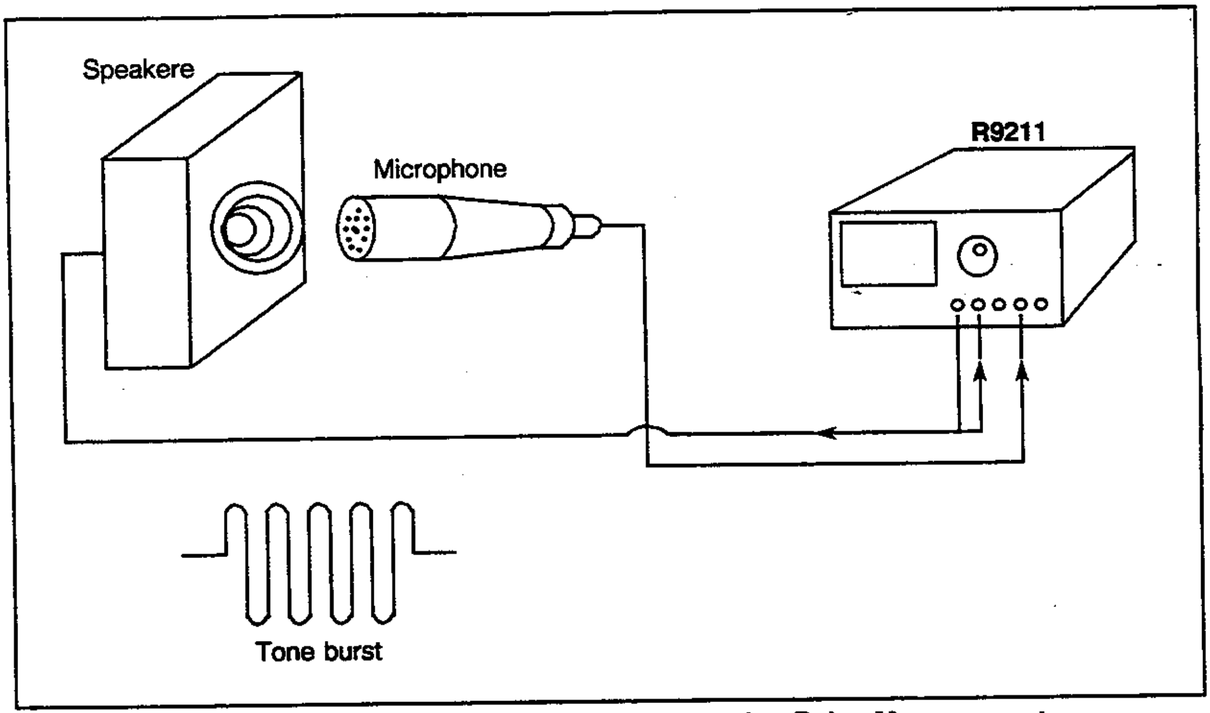


Figure 8-5 Connections for a Sound Propagation Delay Measurement

Send the tone burst signal generated by the built-in signal generator (SG) of the R9211 to the speaker and to channel A and connect the output of the microphone (which receives the speaker's sound) to channel B.
The sound propagation time, from the speaker to the microphone, is measured by computing the cross-correlation function of channel A and channel B. Using a rectangular window as the lag window, you can obtain an accurate measurement result.

[Setup procedure]

1 Preparation
2 SG's Setup

1 Make the connections shown on Figure 8-5.

Connect the R9211's SG's output to the speaker and to channel A.

Connect the microphone's output to channel B.

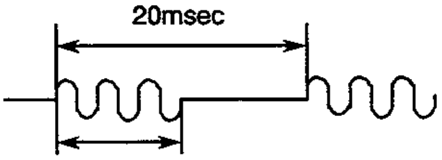
2 Output a tone burst signal from the SG.

SG CONT ⇒ SIGNAL ⇒ SINE
⇒ FREQ ⇒ f 10.00kHz
⇒ SG VIT ⇒ AMPLITUDE 1.00V
⇒ CONNECT ⇒ to ChA : Internally connect the SG's output to channel A.
⇒ OUT MODE ⇒ INTERNAL
⇒ (PERIOD)
⇒ PERIOD t 20.00msec
⇒ RETURN
⇒ nCYCLE 16
OUT CTRL ⇒ GENERATOR START

SIGNAL OUTPUT

OPR

When you reach this point, the signal shown at the right is output from the SG.



16 cycles of 10kHz sine wave

Mode selection

3 Select a waveform mode.

MODE ⇒ MEAS ⇒ WAVEFORM

Measurement conditions setup

4 Select a cross-correlation function.

SETUP ⇒ FUNC ⇒ CROSS-CORR

5 Set a sampling rate.

⇒ RANGE ⇒ SAMPL RAT 19.5μsec

⇒ FRAME TIM 1024spl

6 Set input sensitivity.

⇒ SENS ⇒ CH-A AUTO/MAN

⇒ SET CH-A 0dBV

⇒ CH-B AUTO/MAN

⇒ SET CH-B 0dBV

7 Measurement conditions setup

Set up the trigger.

⇒ **TRTG** ⇒ SOURCE (CH-A)

⇒ SLOPE (+)

⇒ LEVEL 0.0mV

⇒ HYSTERESI 11.04mV

⇒ DELAY -10.00ms

8 Selection of the type of display

Select the triple screen configuration.

Observe the time waveforms of channel A and channel B to check whether the trigger has been correctly activated.

VIEW ⇒ **TYPE** ⇒ TRIPLE

⇒ **SEL ▤**

⇒ **INST VW** ⇒ CH-A TIME

⇒ **SEL ▤** ⇒ CH-B TIME

9 Set TRACEonST to OFF.

Exception

Pressing the START key in this state would display the default screen.

To prevent this, set TRACEonST to OFF.

MODE ⇒ EXTEND ⇒ TRACEonST ON/**OFF**

10 Set the number of averages.

Measurement conditions setup

SETUP ⇒ AVG ⇒ AVG NO 10

11 Select the AUTO ARM mode.

⇒ ARM/HLD ⇒ AUTO ARM

12 Start averaging.

Averaging Start

START .... Averaging is being performed.

13 Select the cross-correlation function display mode.

Selection of the type of display

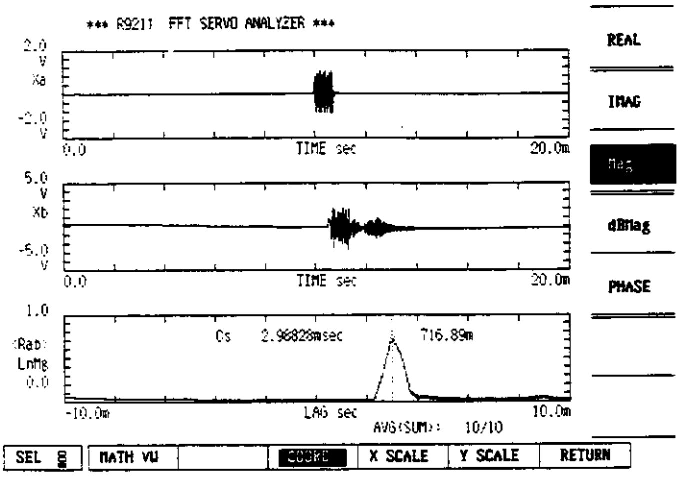
VIEW ⇒ SEL ▤

⇒ AVG VW ⇒ CROSS-CORR

14 Display a marker.

Marker

MKR ⇒ MKR VAL ⇒ SINGLEX X1 Y1



: Time waveform of channel A

: Time waveform of channel B

: Cross-correlation function of channel A and channel B

Figure 8-6 Propagation Delay Measurement

■ Pulse Rise Time Measurement (Using a Pulse Marker)

The procedure followed for the measurement of a pulse rise time, a pulse fall time, and a pulse width using a pulse marker is described below.

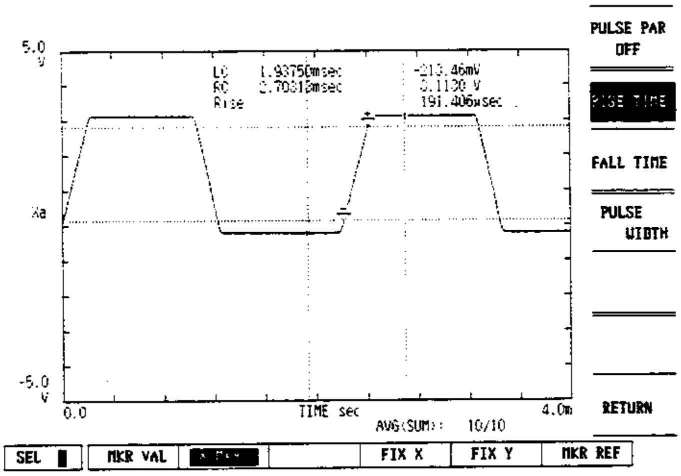


Figure 8-7 Pulse Rise Time Measurement

1 Preparation

Input the pulses to channel A.

2 Mode selection

Select the waveform mode.

MODE ⇒ MEAS ⇒ WAVEFORM

3 Measurement conditions setup

Select the time waveform measurement function.

SETUP ⇒ FUNC ⇒ TIME

4

Set the input sensitivity.

⇒ SENS ⇒ CH-A AUTO/MAN

SET CH-A
15dBV

Measurement conditions setup

5 Set up the trigger.

⇒ TRIG ⇒ SOURCE
⇒ CH-A
⇒ RETURN

⇒ ARM/HLD ⇒ ARM

Markers setup

6 Set up the marker.

MKR ⇒ FIX X ⇒ X FIXED RIGHT
⇒ X FIXED LEFT

Using the ◯ knob, enclose the rising portion of the pulse.

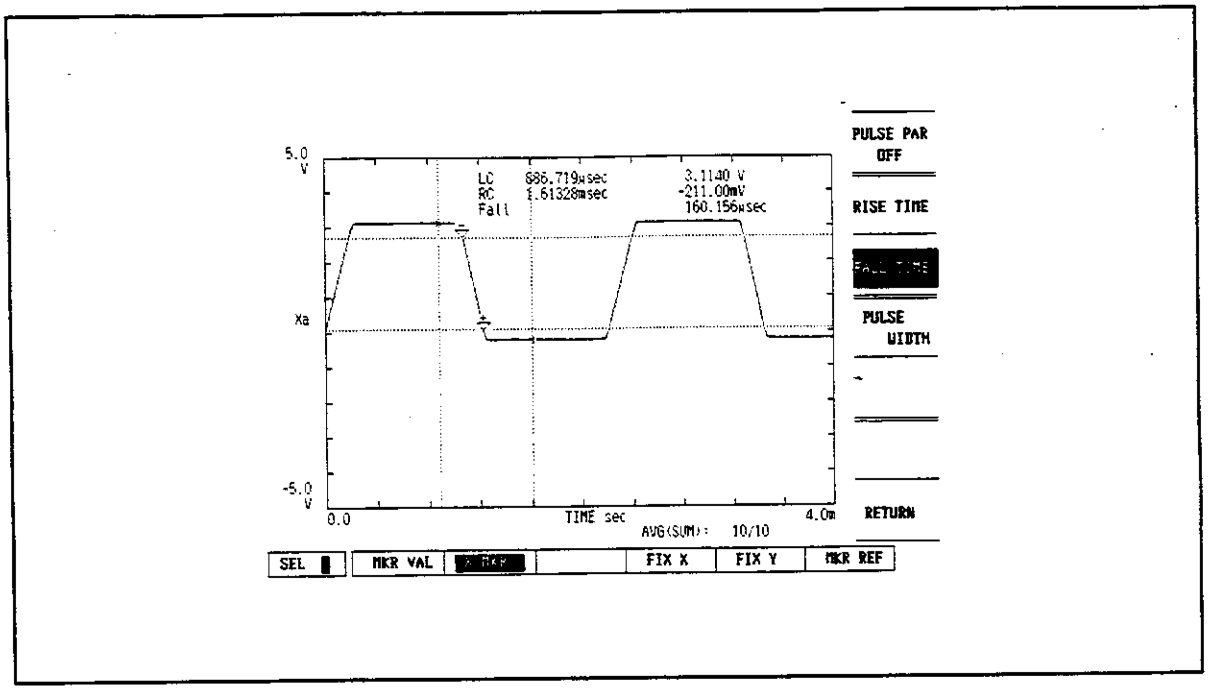
⇒ X MKR ⇒ PULSE PAR
⇒ RISE TIME
⇒ X MARKER DO ESTIM

In the same way, the pulse fall time and pulse width can be measured with the marker.

MKR ⇒ X MKR ⇒ PULSE PAR
⇒ FALL TIME ..... Pulse fall time
⇒ PULSE WIDTH ..... Pulse width measurement

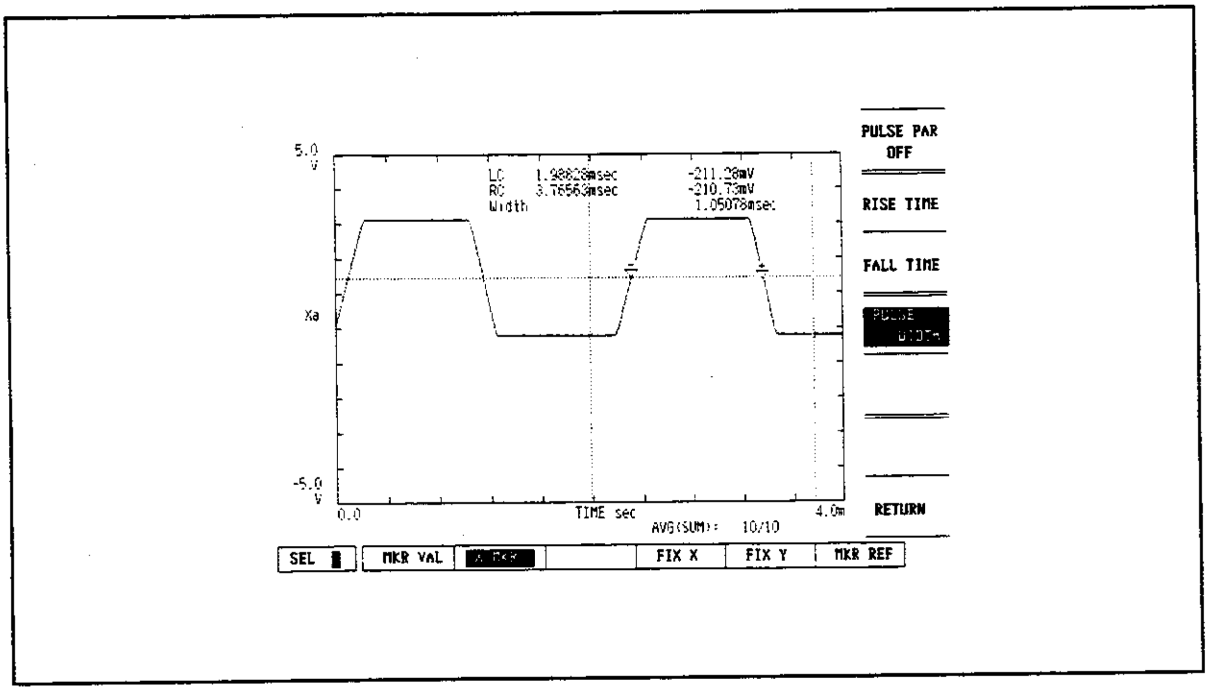
Enclose with the marker, the falling portion of the signal or the portion where the signal is high.

⇒ X MARKER DO ESTIM



```
LC    886.719µsec       3.1140 V
RC    1.61328msec      -211.00mV
Fall                    160.156µsec
```

Figure 8-8 Pulse Fall Time Measurement



```
LC    1.98828msec      -211.28mV
RC    3.76563msec      -210.73mV
Width                   1.05078msec
```

Figure 8-9 Pulse Width Measurement

CHAPTER 9

BASIC PANEL KEYS

This chapter describes the functions and setup procedure of the PRESET , MODE , SETUP , VIEW , and SG CONT keys.

CONTENTS

1. PRESET KEY OPERATION

The PRESET key is used to allocate MATH functions' menus.

The MATH functions are classified into the 4 following categories:

- **Ordinary operations**
  An arithmetic operation is performed on the measured waveform.
  For further details, see Chapter 11.
- **Comparator (GO/NO GO)**
  The measured waveform is compared with a reference value to determine whether some specified conditions are satisfied.
  For further details, see Chapter 13.
- **Frequency response function curve fitting**
  Through such calculations, are determined the parameters, which define the frequency response function of the DUT in the Laplace domain.
  For further details, see Chapter 12.
- **Frequency response function synthesis**
  Through such calculations, is a obtained the frequency response function of a DUT, given its description in the Laplace domain. (parameters and formula)
  For further details, see Chapter 12.

Allocation of MATH Functions

A MATH functions allocation is done as is now described:

PRESET ⇒ MATH ⇒

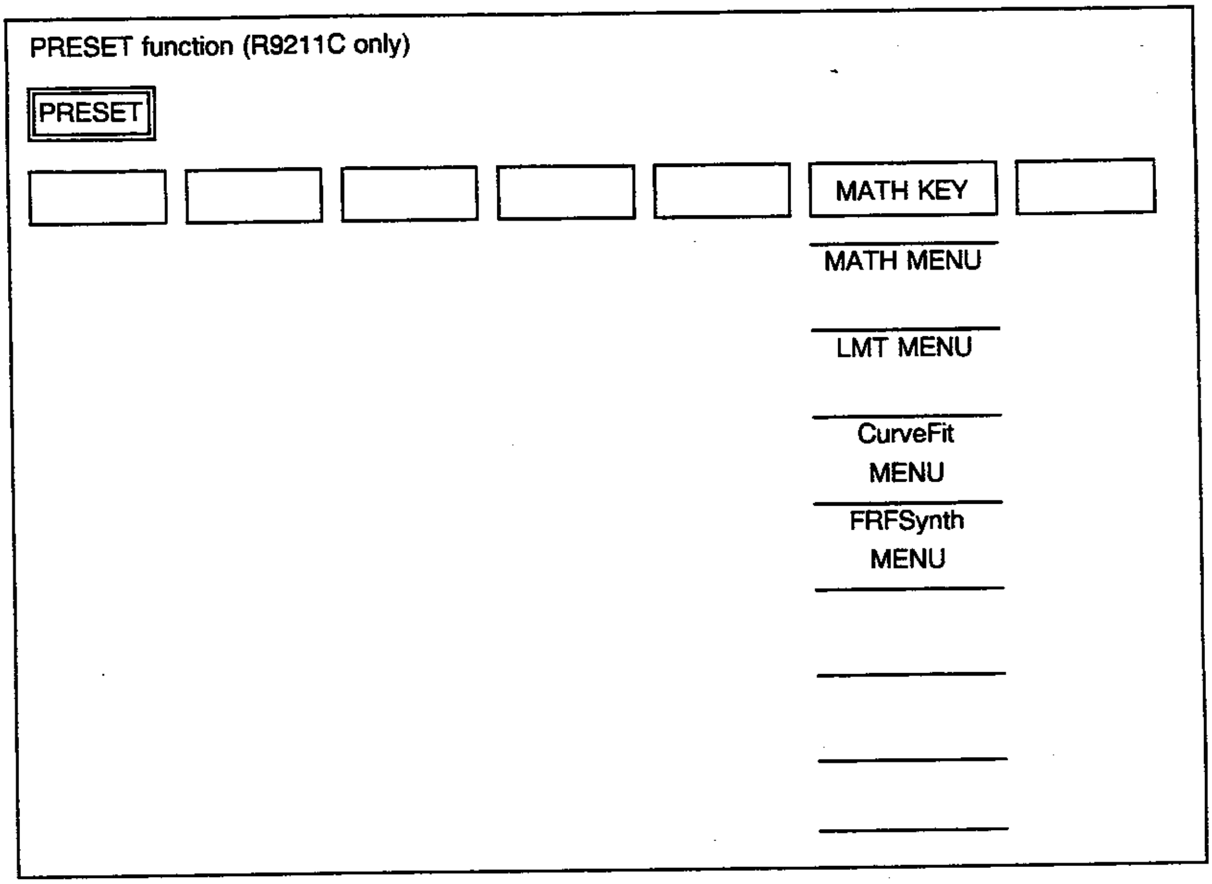
MATH MENU	Specifies the MATH menu for ordinary operation.
LMT MENU	Specifies the MATH menu for comparator functions. (in a mode other than the WAVEFORM mode).
CurveFit MENU	Specifies the MATH menu for curve fitting. (in the FRF/SERVO mode).
FRFSynth MENU	Specify the MATH menu for synthesis. (in the FRF/SERVO mode).

The specification of one of these Y softmenus, defines the MATH functions menu, so that, when the MATH key is pressed, the displayed menu is changed.

NOTE

If you press the PRESET key during the execution of the self-diagnosis, after the power is switched, the R9211 is initialized, and processings start from the initial status. For details about the initialization, see " ■ Initialization" in Chapter 3.

■ A LOOK at the PRESET Menu



2. MODE KEY OPERATION

The different items set with the MODE panel key (measurement mode, calibration, label, date, and extended function) are described below.

■ Selection of the Measurement Mode

To select a measurement mode for the R9211, proceed as follows:

MODE ⇒ MEAS ⇒

WAVEFORM	Selects the WAVEFORM mode.
SPECTRUM	Selects the SPECTRUM mode.
TIME-FREQ	Selects the TIME-FREQ mode.
FRF	Selects the FRF mode.
SERVO	Selects the SERVO mode.

■ Calibration

The DC level of the analog input circuit may change with the temperature. For such situations, the R9211 is equipped with a calibration function.

MODE ⇒ CAL ⇒

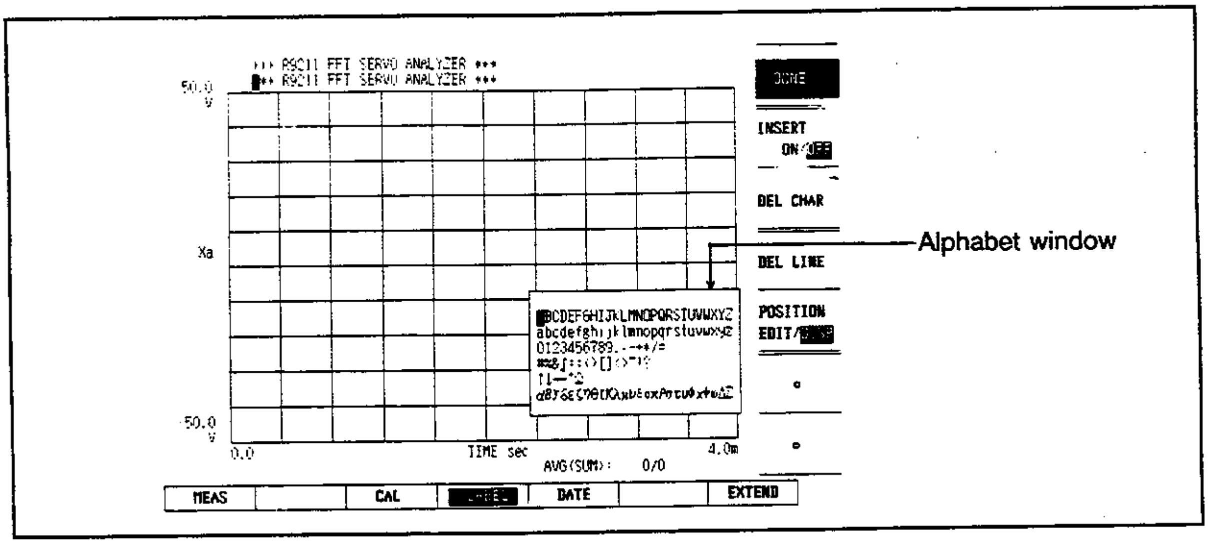
SINGLE DC CAL	Execution of a "SINGLE DC CAL"

During calibration, the massage "SINGLE DC CAL" is displayed on the CRT. When the calibration is completed, the message "SINGLE DC CAL ... end" is displayed.

After switching the R9211 on, or before using the auto range function in the servo mode, be sure to perform a calibration.

Label

The R9211 can display one label on its CRT. You can enter up to 40 characters per line.
Each character you must enter by choosing one of those belonging to the alphabet window.



MODE ⇒ **LABEL** ⇒

Enters the label edition mode.

DONE	Validates the input label and exits the label edition mode.
INSERT ON/OFF	Switches between the 2 available character insertion modes.
DEL CHAR	Deletes one character.
DEL LINE	Deletes one line.
POSITION EDIT/DISP	Switches between the label edition mode and the displacement mode.
⇐	Moves the label edition cursor to the left.
⇒	Moves the label edition cursor to the right.

NOTE
Use the step keys ⇧ and ⇩, the ◎ knob, and the ENT key to select a character in the alphabet window.

● Label Setting procedure

(1) When you press the LABEL key of the X softmenu, you enter the label edition mode.

The label previously edited is then displayed, and under it the label being currently edited is displayed.

MODE ⇒ LABEL

← Label before edition

← Label currently being edited

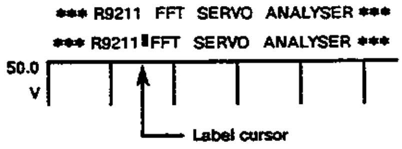
(2) You must now enter the label characters.

- Select "EDIT" with the "POSITION" key of the Y softmenu.

MODE ⇒ LABEL ⇒ POSITION EDIT/DISP

- If a label contains unnecessary characters or lines, move the cursor with the "→" and "←" Y softkeys and press "DEL CHAR" or "DEL LINE" to delete the unwanted character or line.

MODE ⇒ LABEL ⇒ DEL CHAR / DEL LINE / ⇐ / ⇒



- Select the character input mode by toggling the "INSERT ON/OFF" Y softkey.

MODE ⇒ LABEL ⇒ INSERT ON/OFF

ON : Insertion mode

OFF : Overwrite mode

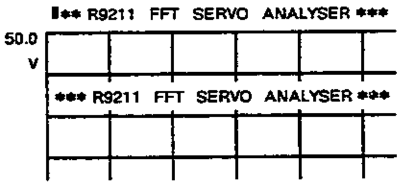
- Move the cursor to the character insertion position with the "→" and "←" Y softkeys.

MODE ⇒ LABEL ⇒ ⇐ / ⇒

(3) You can change the label display position.

- Select "DISP" with the "POSITION" Y softkey.

MODE ⇒ LABEL ⇒ POSITION EDIT/DISP



- Change the label position with the step keys (⇧ and ⇩).

(4) Label Validation

- You validate a label with the "DONE" Y softkey.

MODE ⇒ LABEL ⇒ DONE

You cannot exit from the label edition mode before pressing this key.

Calendar's Setting

You can set the calendar provided in the R9211.

MODE ⇒ DATE ⇒

YEAR	Sets the year.
MONTH	Sets the month.
DAY	Sets the day.
HOUR	Sets the hours.
MINUTE	Sets the minutes.
SECOND	Sets the seconds.

To set any of these you must use the numeric keys and the ENT key.

The provided calendar is displayed at the right area of the label.

Extended Functions' Setting

● Buzzer's Control

You can control whether and when the buzzer should sound.

MODE ⇒ EXTEND ⇒ BUZZER (ON) ⇒

BUZZER ON/OFF	Controls whether the buzzer should sound.
WARNING YES/NO	Controls when the buzzer should sound if ever it was allowed to sound with the former setting.

- When the BUZZER is set to ON, both "setting" sound and "warning" sound are allowed.(the "setting" sound means the sound issued after each key is pressed, the "warning" sound is the sound issued when some error occurs).
- When the BUZZER is set to OFF, neither "setting" sound nor "warning" sound is allowed.

— When BUZZER is set to ON —

- When WARNING is set to YES, only the "warning" sound is allowed.
- When WARNING is set to NO, both "setting" and "warning" sounds are allowed.

The name in parentheses on the BUZZER Y softkey indicates the buzzer state.
(ON) is displayed when BUZZER is set to ON. (OFF) is displayed when BUZZER is set to OFF. (WARNING) is displayed when WARNING is set to YES.

- **Automatic setting of the display (Trace-on-start function)**

When an analysis process such as averaging is performed, the R9211 can automatically change the display format to a format decided in the advance. You can control this "trace-on-start" function.

MODE ⇒ EXTEND ⇒ TRACEonST ON/OFF	Controls the trace-on-start function.

- When the "START" key is pressed to start an analysis process, while "trace-on-start" is on, the display format automatically becomes the predetermined display format.
  Table 9-1 lists the predetermined display formats.
- When TRACEonST is set to OFF, the display format is not automatically modified when the "START" key is pressed to start an analysis.

Table 9-1 Predetermined Display Formats (Only Set when TRACEonST Is Set to ON)

		Automatically set display formats	
MODE	FUNC	First screen	Second screen (multiscreen)
WAVEFORM	TIME AUTOCORR CROSS-CORR HISTOGRAM	Average time waveform of CH-A Average auto-correlation function of CH-A Average cross-correlation function Average amplitude probability density of CH-A	Average time waveform of CH-B Average auto-correlation function of CH-B — Average amplitude probability density of CH-B
SPECTRUM/ TIME-FREQ	POWER SPECT CROSS SPECT COMPLEX SPECT	Average power spectrum of CH-A Average cross spectrum Average complex spectrum of CH-A	Average power spectrum of CH-B — Average complex spectrum of CH-B
FRF/SERVO	FRF	FRF (always in the dual mode)	Coherence function (always in the dual mode)

- **Instantaneous data automatically set display format (monitor X function)**

NOTE
The monitor X function is only available in the FRF and SERVO modes.

The R9211 can monitor the instantaneous input data during FRF measurement (in the FRF or SERVO mode). When a FRF is measured, the +MONITOR function (display function) is used to change the first or second screen display to the display of the instantaneous input data. Specify whether the time data or the frequency data are to be displayed on this instantaneous data screen.
(cf. the explanation of the "VIEW" menu.)

MODE ⇒ EXTEND ⇒ MONITOR TIM/FREQ	Specify the type of data to be displayed with the +MONITOR function.

- When MONITOR is set to TIM, instantaneous time data are displayed on the instantaneous data screen.
- When MONITOR is set to FREQ, instantaneous frequency data are displayed on the instantaneous data screen.

As for the relationship between the position of the instantaneous data screen, and the number of screens, see "■ Monitor Function" in Chapter 5.

■ A Look at the MODE Menu

R9211 Series Menu List (MODE)

MODE

MEAS	CAL	LABEL	DATE	EXTEND	
WAVEFORM		DONE	YEAR 90	BUZZER (ON)	
SPECTRUM	SINGLE DC CAL	INSERT ON/OFF	MONTH 6		BUZZER ON/OFF
TIME-FREQ		DEL CHAR	DAY 24	TRACEonST ON/OFF	WARNING *2 YES/NO
FRF		DEL LINE	HOUR 17	MONITOR X*1 TIM/FREQ	
SERVO		POSITION EDIT/DISP	MINUTE 16		
		⇐	SECOND 53		
		⇒			RETURN

*1 This key is displayed in the FRF or SERVO mode.
*2 This key is displayed when BUZZER is set to ON.

3. SETUP KEY OPERATION

This section explains the functions (parameters set for a measurement) of the SETUP panel key.

Measurement Functions and Active Channel Selections

X softkey "FUNC" enables to select a measurement function and to specify which channels) will be active.

● **Selection of a measurement function**
In the R9211, according to the measurement mode, you can choose several measurement functions:

Mode	Selectable functions
WAVEFORM	TIME (Time) AUTOCORR (Autocorrelation function) CROSS-CORR (Cross-correlation function) HISTOGRAM (Histogram)
SPECTRUM TIME-FREQ	POWER SPECT (Power spectrum) CROSS SPECT (Cross spectrum) COMPLEX SPECT (Complex spectrum)
FRF SERVO	FRF (Frequency Response Function)

After the selection of a measurement mode, to select a measurement function, proceed as is now described:

SETUP ⟹ FUNC ⟹ Functions menu dependent on the measurement mode — Select a function by pressing its key.

Example : Menu displayed in the SPECTRUM mode

POWER SPECT
CROSS SPECT
COMPLEX SPECT

- **Specification of the active channel(s)**

In the R9211, you can specify that 1 channel only is active or that both channels are active.

SETUP ⇒ FUNC ⇒ ACTIVE CH (CH-A&B)	Displays the active channel specification menu. Inside the parentheses is indicated the channel(s) currently active.
CH-A&B	Specifies that both channels are active.
CH-A	Specifies that channel A only is active.
CH-B	Specifies that channel B only is active.

- **Choosing the digital input mode**

If your analyzer is equipped with option 11 (implemented in all R9211C), 16-bit digital input are possible, however only through channel A.

SETUP ⇒ FUNC ⇒ DIGITAL in ChA/OFF	Switches channel A's input mode between digital and analog.

For details about digital inputs, see Chapter 14.

Setting of the Numbers of Samples and Lines

X softkey RANGE, enables to set the sampling frequency and the number of data to be acquired.

- **Setting of the sampling interval**

Data sampling is performed according to the R9211 internal clock. The setting of the sampling interval differs from one mode to another: in the waveform you must specify a "sampling rate", while in every other mode you must specify a "sampling frequency". The sampling frequency can be chosen between 10mHz and 100kHz (6y steps of 1, 2 or 5). The sampling rate corresponds to 1/(sampling frequency × 2.56), and must be set accordingly.
The antialiasing filter is set according to the sampling interval.

Table 9-2 Correspondence Between the Sampling Frequency and the Sampling Rate

Sampling frequency	Sampling rate	Sampling frequency	Sampling rate
10mHz	39.1 sec	50 Hz	7.81msec
20mHz	19.5 sec	100 Hz	3.91msec
50mHz	7.81 sec	200 Hz	1.95msec
100mHz	3.91 sec	500 Hz	781 μsec
200mHz	1.95 sec	1kHz	391 μsec
500mHz	781msec	2kHz	195 μsec
1 Hz	391mesc	5kHz	78.1 μsec
2 Hz	195msec	10kHz	39.1 μsec
5 Hz	78.1msec	20kHz	19.5 μsec
10 Hz	39.1msec	50kHz	7.81 μsec
20 Hz	19.5msec	100kHz	3.91 μsec

○ **Setting of the sampling rate (in the WAVEFORM mode)**

SETUP ⇒ RANGE ⇒ SAMPL RAT 3.91μsec

Sets the sampling rate. The value of the sampling rate must be specified with the step keys.

○ **Setting of the sampling frequency (in the SPECTRUM/TIME-FREQ/FRF/SERVO modes)**

SETUP ⇒ RANGE ⇒ FREQ RNG* 100 kHz

Sets the sampling frequency. The value of the sampling frequency can be specified with the step keys, the knob or the numeric keys.

NOTE

The * mark is displayed while an analysis starting at frequency 0 is being performed. It is not displayed during a zoom analysis. (See the explanations about the starting and ending frequencies specification.)

<u>About the numeric keys</u>

- ***If a value not listed in Table 9-2 is input with the numeric keys, the closest value listed in this table is set instead.***
- ***Specify the unit of a value input with the numeric keys with the unit Y softkeys.***

kHz	***kHz the unit becomes kiloHertz.***
Hz	***Hz the unit becomes Hertz.***
mHz	***mHz the unit becomes milliHertz.***

If the ENT key is pressed immediately after a value is input, the unit by default kHz.

Zero start analysis	:	The analysis is executed from 0Hz to the specified maximum frequency.
Zoom analysis	:	The analysis is executed from a specified starting frequency to a specified ending frequency, thus enhancing the frequency resolution.

● **Selection of the sampling clock source**
With the R9211, either the internal clock or an external clock can act as sampling clocks.

○ **WAVEFORM mode**

SETUP ⇒ RANGE ⇒ SAMPL CLK INT/EXT	Switches between internal and external sampling clocks.

○ **SPECTRUM/TIME-FREQ/FRF mode**

SETUP ⇒ RANGE ⇒ f RESOLN (LIN f)	Enters the frequency resolution menu.
↓ SAMPL CLK INT/EXT	Switches between internal and external sampling clocks.

When you select an external clock, you must input this external clock signal to the analyzer through the BNC connector, named "INPUT SMPLG CLK", at the rear panel of the analyzer.

NOTE
If an external clock is selected, the antialiasing filter and display annotations are set according to the sampling interval.

● **Setting of the numbers of analysis lines and samples**
Table 9-3 lists the relationship between the frequency data and time data. (The number of frequency lines is effective only in the linear resolution analysis mode.)

Table 9-3 Relationship Between the Frequency Data and the Time Data

Number of time samples	Number of frequency lines
8192	3200
4096	1600
2048	800
1024	400
512	200
256	100
128	50
64	25

○ **WAVEFORM mode**

The number of samples is specified by setting the value of FRAME TIM (frame time).

SETUP ⇒ RANGE ⇒ FRAME TIM 1024 spl — Sets the number of samples.

Use the step keys for this setting.
The maximum number of samples is 4096. (When only one channel is active, the maximum number of samples is 8192.)

○ **SPECTRUM/TIME-FREQ/FRF mode**

The number of lines is specified by setting the value of "LINE/SPN" (Line per span).

SETUP ⇒ RANGE ⇒ f RESOLN (LIN f) — Enters the frequency resolution menu.

↓

LINE/SPN 400 line — Specifies the number of lines.

Use the step keys, the knob, or the numeric keys for this setting.
The maximum number of lines which can be specified depends on the selected mode (Table 9-4).

Table 9-4 Maximum Numbers of Lines (linear resolution)

Mode	1 active channel	2 active channels
SPECTRUM	3200 line	1600 line
TIME-FREQ	800 line	800 line
FRF	——	800 line

● **Setting of the analysis resolution (linear resolution, logarithmic, or octave analysis)**

The R9211 can perform three types of analysis: linear resolution, logarithmic resolution, and octave analysis (only when the POWER SPECT function is selected).

SETUP ⇒ RANGE ⇒

f RESOLN (LIN f)	Enters the frequency resolution menu. Inside the parentheses is indicated the frequency resolution type currently in use.
→ LIN f	Selects the linear frequency analysis.
LOG f	Selects the logarithmic frequency analysis.
1/3 OCT	Selects the 1/3 octave analysis.
1/1 OCT	Selects the 1/1 octave analysis.

○ **Setting the number of decades for the logarithmic or the octave analysis**

For a logarithmic analysis, or an octave analysis, the frequency range for the analysis is determined by the number of decades.

SETUP ⇒ RANGE ⇒

f RESOLN (LOG f)	Enters the frequency resolution menu. Inside the parentheses is indicated the frequency resolution type currently in use.
↓	
DECADE 2 decade	Specify the number of decades.

Use the numeric keys or the step keys to enter the number of decades. Table 9-5 summarizes the relationships between the analyzer types and the maximum number of decades.

Table 9-5 Maximum Number of Decades

R9211B	R9211C
2 decades (3 decades when only 1channel is active.)	3 decades

- **Setting of the number of histogram points (only when the HISTOGRAM function is used)**

Set the resolution (number of histogram points) of the histogram (probability density function).
The number of histogram points is specified, using the step keys, the knob, or the numeric keys. It is defined as a nth power of 2, and cannot exceed 2048 bin.

SETUP ⇒ RANGE ⇒ HIST POIN 256 bin — Specifies the number of histogram points.

- **Setting of the start and the stop frequencies (when the zoom analysis function is used) (R9211C)**

When a zoom analysis is performed, a start frequency and a stop frequency must be specified to define the domain over which the zoom analysis will be performed.

SETUP ⇒ RANGE ⇒ START f * 0.0kHz — Sets the start frequency.
STOP f 100kHz — Sets the stop frequency.

The starting and ending frequencies are set as the maximum frequency of the frequency range (zero start analysis) is set : with the numeric keys, the knob or with the step keys. (cf.frequency range's setting)

NOTE
The * mark is displayed for a zoom analysis. (It is not displayed for a zero start analysis.)

If the START f key is pressed in a mode other than the servo mode, the zoom function is selected. If you press the START f key by mistake, press the FREQ RNG key to select the zero start analysis mode again.

Setting of the Input Sensitivity

X softkey SENS is used to set the input sensitivity.

- **Manual setting of the input sensitivity range**

In this case, you directly set the measurement sensitivity range.The sensitivity takes its value between –60dBV and +30dBV (1dBV/step). This parameter is set with ten keys/knob/step key.

SETUP ⇒ SENS ⇒

CH-A AUTO/MAN	Switches to the manual setting mode of the input sensitivity of channel A.
SET CH-A +30dB	Set the sensitivity range of channel A.
CH-B AUTO/MAN	Switches to the manual setting mode of the input sensitivity of channel B.
SET CH-B +30dB	Set the sensitivity range of channel B.

- **Automatic setting of the input sensitivity range**

By automatic setting of the input sensitivity range, we mean that the input sensitivity range is automatically evaluated and set according to the input signal. The R9211 analyzer is provided with two automatic setting methods for the input sensitivity range: with the UP & D (up and down) method, the sensitivity range follows the variations of the signal amplitude, that is to say that when the signal amplitude increases, the input sensitivity range also increases, and when the signal amplitude decreases, the input sensitivity also decreases. With the UP method, only the increases of amplitude are followed by the input sensitivity range: when the signal amplitude decreases, the sensitivity range is not modified.

SETUP ⇒ SENS ⇒

CH-A AUTO/MAN	Switches to the automatic setting mode of the input sensitivity range of channel A.
A : UP&D/UP +30dB	Enables the selection of the automatic setting method for channel A and displays the current range value.
CH-B AUTO/MAN	Switches to the automatic setting mode of the input sensitivity range of channel B.
B : UP&D/UP +30dB	Enables the selection of the automatic setting method for channel B, and displays the current range value.

NOTE

Before using the automatic range setting function, be sure to calibrate the analyzer.

(See section 2. MODE key in this chapter.)

Setting of the Signal Input Block

X softkey "input" enables the setting of the input block.

You must select one of the channel, and once this has been done you will be able to set up the selected channel input block.

Channel selection method

SETUP ⇒ INPUT ⇒	CHANNEL CH-A/CH-B	Selects the channel whose input block is to be setup.

● Setting of the input coupling

In for the R9211, either AC or DC input coupling can be set.

SETUP ⇒ INPUT ⇒	COUPLING AC/DC	Switches between AC and DC input coupling.

● Setting of the input connectors status

In order to enable differential inputs, both channels of the R9211 are equipped with a positive and a negative input connectors. Both of these connectors can independently set to the ground (GND) or set to receive a signal (IN).

SETUP ⇒ INPUT ⇒	+ INPUT IN/GND	Sets the + input connector to receive signals (IN) or to be grounded (GND).
	– INPUT IN/GND	Sets the – input connector to receive signals (IN) or to be grounded (GND).

● Setting of the antialiasing filter

In the R9211, an antialiasing filter is automatically set according to the frequency range to prevent spectrum aliasing. You can also cancel this setting.

SETUP ⇒ INPUT ⇒	FILTER ON/OFF	Switches on(/off) the antialiasing filter.

NOTE

Be sure to switch this filter on before spectrum analysis.

- **Setting of the power supply for accelerometers provided with an internal amplifier**

The R9211 has a power supply unit for accelerometers provided with an internal amplifier.
You can switch on(/off) this power supply unit.

SETUP ⇒ INPUT ⇒ ICP ON/OFF

Switches on(/off) the power supply unit for accelerometers provided with an internal amplifier. The accelerometer must be connected to the + connector of the selected channel.

- **Generation of a test signal**

The R9211 can generate a test signal to test itself.

SETUP ⇒ INPUT ⇒ TEST ON/OFF

When ON is selected, a test signal is generated.

The test signal is a 8kHz sine wave.

Example : In the range of 20kHz, the test signal value can be calculated as the following format.

$$\underbrace{20\times10^3}_{\text{frequency range (20kHz)}}\times\underbrace{0.08}_{8\%}=1.6\text{kHz}$$

Setting of the Trigger

X softkey "TRIG" enables the setting of the conditions of synchronized inputs. The actual execution and start of triggering operation are controlled in X softmenu "ARM/HLD".

● Selection of the trigger signal

In the R9211, the trigger signal (that is to say the synchronization signal) may be either the signal input to channel A, or that input to channel B, or even an external TTL signal.

SETUP ⇒ TRIG ⇒

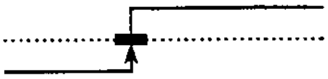
SOURCE (CH-A)	Enters the menu that enables the specification of the trigger signal origin. The currently specified signal origin is indicated inside the parentheses.
CH-A	Selects channel A as trigger signal source.
CH-B	Selects channel B as trigger signal source.
EXT	Selects an external source as trigger signal source.

When the trigger signal source is external, the trigger signal is a TTL-level signal and the trigger and the rising edge of the signal.

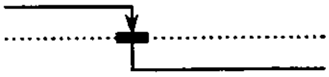
● Setting of the triggering conditions

In the R9211, there are four trigger types (plus the external trigger).

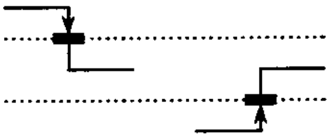
(1) + SLOPE trigger
The trigger event corresponds to the rising edge of the trigger signal.
(+) is displayed on the menu.



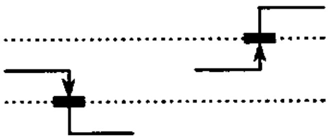
(2) – SLOPE trigger
The trigger event corresponds to the falling edge of the trigger signal.
(–) is displayed on the menu.



(3) BI-SLOPE INSIDE trigger
The trigger event corresponds to the enter of the trigger signal into a determined domain.
(BI, IN) is displayed on the menu.



(4) BI-SLOPE OUTSIDE trigger
The trigger event corresponds to the exit of the trigger signal from a determined domain.
(BI, OUT) is displayed on the menu.



The trigger setting procedure is the following one:

SETUP ⇒ TRIG ⇒

SLOPE (+)	Enters the menu that enables you to choose a type of trigger. The current trigger type is indicated within the parentheses.
+ SLOPE	Triggers when the synchronization signal's slope is positive.
– SLOPE	Triggers when the synchronization signal's slope is negative.
BI-SLOPE INSIDE	Triggers when the synchronization signal enters a specific domain.
BI-SLOPE OUTSIDE	Triggers when the synchronization signal exits a specific domain.

● **Specification of a trigger level (± SLOPE types)**

The trigger level can be set with a resolution of 1/256 of the maximum input voltage for the input sensitivity range (Table 4-4).

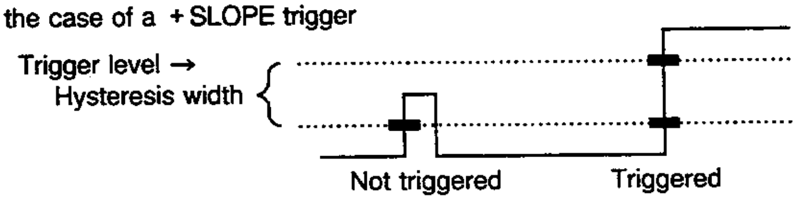
SETUP ⇒ TRIG ⇒

LEVEL 0.1V	Defines the trigger level with the numeric keys.

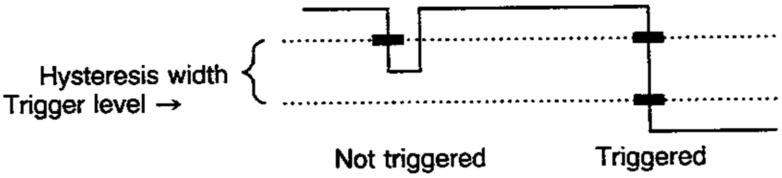
● **Specification of the hysteresis width (± SLOPE types)**

The hysteresis width is the margin defined to prevent triggering errors caused by very low noise. It can be set with the numeric keys with a resolution of 1/256 of the maximum input voltage in the input sensitivity range (Table 4-4).

In the case of a + SLOPE trigger



In the case of a – SLOPE trigger



SETUP ⇒ TRIG ⇒	HISTERESI 0.1V	Defines the hysteresis width with the numeric keys.

- **Specification of a BI-SLOPE domain (BI-SLOPE types)**

A BI-SLOPE domain is defined by its upper and lower limits these limits can be set with a resolution of 1/256 of the maximum input voltage for the input sensitivity range.

SETUP ⇒ TRIG ⇒	LEVEL (UP) 0.5V	Sets the upper limit of the BI-SLOPE trigger domain.
	LEVEL (LW) 0.5V	Sets the lower limit of the BI-SLOPE trigger domain.

Use the numeric keys for the above setting.

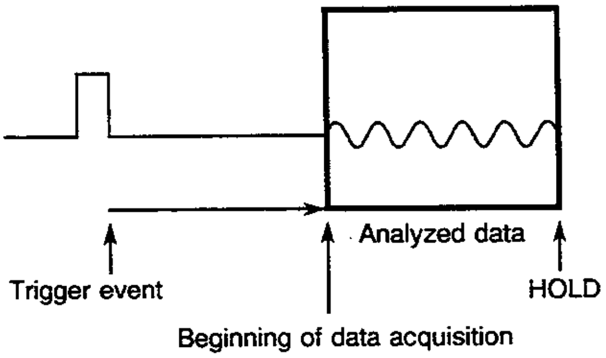
CAUTION !

When an external trigger is used, the above level settings are ignored. The external trigger level is fixed.

- **Setting of the trigger delay**

It corresponds the time delay from the trigger to the data acquisition time. The trigger delay is represented by a positive or a negative value. When you are interested in data taking place before the trigger event, the trigger delay must be negative.

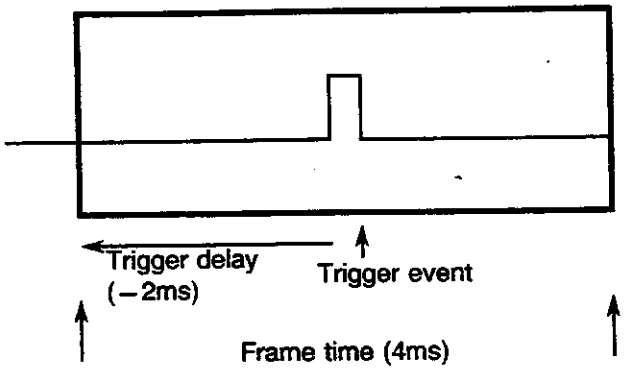
Example : When the analysis frequency range is equal to 100kHz, the resolution is equal to 400 lines, and the trigger delay is equal to 16ms



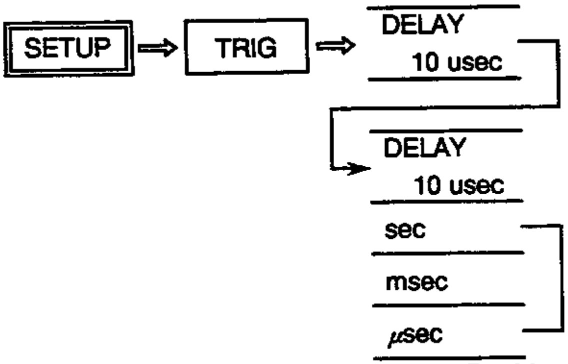
		Trigger delay time		Frame time	
Time lapsed after the trigger event	0	(16msec)	16msec	(4msec)	20msec

If you want the trigger event time to appear at the middle of the screen then the value you will specify as trigger delay must be equal to − 1/2 frame time.

Example : If the analysis frequency range is equal to 100Hz and the frequency resolution is 400lines (frame time = 4 ms) is equal to 400lines, set −2ms as the trigger delay.



The setting procedure of the trigger delay is the following one :

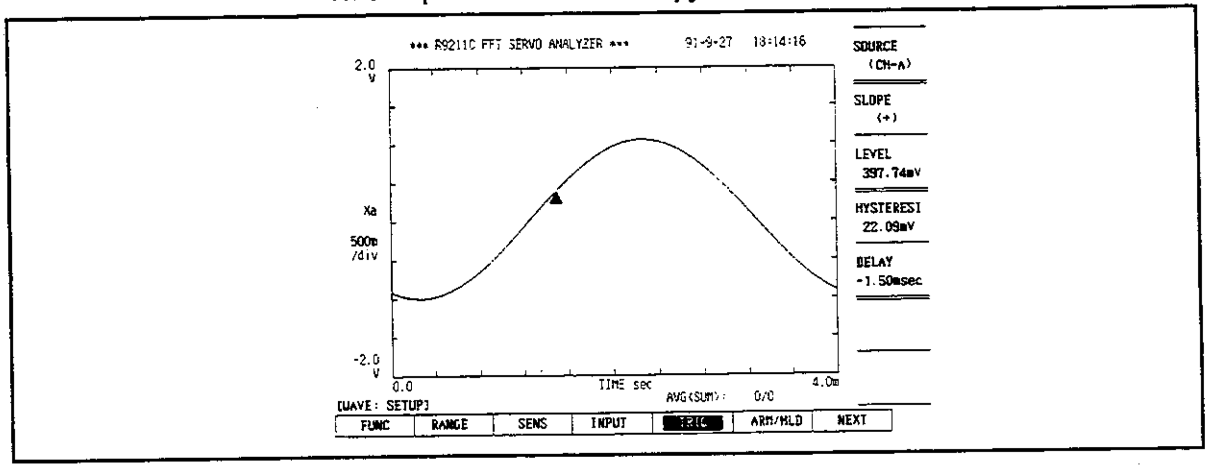


DELAY 10 usec	Enters the menu that enables you to specify trigger delay value. Also indicates the current value of the trigger delay.
DELAY 10 usec	Sets the trigger delay value. To enter the value of the delay use the numeric keys, then press the appropriate unit key (pressing a unit key validates the setting).
sec msec μsec	Unit keys for the trigger delay.

● Trigger Position Marker

The point at which the arm trigger use a trigger is displayed with the Marker(▲).
Therefore, the following case is not displayed.

- When the trigger point before fetching data is used. (out of arm length)
- When input data from the floopy disk.



SOURCE (CH-A)
SLOPE (+)
LEVEL 397.74mV
HYSTERESI 22.09mV
DELAY -1.50msec

● Setting of the arm length (in the TIME-FREQ mode)
In any other modes than the TIME-FREQ mode, the size of the data you can synchronously acquire is limited to the frame. In the TIME-FREQ mode, you can define the size of the data you want to synchronously acquire.
Specify this size of data (8K) with as a nth power of 2 minimum.
(For further details, see Table 9-6.)
Using the step keys, the knob, or the numeric keys, set the arm length in the following way:

SETUP ⇒ TRIG ⇒ ARM LEN 64 K — Sets the arm length. The current value is displayed(the unit is number of samples).

○ Data displayed after triggering
After triggering (hold state), the last frame of the input data buffer is displayed. To display all acquired data (arm length), use the DATA VIEW functions. (About the DATA VIEW functions, see "● VIEW STEP" in "■ How to Display Various Data" in Chapter 9.)

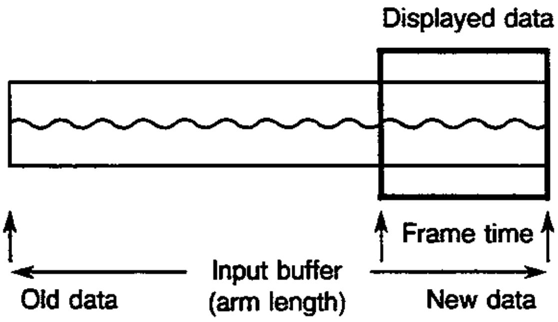


Table 9-6 Arm Length Range

Model	Optional memory	Minimum arm length	Maximum arm length
R9211B	None (standard)	8K samples/CH	64K samples/CH (128K samples/CH if one channel only is active)
	Option 10 or 11		512K samples/CH (1M samples/CH if one channel only is active)
	Option 10 + Option 11		1M samples/CH (2M samples/CH if one channel only is active)
R9211C	None (standard)		512K samples/CH (1M samples/CH if one channel only is active)
	Option 10		1M samples/CH (2M samples/CH if one channel only is active)

Setting of a Data acquisition Mode

The R9211 is provided with four data input modes.

(1) FREE RUN
The data are all the time input at the specified sampling interval.

(2) ARM
The data acquisition stops when the acquired data satisfy the specified trigger conditions. The data do not change until this mode is canceled.

(3) AUTO ARM
The operations of the ARM mode are automatically repeated when ever the trigger is activated.

(4) HOLD
The data acquisition stops.

SETUP ⇒ ARM/HLD ⇒

AUTO ARM	Carries out auto arm operations.
ARM	Carries out arm operations.
HOLD	Carries out hold operations.
FREE RUN	Carries out free run operations.

Selection of a Window

X softkeys WEIGHT and LAG WND enable the selection of a window which can be multiplied with the data. For this purpose, you have access to the LAG WND menu in the "WAVEFORM" mode, and to the "WEIGHT" menu in any other modes. Besides, the WEIGHT menu, enables the selection of frequency data weights.

● **Windows' types**
The R9211 is provided with the windows listed in Table 9-7.

Table 9-7 Windows' Types

Window	Advantages	Drawbacks	Application domain
Rectangular window (RECT)	• Does not modify the energy of the sampled data during the frame time. • Presents the frequency resolution.	• Presents a poor level accuracy. • Generates discontinuities on a periodic continuous.	• Is optimum for the analysis of transient signal and of impulse signals.
HANNING	• Does not generate any discontinuities on a periodic continuous signals.	• Presents a frequency resolution lower than that of the rectangular waveform window. • Presents a relatively poor level accuracy.	• Is generally used for observing continuous waveforms. • Enables spectrum analysis up to 70dB.
FLAT-PASS	• Presents the best amplitude accuracy.	• Presents a poor frequency resolution.	• Is effective for harmonics analyses.
MINIMUM	• Presents an excellent side band shape. • Presents a better frequency resolution than the FLAT-PASS window. • Presents a higher amplitude accuracy than the HANNING window.	• Presents not as good a frequency resolution as the HANNING window. • Presents a lower amplitude accuracy than the FLAT-PASS window.	• Is effective for observing small adjacent spectrum lines (e.g., notches). • Enables spectrum analysis beyond 70dB.
FORCE/RESPONSE	• For input signals such as an impulse waveform, a time dependent weight is applied. • Perturbations Influence outside the specified time range are ignored. (FORC)	• Since the weight is time dependent, this weight is not suitable for analyses of continuous waveforms.	• Used to analyze signals damped with the time.

● **Setting of a window**

The window setting procedure is the following one:

○ **In a mode other than the WAVEFORM mode.**

SETUP ⇒ WEIGHT ⇒

MINIMUM	Sets a minimum window.
HANNING	Sets a hanning window.
FLAT-PASS	Sets a flat-pass window.
RECT	Sets a rectangular window
FORCE/ RESPONSE	Enters the setting menu for force/response windows.

○ In the Waveform mode

SETUP ⇒ LAG WND ⇒

STATIONAR (HANN)	Sets a hanning window.
TRANSIENT (RECT)	Sets a rectangular window.

● Setting of the force/response windows

To use the FORCE/RESPONSE windows, the following procedure must be followed:

(1) The data upon which the force/response windows are to be applied must be selected.
(2) Either the FORCE or the RESPONSE window must be selected.
(3) START TIM : The starting time of the FORCE(RESPONSE) windows is specified.
(4) STOP TIM : The ending time of the FORCE window is specified.
(5) DAMPING : The damping value of the RESPONSE window is specified.
(6) Weight view : Determine whether the time data are to be displayed after or before the application of the FORCE/RESPONSE windows.

All of these are set through the following menu:

SETUP ⇒ WEIGHT ⇒

FORCE/ RESPONCE	Enters the FORCE/RESPONSE windows setting menu.
SET CH CH-A/CH-B	Selects the channel whose data are to be multiplied by a FORCE(RESPONSE) window.
SET WND FORC/RESP	Selects the FORCE(RESPONSE) window.
START TIM 2 msec	Sets the starting time.
STOP TIM 10 msec	Sets the ending time.
DAMPING 2 sec	Sets a damping value for the RESPONSE function.
VIEW SW RECT:F/R	Displays the time data multiplied by the FORCE(RESPONSE) window. (When "RECT" is selected the time data is displayed without the FORCE(RESPONSE) window being applied to it.)

To enter those value, use the numeric keys, the knob, or the step key.

ADVICE

The response window is defined, from the starting time, as the following function of time t : $e^{-(t/\text{damping factor})}$.

- **Weighting of the frequency domain data**

In the R9211, the frequency domain data (power spectrum) can be multiplied by a weighted (except in the WAVEFORM and SERVO modes).

SETUP ⇒ WEIGHT ⇒

WEIGHT (f) (OFF)	Enters frequency domain data weights' menu. The currently set weight is indicated inside the parentheses.
OFF	Invalidates the frequency domain data weighting.
A WGT	Selects the weight A (audio weight).
B WGT	Selects the weight B.
C WGT	Selects the weight C.
C-MES WGT	Selects the weight C-message.

REFERENCE→

Regarding these weights characteristics, see "Audio Correction" in Appendix 2 "Glossary" page A-19 & A-20.

Setup of an averaging process

With X softkey "AVG" you setup an averaging process. You control the execution of such a process with panel keys START and STOP .

- **Averaged Data**

What data will be averaged depends on the measurement function you have selected.

Table 9-8 Measurement Functions and Averaged Data

FUNCTION	Averaged data	FUNCTION	Averaged data
TIME	Time data	POWER SPECTRUM	Power spectrum
AUTOCORR	Autocorrelation function	CROSS-SPECTRUM	Cross-spectrum
CROSS-CORR	Cross-correlation function	COMPLEX SPECTRUM	Complex spectrum
HISTOGRAM	Probability density function	FRF	Power spectrum Cross spectrum FRF, COH Impulse response
FRF (SERVO)	FRF, COH Impulse response		

● **Selection of an averaging method**

Use the following menu to select the averaging method:

SETUP ⇒ AVG ⇒

AVG MODE (SUM)	Enters the averaging method selection menu. The currently selected method is indicated inside the parentheses.
SUM	Selects the arithmetic averaging method.
EXP	Selects the exponential averaging method.
PEAK	Selects the peak hold averaging method.
SUB	Selects the subtraction averaging method.

○ **Relationships between averaging methods and measurement functions**

Some averaging methods cannot be used depending on the selected measurement function.

Table 9-9 indicates which averaging methods you can use for each measurement function.

Table 9-9 Available Averaging Method for Each Measurement Functions

Measurement function	TIME	AUTOCORR CROSS-CORR	HIST	POWER SPECTRUM CROSS-SPECTRUM COMPLEX SPECTRUM	FRF	FRF (SERVO)
Average method	SUM	SUM, EXP	SUM	SUM, EXP, PEAK, SUB	SUM, EXP, PEAK	SUM

○ **Mathematical definition of each averaging methods:**
(j : number of averages, X_i : ith instantaneous value, A_j : jth average)

(1) SUM

$$A_j = (\sum_{i=1}^{j} X_i) / j$$

(2) EXP

$$A_j = (1 - 1/k) \times A_{j-1} + X_j / k$$

k: Weighting factor
(You specify it by setting the number of averages)

(3) PEAK

$$A_j = \mathrm{MAX}\,(A_{j-1}, X_j)$$

(4) SUB

$$A_j = A_{j-1} - X_j / k$$

k: Is the specified number of averages

3. SETUP KEY OPERATION

Setting of the number of averages

The number of averages can be chosen between 1 and 32767.

SETUP ⇒ AVG ⇒	AVG NO 32	Enables the setting of the number of averages. The displayed number corresponds to currently set number of averages.

You can use the numeric keys or the knob or the step keys for this setting.

Setting of the weighting factor of the exponential averaging method

You must use the "AVG NO" key to set the weighting factor of the exponential averaging method.

SETUP ⇒ AVG ⇒	AVG NO 32	Sets the weighting factor of the exponential averaging method. You can use the numeric keys, the knob, or the step keys for this setting.

Setting of the maximum number of averages of the exponential averaging method.

You must set a maximum number of averages which must not be exceeded in the exponential averaging method.

SETUP ⇒ AVG ⇒	LIMIT NO 2000	Set the maximum number of averages for the exponential averaging method. You can use the numeric keys the knob or the step keys for this setting.

Selecting an averaging process

There are three types of averaging processes:

NORMAL : Each data frame is averaged and displayed (Intermediate results display).
FAST : The first data and the last data (result data) only are displayed.
+1 AVG : Averaging is performed each time the STOP/C key is pressed. To abort this process execution, press the STOP+1 key.

To select an averaging process proceed as follows:

SETUP ⇒ AVG ⇒	PROCESS (NORMAL)	Enters the averaging process selection menu. The current process is indicated inside the parentheses.
	NORMAL	Selects the "NORMAL" process.
	FAST	Selects the "FAST" process.
	+1 AVG	Selects the " +1 AVG" process.
	STOP+1	Aborts the " +1 AVG" process.

- **Averaging of overloaded data**

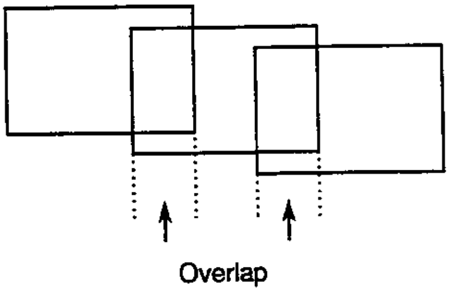
When the acquired data overloads the input block of the analyzer, if these data are used for the averaging process, the result may prove incorrect. With the R9211, you can decide not to take into account these over loading data, for the averaging process.

SETUP ⇒ AVG ⇒ REJECT ON/OFF	Selects whether to exclude the overloading data from the averaging process.

When REJECT is set to ON, the overloading input data are not averaged.
When REJECT is set to OFF, the overloading input data are averaged.

- **Control of the averaging of overlapped data**

Data are acquired each time the R9211 performs an internal process. If the internal between 2 time series acquisition is shorter than the frame time, the input data can overlap.



For the R9211, you can specify an overlap ratio as follows:

SETUP ⇒ AVG ⇒ OVERLAP (MAX %)	Enters the overlap ratio specification menu. The current overlap ratio is indicated inside the parentheses.
0 %	Averages without overlapping the data.
50 %	Averages data overlapped by 50% of the frame time.
75 %	Averages data overlapped by 75% of the frame time.
MAX %	Averages data overlapped as much as possible considering the processing and data acquisition constraints.

Setting of the Unit

With the R9211, you can choose either Vlt, Vrms, or EU, as unit, depending on the data.

How to express the data in EU (Engineering Unit)

An Engineering Unit setting takes effect on one channel.

[Time waveform]
1V=x' EU or 0dBV=y dBEU
[Spectrum waveform]
1Vrms=x' EU or 0dBVrms=y' dBEU

Besides you can assign a name to an Engineering Unit. This name is "EU" by default. It must be composed of at most 2 characters.

The setting procedure is the following one:

(1) First you must select the channel on which the EU is to be effective.

SETUP ⇒ UNIT (*) ⇒ SELECT CH ⇒ CH-A Sets channel A.
CH-B Sets channel B.
CROSS Sets the unit label to be displayed on the CROSS data screen.

NOTE
(*) indicates that the next key must be pressed if this menu is not displayed.

(2) Setting of the scaling correspondence factor (i.e. a number to be multiplied to the internal data). However, you cannot define a correspondence factor when you have selected "CROSS" in (1) .
You will consider either one of the following equations depending on the type of data displayed along the Y-axis currently selected with the SEL key.
Logarithmic data (dB Mag) : 0 dBV (rms) = y dBEU ——(a)
Linear data (Mag) : 1V (rms) = x EU ——(b)

(a) Engineering Unit definition procedure when the data displayed along the Y-axis are logarithmic data expressed in dBMag:

SETUP ⇒ UNIT ⇒ A:VALUE 40.000dBEU

20 ⇒ ENT

⇒ A:VALUE 20.000dBEU — In this case, 0dBVrms corresponds to 20dBEU on channel A.

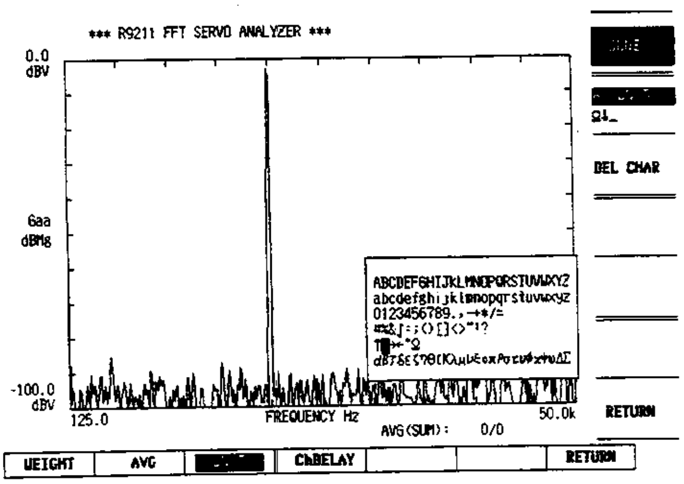
(b) Procedure for transforming logarithmic data (dBMag) into linear data (Mag):

VIEW ⇒ COORD ⇒ MAG — Transforms dBMag into Mag.

SETUP ⇒ UNIT ⇒ A:VALUE 10.00EU — Switches dBEU display to EU display.

(3) Definition Procedure for a unit label. Note that you must use a single screen configuration.

SETUP ⇒ UNIT ⇒ A: UNIT EU — A table of characters to be used for the unit name edition is displayed on the screen.



Select the first character with the knob or ⇧ or ⇩ key, then press the ENT key. Select the second character in the same manner, then press the ENT key.

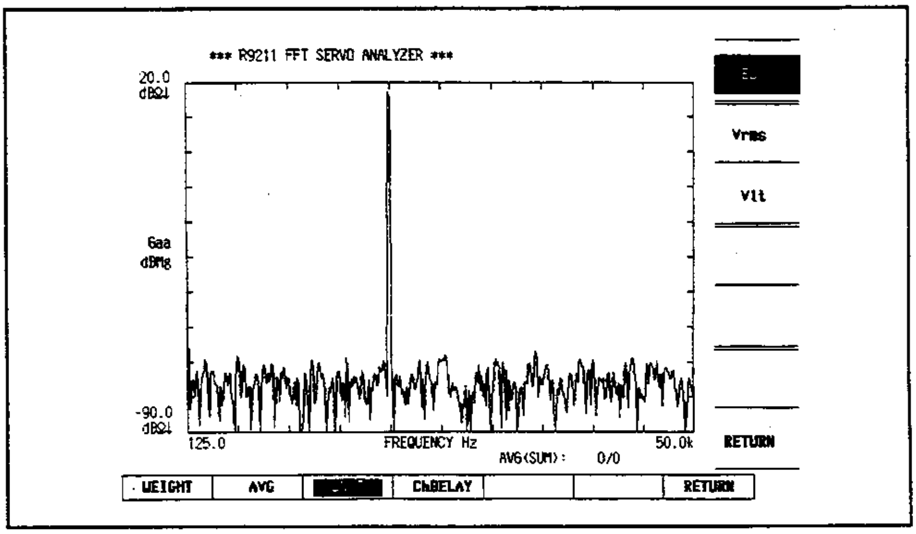
⇨ DEL CHAR	Press this key to delete a character you entered by mistake.
⇨ DONE	Validates the Engineering unit setting.

NOTE

The Engineering Unit label can be composed of two characters maximum. If 3 or more characters were input, only the first two characters would be taken into account.

(4) Selection of the engineering unit.

UNIT	⇨ EU or Vlt	⇨ EU	Displays in Engineering Unit (EU).
		Vrms	Displays in Vrms.
		Vlt	Displays in Vlt.



(5) Complementary information

Table 9-10 explains through examples, depending on each data, which channel's correspondence factor will be used and which channel's unit label will be displayed.

Table 9-10 Data and Unit Labels

Data	Scaling factor	Unit label
Xa	A	Label for channel A
Sb	B	Label for channel B
Gaa	A∗A	Label for channel A . . . . (∗1)
Gab	A∗B	Label for "CROSS channel"
Hab	B/A	Label for "CROSS channel"

∗1 Since a power spectrum is considered, the scaling factor is squared.
A : Scaling factor set for channel A
B : Scaling factor set for channel B

NOTE

In the case of MATH's results, the channel whose Engineering Unit is used is the channel of the data specified as operand, while in the case of T-F analysis results, it is the channel of the trace data.

● **Displaying power spectrum density**

The procedure for displaying power spectrum density is as follows:

SETUP ⇒ UNIT (∗) ⇒ PSD ON/OFF Displays a PSD.

NOTE

(∗) indicates that the NEXT key is to be pressed if this menu is not displayed.

■ Setting of the Interchannel Delay

You can define the time delay between the input channels (taking channel B as the reference)

SETUP ⇒ NEXT

⇒ ChDELAY ⇒

ICH DELAY ON/OFF	Switches between on and off.
⇒ ICH DELAY ON/OFF	Press this key to select ON (When selected, ON is displayed in inverse mode).
⇒ DELAY T 0 msec	This menu is displayed when ICH DELAY is ON.

Use the ⊙ knob, the ⇧ and ⇩ keys, or the numeric keys and the ENT key for the above setting.

NOTE

1. ***The unit of the time delay depends on the time range.***
2. ***The following restriction is placed on the time delay:***
   If X = Input buffer size/One frame size * Frame time − Frame time then, the specified delay must belong to the interval [−X; X].
3. ***An interchannel delay cannot be defined in the arm or hold state. Only when the T-F mode is selected, can it be defined in the arm state. In this case, the input buffer size is equivalent to the arm length (see "● Setting of the arm length" in " ■ Setting of the Trigger" in chapter 9).***

Table 9-11 Frequency Ranges and Time Delay

Frequency range (Hz)	Maximum time delay according to the spectrum size (msec)						
	25 lines	50 lines	100 lines	200 lines	400 lines	800 lines	1600 lines
10m	20477e5	20475e6	2047e7	2046e7	2044e7	2040e7	2032e7
20m	1023875e4	102375e5	10235e6	1023e7	1022e7	1020e7	1016e7
50m	40955e5	4095e6	4094e6	4092e6	4088e6	4083e6	4064e6
100m	204775e4	20475e5	2047e6	2046e6	2044e6	2040e6	2032e6
200m	1023875e3	102375e4	10235e5	1023e6	1022e6	1020e6	1016e6
500m	40955e4	409500e3	40940e4	4092e5	4088e5	4083e5	4064e5
1	204775000	204750e3	20470e4	2046e5	2044e5	2040e5	2032e5
2	102387500	102375e3	10235e4	1023e5	1022e5	1020e5	1016e5
5	40955000	40950000	40940000	4092e4	4088e4	4083e4	4064e4
10	20477500	20475000	20470000	2046e4	2044e4	2040e4	2032e4
20	10238750	10237500	10235000	1023e4	1022e4	1020e4	1016e4
50	4095500	4095000	4094000	4092e3	4088e3	4080e3	4064e3
100	2047750	2047500	2047000	2046e3	2044e3	2040e3	2032e3
200	1023875	1023750	1023500	1023e3	1022e3	1020e3	1016e3
500	409550	409500	409400	409200	408800	408000	406400
1k	204775	204750	204700	204600	204400	204000	203200
2k	102387.5	102375	102350	102300	102200	101600	100800
5k	40955	40950	40940	40920	40880	40800	40640
10k	20477.5	20475	20470	20460	20440	20400	20320
20k	10238.75	10237.5	10235	10230	10220	10200	10160
50k	4095.5	4095	4094	4092	4088	4080	4064
100k	2047.75	2047.5	2047	2046	2044	2040	2032

In this table, we indicated the maximum possible value that the time delay can take depending on the frequency range and the member of lines.

For instance if the frequency range is 100kHz and the spectrum size is 400 lines, the time delay must be defined between −2044ms and 2044ms.

204775e5 means 204775 × 10^5.

T-F Analysis setup

To execute T-F analysis, the following parameters must be set:

(1) T-F analysis time domain
(2) Data subjected to T-F analysis
- Identification number (1 to 4)
- Channel whose signal is to be analyzed
- Type of the trace data to be analyzed
- Frequency of the trace data to be analyzed

The R9211 can analyze up to four types of data simultaneously (they must correspond to the same time domain).
Identification numbers are used to differentiate these four types of data.

NOTE

If the INST t-f key in the Y softmenu is ON, the above settings cannot be changed. Set it to OFF, and then make the changes.

● Setting a time domain

The time domain setting procedure is described below. If the set value does not match the sampling clock, immediately after the T-F analysis starts, it is automatically changed to fit the sampling clock requirements.

SETUP ⇒ T-F (*) ⇒ t RANGE ⇒

START t 0 msec	Sets the start time.
STOP t 4 msec	Sets the stop time.
STEP t 1 msec	Sets the step time.
sec	Sets the unit and validates setting.
msec	
μsec	

NOTE

(*) indicates that the NEXT key is to be pressed if this menu is not displayed.

There are some restrictions on the start time, stop time and step time according to the maximum size of the data subject to T-F analysis (1K) and to the input buffer size.

● **Setting of the T-F analysis data**

You must set the T-F analysis data setting menu (which is the menu displayed when you press the t-f MODE key) top down.

(1) Setting of an identification number

SETUP ⇒ T-F ⇒ t-f MODE ⇒ t-f ID 2 ⇒ 2 ⇒ ENT

Thus, 2 is registered as the identification number.

(2) Selection of a channel

You can select channel A or channel B as the channel to be submitted to T-F analysis.

SETUP ⇒ T-F ⇒ t-f MODE ⇒ t-f CH (CH-A) ⇒ CH-A (*1)
CH-B (*2)

(*1) Spectra Gaa and Sa of channel A are displayed as trace data.
(*2) Spectra Gbb and Sb of channel B are displayed as trace data.

(3) Setting of a trace data type

SETUP ⇒ T-F ⇒ t-f MODE ⇒ t-f DATA (Gxx) ⇒ Gxx (f) (*1)
ΣGxx (f) (*2)
REAL (*3)
IMAG (*4)
PHASE (*5)
f PEAK (*6)
RETURN

If (*1), (*3), (*4), or (*5) is selected, by pressing the RETURN key you come back to the previous menu, which has become:

t-f ID
2
t-f CH
(CH-A)
t-f DATA
(***)
SPOT f
**kHz

If (*2) or (*6) is selected, the previous menu has become:

t-f ID
2
t-f CH
(CH-A)
t-f DATA
(***)
START f
**kHz
STOP f
***kHz

(4) Setting of a tracing frequency
Since a single frequency is traced when Gxx, REAL, IMAG, or PHASE is selected as trace data type, a spot frequency must be specified, which is done as follows:

SETUP ⇒ T-F ⇒ t-f MODE ⇒ SPOT f 30kHz ⇒ SPOT f 30kHz

kHz
Hz
mHz

If ΣGxx or f PEAK is selected as trace data type, START f and STOP f are displayed instead of the SPOT f .
Set a trace frequency range in the same way as you would set a single frequency.

- **Execution of a T-F analysis**

SETUP ⇒ T-F ⇒ INST t-f ON/OFF

In this state, T-F analysis starts when you press the START key.

- **Display of T-F analysis results**

The procedure for displaying T-F analysis results is the following one:

VIEW ⇒ T-F VW (*1) ⇒

t-f TRACE 1	Displays the analysis results of the data assigned ID 1. (*2)
t-f TRACE 2	Displays the analysis results of the data assigned ID 2.
t-f TRACE 3	Displays the analysis results of the data assigned ID 3.
t-f TRACE 4	Displays the analysis results of the data assigned ID 4.

(*1) Press the NEXT key if this menu is not displayed.

(*2) This ID is the ID set with the following procedure:

SETUP ⇒ T-F ⇒ t-f ID 1

In the trace-on-start ON mode, when data other than the T-F analysis data are displayed, the T-F analysis results of the data whose ID was set last is displayed automatically, immediately after pressing the START key.
For details on the TRACEonST function, see "● Automatic Setting of the display" in "■ Extended Functions' Setting" in chapter 9.

3. SETUP KEY OPERATION

● Example of T-F analysis results

An example of T-F analysis is given below.
The T-F analysis conditions are listed in the following table:

START t	Start time	0msec
STOP t	Stop time	20msec
STEP t	Step time	78.12μsec
t-f ID	Identification number	2
t-f CH	Channel	CH-A
t-f DATA	Trace data	Gxx
SPOT f	Spot frequency	8kHz

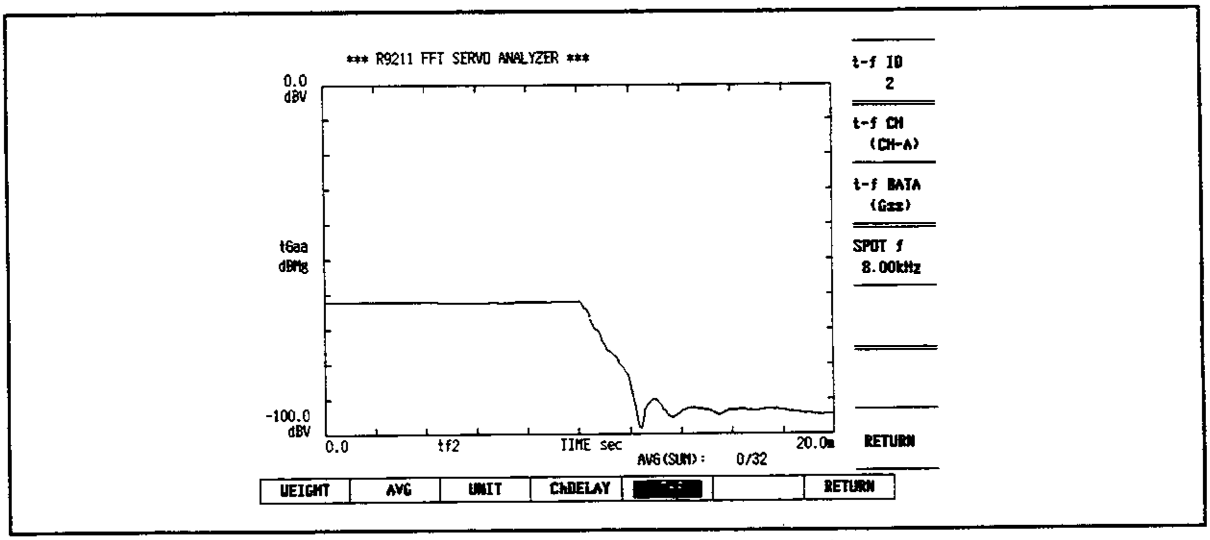


Figure 9-1 Example of Analysis Results

Selection of a Sweep Signal Type in the Servo Mode

When you want to measure a Frequency Response Function in the servo mode, you will select the signal to be output from the internal Signal Generator as is now explained.

SETUP ⇒ SWEEP ⇒

LIN MSIN	The measurement shall be done with a linear frequency sweep multi-sine wave.
LOG MSIN	The measurement shall be done with an logarithmic frequency sweep multi-sine wave.
LIN SIN	The measurement shall be done with a linear frequency sweep sine wave.
LOG SIN	The measurement shall be done with a logarithmic frequency sweep sine wave.
LIN F-Tab	The measurement shall be done using a previously set frequency table, and with a linear frequency axis.
LOG F-Tab	The measurement shall be done using a previously set frequency table, and with a logarithmic frequency axis.
Meas Time (SHORT)	This key is displayed when the LIN MSIN or the LIN SIN key is pressed. If you press this key, the measurement time setting menu will be displayed.

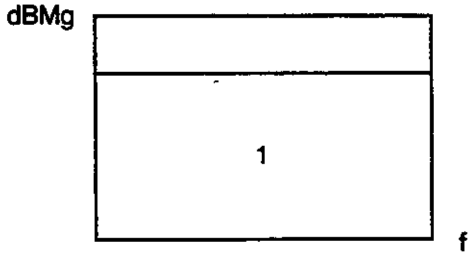
- **Setting of the measurement time**

When LIN MSIN or LIN SIN is selected with the SWEEP key, a measurement time must be set.

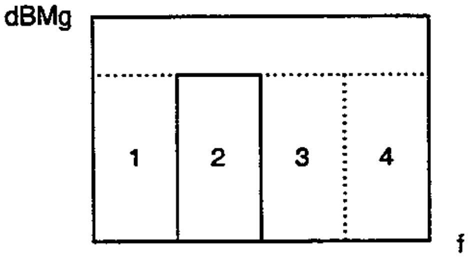
Meas Time (SHORT) ⇒

SHORT	To be specified if you want to measure a Frequency Response Function, with the smallest possible number of sweeps, in a short time.
MIDDLE	To be specified if you want to measure a Frequency Response Function with a mean number of sweeps.
LONG	To be specified if you want to measure a Frequency Response Function with a maximum number of sweeps.

The number of sweeps represents the number of spectra generated to measure a Frequency Response Function over the entire frequency range. If LIN MSIN is selected with the SWEEP key and SHORT is selected to specify a short sweep time, all spectrum lines are generated at once. In this case, the number of sweeps is only one.



When MIDDLE is selected to specify a mean sweep time, 1/4 of all spectrum lines are generated at once. In this case, the number of sweeps is 4.



When LIN SIN is selected with the SWEEP key, the frequency step changes according to the selected measurement time. For example if the total number of lines is 800 and "LONG" is chosen as sweep time, the Frequency Response Function on all 800 lines is measured. In this case, the number of sweeps is 800. When SHORT or MIDDLE is selected, one every 4 lines is analyzed, therefore the Frequency Response Function is measured only on 200 lines. In this case, the number of sweeps is 200. The Relationship between the measurement time and the number of sweeps is the following one:

Table 9-12 Relationship between Measurement Time and Number of Sweeps

Sweep type / Measurement time / Total number of lines	LIN MSIN			LIN SIN		
	SHORT	MIDDLE	LONG	SHORT	MIDDLE	LONG
25	1	1	1	25	25	25
50	1	2	5	25	25	50
100	1	4	10	25	25	100
200	1	4	20	25	50	200
400	1	4	16	25	100	400
800	1	4	16	50	200	800

For details on the total number of lines, see " ■ Setting of the Number of Frequency Lines and Sweep Direction in the Servo Mode".

Below are examples of time waveforms generated by the internal signal generator and their power spectrum.
These time waveforms are those used as sweep signals for "LIN SIN" sweeps and "LIN MSIN" sweeps with the measurement time equal to "SHORT", "MIDDLE" or "LONG" respectively.

(1) LIN SIN

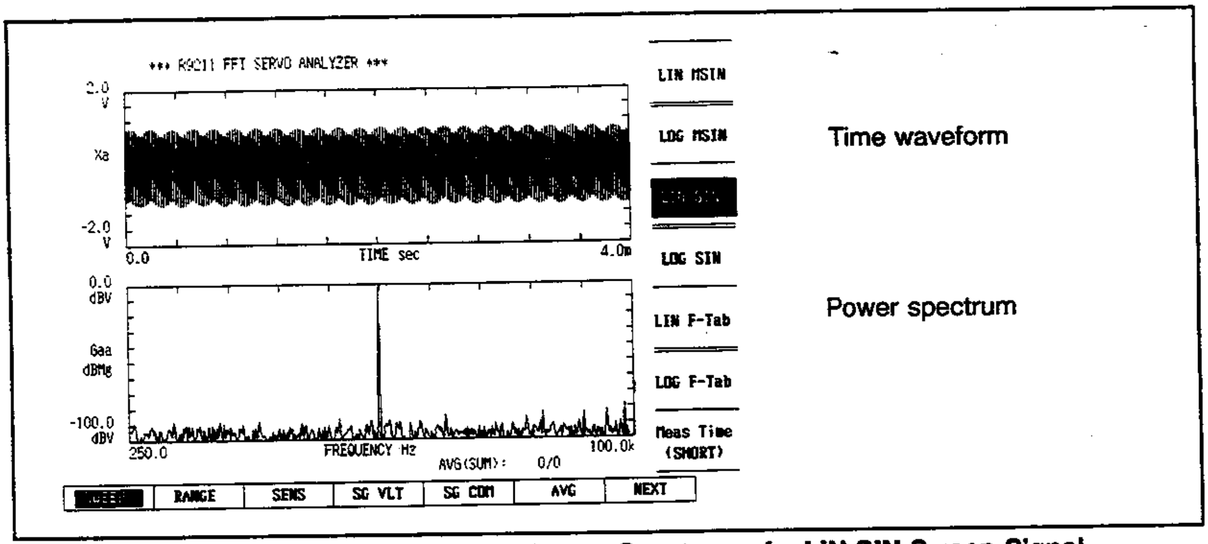


Figure 9-2 Time Waveform and Power Spectrum of a LIN SIN Sweep Signal

(2) LIN MSIN (SHORT)

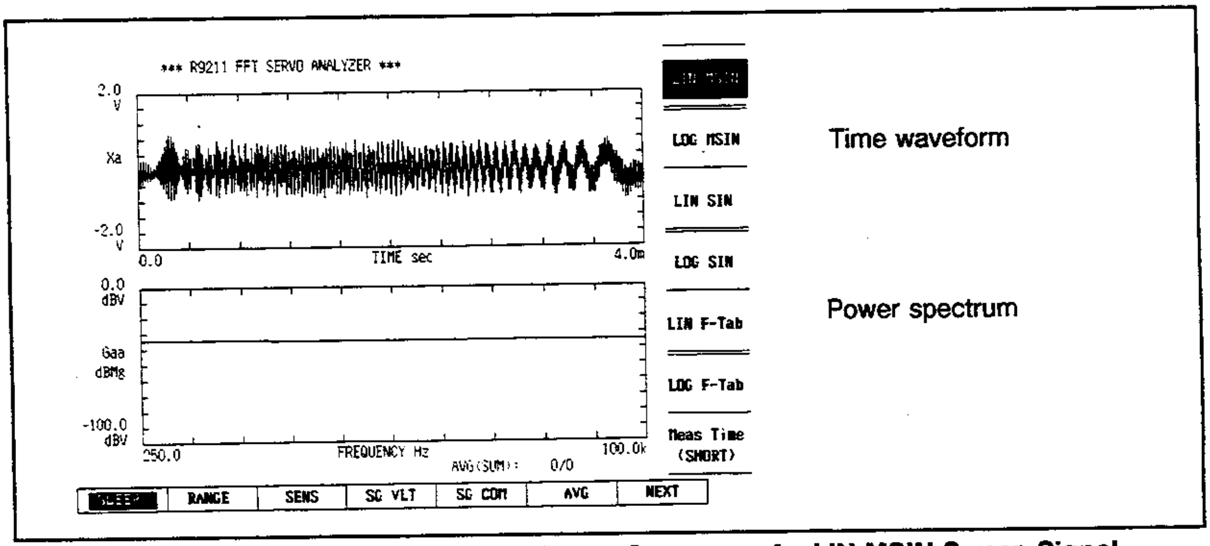
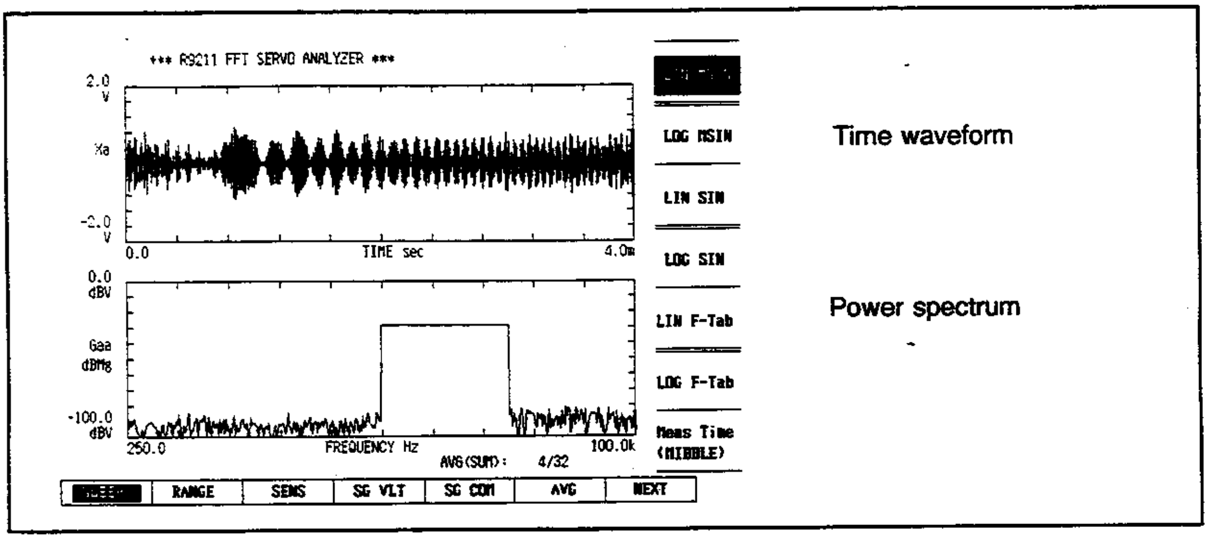


Figure 9-3 Time Waveform and Power Spectrum of a LIN MSIN Sweep Signal ("SHORT" measurement time)

(3) LIN MSIN (MIDDLE)

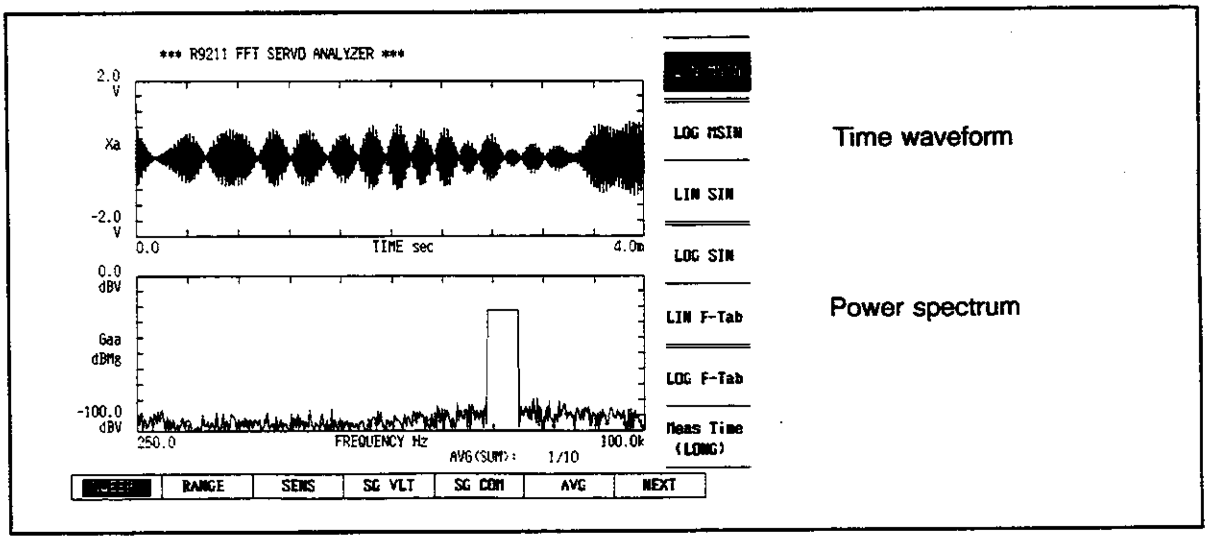


Time waveform

Power spectrum

Figure 9-4 Time Waveform and Power Spectrum of a LIN MSIN Sweep Signal ("MIDDLE" measurement time)

(4) LIN MSIN (LONG)



Time waveform

Power spectrum

Figure 9-5 Time Waveform and Power Spectrum of a LIN MSIN Sweep Signal ("LONG" measurement time)

Setting of the Number of Frequency Lines and Sweep Direction in the Servo Mode

● Linear frequency axis

When LIN MSIN or LIN SIN is selected with the SWEEP key, the total number of lines and the sweep direction, must be specified.

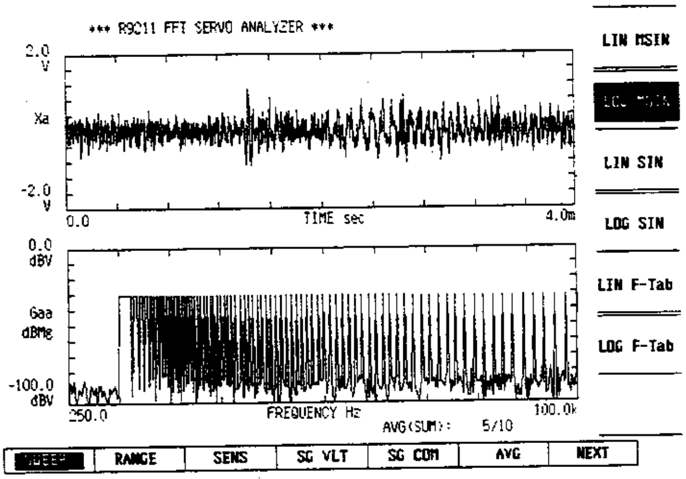
SETUP ⇒ RANGE ⇒ f RESOLN ⇒

LINE/SPAN 400	Specifies the total number of lines. This setting is done with the numeric keys and validated by pressing the ENT key.
SWEEP UP	Sweeps from the low frequencies toward the high frequencies.
SWEEP DOWN	Sweeps from the high frequencies toward the low frequencies.

Select the total number of lines either equal to 25, 50, 100, 200, 400, or to 800.

● LOG MSIN

When LOG MSIN (logarithmic frequency axis and multi-sine wave) is selected, a multi-sine wave is selected for each decade and swept over the decade. The following example shows a time waveform generated by the built-in SG and is spectrum when LOG MSIN is selected with the SWEEP key.



AVG(SUM): 5/10

Figure 9-6 Time Waveform and Power Spectrum of a LOG MSIN Sweep Signal

● Logarithmic frequency axis

When LOG MSIN or LOG SIN is selected with the SWEEP key, the number of decades, the number of lines per decade, and the sweep direction must be specified.

SETUP ⇒ RANGE ⇒ f RESOLN ⇒

LINE/Dec	You enter the number of lines per decade with the numeric keys, and press the ENT key to validate your setting.
Decade	You enter the number of decades with the numeric keys, and press the ENT key to validate your setting.
SWEEP UP	Sweeps from the low frequencies towards the high frequencies.
SWEEP DOWN	Sweeps from the high frequencies towards the low frequencies.

You can choose the number of decades from 1 to 6. Then you can specify a number of lines per decade equal either to 10, 25, 50, 100, or to 200. The total number of lines between all the decades must not exceed 1000. (When 200 lines are specified per decade, six decades can not be specified.)

● Linear frequency table

When LIN F-Tab is selected with the SWEEP key, the total number of lines and the ID numbers sequence must be specified. The range of the total number of lines is the same as that of the linear frequency axis.

SETUP ⇒ RANGE ⇒ f RESOLN ⇒

LINE/SPAN 400	You enter the total number of lines with the numeric keys, then validate this setting by pressing the ENT key.
SWEEP UP	Specifies that the measurement is to performed starting from the data assigned the smallest ID number (increasing order).
SWEEP DOWN	Specifies that the measurement is to performed starting from the data assigned the largest ID number (decreasing order).

For details about the ID number, see "■ Edition of the Frequency Table in the Servo Mode" in chapter 9.

- **Logarithmic frequency table**

When LOG F-Tab is selected with the SWEEP key, the number of decades, the number of lines per decade, and the ID numbers sequence must be specified. The number of decades and the number of lines per decade settings are similar to the settings for the logarithmic frequency axis.

SETUP ⇒ RANGE ⇒ f RESOLN ⇒

LINE/Dec	You enter the number of lines per decade with the numeric keys, and press the ENT key to validate your setting.
Decade	You enter the number of decades with the numeric keys, and press the ENT key to validate your setting.
SWEEP UP	Specifies that the measurement is to performed starting from the data assigned the smallest ID number (increasing order).
SWEEP DOWN	Specifies that the measurement is to performed starting from the data assigned the largest ID number (decreasing order).

For details about the ID number, see "■ Edition of the Frequency Table in the Servo Mode" in chapter 9.

■ Setting of the Amplitude and of the Offset of Signals in the Servo Mode

You have to specify the amplitude and the offset of the signal generated by the built-in SG (Signal Generator).

SETUP ⇒ SG VLT ⇒

AMPLITUDE 2.00V	Sets the amplitude of the signal generated by the built-in SG.
OFFSET 0.5V	Sets the offset of the signal generated by the built-in SG.

LIMIT VOLT 5.00V	Set the upper limit (including the offset) of the signal generated by the built-in SG.
V	
mV	
μV	

■ Control of the Generation of the Output Signal in the Servo Mode

You must define the operation mode of the built-in SG when you want to measure a frequency response function in the SERVO mode.

SETUP ⇒ SG COM ⇒

GENERATOR START	Outputs from the built-in SG a signal equal to the sweep signal earlier selected ("■ Selection of a Sweep Signal Type in the Servo Mode") to which an offset is eventually (earlier setting) added.
GENERATOR STOP	Outputs only the offset voltage from the built-in SG.
INVL TIME (OFF)	Specifies the time interval elapsed from the moment when the signal is generated by the SG and the moment when the measurement begins. (Minimum: 1 sec).
GEN ON AVG/MAN	Determines whether the generator's start/stop time is to be executed manually or is to automatically correspond to the start/stop time of the measurement.
SUM AMP ON/OFF	Determine whether the summing amplifier is to be switched on or off before the measurement.

● **Setting of the time interval elapsed from the signal's generation start time to the measurement's start time.**

You will use the INVL TIME Y softkey for this setting.

INVL TIME (OFF)	⇒	INVL TIME ON/OFF	Determines whether the time elapsed from the signal's generation start time to the measurement's start time is to be specified.
		INVL TIME 10msec	You set the time elapsed from the signal's generation start time to the measurement's start time with the numeric keys and one of the unit keys.
		sec	Unit keys
		msec	

Setting of the Averaging Method in the Servo Mode

How to set the averaging method in the SERVO mode is now explained.

SETUP ⇒ AVG ⇒

AVG NO 32	Sets the number of averages if the coherence is not to be taken into account.
LIMIT NO 2000	Sets the maximum number of averages if a coherence threshold must be taken into account.
PROCESS (NORMAL)	Sets the averaging process.
AUTO AVG ON/OFF	Determines whether averaging is to be carried out while taking into account a coherence threshold.
COH LIM 0.95	Sets a coherence threshold. You set the value with the numeric keys.

● Setting of the averaging process

This setting is enabled when you press the PROCESS Y softkey.

PROCESS (NORMAL) ⇒

NORMAL	Displays the result each time the averaged series is updated (normal mode).
FAST	Displays the result after averaging has been completed (high speed mode).
NON-STOP ON/OFF	Determines whether, after completion of the averaging process, a new averaging process (same conditions) must be automatically started. For example, to adjust the frequency characteristic of a filter, set this parameter to ON.

● About AUTO AVG

When AUTO AVG is set to OFF, averaging is carried out the number of times which was specified with "AVG NO".

When AUTO AVG is set to ON, averaging is carried out while comparing the mean coherence value with the value specified with "COH LIM". In this case, the minimum number of averages is 8. Averaging ends when the mean coherence value over all lines becomes greater than the value defined by "COH LIM". If it does not become greater than the value defined by "COH LIM", averaging is carried out the number of times which was specified with "LIMIT NO".

Edition of the Frequency Table in the Servo Mode

● Setting, inserting, deleting, or modifying an ID number

This screen is displayed when LIN F-Tab or LOG F-Tab is selected with the SWEEP key. How to edit the frequency table is explained below:

SETUP ⇒ f EDIT ⇒

DONE	Ends the edition of the frequency table.
EDIT ID	Specifies the ID number to be edited.
INSERT ON/OFF	Determines whether the specified ID number's content is to be modified or inserted.
DEL ID	Deletes the specified ID number.
DEL END	Deletes all data following the specified ID number.
START ID 1	Specifies the ID number at which measurement will start.
STOP ID 4	Specifies the ID number at which measurement will end.

Pressing the f EDIT key will display the frequency table for setting.

Using this frequency table, you can set the type of waveform to be generated (SIG: sine wave or multi-sine wave), the frequency range it belongs to (f START and f STOP), its amplitude (AMP), its offset, and the number of averages which must be performed on this frequency range (AVG). Thus, measurement can be carried out by changing the measurement conditions for each frequency range: for example, a sine waveform can be used in a frequency range that require high measurement accuracy and a multi-sine wave can be used in a frequency range that does not require high measurement accuracy but requires high-speed measurement.

Use SQ BAND and AMP&AVG X softkeys and their Y softmenus for editing this table.

- **Setting of the type and frequency range of the waveform to be generated**

How to set the type and frequency range of the waveform to be generated for each ID number in the frequency table is explained below.

SETUP ⇒ SQ BAND ⇒

SINE	To generate a sine wave.
M-SINE	To generate a multi-sine wave.
f START 20Hz	Sets the start frequency of the waveform to be generated.
f STOP 20kHz	Sets the stop frequency of the waveform to be generated.
kHz Hz mHz	Unit key

- **Setting of the amplitude, offset, and number of averages of the waveform to be generated**

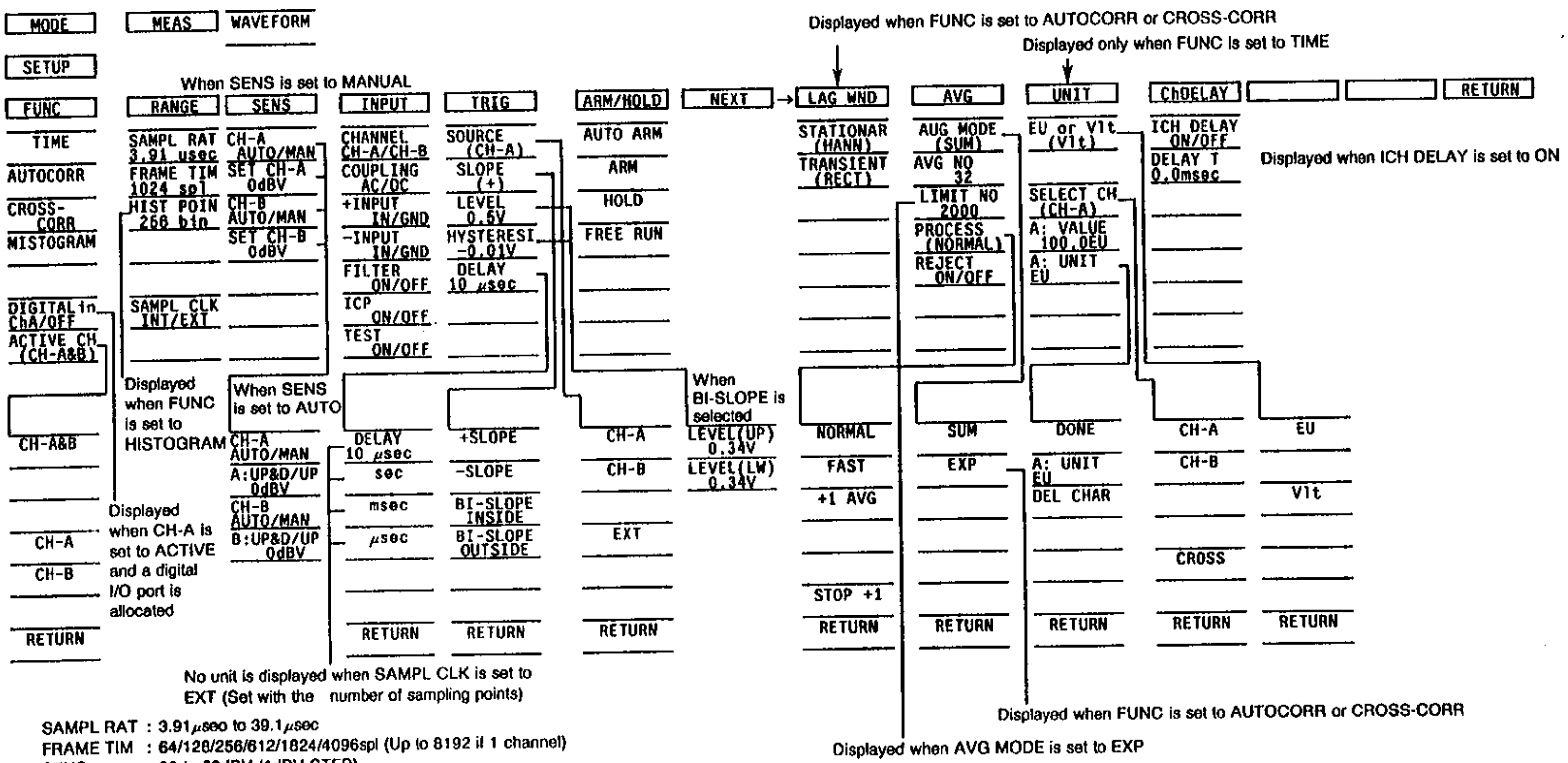
How to set the amplitude, offset, and number of averages of the waveform to be generated for each ID number in the frequency table is explained below:

SETUP ⇒ AMP&AVG ⇒

AMPLITUDE 1.00V	Sets the amplitude of the waveform to be generated.
OFFSET 1.00V	Sets the offset of the waveform to be generated.
AVG NO 32	Sets the number of averages.
V mV μV	Unit key

SETUP Menu List

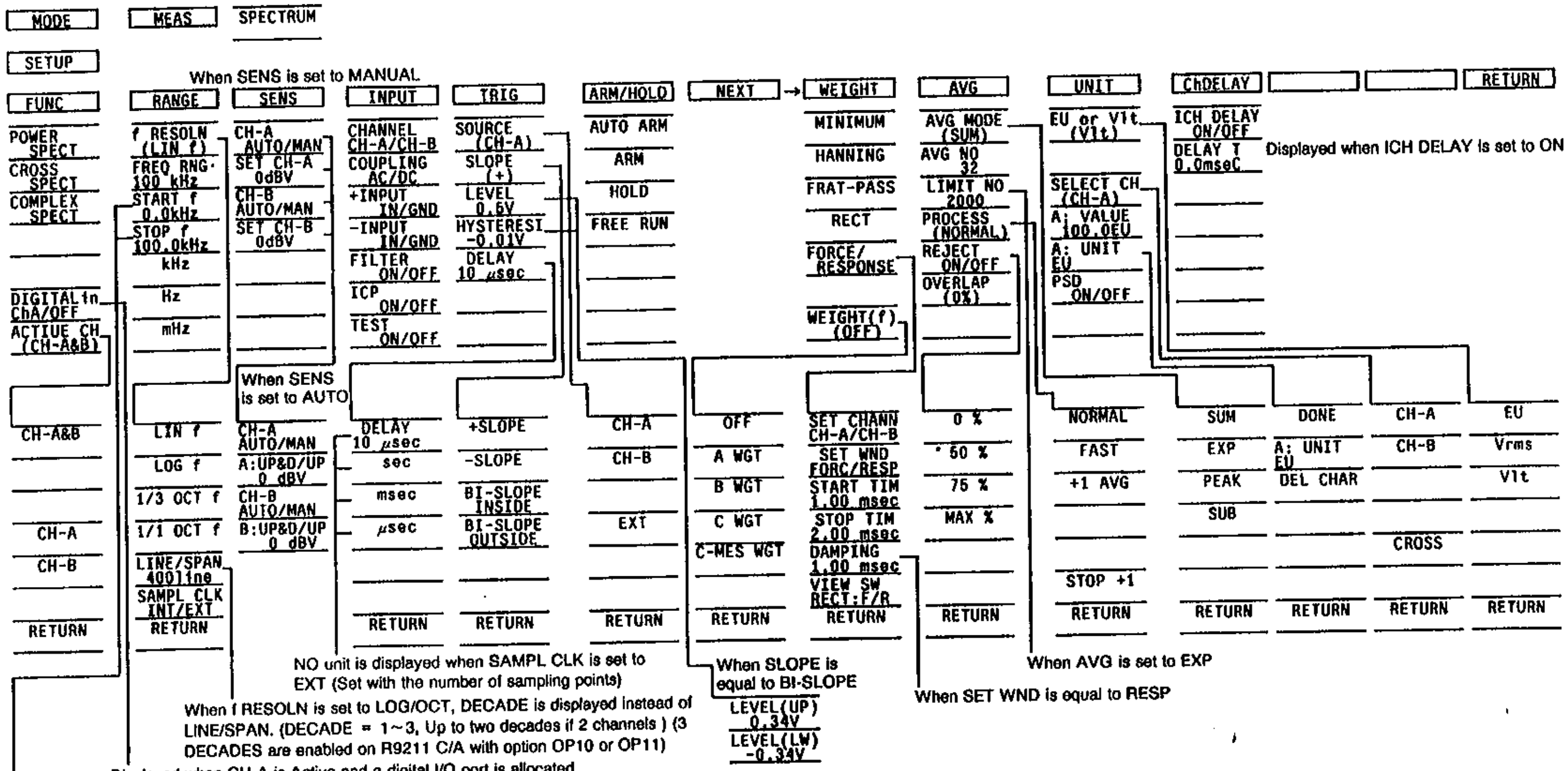
R9211 Series Menu List (SETUP in the WAVEFORM mode)



SAMPL RAT : 3.91μsec to 39.1μsec
FRAME TIM : 64/128/256/612/1624/4096spl (Up to 8192 if 1 channel)
SENS : 30 to 60dBV (1dBV STEP)
TRIG LEVEL : 1/256 of amplitude range
HYSTERESIS: 1/256 of amplitude range
TRIG DELAY : −128k to +1M samples (1 channel)
−64k to +1M samples (2 channels)

AVG NO : 1 to 32767
HIST POIN : 64/128/256/512/1024/2048 bin
LIMIT NO : 1 to 32767

R9211 Series Menu List (SETUP in the SPECTRUM mode)



NO unit is displayed when SAMPL CLK is set to EXT (Set with the number of sampling points)

When f RESOLN is set to LOG/OCT, DECADE is displayed instead of LINE/SPAN. (DECADE = 1~3, Up to two decades if 2 channels) (3 DECADES are enabled on R9211 C/A with option OP10 or OP11)

Displayed when CH-A is Active and a digital I/O port is allocated

RANGE ZOOM is enabled on R9211A/C. When ZOOM is selected, LOG f, 1/3 OCT f, 1/1 OCT f of f RESOLN and AUTO ARM and ARM of ARM/HOLD are not displayed.

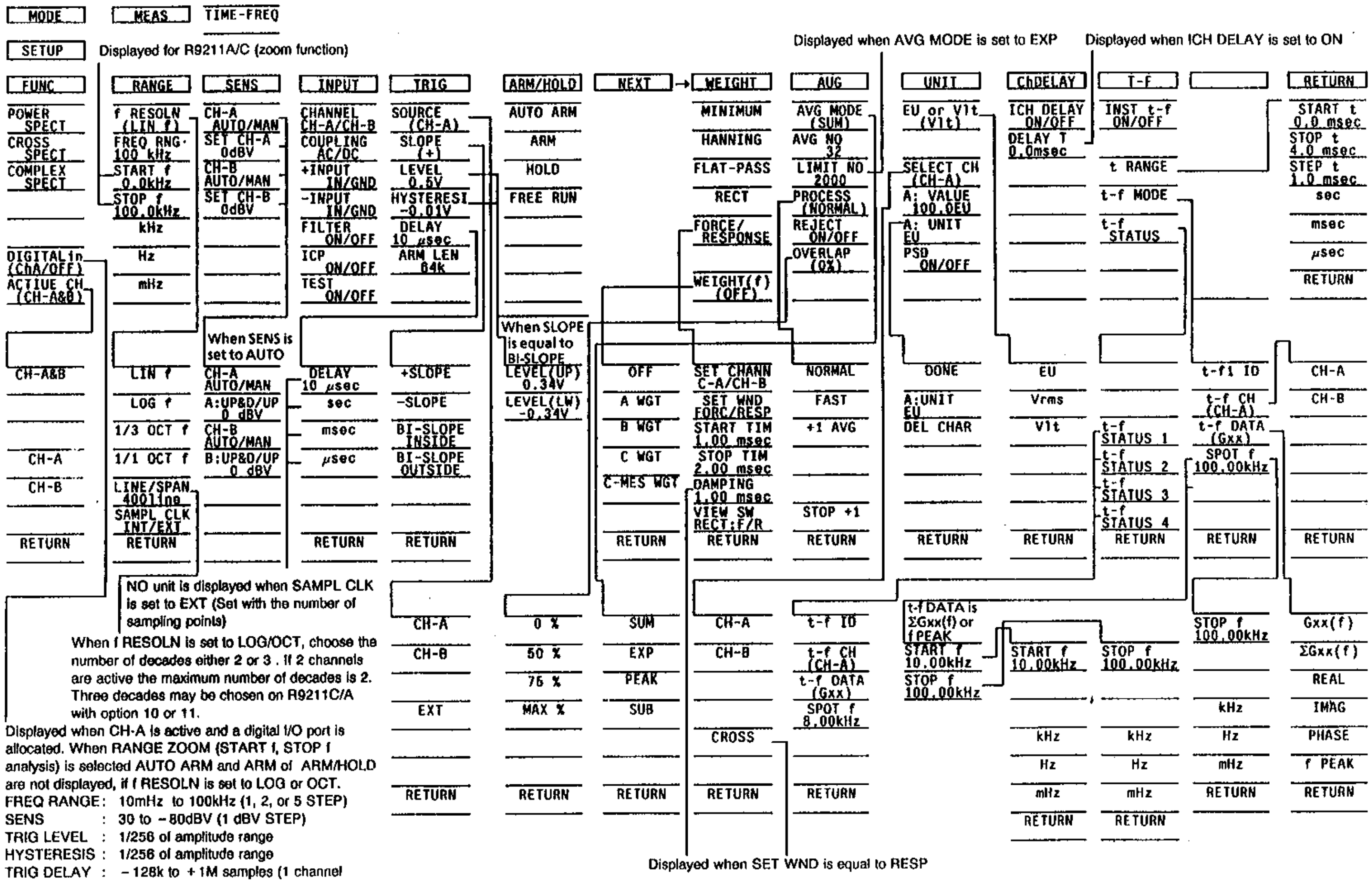
FREQ RANGE: 10mHz to 100kHz (1, 2, or 5 STEP)

LINE/SPAN: 25/50/100/200/400/800/1600 (Up to 3200 if 1 channel)

3. SETUP KEY OPERATION

R9211 Series Menu List (SETUP in the T-F mode)

R9211 Series Menu List (SETUP in the TIME-FREQ mode)



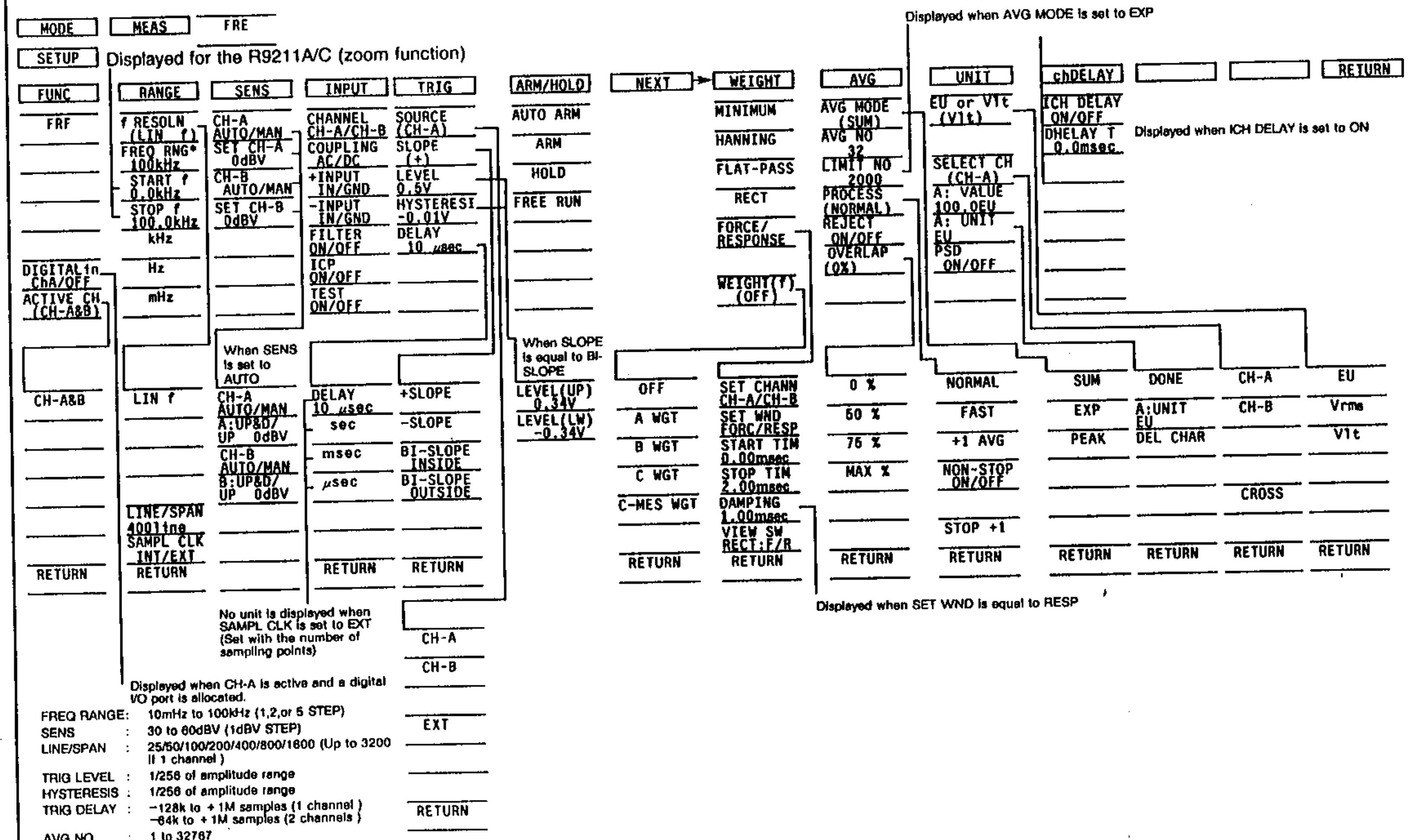
NO unit is displayed when SAMPL CLK is set to EXT (Set with the number of sampling points)

When f RESOLN is set to LOG/OCT, choose the number of decades either 2 or 3. If 2 channels are active the maximum number of decades is 2. Three decades may be chosen on R9211C/A with option 10 or 11.

Displayed when CH-A is active and a digital I/O port is allocated. When RANGE ZOOM (START f, STOP f analysis) is selected AUTO ARM and ARM of ARM/HOLD are not displayed, if f RESOLN is set to LOG or OCT.

FREQ RANGE : 10mHz to 100kHz (1, 2, or 5 STEP)
SENS : 30 to −80dBV (1 dBV STEP)
TRIG LEVEL : 1/256 of amplitude range
HYSTERESIS : 1/256 of amplitude range
TRIG DELAY : −128k to +1M samples (1 channel mode)
-64k to +1M samples (2 channel mode)

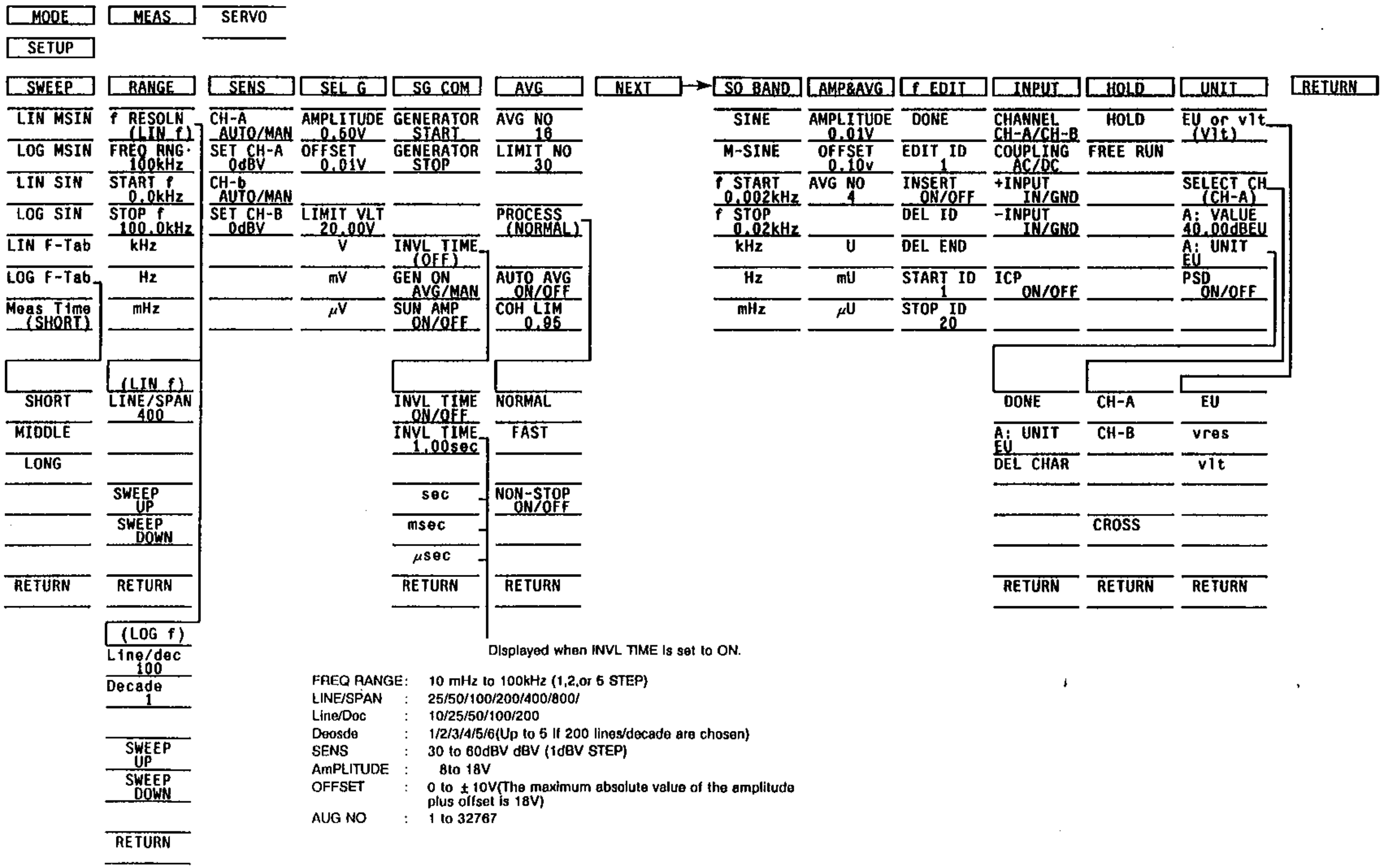
R9211 Series Menu List (SETUP in the FRF mode)



FREQ RANGE: 10mHz to 100kHz (1,2,or 5 STEP)
SENS : 30 to 60dBV (1dBV STEP)
LINE/SPAN : 25/50/100/200/400/800/1600 (Up to 3200 if 1 channel)
TRIG LEVEL : 1/256 of amplitude range
HYSTERESIS : 1/256 of amplitude range
TRIG DELAY : −128k to + 1M samples (1 channel)
−64k to + 1M samples (2 channels)
AVG NO : 1 to 32767

3. SETUP KEY OPERATION

R9211 Series Menu List (SETUP in the SERVO mode)



Displayed when INVL TIME Is set to ON.

FREQ RANGE: 10 mHz to 100kHz (1,2,or 5 STEP)
LINE/SPAN : 25/50/100/200/400/800/
Line/Doc : 10/25/50/100/200
Deosde : 1/2/3/4/5/6(Up to 5 If 200 lines/decade are chosen)
SENS : 30 to 60dBV dBV (1dBV STEP)
AmPLITUDE : 8to 18V
OFFSET : 0 to ± 10V(The maximum absolute value of the amplitude plus offset is 18V)
AUG NO : 1 to 32767

4. VIEW KEY OPERATION

This section explains how to use the VIEW panel key.

■ Selection of a Screen in the Multi-Screen Configuration

VIEW ⇒ SEL □ (There is no corresponding Y menu.)

Press the above key sequence to select a screen (waveform) according to the number of displayed screens. When a screen is selected, the Y menu corresponding to the data displayed on this selected (active) screen is displayed.
Pressing the following key sequences yields the same result:

MKR ⇒ SEL □ or MATH ⇒ SEL □

The black square (■) indicates the position of the current selected screen (active).

- When the screen configuration is set to SINGLE (1 screen):

  SEL ■

- When the screen configuration is set to DUAL (2 screens):

  Each time the SEL ⊟ key is pressed, the active screen position switches:

- When the screen configuration is set to TRIPL (3 screens):

  Each time the SEL ☰ key is pressed, the active screen position switches:

- When the screen configuration is set to QUAD (4 screens):

  Each time the SEL ⊞ key is pressed, the active screen position switches:

Display Related Modifications

● Changing the number of screens

You change the number of screens as follows:

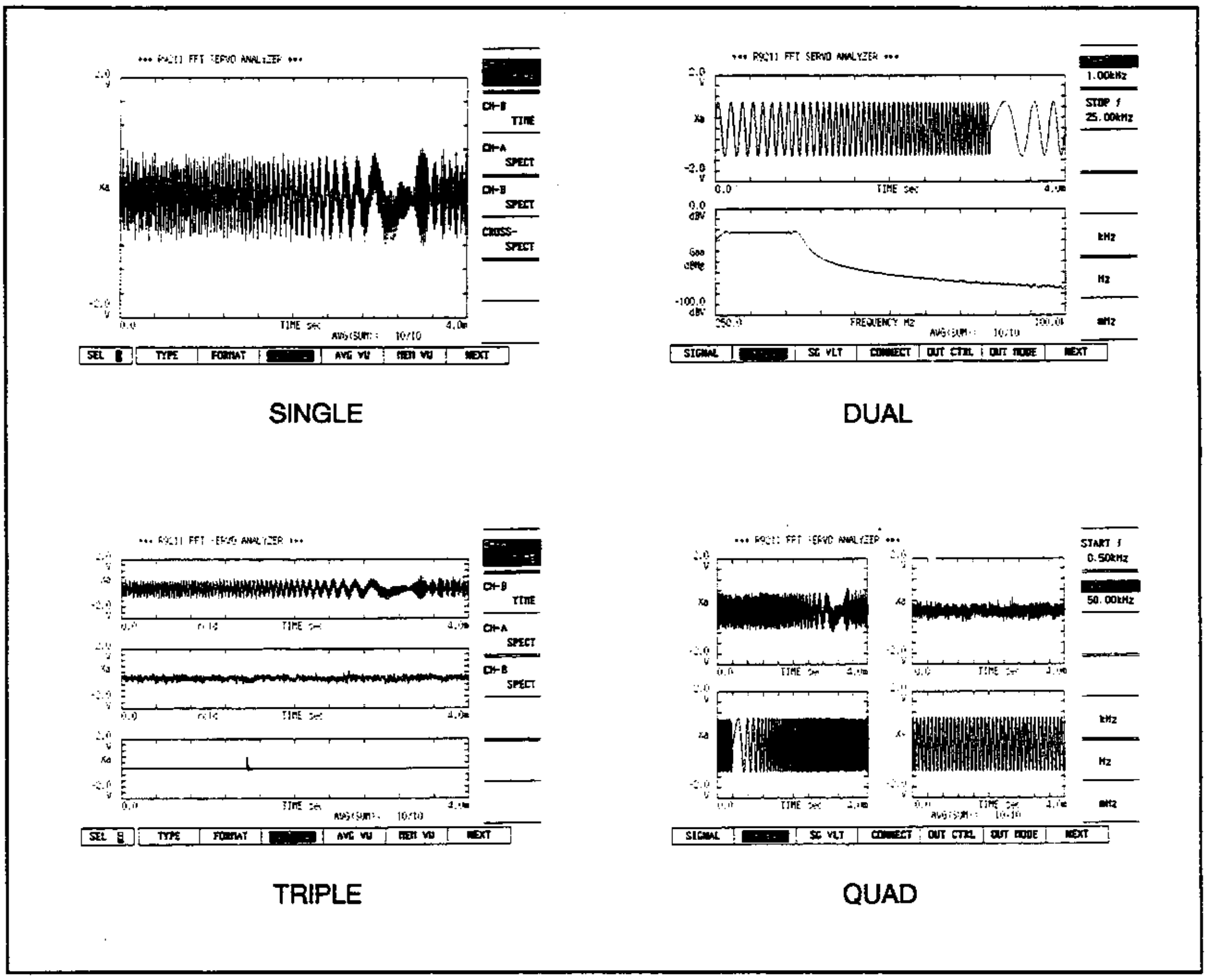
VIEW ⇒ TYPE ⇒

SINGLE	Displays one screen.
DUAL	Displays two screens.
TRIPLE	Displays three screens.
QUAD	Displays four screens.

NOTE

1. The number of screens that can be displayed depends on the waveform type (polar coordinates or others) and number of lines.

2. The SEL ☐ X softkey changes according to the number of screens.



SINGLE

DUAL

TRIPLE

QUAD

Figure 9-7 Multi-screen Display

- **Instantaneous data monitor (only in the FRF and SERVO modes)**

VIEW ⇒ TYPE ⇒ +MONITOR DO/UNDO Instantaneous data monitor switch.

MODE ⇒ EXTEND ⇒ MONITOR X TIM/FREQ If MONITOR is set to DO, with this key you can specified the type of data to be displayed by the monitor.

Table 9-13 Data Monitored when DO is Selected

Number of screens	Monitored data
SINGLE	First screen : Time waveform or spectrum of CH-B
DUAL	Second screen: Time waveform or spectrum of CH-B
TRIPLE	Second screen: Time waveform or spectrum of CH-B Third screen : Time waveform or spectrum of CH-A
QUAD	Third screen : Time waveform or spectrum of CH-A Fourth screen : Time waveform or spectrum of CH-B

The number of screens does not change.
To select either time waveform or spectrum, see the explanation of the following key sequence:

MODE ⇒ EXTEND ⇒ MONITOR X TIM/FREQ

- **Read-out window (Visible or Invisible) for marker results**

You can determine whether the marker results are to be displayed in a readout window.
This setting is effective on all screens using a marker.

VIEW ⇒ TYPE ⇒ Visible ON/OFF

- Set "Visible" to ON to display a readout window.
- Set "Visible" to OFF not to display a readout window.

4. VIEW KEY OPERATION

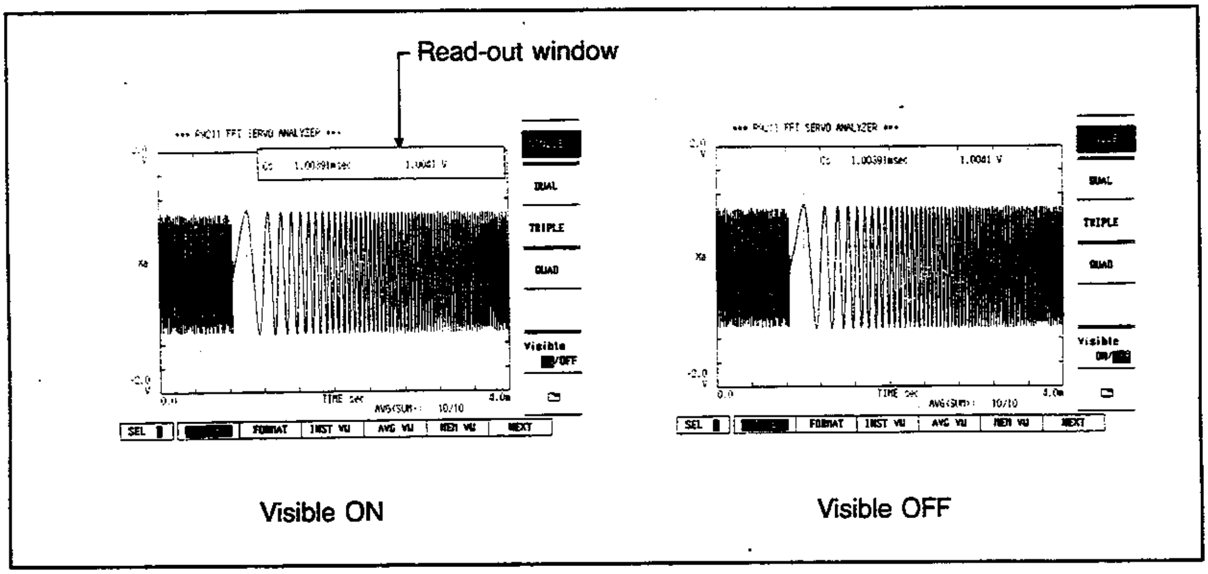


Figure 9-8 Read-out Window for Marker Results

- **Position of the readout window**

You can specify where to display the readout window for marker results. This setting is effective on all screens where a marker is used.

VIEW ⇒ TYPE ⇒ ▝

- ▝ Displays the readout window at the upper right corner of the screen.
- ▖ Displays the readout window at the lower left corner of the screen.

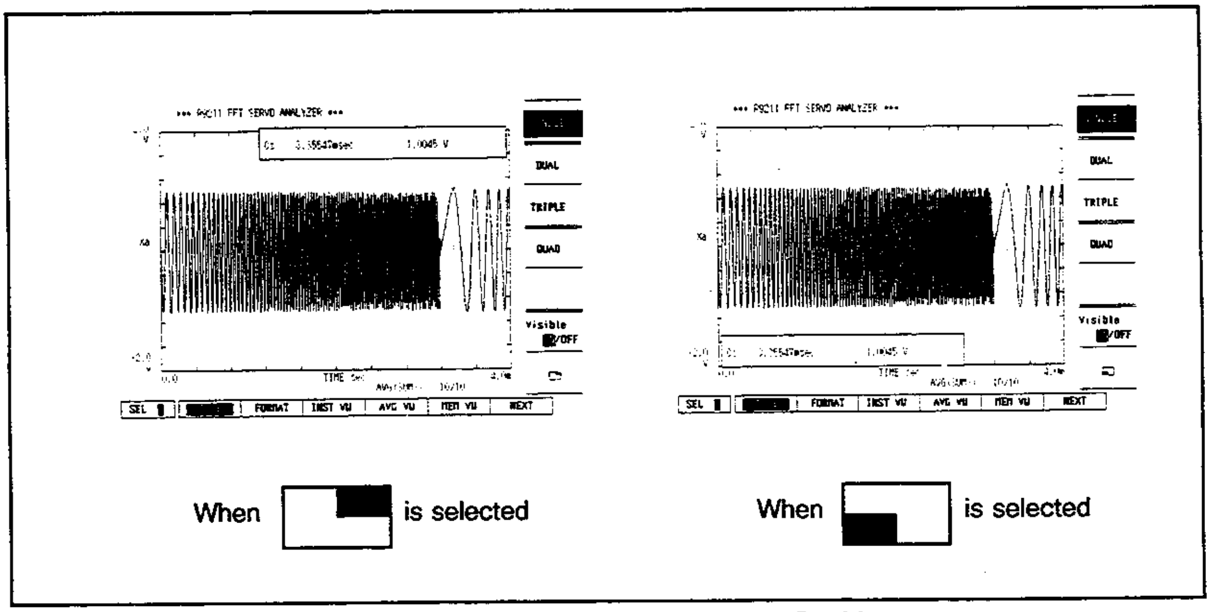


Figure 9-9 Read-out Window Display Position

Display Format

Changing the display format

VIEW ⇒ FORMAT ⇒

GRAPH	Displays a graph. Switches back to the normal display mode after a numeric list or a tridimensional display were visualized.
NUMERIC LIST	Displays a list of the data obtained for example with the marker.
3D DISPLAY	Displays a tridimensional graph.

CAUTION !

Depending on the number of screens or display type, you cannot select certain display formats.

○ **NUMERIC LIST**

- You cannot display a numeric list if you have earlier selected the triple or the quadruple screen configuration.
- When a list is being displayed, some keys cannot be used.
- This format is associated with the marker.
  (A harmonic list, side band list, or reference points list may be displayed.)

NOTE

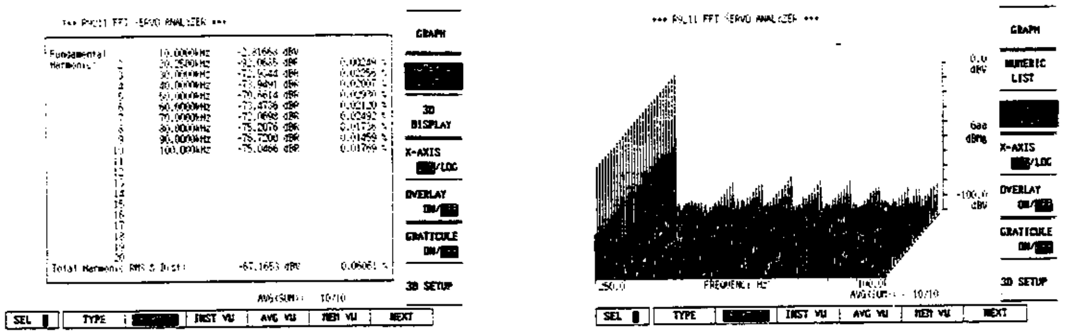
To return to your original display, press the GRAPH key.

○ **3D DISPLAY**

- A tridimensional display can always be chosen if the first screen (SEL1) is selected.
- A tridimensional display cannot be chosen if any screen other than the first screen (SEL1) is selected.
- When a tridimensional display is being visualized, some keys cannot be used.

NOTE

To return to your original display, press the GRAPH key.



NUMERIC LIST

3D DISPLAY

Figure 9-10 Numeric List and Tridimensional Display

- **Changing the display method (linear/logarithmic)**

The X axis of the displayed data can be either linear or logarithmic.

VIEW ⇒ FORMAT ⇒ X-AXIS LIN/LOG

Specifies either a linear or a logarithmic X axis for the waveform being displayed.

X-AXIS LIN : Linear display

X-AXIS LOG : Logarithmic display

CAUTION !

Data acquired in the linear mode can be displayed with the logarithmic frequency display method; however, the data acquired in the logarithmic or octave mode cannot be displayed with the linear frequency method.

- **Changing the display mode (OVERLAY)**

You can superpose 2 or more screen's data: in a multiple screen configuration the waveforms of the other screens are superposed on the active (selected with the SEL key) screen.

VIEW ⇒ FORMAT ⇒ OVERLAY ON/OFF

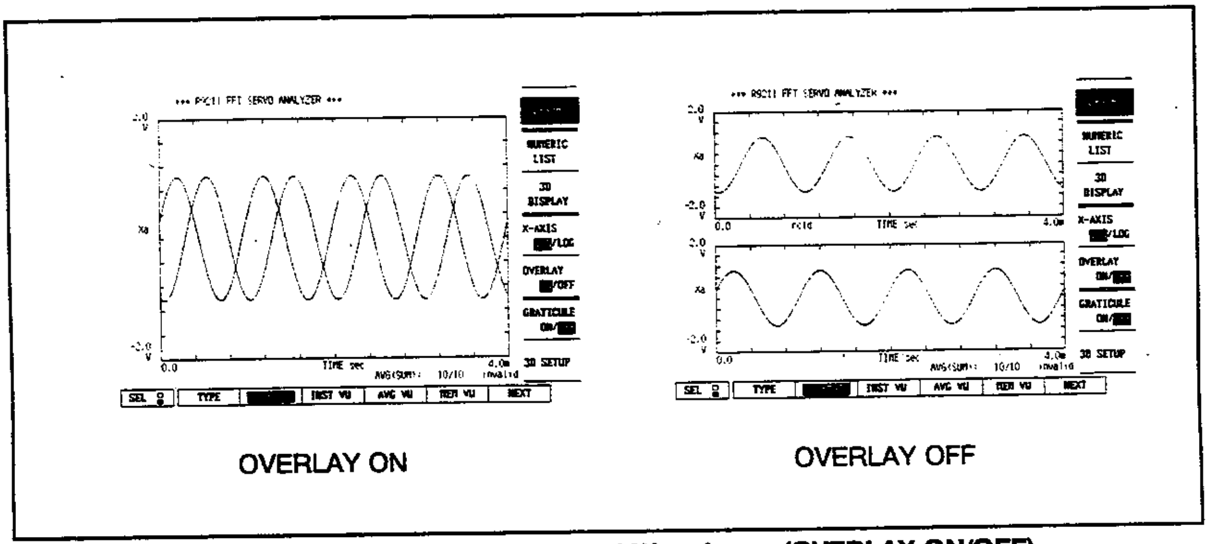
"OVERLAY ON" : superposition of the screens.

"OVERLAY OFF" : each screen is independently displayed.

CAUTION !

"OVERLAY ON" cannot be specified in the following cases:

- ***When the X axis units differ between the screens***
- ***When the frequency resolution differs between the screens***



OVERLAY ON

OVERLAY OFF

Figure 9-11 Display of Superposed Waveforms (OVERLAY ON/OFF)

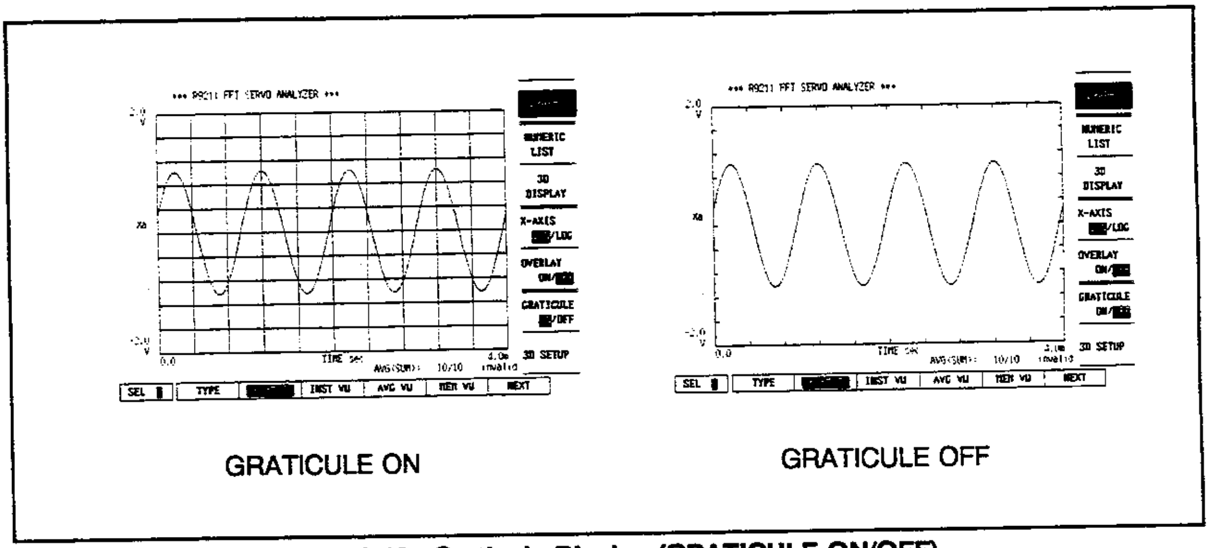
- **Changing the display mode (graticule)**

This function is used to set or not a graticule over all displayed screens.

VIEW ⇒ FORMAT ⇒ GRATICULE ON/OFF

Determines whether a graticule is to be displayed.
"GRATICULE ON" : a graticule will be displayed.
"GRATICULE OFF" : no graticule will be displayed.

This setting is effective on all screens at the same time.



GRATICULE ON

GRATICULE OFF

Figure 9-12 Graticule Display (GRATICULE ON/OFF)

4. VIEW KEY OPERATION

● **Tridimensional display conditions setup**

VIEW ⇒ FORMAT ⇒ 3D SETUP	The tridimensional display conditions are set through the second menu page.

○ **Tridimensional display execution control**

Tridimensional display conditions setup menu (third page).

3D SETUP ⇒	3D CTRL (FR STEP) ⇒	ARM/HOLD	Displays in 3 dimensions the data each time they are acquired.
		AVG END	Displays in 3 dimensions the data after averaging completion.
		FREE STEP	Displays the data in 3 dimensions in synchronization with the internal timing.
		VIEW STEP	(Only in TIME-FREQ mode) Displays the data in 3 dimensions each time the data window step changes. (See p9 to 75 Data View, View setup)

○ **Number of waveforms to appear on a tridimensional display**

Tridimensional display conditions setup menu (second page) .

3D SETUP ⇒	STACK NO 20	Sets the number of waveforms to appear on a tridimensional display.

Use the numeric keys (followed by the ENT key), the knob, or the ⇧ and ⇩ keys for the above setting.

From four to fifty waveforms may be specified.

○ **Axis angle of a tridimensional display**

Tridimensional display conditions setup menu (second page).

3D SETUP ⇒	3D ANGLE 45 deg	Sets the angle the Y axis of a tridimensional display makes with the horizontal.

Use the numeric keys (followed by the ENT key), the knob, or the ⇧ and ⇩ keys for the above setting.

Select an angle equal either to 15°, 30°, 45°, 60°, 75° and 90°.

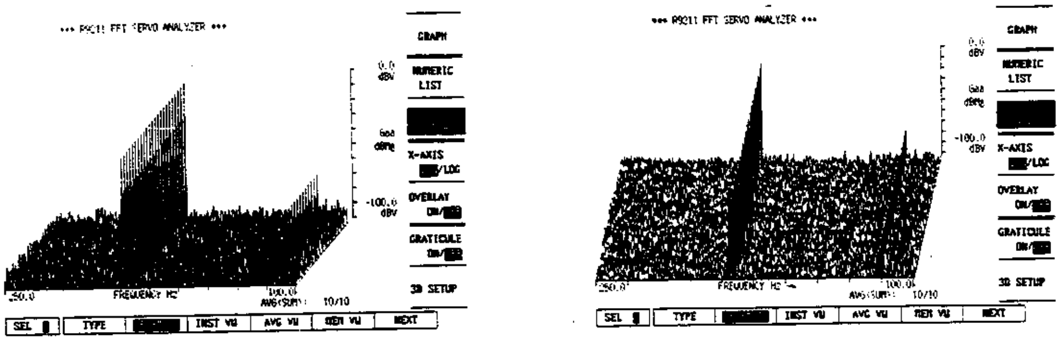


Figure 9-13 Tridimensional Display Y axis Angle Examples

How to Display Various Data

The R9211 can display the following data (the tables 9-14 and 9-15 list the data which may be displayed in each measurement mode).

- Instantaneous data : Time data, autocorrelation function, cross-correlation function, probability density function, power spectrum, cross-spectrum, and complex spectrum
- Averaged data : Time data, autocorrelation function, cross-correlation function, probability density function, power spectrum, cross-spectrum, complex spectrum, frequency response function, coherence function, and impulse response function
- Saved data
- Arithmetic operation results
- T-F (TIME-FREQ) data

The display operations are valid for the screen selected with the SEL key (active screen).

NOTE
Either a power spectrum or a complex spectrum can be displayed for each channel through the specification of the parameter COORDINATE.

● Instantaneous data display

On the R9211, the instantaneous data you can display depend on the measurement mode and function you have specified, as table 9-14 shows. The instantaneous data display procedure is the following one (example in the SPECTRUM mode):

VIEW ⇒ INST VW ⇒

CH-A TIME	Displays the time waveform of channel A.
CH-B TIME	Displays the time waveform of channel B.
CH-A SPECT	Displays the spectrum of channel A.
CH-B SPECT	Displays the spectrum of channel B.

Table 9-14 Instantaneous Data Which can be Displayed

Mode	Function	Data which can be displayed (Menu Symbol)
WAVEFORM	TIME	Time data (TIME)
	AUTOCORR	Time data (TIME) and autocorrelation function (AUTOCORR)
	CROSS-CORR	Time data (TIME), cross-correlation function (CROSS-CORR), and autocorrelation function (AUTOCORR)
	HIST	Time data (TIME) and probability density function (HIST)
SPECTRUM TIME-FREQ	POWER SPECTRUM CROSS-SPECTRUM COMPLEX SPECTRUM	Time data (TIME) and spectrum (SPECT)
FRF SERVO	FRF	Time data (TIME) and spectrum (SPECT)

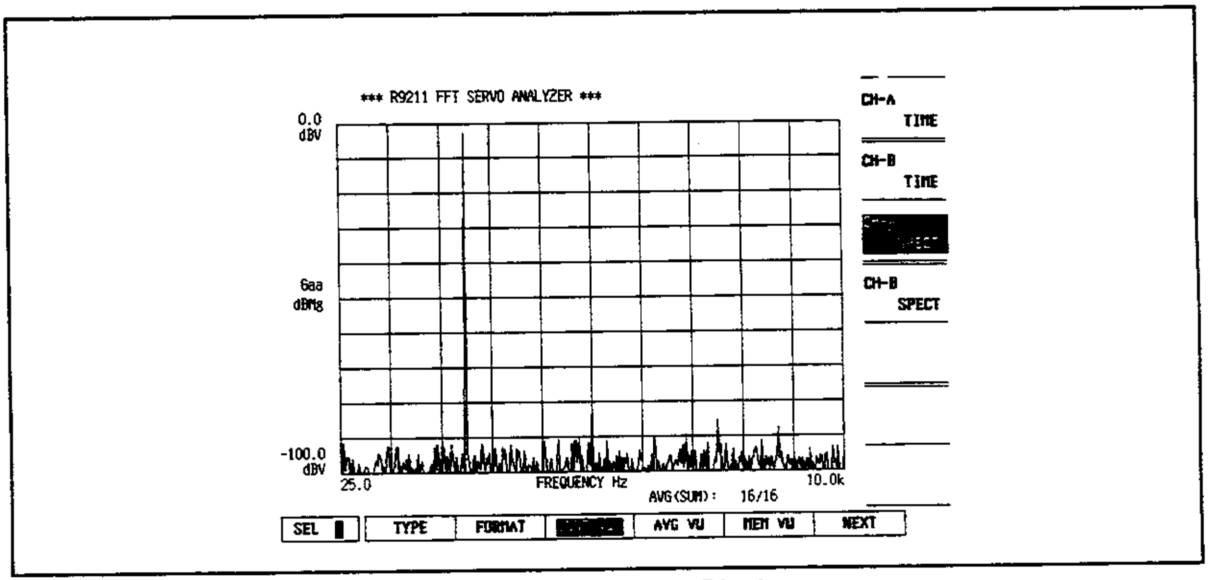


Figure 9-14 Spectrum Display

- **Averaged data display**

On the R9211, the averaged data you can display depend on the measurement mode and function you have selected as table 9-15 shows.

The averaged data display procedure is the following one (example of the spectrum mode with the power spectrum function):

VIEW ⇒ AVG VW ⇒

CH-A PWR SPECT	Displays the averaged power spectrum of channel A.
CH-B PWR SPECT	Displays the averaged power spectrum of channel B.

Table 9-15 Averaged Data Which can be Displayed

Mode	Function	Data which can be displayed (Menu Symbol)
WAVEFORM	TIME	Time data (TIME)
	AUTOCORR	Autocorrelation function (AUTOCORR)
	CROSS-CORR	Cross-correlation function (CROSS-CORR)
	HIST	Probability density function (HIST)
SPECTRUM TIME-FREQ	POWER SPECTRUM	Power spectrum (PWR SPECT)
	CROSS-SPECTRUM	Cross spectrum (CROSS-SPECT)
	COMPLEX SPECTRUM	Complex spectrum (CMP SPECT)
FRF	FRF	Frequency response function (FRF), coherence function (COHERENCE), impulse response function (IMPULSE RESPONSE), power spectrum (PWR SPECT), and cross-spectrum (CROSS-SPECT)
SERVO	FRF	Frequency response function (FRF), coherence function (COHERENCE), and impulse response function (IMPULSE RESPONSE)

- **Saving and retrieving data**

The R9211 can save (retrieve) the displayed data in (from) its internal memory.
Data saving (retrieving) procedure is the following one:

VIEW ⇒ MEM VW ⇒

DATA RECALL 1	Retrieves saved data 1.
DATA RECALL 2	Retrieves saved data 2.

DATA SAVE 1	Saves the displayed data as saved data 1.
DATA SAVE 2	Saves the displayed data as saved data 2.

NOTE
The data saving and recalling is performed for the screen selected with the SEL key (active screen).
When some saved data are retrieved, the display identifier "rcld" is displayed at the lower left corner of the screen.

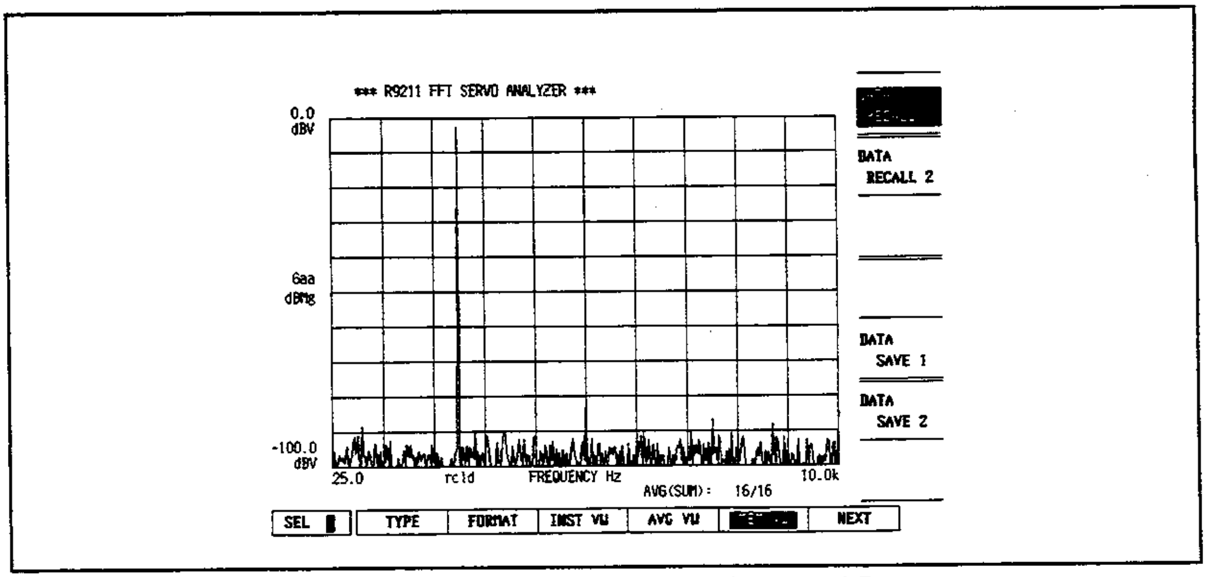


Figure 9-15 Display of Saved and Retrieved Data

● Mathematical operation results display

Below is described how to display the results of post measurement computations (i.e. mathematical operations) you have executed with the MATH key. (If no arithmetic operation was performed, display of arithmetic operation results is inhibited.)
There are two types of mathematical operation results: results of ordinary arithmetic operations and results of curve fitting and synthesis.

You will display the results of mathematical operations in the following way:

VIEW ⇒ MATH VW ⇒
(NEXT menu)

RESULT ARRAY	Displays the result of ordinary-arithmetic operations.
FITTED FRF	Displays the results of curve-fitting applied on a frequency response function.
FITTED IMPRESP	Displays the results of curve fitting applied to an impulse response function.
FITTED STEPRESP	Displays the results of curve fitting applied to a step response function.
SYNTH FRF	Displays the frequency response function obtained through synthesis.
SYNTH IMPRESP	Displays the impulse response function obtained through synthesis.
SYNTH STEPRESP	Displays the step response function obtained through synthesis.

> These are displayed when the analyzer is provided with curve fitting and synthesis functions, when the FRF/SERVO mode is selected, and when curve fitting or synthesis is attributed to MATH of PRESET .
>
> For further details, see the explanations about PRESET .

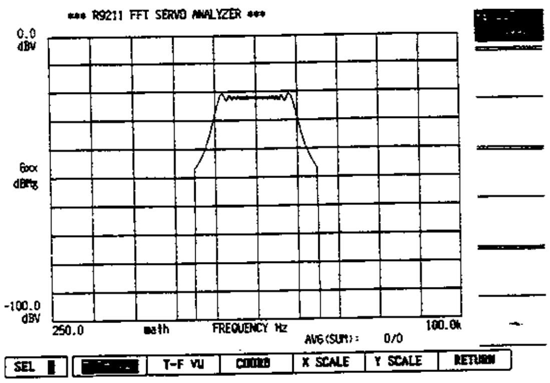


Figure 9-16 Display of Arithmetic Operation Results

● **T-F data display**

T-F data are displayed when T-F analysis is executed in the TIME-FREQ mode.

VIEW ⇒ T-F VW ⇒

(NEXT menu)

t-f TRACE 1	Displays TIME-FREQ measurement data 1.
t-f TRACE 2	Displays TIME-FREQ measurement data 2.
t-f TRACE 3	Displays TIME-FREQ measurement data 3.
t-f TRACE 4	Displays TIME-FREQ measurement data 4.

NOTE

This menu is displayed only in the TIME-FREQ mode.

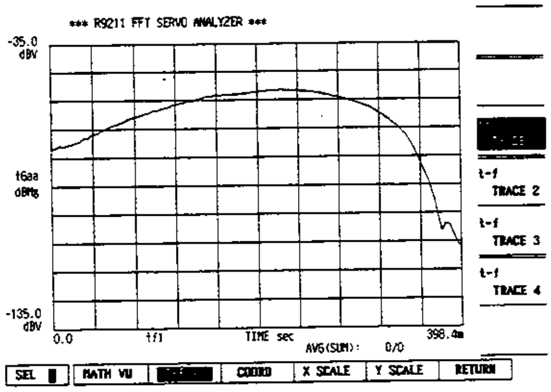


Figure 9-17 Display of TIME-FREQ Data

- **VIEW STEP (data view function)**

In the TIME-FREQ measurement mode, time data are acquired during a long period of time, stored in the input buffer, and analyzed. VIEW STEP is used to perform the Data View function.
The VIEW STEP execution procedure is explained below:

1 Input the data.

Acquire the data with the ARM function.

2 Set DATA VIEW to ON.

VIEW ⇒ INST VW ⇒ DATA VIEW ON/OFF

When DATA VIEW is set to ON, the DATA VIEW setting menu is displayed.

3 Set the step time.

The step time is the time shift between two displayed frames.

VIEW ⇒ INST VW ⇒	VIEW STEP	Enter the VIEW STEP setting menu.
⇒	STEP TIME 0.004SEC	Enter the step time setting menu.
⇒	STEP TIME 0.004SEC	Set the step time, However, the step time can be set only if VIEW STEP is set to PAUSE.

Input the step time with the numeric keys (followed by a unit key), the knob, or the ⇧ and ⇩ keys.

4 Position yourself at the head of the input buffer.

VIEW ⇒ INST VW ⇒	VIEW STEP	Enter the VIEW STEP setting menu.
⇒	AUTO TOP	Go back to the head of the input buffer.

5 Display sequentially the buffer's content.

The data in the buffer are analyzed/displayed.

VIEW ⇒ INST VW ⇒ VIEW STEP	Enter the VIEW STEP setting menu.
↓	
⇒ AUTO RIGHT	Lets you visualize and shift to the right automatically.
⇒ AUTO LEFT	Lets you visualize and shift to the left automatically.
⇒ MANUAL STEP	Shifts the data one step to the right, and displays it.

When the display ends, if the buffer was displayed from left to right, the last displayed data are the buffer's head data, whereas, if the buffer was displayed from right to left, the last displayed data are the buffer's end data.

Selection of the Various Data Display Formats

The R9211 can display data in various formats. (The relationships between the data types and the formats, are summarized in Table 9-16.)

The display formats are the following ones:
Real part, imaginary part, magnitude, square magnitude, logarithmic magnitude, phase, inverse phase (multiplied by -1)

The combination of the number of screens and the ordinates and abscissa axes enables display the following diagrams:
Nyquist diagram, Bode diagram, CO-QUAD diagram, Cole-cole diagram, and Nichols diagram

A data display format selection is effective on the screen selected with the SEL key (active screen).
The display format menu lists only the formats that may be selected considering the specified screen data.

● Real part display

Display real data (in the case of a time series for example) or the real part of complex data (in the case of a complex spectrum for example).

VIEW ⇒ COORD ⇒ REAL

● Imaginary part display

Displays the imaginary part of complex data (complex spectrum, etc.).

VIEW ⇒ COORD ⇒ IMAG

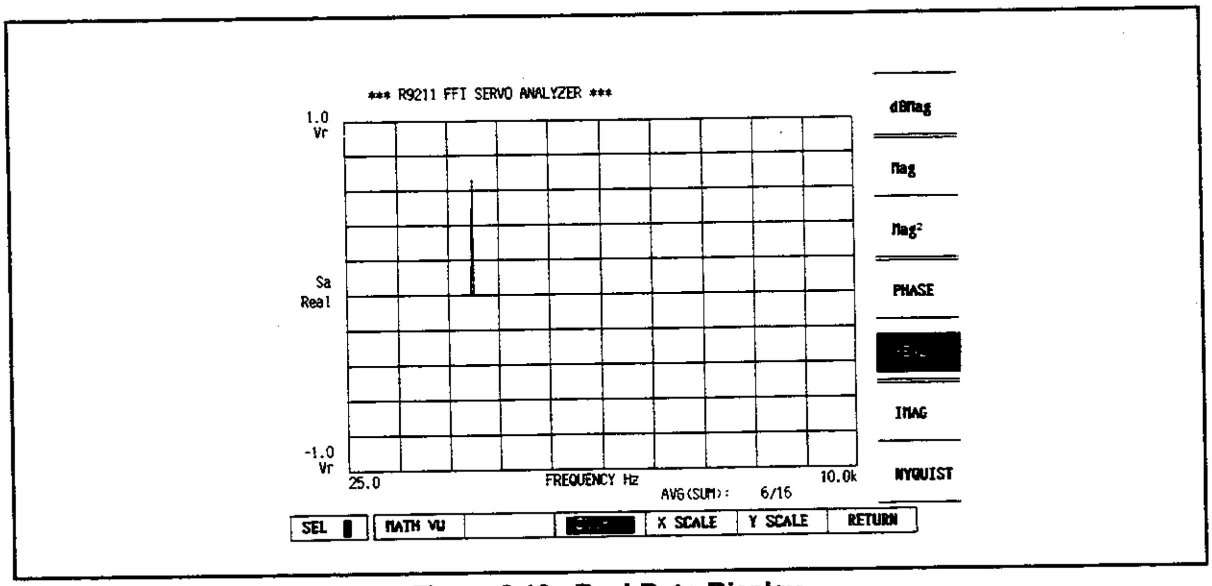


Figure 9-18 Real Data Display

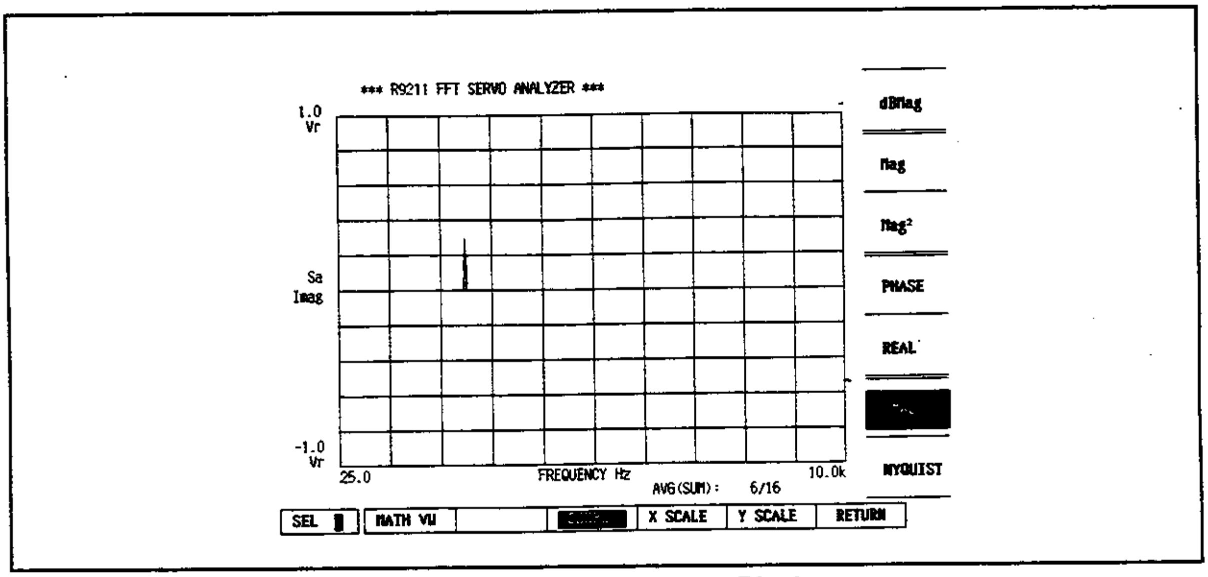


Figure 9-19 Imaginary Data Display

Table 9-16 Coordinates and Displayed Waveforms

Displayed Waveforms / Coordinates	Time histogram, coherence, or f peak of t-f	Autocorr Cross-Corr HILBERT	Spectrum	Cross-spectrum, cepstrum, or complex spectrum of t-f	Power Spectrum of t-f SNR, COP, In COP Liftered Spectrum	FRF	Impulse REsponse Step Response
dBMag		○	○	○	○	○	○
MAG		○	○	○	○	○	○
MAG²			○	○	○		
PHASE		○	○	○		○	○
REAL	○	○	○	○		○	○
IMAG		○	○	○		○	○
NYQUIST			○				
--PHASE						○	
GROUP DELAY						○	

4. VIEW KEY OPERATION

● Logarithmic magnitude display

Displays the logarithmic magnitude of real data (power spectrum, etc.) or complex data (complex spectrum, etc.).

VIEW ⇒ COORD ⇒ dBMag

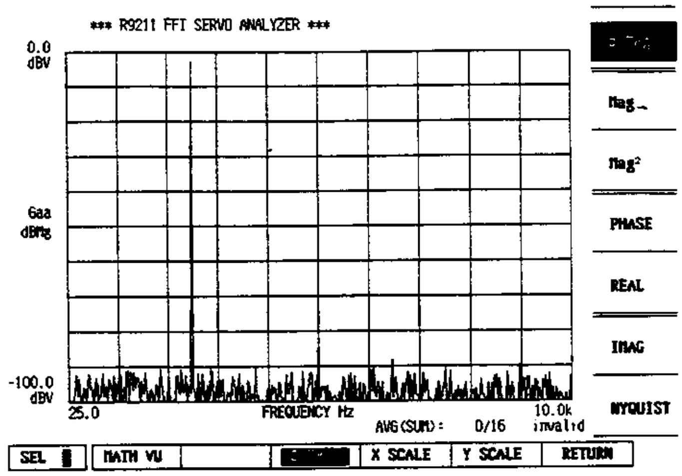


Figure 9-20 Logarithmic Magnitude Display

● Magnitude display

Displays the magnitude of real data (power spectrum, etc.) or complex data (complex spectrum).

VIEW ⇒ COORD ⇒ MAG

● Linear square magnitude display

Display the square magnitude of real data (power spectrum, etc.) or complex data (complex spectrum, etc.).

VIEW ⇒ COORD ⇒ MAG^2

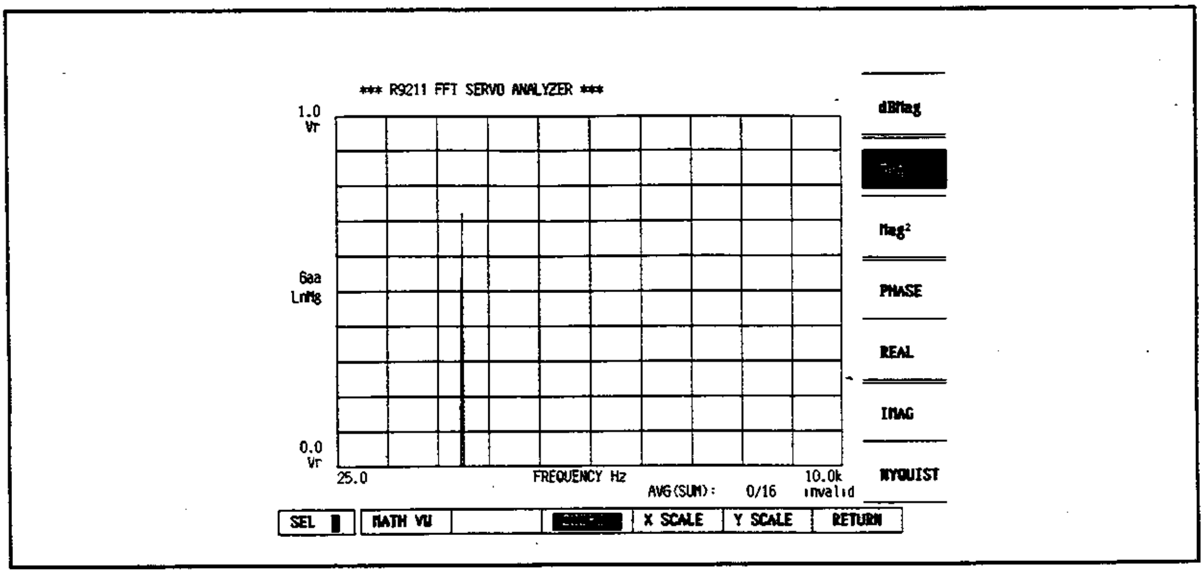


Figure 9-21 Magnitude Display

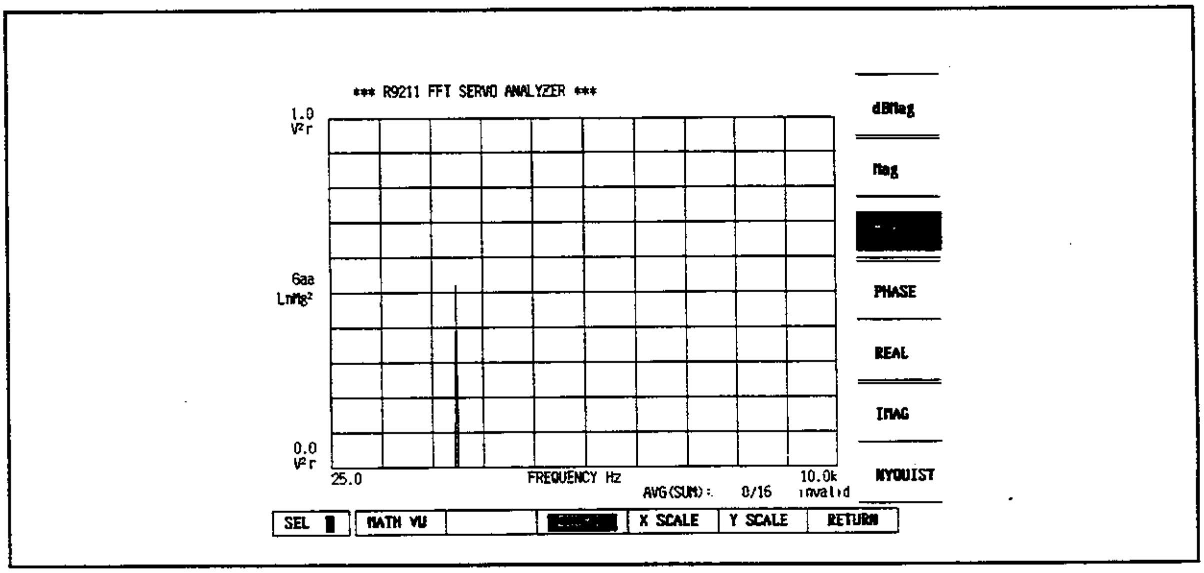


Figure 9-22 Square Magnitude Display

- **Phase display**

Displays the phase of complex data (complex spectrum, etc.).

VIEW ⇒ COORD ⇒ PHASE

- **Inverse phase display (only for FRF data)**

Displays the inverse phase of FRF data.

VIEW ⇒ COORD ⇒ −PHASE

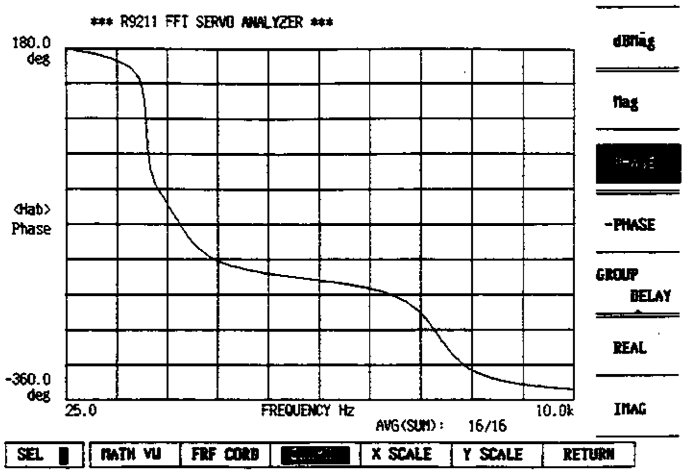


Figure 9-23 Phase Display

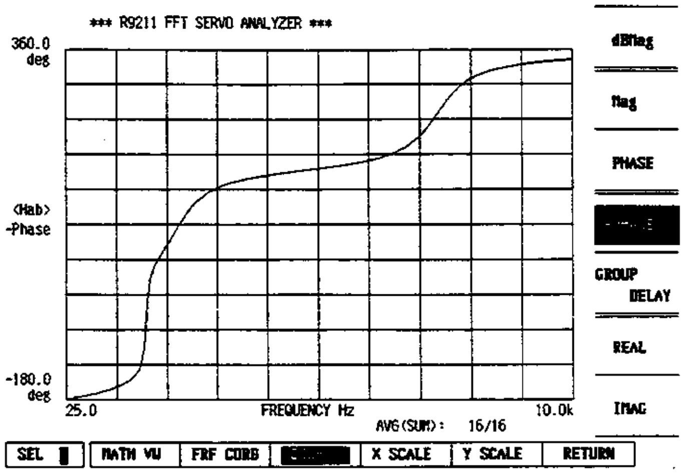


Figure 9-24 Inverse Phase Display

- **Group delay display (only for FRF data)**

Displays the group delay of FRF data.

VIEW ⟹ COORD ⟹ GROUP DELAY

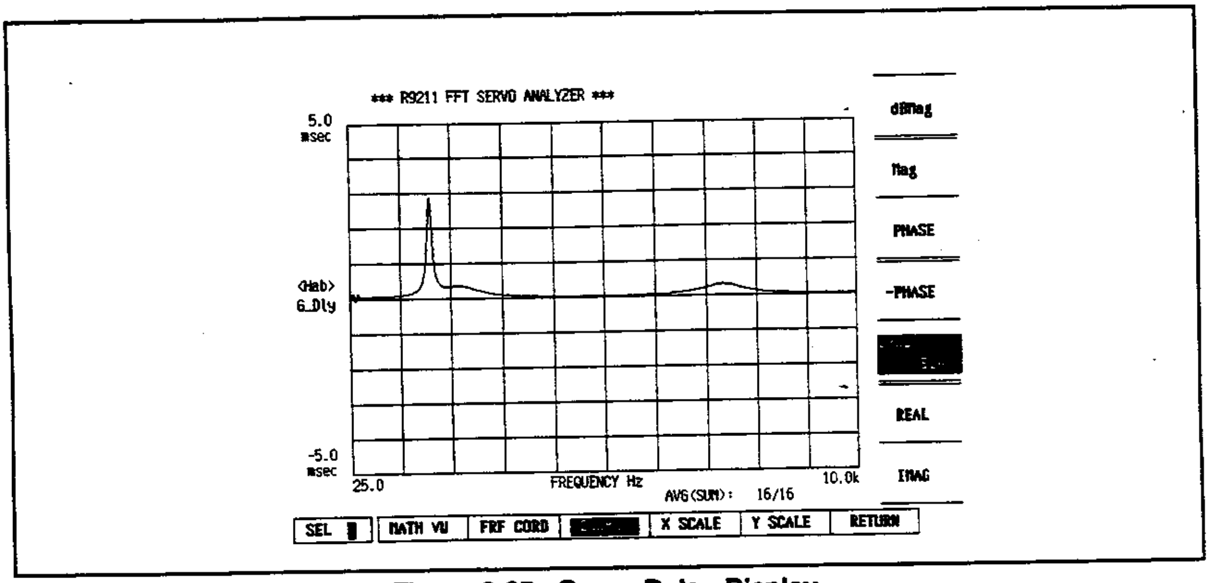


Figure 9-25 Group Delay Display

- **Nyquist diagram display**

Display a Nyquist diagram in the complex coordinate system where the ordinates axis represents the imaginary part and the abscissa axis represents the imaginary part.

VIEW ⇒ COORD ⇒ NYQUIST (Other than FRF data)

VIEW ⇒ FRF COORD ⇒ NYQUIST (FRF data)

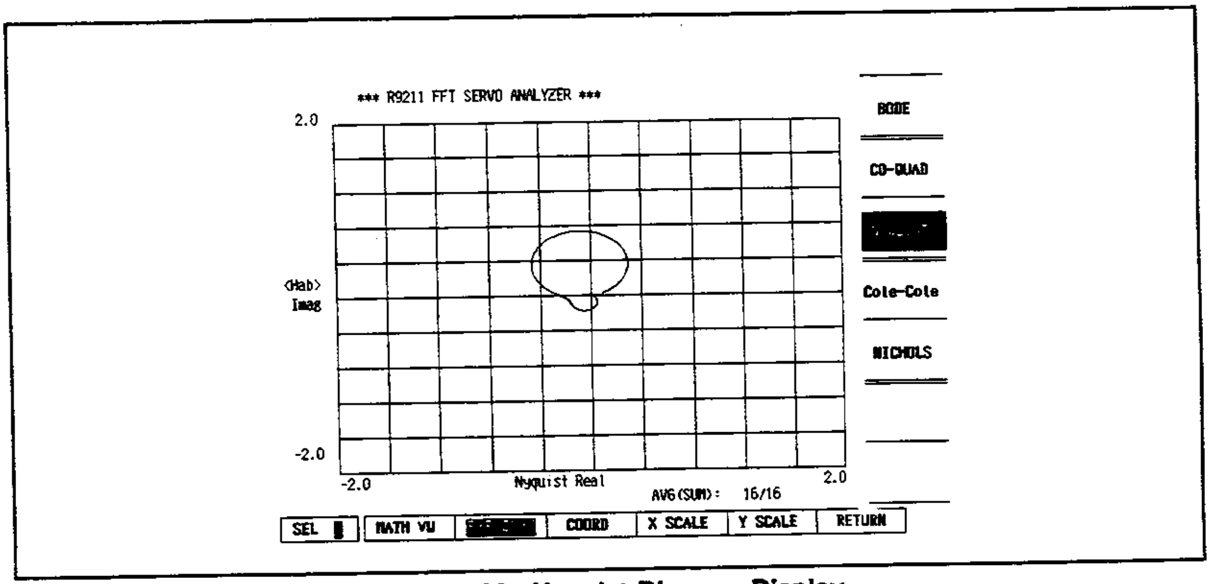
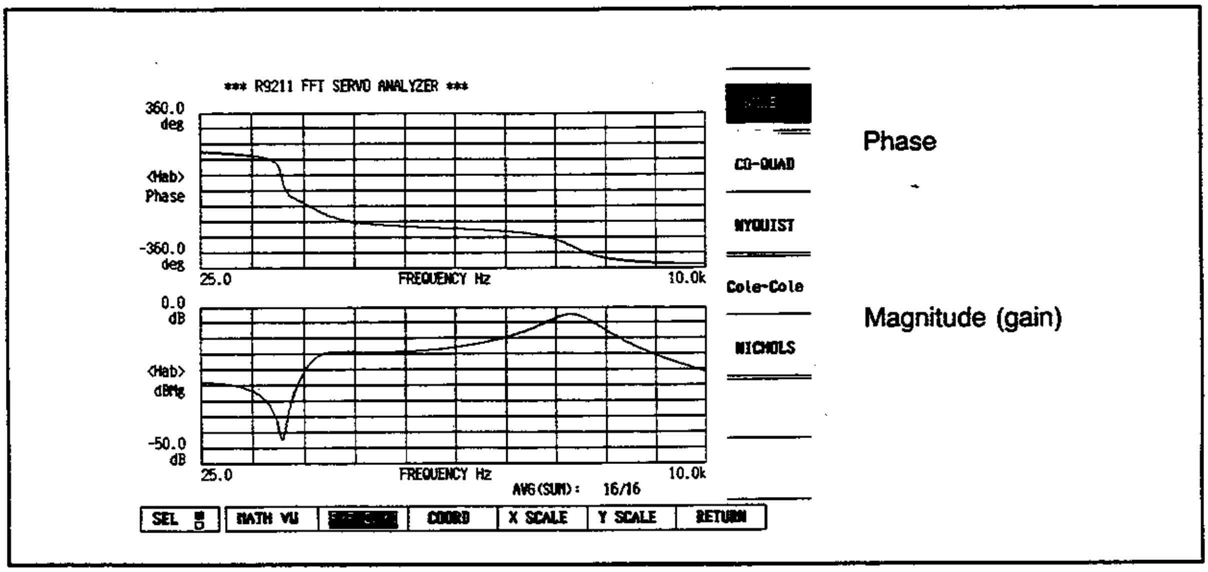


Figure 9-26 Nyquist Diagram Display

- **Bode diagram display (only in the FRF and SERVO modes)**
Displays the magnitude on the lower screen and the phase on the upper screen, with a double screen configuration.

VIEW ⇒ FRF COORD ⇒ BODE



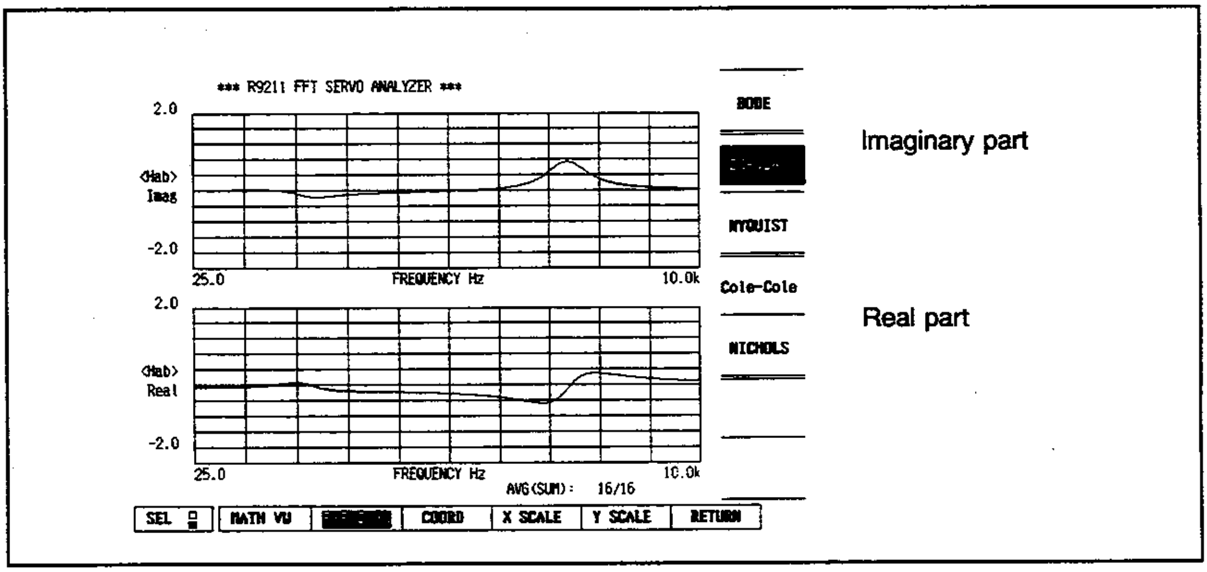
Phase

Magnitude (gain)

Figure 9-27 Bode Diagram Display

- **Co-quad diagram display (only in the FRF and servo modes)**
Displays the real part on the lower screen and the imaginary part on the upper screen, with a double screen configuration.

VIEW ⇒ FRF COORD ⇒ CO-QUAD



Imaginary part

Real part

Figure 9-28 Co-quad Diagram Display

- **Cole-cole diagram display (only in the FRF and SERVO modes)**

Display the imaginary part inverse along the ordinates axis and the real part along the abscissa axis.

VIEW ⇒ FRF COORD ⇒ Cole-Cole

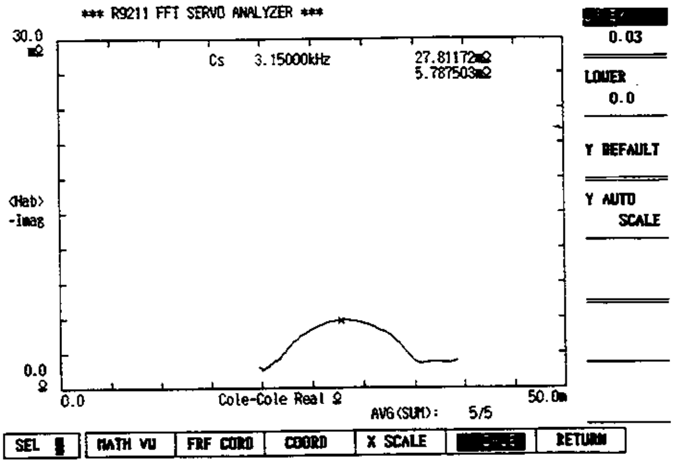


Figure 9-29 Cole-cole Diagram Display

- **Nichols diagram display (only in the FRF and SERVO modes)**

Display the magnitude along the abscissa axis and the phase along the ordinates axis.

VIEW ⇒ FRF COORD ⇒ Nichols

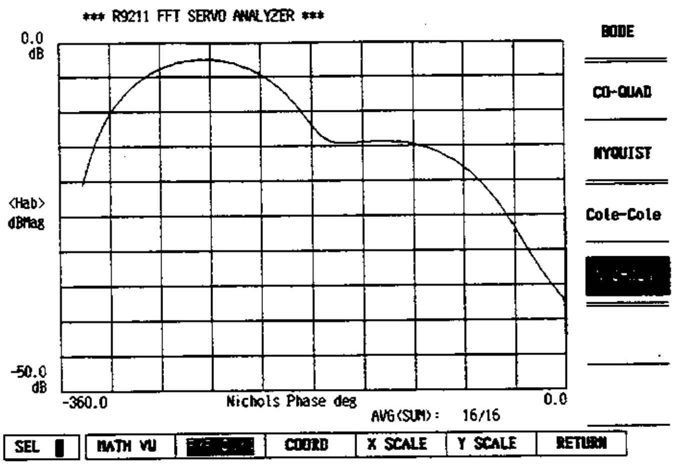


Figure 9-30 Nichols Diagram Display

Displaying and Setting the X Axis Scale

- **Setting the X axis scale and referencing values**

VIEW ⇒ X SCALE ⇒

LEFT 0.00sec	Enables the definition of the LEFT value (display start) of the X axis.
RIGHT 0.004sec	Enables the definition of the RIGHT value (display stop) of the X axis.

Use the numeric keys and the ENT key or the numeric keys and a unit key (Y menu) for the above settings.
The values and units displayed on the Y menu correspond to the type of the selected waveform.
Table 9-17 summarizes the relationships between units displayed on the Y menu and the waveforms.

Table 9-17 X Scale Unit and Y Menu

Displayed data	Annotations	X axis Unit
TIME LAG T-F analysis	Xa, Xb, <Xa>, <Xb> Raa, Rbb, Rab, <Raa>, <Rbb>, <Rab>, <IMP> tSa, tSb, tFa, tFb	sec
ORBITAL HISTOGRAM NYQUIST (SPECT)	(Xa, Xb) Pa, Pb, <Pa>, <Pb> Sa, Sb	V
FREQUENCY	Gaa, Gbb, Gab, <Gaa>, <Gbb>, <Gab>, <Hab>, <Coh>	Hz
NYQUIST (FRF) Cole-Cole (FRF)	<Hab> <Hab>	None
NICHOLS (FRF)	<Hab>	deg

● Setting the X axis scale (default/auto scaling)

We shall explain here the X axis default setting and the X axis automatic setting (polar coordinates only).

VIEW ⇒ X SCALE ⇒

X DEFAULT	Sets the X axis range so that all data in the range specified on RANGE menu can be displayed.
X AUTO SCALE	Sets the X axis range so that the waveform (polar coordinates only) can be entirely displayed as well as possible.

New values are displayed on the Y menu and the X-axis range of the selected screen is changed simply by pressing one of the above keys.

● Setting the X axis scale (unit key)

Use a unit key to set the X axis display range manually.
Use a unit key suitable for the type of the waveform to be displayed.

VIEW ⇒ X SCALE ⇒

sec
msec
μsec

} Unit keys

For further details, see Table 9-17 in "● Setting the X axis scale and referencing values".

■ Displaying and Setting the Y Axis Scale

● **Setting the Y axis scale and referencing values**

VIEW ⇒ Y SCALE ⇒

UPPER 0.00V	Enables to enter the UPPER value (upper limit of the screen) of the Y axis.
LOWER 0.004V	Enables to enter the LOWER value (lower limit of the screen) of the Y axis.

Use the numeric keys and the ENT key or the numeric keys and a unit key (Y menu) for the above settings.
The values and unit displayed on the Y menu correspond to the type of the selected waveform.
Tables 9-18 and 9-19 summarize the relationships between the units displayed on the Y menu and the waveforms.

Table 9-18 Y Scale Unit and Y Menu Display (1)

Displayed data	Y axis unit
TIME ORBITAL NYQUIST (SPECT)	V V V
NYQUIST (FRF)	None (no unit)
HISTOGRAM NICHOLS GROUP-DELAY	% dB sec

Table 9-19 Y Scale Unit and Y Menu Display (2)

		Display type				
		LAG	SPECT	CROSS	T-F analysis	FRF
Data display format	dBMag	dB	dBV	dBV	dBV	dB
	Mag	None (no unit)	V	V^2	V	None (no unit)
	Mag^2		V^2	V^4	V^2	
	PHASE	deg	deg	deg	deg	deg
	REAL	None (no unit)	V	V^2	V Hz	None (no unit)
	IMAG	None (no unit)	V	V^2	V	None (no unit)

● **Setting the Y axis scale (default/auto scaling)**

We shall explain here the Y axis default setting and the Y axis automatic setting (not available for the real data of a T-F analysis).

VIEW ⇒ Y SCALE ⇒

Y DEFAULT	Sets the X axis range so that all data in the range specified on SENS menu can be displayed.
Y AUTO SCALE	Sets the range of the Y axis so that the whole waveform can be displayed as well as possible.

The new values are displayed in the Y menu and the Y-axis display range of the selected screen are modified simply by pressing one of the above keys.

● **Setting the Y axis scale (unit key)**

When you set the Y axis manually, you must specify the unit with a unit key. The available unit keys differ according to the type of the displayed data.

VIEW ⇒ Y SCALE ⇒

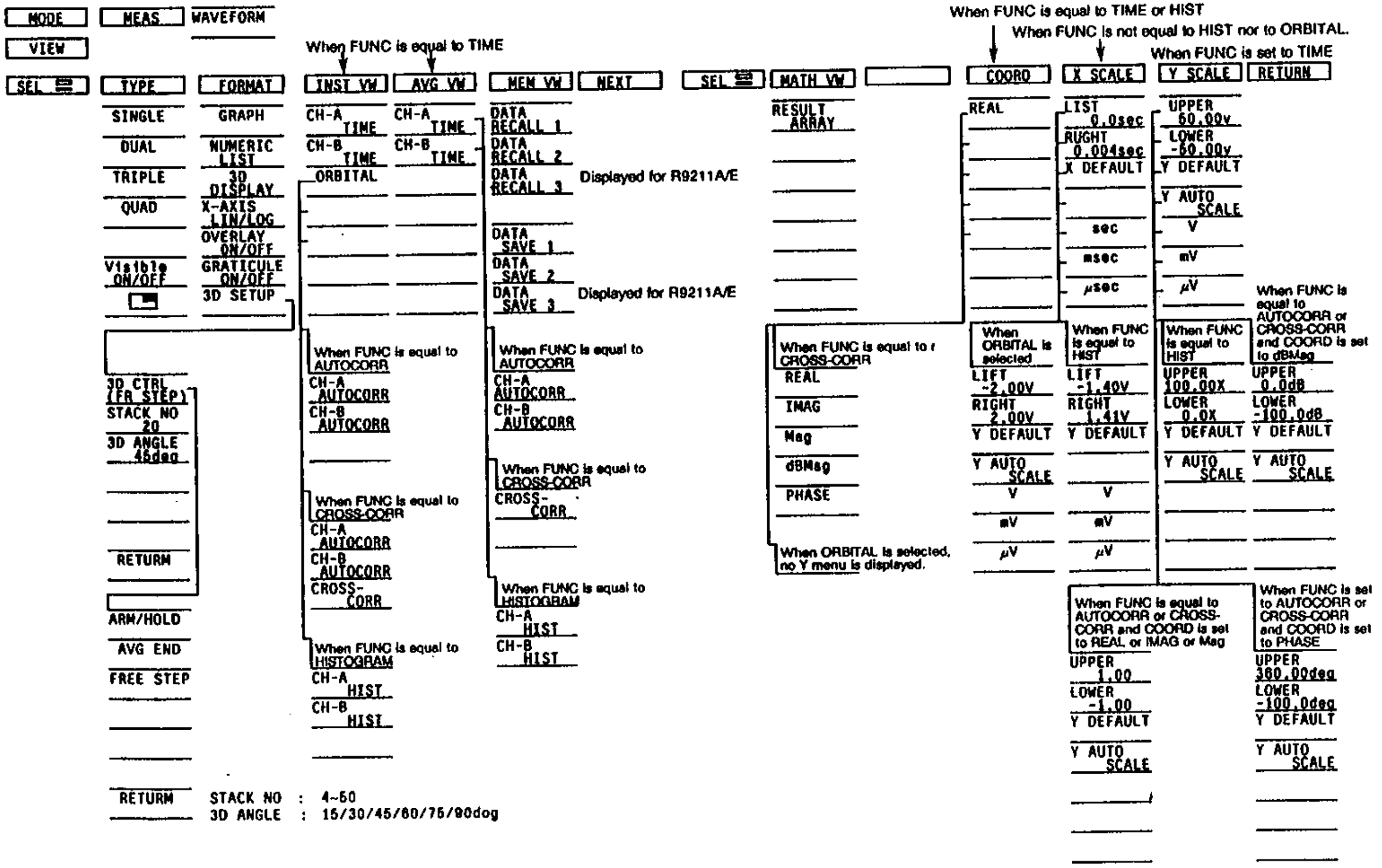
- V
- mV
- μV

} Unit keys

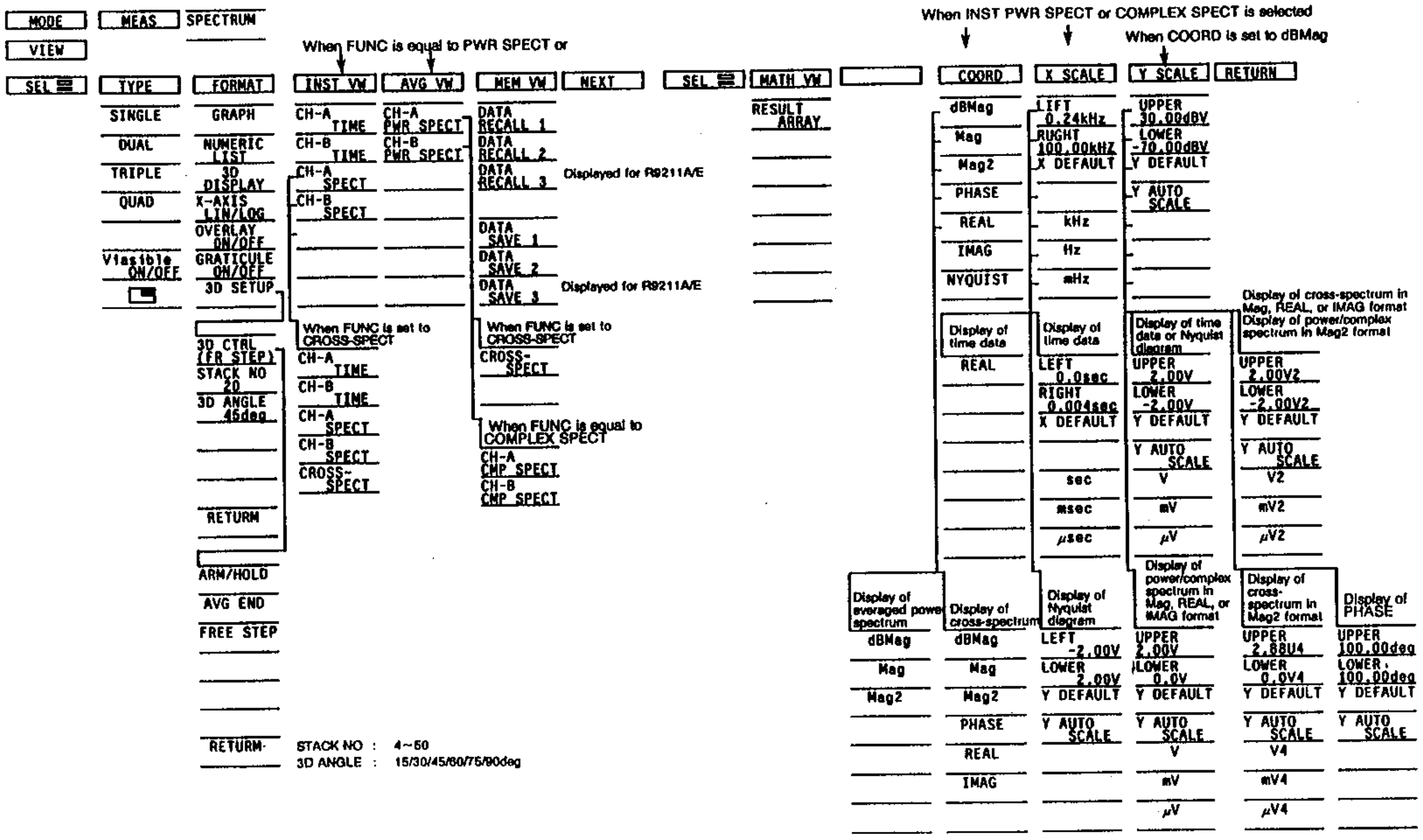
For further details, see Tables 9-18, 9-19 in "● Setting the Y axis scale and referencing values".

VIEW Menu List

R9211 Series Menu List (VIEW Key when used in the WAVEFORM Mode)

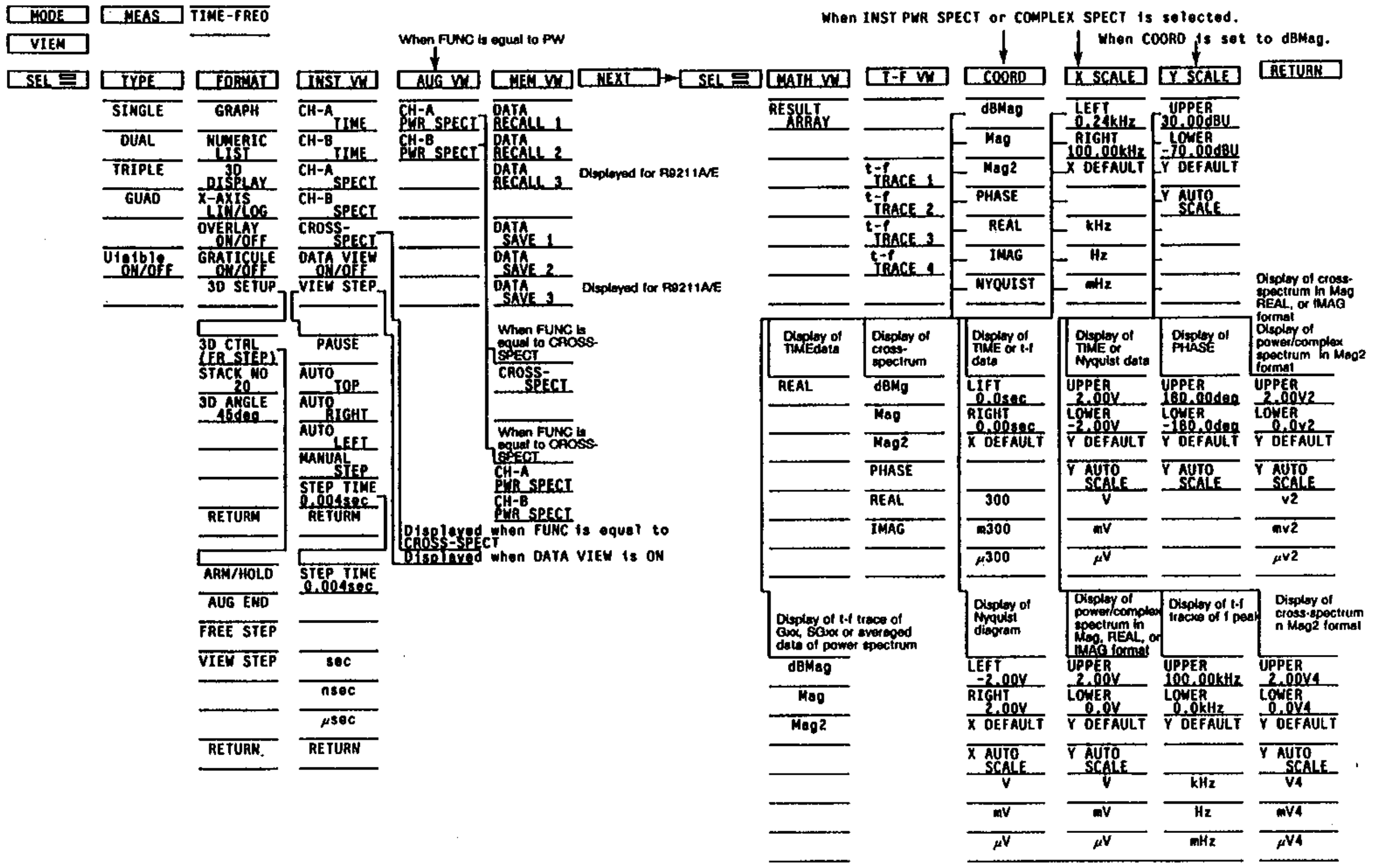


R9211 Series Menu List (VIEW Key when used in the SPECTRUM Mode)

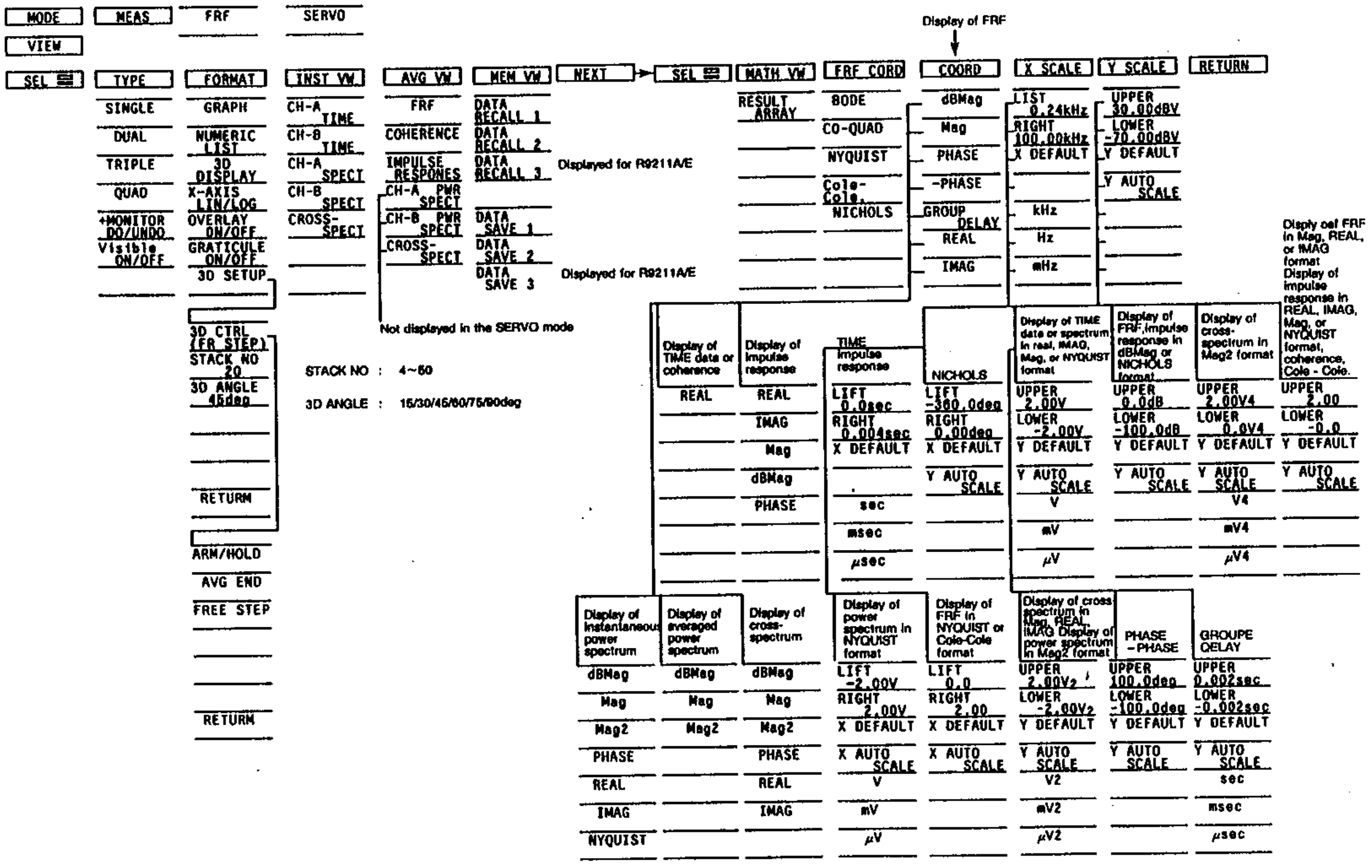


4. VIEW KEY OPERATION

R9211 Series Menu List (VIEW Key When used in the TIME-FREQ Mode)



R9211 Series Menu List (VIEW Key when used in the FRF or SERVO Mode)

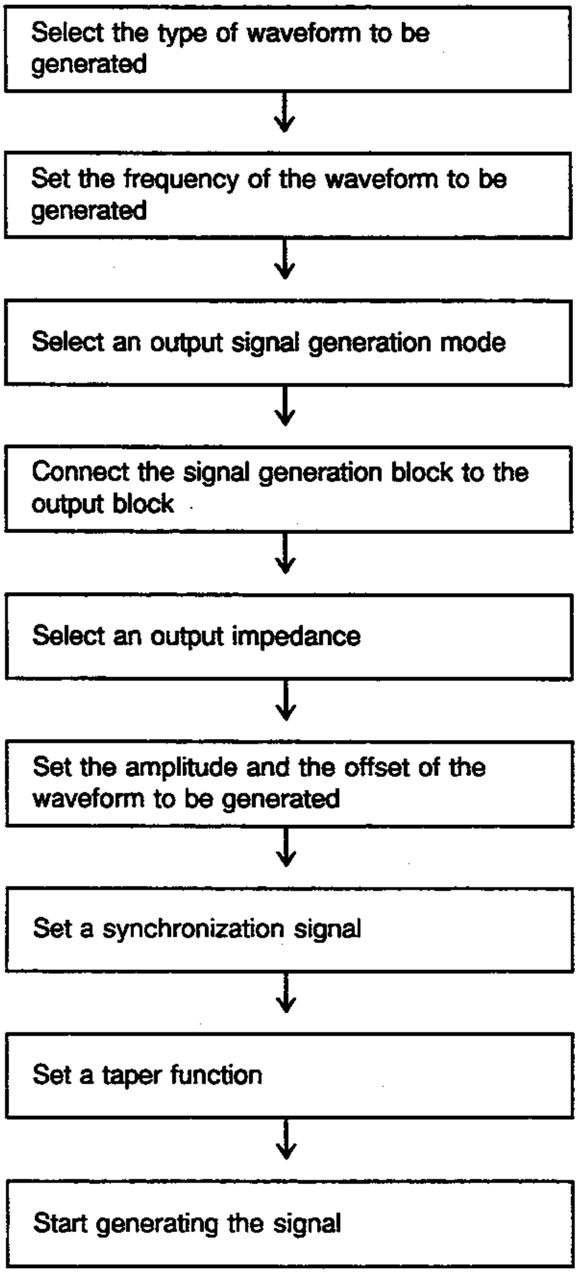


5. SG CONT KEY OPERATION

This section explains how to use the SG CONT panel key (for the signal generation).

Parameters to be Set and Basic Setting Procedure

At first, we describe the basic parameters setting flow for the signal generation. The concrete parameters setting procedure is described later.



When an arbitrary waveform is selected, transfers it.

This setting is done only for a sine or swept sine wave.

If the signal generation has not yet begun, and if the signal generator is connected to the output, then only the offset is output at this stage.

Set such signal only if it is necessary.

A taper function is available only when CONTINUE is selected as the generation mode.

Selection of the Waveform to be Generated

The Signal Generator (SG) can generate sine waves, swept sine waves, impulse waves, random waves, and arbitrary waves.
As for the arbitrary function waveforms, the waveform data transfer method is described later.

SG CONT ⇒ SIGNAL ⇒

SINE	Selects a sine wave.
SWEPT	Selects a swept sine wave.
M-SINE	Selects a multi-sine wave.
IMPULSE	Selects an impulse wave.
RANDOM	Selects a random waveform.
ARBITRAY	Select an arbitrary function waveform.
(XFER)	Control the arbitrary waveform memory (only when ARBITRAY is selected). The second page of the menu will be displayed.

CAUTION !

(1) For zoom analysis, IMPULSE and ARBITRAY cannot be selected. If the zero start analysis mode is switched to the zoom analysis mode when IMPULSE or ARBITRAY is selected, the signal type is automatically switched to M-SINE . If a signal is being generated at such a moment, it stops immediately irrespective of its type.

(2) If the number of analysis lines is 1600 or more, SWEPT , M-SINE or IMPULSE cannot be selected. If the number of analysis lines is changed to 1600 or more when SWEPT , M-SINE , or IMPULSE is selected, the signal type is switched to SINE automatically. If a signal is being generated at this moment, it stops immediately irrespective of its type.

- **How to control the arbitrary waveform memory**

The Signal Generator of the R9211 can generate arbitrary time waveforms by acquiring and storing in its arbitrary waveform buffer, either the "waveform data currently displayed" or the "waveform stored in the input buffer" or some waveform acquired through the GPIB, and then outputting them. Up to 64-kiloword data can be stored in the waveform memory.

CAUTION !

If the type of the signal to be generated is changed to M-SINE , IMPULSE , or RANDOM after transferring data to the arbitrary waveform buffer, the data in the waveform buffer are overwritten. They are not overwritten if the signal type is changed to SINE or SWEPT .

The control menu is the following one:

SG CONT ⇒ SIGNAL ⇒ ARBITRAY	Selects an arbitrary waveform.
(XFER)	Controls the arbitrary waveform buffer (only when ARBITRAY is selected). The second page of the menu will be displayed.
XFER	Transfers an arbitrary waveform to the memory.
TRACE WAVEFORM	Selects the transfer of the displayed waveform data to the memory.
INPUT BUFFER	Selects the transfer of the input buffer data to the memory.
RETURN	Switch back to the first page of the menu.

When ARBITRAY is selected, transfer the waveform data to the memory according to the data origin, as is now explained:

● Transfer of displayed waveform data

Eight times more points than are displayed are transferred to the arbitrary waveform memory. In the multi-screen mode, the time waveform data displayed on the screen selected with the SEL key is transferred. Since 8 times more points are transferred than displayed, only 8K words of displayed points may be transferred.

If the displayed data do not belong to the time domain, they cannot be transferred.

The operation procedure is the following one:

(1) SG CONT ⇒ SIGNAL ⇒ (XFER) Control the arbitrary waveform memory. The second page of the menu will be displayed.

(2) ⇒ TRACE WAVEFORM Select transfer of the displayed waveform data to the waveform buffer.

(3) Display the data to be transferred on the screen. In the multi-screen mode, select the screen displaying the data to be transferred with the SEL key.
(About the screen management, see " ■ Selection of a Screen in the Multi-Screen Configuration" in this chapter.)

(4) ⇒ XFER Transfer the selected arbitrary function to the waveform memory.

● Transfer of waveform data stored in the input buffer

The data stored in the input buffer are transferred as they are. Table 9-20 summarizes the relationships between the active channels and the transferred data.

Table 9-20 Active Channels and Transferred Data

Active channel	Transferred data
A&B	B
A	A
B	B

If the input buffer was held manually (the input buffer size is longer than 64 kilowords), the latest 64-kiloword data are transferred from the hold point. When the input buffer is held through the arm function, as many data as determined by the arm length are transferred. If the arm length is set to 128 kilowords or more in the T-F mode, the latest 64-kiloword data are transferred.

5. SG CONT KEY OPERATION

The transfer procedure is the following one:

(1) SG CONT ⇒ SIGNAL ⇒ (XFER) Control the arbitrary waveform memory. Displays the second page of the menu.

(2) ⇒ INPUT BUFFER Select the transfer of the waveform data stored in the input buffer.

(3) Select ARM, or HOLD to hold the input buffer.

(4) ⇒ XFER Transfer the selected arbitrary function to the waveform memory.

● **Transfer of data Input through the GPIB**

An arbitrary waveform data generated by a personal computer may be transferred as it is through the GPIB.
The data must be transferred as 16-bit fixed-point format data.

After selecting ARBITRAY, transfer the data from the personal computer by the "TO ARBIT" GPIB command.
(For details on this GPIB command, refer to the GPIB Handbook.)

XFER must not be pressed. (If it is pressed, the waveform data will be replaced with other data.)

How to Set the Frequency of the Signal to be Generated

We explain how to set the frequency of the signal to be generated by the SG.
This menu can be set only when the signal type is sine or swept sine.

- **Sine wave**

SG CONT ⇒ FREQ ⇒

f 10kHz	Sets the frequency of the sine wave.
RESOLN ON/OFF	Determine whether the generated signal frequency must match the analysis frequency resolution.

kHz
Hz
mHz
} Unit keys

Table 9-21 lists the upper and lower limits of the frequencies that may be set.

Table 9-21 Upper and Lower Limits of Sine Wave Frequencies

RESOLN	Lower limit	Upper limit
ON	Measurement frequency resolution	Measurement frequency range
OFF	3.125μHz	100kHz

○ **RESOLN key**
The RESOLN key is used to determine whether the input frequency must match automatically the measurement frequency resolution.
Using this key, you can set the frequency of the signal to be generated without worrying about the measurement resolution. (See Figure 9-31.)

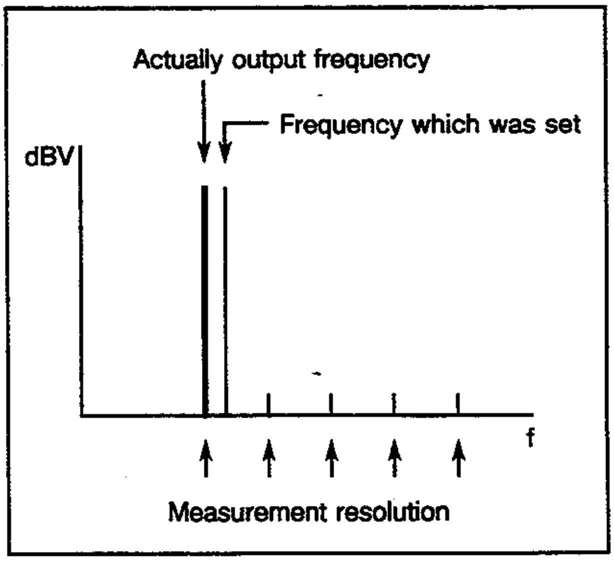


Figure 9-31 Frequencies when RESOLN ON

RESOLN ON : The signal is generated according to the frequency resolution set for the measurement system.
RESOLN OFF : The signal is generated as set, irrespective of the frequency resolution set for the measurement system.

Example 1 : When the measurement range is 100kHz with a 400 lines, and the chosen signal is a 550Hz sine wave, the actually generated sine wave is: (in this case the frequency resolution is 250Hz)

RESOLN ON : A 500Hz sine wave is output. (The multiple of 250Hz which is closest to 550Hz within the range from 250Hz to 100kHz is chosen.)
RESOLN OFF : A 550Hz sine wave is output.

Example 2 : When in the zoom mode 20kHz is set as the start frequency, 40kHz is set as the stop frequency, with a resolution of 800 lines, and the chosen signal is a 50kHz sine wave, the frequency to be actually set is : (the frequency resolution set for the measurement system is 25Hz):

RESOLN ON : A 40kHz sine wave is output. (The multiple of 25Hz which is closest to 50kHz within the range from 20Hz to 40kHz is set.)
RESOLN OFF : A 50kHz sine wave is output.

- **Swept sine wave**

SG CONT ⇒ FREQ ⇒

START f 10kHz	Sets the start frequency of the swept sine wave.
STOP f 100kHz	Sets the stop frequency of the swept sine wave.
kHz Hz mHz	Unit keys

Table 9-22 lists the upper and lower limits of the frequencies that may be set.

Table 9-22 Upper and Lower Limits of Swept Sine Wave Frequencies

	Lower limit	Upper limit
Start frequency	Measurement frequency resolution	Stop frequency
Stop frequency	Start frequency	Measurement frequency range

How to set the Amplitude and the Offset of the Waveform to be Generated

We will now explain how to set the amplitude and offset of the signal generated by the SG.
You can also set a limit voltage so that an excessive input cannot be set. The value set for the amplitude defines the signal peak. The value set for the limit represents the amplitude peak that the signal amplitude added to the offset must not exceed. The limit has no sign, that is, the input is limited to the set value as well in the positive values as in the negative values.

5. SG CONT KEY OPERATION

SG CONT ⇒ SG VLT ⇒

AMPLITUDE 2.00V	Sets the amplitude of the signal.
OFFSET 1.00V	Sets the offset of the signal.
LIMIT VLT 5.00V	Sets the limit of the signal peak.
V	Unit keys
mV	
μV	

Figure 9-32 shows the relationships between these values.

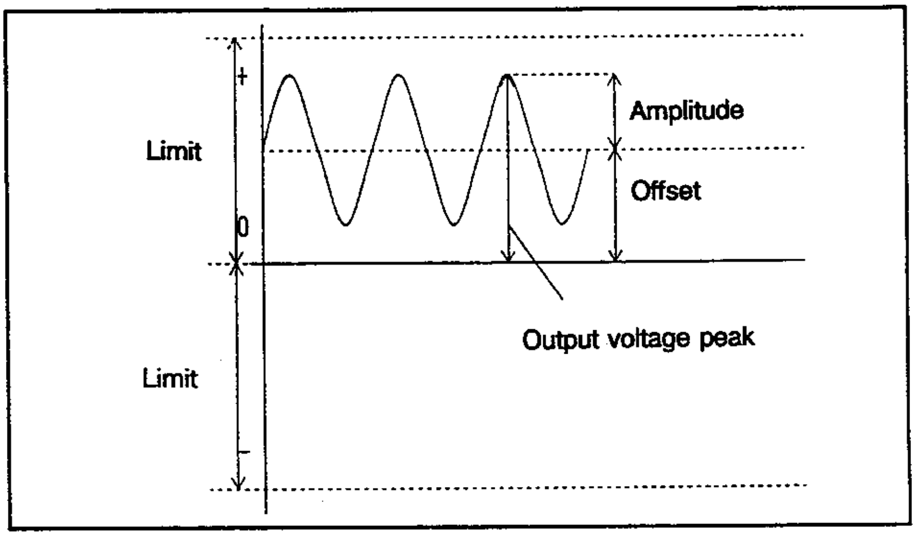


Figure 9-32 Relationship Between the Output Levels

The setting range of the limit value is defined by:
Minimum : 2.0 mV
Maximum : 20.0 V

CAUTION !

The offset voltage is output irrespective of the start/stop state if the OPR key (of SIGNAL OUTPUT) is set to ON (operate). However, the offset voltage is not output unless the GENERATOR START key is pressed after the power is turned on.

● Setting resolution of amplitude and offset

The setting resolution of amplitude and offset differs in the range of SG output impedance and amplitude.

Table 9-23 SG Output and Offset in Zout=0Ω

SG OUT		Offset	
Output voltage	Step	Voltage	Setting resolution
18V to 10V	1V	±10V max	19.5mV 10bit resolution
9.5V to 5V	0.5V		
4.75V to 2.5V	0.25V		
2.375V to 1.875V	0.125V		
1.8V to 1V	0.1V		
0.95V to 0.5V	50mV		
0.475V to 0.25V	25mV		
237.5mV to 187.5mV	12.5mV		
180mV to 100mV	10mV		
95mV to 50mV	5mV		
47.5mV to 25mV	2.5mV		
23.75mV to 18.75mV	1.25mV		
18mV to 10mV	1mV		
9.5mV to 5mV	0.5mV		
4.75mV to 2.5mV	0.25mV		
2.375mV to 1.875mV	0.125mV		

The voltage to add signal output and offset voltage is not over the range of ±18V.

CAUTION !

On the menu, the value in addition to the step value can be set.
In this range, the actual output amplitude is output according to the step of the above table.

Table 9-24 SG Output and Offset in Zout = 50Ω

SG OUT		Offset	
Output voltage	Step	Voltage	Setting resolution
5V to 2.5V	0.25V	±5V max	9.8mV 10bit resolution
2.375V to 1.25V	0.125V		
1.188V to 0.9375V	62.5mV		
0.9V to 0.5V	50mV		
475mV to 0.25V	25mV		
237.5mV to 0.125V	12.5mV		
118.8mV to 93.75mV	6.25mV		
90mV to 50mV	5mV		
47.5mV to 25mV	2.5mV		
23.75mV to 12.5mV	1.25mV		
11.88mV to 9.375mV	0.625mV		
9mV to 5mV	0.5mV		
4.75mV to 2.5mV	0.25mV		
2.375mV to 1.25mV	0.125mV		
1.188mV to 0.9375mV	62.5μV		

The voltage to add signal output and offset voltage is not over the range of ±5V.

CAUTION !

On the menu, the value in addition to the step value can be set.
The actual output value is output accoding to the step of the above table.

Table 9-25 SG Output and Offset in Zout=600Ω

SG OUT		Offset		Limit voltage*
Output voltage	Step	Voltage	Setting resolution	
9V to 5V	0.5V	±5V max	9.8mV	±9V
4.75V to 2.5V	0.25V			
2.375V to 1.25V	0.125V	±1.58V max	3.1mV	±2.85V
1.188V to 0.9375V	62.5mV			
0.9V to 0.5V	50mV	±500mV max	980μV	±900mV
475mV to 0.25V	25mV			
237.5mV to 0.125V	12.5mV	±158mV max	310μV	±285mV
118.8mV to 93.75mV	6.25mV			
90mV to 50mV	5mV	±50mV max	98μV	±90mV
47.5V to 25mV	2.5mV			
23.75V to 12.5mV	1.25mV	±15.8mV max	31μV	±28.5mV
11.88V to 9.375V	0.625mV			
9mV to 5mV	0.5mV	±5mV max	9.8μV	±9mV
4.75mV to 2.5mV	0.25mV			
2.375mV to 1.25mV	0.125mV	±1.58V max	3.1μV	±2.9mV
1.188mV to 0.9375mV	62.5μV			

* : Limit voltage means that voltage value to add signal output and offset is not over the specified value.

CAUTION !

On the menu, the value in addition to the step value can be set. In this range, the actual output amplitude is output according to the step of the above table.

How to Internally Connect the Signal Generator Output

You can select one of four signal generator output connection methods. You select the method with the CONNECT menu, but the connection is actually made only once you pressed the OPR key.

- **How to select the signal generator output connection method**

SG CONT ⇒ CONNECT ⇒

SG OUTPUT	Outputs the signal from the BNC output socket.
SUM AMP	Internally connect the signal generator to the summing amplifier; this is used for measuring open-loop characteristics. (See Figure 9-33.)
to CHA	Outputs the signal from the BNC output socket, and at the same time sends it to the + input socket of channel A.
to CHB	Outputs the signal from the BNC output socket and at the same time sends it to the + input terminal of channel B.

CAUTION !

- ***When the to ChB key is selected, the MEASUREMENT START key must not be used.***
- ***When select SUM AMP connection, SG output impedance selects 0Ω or 50Ω.***
- ***Floating unit output can not output directly to each CH by to ChA or to ChB .***

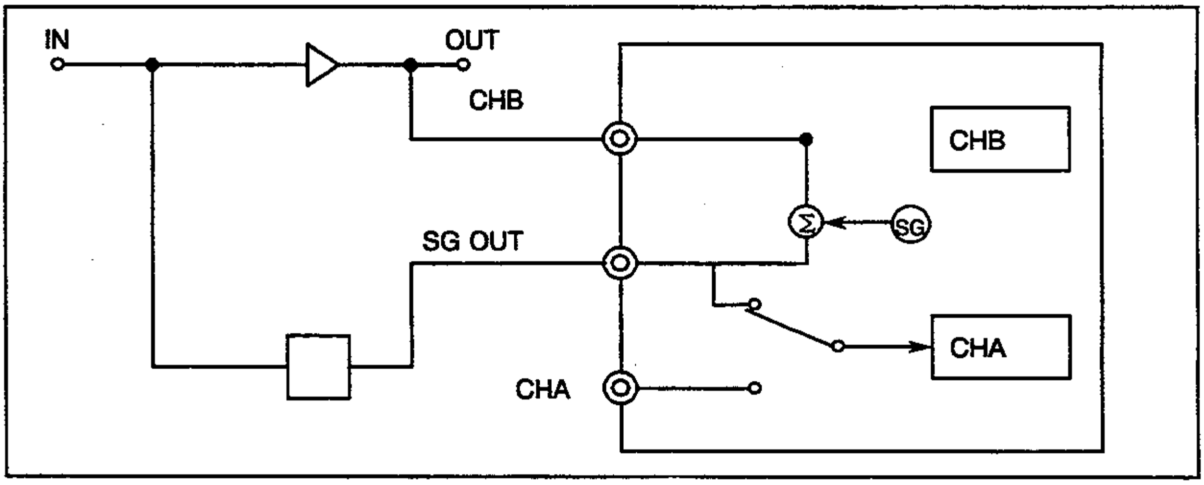


Figure 9-33 Example of Connection in SUM AMP Mode

- **Connection of the signal generator's output**

The SIGNAL OUTPUT OPR key is used to set the switch located at the signal generator output stage to ON/OFF. The LED situated on top of the key indicates the state of this switch.

LED on : Operating (ON)
The output signal is actually connected as you selected with the CONNECT key. In this case, the offset voltage is output even if the GENERATOR STOP key is pressed. (However, the offset voltage is not output unless the GENERATOR START key is pressed after turning the power on.)

LED off : Standby (OFF)
No signal is output, whether the GENERATOR START or GENERATOR STOP key is pressed or not.

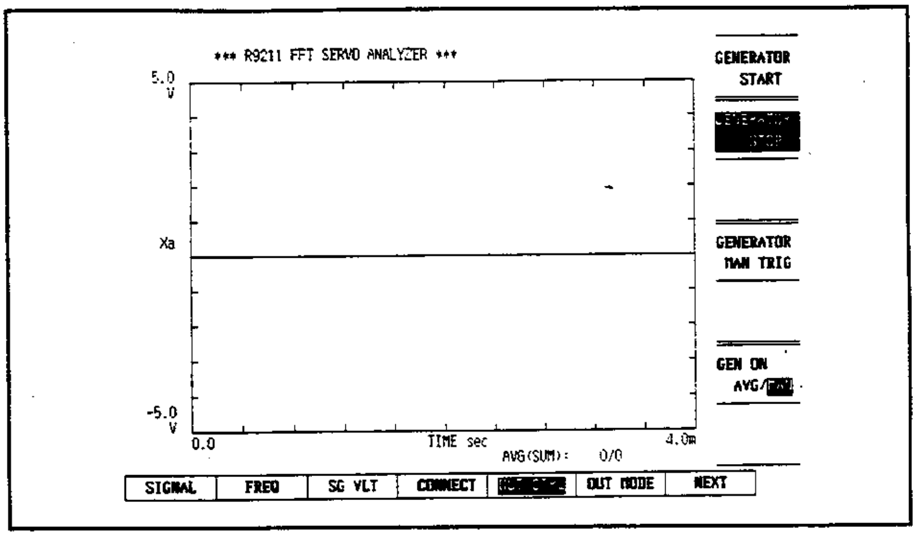
○ **Relationships between the OPR key and the signal start /stop**

The relationships between the OPR key and the signal start/stop are described here.

5. SG CONT KEY OPERATION

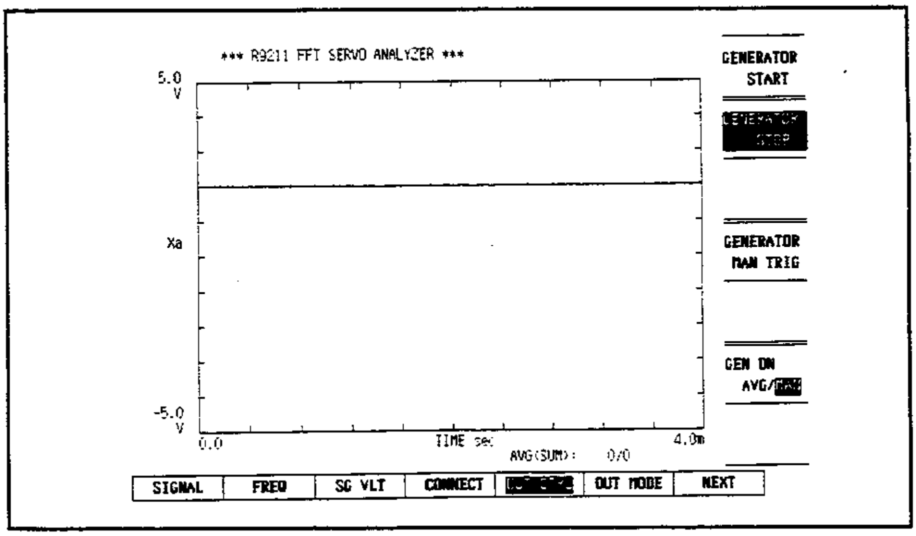
(1) OPR : Standby (OFF)
Signal : Generated or stopped

No signal is output whether the generator start or stop have been selected.



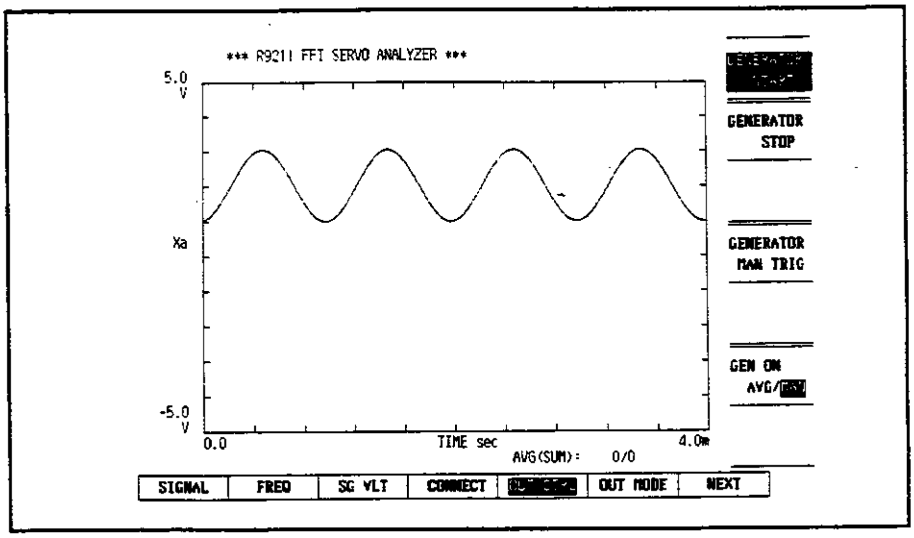
(2) OPR : Operating (ON)
Signal : Stopped

Only the offset value is output.



(3) OPR : Operating (ON)
Signal : Generated

The waveform resulting of the summation of the offset and the selected waveform (amplitude) output.



How to Control the Signal Generation

At this point, after having set the signal generation conditions, you determine whether the signal is to be output, or not.

SG CONT ⇒ OUT CTRL ⇒

GENERATOR START	Generates the signal. (A trigger wait state is set.)
GENERATOR STOP	Stops the signal. (The trigger wait state is canceled; however, the offset voltage is output.)
GENERATOR MAN TRIG	Starts signal generation when the manual signal output mode is selected.
GEN ON AVG/MAN	When the continuous signal output mode is selected, synchronizes the signal generation start with the average measurement start.

5. SG CONT KEY OPERATION

- **Signal generation start/stop**

GENERATOR START : The signal generation starts when this key is pressed.
- In the CONTINUE mode, the signal generation starts.
- In the other modes, a trigger wait state is set. If a triggering event is detected, the signal generation starts.

GENERATOR STOP : The signal generation stops when this key is pressed.
- In the "CONTINUE" mode, the signal generation stops.
- In the other modes, the trigger wait state is canceled. If a signal is being generated, its generation stops.

CAUTION !

The offset voltage is output irrespective of the start/stop state.

To stop output of the offset voltage, switch off the OPR key (standby).

- **Manual triggering ("GENERATOR MAN TRG")**

When the MANUAL mode is selected as the output signal generation mode, the signal generation is manually triggered.
This key is effective only when the "MANUAL" mode is selected and a trigger wait state is set with the GENERATOR START key.

- **Synchronization with an average measurement (GEN ON AVG/MAN)**

If AVG is selected, the signal generation is synchronized with the average measurement. This function is effective only if the output mode is the "CONTINUE" mode.

AVG ON : If the START key is pressed, signal generation starts at the same time as the averaging process and stops upon completion of averaging.

CAUTION !

When select AVG in the condition that signal is generated, press GENERATOR STOP key at first.

AVG OFF : The signal generation is controlled with the GENERATOR START and GENERATOR STOP keys independently on the START key.

● **Operation procedures**

Some simple operation procedures in different output modes are outlined below. (For details about the setting of the output mode, see " ■ Selection of an Output Signal Generation Mode".

○ **Single generation in the continuous mode (GEN ON MAN) and internal trigger mode**

(1) Select the "CONTINUE" or "INTERNAL" mode.

SG CONT ⇒ OUT MODE ⇒ CONTINUE — Signals are continuously generated.

⇒ INTERNAL — Signals are generated in synchronization with the internal trigger.

(2) In the INTERNAL mode, set the time period and the number of output frames (cycles for a sine wave).
For further details, refer to the sections dealing with the selection of the control parameters for the signal generation mode.

(3) Select a signal generator output connection method. At this point, only the offset voltage is output. For further details, see "● Connection of the signal generator's output ".

(4) Start the signal generation.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR START — Start the signal generation . (A trigger wait state is set.)

In the "CONTINUE" mode, signals are generated continuously.
In the "INTERNAL" mode, signals are generated during the specified time period.

(5) To change the setting, stop the signal generation.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR STOP — The trigger wait state is canceled and the signal generation stops.

5. SG CONT KEY OPERATION

○ **Signal generation in the external trigger mode**

(1) Select the "EXTERNAL" or "EXT.GATE" mode.

SG CONT ⇒ OUT MODE ⇒ EXTERNAL In this mode the signal generation is synchronized with an external trigger.

⇒ EXT.GATE In this mode the signal generation is synchronized with external gates.

(2) In the EXTERNAL mode, you must select the trigger slope and set the number of output frames (cycles).
For further details, see "■ Selection of an Output Signal Generation Mode".

(3) Select a signal generator output connection method. At this point, only the offset voltage is output.
For further details, see the explanation "● Connection of the signal generator's output ".

(4) A trigger wait state is set.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR START A trigger wait state is set.

(5) When a triggering event is encountered, the signal is generated.
If a trigger signal is input into the external trigger input socket (EXT TRIG INPUT), signals are generated in synchronization with this external trigger signal.

(6) To change the setting, cancel the trigger wait state and stop the signal generation.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR STOP The trigger wait state is cancelled, and the signal generation stops.

○ **Signal generation in the manual trigger mode**

(1) Select the MANUAL mode.

SG CONT ⇒ OUT MODE ⇒ MANUAL In this mode, the signal generation is manually triggered.

(2) Set the number of output frames (cycles).
For further details, see "■ Selection of an Output Signal Generation Mode".

(3) Select a signal generator's output connection method. At this point, only the offset voltage is output.
For further details, see "● Connection of the signal generator's output".

(4) A trigger wait state is set.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR START — Sets a trigger wait state.

The signal generation does not start yet.

(5) Generate a triggering event so that the signal generation starts.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR MAN TRIG — Starts the signal generation.

The signal generation starts when the GENERATOR MAN TRIG key is pressed.

(6) To change the setting, cancel the trigger wait state and stop the signal generation.

SG CONT ⇒ OUT CTRL ⇒ GENERATOR STOP — Cancel the trigger wait state and stop the signal generation.

○ **Signal generation in the continuous mode (GEN ON AVG)**

(1) Select the "CONTINUE" mode.

SG CONT ⇒ OUT MODE ⇒ CONTINUE — Continuously generates signals.

(2) Select "GEN ON AVG".

SG CONT ⇒ OUT CTRL ⇒ GEN ON AVG/MAN — When the signal is continuously generated, synchronizes the signal generation start with the averaging process start.

(3) Select a signal generator output's connection method. At this point, only the offset voltage is output. For further details, see "● Connection of the signal generator's output ".

(4) Start, at the same time, the signal generation and the average process.
Averaging starts when the START key is pressed.

(5) The signal generation stops at completion of averaging.
During the averaging process, pressing the STOP/C key will oblige the averaging process to stop, but not the signal generation.
In this case, press the GENERATOR STOP key to stop the signal generation.

Selection of an Output Signal Generation Mode

You can select the signal generation timing.
You will chose a mode among: CONTINUE, INTERNAL, EXTERNAL, EXT.GATE. or MANUAL depending on the time when you want the waveform to be output.
About the output signal generation procedures in different modes, see " ■ How to Control the Signal Generation".

SG CONT ⇒ OUT MODE ⇒

CONTINUE	Generates signals continuously.
INTERNAL	Generates signals synchronously with the internal trigger.
EXTERNAL	Generates signals synchronously with an external trigger.
EXT.GATE	Generates signals synchronously with external gates.
MANUAL	Generates signals manually.
(PERIOD)	*1 Enters the time period (trigger slope) setting menu (second page).
(n FRAME) 1000	*2 Sets the cycle (number of frames).

*1 When INTERNAL is selected, (PERIOD) is displayed.
When EXTERNAL is selected, (X TRIG) is displayed.

*2 When SINE is selected, (n CYC) is displayed.
When a signal type other than SINE is selected, (n FRM) is displayed.

CAUTION !

When the zoom analysis function is used, only the "CONTINUE" mode can be selected. If the zero start analysis function is changed to the zoom analysis function in a mode other than the "CONTINUE" mode, the mode is automatically switched to the CONTINUE mode.

- **"CONTINUE" mode**

Signals are generated continuously irrespective of any trigger signal.

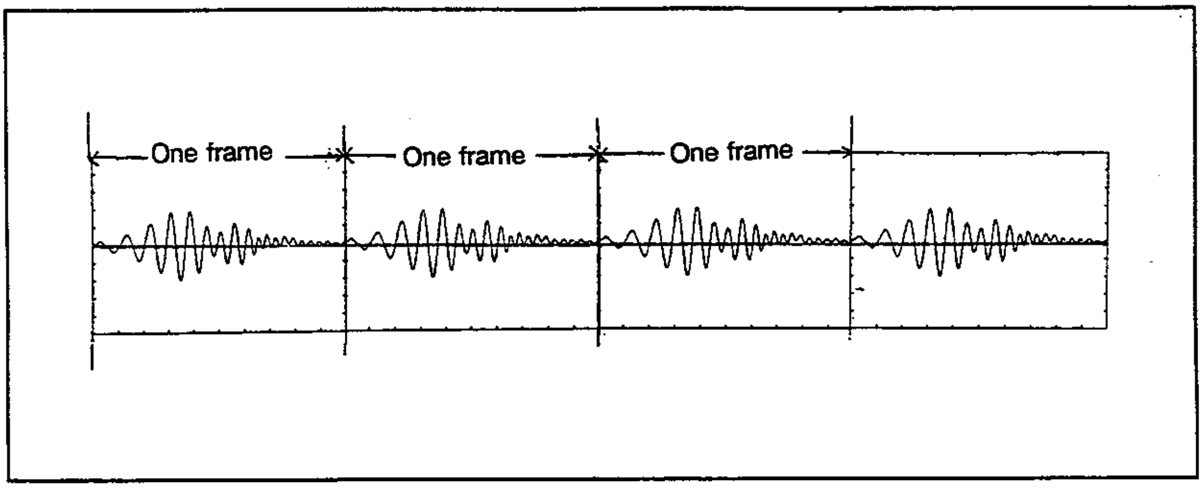


Figure 9-34 Example of Output in the "CONTINUE" Mode

- **"INTERNAL" mode**

The signal is generated at specified intervals according to the specified internal trigger conditions (time period). The number of frames (cycles for a sine wave) to be output at each trigger event must also be determined.

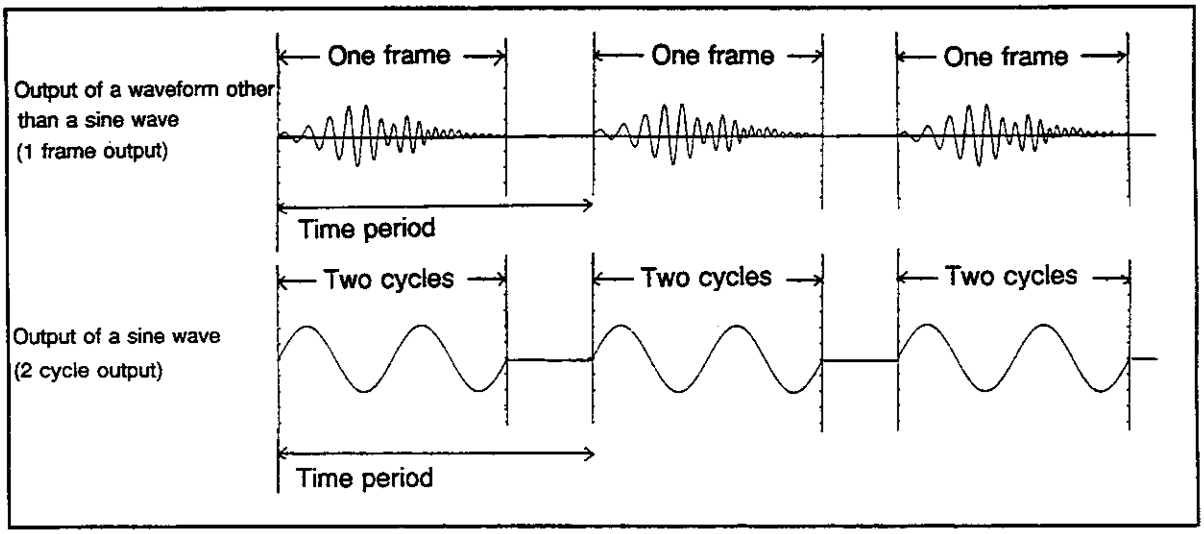


Figure 9-35 Example of Output in the "INTERNAL" Mode

○ **Setting the time period**

When INTERNAL is selected, (PERIOD) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒ (PERIOD) Sets the time period.
The second page of the menu will be displayed.

PERIOD t
100msec

sec
msec
µsec
} Unit keys

RETURN The first page of the menu will be displayed again.

The time period must be longer than the waveform output time.
The setting range of the actual time period is as follows:

Minimum value for a sine wave = (Number of cycles + a)/Output frequency
Minimum value for other waves = (Number of frames + a) x Number of analysis lines/Frequency range
where a = 1/5Number of lines = 25
a = 1/2Number of lines = 50
a = 1/10Others
Maximum value = 6.5 seconds

○ **How to set the number of output frames (cycles)**

When SINE is selected, (n CYC) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒ (n CYC) 10 Sets the number of cycles of the output sine wave.

When a signal type other than SINE is selected, (n FRM) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒ (n FRM) 10 Sets the number of output frames.

The number of output frames (cycles) must not yield a time superior to the time period. It must also be chosen in the following range:
Minimum value: 1
Maximum value: 1023

- **"EXTERNAL" mode**

The signal is generated when the external trigger signal (input through the EXT TRG INPUT connector) rises or falls. The number of frames (cycles for a sine wave) output at each trigger event must be specified.

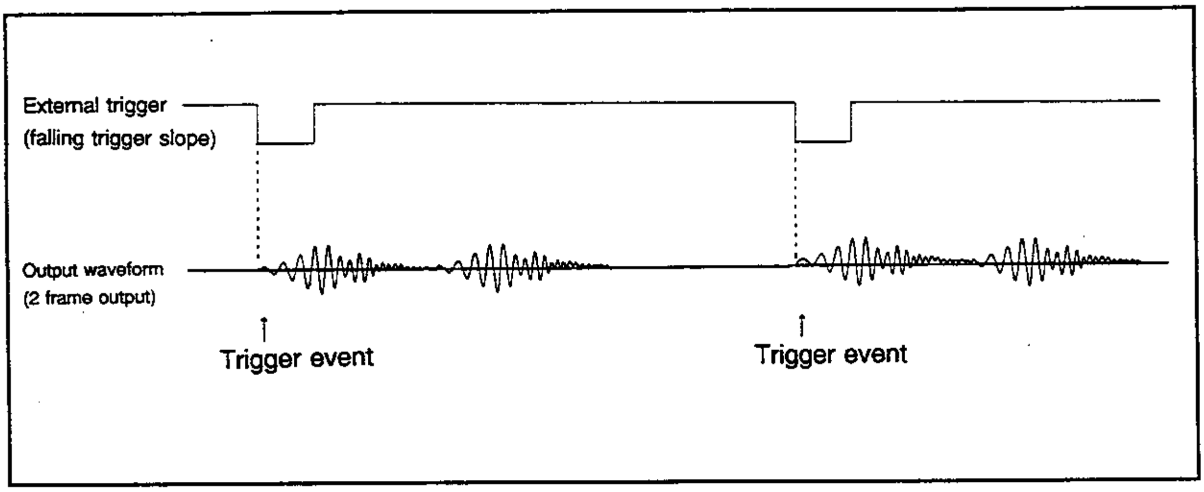


Figure 9-36 Example of Output in the "EXTERNAL" Mode

The time from a trigger point to the next trigger point must be longer than the waveform output time.
This time can be set in the following range:
Minimum value for a sine wave = (Number of cycles + a)/Output frequency
Minimum value for other waves = (Number of frames + a) x Number of analysis lines/Frequency range
where a = 1/5Number of lines = 25
a = 1/2Number of lines = 50
a = 1/10Others
Maximum value = 6.5 seconds

○ How to set the trigger slope

When EXTERNAL is selected, (X TRIG) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒

(X TRIG)	Sets the trigger slope. The second page of the menu will be displayed.
↑ X TRIG	A signal is generated synchronously with the rising edge of the trigger signal.
↓ X TRIG	A signal is generated synchronously with the falling edge of the trigger signal.
RETURN	The first page of the menu will be displayed again.

○ How to set the number of output frames (cycles)

When SINE is selected as signal type, (n CYC) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒

(n CYC) 10	Sets the number of output sine wave cycles.

When a signal type other than SINE is selected, (n FRM) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒

(n FRM) 10	Sets the number of output frames.

The number of output frames (cycles) must not yield a time superior to the time between 2 consecutive trigger points. This number must also be chosen in the following range:

Minimum value : 1
Maximum value : 1023

● **"EXT.GATE" mode**

Signals are generated only when the external gate trigger signal input through the EXT TRG INPUT connector (rear panel) is low. If the gate trigger signal level becomes high before completion of generation of one frame (one cycle for the sine wave), signals are generated until this frame ends. In this mode, the number of output frames (cycles) is not specified unlike the other modes: it is determined according to the period during which the external gate trigger signal level is low.

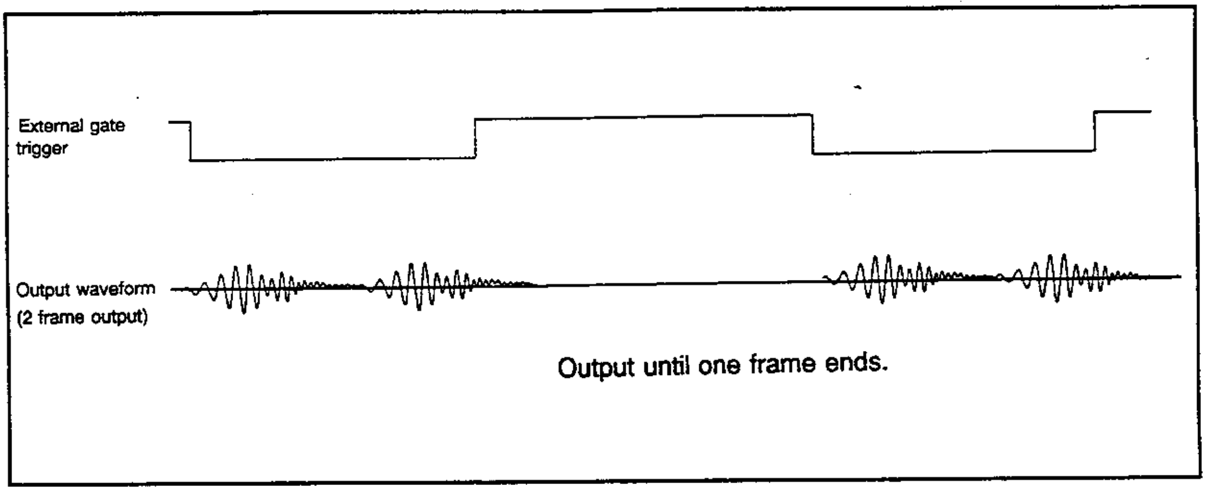


Figure 9-37 Example of Output in the "EXT. GATE" Mode

The time during which the external gate trigger signal level is low must be longer than the output signal basic time period (cycle or frame).
This period can be set in the following range:
Minimum value for a sine wave = (Number of cycles + a)/Output frequency
Minimum value for other waves = (Number of frames + a) x Number of analysis lines/Frequency range
where a = 1/5Number of lines = 25
a = 1/2Number of lines = 50
a = 1/10Others
Maximum value = 6.5 seconds

● **"MANUAL" mode**

Signals are generated by manually triggering the generation. Signal generation starts when the GENERATOR MAN TRIG key of OUT CTRL is pressed. The number of frames (cycles for a sine wave) output at each trigger event, must be specified.

5. SG CONT KEY OPERATION

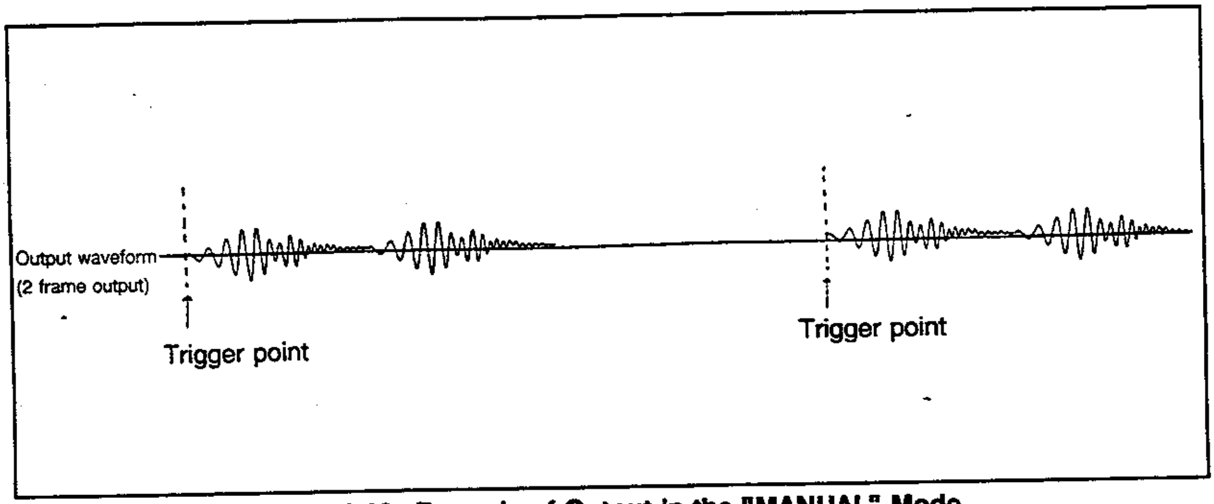


Figure 9-38 Example of Output in the "MANUAL" Mode

The time between 2 trigger points must be longer than the waveform output time.
The actual period time can be set in the following range:

Minimum value for a sine wave = (Number of cycles + a)/Output frequency
Minimum value for other waves = (Number of frames + a) x Number of analysis lines/Frequency range
where a = 1/5 Number of lines = 25
a = 1/2 Number of lines = 50
a = 1/10 Others
Maximum value = 6.5 seconds

○ **How to set the number of output frames (cycles)**

When SINE is selected signal type, (n CYC) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒ (n CYC) 10 Sets the number of output sine wave cycles.

When a signal type other than SINE is selected, (n FRM) is displayed in the Y softmenu.

SG CONT ⇒ OUT MODE ⇒ (n FRM) 10 Sets the number of output frames.

The number of output frames (cycles) must not exceed the time between 2 trigger points: It must be chosen within the following range:
Minimum value : 1
Maximum value : 1023

Selection of the Output Impedance

You must select the output impedance of the signal generator either 0, 50, or 600Ω.

SG CONT ⇒ NEXT

⇒ IMPEDANC ⇒

When use the internal SUM amplifier, 0Ω or 50Ω is selected.

0Ω	Sets the output impedance of the signal generator to 0Ω.
50Ω	Sets the output impedance of the signal generator to 50Ω.
600Ω	Sets the output impedance of the signal generator to 600Ω.

When the impedance is 50Ω, a 50Ω load is connected, and the amplitude and offset voltage set with "SG VLT" are output.
When the impedance is 600Ω , the internal load is changed to damp the output. Therefore, the offset voltage that can be output is limited.

How to Set a Synchronization Signal

A synchronization trigger signal is output from the SYNC OUTPUT connector (at the rear panel), synchronized with the period of the signal output from the signal generator. This synchronization signal is a TTL level signal.
The ratio of the period of the signal output from the SG to the number of synchronization trigger signals can be controlled.

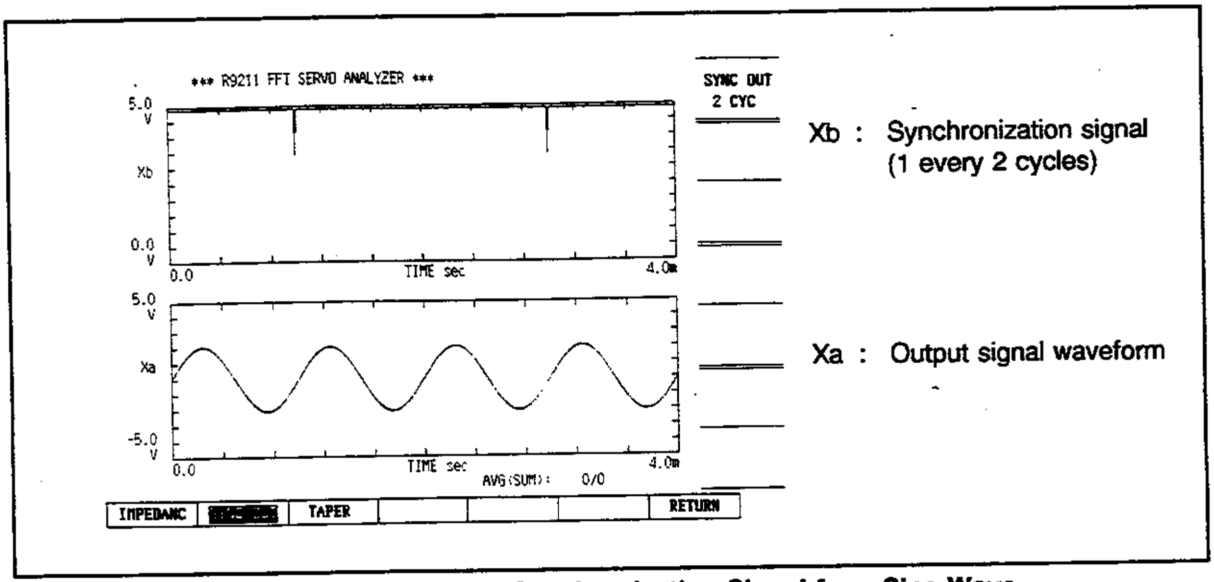
- **Sine wave**

You set the number of signal cycles to be output between 2 trigger pulses.
You may choose this cycles number within the range:
Minimum: 1 cycle
Maximum: 1024 cycles

SG CONT ⇒ NEXT

⇒ SYNC. OUT ⇒ SYNC. OUT (2 CYC) — Sets the number of cycles.

5. SG CONT KEY OPERATION



Xb : Synchronization signal (1 every 2 cycles)

Xa : Output signal waveform

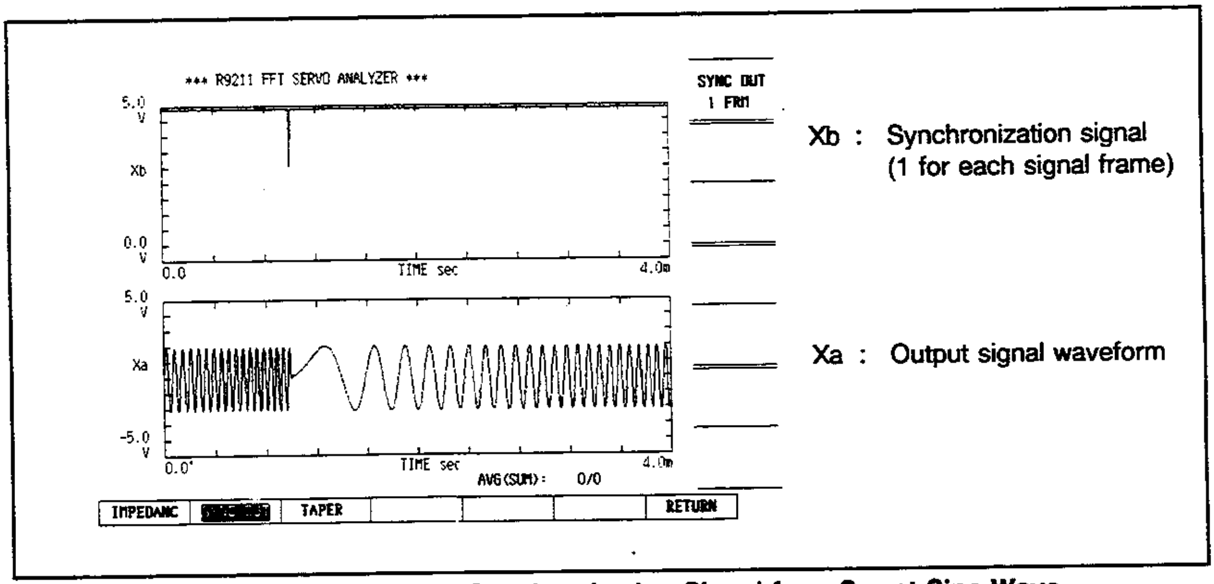
Figure 9-39 Example of Synchronization Signal for a Sine Wave

- **Other types of waveforms**

You set the number of signal frames to be output between 2 trigger pulses.
You may choose this number within the range:
Minimum : 1 frame
Maximum : 1024 frames

SG CONT ⇒ NEXT

⇒ SYNC. OUT ⇒ SYNC. OUT (1 FRM) Sets the number of frames.



Xb : Synchronization signal (1 for each signal frame)

Xa : Output signal waveform

Figure 9-40 Example of Synchronization Signal for a Swept Sine Wave

How to Set the Taper Function

You can use the taper function for measurements (e.g., speaker measurement) that may be affected by sudden waveform output changes caused when the output signal generation starts or stops.

When the taper function is used, the signal amplitude can be increased or decreased gradually when the GENERATOR START or GENERATOR STOP key is pressed. The time required for these gradual signal evolution can be set.
The taper function is available only when CONTINUE is selected as the output mode.

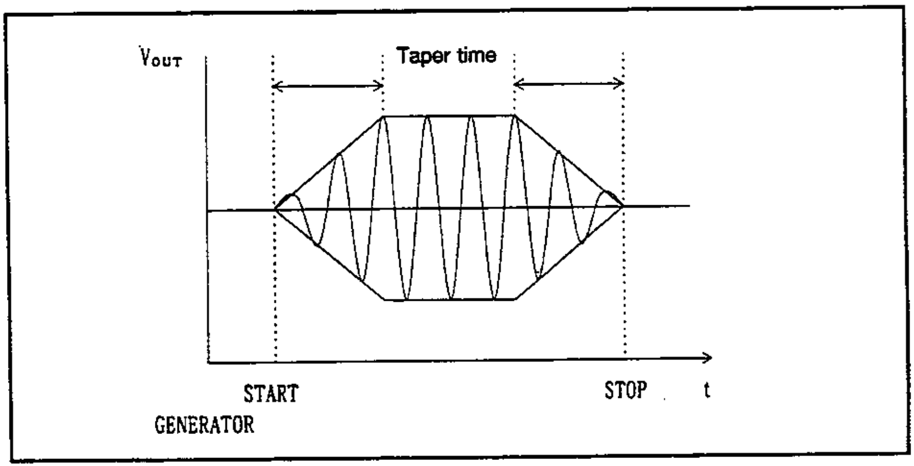


Figure 9-41 Example of Output when the Taper Function is Used

○ **Setup procedure**

(1) Before setting up the taper function, press the GENERATOR STOP key to stop the signal output.

SG CONT ⇒ CONNECT ⇒ GENERATOR STOP — Stop the signal output. (The offset voltage is still output.)

(2) Select or cancel the taper function

SG CONT ⇒ NEXT

⇒ TAPER ⇒ TAPER ON/OFF — Determine whether the taper function is to be used.
(ON can be selected only when the "CONTINUE" mode is used.)

CAUTION! !

ON can be selected only when "CONTINUE" is selected as the output mode.

If the CONTINUE mode is switched to another mode when ON is selected, the taper function is canceled automatically.

(3) Set the taper time

If represents the time elapsed from the moment the output starts to the moment the output waveform amplitude reaches is normal level, as well as the time elapsed from the moment the output stops to the moment the amplitude becomes zero.

When TAPER ON/OFF is selected, the following menu is displayed, so that you may specified the taper time as you wish. This time may be chosen within the range:

Minimum : 102.4 μs

Maximum : 200 ms

SG CONT ⇒ NEXT

⇒ TAPER ⇒

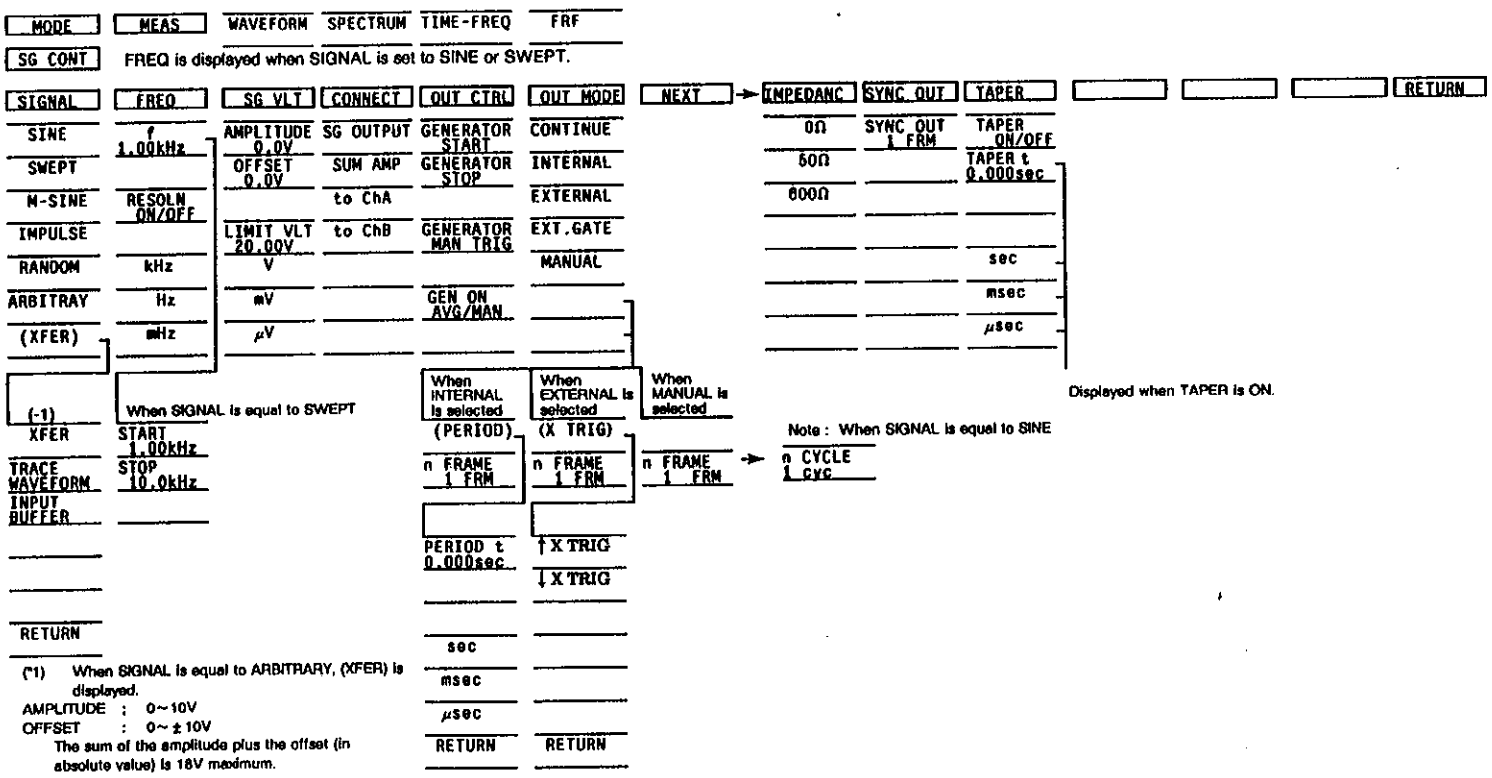
TAPER ON/OFF	Determines whether the taper function is to be used.
TAPER f 10.0msec	Sets the taper time. (This key is displayed only when TAPER /OFF is selected.)
sec	Unit keys
msec	
μsec	

CAUTION!

During the taper function operation, and until the end of it, the other SG keys (OPR key excluded) cannot be used.

SG CONT Menu List

R9211 Series Menu List (SG CONT)



(*1) When SIGNAL is equal to ARBITRARY, (XFER) is displayed.

AMPLITUDE : 0~10V
OFFSET : 0~±10V
The sum of the amplitude plus the offset (in absolute value) is 18V maximum.

CHAPTER 10

HOW TO USE MARKERS

This chapter gives explanations about the two types of markers:

- Cursor marker : used to read measurement data
- Search marker : used to find some characteristics of the data (peak, harmonics ···)

CONTENTS

1. CURSOR MARKERS

How to Use X Axis Cursor Markers

- **Types of X Axis Cursor Markers**

Before using X axis cursor markers, select the active screen.

MKR ⇒ SEL	Selects a screen.
⇒ MKR VAL	Selects the X axis cursor marker type.
SINGLE X X1 Y1	Reads the coordinates of one point.
X1 Y1 X2 X2	Reads the coordinates of two points.
X1 Y1 X2 ΔY	Reads the coordinates of two points and computes and displays the difference along the Y axis.

NOTE

You can select cursor markers for each screen.

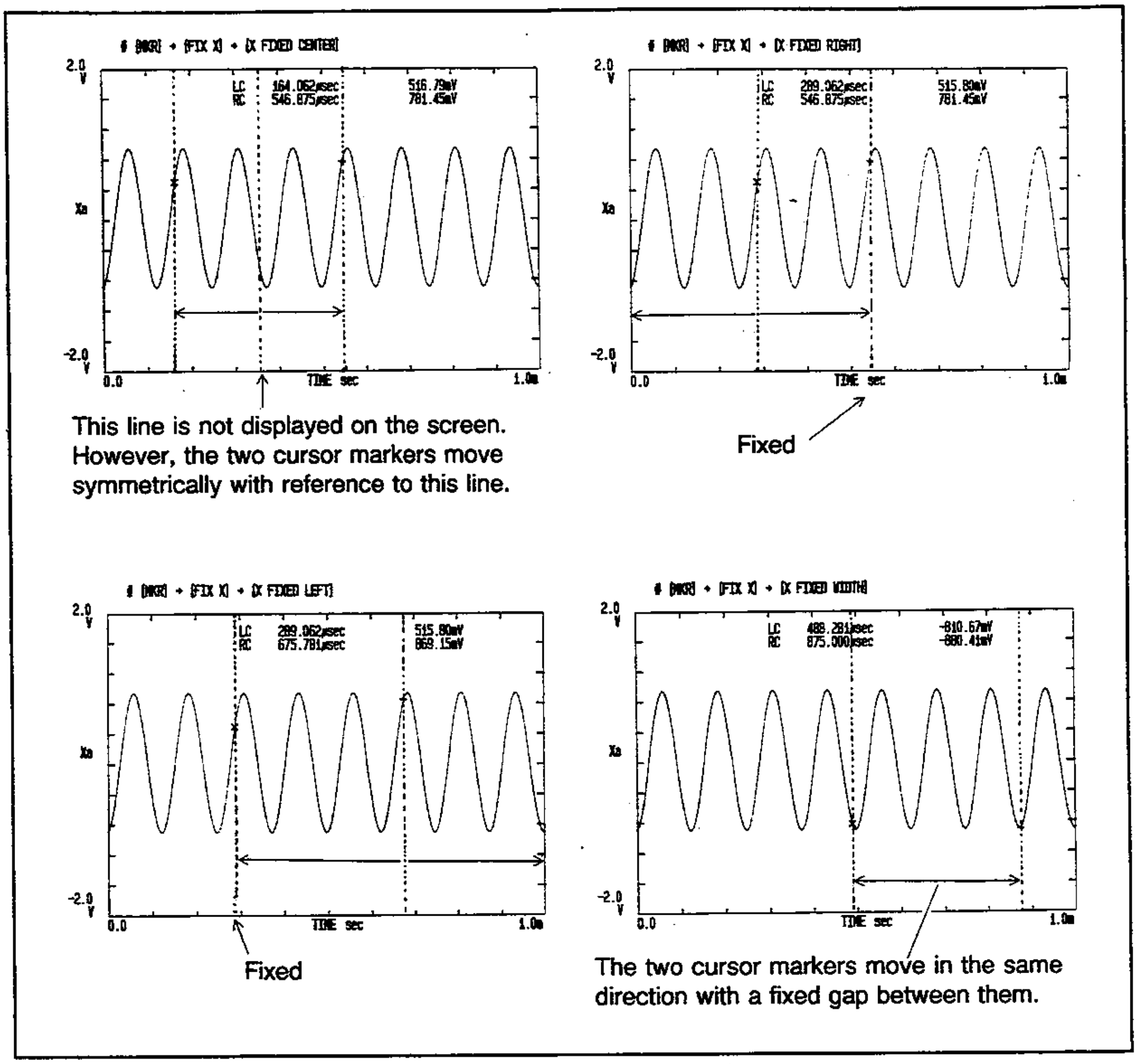
- **Moving X axis cursor markers**

When X axis cursor markers are selected, their read-out values are displayed. Use the rotary knob to move the X axis cursor markers. In case of 2 markers, first select the cursor moving method by pressing FIX X .

⇒ FIX X	
X FIXED CENTER	The two cursor markers move symmetrically. (See the upper left diagram in Figure 10-1.)
X FIXED RIGHT	Of the two X axis cursor markers, the right-hand cursor marker is fixed and only the left-hand cursor marker moves. (See the upper right diagram in Figure 10-1.)
X FIXED LEFT	Of the two X axis cursor markers, the left-hand cursor marker is fixed and only the right-hand cursor marker moves. (See the lower left diagram in Figure 10-1.)
X FIXED WIDTH	The interval between the two X axis cursor markers is fixed while they both move in the same direction. (See the lower right diagram in Figure 10-1.)

Note

Select the cursor moving method by pressing [FIX X].
This will determine either how the cursors respectively move, or which cursor remains fixed.



This line is not displayed on the screen. However, the two cursor markers move symmetrically with reference to this line.

Fixed

Fixed

The two cursor markers move in the same direction with a fixed gap between them.

Figure 10-1 X Axis Cursor Markers

How to Use Y Axis Cursor Markers

- **Types of Y Axis Cursor Markers**

Before using Y axis cursor markers, select the active screen.

MKR ⇒ SEL ☰		Selects a screen. Selects the Y axis cursor marker type.
⇒ MKR VAL	⇒ Y1 Y2	Reads the coordinates of the 2 points selected by two Y axis cursor markers.
	⇒ Y1 ΔY	Reads the value of the cursor difference between the upper and the lower in two Y-axis cursors.

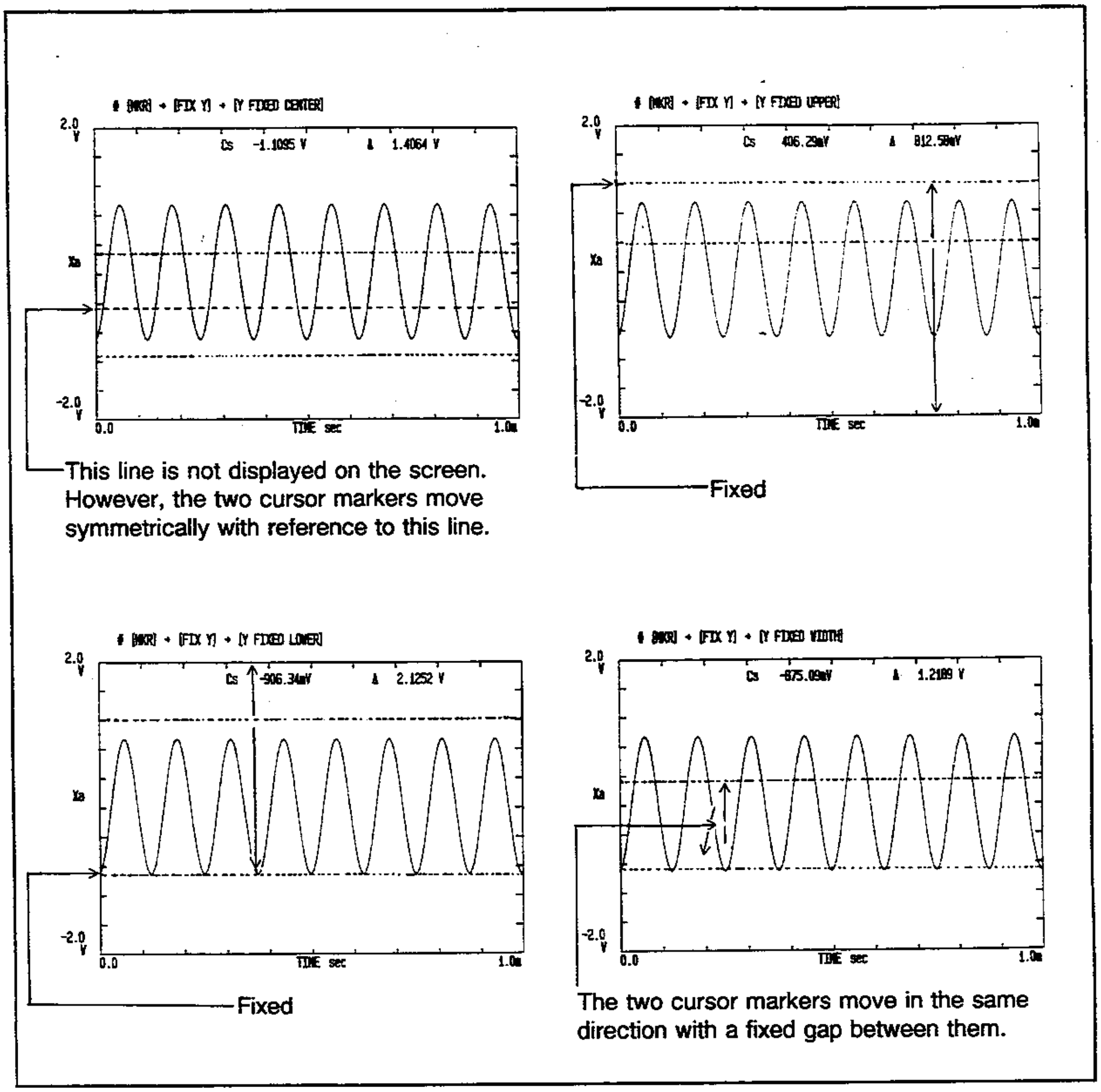
NOTE
You can select cursor markers for each screen.

- **Moving Y axis cursor markers**

When Y axis cursor markers are selected, their read-out values are displayed. Use the rotary knob to move Y axis cursor markers.
Select the cursor moving method by pressing FIX Y .

⇒ FIX Y	⇒ Y FIXED CENTER	The two cursor markers move symmetrically. (See the upper left diagram in Figure 10-2.)
	⇒ Y FIXED UPPER	Of the two Y axis cursor markers, the upper cursor marker is fixed and only the lower cursor marker moves. (See the upper right diagram in Figure 10-2.)
	⇒ Y FIXED LOWER	Of the two Y axis cursor markers, the lower cursor marker is fixed and only the upper cursor marker moves. (See the lower left diagram in Figure 10-2.)
	⇒ Y FIXED WIDTH	The interval between the two Y axis cursor markers is fixed while both these markers move in the same direction. (See the lower right diagram in Figure 10-2.)

NOTE
Select the cursor moving method by pressing FIX Y .
This will determine either how the cursors respectively move, or which cursor remains fixed.



This line is not displayed on the screen. However, the two cursor markers move symmetrically with reference to this line.

Fixed

Fixed

The two cursor markers move in the same direction with a fixed gap between them.

Figure 10-2 Y Axis Cursor Markers

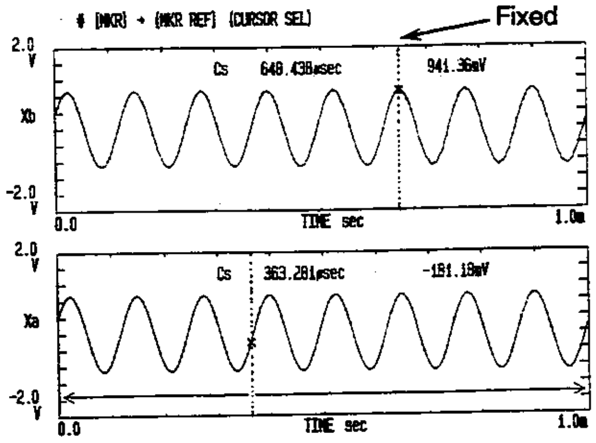
How to Move Cursor Markers Simultaneously on Different Screens

In multi-screen mode, you can decide whether the cursor marker of the selected screen (active screen) is to be moved together with the cursor marker of an unselected screen.

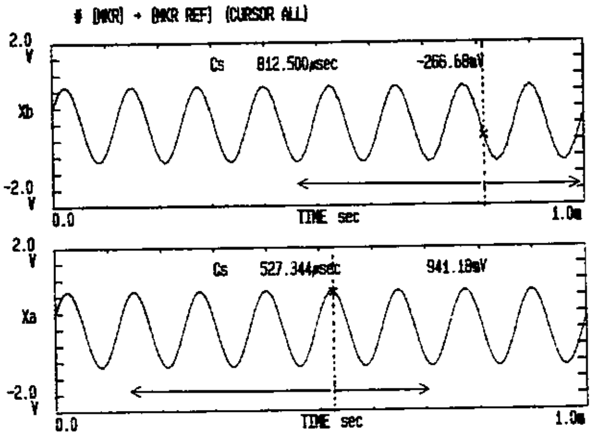
MKR ⇒ MKR REF ⇒ CURSOR SEL/ALL

This sequence enables you to determine whether cursor markers are to be moved simultaneously on all screens, or only on the active screen.

- CURSOR SEL/ALL: The cursor marker moves only on the active screen. (Upper screens in Figure 10-3)
- CURSOR SEL/ALL: The cursor marker moves on all screens. (Lower screens in Figure 10-3)



When the lower screen is active, the cursor marker can be moved only on this screen.



The lower screen is active ; but the cursor markers can be moved on both screens.

Figure 10-3 Moving Cursor Markers Simultaneously

How to set the position of the Cursor Marker simultaneously on different screens

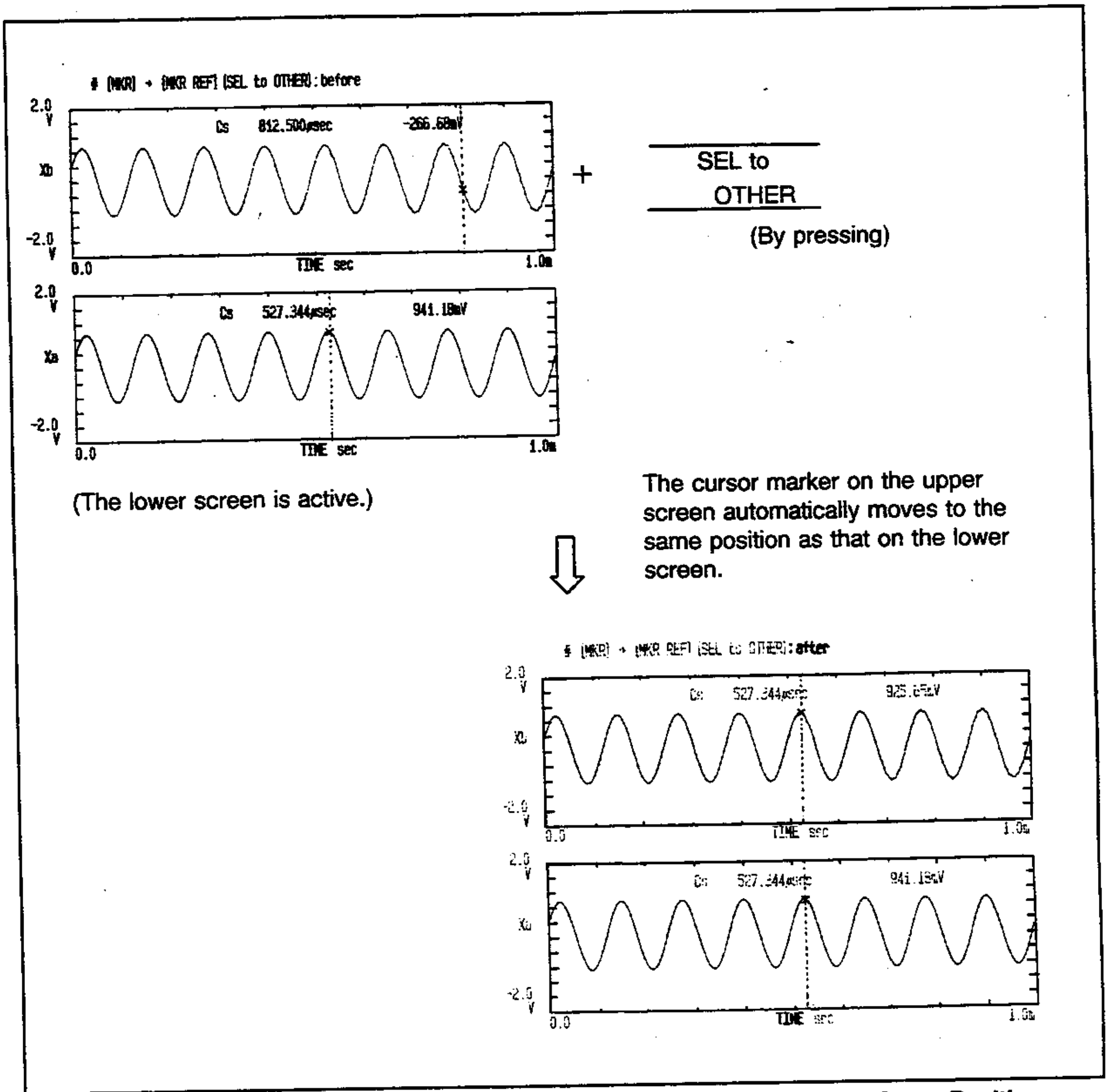
The cursor marker of the unselected screen can be moved to the same position as that of the cursor marker of the selected (active) screen.

MKR ⇒ MKR REF ⇒ SEL to OTHER

The X axis coordinate of the cursor marker of the unselected screen is changed into the one of the cursor marker of the selected screen.
(In other words, the cursor marker on the active screen is copied onto the other screens.)

Using "SEL to OTHER" effectively

(1) Is the (X axis cursor) marker displayed on the selected screen?
(If not, it must be displayed.)
(2) Is the (X axis cursor) marker displayed on the unselected screen?
(If not, it must be displayed.)



(By pressing)

(The lower screen is active.)

The cursor marker on the upper screen automatically moves to the same position as that on the lower screen.

Figure 10-4 Setting the Cursor Marker on the Unselected Screen at the Same Position as that on the Selected Screen

2. SEARCH MARKERS

Relationships between Search Markers and Waveform Types

The types of search markers that can be used depend on the type of waveform displayed on the selected screen.
Table 10-1 summarizes the relationships between search markers and waveform types.

Table 10-1 Possibly Display Search Markers

Maker type		Type of computation performed on the data						
Group	Search marker	Time waveform	Correlation function	Histogram	Spectrum	t-f analysis	Frequency response function	Impulse response function
PK	'PKPK'	○						
	'SINGLE PK'		○	○	○	○	○	○
	'NEXT RIGHT PK'	○	○	○	○	○		○
	'NEXT LEFT PK'	○	○	○	○	○		○
	'NEXT RIGHT MIN'	○	○					○
	'NEXT LEFT MIN'	○	○					○
	'+PK'						○	
	'−PK'						○	
BAND	'PKPK'	○						
	'RMS'	○						
	'PK'		○		○	○		○
	'OVERALL'		○		○	○		○
	'MEAN'		○		○	○		○
	'VARIANCE'		○		○	○		○
PULSE PAR	'RISE TIME'	○						
	'FALL TIME'	○						
	'PULSE WIDTH'	○						
DAMP PWR	'DAMP PWR'		○			○		
	'DAMP PWR' (IMP)							○
'HARMONIC'					○			
'SIDEBAND'					○			
'X dB BWD'							○	
'SHAPE'							○	
'RIPPLE'							○	
For servo analysis	'BODE'						☆	
	'CLOSE LOP'						☆	

○ indicates the search marker that can be displayed with X MKR.
☆ indicates the search marker that can be displayed with CTRL SYS.

NOTE

Be careful, because, even if a marker can be used for a certain type of analyzed data (cf. above table), it might be impossible to use it for this type of data, if the representation of these data (selected COORD) is not suitable because of compatibility reasons between a marker and the data format. For example, you cannot use a BAND marker or a DAMP PWR marker for a correlation function or an impulse response function, if you are displaying only the real part of the data.

What the Search Markers do

Table 10-2 lists search markers according to what group they belong to and to what they do. Select the appropriate search marker according to this table.

Table 10-2 Search Marker Name and Action

Maker type		Action
Group (X menu)	Search marker name (Y menu)	
PK	'PKPK'	Searches for the maximum and minimum values.
	'SINGLE PK'	Searches for the maximum value.
	'NEXT RIGHT PK'	Searches for the next peak value at the right of the current X axis cursor.
	'NEXT LEFT PK'	Searches for the next peak value at the left of the current X axis cursor.
	'NEXT RIGHT MIN'	Searches for the next minimum value at the right of the current X axis cursor.
	'NEXT LEFT MIN'	Searches for the next minimum value at the left of the current X axis cursor.
	'+PK'	Searches for the peak value (higher than the specified level) on both sides of the center.
	'−PK'	Searches for the minimum value (lower than the specified level) on both sides of the center.
BAND	'PKPK'	Searches for the maximum and minimum values between two X axis cursors.
	'RMS'	Displays the root mean square value between two X axis cursors.
	'PK'	Searches for the maximum value between two X axis cursors.
	'OVERALL'	Adds the signal amplitudes of the points within the interval, delimited by 2 X axis cursors, and displays the results in the "bar" format.
	'MEAN'	Computes the average of the data between two X axis cursors and displays it in the bar format.
	'VARIANCE'	Computes the variance and the normalized standard error of the whole data between two X axis cursors and displays them in the bar format.
PULSE PAR	'RISE TIME'	Computes the rise time of the waveform between two X axis cursors.
	'FALL TIME'	Computes the fall time of the waveform between two X axis cursors.
	'PULSE WIDTH'	Computes the pulse width of the waveform between two X axis cursors.
DAMP PWR	'DAMP PWR'	Displays the damping coefficient of the waveform between two X axis cursors.
	'DAMP PWR' (IMP)	Displays the damping coefficient and damping ratio of the waveform between two X axis cursors.
'HARMONIC'		Searches for the harmonics corresponding to the specified frequency or peak.
'SIDEBAND'		Searches for the sideband corresponding to the specified frequency.
'X dB BWD'		Points out (and computes) the parameters of the band, over which the signal level stands between the specified level, and the level computed from the specified level and the specified level difference.
'SHAPE'		Estimates the ratio of the band width of the band described above.
'RIPPLE'		Estimates the difference between the maximum value (peak) and the minimum value (trough).
For servo analysis	'BODE'	Displays the phase margin and gain margin.
	'CLOSE LOP'	Displays the frequency, gain, and bandwidth of the maximum value (peak).
Cursor	① 'SINGLE X X1 Y1'	Evaluates the coordinates (position & level) of the X axis cursor.
	② 'X1 Y1 X2 X2'	Evaluates the levels of two X axis cursors at the same time.
	③ 'X1 Y1 X2 ΔY'	Evaluates the levels and the difference (ΔY) between two X axis cursors at the same time.
	④ 'Y1 Y2' ⑤ 'Y1 ΔY'	Evaluates the levels of and the difference (ΔY) between two cursors. * Cursor markers are used to specify the bandwidth, points, and level for X MKR. They can also be used independently.

■ Operating the Search Markers

Table 10-3 lists the procedures (①→②→③→④) for operating and displaying search markers.

Table 10-3 Search Marker Operations and Display Procedures

		Marker display procedure(①→②→③→④)			
		① Condition setting	②Marker selection method	③ Action	④Marker symbol
PK	'PKPK'	None	-	○	▽ △
	'SINGLE PK'	None	Selective	○	▽
	'NEXT RIGHT PK'	Specify the reference level with marker IV.		DO	▽
	'NEXT LEFT PK'	Specify the reference level with marker IV.		DO	▽
	'NEXT RIGHT MIN'	Specify the reference level with marker IV.		DO	▽
	'NEXT LEFT MIN'	Specify the reference level with marker IV.		DO	▽
	'+PK'	1. Specify the reference level with marker IV. 2. Specify the reference point and level with marker I.	Selective	○	▽ ▽
	'−PK'			○	▽ ▽
BAND	'PKPK'	With marker II, specify the start (left) and stop (right) points of the X axis band to be searched.	Selective	○	▽ △
	'RMS'			○	Rms Bar
	'PK'			○	▽
	'OVERALL'			○	Σ Bar
	'MEAN'			○	Mean Bar
	'VARIANCE'			○	Var Bar
PULSE PAR	'RISE TIME'	Specify the start and stop points and levels with marker II. (It is assumed that the level of the left cursor is is 0% and that of the right one is 100%.)	Selective	DO	▽ ▽
	'FALL TIME'	Specify the start and stop points and levels with marker II. (It is assumed that the level of the left cursor is 100% and that of the right one is 0%.)	Selective	DO	▽ ▽
	'PULSE WIDTH'	Specify the start and stop points and levels with marker II. (It is assumed that the minimum level of the X cursor marker is 0% and maximum one between 2 points is 100%.)	Selective	DO	▽ ▽

(Settings before Execution) Marker I : Cursor marker for one point along the X axis ([MKR VAL][SINGLE X])
Marker II : Cursor markers for two points along the X axis ([MKR VAL][X1 Y1 X2 Y2])
Marker IV : Cursor markers for two points along the Y axis ([MKR VAL][Y1 Y2])

(Selection Method) Toggle: [ON/OFF] → [ON/OFF]: to change from inactive to active
Selective: Selection of one condition among several.

(Execution) ○ : The marker is displayed automatically, simply by specifying the selection method.
DO : Select the type of the marker to be displayed, then press the X MARKER key.
DO ESTIM

Table 10-3 Search Marker Operations and Display Procedures (cont'd)

		Marker display procedure(①→②→③→④)			
		① Condition setting	②Marker selection method	③ Action	④Marker symbol
DAMP PWR	'DAMP PWR'	Specify the start and stop points with marker II.	Toggle	DO	σ Value
	'DAMP PWR'(IMP)	1. Specify the start and stop points with marker II. 2. Enter the frequency whose damping coefficient is to be obtained. (Enter a value for FREQUENCY.)	Toggle	DO	σζ Value
'HARMONIC'		Select the fundamental frequency. Enter the fundamental frequency. (Enter a value for FUND FREQ.) Specify the maximum point to search.	Toggle	○	▽ ▽ ▽
'SIDE BAND'		1. Carrier (Enter a value for CARRIER.) 2. Enter the modulation frequency. (Enter a value for MOD FREQ.)	Toggle	○	▽ ▽~▽ ▽~▽
'X dB BWD'		1. Specify the reference coordinates with marker I. 2. Specify the search width. (Enter a value for X dB)	Toggle	○	▽ ▽
'SHAPE'		1. Specify the reference coordinates with marker I. 2. Specify the search width. (Enter values for X dB and Y dB.)	Toggle	○	▽ ▽ ▼ ▼
'RIPPLE'		None	Toggle	○	Rpl ▽▽
For servo analysis	'BODE'	None	Toggle	○	G P ▼▽
	'CLOSE LOP'	Specify the DC gain. (Enter a value for DC GAIN.)	Toggle	○	Gpk ω ▽▼
Cursor	① 'SINGLE X X1 Y1'	None	Selective	○	X axis cursor 1
	② 'X1 Y1 X2 Y2'	None		○	X axis cursor 2
	③ 'X1 Y1 X2 ΔY'	None		○	X axis cursor 2
	④ 'Y1 Y2'	None		○	Y axis cursor 1
	⑤ 'Y1 ΔY'	None		○	Y axis cursor 2

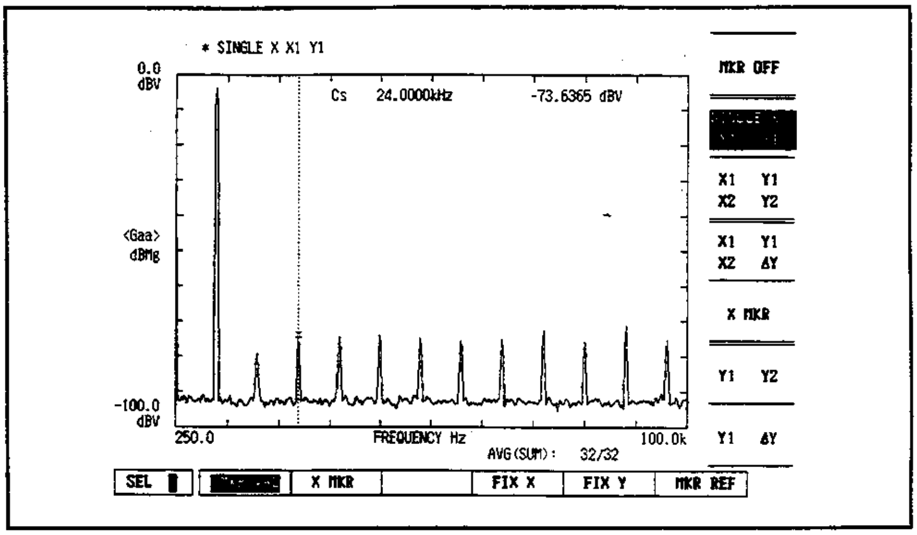
(Settings before Execution) Marker I : Cursor marker for one point along the X axis ([MKR VAL][SINGLE X])
Marker II : Cursor markers for two points along the X axis ([MKR VAL][X1 Y1 X2 Y2])
Marker IV : Cursor markers for two points along the Y axis ([MKR VAL][Y1 Y2])

(Selection Method) Toggle: [ON/OFF] → [ON/OFF]: to change from inactive to active
Selective: Selection of one condition among several.

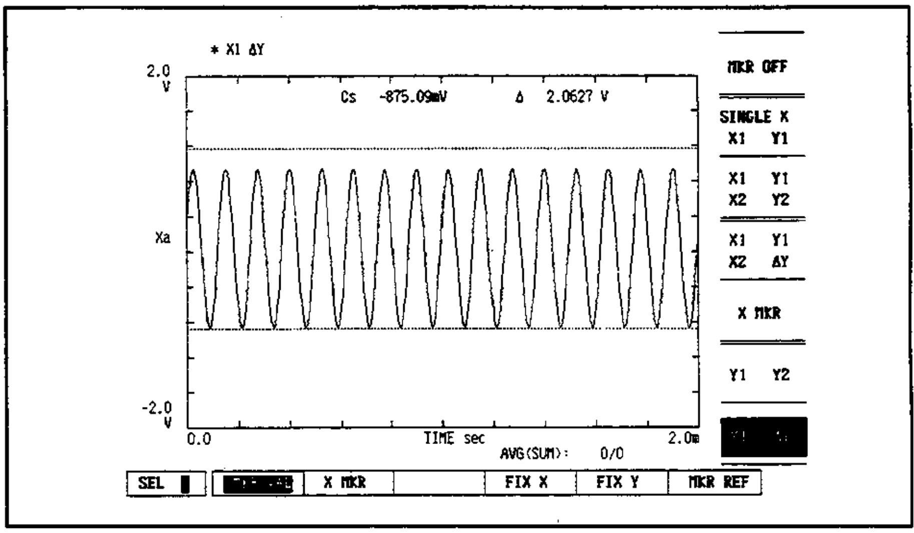
(Execution) ○ : The marker is displayed automatically, simply by specifying the selection method.
DO: Select the type of the marker to be displayed, then press the X MARKER key.
DO ESTIM

- **Marker Display Examples**

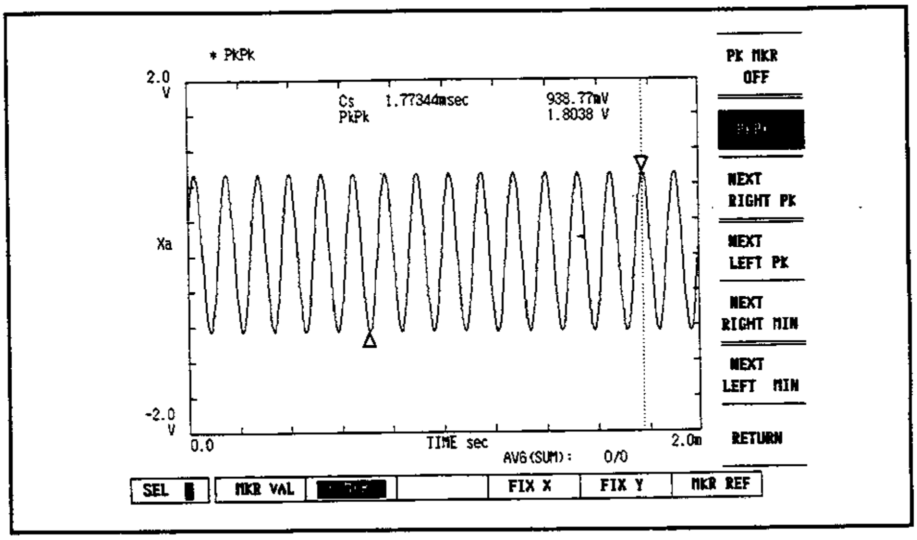
(1) Example of X axis cursor marker display: SINGLE X X1 Y1
One X axis cursor marker is displayed and its coordinates are displayed (Cs).



(2) Example of display of Y axis cursor markers: Y1 △Y
Two Y axis markers are displayed and the difference (△) between the amplitude (Cs) of the lower cursor and the amplitude of the upper cursor are displayed as well as the amplitude of the lower coursor (Cs).

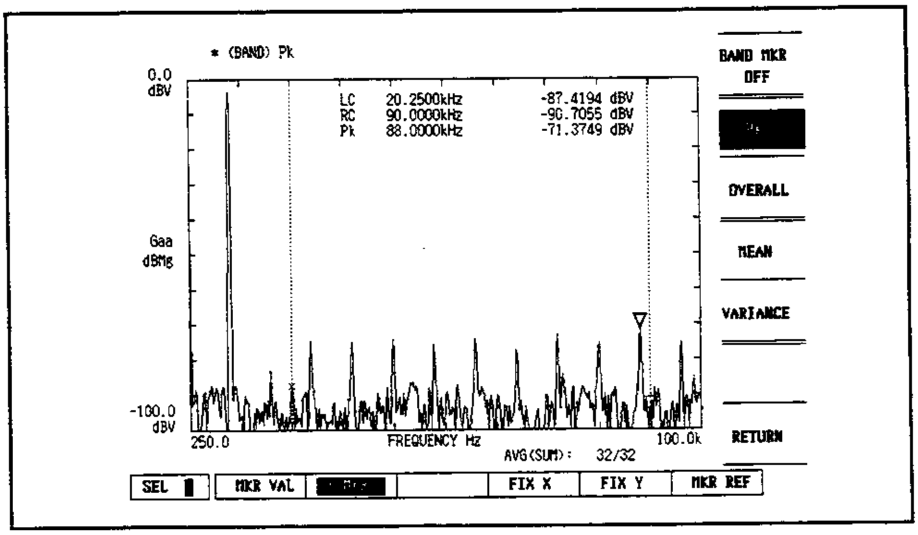


(3) Example of peak marker display: PKPK
The coordinates (Cs) of the higher cursor peak (▽) are displayed as well as the difference (PKPK) between the higher cursor (▽) and lower cursor (△) amplitude.



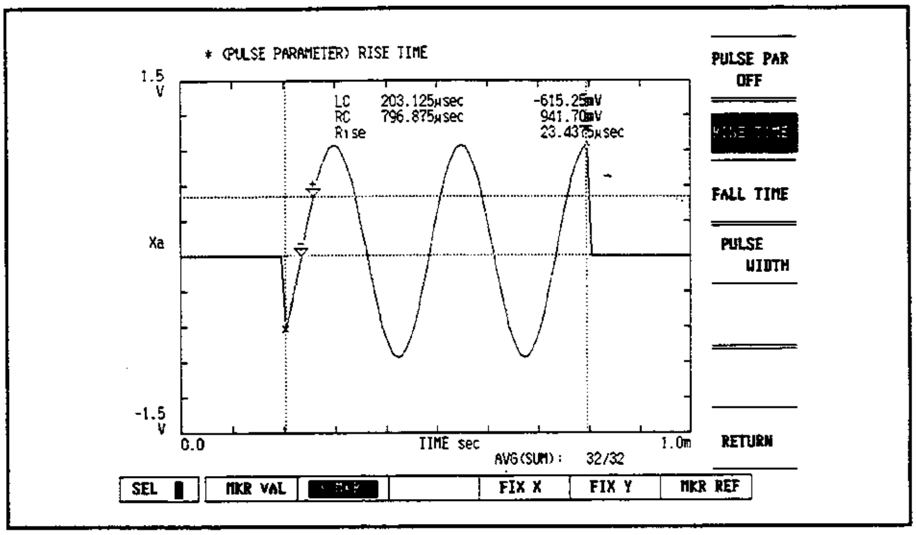
```
Cs      1.77344msec        938.77mV
PkPk                       1.8038 V
AVG(SUM):    0/0
```

(4) Example of display of band marker: PK
The peak coordinates (PK) of the peak (▽) of the waveform between two X axis cursor markers (the left cursor coordinates are indicated by LC and the right cursor coordinates by RC) as well as the boundaries (LC & RC) are displayed.



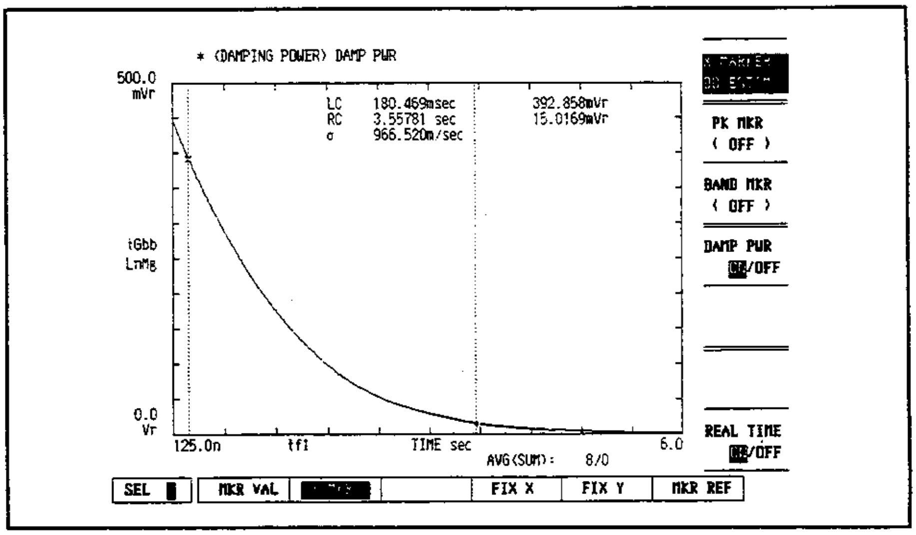
```
LC    20.2500kHz      -87.4194 dBV
RC    90.0000kHz      -90.7055 dBV
Pk    88.0000kHz      -71.3749 dBV
AVG(SUM):    32/32
```

(5) Example of pulse parameters display: RISE TIME
If the left X cursor (LC) and the right X cursor (RC) respectively correspond to 0% and 100% in amplitude, two Y axis cursors (the lower one, $\bar{\nabla}$, for 10% of the maximum amplitude and the upper one, $\overset{+}{\nabla}$, for 90%) define the risetime, whose value is then computed and displayed.



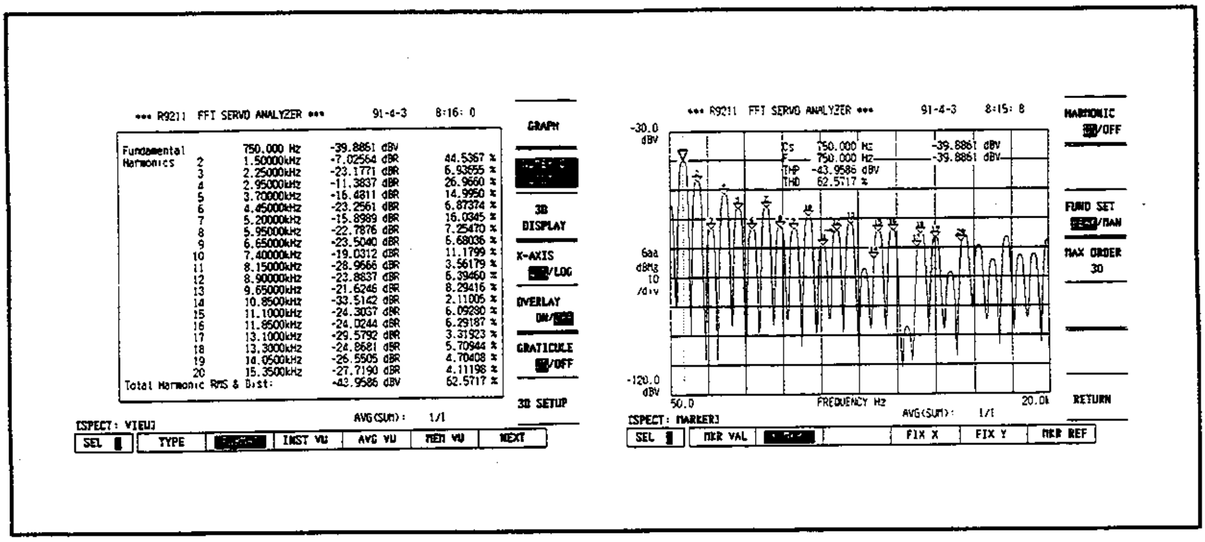
LC 203.125μsec -615.25mV
RC 796.875μsec 941.70mV
Rise 23.4375μsec

(6) Example of damping power display: DAMP PWR
The damping coefficient (σ) of the data between two X axis cursor markers is computed and displayed.(the left cursor value is indicated by LC and the right cursor value is indicated by RC)



LC 180.469msec 392.858mVr
RC 3.55781 sec 15.0169mVr
σ 966.520m/sec

(7) Example of harmonics markers display: HARMONIC
Harmonics are searched with reference to the fundamental waveform (∇ : PEAK) and displayed with ∇ markers. The distortion factor can be viewed by displaying the markers in the list format.

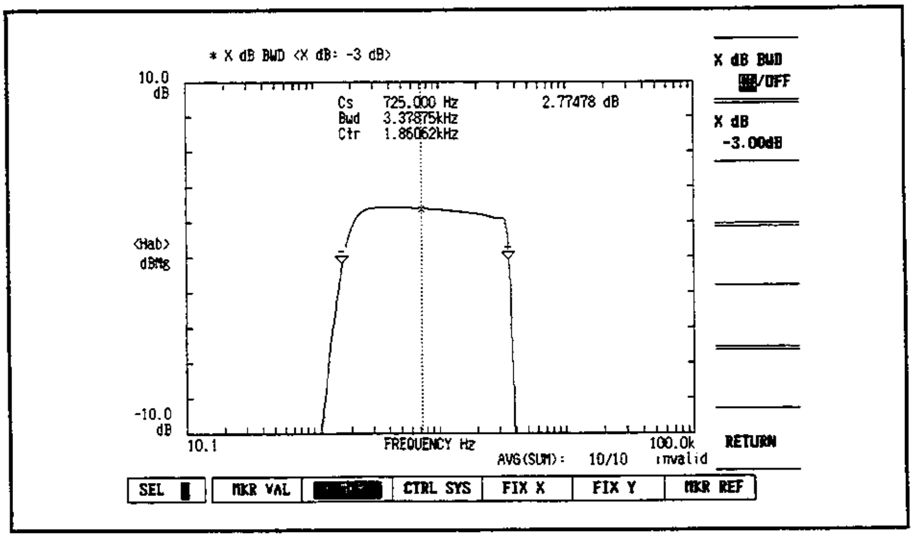


```
*** R9211  FFT SERVO ANALYZER ***         91-4-3     8:16: 0

Fundamental           750.000 Hz     -39.8861 dBV
Harmonics      2      1.50000kHz     -7.02564 dBR       44.5367 %
               3      2.25000kHz     -23.1771 dBR       6.93655 %
               4      2.95000kHz     -11.3837 dBR       26.9660 %
               5      3.70000kHz     -16.4811 dBR       14.9950 %
               6      4.45000kHz     -23.2561 dBR       6.87374 %
               7      5.20000kHz     -15.8989 dBR       16.0345 %
               8      5.95000kHz     -22.7876 dBR       7.25470 %
               9      6.65000kHz     -23.5040 dBR       6.68036 %
              10      7.40000kHz     -19.0312 dBR       11.1799 %
              11      8.15000kHz     -28.9666 dBR       3.56179 %
              12      8.90000kHz     -23.8637 dBR       6.39460 %
              13      9.65000kHz     -21.6246 dBR       8.29416 %
              14      10.8500kHz     -33.5142 dBR       2.11005 %
              15      11.1000kHz     -24.3037 dBR       6.09290 %
              16      11.8500kHz     -24.0244 dBR       6.29187 %
              17      13.1000kHz     -29.5792 dBR       3.31923 %
              18      13.3000kHz     -24.8681 dBR       5.70944 %
              19      14.0500kHz     -26.5505 dBR       4.70408 %
              20      15.3500kHz     -27.7190 dBR       4.11198 %
Total Harmonic RMS & Dist:           -43.9586 dBV       62.5717 %

[SPECT: VIEW]                        AVG(SUM):    1/1
```

```
*** R9211  FFT SERVO ANALYZER ***         91-4-3     8:15: 8

Cs     750.000 Hz               -39.8861 dBV
F      750.000 Hz               -39.8861 dBV
THP    -43.9586 dBV
THD    62.5717 %

[SPECT: MARKER]                      AVG(SUM):    1/1
```

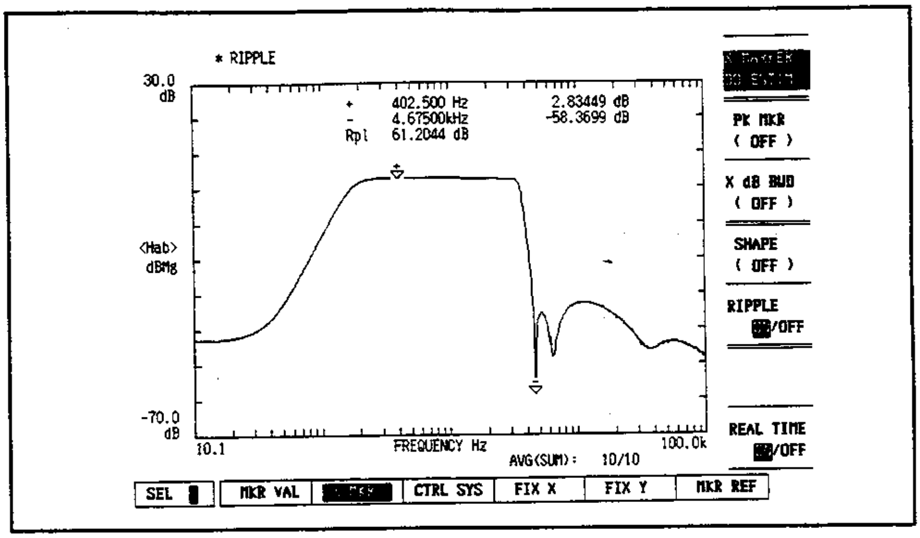
(8) Example of X dB band markers display: X dB BWD
The frequency (Cs) (marked $\bar{\nabla}$), corresponding to the data whose amplitude is lower than the specified reference level (X dB (-3dB in this example)), is searched and displayed.

- Bwd: Frequency range (between $\bar{\nabla}$ and $\overset{+}{\nabla}$) between the two frequencies which have a level lower than the specified reference level minus the specified difference.
- Ctr : Center frequency between $\bar{\nabla}$ and $\overset{+}{\nabla}$



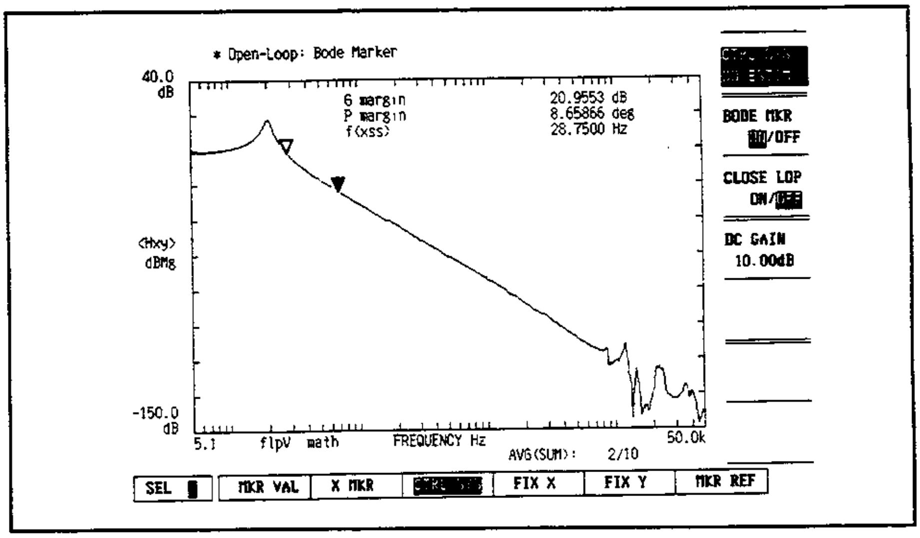
```
* X dB BWD <X dB: -3 dB>

Cs    725.000 Hz          2.77478 dB
Bwd   3.37875kHz
Ctr   1.86062kHz

AVG(SUM):    10/10    invalid
```

(9) Example of ripple markers display: RIPPLE
The maximum value ($\overset{+}{\triangledown}$), minimum value ($\overset{-}{\triangledown}$), and difference (Rpl) between these values are computed and displayed.



```
* RIPPLE
+     402.500 Hz      2.83449 dB
-     4.67500kHz     -58.3699 dB
Rpl   61.2044 dB
AVG(SUM):  10/10
```

(10) OPEN LOOP: BODE MKR
The gain corresponding to a phase of -180° is displayed with reference to 0dB (display of the Gain margin). The phase corresponding to a gain of 0dB is also displayed with reference to -180° (display of the Phase margin).



```
* Open-Loop: Bode Marker
G margin    20.9553 dB
P margin    8.65866 deg
f(xss)      28.7500 Hz
AVG(SUM):   2/10
```

Search Markers Display Timing

You can determine whether markers are to be updated each time the waveform changes.

MKR ⇒ X MKR ⇒ REAL TIME ON/OFF

• REAL TIME ON/OFF :	Markers are updated each time the waveform changes. (Markers are displayed in the real time mode.)
• REAL TIME ON/OFF:	Markers are displayed only once, either when the [DO ESTIM] key is pressed or when they are selected, they are not updated with the changes of the waveform.

3. DISPLAYING LISTS OF MARKERS

■ Reference Markers

The MKR REF (marker reference) key is used to set the output list in the list mode.

(VIEW ⇒ FORMAT ⇒ NUMERIC LIST)

See Figure 10-5.

MKR ⇒ MKR VAL ⇒ SINGLE X X_1 Y_1 — Displays one cursor. ⊙ (Move the cursor with the knob).

⇒ MKR REF ⇒ SET REF 1 — Sets the reference value (1-20) with numeric keys and the ENT key.

⇒ MKR REF — ⊙ (Move the cursor with the knob).

⇒ SET REF 2 — Sets the reference value (1-20) with numeric keys and the ENT key.

Up to twenty reference markers can be set by repeating the above procedure.

- **Recall method**

The method for recalling a reference marker, when you are in the graph-mode (not list mode), is as follows:

MKR ⇒ MKR REF ⇒ RCL REF 2 — Set the number of the reference marker (between 1 to 20) to be recalled with numeric keys and the ENT key.

- **Deletion method**

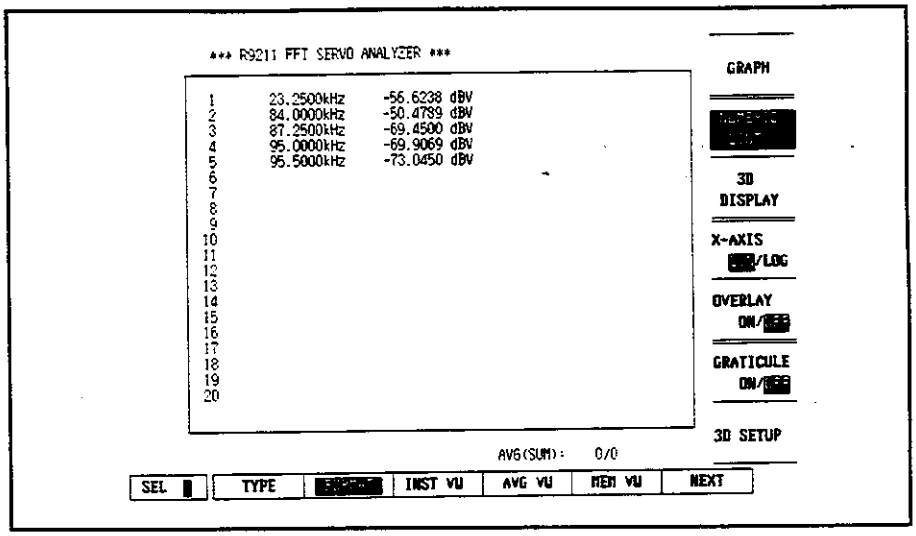
The method for deleting a reference marker is as follows:

MKR ⇒ MKR VAL ⇒ DEL REF 3 — Set the number of the reference marker (between 1 to 20) to be deleted with numeric keys and the ENT key.

- **Setting example**

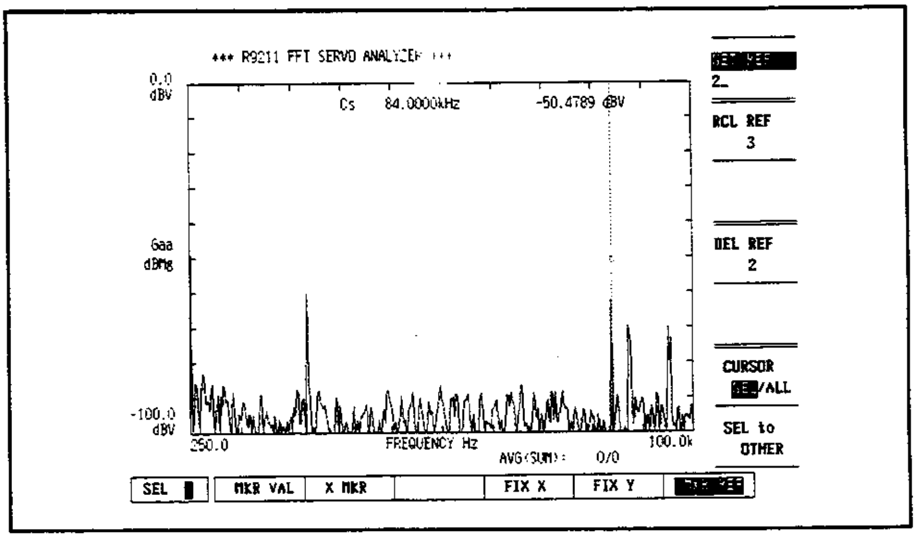
Display a cursor with MKR VAL. Press the SET REF key, then enter the reference marker number 2 with the numeric keys.

Press the ENT key to input the 84.00 kHz cursor as reference marker 2. See Figure 10-6.



```
*** R9211 FFT SERVO ANALYZER ***

 1    23.2500kHz    -56.6238 dBV
 2    84.0000kHz    -50.4789 dBV
 3    87.2500kHz    -69.4500 dBV
 4    95.0000kHz    -69.9069 dBV
 5    95.5000kHz    -73.0450 dBV
 6
 7
 8
 9
10
11
12
13
14
15
16
17
18
19
20

AVG(SUM):    0/0
```

Figure 10-5 Displaying a List of Reference Markers



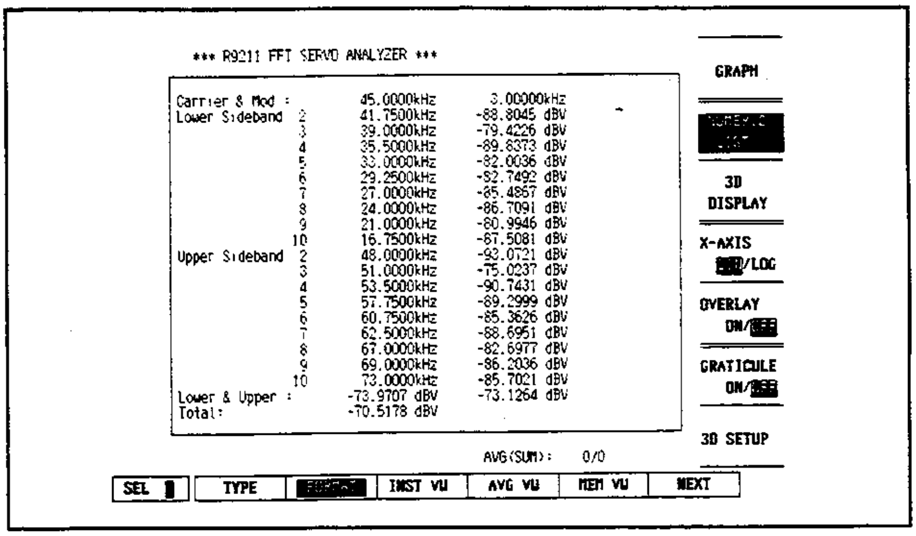
```
*** R9211 FFT SERVO ANALYZER ***
Cs    84.0000kHz        -50.4789 dBV
```

Figure 10-6 Example of Reference Marker Setting

Displaying Lists of Search Markers

If the following key sequence is executed when harmonics or sideband markers are displayed, the corresponding markers results list is displayed.

VIEW ⇒ FORMAT ⇒ NUMERIC LIST



```
*** R9211 FFT SERVO ANALYZER ***

Carrier & Mod :        45.0000kHz      3.00000kHz
Lower Sideband  2      41.7500kHz     -88.8045 dBV
                3      39.0000kHz     -79.4226 dBV
                4      35.5000kHz     -89.8373 dBV
                5      33.0000kHz     -82.0036 dBV
                6      29.2500kHz     -92.7492 dBV
                7      27.0000kHz     -85.4867 dBV
                8      24.0000kHz     -86.7091 dBV
                9      21.0000kHz     -80.9946 dBV
               10      16.7500kHz     -87.5081 dBV
Upper Sideband  2      48.0000kHz     -93.0721 dBV
                3      51.0000kHz     -75.0237 dBV
                4      53.5000kHz     -90.7431 dBV
                5      57.7500kHz     -89.2999 dBV
                6      60.7500kHz     -85.3626 dBV
                7      62.5000kHz     -88.6951 dBV
                8      67.0000kHz     -82.6977 dBV
                9      69.0000kHz     -86.2036 dBV
               10      73.0000kHz     -85.7021 dBV
Lower & Upper :       -73.9707 dBV    -73.1264 dBV
Total:                -70.5178 dBV

                             AVG(SUM):    0/0
```

Figure 10-7 Example of Marker Results List Corresponding to Sideband Marker

4. MAJOR EXAMPLES OF SEARCH MARKER SETTING

■ How to Use Search Markers

Markers are classified according to the initial conditions to be set.

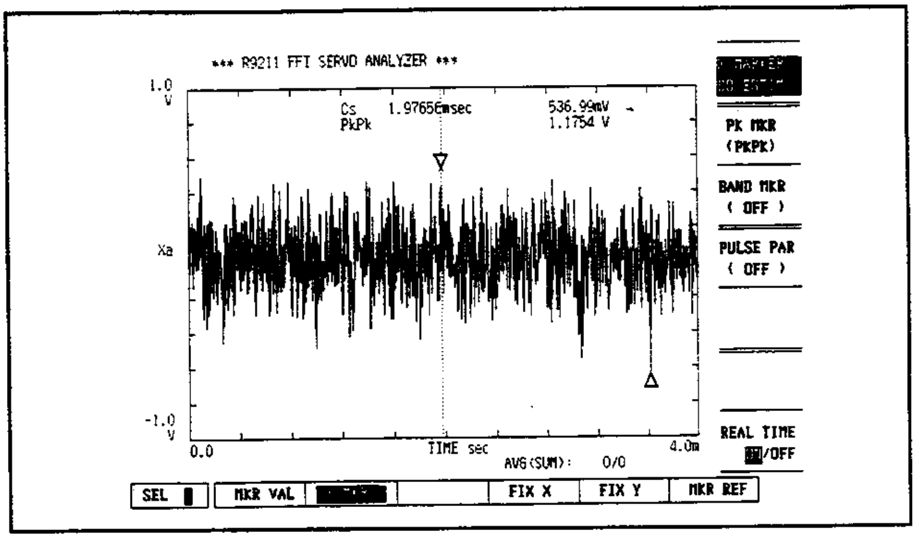
A	PKPK SINGLE PK	No condition must be set.
B	+PK, −PK NEXT RIGHT PK NEXT LEFT PK NEXT RIGHT MIN NEXT LEFT MIN	A range must be specified with a vertical and a horizontal cursor.
C	BAND MKR PULSE PAR	A range must be specified with two vertical cursors. (A default state is automatically provided.)
	DAMP PWR	
D	HARMONIC SIDEBAND	Frequency or amplitude must be specified.
	SHAPE X dB BWD	
E	BODE MKR CLOSE LOP RIPPLE	Others (CTL SYS)

- **How to use PKPK in the waveform mode**

This is the most basic procedure of the X MKR key:

MKR ⇒ X MKR ⇒ PK MKR (OFF) ⇒ PKPK

By pressing the above sequence, you will display the data related to the marked peak on the upper part of the screen.



```
Cs      1.97656msec     536.99mV
PkPk                    1.1754 V
```

Figure 10-8 Displaying the Marked Peak Data

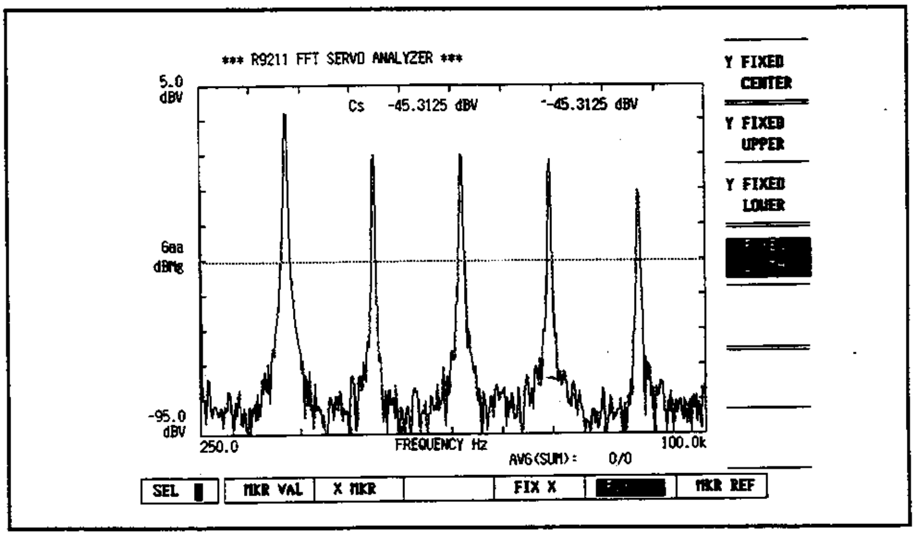
- **How to use the NEXT RIGHT PK (NEXT LEFT PK) marker in the spectrum mode,** to find the next right peak (the next left peak) whose amplitude exceeds the value previously set by the Y axis reference cursor.

(1) How to set the value of the reference Y cursor.

MKR ⇒ MKR VAL ⇒ Y1 Y2

By pressing the previous key sequence, you let the Y cursor appear on the screen.
Press the FIX Y key, then move the cursor with the knob.
(In this case, all selections from the Y axis fit. However, using Y FIXED WIDTH is the most suitable selection.)

Since the lower cursor is used as the reference cursor, the value of the upper cursor is ignored.



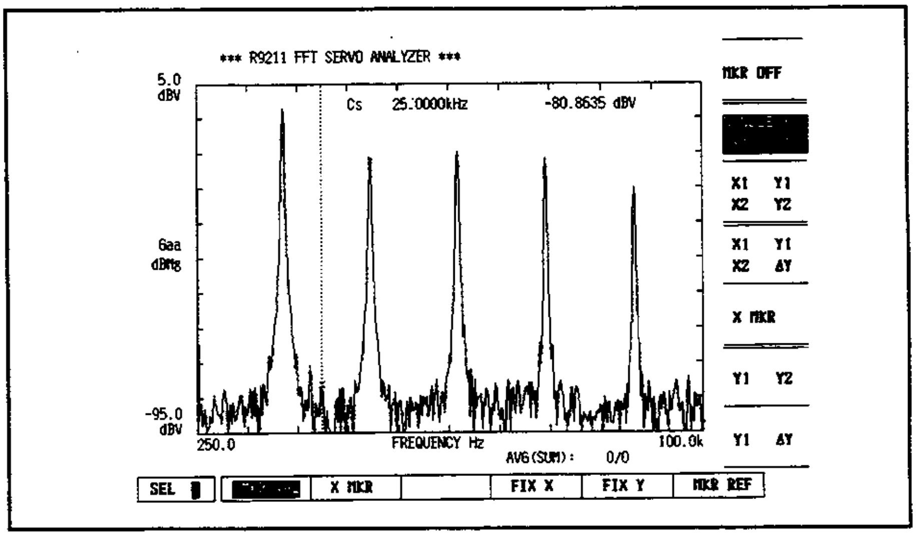
Note

VIEW ⇒ ***TYPE*** ⇒ ***Visible ON/OFF*** ***When this procedure is executed, the marker read-out window (marker read value frame) appears.***

(2) How to set the X cursor.

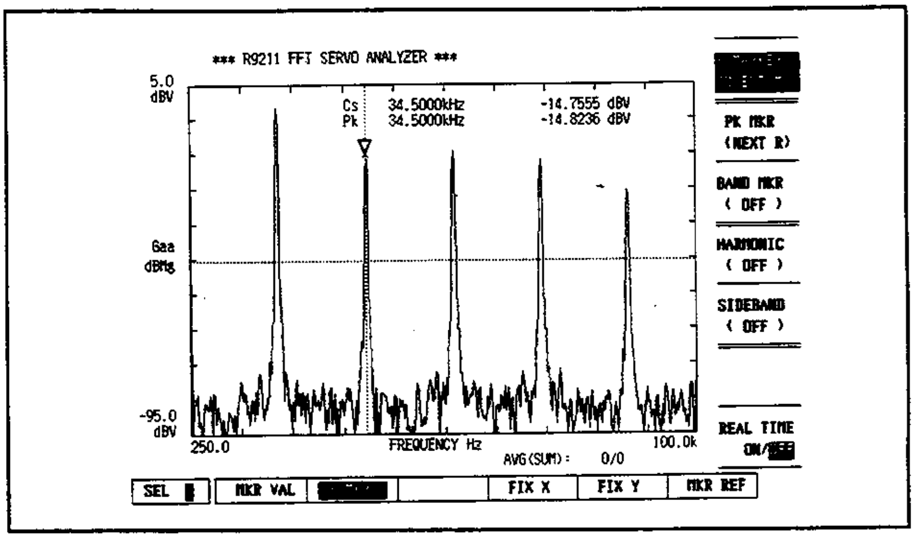
MKR VAL ⇒ SINGLE X X1 Y1 Press this key sequence

and move the X marker with the knob.



(3) How to evaluate the right peak value.

X MKR ⇒ PK MKR ⇒ NEXT RIGHT PK ⇒ RETURN ⇒ X MARKER DO ESTIM



● How to use BAND MKR

Obtain the peak, overall, average, or variance value in the specified frequency range.

(1) How to specify the frequency range.

MKR ⇒ MKR VAL ⇒ X1 Y1 X2 Y2

This sequence displays two cursors.

You need to fix the left cursor and move the right one to the upper limit of the frequency range to be specified.

FIX X ⇒ X FIXED LEFT

Using this sequence, the left cursor has been fixed.
You need to move the right cursor with the knob.
Now fix the right cursor and move the left one to the lower limit of the frequency range to be specified.

FIX X ⇒ X FIXED RIGHT

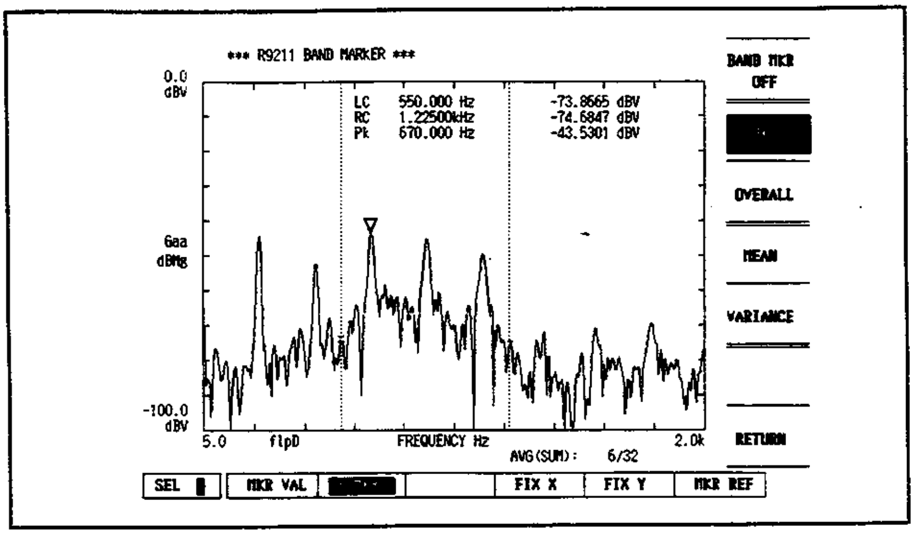
Thus, the right cursor has been fixed.
Move the left cursor with the knob.

Using this sequence, the range has been specified.

The frequency range has finally been specified.

(2) How to Evaluate the peak marker value.

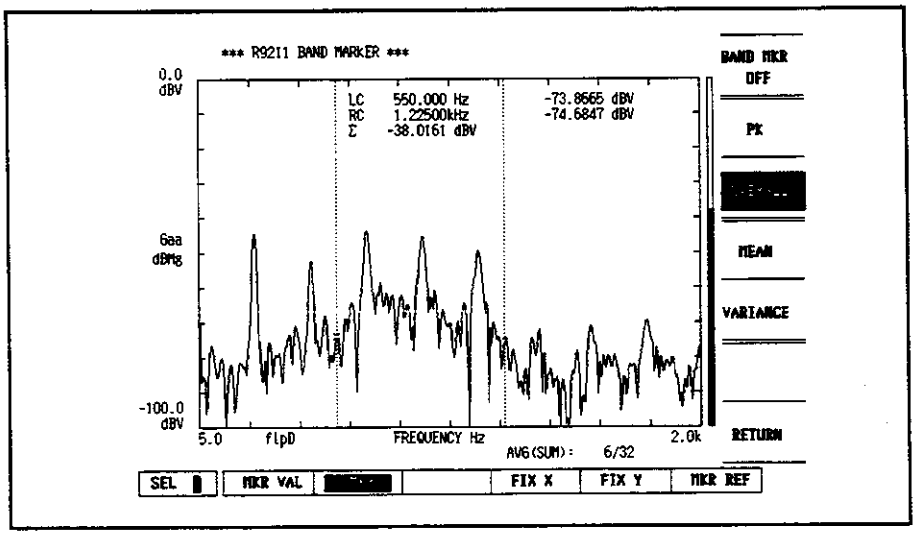
X MKR ⇒ BAND MKR (OFF) ⇒ PK



```
*** R9211 BAND MARKER ***
LC    550.000 Hz         -73.8665 dBV
RC    1.22500kHz         -74.6847 dBV
Pk    670.000 Hz         -43.5301 dBV
AVG(SUM):    6/32
```

(3) How to obtain the sum of the spectrum lines amplitude in the specified frequency range and display it in the bar format.

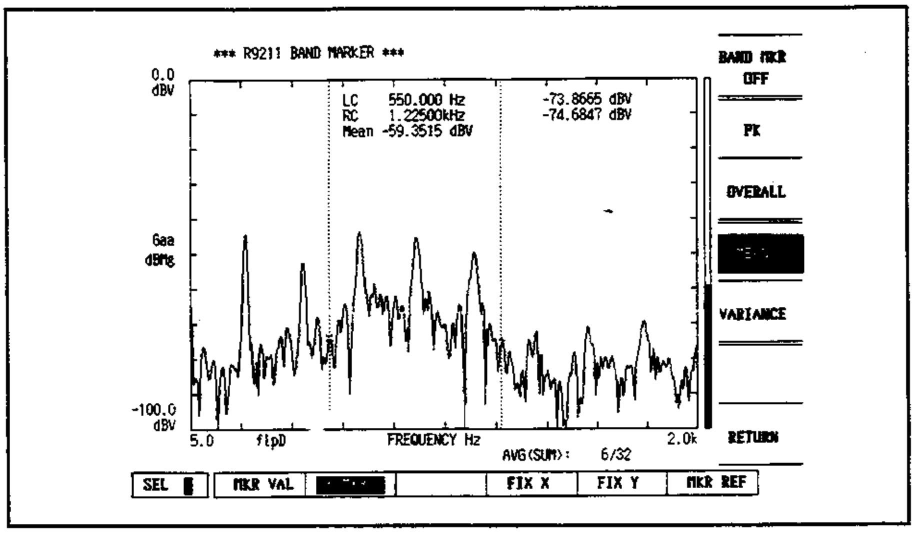
X MKR ⇒ BAND MKR ⇒ OVERALL



```
*** R9211 BAND MARKER ***
LC    550.000 Hz         -73.8665 dBV
RC    1.22500kHz         -74.6847 dBV
Σ     -38.0161 dBV
AVG(SUM):    6/32
```

(4) How to obtain the average of the spectrum in the specified range and display it in the bar format.

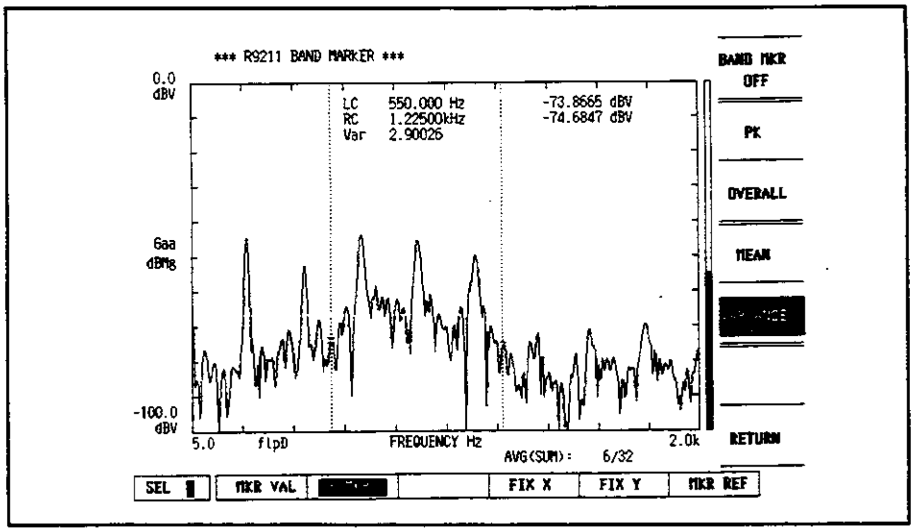
X MKR ⇒ BAND MKR ⇒ MEAN



```
*** R9211 BAND MARKER ***
LC    550.000 Hz        -73.8665 dBV
RC    1.22500kHz        -74.6847 dBV
Mean -59.3515 dBV
AVG(SUM):   6/32
```

(5) How to obtain the variance of the spectrum in the specified frequency range and display it in the bar format.

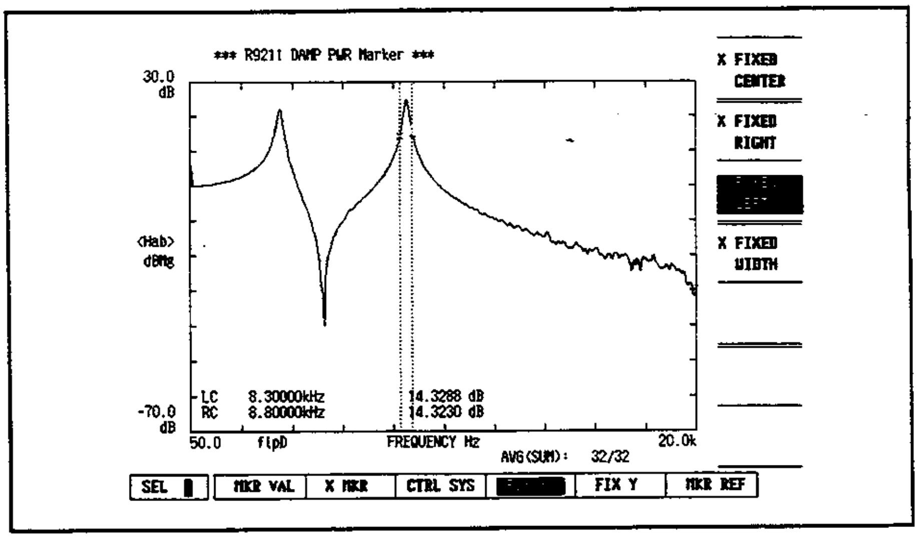
X MKR ⇒ BAND MKR ⇒ VARIANCE



```
*** R9211 BAND MARKER ***
LC    550.000 Hz        -73.8665 dBV
RC    1.22500kHz        -74.6847 dBV
Var   2.90026
AVG(SUM):   6/32
```

- **How to use DAMP PWR**

Evaluate the damping power marker value of the impulse response function. Use the arithmetic operation function to make the impulse response function suitable for the evaluation.
To do that, you first have to sample the peak portion of the frequency response function waveform and then execute an inverse Fourier transformation. The process is illustrated below.



```
LC   8.30000kHz    14.3288 dB
RC   8.80000kHz    14.3230 dB
```

(1) Register the frequency response function as an operand.

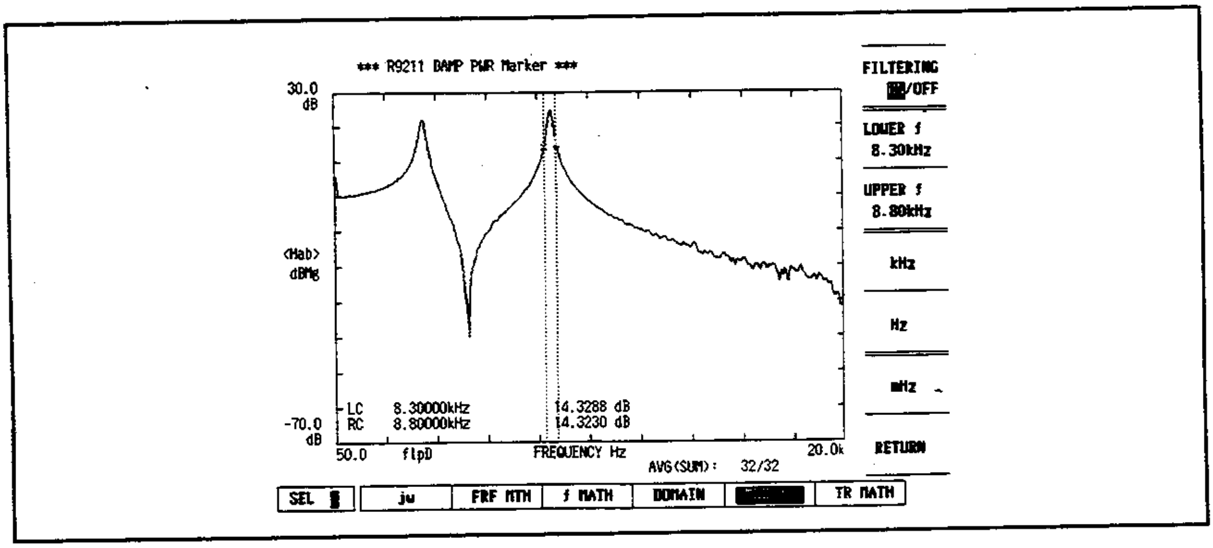
MATH ⇒ MOD f ⇒ MATH SEL ⇒ OPERAND

(2) Set the sampling range and set an operator.

RETURN ⇒ BANDPASS ⇒

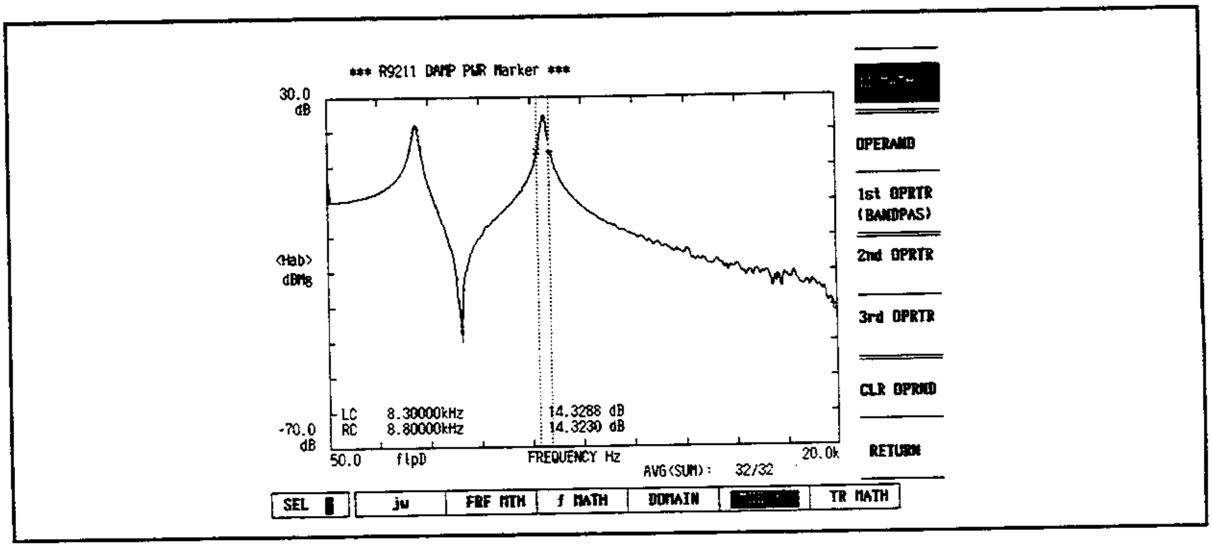
LOWER f ***	Set the sampling range with the numeric keys and a unit key.
UPPER f ***	
FILTERING ON/OFF	Press the filtering toggle key.

4. MAJOR EXAMPLES OF SEARCH MARKER SETTING



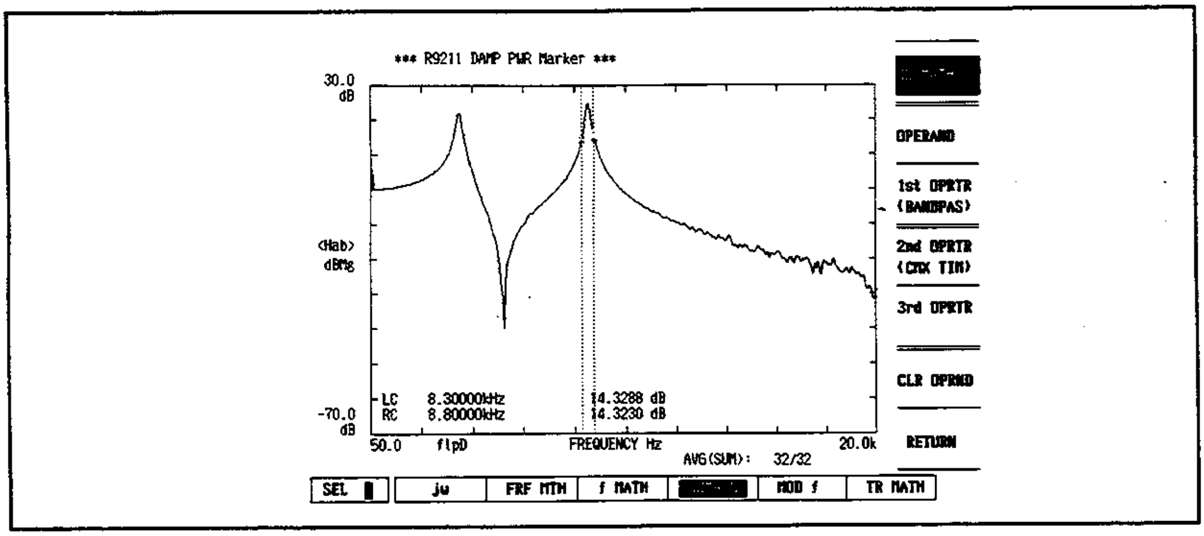
(3) Register the first OPRTR.

RETURN ⇒ MATH SEL ⇒ 1st OPRTR



(4) Prepare the reverse Fourier transformation for the second OPRTR.

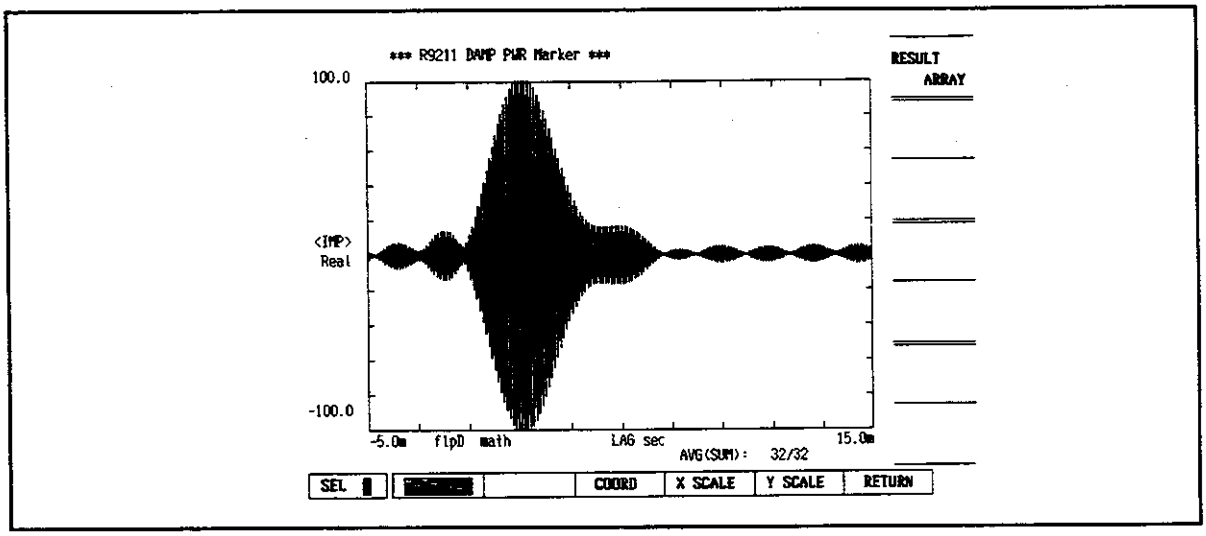
DOMAIN ⇒ to CMP TM (HILBERT) ⇒ MATH SEL ⇒ 2nd OPRTR


```
LC   8.30000kHz     14.3288 dB
RC   8.80000kHz     14.3230 dB
```

(5) By pressing the following sequence, the arithmetic operation is executed and the results are displayed.

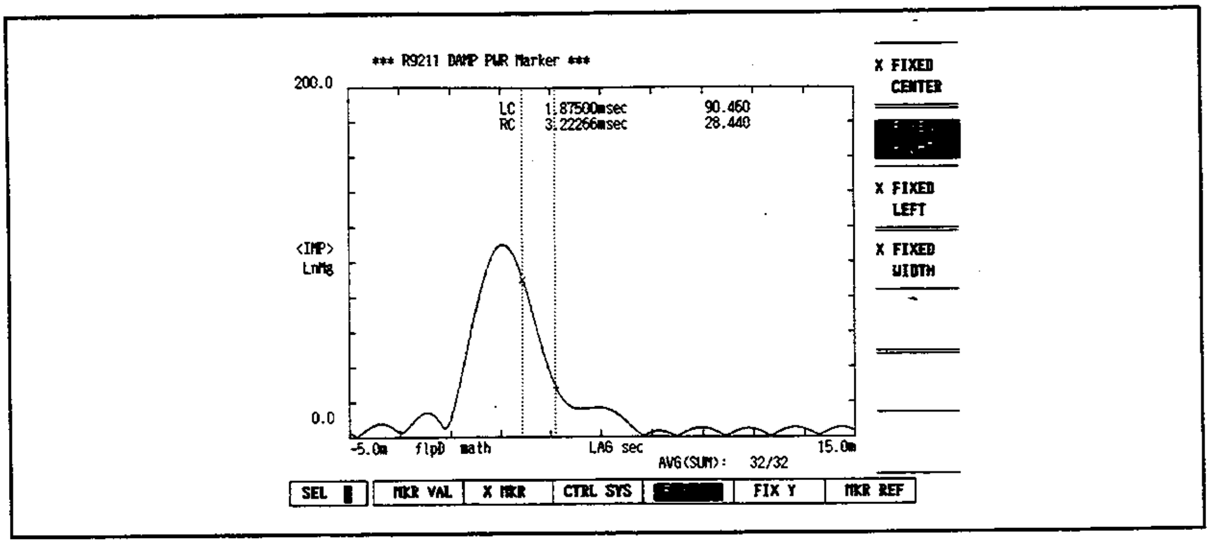
VIEW ⇒ NEXT ⇒ MATH VW ⇒ RESULT ARRAY

The impulse response function is displayed as shown below.
The damping power marker value can now be calculated.



4. MAJOR EXAMPLES OF SEARCH MARKER SETTING

(6) Specify the range with two vertical cursors. As explained in "o How to use BANK MKR". A linear portion of the curve must be selected.

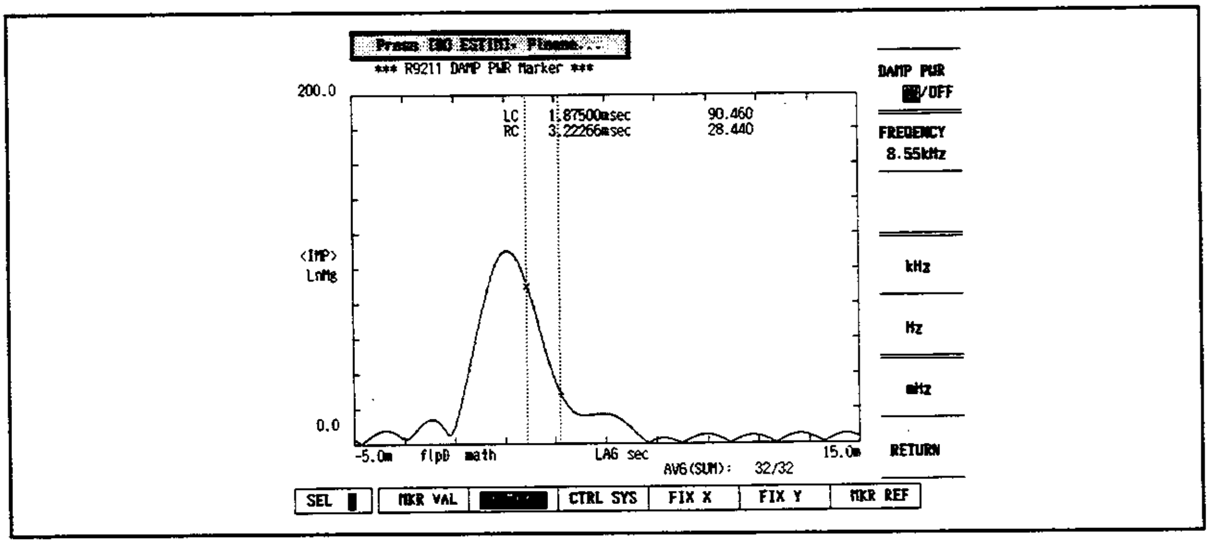


(7) Set the frequency for the damping ratio.

MKR ⇒ **X MKR** ⇒ **DAMP PWR (OFF)** ⇒ **FREQENCY ***** Enter the frequency with the numeric keys and a unit key.

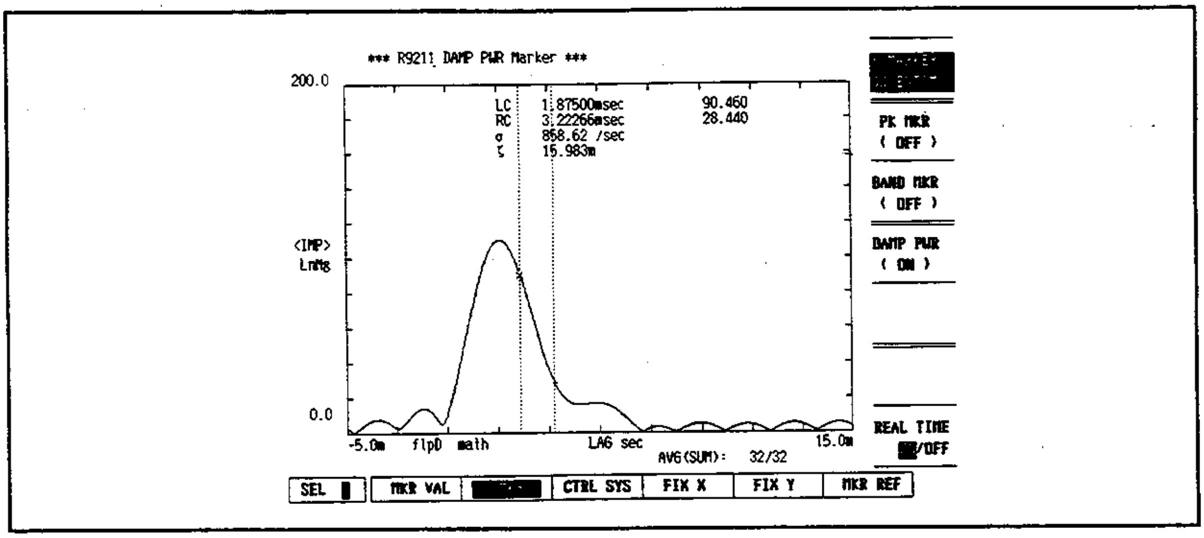
DAMP PWR ON/OFF When this key is pressed, the following message

Press [DO ESTIM], Please ... is displayed at the upper left corner of the screen:



RETURN ⇒ X MARKER DO ESTIM — When these keys are pressed, the marker value is displayed.

(Move the two vertical cursors to obtain an accurate damping coefficient. To obtain a more accurate damping coefficient, you can also average the damping coefficients obtained by moving the two vertical cursors.)



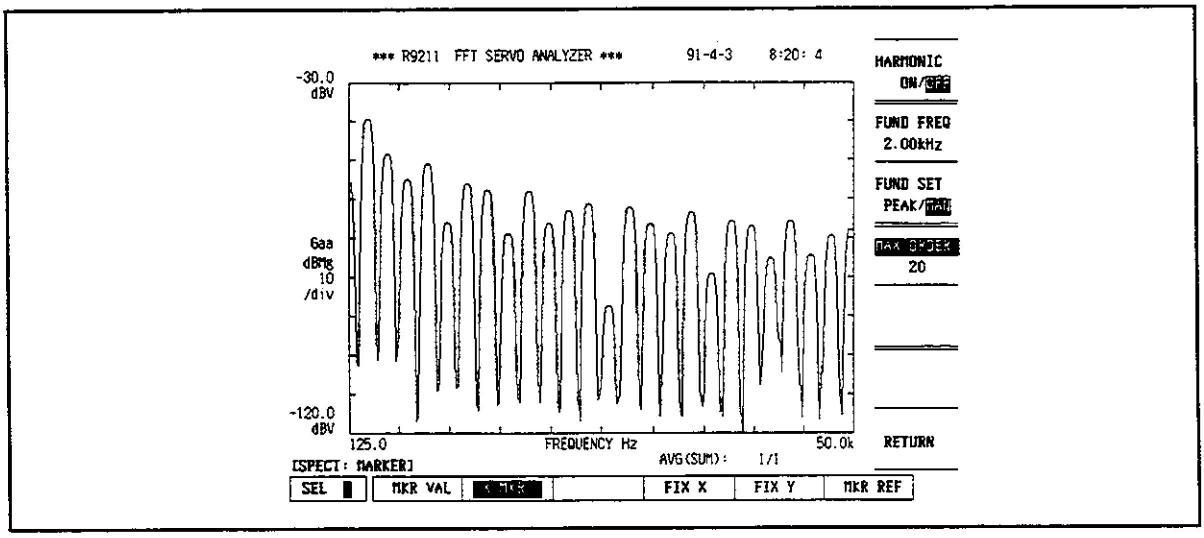
```
LC  1.87500msec   90.460
RC  3.22266msec   28.440
σ   858.62 /sec
ζ   15.983m
AVG(SUM):   32/32
```

● **How to use HARMONIC (when set the fundamental frequency)**

(1) Select the manual input for the fundamental frequency (When select PEAK, the setting value of the fundamental frequency is ignored.)

MKR ⇒ X MKR ⇒ HARMONIC (OFF) ⇒ FUND SET PEAK/MAN

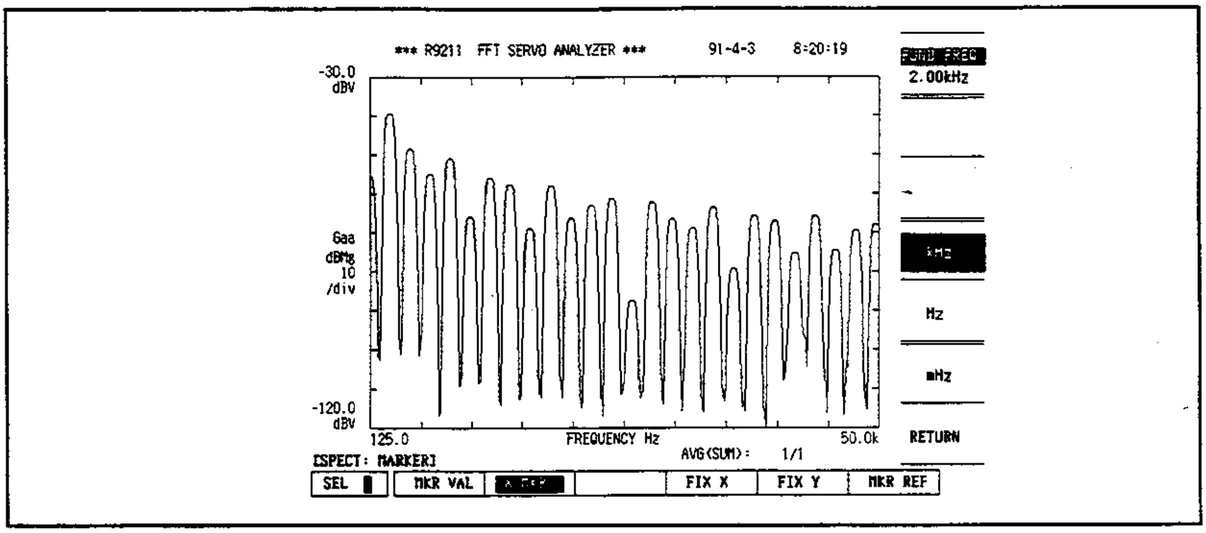
Specify this menu as FUND SET PEAK/**MAN**.



AVG(SUM): 1/1

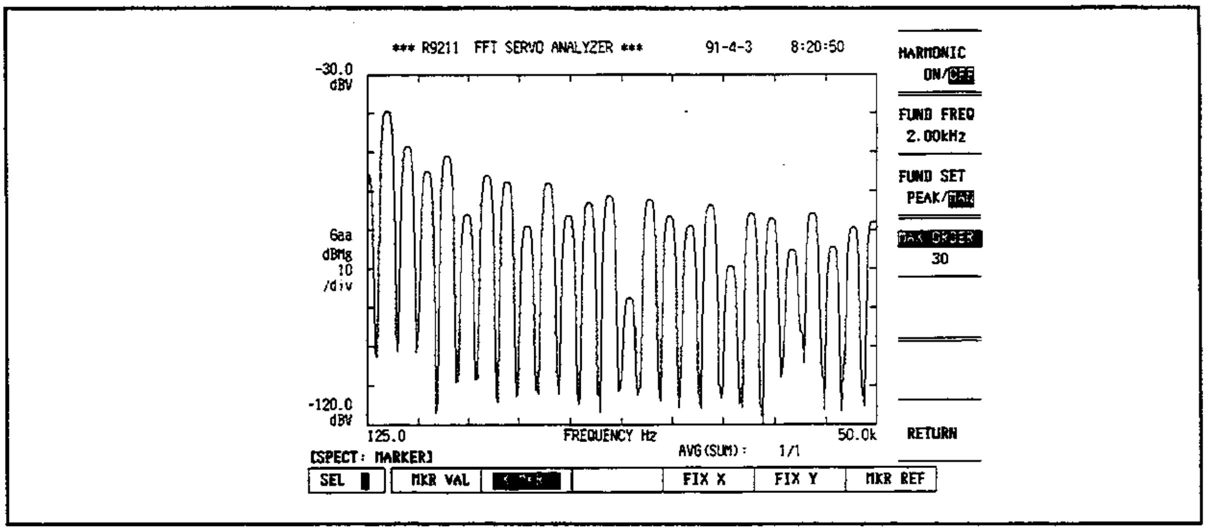
(2) Set the fundamental frequency.

When press $\frac{\text{FUND FREQ}}{\text{2.00kHz}}$, the new menu is displayed and enter with the numeric keys and the terminator key.



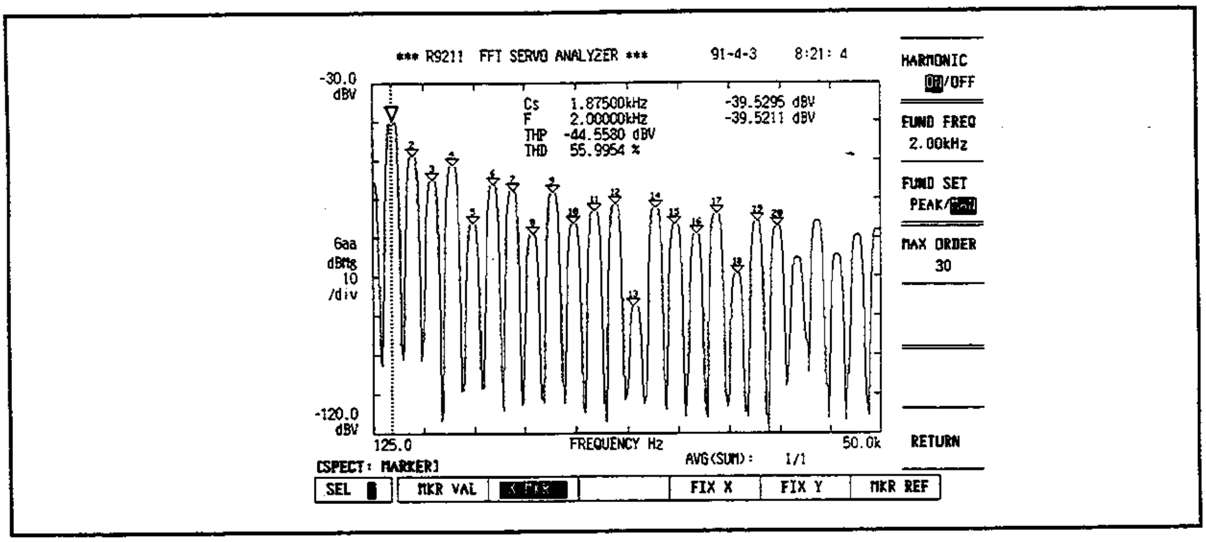
(3) Set search marker. (3 to 100)

Press $\frac{\text{MAX ORDER}}{\text{20}}$ and enter with the numeric keys and the $\boxed{\text{ENT}}$ key.



(4) Evaluate harmonic marker.

When press HARMONIC ON/OFF and HARMONIC ON/OFF is specified, the following Fig. is shown. (The marker displays to the 20 points in the maximum. The points more than 20 is reffered to the list display.)

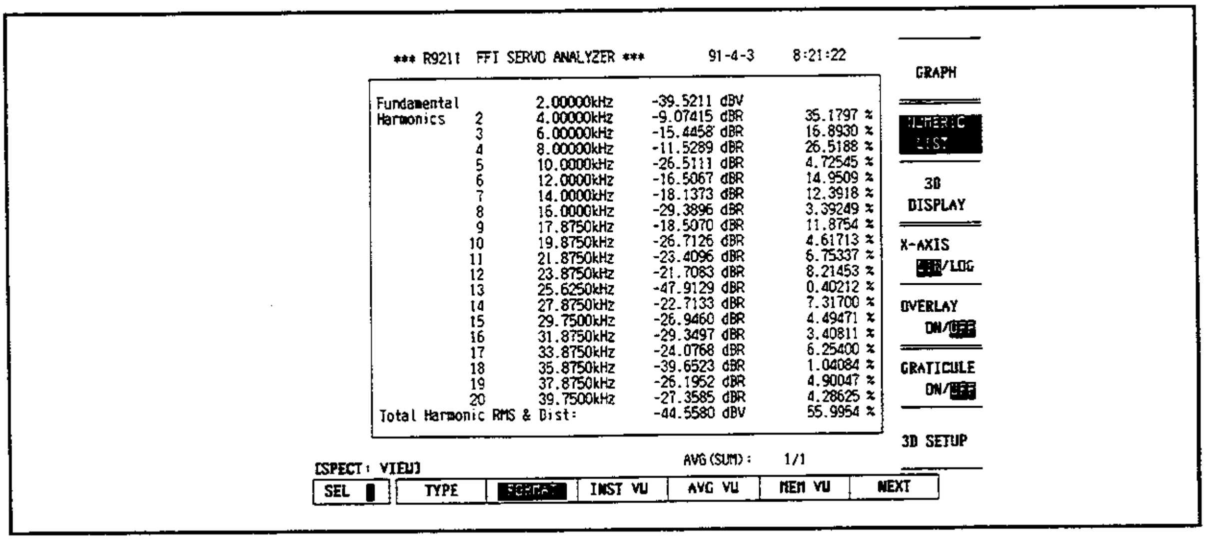


```
*** R9211  FFT SERVO ANALYZER ***        91-4-3     8:21: 4

   Cs    1.87500kHz              -39.5295 dBV
   F     2.00000kHz              -39.5211 dBV
   THP  -44.5580 dBV
   THD   55.9954 %
```

REMARK→

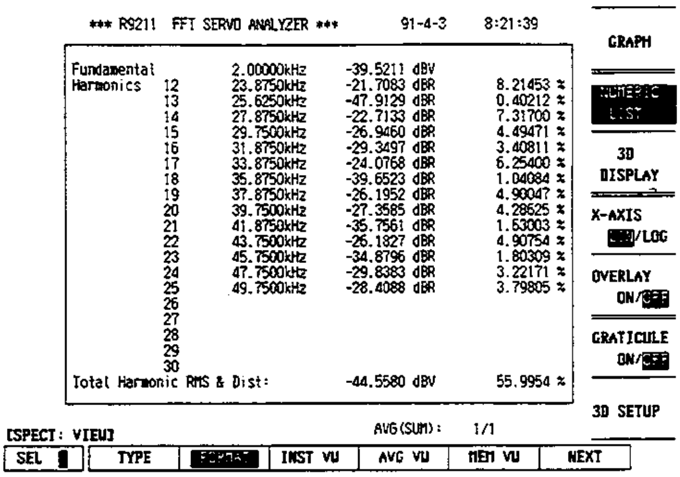
The following procedure can display the list of the harmonic marker.

VIEW ⇒ FORMAT ⇒ NUMERIC LIST



```
*** R9211  FFT SERVO ANALYZER ***        91-4-3     8:21:22

Fundamental          2.00000kHz     -39.5211 dBV
Harmonics      2     4.00000kHz     -9.07415 dBR      35.1797 %
               3     6.00000kHz     -15.4458 dBR      16.8930 %
               4     8.00000kHz     -11.5289 dBR      26.5188 %
               5     10.0000kHz     -26.5111 dBR      4.72545 %
               6     12.0000kHz     -16.5067 dBR      14.9509 %
               7     14.0000kHz     -18.1373 dBR      12.3918 %
               8     16.0000kHz     -29.3896 dBR      3.39249 %
               9     17.8750kHz     -18.5070 dBR      11.8754 %
              10     19.8750kHz     -26.7126 dBR      4.61713 %
              11     21.8750kHz     -23.4096 dBR      6.75337 %
              12     23.8750kHz     -21.7083 dBR      8.21453 %
              13     25.6250kHz     -47.9129 dBR      0.40212 %
              14     27.8750kHz     -22.7133 dBR      7.31700 %
              15     29.7500kHz     -26.9460 dBR      4.49471 %
              16     31.8750kHz     -29.3497 dBR      3.40811 %
              17     33.8750kHz     -24.0768 dBR      6.25400 %
              18     35.8750kHz     -39.6523 dBR      1.04084 %
              19     37.8750kHz     -26.1952 dBR      4.90047 %
              20     39.7500kHz     -27.3585 dBR      4.28625 %
 Total Harmonic RMS & Dist:         -44.5580 dBV      55.9954 %
```

The range of the list display can be changed with the up-down key and the knob.
The start point of the list display can be specified with the numeric keys and the **ENT** ***key.***



```
*** R9211  FFT SERVO ANALYZER ***        91-4-3     8:21:39

Fundamental          2.00000kHz    -39.5211 dBV
Harmonics     12     23.8750kHz    -21.7083 dBR         8.21453 %
              13     25.6250kHz    -47.9129 dBR         0.40212 %
              14     27.8750kHz    -22.7133 dBR         7.31700 %
              15     29.7500kHz    -26.9460 dBR         4.49471 %
              16     31.8750kHz    -29.3497 dBR         3.40811 %
              17     33.8750kHz    -24.0768 dBR         6.25400 %
              18     35.8750kHz    -39.6523 dBR         1.04084 %
              19     37.8750kHz    -26.1952 dBR         4.90047 %
              20     39.7500kHz    -27.3585 dBR         4.28625 %
              21     41.8750kHz    -35.7561 dBR         1.63003 %
              22     43.7500kHz    -26.1827 dBR         4.90754 %
              23     45.7500kHz    -34.8796 dBR         1.80309 %
              24     47.7500kHz    -29.8383 dBR         3.22171 %
              25     49.7500kHz    -28.4088 dBR         3.79805 %
              26
              27
              28
              29
              30
Total Harmonic RMS & Dist:         -44.5580 dBV        55.9954 %

[SPECT: VIEW]                      AVG(SUM):    1/1
```

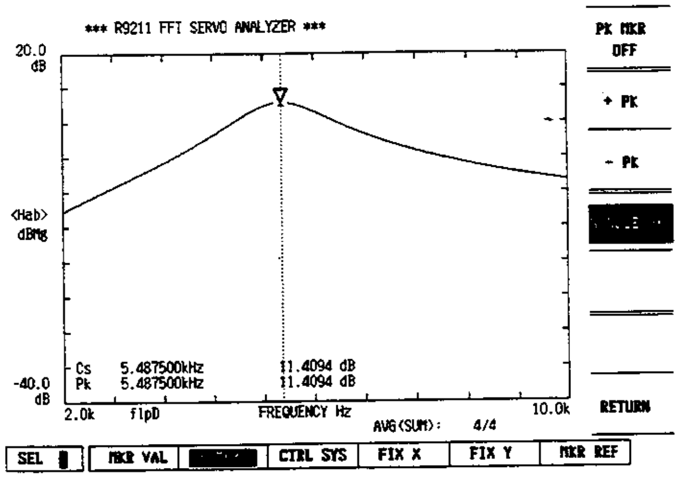
CAUTION !

When three or more screens are displayed in the multi-screen mode, a list cannot be displayed. Reduce the number of screens to 1 or 2.

● How to use X dB BWD

(1) Find a peak value with the single peak marker.

MKR ⇒ X MKR ⇒ PK MKR (OFF) ⇒ SINGLE PK



```
Cs    5.487500kHz      11.4094 dB
Pk    5.487500kHz      11.4094 dB
AVG(SUM):   4/4
```

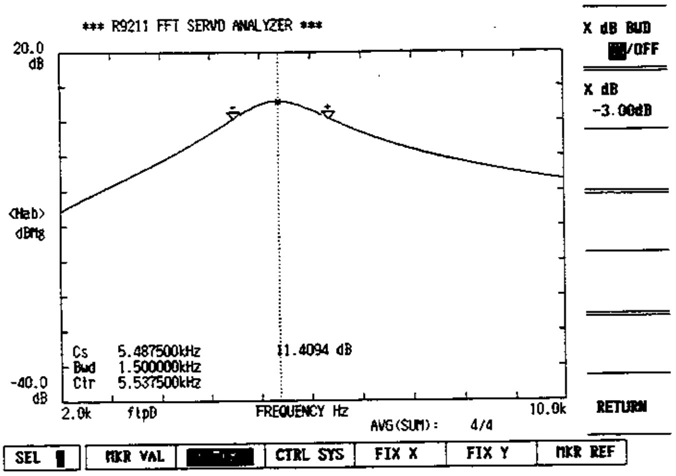
(2) Enter a value for X dB

X MKR ⇒ X dB BWD (OFF) ⇒ X dB *** dB

Enter the value with the numeric keys and the ENT key.

⇩

X dB BWD ON/OFF

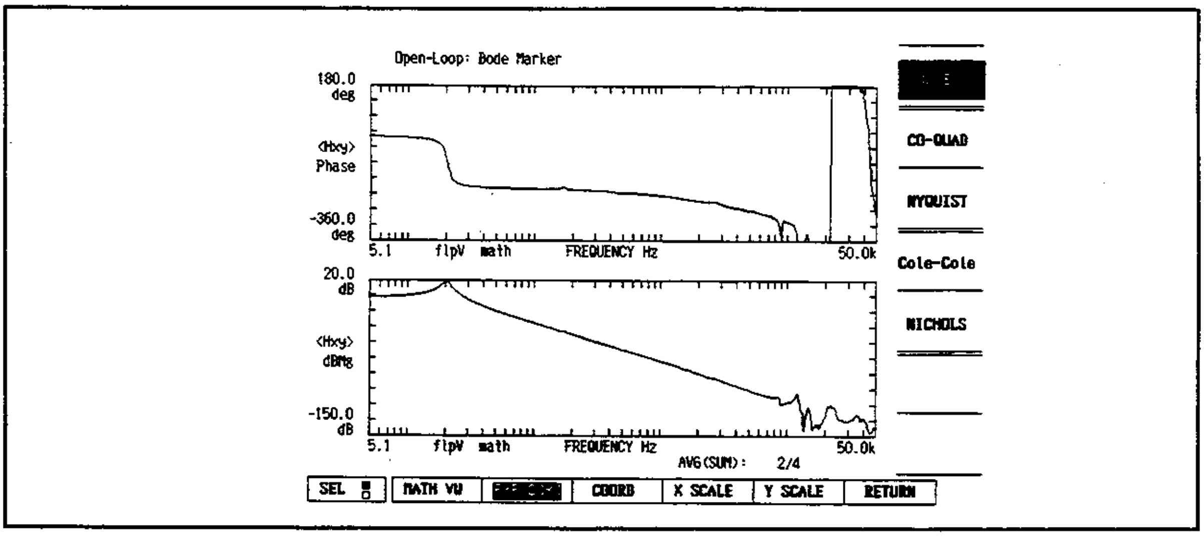


```
Cs    5.487500kHz      11.4094 dB
Bwd   1.500000kHz
Ctr   5.537500kHz
AVG(SUM):   4/4
```

● How to use BODE MKR

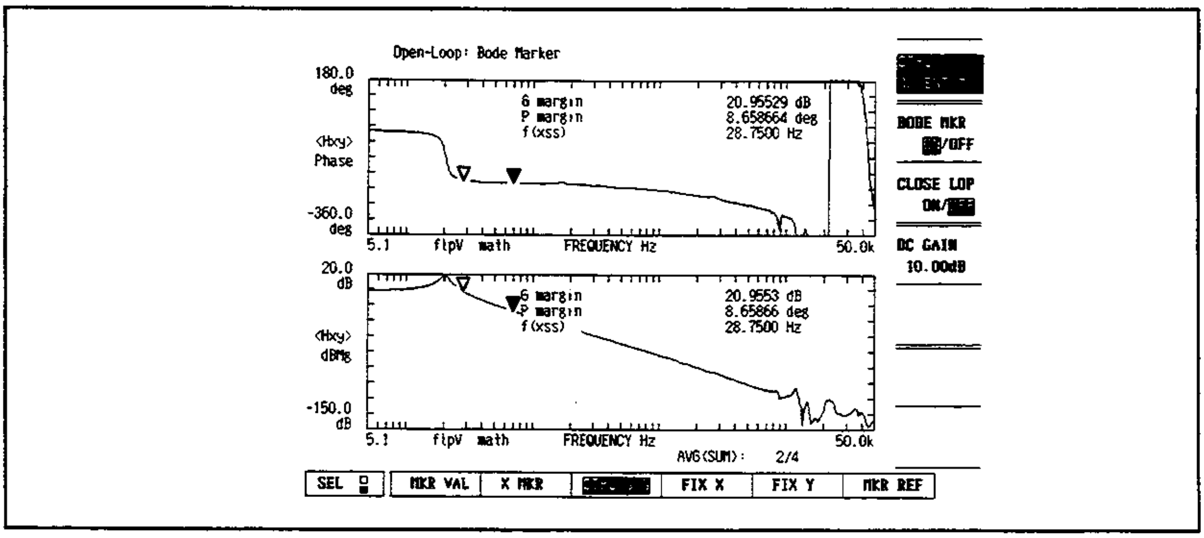
(1) The following sequence enables you to display the frequency response function.
(Displays Bode diagrams to show the phase and gain margin.)

VIEW ⇒ NEXT ⇒ FRF CORD ⇒ BODE



(2) With this sequence you can evaluate the Bode marker value.

MKR ⇒ CTRL SYS ⇒ BODE MKR ON/OFF

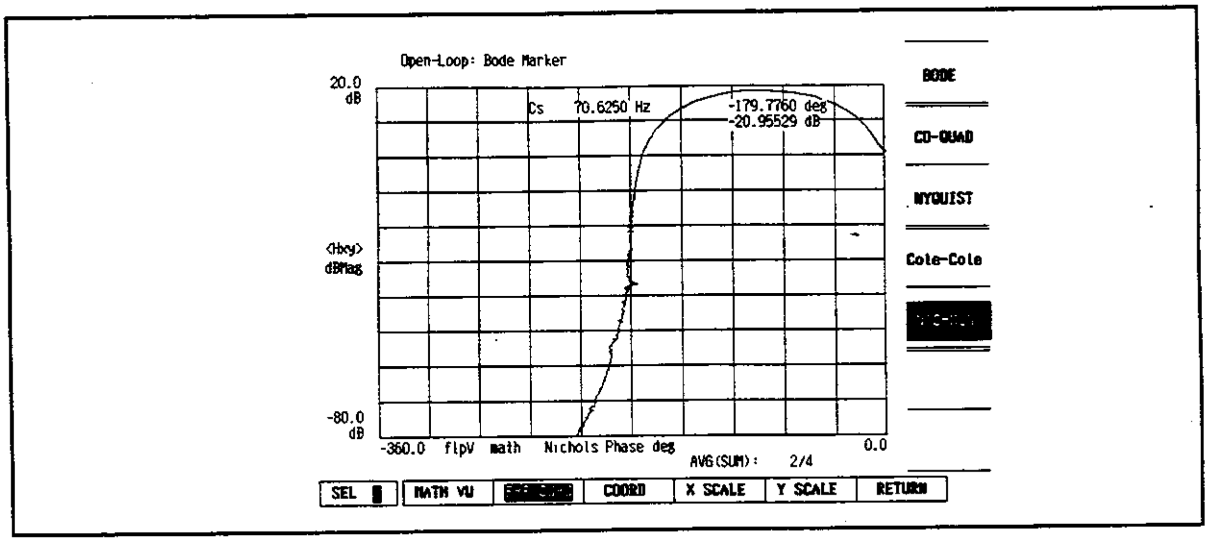


```
G margin       20.95529 dB
P margin       8.658664 deg
f(xss)         28.7500 Hz
```

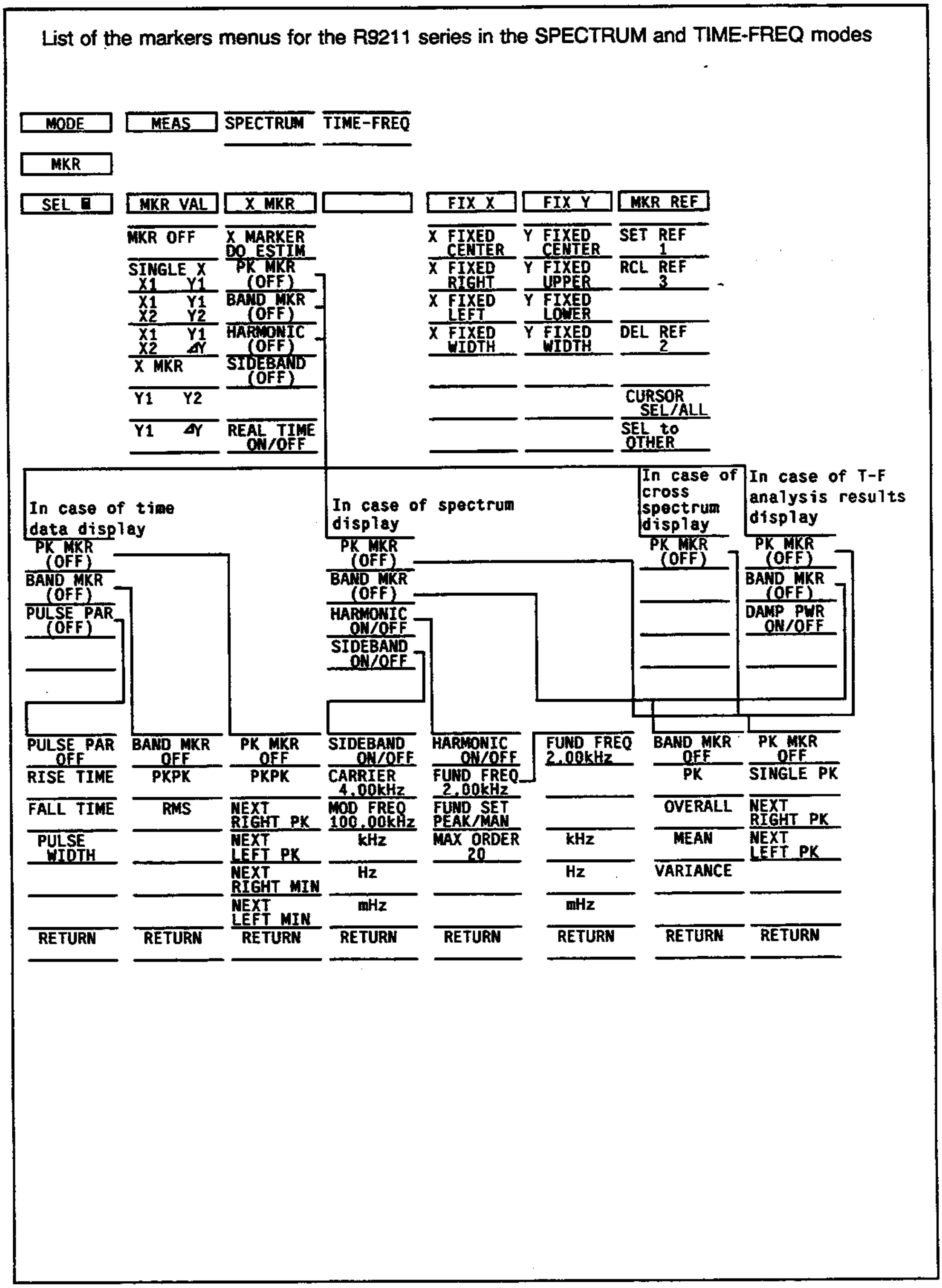
```
G margin       20.9553 dB
P margin       8.65866 deg
f(xss)         28.7500 Hz
```

(3) You can display a Nichols diagram by pressing the following keys:

VIEW ⇒ NEXT ⇒ FRF CORD ⇒ NICHOLS

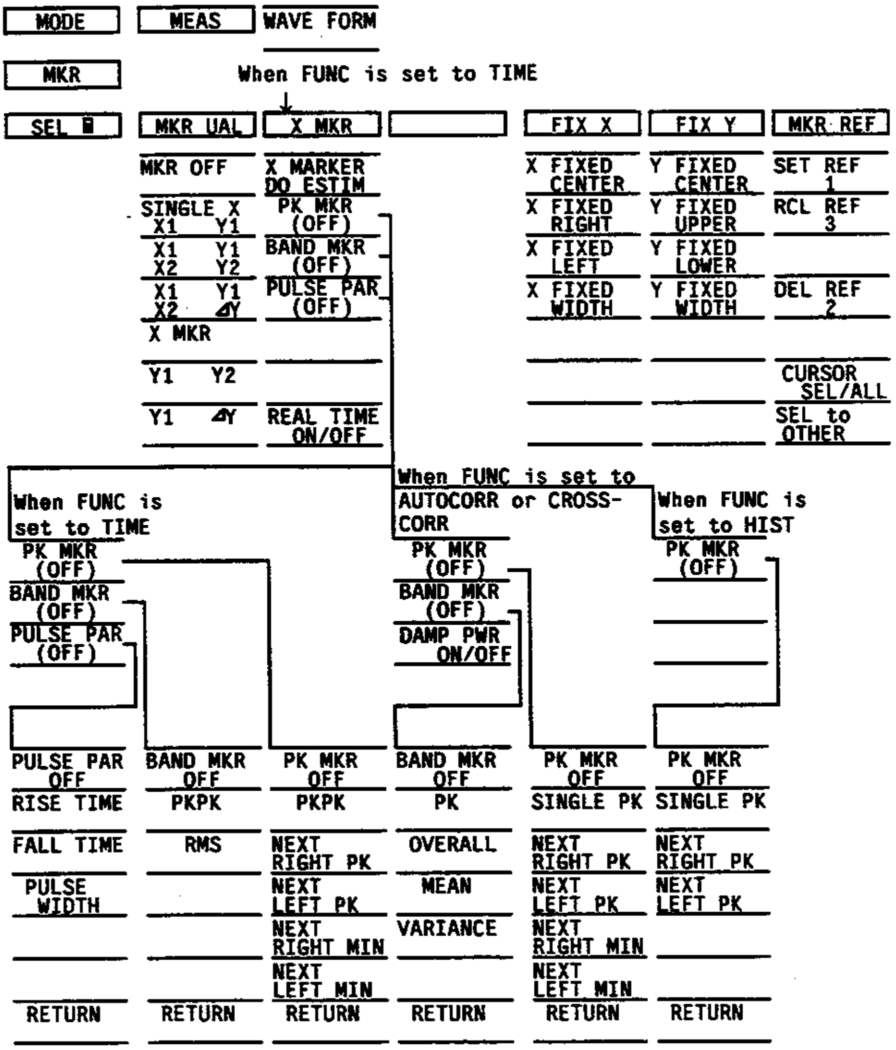


4. MAJOR EXAMPLES OF SEARCH MARKER SETTING



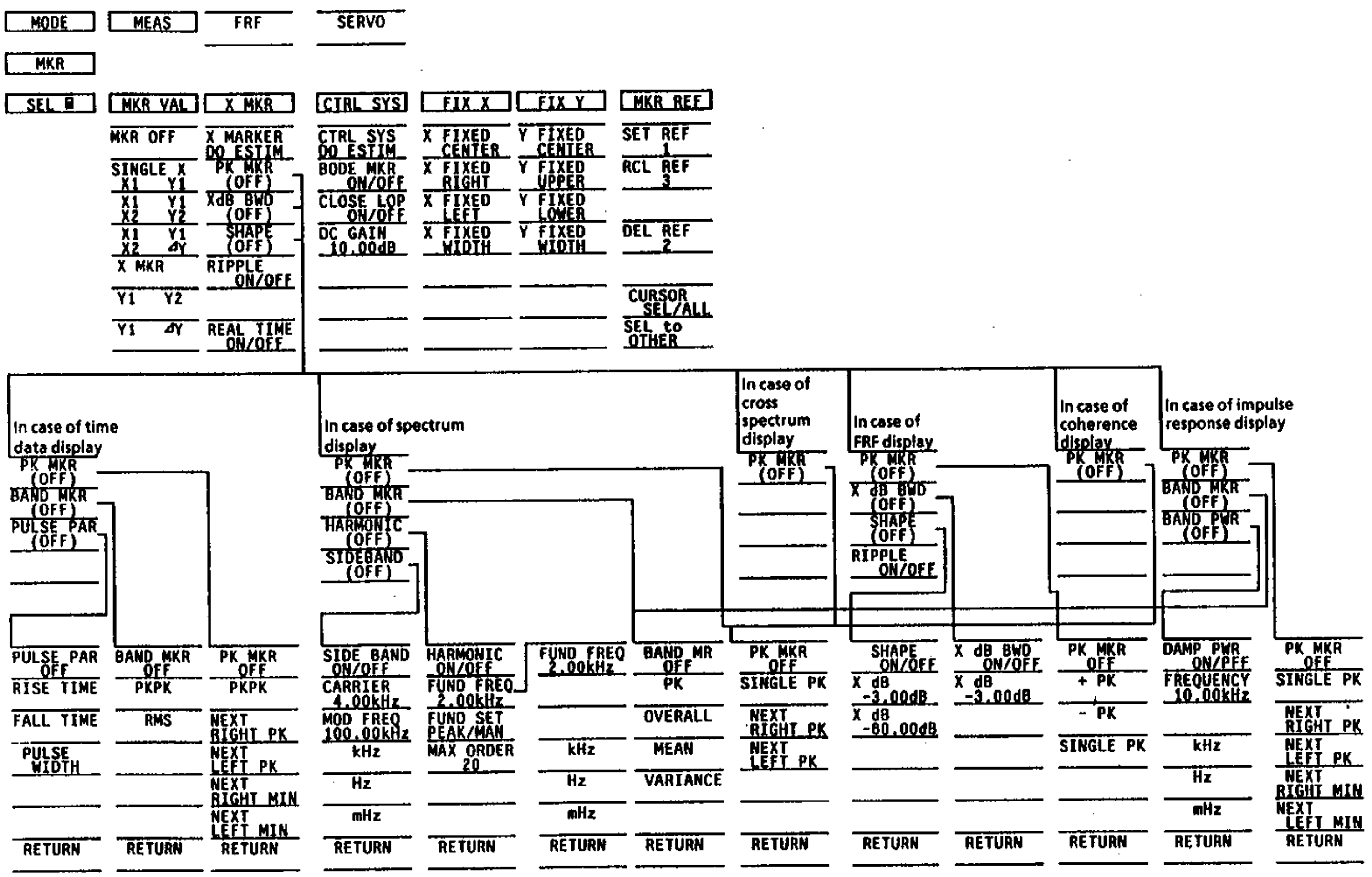
List of the markers menus for the R9211 series in the SPECTRUM and TIME-FREQ modes

List of the markers menu in the WAVEFORM mode for the R9211 series



4. MAJOR EXAMPLES OF SEARCH MARKER SETTING

List of markers menus in the FRF and SERVO modes for the R9211 series



CHAPTER 11

MATHEMATICAL OPERATIONS PROCEDURES

This chapter describes the different types of mathematical operations and explains how to use them.
Concrete procedures are given as examples.

CONTENTS

1. MATHEMATICAL OPERATIONS

The R9211 can execute the four basic arithmetic operations (+, −, ×, ÷), as well as integrations, differentiations, Fourier transformations, and so on, on the measurement data.
This constitutes what we call the mathematical (MATH) operations.

This chapter provides with easy-to-understand information about the mathematical operations that can be performed with the MATH key.

(These mathematical operations can be executed only if the MATH MENU has been previously selected with the PRESET key.)

The Different Types of Mathematical Operations

Table 11-1 Mathematical Operations Types (1)

Operator type		Measurement modes which can be selected			Function
Group	Operator	WAVE	SPECT TF	FRF SERVO	
$j\omega$	$j\omega$		○	○	Executes differentiation ($j\omega$), double differentiation $(j\omega)^2$, integration ($1/j\omega$), and double integration $(1/j\omega)^2$ on frequency domain data.
	$(j\omega)^2$		○	○	
	$1/j\omega$		○	○	
	$(1/j\omega)^2$		○	○	
	ROTATION		○	○	The operation destination domain is set in advance with $j\omega$ RANGE.
	FREQ SHIFT		○	○	Shifts frequency domain data from the frequency band specified as the source band to the band specified as destination band.
CEPSTRUM	CEPSTRUM		○		Computes the cepstrum of a power spectrum. (cf. Note) Obtains frequency-domain data (liftered spectrum) by liftering the cepstrum data.
	LIFTERING		○		
FRF	H/(1 + H)			○	For feedback control systems, computes the closed loop's FRF from the open loop's FRF when the feed back block has a transfer function of 1 : H(1 + H), or of G : H(1 + G.H).
	H/(1 + G•H)			○	
	H(1 − H)			○	For feed-back control systems, computes the open loop's FRF from the close loop's FRF when the feed-back block has a transfer function of 1 : H/(1-H) or of G : H/(1-G.H).
	H/(1 − G•H)			○	
	EQUALIZE			○	Equalizes FRF data using correction data.
	SNR			○	Computes, in the FRF mode the signal-to-noise ratio (SNR) according to the coherence function.
	COP			○	Extracts the signal components using the coherence function and the specified power spectrum, in the FRF mode.
	InCOP			○	Extracts the noise components using the coherence function and the specified power spectrum, in the FRF mode.
t (f) MATH	X + Y	○	○	○	Performs one of the 4 basic arithmetic operations on 2 arbitrary data series (linear Y axis data are used in the computations) at the condition that they are same X axis data (same domain and same range).
	X − Y	○	○	○	
	X•Y	○	○	○	
	X/Y	○	○	○	
	CNST + X	○	○	○	Adds to or multiplies by a specified constant (linear amplitude) arbitrary data.
	CNST •X	○	○	○	
	NEGATE	○	○	○	Multiplies data by -1.
	1/X	○	○	○	Inverses data.
	COMPLEX CONJUGATE	○	○	○	Computes the complex conjugate of data.
DOMAIN	to CMP TIME (HILBERT)	○	○	○	Estimates a pre-envelope (envelope) through Hilbert transformation.
	to TIME(IFFT)		○	○	Transfers frequency domain data to the time domain through IFFT (Inverse Fast Fourier Transform).
	to FREQ(FFT)	○	○	○	Transfers time domain data to the frequency domain through FFT.
MOD f	BANDPASS : FILTERING		○	○	Keeps only the frequency domain data within a specified frequency band.
	BANDSTOP : FILTERING		○	○	Keeps only the frequency domain data outside a specified frequency band.

Note : The logarithmic power spectrum is processed through FFT to obtain the time-domain data which compose the cepstrum. Thus, if low-level spectrum components are enlarged by a logarithmic representation in the frequency domain, these characteristics can be obtained in the time domain as well.
Liftering is the procedure by which FFT is executed on the necessary portion of the cepstrum data to restore it to the frequency domain.

Table 11-2 Mathematical Operations Types (2)

Group	Operator	Function
TR MATH	SMOOTHING	Smooths linear frequency power spectrum data.
	CUMULATION	Adds data together, (used for probability density functions or t-f analysis data).
	DIFFERENT	Differentiates time domain data.
	INTEGRATE	Integrates time domain data.
	INT ZERO	Integrates time domain data assuming that the start point is zero.
	TREND RMV	Removes the waveform trends.

■ Caution on Engineering Unit Setting for Operation Result

When execute the following operations, Engineering System Transform is not performed.

- 1/X
- X+Y
- X−Y
- X×Y
- X÷Y
- EQUALIZE

Classification of the Mathematical Operations

Table 11-3 Classification of the Mathematical Operations

<table>
<tr><td colspan="2">Two operands operations.</td></tr>
<tr><td>X + Y
X − Y
X * Y
X / Y
EQUALIZE
H/(I + G*H)
H/(I − G*H)
COP
lnCOP</td><td>The first operand is specified with the OPERAND key. The second operand specification is validated when the operator is selected.</td></tr>
<tr><td colspan="2">One operand operations.</td></tr>
<tr><td>NEGATE
1/X
COMPLEX CONJUGATE
SNR
H/(I + H)
H/(I − H)
to CMP TIME
to TIME
to FREQ</td><td>The operand is specified with the OPERAND key.</td></tr>
<tr><td colspan="2">One operand operations with parameters.</td></tr>
<tr><td>CNST + X
CNST*X
$j\omega(j\omega)^2$, $1/(j\omega)$, $1/(j\omega)^2$
ROTATION
FREQ SHIFT
BANDPASS
BANDSTOP
CEPSTRUM
LIFTERING</td><td>The operand is specified with the OPERAND key.
The other parameters specification is validated at the time the operator is selected and must be set in advance.</td></tr>
<tr><td colspan="2">TR MATH mode operations.</td></tr>
<tr><td>SMOOTHING
CUMULATION
DIFFERENT
INTEGRATE
INT ZERO
TREND RMV</td><td>"SMOOTHING" requires that "TERMS" be set. Others do not require it.
They are activated (deactivated) for the data on the screen by selecting on (off).</td></tr>
</table>

Restrictions on the Mathematical Operations

There are constraints on the waveforms that can be input as operand for certain operations. Restrictions on the operations except the TR MATH functions are described in points (1) to (3) and the restrictions on the TR MATH functions are described in point (4).

(1) Restrictions common to all operation functions

T-F analysis results
Operation Results
Orbit
Zoomed time Waveform

} No operation enabled.

No operation is enabled if either the operand or the operation result is a complex series of more than 1024.

(2) Restrictions on the four basic arithmetic operations
Table 11-4 lists the possible combinations of the 4 basic arithmetic, 2 operands, operations. (These operations are disabled for the coherence function.)

Table 11-4 Possible Combinations of the 4 Basic Arithmetic Operations

	Xx	Rxx	Rxy	Imp	Step	Px	Sx	Gxx	Gxy	Hxy
Xx (Time waveform)	○	×	×	×	×	×	×	×	×	×
Rxx (Autocorrelation function)	×	○	○	×	×	×	×	×	×	×
Rxy (Cross-correlation function)	×	○	○	×	×	×	×	×	×	×
Imp (Impulse response function)	×	×	×	○	○	×	×	×	×	×
Step (Step response function)	×	×	×	○	○	×	×	×	×	×
Px (Probability density function)	×	×	×	×	×	○	×	×	×	×
Sx (Complex spectrum)	×	×	×	×	×	×	○	○	×	A
Gxx (Power spectrum)	×	×	×	×	×	×	○	○	×	A
Gxy (Cross-spectrum)	×	×	×	×	×	×	×	×	○	×
Hxy (Frequency response function)	×	×	×	×	×	×	×	B	B	○

○ : X+Y, X-Y, X∗Y, and X/Y are enabled.
A : Only X∗Y and X/Y are enabled.
B : Only X∗Y is enabled.
× : None is enabled.

CAUTION !

- ***No operation is enabled if the sizes or the abscissa axis scales are different between the operands.***
- ***No operation is enabled on servo data if the sweep methods are different.***

(3) Other mathematical operations
COP and lnCOP can be executed only on the combination of a power spectrum and a coherence function.
For other operations, see Table 11-5.

Table 11-5 Enabled Mathematical Operations Versus Data Types

Enabled mathematical operations versus data types												
	Xx	Gxx	Rxy	Imp	Step	Px	Sx	Gxx	Gxy	Hxy	Coh	
CNST+X	○	×	×	○	○	○	○	○	○	○	×	
CNST*X	○	×	×	○	○	○	○	○	○	○	×	
NEGATE	○	×	×	○	○	○	○	○	○	○	×	
1/X	○	×	×	○	○	○	○	○	○	○	×	
CMP CNJ	○	×	×	○	○	○	○	○	○	○	×	
to FREQ	○	×	×	×	×	×	×	×	×	×	×	*1
to TIME	×	×	×	×	×	×	○	×	×	○	×	*2
to CMPTM	×	×	×	×	×	×	○	×	×	○	×	*2
jω related operations	×	×	×	×	×	×	○	○	×	○	×	*3
ROTATION	×	×	×	×	×	×	○	×	×	○	×	
frq SHFT	×	×	×	×	×	×	○	○	×	○	×	*4
to QUFR	×	×	×	×	×	×	×	○	×	×	×	*5
LIFT	×	×	×	×	×	×	×	×	×	×	×	*6
H/(1+H)	×	×	×	×	×	×	×	×	×	○	×	
H/(1+GH)	×	×	×	×	×	×	×	×	×	○	×	*7
H/(1−H)	×	×	×	×	×	×	×	×	×	○	×	
H/(1−GH)	×	×	×	×	×	×	×	×	×	○	×	*7
EQUALIZE	×	×	×	×	×	×	×	×	×	○	×	*7
SNR	×	×	×	×	×	×	×	×	×	×	○	
BANDPASS	×	×	×	×	×	×	○	○	×	○	×	
BANDSTOP	×	×	×	×	×	×	○	○	×	○	×	

Under the following conditions, the operations marked with a number from *1 to *7 cannot be executed even on the data marked with ○.

*1 : In the log or octave analysis mode
: When included in an operations sequence, the operation registered next to this one cannot be executed.

*2 : Same as *1.
: The data is zoomed and the start frequency is not 0Hz.
: When a pre-envelope is estimated (in the case when the operand is not a frequency response function), the window applied to the operand is a flat pass, a force, or a response window. (The operation result is forced to 0.)

*3 : More than 2 operations such as differentiation, integration, double differentiation, or double integration, cannot be used in an operations combination.

*4 : The abscissa axis is not linear. (Servo, T-F analysis are disabled.)

*5 : The abscissa axis is not linear.
: Zoomed data.
: Operation combination (The only possible situation is when the first operator is "to QUFR" and the second operator is "LIFT".)

*6 : The operand is Cx (cepstrum) only. However, since an operation result cannot be set as operand, use an operations combination :
First operator: to QUFR
Second operator: LIFT

*7 : The operation between two data (frequency response functions) cannot be executed in the following cases:
When the sizes are different.
When the abscissa scales are different.
When the sweep methods (servo mode) are different.

(4) Restrictions on TRACE MATH functions

CUMULATION	Enabled for all data.
SMOOTHING TREND RMV	Disabled if the abscissa axis scale is not linear.
DIFFERENT INTEGRATE INT ZERO	Enabled only for time waveforms. (A pre-envelope cannot be estimated.)

2. BASIC PROCEDURES

The basic procedure common to all operations except the TR MATH procedure is described below.
About the TR MATH operation procedure, see "■ TR MATH".
The operation is executed on the data displayed on the selected screen.

■ Basic Operation Procedure (Example of "X + Y")

1 Specify an operand (unique operand or first operand)

MATH ⇒ SEL .... Select the screen where the operand is displayed with the SEL key.

⇒ MATH SEL

⇒ OPERAND .... The screen selected with the SEL key is registered as operand (X).

⇒ RETURN

CAUTION !
If two operands are required for the desired operation (for example, for "X + Y": X and Y are the required operands), you must register the first operand as has been described above (OPERAND key), next, you must select the second operand's screen with the SEL key, finally you must step to point 2 of this procedure.

2 Select an operator.

jω
CEPSTRUM
FRF MATH
⇒ f MATH
DOMAIN
MOD f

.... Select the operator's class. For "X + Y", press the f MATH key.

⇒ ALGEBRA (OFF)

⇒ X+Y ......Select the first operator. In our example, we select X+Y.

⇒ RETURN

Other parameters may be required depending on the operator type. See concrete setup examples.

3 Register the selected operator.

⇒ MATH SEL ⇒ 1st OPRTR ...... The operand (Y) is registered simultaneously with the 1st operator.

CAUTION !
For an operations combination, select the second operand and press the 2nd OPRTR key, or select the third operand, and press the 3rd OPRTR key.
If some operand is required, display the operand data in advance and select the data with the SEL key, before registering the corresponding operator.

4 Execute the selected operation.

⇒ DO MATH ......Execution

MT.mg = MATH completed! ...... Execution completion

CAUTION !
If the selected operation cannot be executed, an error message is displayed. For details on the error messages, see the Appendix.

5 Display the operation results.

VIEW ⇒ (NEXT)

⇒ MATH VW ⇒ RESULT ARRAY ......Display of the results.

3. EXAMPLES OF MATHEMATICAL OPERATIONS

Major operations examples are described below.

■ 1/(jω)^2

A double integration will be executed on frequency domain data (spectrum or FRF data). For example, a displacement can be estimated through a double integration of the acceleration output from an acceleration sensor. In this example, we describe how to estimate the power spectrum of a displacement from the power spectrum of the corresponding acceleration.

1 Specify the operand.

Input the output signal of the acceleration sensor to channel A.
Display this data.

VIEW ⇒ TYPE ⇒ DUAL — Use the double screen configuration.

⇒ SEL ▤

⇒ INST VW ⇒ CH-A SPECT — Display the operand on the upper screen.

MATH ⇒ MATH SEL

⇒ OPERAND — Register the operand. The operand must have been displayed on the screen, and the screen selected.

2 Select an operator.

⇒ j ω ⇒ j ω RANGE

⇒ THRESHOLD −100dBV — To avoid noise influence, execute the operation only on data whose level is higher than a specified level threshold.

⇒ LOWER f 25Hz

⇒ UPPER f 10kHz

Specify a frequency range (band pass filter) for the operation. In this example, we chose to perform the operation over the whole analysis domain.

⇒ RETURN

⇒ j ω ? Select the operator.

⇒ (l/j ω)2 A double integration is chosen in this example.

⇒ RETURN

3 **Register the operator.**

⇒ MATH SEL

⇒ 1st OPRTR Register $(1/j\omega)^2$ as 1st operator.

4 **Execute the operation.**

⇒ DO MATH Execute the operation.

MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

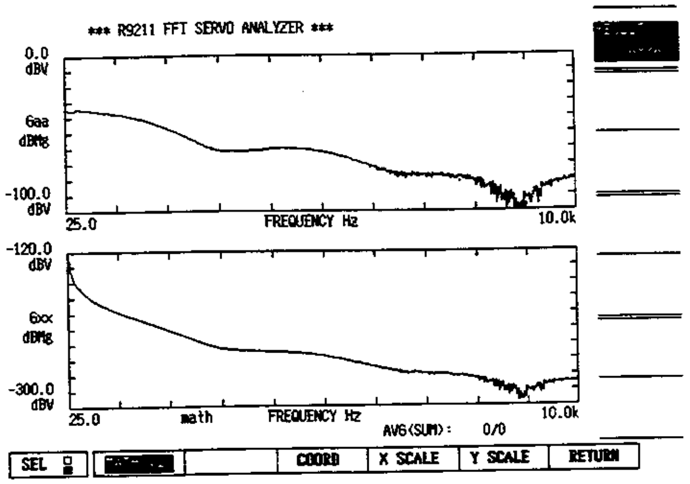
5 **Display the operation result on the lower screen.**

VIEW ⇒ SEL ▤

⇒ NEXT

⇒ MATH VW ⇒ RESULT ARRAY The result is displayed.

⇒ Y SCALE ⇒ Y AUTO SCALE



Power spectrum of the accelerator sensor output.

Result of the double integration $(1/(j\omega)^2)$

Figure 11-1 $1/(j\omega)^2$

Real-Time Operation

TR MATH performs the real-time processing.
Operations other than this is usually executed only when the DO MATH key is pressed.
This explains how to perform a real-time processing about operations other than TR MATH.

1 Real Time goes to ON.

MATH ⇒ X Soft key ⇒ Real Time ON/OFF

2 Execute operation.

⇒ MATH SEL

⇒ DO MATH .... Execution

This procedure starts a real-time processing.
When the execution is completed, MT.mg = MATH completed! is not displayed.
During the execution of real-time operation, RTM is displayed on the right-down of the screen.

3 Interrupt real-time operation.

⇒ DO MATH .... Interrupt

The message of MT.er = Real-Time MATH interrupted! is displayed to interrupt.

CAUTION !
In the following case, the real-time operation is forced to be interrupted.

Change of setting operation	Change of setting condition
OPERAND setting	MODE change
1st OPRTR setting	FUNCTION change
2nd OPRTR setting	ACTIVE CH change
3rd OPRTR setting	RANGE change
	SENS (Sensitivity range) change
	SWEEP change
	A/D input change

* SAMPL CLK available to change
INT/EXT

Display of Setting Condition for Operation Result

The operator and the operated data information about the operation result can be displayed on the message box of the left-upper side of the screen. The procedure is shown as below.

1 **Display the first operation information.**

MATH ⇒ X Soft key ⇒ MATH SEL Information as 1st OPRTR is displayed.
⇒ 1st OPRTR

2 **Display the second operation information.**

⇒ 2nd OPRTR Information as 2nd OPRTR is displayed.
When the buzzar rings and nothing is displayed, the combinational operation is not performed.

3 **The third operation information is displayed, the same as 2nd.**

CAUTION !
When the operation result to be displayed is a regenerative data from floppy, the operation information can not be displayed.

■ Rotation

A specified time delay is compensated on frequency domain data (spectrum or FRF data) by rotation.
The procedure for compensating a − 10μs delay on some FRF data is described below. FRF data are measured, then the phase of these FRF data is displayed on the upper screen of a double screen configuration.

1 Specify the operand.

VIEW ⇒ TYPE	⇒ DUAL	Select the double screen configuration.
⇒ SEL ▀		
⇒ AVG VW	⇒ FRF	Display the phase of the FRF data and select it (SEL key).
⇒ NEXT		
⇒ COORD	⇒ PHASE	
MATH	⇒ MATH SEL	
	⇒ OPERAND	Register the selected data as operand.

2 Select the operator.

⇒ j ω	⇒ ROTATION	Select the operation.
	⇒ TIME CONS	Set the time delay. In this example, − 10μs is the delay.
	⇒ − 10	
	⇒ μsec	
	⇒ ROTATION ON/OFF	Set ROTATION to ON.
	⇒ RETURN	

3 Register the operator

⇒ MATH SEL

⇒ 1st OPRTR Register the rotation as 1st operator.

4 Execute the operation.

⇒ DO MATH Execute the operation.

MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

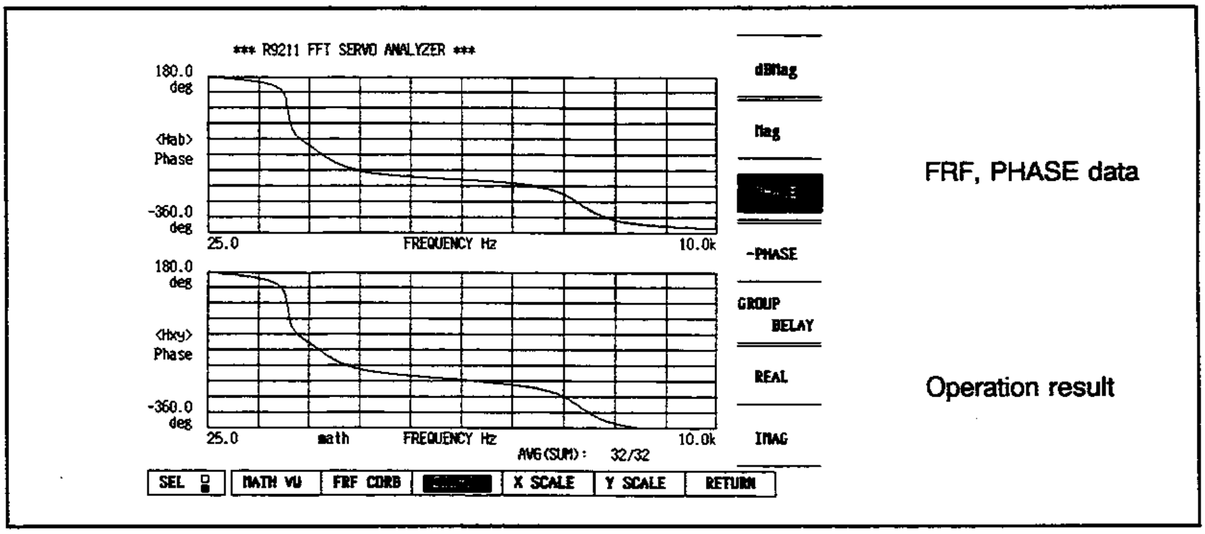
5 Display the operation result on the lower screen.

VIEW ⇒ SEL

⇒ NEXT

⇒ MATH VW ⇒ RESULT ARRAY Display the result.

⇒ COORD ⇒ PHASE



FRF, PHASE data

Operation result

Figure 11-2 Rotation

CAUTION !
The rotation operation does not affect the magnitude of the FRF data.

Cepstrum and Liftering

The cepstrum operation is performed to estimate a cepstrum from a power spectrum. The cepstrum is obtained by performing an inverse FFT on the logarithm of the power spectrum. The obtained data belongs to the quefrency domain (very similar to the time domain). This operation is close to an autocorrelation computation.

ADVICE

In the Quefrency domain, low-level spectrum components are enlarged and their characteristics can be pointed out, because the logarithm of the data in the frequency domain is used.

LIFTERING is the procedure for transporting back to the frequency domain, a specified portion of the cepstrum in the quefrency domain (similar to the time domain). The spectrum obtained through liftering is called liftered spectrum.
In the following example, is described the procedure for estimating the cepstrum and liftered spectrum of a voice signal recorded through a microphone.

1 Specify an operand.

Input the microphone signal to channel A and acquire the data with the arm function. Display the received data on the top screen and its power spectrum on the middle screen in the triple screen configuration.

VIEW ⇒ TYPE ⇒ TRIPLE — Select the triple screen configuration.

⇒ SEL ⬒

⇒ INST VW ⇒ CH - A TIME

⇒ SEL ▣ ⇒ CH - A SPECT

MATH ⇒ MATH SEL

⇒ OPERAND — Register the power spectrum as the operand.

2 **Select an operator.**

⇒ CEPSTRUM ⇒ THRESHOLD

⇒ THRESHOLD -135dBV

⇒ LOWER f 25Hz

⇒ UPPER f 10kHz

Here we specify that we want to estimate the cepstrum over the entire frequency range.

⇒ RETURN

⇒ CEPSTRUM ON/OFF

Set CEPSTRUM to ON.

3 **Register the operator.**

⇒ MATH SEL

⇒ 1st OPRTR

Register the cepstrum operation.

4 **Execute the operation.**

⇒ DO MATH

MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

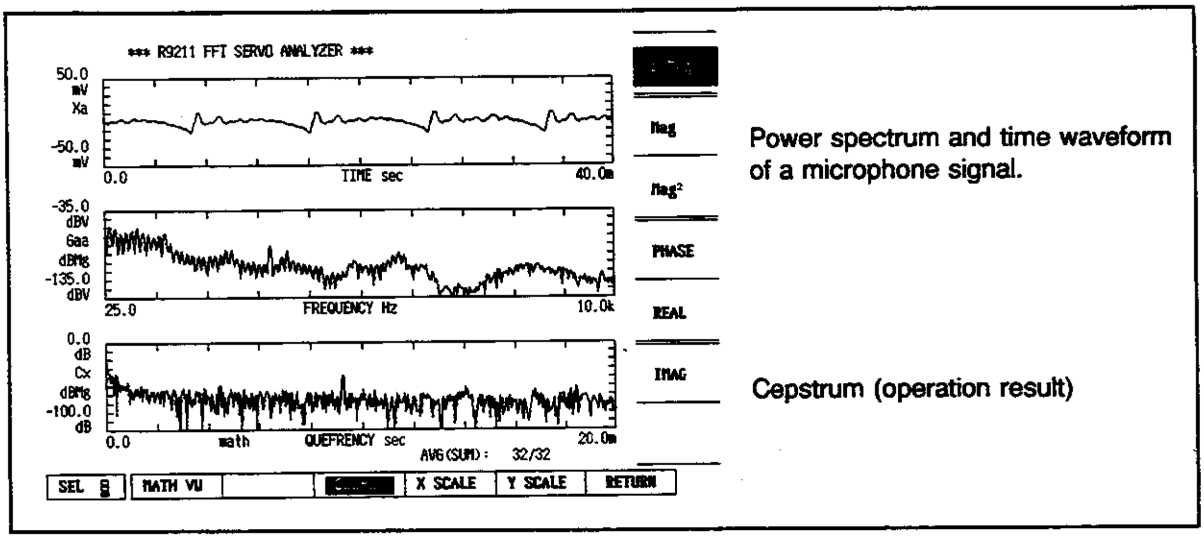
5 Display the operation result on the lower screen.

VIEW ⇒ SEL ▤

⇒ NEXT

⇒ MATH VW ⇒ RESULT ARRAY Display the operation result.

⇒ COORD ⇒ dBMag



Power spectrum and time waveform of a microphone signal.

Cepstrum (operation result)

Figure 11-3 Cepstrum

The cepstrum waveform obtained above is liftered to estimate the liftered spectrum.
To obtain the liftered spectrum, add the liftering operation to the above procedure (combination operation).

6 **Select an operator.**

CAUTION !

Select the middle screen with the SEL key (power spectrum display screen) in advance. (An operator cannot be registered if the data selected as operand correspond to the result of an other operation)

MATH ⇒ CEPSTRUM ⇒ LIFTERING

⇒ LOWER t 0msec
⇒ UPPER t 20msec

Transform the waveform over the entire range. (In practice, you should specify only the range you need.)

⇒ LIFTERING ON/OFF

Set LIFTERING to ON.

⇒ RETURN

7 **Register the operator.**

⇒ MATH SEL

⇒ 2nd OPRTR

8 **Execute the operation.**

⇒ DO MATH

MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

9 The operation result is displayed on the lower screen.

(Display of the operation result has been specified.)

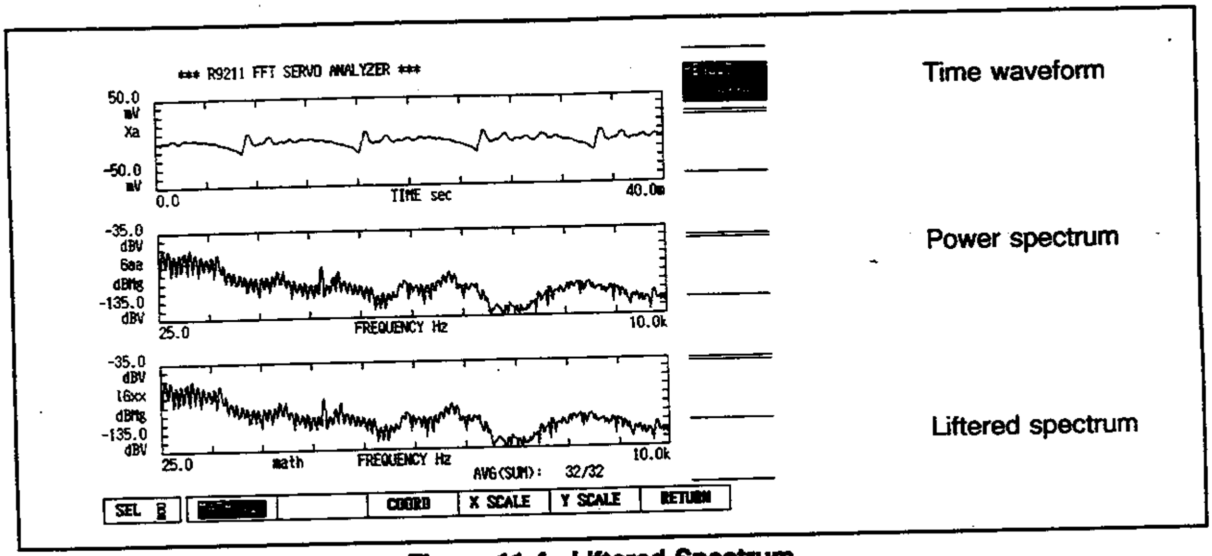
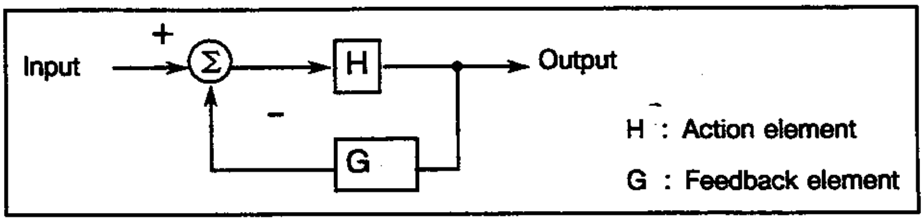


Figure 11-4 Liftered Spectrum

Eventually, the liftered spectrum is equal to the original spectrum (because the cepstrum, as well as the liftered spectrum were estimated over the entire range)

Conversion of a Feedback Loop System

This operation is performed to convert open loop characteristics (FRF data) to closed loop characteristics (FRF data) of feedback loop control systems, and the other way around.
The following block diagram shows the general concept of feedback loop control.



Hopen, the open loop characteristic, is defined as Hopen = G · H. This characteristic is essential in feedback loop control. The input/output characteristic of such a system is the closed loop characteristic, Hclose. The relationships between these characteristics are expressed as follows:

$$\mathrm{Hclose} = \frac{H}{(1 + G \cdot H)} \quad \cdots\cdots \quad (A)$$

$$H = \frac{\mathrm{Hclose}}{(1 - G \cdot \mathrm{Hclose})} \quad \cdots \quad (B)$$

If the feedback element, G, is equal to 1, the above equations (A) and (B) become:

$$\mathrm{Hclose} = \frac{\mathrm{Hopen}}{(1 + \mathrm{Hopen})} \quad \cdots\cdots \quad (C)$$

$$\mathrm{Hopen} = \frac{\mathrm{Hclose}}{(1 - \mathrm{Hclose})} \quad \cdots\cdots \quad (D)$$

The R9211 transforms the FRF data according to the above equations. We are now going to describe the procedure to follow in order to estimate the closed loop characteristics of a feedback loop control system knowing the open loop characteristics.

1 Specify an operand.

Measure the open loop characteristic and display it on the upper screen of the dual screen configuration.

VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ⬒

⇒ AVG VW ⇒ FRF

MATH ⇒ MATH SEL

⇒ OPERAND

⇒ RETURN

2 Select an operator.

⇒ FRF MATH ⇒ Open Close

⇒ H/(1 + H)

⇒ RETURN

3 Register the operator.

⇒ MATH SEL

⇒ 1st OPRTR

↓

4 **Execute the operation.**

⇒ DO MATH

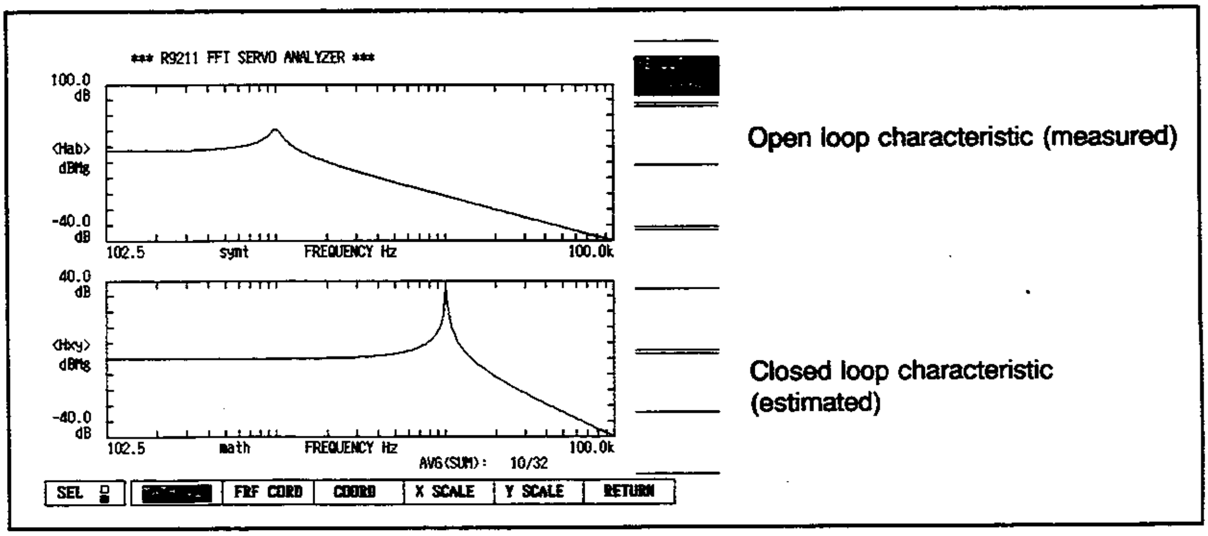
MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

5 **Display the operation result on the lower screen.**

VIEW ⇒ SEL ⊟

⇒ NEXT

⇒ MATH VW ⇒ RESULT ARRAY



Open loop characteristic (measured)

Closed loop characteristic (estimated)

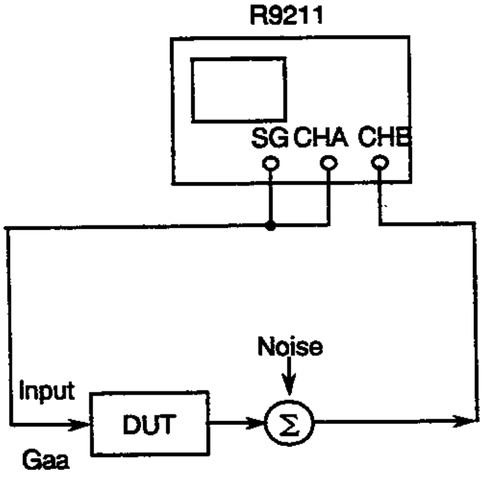
Figure 11-5 Closed Loop Characteristic

ADVICE

When the feedback element G is not equal to 1, display its characteristics on the screen before setting the 1st OPRTR , so that you can register it also. Then, perform the same operations.

■ InCOP (COP, SNR)

Through this operation, the noise components, contained in the output, can be estimated, according to the coherence function (FRF analysis) and the specified power spectrum. As for the SNR operation, the ratio of the signal components to the noise components is estimated.



COP : Coherent Output Power
InCOP : Incoherent Output Power

Output spectrum Gbb = Signal directly corresponding to the input + Noise

COP = Gbb · Coherence .... Signal spectrum corresponding to the input
InCOP = Gbb · (1- Coherence) .... Noise spectrum

CAUTION !
The power spectrum is not required for the SNR operation.

The procedure to follow in order to obtain the noise components in a notch filter characteristic is described below.

1 Specify the operand.

Estimate the FRF data of the notch filter, through a FRF measurement.
Select the triple screen mode. Display the coherence data on the upper screen and the power spectrum on the middle screen.

VIEW ⇨ TYPE ⇨ TRIPLE	Select the triple screen configuration.
⇨ SEL ▣	Select the middle screen.
⇨ AVG VW ⇨ CH-B PWR SPECT	Display the power spectrum. (Select the power spectrum of channel B)
⇨ SEL ⬒ ⇨ COHERENCE	Display the coherence data.
MATH ⇨ MATH SEL	
⇨ OPERAND	
⇨ RETURN	

2 Select an operator.

⇨ FRF MTH ⇨ SNR	
⇨ lnCOP	Select lnCOP as the operation type.
⇨ RETURN	

3 Register the operator.

⇨ SEL ▣ ⇨ MATH SEL	Select the second operand (channel B power spectrum) before registering the operation.
⇨ 1st OPRTR	The second operand is registered at the same time as the operation.

⬇

4 Execute the operation.

⇨ DO MATH   Execute the operation.

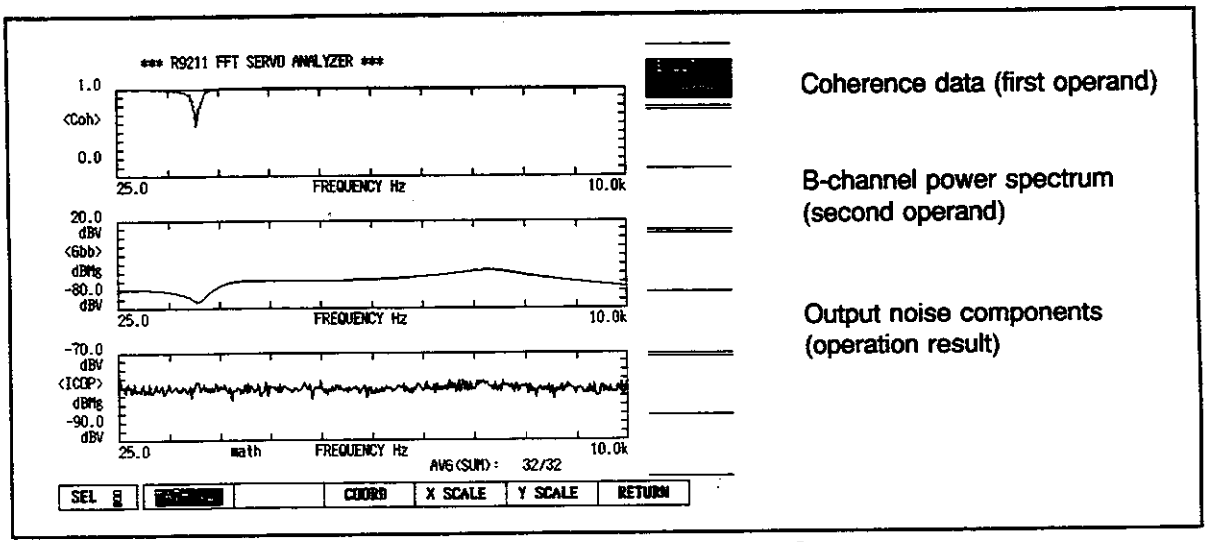
MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

5 Display the operation result on the lower screen.

VIEW ⇨ SEL ▤

⇨ NEXT

⇨ MATH VW ⇨ RESULT ARRAY



Coherence data (first operand)

B-channel power spectrum (second operand)

Output noise components (operation result)

Figure 11-6 Power Spectrum of the Noise Components

■ to CMP TIME

An Hilbert transformation is performed on a time-serie X(t), then the pre-envelope is estimated according to the transformation results as follows:
$z(t) = X(t) + j\hat{x}(t) \quad (j = \sqrt{-1}\ )$
The pre-envelope is transformed to the time domain by internally performing an IFFT.
The envelope corresponds to the magnitude of the pre-envelope. Thus, the signal energy distribution can be analyzed .

ADVICE

THEORETICAL BACKGROUND
The Hilbert transform of a real-valued time domain signal x(t) is another real-valued time domain signal, denoted $\hat{x}(t)$, such that $z(t) = x(t) + j\hat{x}(t)$ is an analytic signal. From z(t), one can define a magnitude function, which corresponds to the envelope of the original signal. The Hilbert transform may be mathematically defined in several ways. One of these is as a (Π/2) Phase Shift system.
One can show (see the excellent book "Random data, Analysis and Measurement procedures" Julius S. Bendat and Allan G. Piersol, Wiley Interscience edition) that the Hilbert transform consists of passing x(t) through a system which leaves the magnitude of x(f) (Fourier transform of x(t)) unchanged, but shifts its phase Π/2 for positive frequencies and -Π/2 for negative frequencies.

The procedure followed to obtain the envelope of a voice signal output by a microphone is described below.

CAUTION !
This operation can be performed only on complex spectrum data and FRF data.
The operation result is a time domain data.

1 Specify the operand.

The signal output from the microphone is triggered and input to channel A. The input data is displayed on the upper screen in the dual screen configuration.

VIEW ⇒ TYPE ⇒ DUAL   Select the dual screen configuration.

⇒ SEL ⬒

⇒ INST VW ⇒ CH-A SPECT

⇒ NEXT

⇒ COORD ⇒ REAL   Display the complex spectrum's real part.

MATH ⇒ MATH SEL

⇒ OPERAND   Register the operand.

⇒ RETURN

2 Select an operator.

DOMAIN ⇒ to CMP TM   Select an operation.

3 Register the operator.

⇒ MATH SEL

⇒ 1st OPRTR   Register the operation.

↓

4 Execute the operation.

⇒ DO MATH Execute the operation.

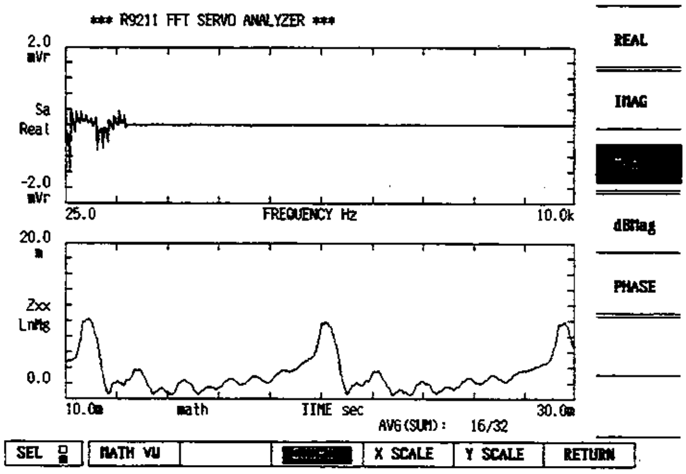
MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

5 Display the operation result on the lower screen.

VIEW ⇒ SEL ⊟

⇒ MATH VW ⇒ RESULT ARRAY Display the operation result.

⇒ COORD ⇒ Mag



Complex spectrum of a voice record

Envelope (energy distribution)

Figure 11-7 Voice Envelope

■ to TIME/to FREQ

These operations are used to transfer time domain data to the frequency domain through FFT, or frequency domain data to the time domain through IFFT.

ADVICE

These operations are used to convert measurement data of one domain (time or frequency), over which different operations may have been executed, to the other domain. When executing an inverse FFT, the operand must be complex data. To only execute a FFT, you can use the FFT function in the spectrum or T-F mode.

In the following example, a square wave is input to channel A, an integration (1/jω) is performed on the complex spectrum, and an IFFT is performed on the integration result to transfer it to the time domain.

1 Specify an operand.

VIEW ⇒ TYPE ⇒ TRIPLE — Select the triple screen configuration.

⇒ SEL ⬒

⇒ INST VW ⇒ CH-A TIME

⇒ SEL ▣ ⇒ CH-A SPECT

⇒ NEXT

⇒ COORD ⇒ REAL — Display the complex spectrum.

MATH ⇒ MATH SEL

⇒ OPERAND — Register the operand (complex spectrum data).

⇒ RETURN

2 **Select an operator.**

⇒ j ω ⇒ j ω RANGE

⇒ THRESHOLD −100dBV

⇒ LOWER f 25Hz

⇒ UPPER f 10kHz

⇒ RETURN

⇒ j ω ?

⇒ 1/j ω — Select the integration (1/jω).

⇒ RETURN

3 **Register the operator.**

⇒ MATH SEL

⇒ 1st OPRTR — Register 1/jω operation.

⇒ RETURN

4 **Select the second operator.**

⇒ DOMAIN ⇒ to TIME — Select the second operation (IFFT).

5 Register the 2nd operator.

⇒ MATH SEL

⇒ 2nd OPRTR Register IFFT operation.

6 Execute the operation.

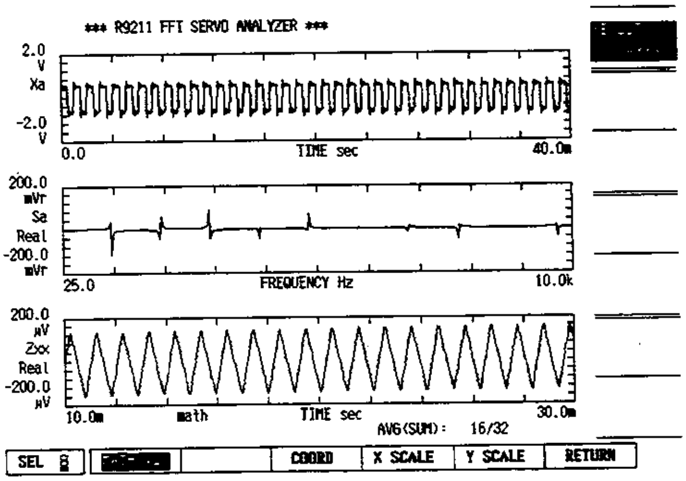
⇒ DO MATH Execute the operation.

MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

7 Display the operation result on the lower screen.

VIEW ⇒ SEL ⬓

MATH VW ⇒ RESULT ARRAY Display the result.



Input square waveform

Complex spectrum (operand)

Time waveform obtained by IFFT *

* The square waveform was changed to the chopping waveform by integration (1/jω).

Figure 11-8 Time Waveform Obtained by IFFT

BANDPASS (BANDSTOP)

This operation is performed to obtain the frequency domain data (power spectrum, complex spectrum, or FRF data) that passed (or did not pass) through the specified frequency range.

The procedure followed to extract the necessary portion of some FRF data is the following one:

1 Specify an operand.

Perform a FRF measurement.
Display the FRF data on the upper screen in the double screen configuration.

VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ⬒

⇒ AVG VW ⇒ FRF

MATH ⇒ MATH SEL

⇒ OPERAND — Register the FRF data as operand.

⇒ RETURN

2 Select an operator.

MOD f ⇒ BANDPASS

⇒ LOWER f 25Hz

⇒ UPPER f 3kHz

Select only the frequencies within the range 25Hz to 3kHz.

⇒ FILTERING ON/OFF — Switch on the band pass filter.

⇒ RETURN

3 Register the operator.

⇒ MATH SEL

⇒ 1st OPRTR — Register the band pass filter operation.

4 Execute the operation.

⇒ DO MATH

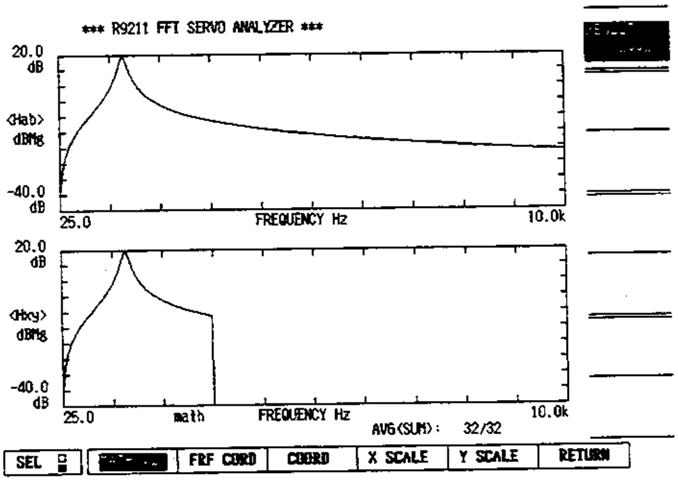
MT.mg = MATH completed! is displayed. (When REAL TIME is OFF)

5 Display the operation result on the lower screen.

VIEW ⇒ SEL ⊟

⇒ NEXT

⇒ MATH VW ⇒ RESULT ARRAY



FRF data (operand)

Band passed data

Figure 11-9 BAND PASS

■ TR MATH (Trace MATH)

Each TR MATH operations are performed in real time on the displayed data. The operation to be processed can be selected in the Y softmenu. Unlike the other operations, a result array different from the operand data array is not generated. Reversely the results are directly over-written on the operand data.

A TR MATH Operation takes effect on the data displayed on the screen selected with the SEL key immediately after the operation selection.

For example, start the smoothing of spectrum (See Figure 11-10).

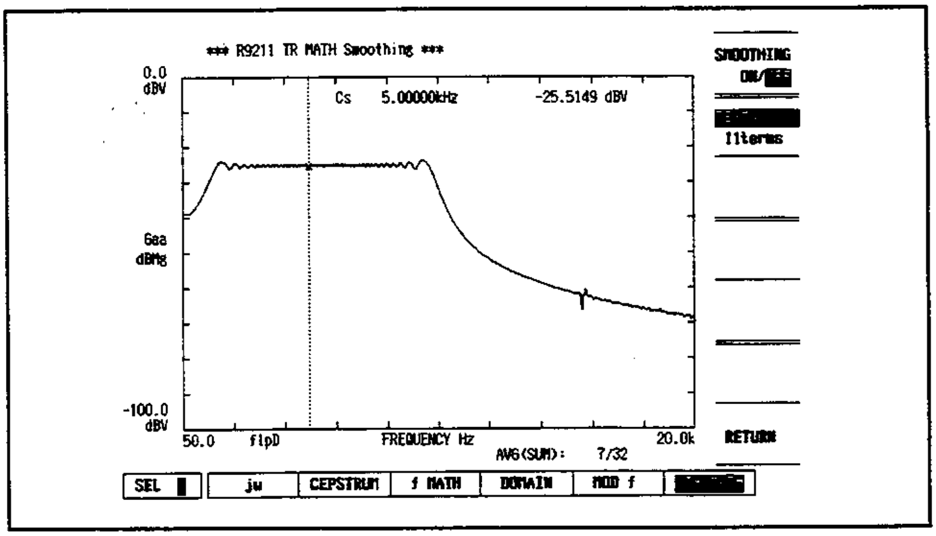
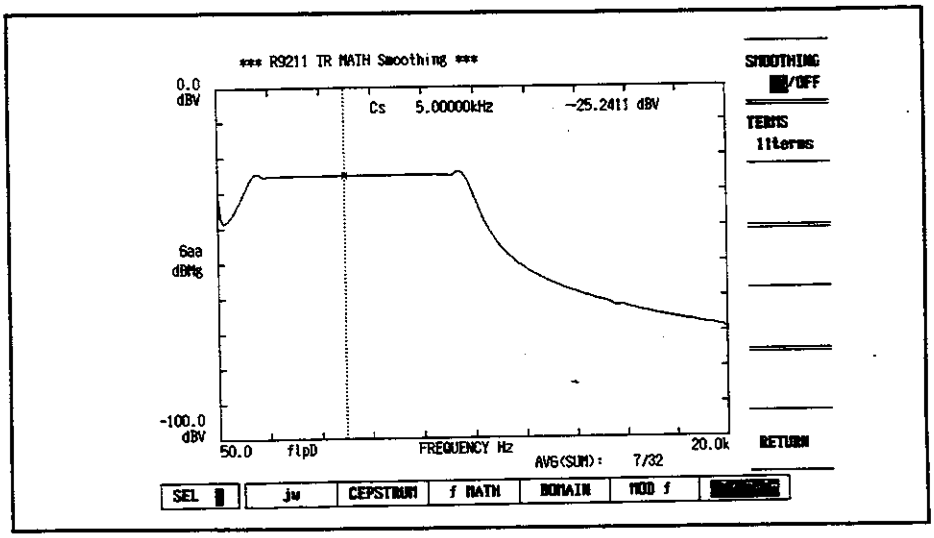


Figure 11-10 TR MATH Operand (before execution)

MATH ⇒ TR MATH ⇒ SMOOTHING (OFF) ⇒ SMOOTHING ON/OFF

Smoothing starts when SMOOTHING is set to ON and stops only when SMOOTHING is set to OFF.



*** R9211 TR MATH Smoothing ***

Cs 5.00000kHz −25.2411 dBV

AVG(SUM): 7/32

SMOOTHING ON/OFF

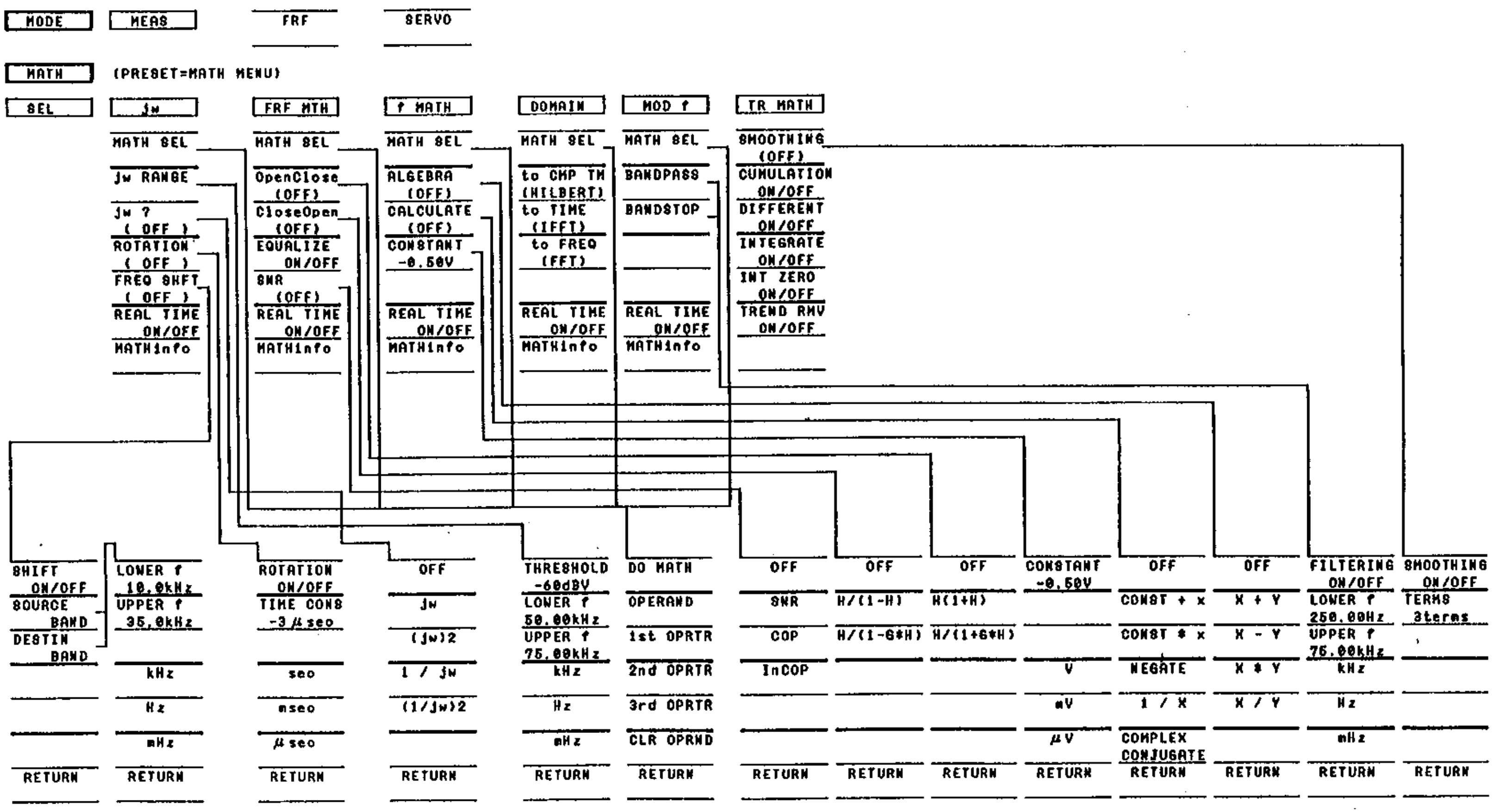
TERMS 11terms

Figure 11-11 TR MATH

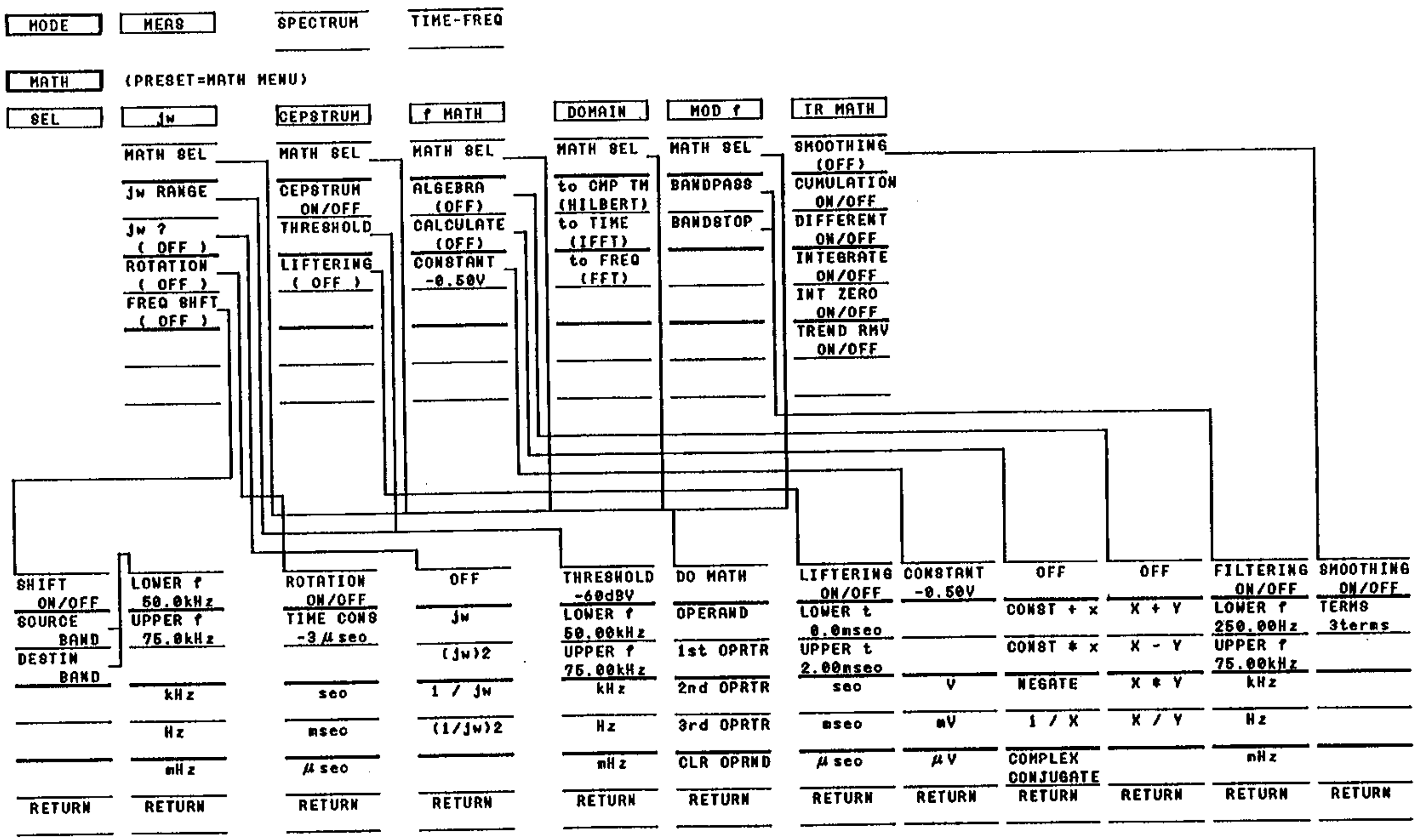
NOTE

"TERMS" may be changed during smoothing.

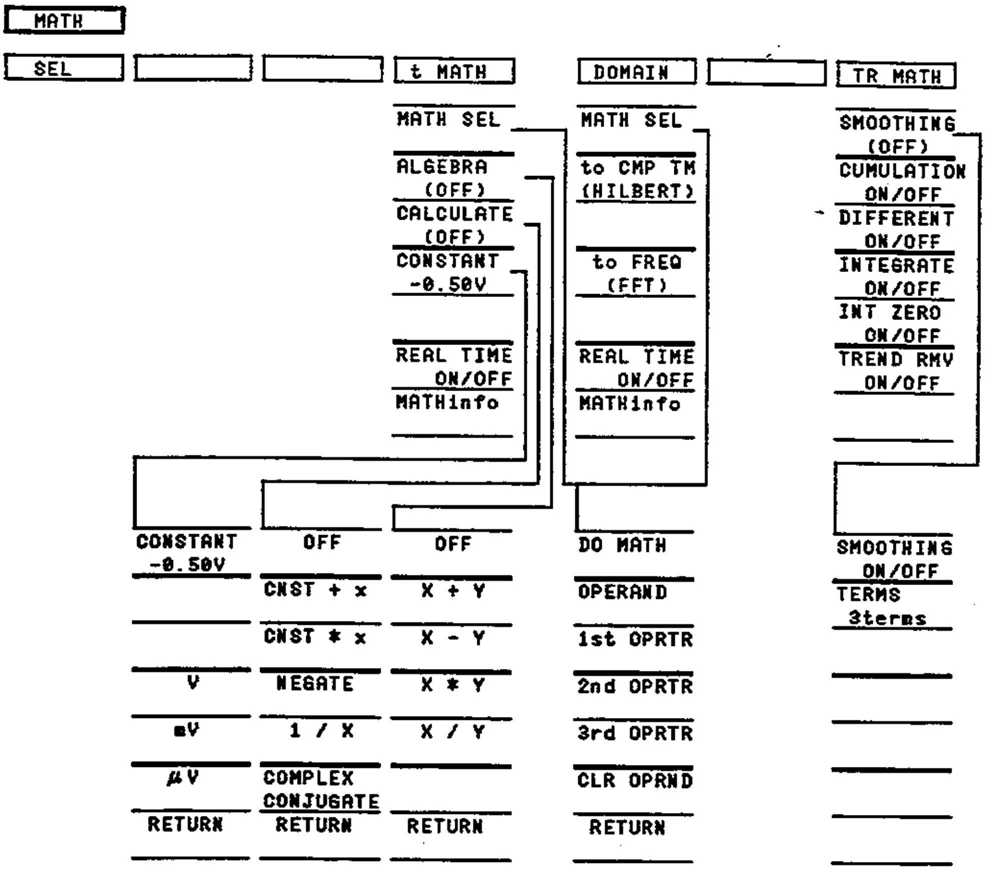
R9211 Series Menu List (MATH in the FRF and SERVO modes)



R9211 Series Menu List (MATH in the SPECTRUM and TIME-FREQ modes)



R9211 Series Menu List (MATH in the WAVEFORM mode)



CHAPTER 12

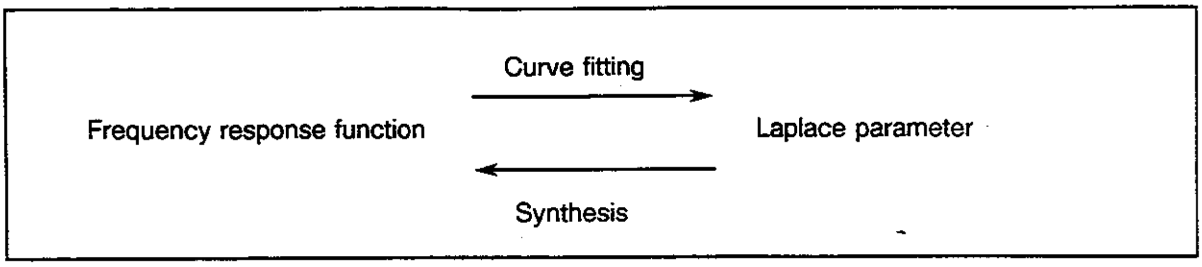
CURVE FITTING AND SYNTHESIS (R9211C ONLY)

This chapter explains the curve fitting and synthesis functions and their usage. This chapter also presents various examples of their use.

CONTENTS

1. Outline

The curve fitting function is used to compute the poles and zeros of the complex frequency in the Laplace domain from the frequency response function.
In reverse, the synthesis function is used to compute the frequency response function from the given poles and zeros in the Laplace domain.



The use data of the curve fitting and synthesis functions facilitates data compression and measurement data pattern recognition.
For example, a 400-line frequency response function can be compressed into 20 pairs of poles and zeros, from which a noiseless frequency response function can be generated.
The effect of any design modification can be evaluated by the comparison between the poles/zeros before and after the modification.
Furthermore, these functions can be used to design control of the frequency at the resonance (pole) and antiresonance (zero) points.

NOTE

The 3 types of Laplace parameters are mentionned below. Furthermore conversion between the 3 types (pole/zero, pole/residue and polynomial) is possible.

Pole/zero : Filter and servo design
Pole/residue : Modal analysis and servo design
Polynomial : Servo analysis

ADVICE

In the curve fitting and synthesis functions, the frequency response function called Hab (S) is represented by the ratio of polynomial P(S) to Q(S), where S is the complex frequency S (real part: damping coefficient, imaginary part: frequency). The coefficient of the highest exponent of denominator and numerator polynomials is set to 1.

$$\begin{aligned} \mathrm{Hab}(S) &= P(S)/Q(S) \\ &= \mathrm{SysGain} \times \frac{1 \times s^{n} + a_1 \times s^{(n-1)} + ... + a_n}{1 \times s^{m} + b_1 \times s^{(m-1)} + ... + b_m} \end{aligned}$$

The convertion to the pole/zero type, leads to following expression:

$$\mathrm{Hab}(S) = \mathrm{SysGain} \times \frac{(s - z_1)(s - z_2)....(s - z_n)}{(s - p_1)(s - p_2)....(s - p_m)}$$

where,
Zj(j:1, 2, ..., n) are called "zeros" (a complex frequency for zeroing P(s) when s = zj): Hab(s) is set to 0 when s = zj.
Pk (k: 1, 2,..., m) is called "pole" (a complex frequency for zeroing Q(s) when s = Pk), and Hab(s) is set to ∞ when s = Pk.
"Poles" and "zeros" (Laplace parameter) are complex frequencies corresponding to the following:

Imaginary part : Resonance/antiresonance frequency at the peak/trough of the frequency response function waveform
Real part : Data on "expansion" of the peak/trough (damping coefficient)

■ Laplace Parameters Formats

- **Frequency response function represented by the ratio of polynomials (POLYNOMI)**

$$\mathrm{Hab}(s) = P(s)/Q(s)$$

$$= \frac{c_0 \times s^n + c_1 \times s^{(n-1)} + \ldots + c_n}{d_0 \times s^m + d_1 \times s^{(m-1)} + \ldots + d_m}$$

$$= \frac{c_0(s^n + (c_1/c_0) \times s^{(n-1)} + \ldots + (c_n/c_0))}{d_0(s^m + (d_1/d_0) \times s^{(m-1)} + \ldots + (d_m/d_0))}$$

$$= \mathrm{SysGain} \times \frac{1 \times s^n + a_1 \times s^{(n-1)} + \ldots + a_n}{1 \times s^m + b_1 \times s^{(m-1)} + \ldots + b_m}$$

j : 0, 1, ..., n
k: 0, 1, ..., m

where, $a_j = (c_j/c_0)$, $b_k = (d_k/d_0)$
$\mathrm{SysGain} = c_0/d_0$

- **Frequency response function represented by poles and zeros (Pole-Zero)**

$$\mathrm{Hab}(s) = P(s)/Q(s)$$

$$= \mathrm{SysGain} \times \frac{(s - z_1)(s - z_2)\ldots(s - z_n)}{(s - p_1)(s - p_2)\ldots(s - p_m)}$$

Z_1, Z_2, ... Z_n : Zero
L_1, L_2, ... P_m : Pole

- **Frequency response function represented by poles and residues (Pole-RES)**

$$\mathrm{Hab}(s) = \mathrm{SysGain} \times [1 \times s^{(n-m)} + L_1 \times s^{(n-m-1)} + \ldots + L_{n-m} + r_1/(s - p1) + r_2/(s - p_2) + \ldots + r_m/(s - p_m)]$$

P_1, P_2, ... P_m : Pole
L_1, L_2 .... L_m : Residue
r_1, r_2, ... r_m : Residue

■ Unit of Poles and Zeros

Hz is used as the unit of the poles and zeros used in the curve fitting and synthesis functions.
Some analyzers use rad/sec (angular frequency); however, the R9211C uses Hz to facilitate the description of the impulse and step response functions.

- **Conversion of the poles and zeros from rad/sec to Hz**

$$T(s) = \mathrm{gain} \times \frac{(s - z_1)(s - z_2) \;\; \ldots\ldots \;\; (s - z_n)}{(s - p_1)(s - p_2) \;\; \ldots\ldots \;\; (s - p_m)}$$

The poles and zeros are divided by 2π and the gain by $(2\pi)^{m-n}$.

$z_i = z_i'/2\pi$
$p_j = p_j'/2\pi$
$\mathrm{gain} = \mathrm{gain}'/(2\pi)^{m-n}$

● Conversion the poles and zeros from Hz to rad/sec

$$T(s) = gain' \times \frac{(s - z_1')(s - z_2') \;....\; (s - z_n')}{(s - p_1')(s - p_2') \;...\; (s - p_m')}$$

The poles and zeros are multiplied by 2π and the gain by $(2\pi)^{m-n}$.

$z_i' = z_i \times 2\pi$
$p_j' = p_j \times 2\pi$
$gain' = gain \times (2\pi)^{m-n}$

where, $T(s)$: Frequency response function
Z_i : Zero in Hz
p_j : Pole in Hz
gain : Gain in Hz M-N
Z_i' : Zero in rad/sec
p_j' : Pole in rad/sec
gain' : Gain in rad/sec M-N

2. How To Use The Curve Fitting Function

Curve Fitting Function

The curve fitting function can be on the frequency response functions obtained in the FRF mode and in the SERVO mode, as well as on the frequncy response function computed thanks to "MATHs" operation. When the curve fitting function is executed, poles/zero, poles/residues or polynomials can be computed. If the number of lines of either the pole/residue or the polynomial table exceeds 20 lines during curve fitting, CS.mg = Pole-Residue & Polynomials : Failed is displayed, but the table is not.

The frequency response function is represented by its poles and zeros calculated through curve fitting. When the frequency axis is linear and the F-Table is not used, the impulse and step response function are computed from the poles/zeros calculated through curve fitting.

Operation Procedure

1 Selects the curve fitting function.

PRESET ⇒ MATH KEY ⇒ CurveFit MENU

.... Assigns the curve fitting function to the MATH function key.

2 Selects the frequency response function subject to curve fitting.

MATH ⇒ Fit ⇒ FIT INPUT AVG/MATH

Selects AVG to execute the curve fitting function on the measured frequency response function. Selects MATH to execute curve fitting on the frequency response function computed through MATH operation.

3 Evaluates the delay time.

MATH ⇒ Fit ⇒ DELAY EST ON/OFF

This Y soft menu is displayed when the frequency axis is linear and the F-table is not used. Selects ON when there is a delay in the DUT operation.

4 Sets a weight function.

MATH ⇒ sWeight ⇒

AUTO WGT	Executes curve fitting in the whole frequency range. The weight function is automatically calculated.
UNIF WGT	Executes curve fitting in the whole frequency range. The weight function is assumed to be 1.0.
USR WGT	Executes curve fitting in the specified frequency range. The weight function is assumed to be 1.0.
USR f	This key is disenabled when "USR WGT" is selected. This key is used to set the frequency range.

For the logarithmic frequency response function, UNIF WGT may be better than AUTO WGT .

5 Sets the frequency range of the weight function.

USR f ⇒

WGT Fstr 1kHz	Sets the start frequency of the weight function. The numeric keys and a terminator (for specifying a unit) are to be used to enter the frequency.
WGT Fstp 10kHz	Sets the stop frequency of the weight function. The numeric keys and a terminator (for specifying a unit) are to be used to enter the frequency.
kHz Hz mHz	Terminator

6 Executes curve fitting.

MATH ⇒ Fit ⇒

CREATE FIT	Executes curve fitting.
STOP FIT	This key is effective during curve fitting. Pressing this key twice terminates curve fitting.

The typical execution (computation) durations are as follows:

Linear frequency sweep

Total number of lines	Standard duration	Maximum duration
400	2 minutes	4 minutes
800	2.5 minutes	5 minutes

Logarithmic frequency sweep

Number of decades	Standard duration	Maximum duration
3	6 minutes	12 minutes
4	8 minutes	15 minutes

CAUTION !

1. ***Curve fitting is inhibited in the case of an averaged frequency response function (FIT INPUT is set to AVG), whose corresponding coherence function is less than 0.8, because of the too large influence of the noise.***

2. ***The message CS.mg = Pole-Residue & Polynomials : Failed is displayed during curve fitting, when the number of poles and residues or the number of polynomial coefficients computed from the poles/zeros representation obtained through exceed the 20 allowed lines curve fitting.***
   When this message appears, poles/residues and polynomial reprsentation are disabled. To enable these representations, the computed poles and zeros must be transfered to the synthesis function with the "to Synth" operation, then thanks to the synthesis function, unnecessary poles and zeros may be elininated in order to diminish their number up to 20 and thus enable the poley residues and polynomials representation.

7 Displays the table of poles/zeros, pole/residues, or polynomials. The table obtained through curve fitting cannot be edited.

MATH ⇒ sCONV ⇒

DONE	Clears the table.
POLE-ZERO	Displays the poles/zeros table.
POLE-RES	Displays the poles/residues table.
POLYNOMI	Displays the polynomials table.

CAUTION !

When the computed poles/residues or polynomial coefficients exceed 20 lines, CS.mg = Pole-Residue & Polynomials : Failed is displayed during execution of the curve fitting or synthesis function.

And the pole/residue or polynomial table cannot displayed even if the POLE-RES or POLYNOMI is pressed.

8 How to display the gain, delay time, and scale frequency.

MATH ⇒ sSCALE ⇒

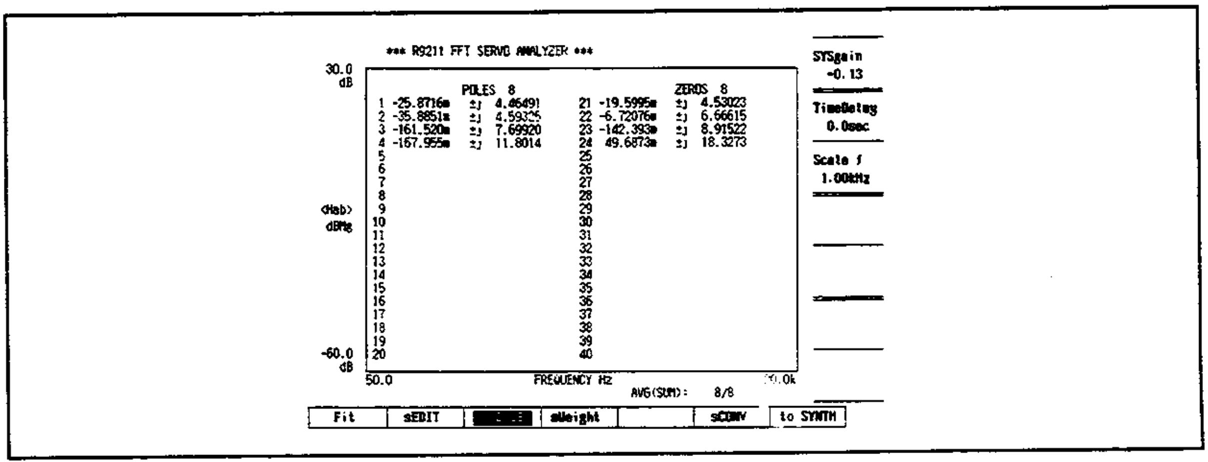
SYSgain
1.00

TimeDelay
0.0sec

Scale f
1.00kHz

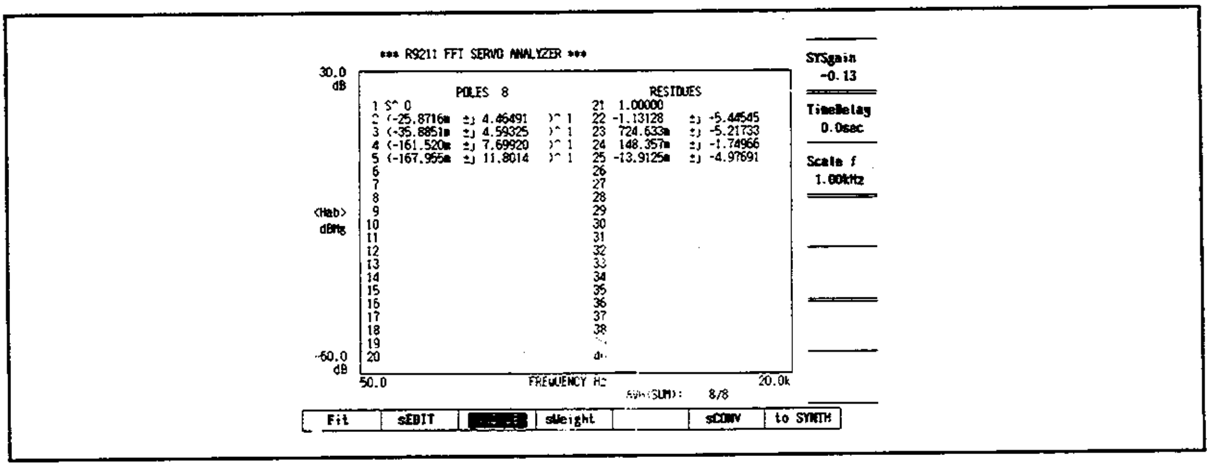
Aften pressing the sSCALE key in the X soft key nemu, the gain, delay time and scale frequency can be selected with the Y soft key menu.

The values of poles and zeros can be obtained by multiplying the values in the table by the scale frequency.
The system gain and delay time are displayed by respectively pressing SYSgain and TimeDelay.
A negative gain implies a polarity inversion.
Hab(s) = Sysgain × Exp (−TimeDelay × s) × P(s')/Q(s')
Where, s' = s/(Scale f)
Figures 12-1 to 12-3 show poles/zeros, poles/residues, and polynomial tables. Please note that the poles/residues and polynomial tables are not displayed if 20 lines of either table are exceeded.



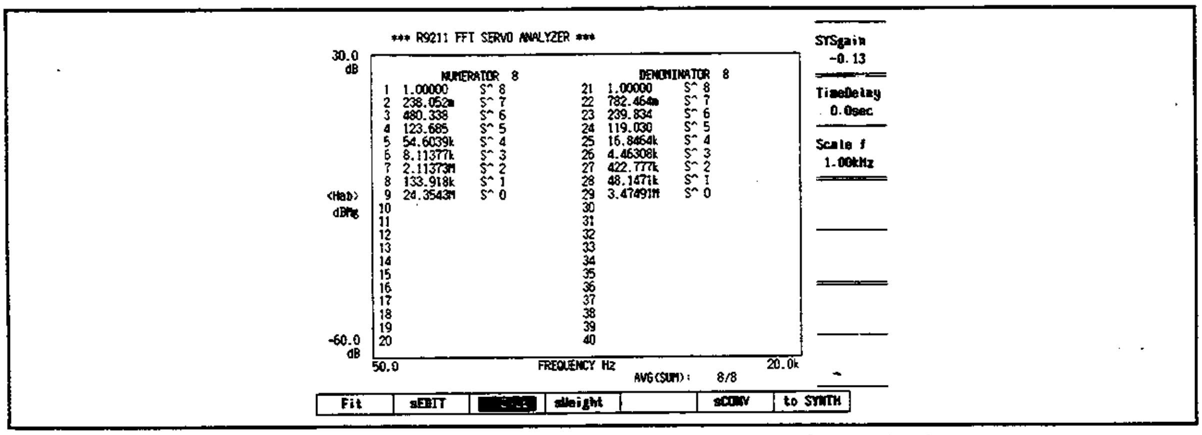
```
            POLES  8                          ZEROS  8
 1 -25.8716m   ±j   4.46491     21 -19.5995m   ±j  4.53023
 2 -35.8851m   ±j   4.59325     22 -6.72076m   ±j  6.66615
 3 -161.520m   ±j   7.69920     23 -142.393m   ±j  8.91522
 4 -167.955m   ±j  11.8014      24  49.6873m   ±j  18.3273
 5                              25
 6                              26
 7                              27
 8                              28
 9                              29
10                              30
11                              31
12                              32
13                              33
14                              34
15                              35
16                              36
17                              37
18                              38
19                              39
20                              40
                                         AVG(SUM):    8/8
```

Figure 12-1 Poles/zeros Table Computed by Curve Fitting



```
            POLES  8                               RESIDUES
 1 S^ 0                                  21  1.00000
 2 (-25.8716m  ±j 4.46491    )^ 1        22 -1.13128      ±j -5.44545
 3 (-35.8851m  ±j 4.59325    )^ 1        23  724.633m     ±j -5.21733
 4 (-161.520m  ±j 7.69920    )^ 1        24  148.357m     ±j -1.74966
 5 (-167.955m  ±j 11.8014    )^ 1        25 -13.9125m     ±j -4.97691
 6                                       26
 7                                       27
 8                                       28
 9                                       29
10                                       30
11                                       31
12                                       32
13                                       33
14                                       34
15                                       35
16                                       36
17                                       37
18                                       38
19                                       39
20                                       40
                                              AVG(SUM):    8/8
```

Figure 12-2 Poles/residues Table Computed by Curve Fitting



```
*** R9211 FFT SERVO ANALYZER ***

           NUMERATOR  8                    DENOMINATOR  8
 1  1.00000      S^ 8             21  1.00000      S^ 8
 2  238.052m     S^ 7             22  782.464m     S^ 7
 3  480.338      S^ 6             23  239.834      S^ 6
 4  123.685      S^ 5             24  119.030      S^ 5
 5  54.6039k     S^ 4             25  16.8464k     S^ 4
 6  8.11377k     S^ 3             26  4.46308k     S^ 3
 7  2.11373M     S^ 2             27  422.777k     S^ 2
 8  133.918k     S^ 1             28  48.1471k     S^ 1
 9  24.3543M     S^ 0             29  3.47491M     S^ 0
10                                30
11                                31
12                                32
13                                33
14                                34
15                                35
16                                36
17                                37
18                                38
19                                39
20                                40
```

Figure 12-3 Polynomial Table Computed by Curve Fitting

9 How to display the frequency response function, impulse response function, and step response function calculated from the poles/zeros computed by curve fitting.

VIEW ⇒ MATH VW ⇒

FITTED FRF	Displays the frequency response function calculated from the poles/zeros computed by curve fitting.
FITTED IMPRESP	Displays the impulse response function calculated from the poles/zeros computed by curve fitting.
FITTED STEPRESP	Displays the step response function calculated from the poles/zeros computed by curve fitting.

Figures 12-4 to 12-7 show the frequency response function, impulse response function, and step response function calculated from the poles/zeros computed by curve fitting. However, when the frequency response function is measured by logarithmic frequency sweeps or by a F-table, impulse and step response functions cannot be computed.

- **Frequency response function**
  The curve fitting function is executed over the whole frequency range (AUTO WGT or UNIF WGT is selected as the weight function)

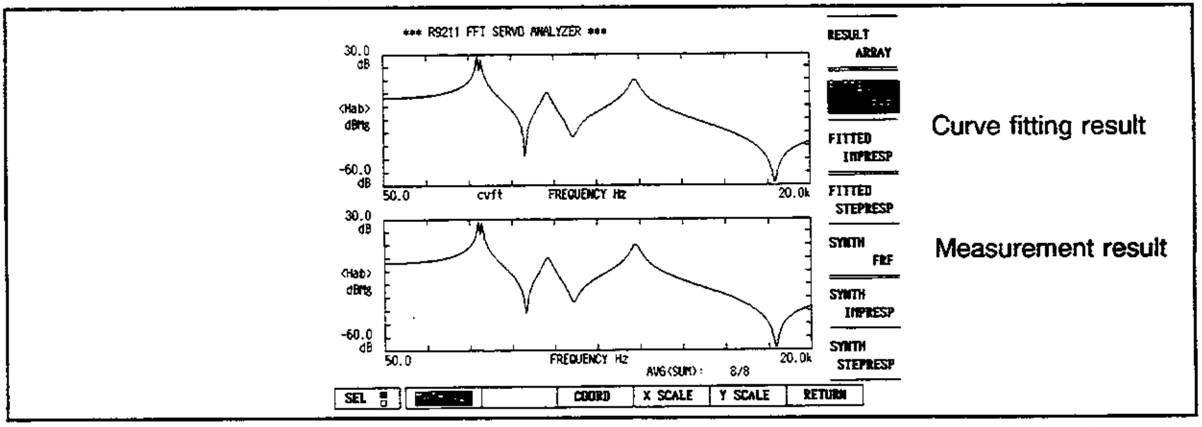


Figure 12-4 Frequency Response Function Computed through Curve Fitting Over the Whole Frequency Range

The curve fitting function is executed over a specified frequency range (USR WGT is selected as the weight function)

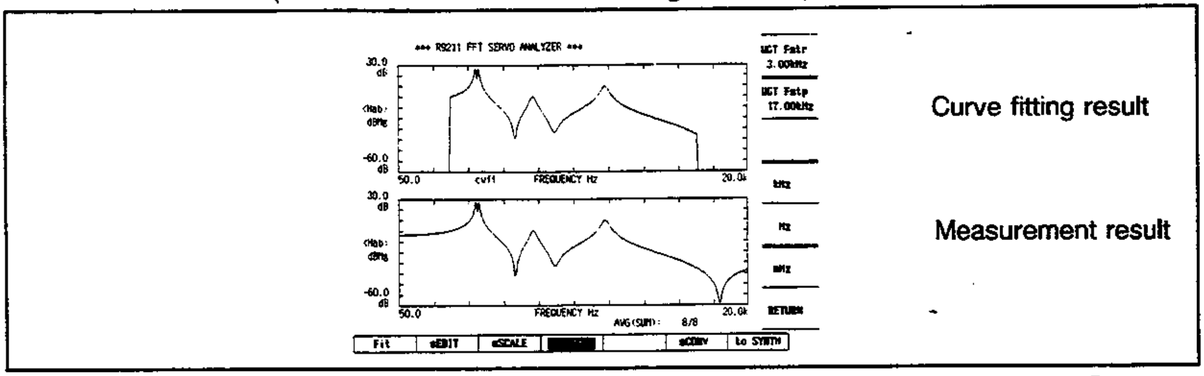


Figure 12-5 Frequency Response Function Computed through Curve Fitting Over a Specified Frequency Range

- **Impulse response function**

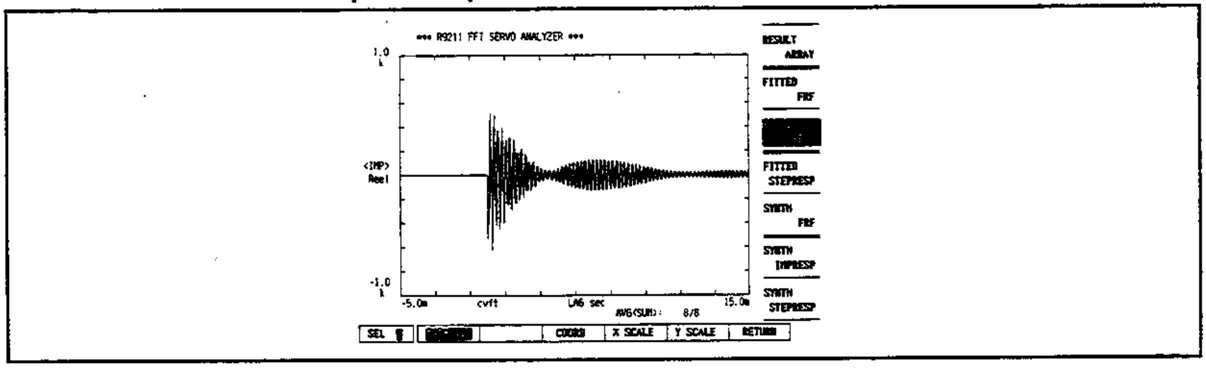


Figure 12-6 Impulse Response Function Computed through Curve Fitting

- **Step response function**

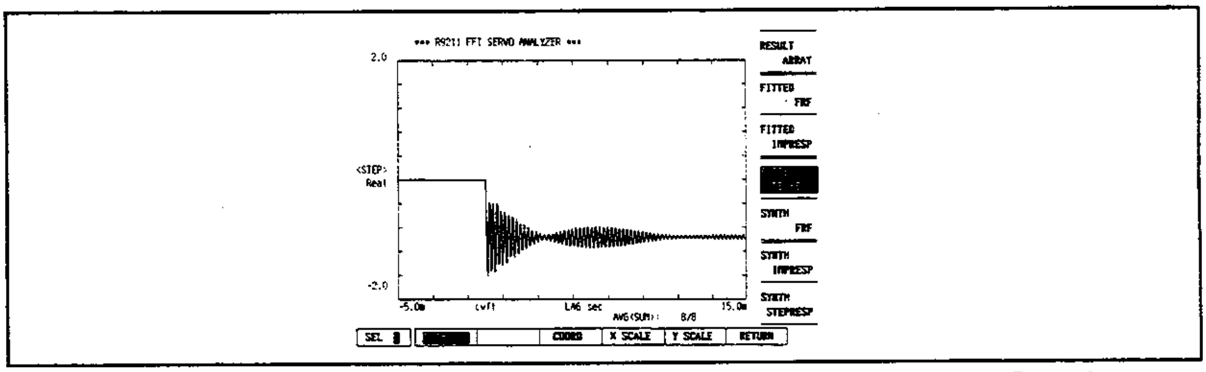


Figure 12-7 Step Response Function Computed through Curve Fitting Over the Whole Frequency Range

10 Transfer poles and zeros to the synthesis function.

MATH ⇒ to SYNTH ⇒ FIT to SYNTH	Transfer the Laplace parameters (poles and zeros) computed through curve fitting to the synthesis function.

3. How To Use The Synthesis Function

■ Synthesis Function

Before executing the synthesis function, the frequency response function in the FRF or SERVO mode must be measured. And the synthesis data output area allocated.

The synthesis function is used to calculate the poles and residues as well as polynomial tables from the previously edited poles and zeros. It is also used to synthesize frequency, impulse, and step response functions from the poles and zeros table.

CAUTION !

1. ***The pole/residue and polynomial tables are not displayed if they contain more than 20 lines.***
2. ***When the frequency response function is measured by logarithmic frequency sweep or with the F-table, impulse and step response functions connot be computed.***

■ Operation Procedure

1 Selects the synthesis function.

PRESET ⇒ MATH KEY ⇒ FRFSynth MENU

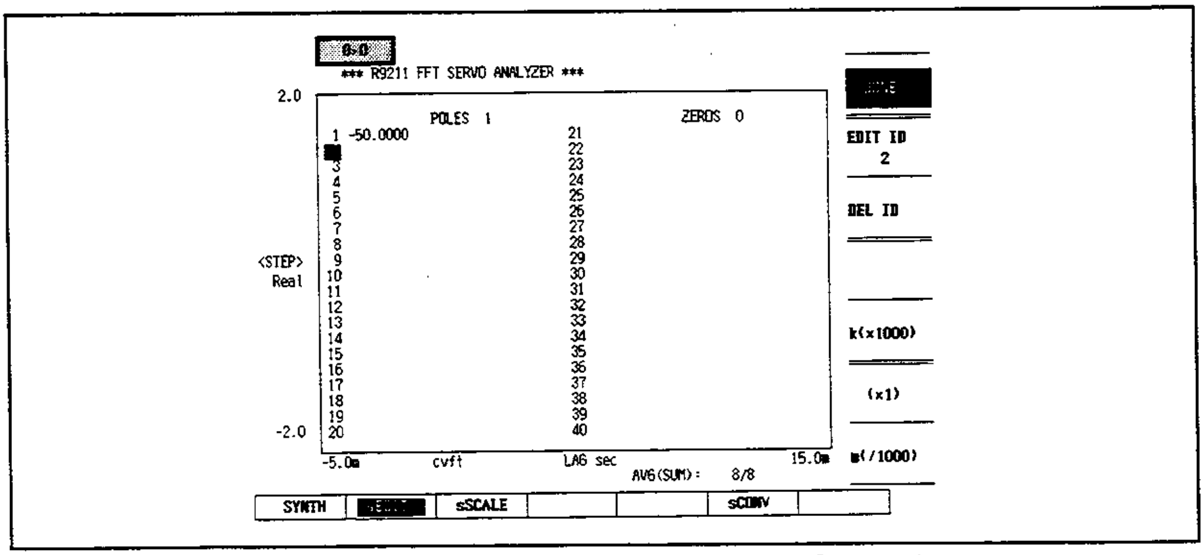
Assigns the synthesis function to the MATH key.

2 Edits the poles and zeros table.

MATH ⇒ sEDIT

Displays the poles/zeros table to be edited.

The poles and zeros coordinates can be entered.



```
*** R9211 FFT SERVO ANALYZER ***
           POLES  1                          ZEROS  0
 1 -50.0000                   21
 2                            22
 3                            23
 4                            24
 5                            25
 6                            26
 7                            27
 8                            28
 9                            29
10                            30
11                            31
12                            32
13                            33
14                            34
15                            35
16                            36
17                            37
18                            38
19                            39
20                            40
```

Figure 12-8 Edition of Poles and Zeros for Synthesis

3 Edits the poles/zeros table.

$\boxed{\text{MATH}}$ ⇒ $\boxed{\text{sEDIT}}$ ⇒

DONE	Terminates the edition of the poles/zeros table.
EDIT ID 1	Specifies the number of the line to be edited.
DEL ID	Deletes the line number specified with the EDIT ID key.
K(×1000)	Unit key
(×1)	
m(/1000)	

After specifying a line number with the EDIT ID key, enter the pole and zero values must be entered with the numeric keypad and a terminator. To enter a complex number a comma has to be used as follows:

$\boxed{-}\ \boxed{5}\ \boxed{,}\ \boxed{2}\ \boxed{0}$ (×1)

In this case, the complex number $-5 \pm j20$ is displayed.

After completing the input of the table, press the DONE key and complete the edit of the ploles/zeros table.

4 Enters a gain, delay time, and scale frequency.

$\boxed{\text{MATH}}$ ⇒ $\boxed{\text{sSCALE}}$ ⇒

SYSgain 1.00	Enters a gain. (First the mantissa must be entered with the numeric keypad, then, after pressing the E key, the characteristic is to be entered with the numeric keypad, the $\boxed{\text{ENT}}$ key finishes the procedure.)
TimeDelay 0.0sec	Enters a delay. (After entering the value with the numeric keypad, the unit is specified with the terminator.)
Scale f 1.00kHz	Enters a scale frequency. (After entering the value with numeric keypad, the unit is specified with the terminator.)
E	Enters the unit of the characteristic.
sec/kHz	Unit key
msec/Hz	
μsec/mHz	

5 Executes the synthesis function.

MATH ⇒ SYNTH ⇒	
CREATE SYNTH	Executes the synthesis function.
STOP SYNTH	This key is effective during execution of synthesis. Pressing this key twice will stop the execution of the synthesis function.

6 Dislpays the result of execution of the synthesis funciton.

MATH ⇒ sCONV ⇒	
DONE	Clears the displayed table.
POLE-ZERO	Displays the poles/zeros table.
POLE-RES	Displays the poles/residues table.
POLYNOMI	Displays the polynomials table.

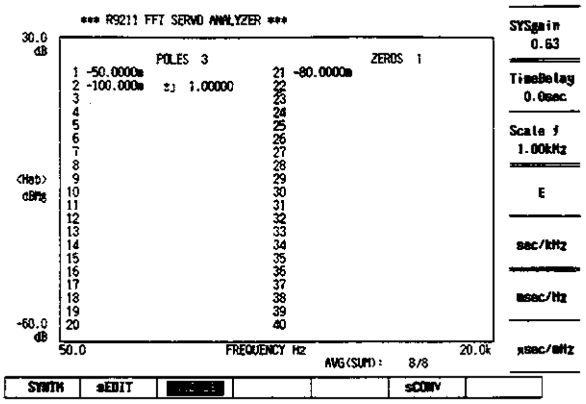
CAUTION !

When the number of poles and residues or polynomials exceed 20,
CS.mg = Pole-Residue & Polynomials : Failed is displayed during execution of the curve fitting or synthesis function.
And the poles/residues or polynomials table is not displayed POLE-RES or POLYNOMI is pressed.

7 Displays the gain, delay time, and scale frequency.

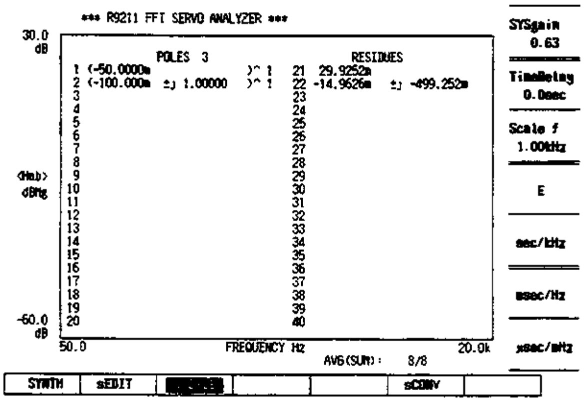
MATH ⇒ sSCALE ⇒	
SYSgain 1.00 TimeDelay 0.0sec Scale f 1.00kHz	After pressing the sSCALE key in the X soft menu, the gain, delay time, and scale frequency can be selected with the Y soft menu.

Figures 12-9 to 12-11 show poles/zeros, poles/residues, and polynomials tables. Note that the poles/residues and polynomials tables are not displayed if 20 lines of either table are exceeded.



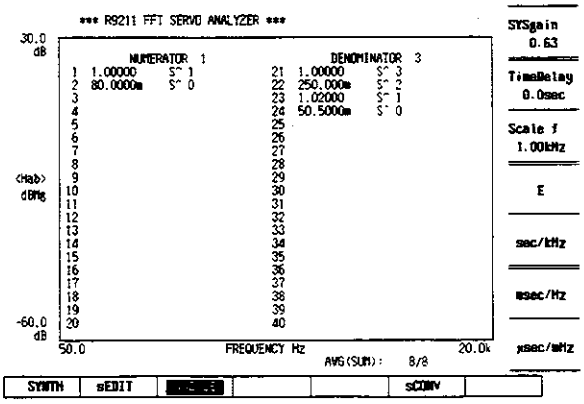
```
*** R9211 FFT SERVO ANALYZER ***
            POLES  3                         ZEROS  1
 1 -50.0000m                      21 -80.0000m
 2 -100.000m   ±j  1.00000        22
 3                                23
 4                                24
 5                                25
 6                                26
 7                                27
 8                                28
 9                                29
10                                30
11                                31
12                                32
13                                33
14                                34
15                                35
16                                36
17                                37
18                                38
19                                39
20                                40
                                         AVG(SUM):   8/8
```

Figure 12-9 Poles/zeros Table Displayed after Synthesis Function



```
*** R9211 FFT SERVO ANALYZER ***
            POLES  3                         RESIDUES
 1 (-50.0000m                 )^ 1   21  29.9252m
 2 (-100.000m  ±j 1.00000     )^ 1   22 -14.9626m    ±j -499.252m
 3                                   23
 4                                   24
 5                                   25
 6                                   26
 7                                   27
 8                                   28
 9                                   29
10                                   30
11                                   31
12                                   32
13                                   33
14                                   34
15                                   35
16                                   36
17                                   37
18                                   38
19                                   39
20                                   40
                                         AVG(SUM):   8/8
```

Figure 12-10 Poles/residues Table Displayed after Synthesis Function



```
*** R9211 FFT SERVO ANALYZER ***
          NUMERATOR  1                      DENOMINATOR  3
 1  1.00000     S^ 1              21  1.00000     S^ 3
 2  80.0000m    S^ 0              22  250.000m    S^ 2
 3                                23  1.02000     S^ 1
 4                                24  50.5000m    S^ 0
 5                                25
 6                                26
 7                                27
 8                                28
 9                                29
10                                30
11                                31
12                                32
13                                33
14                                34
15                                35
16                                36
17                                37
18                                38
19                                39
20                                40
                                         AVG(SUM):   8/8
```

Figure 12-11 Polynomials Table Displayed after Synthesis Function

8 Displays the frequency, impulse and step response function calculated from the poles/zeros from the synthesis function.

VIEW ⇒ **MATH VW** ⇒

SYNTH FRF	Displays the frequency response function calculated from the poles/zeros computed with the synthesis function.
SYNTH IMPRESP	Displays the impulse response function calculated from the poles/zeros computed with the synthesis function.
SYNTH STEPRESP	Displays the step response function calculated from the poles/zeros computed. with the synthesis function.

Figures 12-12 to 12-14 show the frequency, impulse and step response function calculated from the results of execution of the synthesis function. When the frequency response function is measured by logarithmic frequency sweep or with the F-table, impulse and step response functions cannot be displayed.

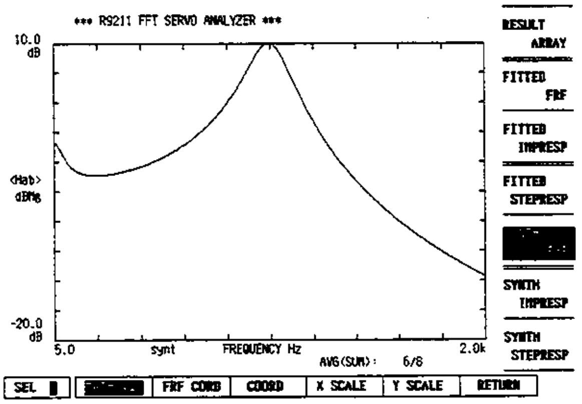


Figure 12-12 Frequency Response Function Calculated from the Poles/zeros Computed with the Synthesis Function

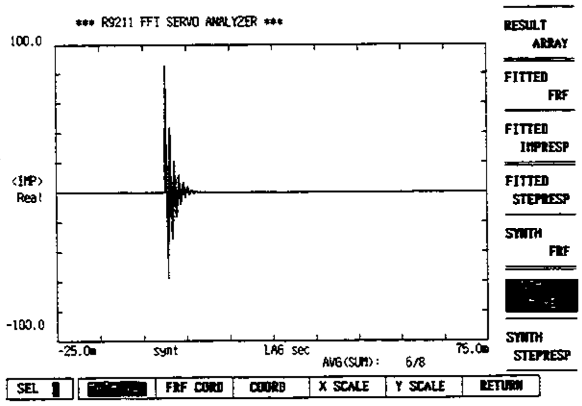


Figure 12-13 Impulse Response Function Calculated from the Poles/zeros Computed with the Synthesis Function

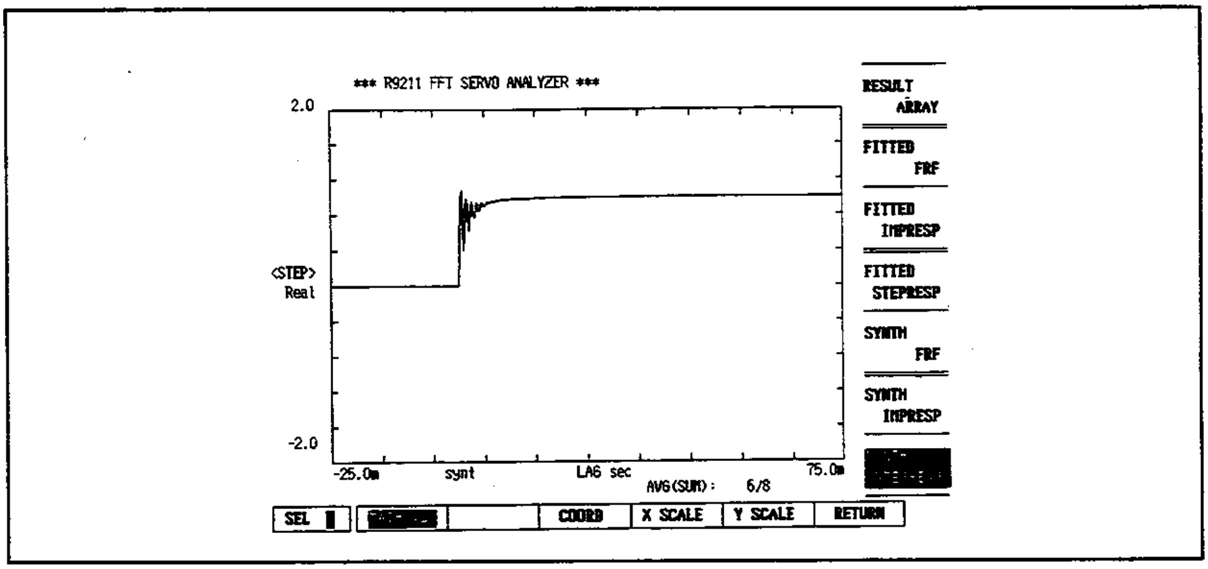


Figure 12-14 Step Response Function Calculated from the Poles/zeres Computed with the Synthesis Function

4. Know-How Of Use

■ Response Functions Calculated by the Curve Fitting and Synthesis Functions

When the curve fitting or synthesis functions is executed in the SERVO mode, the poles/zeros that are either calculated through curve fitting or directly input, lead to the following response functions, according to the sweep:

Table 12-1 Response Functions Calculated from Poles and Zeros

SWEEP	Frequency response function	Impulse response function	Step response function
LIN SIN	○	○	○
LIN MSIN	○	○	○
LOG SIN	○	×	×
LOG MSIN	○	×	×
LIN F-Tab	○	×	×
LOG F-Tab	○	×	×

When the curve fitting function is executed by setting SWEEP to LOG or F-Tab, impulse and step response functions are not calculated.
To obtain the impulse or step response function with the Laplace parameter obtained by logarithmic frequency sweep or with the F-Tab table, the analyzer must be set in the linear frequency sweep mode.
This procedure is described below.

■ How to Compute Impulse and Step Response Functions from Result Acquired with SWEEP Set to LOG or F-Tab

Under servo mode, the frequency response function is acquired with SWEEP set to LOG or F-Tab, then the curve fitting function is executed.

to SYNTH ⇒ FIT to SYNTH	Transfers the Calculated Laplace parameters to the synthesis function.
PRESET ⇒ MATH KEY	The MATH key is going to be affected with a new math function.

⇒ FRF Synth MENU	Allocates the synthesis function to the MATH key.
SETUP ⇒ SWEEP ⇒ LIN SIN	Sets the analyzer in the linear mode to execute the synthesis function on the specified frequency range. The LIN MSIN key can be pressed instead of the LIN SIN.
RANGE ⇒ FREQ RNG *	The maximum frequency range must be entered. ***(NOTE)***

(The frequency range can be entered either with the knob, ⇧ or ⇩ key, the numeric keypad followed by a terminator, or the numeric keypad followed by the ENT key.)

⇒ f RESOLN	The total number of lines must be entered. ***(NOTE)***
⇒ LINE/SPAN	

(The number of lines can be entered with the knob, ⇧ or ⇩ key, or the numeric keypad followed by the ENT key)

START STOP	To internally validate the resolution change (Logarithmic to linear), you must press the START key and immediately afterward the STOP key.
MATH ⇒ SYNTH ⇒ CREATE SYNTH	In the linear mode, executes the synthesis function.
VIEW ⇒ MATH VW ⇒	After completion of the execution of the synthesis function, a display screen can be selected with the MATH VW key.
⇒ SYNTH FRF	Displays the frequency response function.
⇒ SYNTH IMPRESP	Displays the impulse response function.
⇒ SYNTH STEPRESP	Displays the step response function.

NOTE

The time range can be computed with the following expression using the input maximum frequency and the total number of lines.

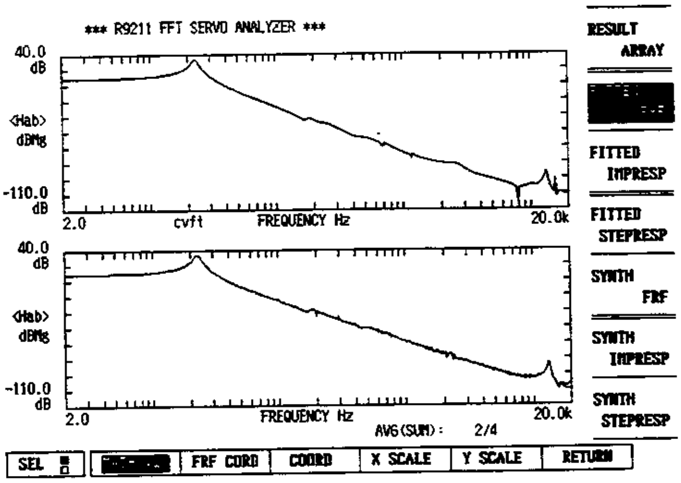
-0.25*(n/f)[sec] to 0.75*(n/f)[sec]

Where, f[Hz] = Maximum frequency

n = Total number of lines

In other words the time range of the computed waveform can be extended or reduced by adjusting the maximum frequency and or the total number of lines.

In the following example, the curve fitting function is executed on the frequency response function of the optical actuator (Figure 12-15) and the Laplace parameters are transferred to the synthesis function to compute the impulse and step response functions (Figure 12-17).



Curve fitting result

Measured frequency response function

Figure 12-15 Measured Frequency Response Functions and Curve Fitting Result

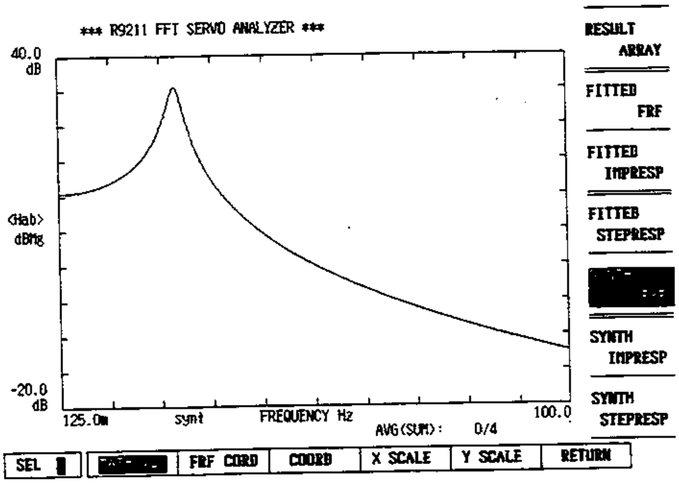
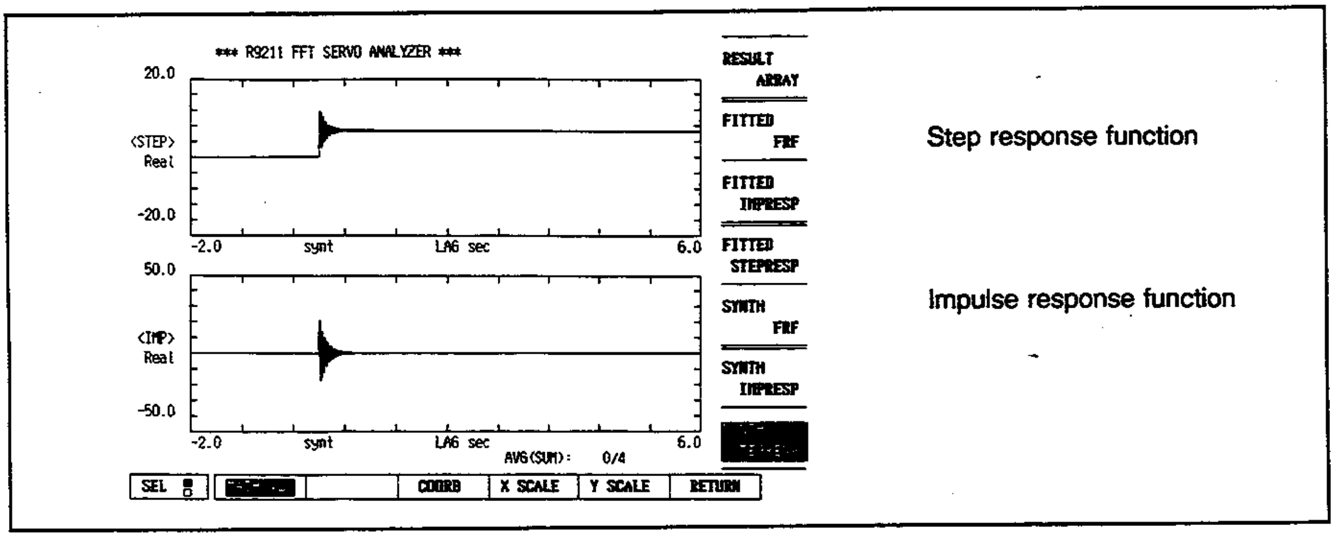


Figure 12-16 Frequency Response Functions Obtained in the 0 to 100Hz Frequency Range, after Transferring the Poles and Zeros (Computed through Curve Fitting) to the Synthesis Function (Total Number of Lines : 800)



Step response function

Impulse response function

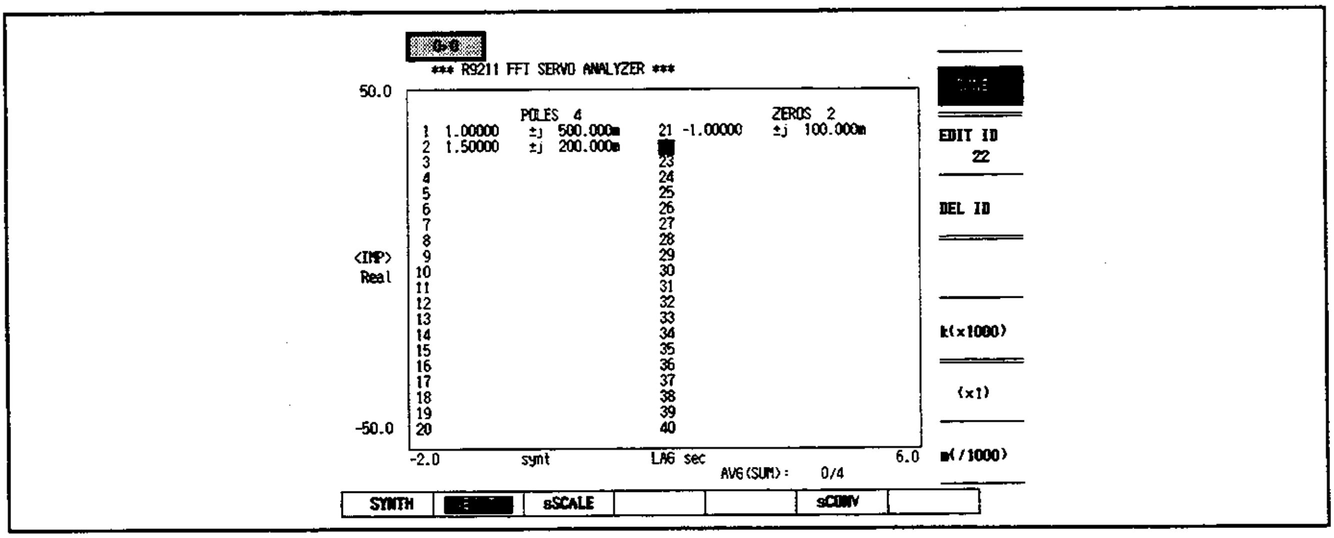
Figure 12-17 Impulse and Step Functions Computed with the Synthesis Function

■ Impulse and Step Response Functions Which Cannot Theoretically be Calculated

If all the real parts of poles are positive when the curve fitting or synthesis function is executed, impulse and step response functions cannot be calculated under the linear sweep mode. In this case, the following message appears for 0.5 second during the execution of the curve fitting or synthesis function:

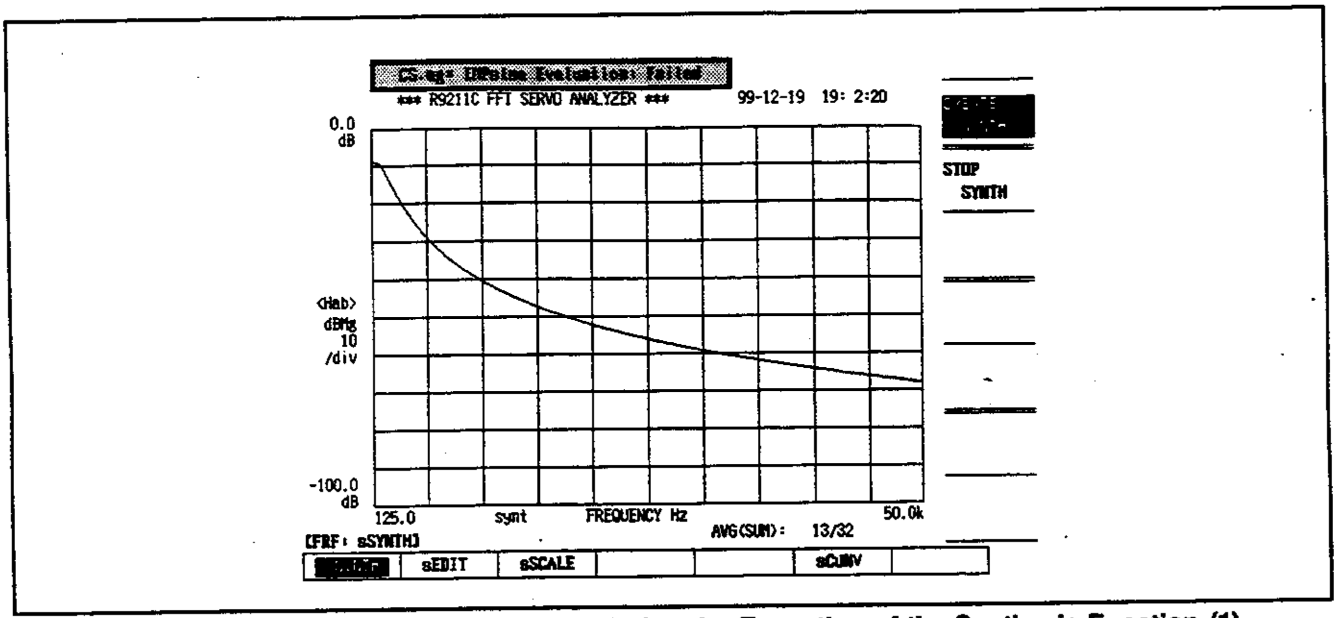
```
CS.mg = IMPulse, STEP responses can't be computed
```

In the following example, all the real parts of poles are with positive and the synthesis function is executed:



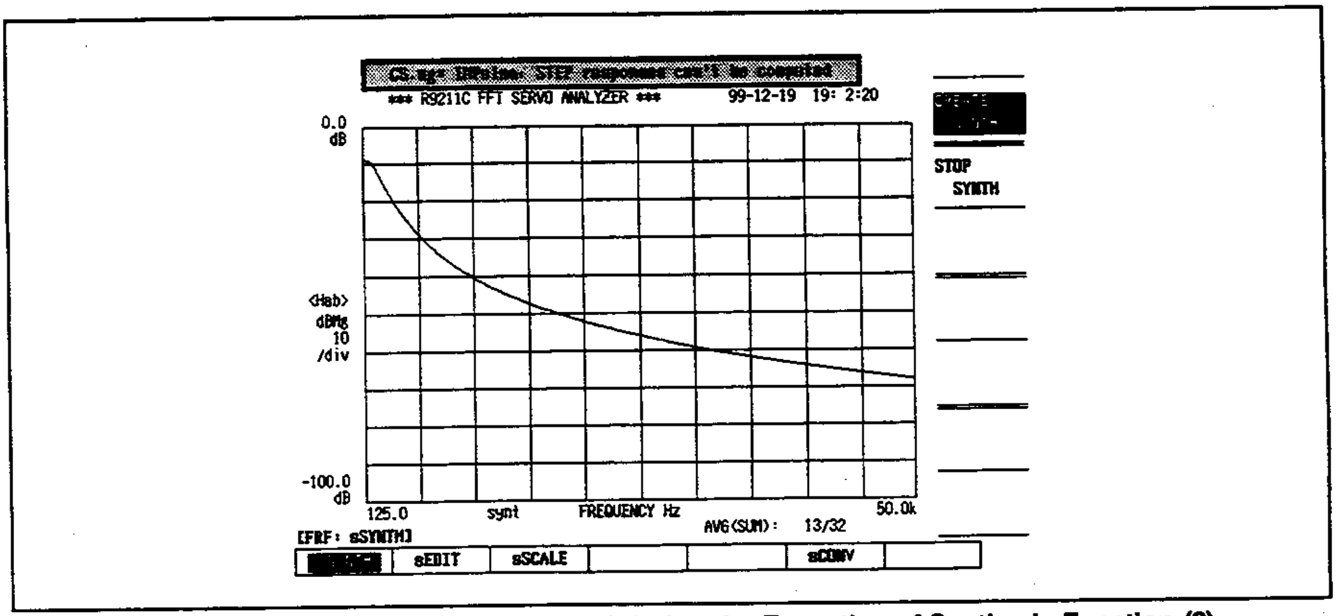
```
            POLES  4                              ZEROS  2
 1  1.00000   ±j  500.000m     21  -1.00000    ±j  100.000m
 2  1.50000   ±j  200.000m
```

Figure 12-18 Example of Poles Whose Real Parts of Poles are All Positive



CS.Msg: IIRPoles Evaluation: Failed

Figure 12-19 Error Message Displayed during the Execution of the Synthesis Function (1)

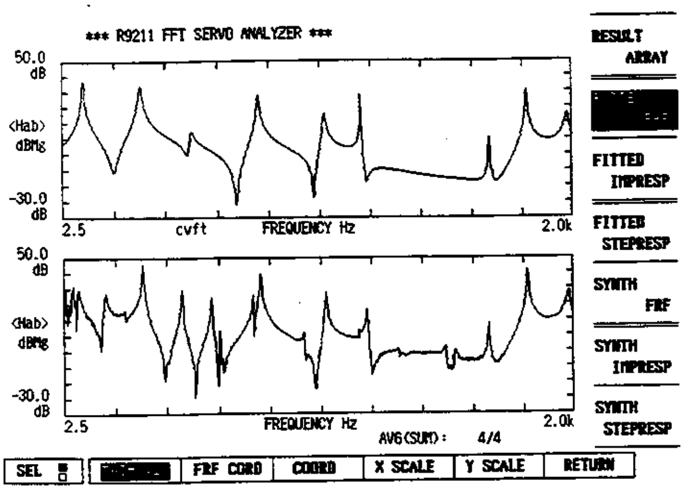


CS.Msg: IIRPoles: STEP response can't be computed

Figure 12-20 Error Message Displayed during the Execution of Synthesis Function (2)

■ Ten or More Positive or Negative Peak Values in the Fitting Range

When dBMg is used as the unit for the measurement frequency response function, the positive peak values (resonance points) correspond to the poles and the negative peak values (antiresonance points) correspond to zeros. If the fitting range contains ten or more positive or negative peak values, the curve fitting function cannot be normally executed. In Figures 12-21 and 12-22, the curve fitting function is executed for the frequency response function having too many poles and zeros in the curve fitting frequency range.

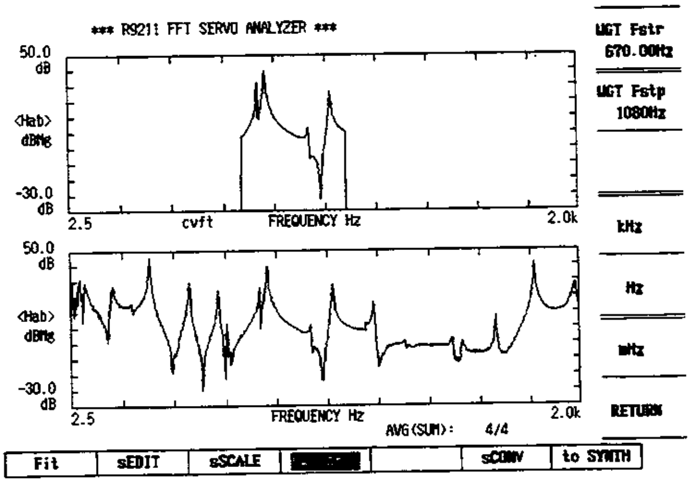


Curve fitting result

Measurement result

Figure 12-21 The Measured Frequency Response Function Posesses More Than 10 Peaks

By selecting USR WGT (weight function), and entering WGT Fstr (start frequency) and WGT Fstp (stop frequency) in order to have a fitting range with a number of positive or negative peak values below to 10. The fitting process can be greatly improved and accurate poles and zeros coordinates can be determined.



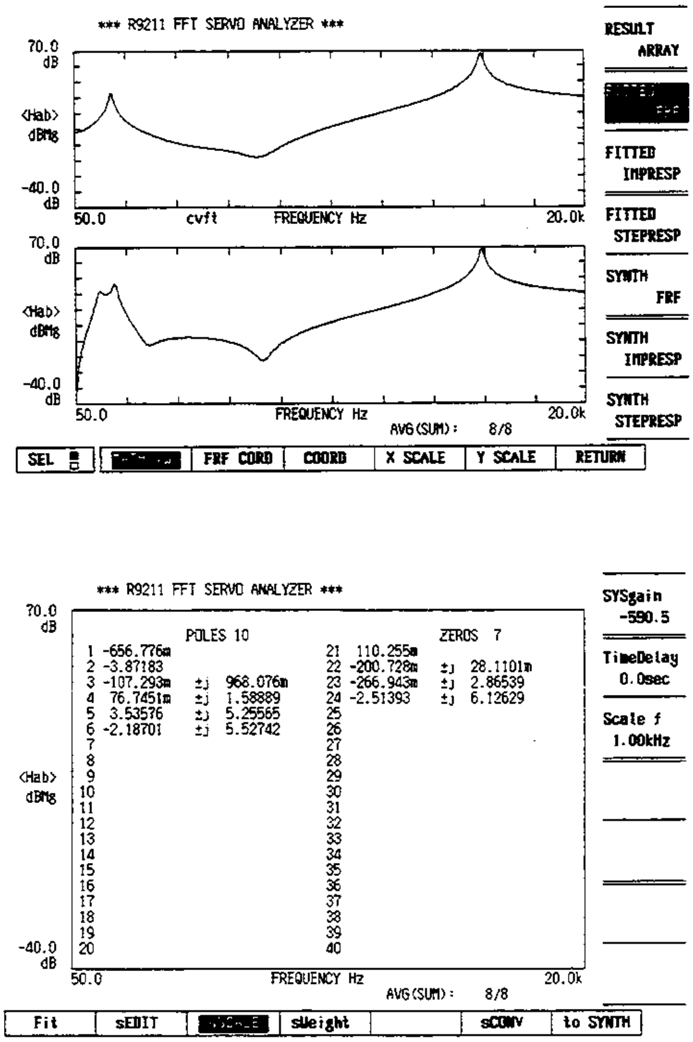
Curve fitting result

Measurement result

Figure 12-22 Using USR WGT to Limit the Number of Peak Values in the Fitting Range

■ Curve Fitting with Low Frequency Poles and Zeros As Well As High Frequency Poles and Zeros.

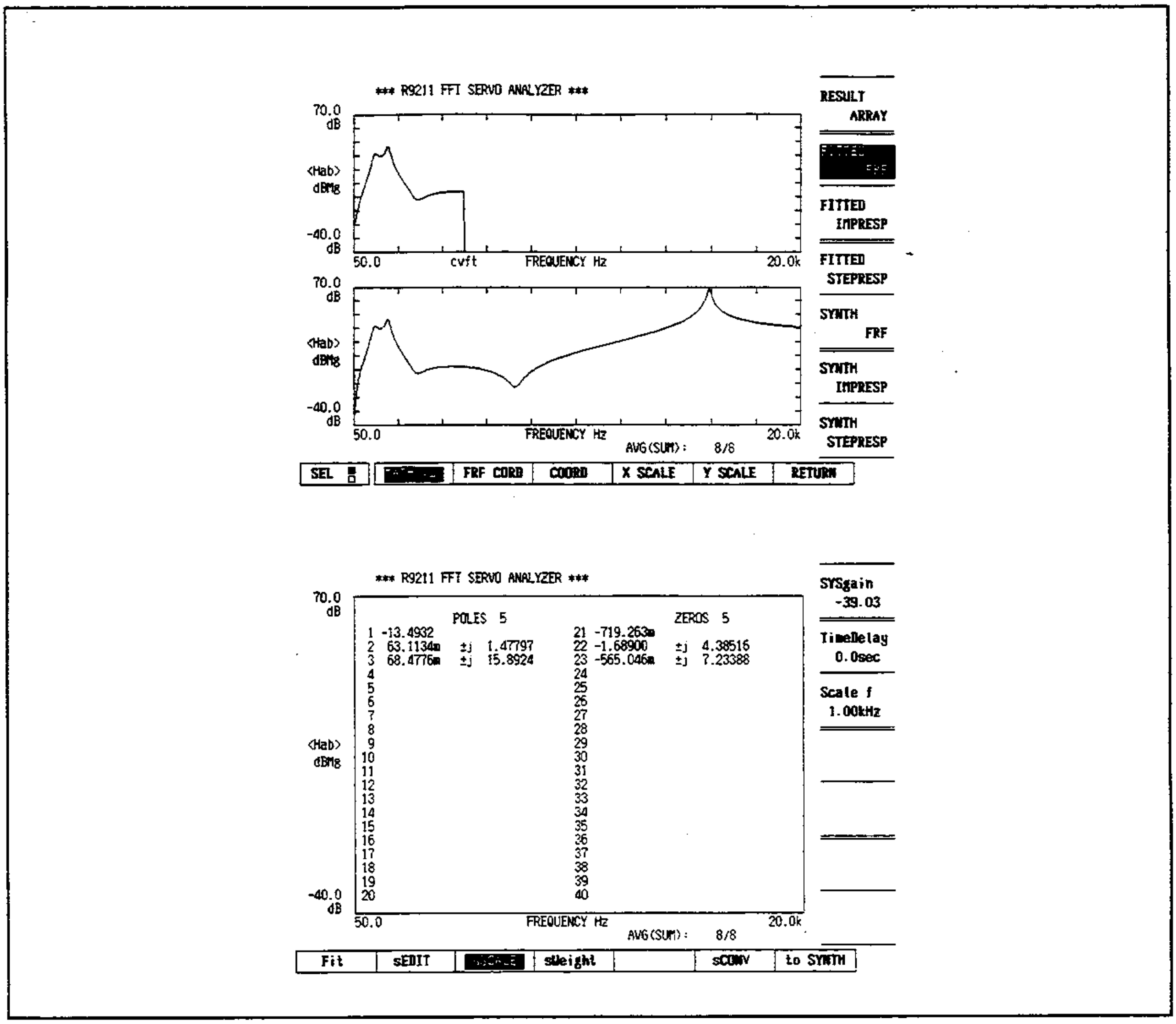
When low frequency poles and zeros exist and the curve fitting function is executed over the whole frequency range (AUTO WGT or UNIF WGT is selected as a weight function), this function cannot be properly executed on the low frequency side. Accordingly, the poles and zeros coordinates cannot be determined. In Figure 12-23, there are two poles on the low frequency side.



```
SYSgain
  -590.5
TimeDelay
  0.0sec
Scale f
  1.00kHz

          POLES 10                            ZEROS  7
 1 -656.776m                    21  110.255m
 2 -3.87183                     22 -200.728m   ±j  28.1101m
 3 -107.293m   ±j  968.076m     23 -266.943m   ±j  2.86539
 4  76.7451m   ±j  1.58889      24 -2.51393    ±j  6.12629
 5  3.53576    ±j  5.25565      25
 6 -2.18701    ±j  5.52742      26
 7                              27
 8                              28
 9                              29
10                              30
11                              31
12                              32
13                              33
14                              34
15                              35
16                              36
17                              37
18                              38
19                              39
20                              40
```

Figure 12-23 Curve Fitting with Low Frequency Poles and Zeros

By using USR WGT as the weight function and select in a low frequency for fitting range the poles and zeros coordinates are accurately determined.

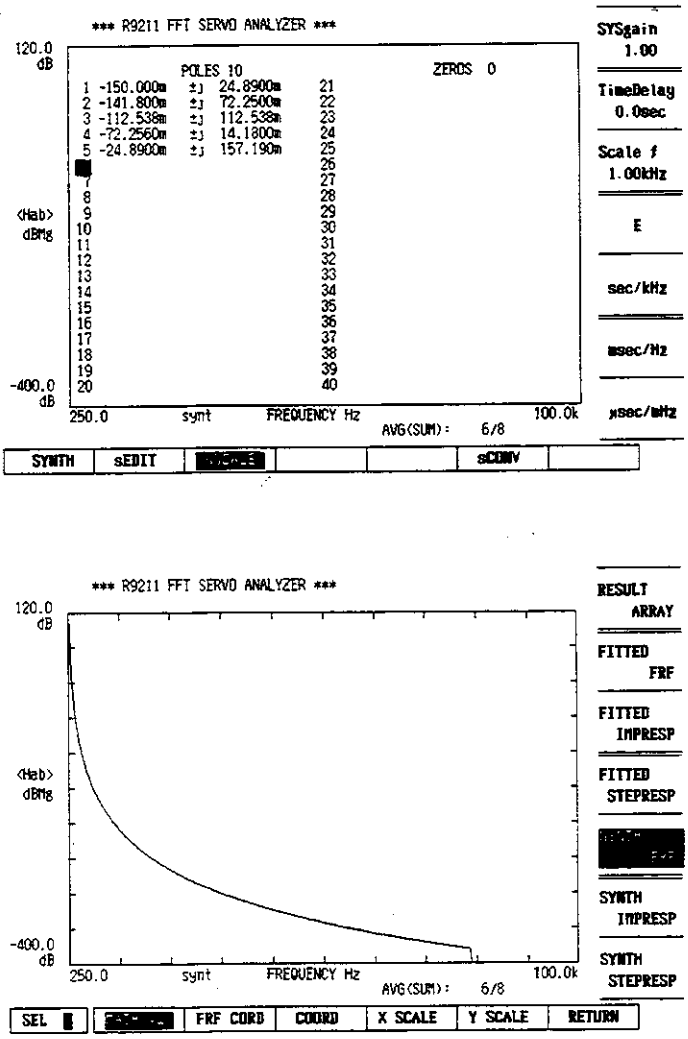


```
          POLES  5                            ZEROS  5
 1 -13.4932                      21 -719.263m
 2  63.1134m   ±j  1.47797       22 -1.68900      ±j  4.38516
 3  68.4776m   ±j  15.8924       23 -565.046m     ±j  7.23388
 4                               24
 5                               25
 6                               26
 7                               27
 8                               28
 9                               29
10                               30
11                               31
12                               32
13                               33
14                               34
15                               35
16                               36
17                               37
18                               38
19                               39
20                               40
```

Figure 12-24 Using USR WGT to Select a Low Frequency Fitting Range

Underflowing during Execution of Synthesis Function

If a value is too small, underflow may occur in the synthesized frequency response function, when the synthesis function is executed. In Figure 12-25, the upper screen shows the input data for synthesis and the lower screen is the display of the frequency response function calculated from the input data. This graph indicates that underflow occurred when the frequency response function came below −380dB.



```
*** R9211 FFT SERVO ANALYZER ***
                 POLES 10                                ZEROS  0
 1 -150.000m   ±j  24.8900m     21
 2 -141.800m   ±j  72.2500m     22
 3 -112.538m   ±j  112.538m     23
 4 -72.2560m   ±j  14.1800m     24
 5 -24.8900m   ±j  157.190m     25
```

Figure 12-25 Underflow during Execution of Synthesis Function

■ Impulse Response Function Calculated from Curve Fitting Result

The impulse response function, of averaged data, is calculated using reverse Fouier transform on the absolute value of the measured frequency response function.

For example, during analysis of 400 lines, the signal is calculated in response to the dummy impulse signal generated from 400 sine waves.

When the measuring frequency range is doubled (it is changed from 0 to 10kHz to 0 to 20kHz), the amplitude of the dummy impulse signal does not change but the time domain is reduced by half.

Therefore, since an impulse signal whose product of the amplifier by the time domain is smaller by 1/2 is fed, the amplitude of the impulse response signal is reduced to 1/2.

That is, the amplitude of the impulse response function calculated with the averaging data varies in reverse proportion to the measured frequency range.

When the curve fitting or synthesis function is executed, the impulse response function is calculated from the Laplace parameters by supplying an ideal impulse signal (the time domain is 0 second, the amplitude is infinite, the product of the time domain by the amplitude is $(\frac{1}{2\pi})^2$ Vsec).

The amplitude of the calculated impulse response function does not change with the measured frequency range.

Impulse response functions calculated from averaged data and from curve fitting results are below.

- **Impulse response function calculated from averaged data**

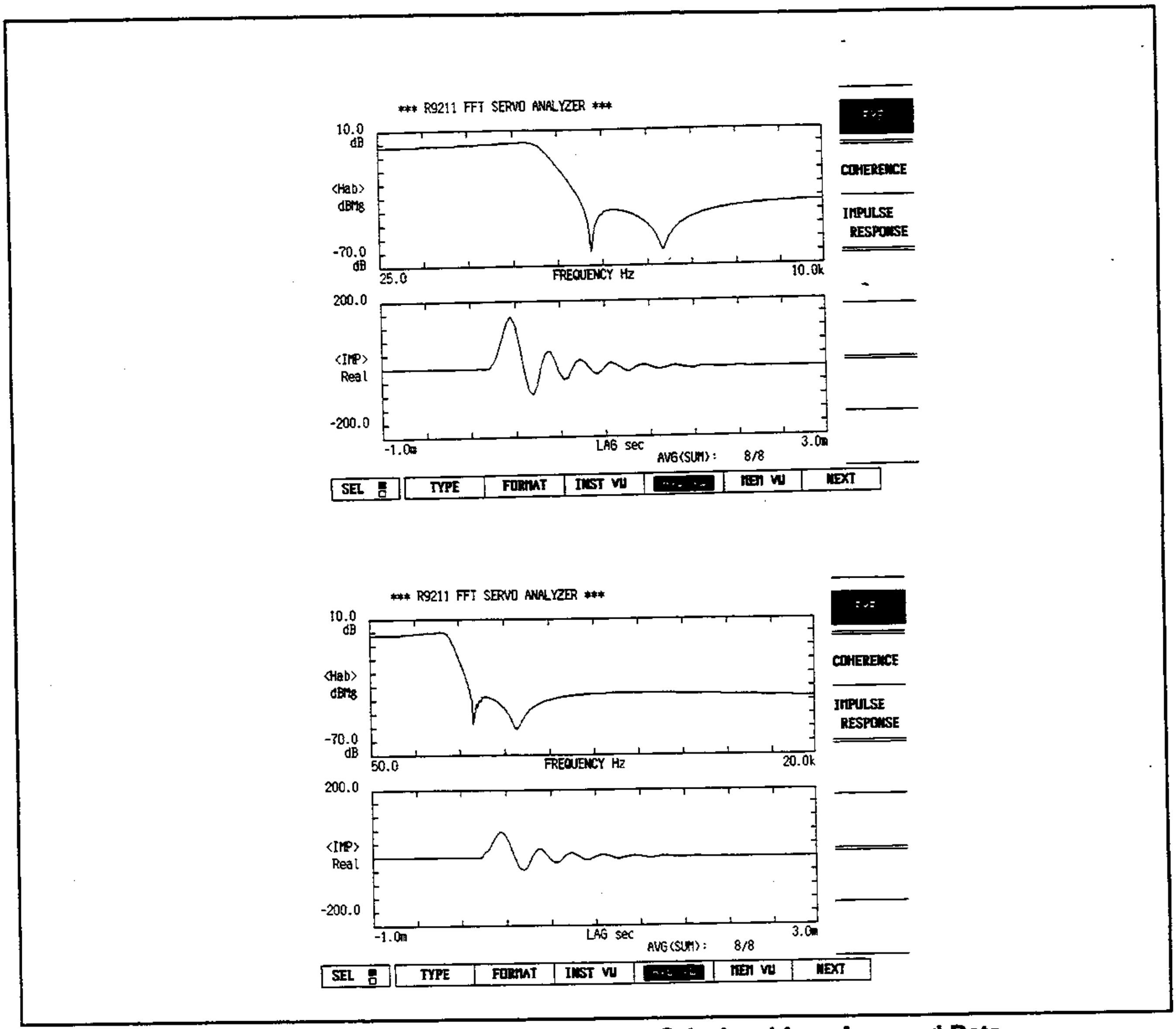


Figure 12-26 Impulse Response Function Calculated from Averaged Data

- **Impulse response function calculated from curve fitting results**

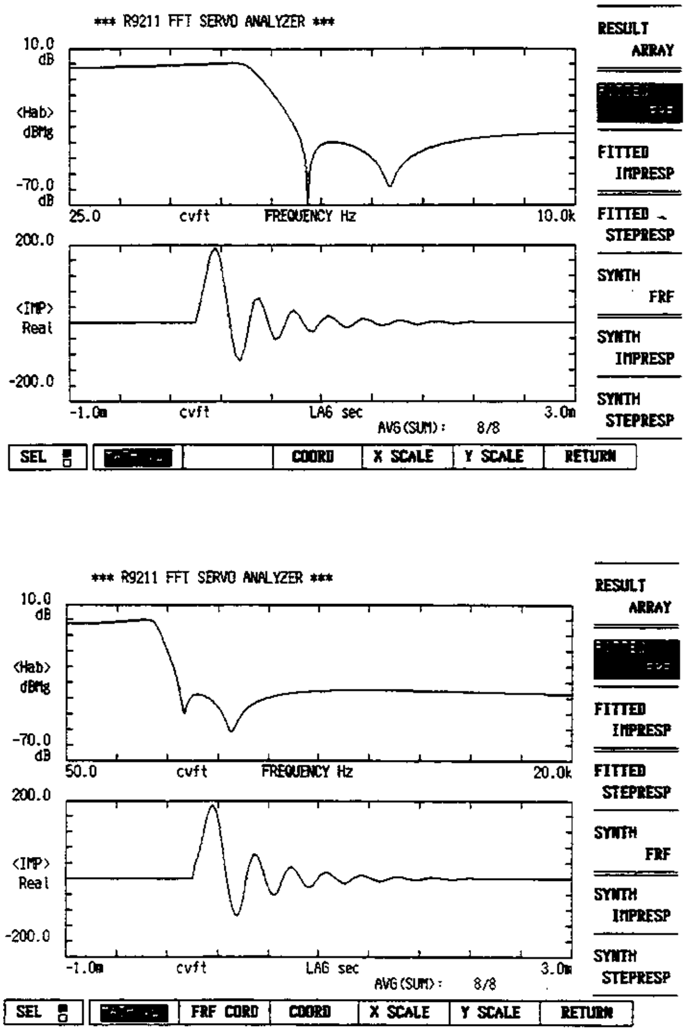


Figure 12-27 Impulse Response Function Calculated from Curve Fitting Results

■ Comparison between Frequency Response Functions Computed with the Synthesis Function and the Servo Function

The method of comparison between the frequency response function computed with the synthesis function and that obtained with the servo function is described below. Moreover, the method of comparison between the quotients of two frequency response functions (assuming that the decibel value at a certain frequency (1kHz in the following example) is 0dB) is described.

(1) Display the frequency response function obtained with the synthesis function and that obtained with the servo function.

(2) Select the MATH function.

PRESET ⇒ MATH MENU

(3) Press the VIEW ⇒ SEL ⬒ keys to select the frequency response function calculated with the synthesis function. (See Figure 12-28.)

(4) Specify that the frequency response function selected in step (3) has become the operand.

MATH ⇒ f MATH ⇒ MATH SEL ⇒ OPERAND

(5) Press the VIEW ⇒ SEL ⬓ keys and select the frequency response function calculated with the servo function. (See Figure 12-29.)

(6) Specify the operation type (division).

MATH ⇒ f MATH ⇒ ALGEBRA ⇒ X/Y ⇒ RETURN

(7) Specify that the frequency response function selected in step (5) has become the operator.

MATH SEL ⇒ 1st OPRTR

(8) Executes the operation.

DO MATH

When the operand specified in step (3) is assigned to X and the operator specified in step (5) is assigned to Y, X is divided by Y.

(9) Displays the operation result. (See Figure 12-30.)

VIEW ⇒ MATH VW ⇒ RESULT ARRAY

To set 0dB at 1kHz, executes the next step.

(10) Sets "A:VALUE" and "B:VALUE" to 0 (dBEU).

SETUP ⇒ UNIT ⇒ SELECT CH (CH-A)

⇒ CH-A ⇒ RETURN

⇒ A:VALUE 0.00dBEU

SETUP ⇒ UNIT ⇒ SELECT CH (CH-B)

⇒ CH-B ⇒ RETURN

⇒ B:VALUE 0.00dBEU

(11) Selects an engineering unit (EU).

SETUP ⇒ UNIT ⇒ EU or VLT ⇒ EU

(12) Displays a marker for the operation results and reads the decibel value at 1kHz.

(13) If the decibel value read in step (11) is not 0dB, change "B:VALUE". When the decibel value at 1kHz is β(dBEU) before change, set "B:VALUE" to $-\beta$(dBEU). In this case, the decibel value at 1kHz becomes 0dB.
Figure 13-31 shows the display before change. The decibel value at 1kHz is β (=0.16185 dBEU). The decibel value at 1kHz is set to 0dB by setting "B:VALUE" to −0.16185 (dBEU) as shown in Figure 12-32.

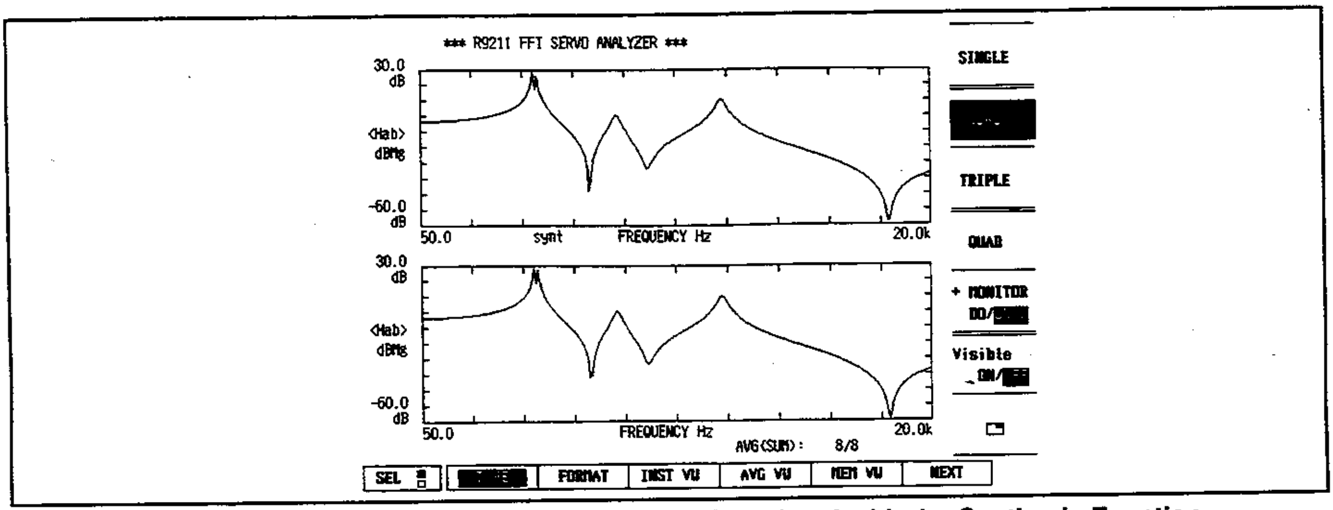


Figure 12-28 Frequency Response Function Calculated with the Synthesis Function

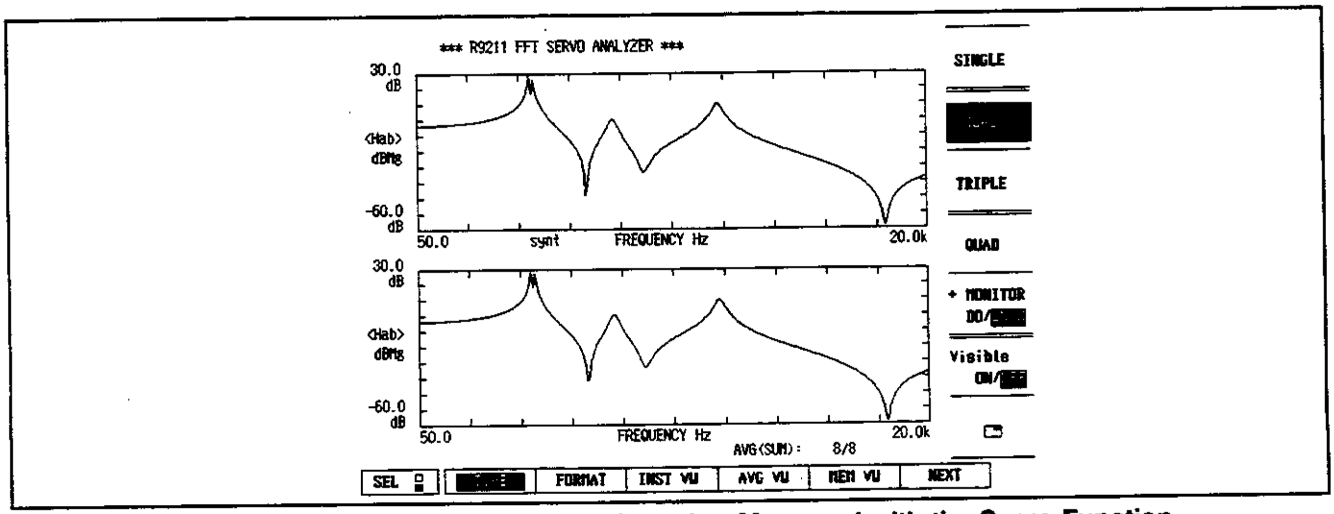


Figure 12-29 Frequency Response Function Measured with the Servo Function

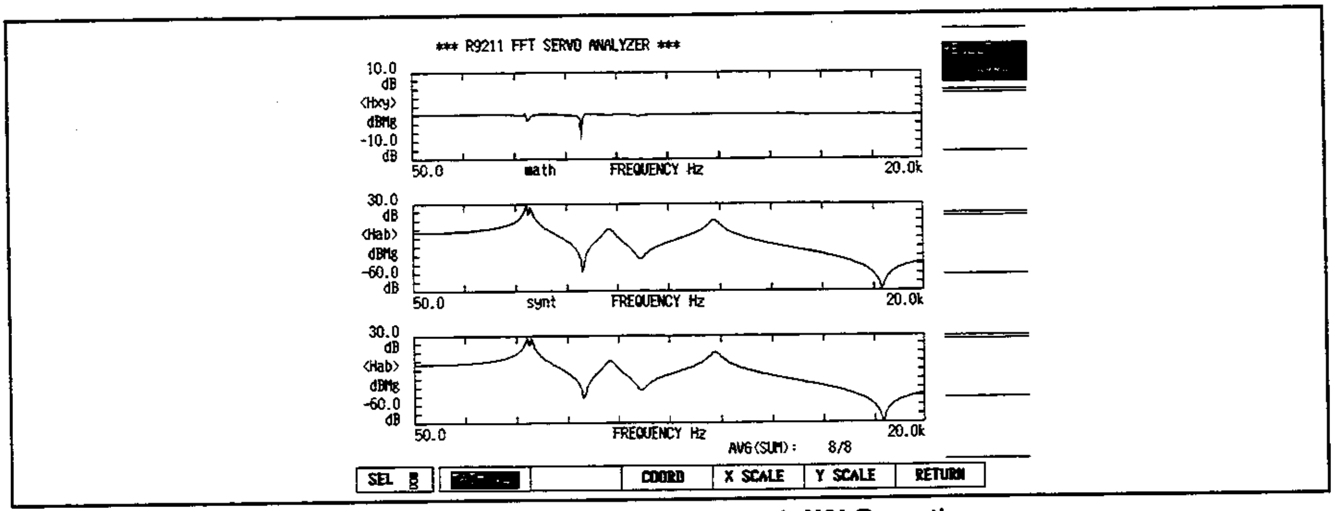


Figure 12-30 Comparison through X/Y Operation

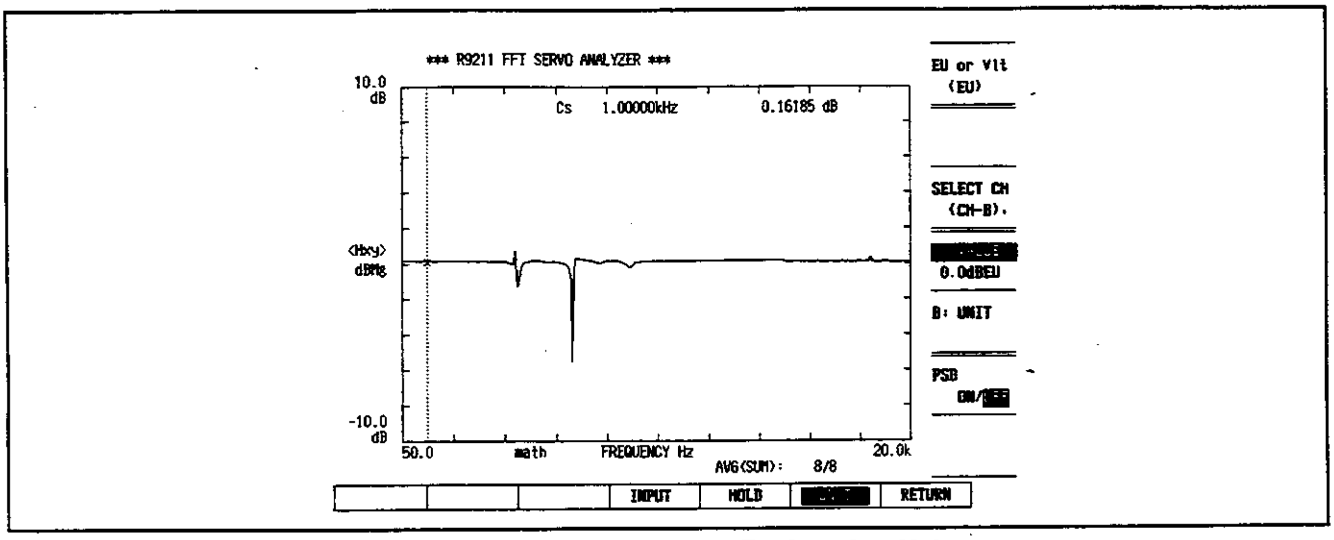


Figure 12-31 Display Using Engineering Unit

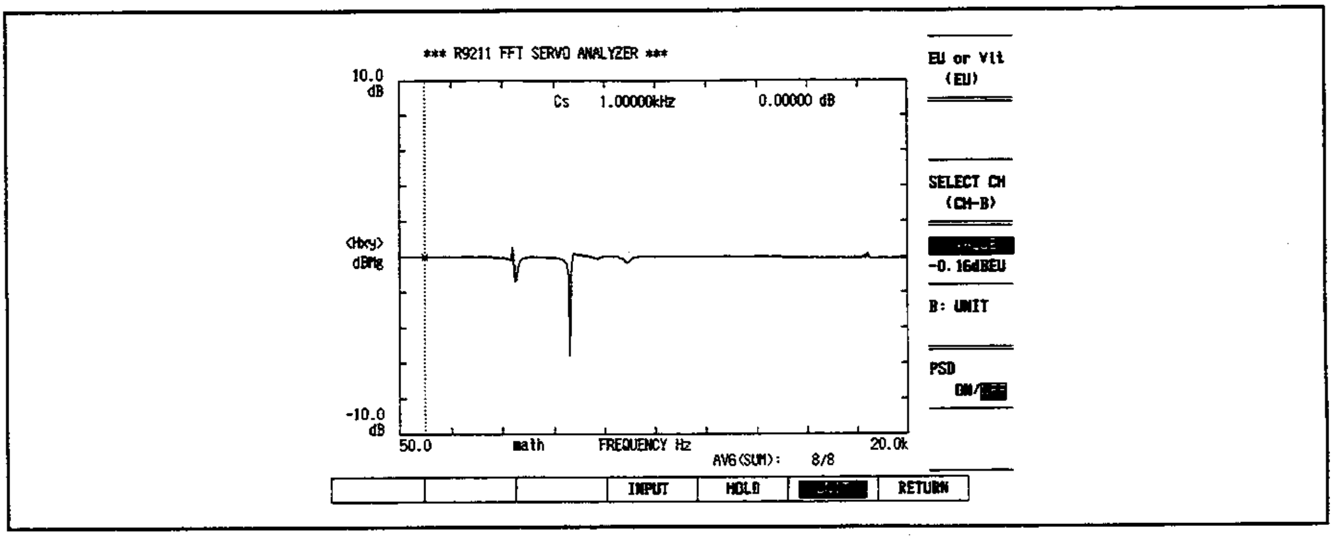


Figure 12-32 Display with 0dB at 1kHz

■ Evaluating Laplace Parameter

Evaluate the Laplace parameters (poles/zeros) of the frequency response function of an electric device or are evaluated according to the flowchart shown in Figure 12-33.
Devices frequency response functions are measured with the multi-sine wave in two measurement time modes (SHORT and LONG) and the curve fitting function is executed for each frequency response function.
The measurement quality in the LONG mode is about three times higher than that in the SHORT mode. If poles and zeros coordinates (curve fitting result) obtained in the SHORT mode are almost the same as those obtained in the LONG mode, the curve fitting result is reliable.
If these results are different, the supply voltage can be changed or the USR WGT must be set as a weight function, to narrow the fitting frequency range, and then the curve fitting function cycle can be executed again.

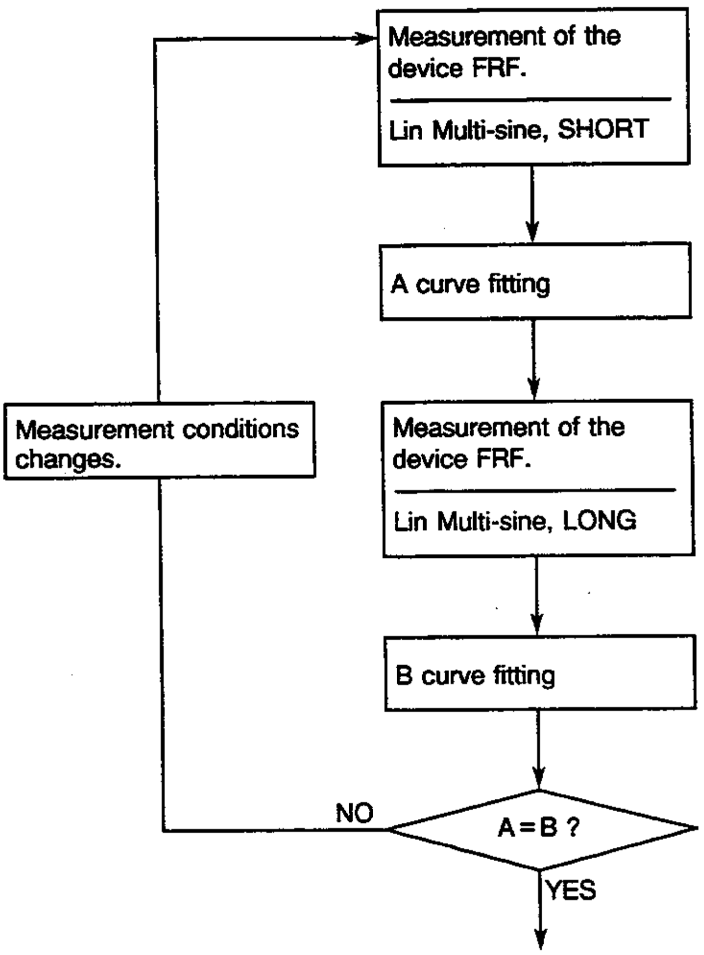
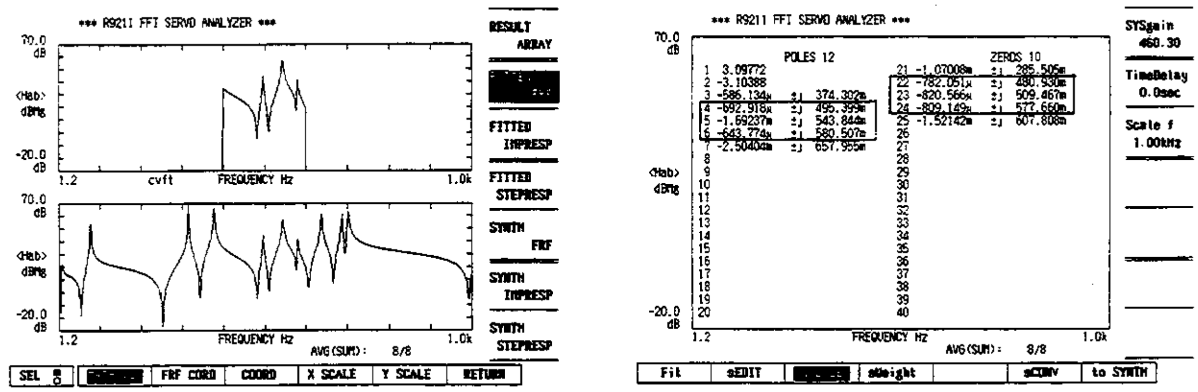


Figure 12-33 Laplace Parameters Evaluation Flow

In the following example, the frequency response function of a certain device is measured, then the curve fitting function is executed. In this case, the curve fitting function is executed assuming that USR WGT is specified as the weight function with a fitting range from 400Hz to 600Hz.
If the dispersion of the poles and zeros coordinates (whose imaginary between the short and long mode results parts are within the range from 400Hz to 600Hz) is at most ±15%, the curve fitting results are reliable.

Measurement time : SHORT (low quality)

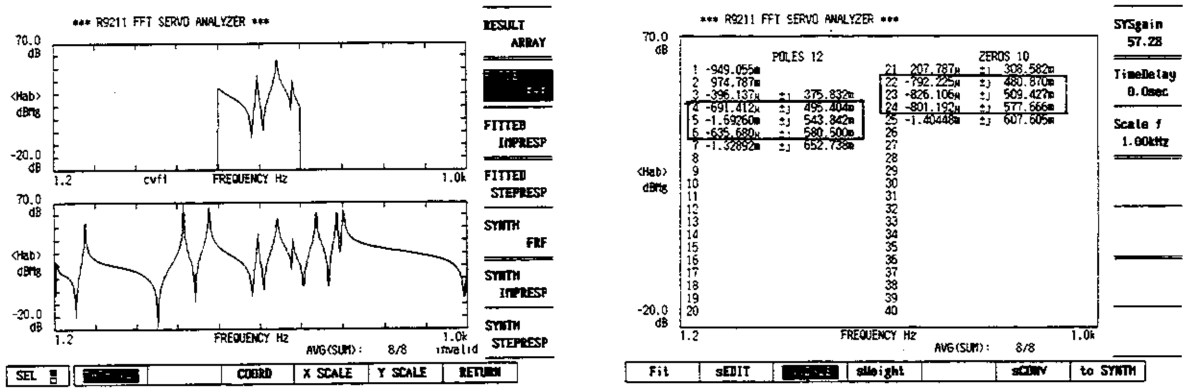


```
            POLES 12                                ZEROS 10
 1  3.09772                         21 -1.07008m   ±j  285.505m
 2 -3.10388                         22 -782.051μ   ±j  480.930m
 3 -586.134μ    ±j  374.302m        23 -820.566μ   ±j  509.467m
 4 -692.918μ    ±j  495.399m        24 -809.149μ   ±j  577.660m
 5 -1.69237m    ±j  543.844m        25 -1.52142m   ±j  607.808m
 6 -643.774μ    ±j  580.507m        26
 7 -2.50404m    ±j  657.955m        27
 8                                  28
 9                                  29
10                                  30
11                                  31
12                                  32
13                                  33
14                                  34
15                                  35
16                                  36
17                                  37
18                                  38
19                                  39
20                                  40
```

(Scale f : × 1kHz)

Figure 12-34 **Execution of the Curve Fitting Function for the Frequency Response Function in the SHORT Mode**

Measurement time : LONG (high quality)



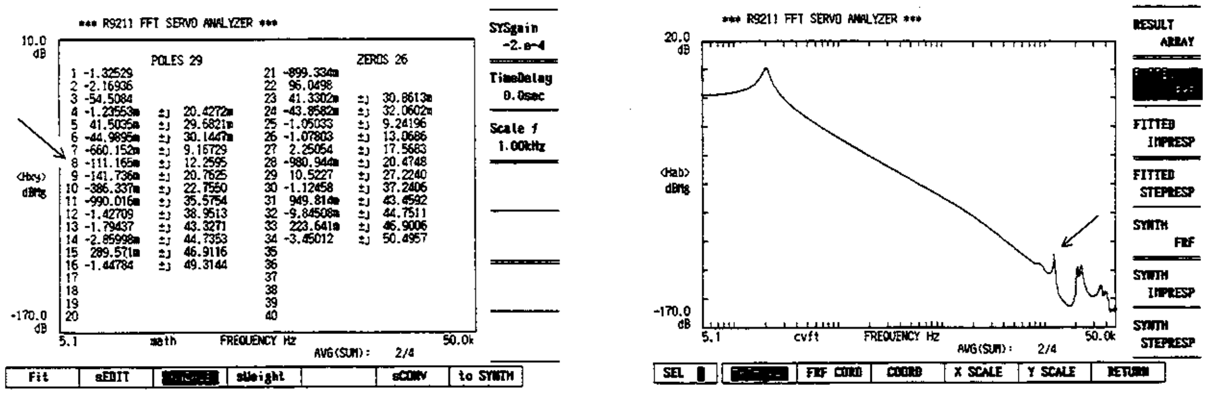
```
            POLES 12                                ZEROS 10
 1 -949.055m                        21  207.787μ   ±j  308.582m
 2  974.787m                        22 -792.225μ   ±j  480.870m
 3 -396.137μ    ±j  375.832m        23 -826.106μ   ±j  509.427m
 4 -691.412μ    ±j  495.404m        24 -801.192μ   ±j  577.666m
 5 -1.69260m    ±j  543.842m        25 -1.40448m   ±j  607.605m
 6 -635.680μ    ±j  580.500m        26
 7 -1.32892m    ±j  652.738m        27
 8                                  28
 9                                  29
10                                  30
11                                  31
12                                  32
13                                  33
14                                  34
15                                  35
16                                  36
17                                  37
18                                  38
19                                  39
20                                  40
```

(Scale f : × 1kHz)

Figure 12-35 **Execution of the Curve Fitting Function for the Frequency Response Function in the LONG Mode**

■ Extracting Ideal Frequency Response Function from Curve Fitting Results

In this example, we suppose that a resonance frequency is detected around 12kHz after completion of curve fitting (See Figure 12-36). To design a device which does not have this resonance frequency, there are two methods to extract the ideal frequency response function.



```
              POLES 29                                 ZEROS 26
 1 -1.32529                          21 -899.334m
 2 -2.16936                          22  96.0498
 3 -54.5084                          23  41.3302m   ±j  30.8613m
 4 -1.23553m    ±j  20.4272m         24 -43.8582m   ±j  32.0602m
 5  41.5035m    ±j  29.6821m         25 -1.05033    ±j  9.24196
 6 -44.9895m    ±j  30.1447m         26 -1.07803    ±j  13.0686
 7 -660.152m    ±j  9.16729          27  2.25054    ±j  17.5683
 8 -111.165m    ±j  12.2595          28 -980.944m   ±j  20.4748
 9 -141.736m    ±j  20.7625          29  10.5227    ±j  27.2240
10 -386.337m    ±j  22.7560          30 -1.12458    ±j  37.2406
11 -990.016m    ±j  35.5754          31  949.814m   ±j  43.4592
12 -1.42709     ±j  38.9513          32 -9.84508m   ±j  44.7511
13 -1.79437     ±j  43.3271          33  223.641m   ±j  46.9006
14 -2.85998m    ±j  44.7353          34 -3.45012    ±j  50.4957
15  289.571m    ±j  46.9116          35
16 -1.44784     ±j  49.3144          36
17                                   37
18                                   38
19                                   39
20                                   40
```

Figure 12-36 Frequency Response Function before Changing Poles and Zeros

First, transfer the poles and zeros obtained through curve fitting to the synthesis function.

$\boxed{\text{MATH}} \Rightarrow \boxed{\text{to SYNTH}} \Rightarrow \dfrac{\text{FIT}}{\text{to SYNTH}}$

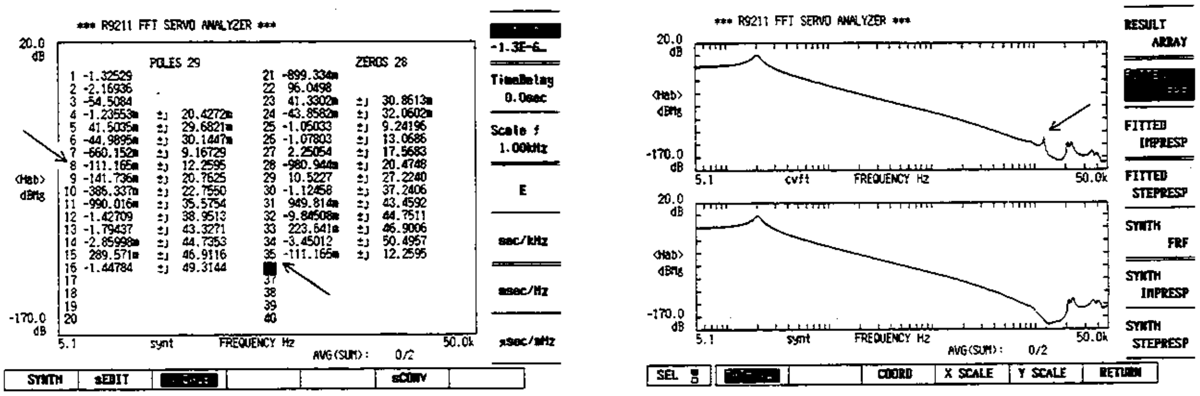
Next, extract the ideal frequency response function by either of the following methods:

(1) By removing the poles and zeros corresponding to the resonance or antiresonance frequency.
To remove the resonance frequency around 12kHz, do not remove pole No.8 whose imaginary part is 12kHz, but add zero No.35 having the same coordinates. Then, adjust the value of SYSgain so that the lower-frequency-side gain matches the curve fitting results (See Table 12-2 ②).
Table 12-2 summarizes the SYSgain adjustment methods.

Table 12-2 SYSgain Adjustment Methods

		SYSgain value adjustment method
①	Remove a real pole. (Add a real zero.)	Divide SYSgain by the module of the pole (zero).
②	Remove a complex pole. (Add a complex zero.)	Divide SYSgain by the square of the module of the pole (zero).
③	Remove a real zero. (Add a real pole.)	Multiply SYSgain by the module of the zero (pole).
④	Remove a complex zero. (Add a complex pole.)	Divide SYSgain by the square of the module of the zero (pole).

Since the square ($0.111165^2 + 12.2595^2$) of the module of the zero to be added is 150, "SYSgain−2E−4" is divided by 150 to produce "−1.3E−6". Figure 12-37 shows the frequency response function obtained with the edit table and synthesis function.



```
                 POLES 29                              ZEROS 28
 1 -1.32529                           21 -899.334m
 2 -2.16936                           22  96.0498
 3 -54.5084                           23  41.3302m   ±j  30.8613m
 4 -1.23553m   ±j  20.4272m           24 -43.8582m   ±j  32.0602m
 5  41.5035m   ±j  29.6821m           25 -1.05033    ±j  9.24196
 6 -44.9895m   ±j  30.1447m           26 -1.07803    ±j  13.0686
 7 -660.152m   ±j  9.16729            27  2.25054    ±j  17.5683
 8 -111.165m   ±j  12.2595            28 -980.944m   ±j  20.4748
 9 -141.736m   ±j  20.7625            29  10.5227    ±j  27.2240
10 -386.337m   ±j  22.7550            30 -1.12458    ±j  37.2406
11 -990.016m   ±j  35.5754            31  949.814m   ±j  43.4592
12 -1.42709    ±j  38.9513            32 -9.84508m   ±j  44.7511
13 -1.79437    ±j  43.3271            33  223.641m   ±j  46.9006
14 -2.85998m   ±j  44.7353            34 -3.45012    ±j  50.4957
15  289.571m   ±j  46.9116            35 -111.165m   ±j  12.2595
16 -1.44784    ±j  49.3144
17                                    37
18                                    38
19                                    39
20                                    40
```

Figure 12-37 Reduction of a Peak Value by Adding a Complex Zero

ADVICE

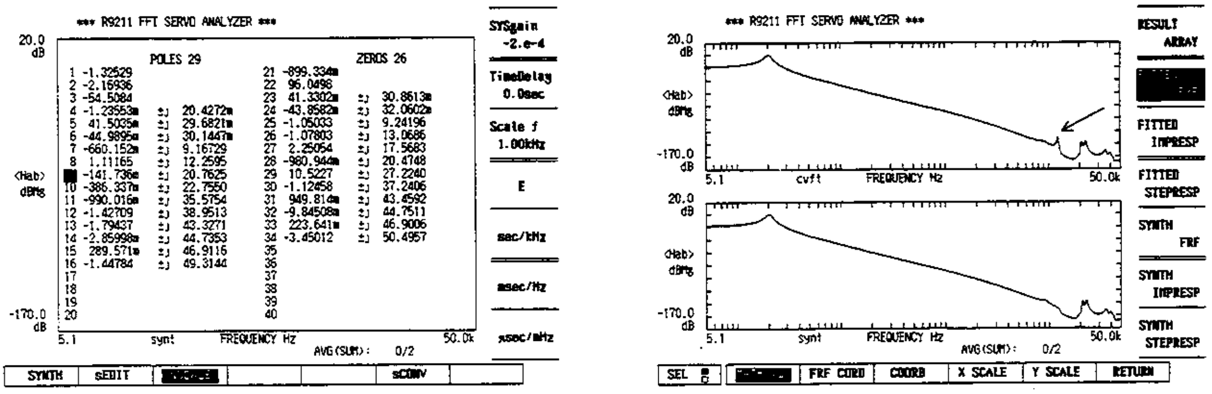
In case of large enough conjugate poles P and P∗, the frequency response function can be approximated on the low frequency side as follows:

$$T(s) = \text{SYSgain} \times \frac{(s-z_1)\cdots\cdots\cdots(s-z_n)}{(s-p_1)\cdots\cdots\cdots(s-p_m)\times(s-P)(s-P*)}$$

$$\fallingdotseq \frac{\text{SYSgain}}{P \cdot P*} \times \frac{(s-z_1)\cdots\cdots\cdots(s-z_n)}{(s-p_1)\cdots\cdots\cdots(s-p_m)}$$

$$= \text{SYSgain'} \times \frac{(s-z_1)\cdots\cdots\cdots(s-z_n)}{(s-p_1)\cdots\cdots\cdots(s-p_m)}$$

(2) By increasing the damping constant (real part) of the pole/zero corresponding to the resonance or antiresonance frequency.
Thus, the peak value can be reduced. Figure 12-38 shows an example where the real part of pole No.8 is increased 10 times to lower the peak at the resonance frequency.



```
*** R9211 FFT SERVO ANALYZER ***

              POLES 29                           ZEROS 26
 1 -1.32529                          21 -899.334m
 2 -2.16936                          22  96.0496
 3 -54.5084                          23  41.3302m   ±j  30.8613m
 4 -1.23553m    ±j  20.4272m         24 -43.8582m   ±j  32.0602m
 5  41.5035m    ±j  29.6821m         25 -1.05033    ±j  9.24196
 6 -44.9895m    ±j  30.1447m         26 -1.07803    ±j  13.0686
 7 -660.152m    ±j  9.16729          27  2.25054    ±j  17.5683
 8  1.11165     ±j  12.2595          28 -980.944m   ±j  20.4748
 ■ -141.736m    ±j  20.7625          29  10.5227    ±j  27.2240
10 -386.337m    ±j  22.7550          30 -1.12458    ±j  37.2406
11 -990.016m    ±j  35.5754          31  949.814m   ±j  43.4592
12 -1.42709     ±j  38.9513          32 -9.84508m   ±j  44.7511
13 -1.79437     ±j  43.3271          33  223.641m   ±j  46.9006
14 -2.85998m    ±j  44.7353          34 -3.45012    ±j  50.4957
15  289.571m    ±j  46.9116          35
16 -1.44784     ±j  49.3144          36
17                                   37
18                                   38
19                                   39
20                                   40
```

Figure 12-38 Reduction of a Peak Value by Increasing the Absolute Value of the Damping Constant of a Pole

CHAPTER 13

COMPARATOR (GO/NOGO) FUNCTION

(R9211C ONLY)

This chapter describes both the table mode and the reference mode of the comparison function. In the table mode, signals are tested against their belonging to a certain specified domain. In the reference mode, signals are comparison to a reference signal.

CONTENTS

1. Outline

The comparator compares the measured data in the frequency domain with a reference value to determine whether these data satisfy some specified conditions.
There are two comparison modes: the table mode and the reference mode.
The comparison result signal can be output through the DIGITAL I/O connector.

■ Table Mode

The measurement data are judged, compared to a specified reference domain determined by its frequency limits (delimits a domain on the displayed abscissa axis) and its level limits (delimits a domain on the displayed ordinates axis).
Figure 13-1 shows an example in the table mode.
In this example, if the maximum value of the spectrum within the range 35kHz to 85kHz is inferior to −65dBV, then the result is PASS(GO).

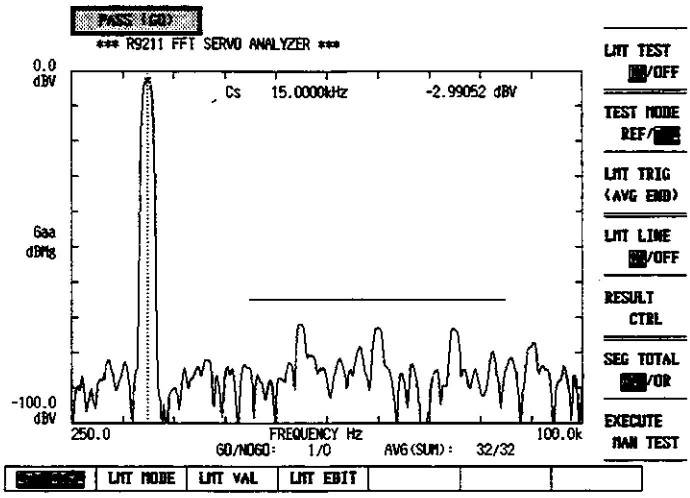


Figure 13-1 Example in the Table Mode

NOTE
For specifying the reference domain the unit of the X-axis (START X and DELTA X) is Hz but the unit of the Y-axis (START Y and DELTA Y) depends on the display data.

■ Reference Mode

Some measurement data are compared with some other measurement data taken as reference.
The reference measurement data must be stored, in advance in the memory (SAVE1).
In Figure 13-2, the data, that are less than ±20dB different from the reference measurement data (that have been stored in the memory), in the range 10kHz to 60kHz, is declared PASS(GO) data.

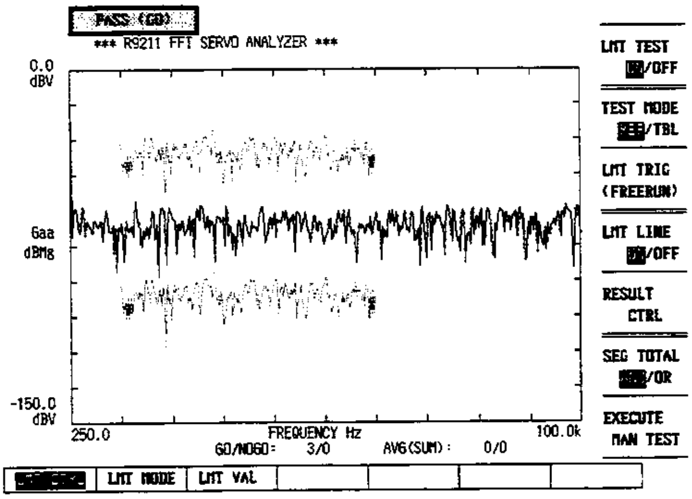


Figure 13-2 Example in the Reference Mode

2. Operation Method

■ How to Use the Table Mode

In this example, SPECTRUM is selected as the measurement mode and the comparator is used on the power spectrum.

1 Select the data on which to execute a comparison.

MODE ⇒ MEAS ⇒ SPECTRUM

Select the single screen configuration and display the data to be compared on the screen.

VIEW ⇒ INST VW ⇒ CH-B SPECT

Display the power spectrum of channel B.

2 Select the comparator function.

PRESET ⇒ LMT MENU

3 Select the table mode.

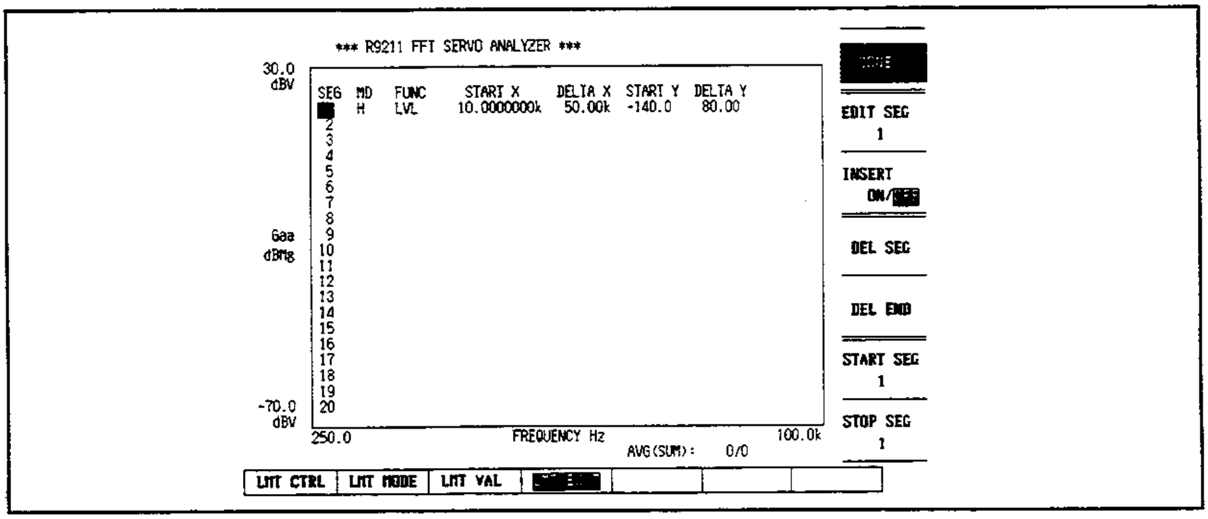
MATH ⇒ LMT CTRL ⇒ TESTMODE REF/TBL

The "TESTMODE REF/TBL" key switches between the table mode and the reference mode (toggle). The table mode is selected if TBL is displayed in inverse mode.

4 Display the comparator table.

⇒ LMT MODE

Press the LMT MODE X softkey to display the comparator table. (See Figure 13-3.)



```
*** R9211 FFT SERVO ANALYZER ***

SEG  MD   FUNC    START X      DELTA X  START Y  DELTA Y
 1    H   LVL    10.0000000k   50.00k   -140.0    80.00
 2
 3
 4
 5
 6
 7
 8
 9
10
11
12
13
14
15
16
17
18
19
20
```

Figure 13-3 Comparator Table

In the comparator table, you can specify the comparison mode (MD: HIGH, LOW, or HIGH/LOW), what to compare (FUNC: LEVEL, PEAK, OVERAL), the comparison range (START X, DELTA X), and the comparison level (START Y, DELTA Y).

5 Edit the comparator table (comparison method).

LMT MODE ⇒	HIGH	Upper limit test Select this key to accept (pass) all data smaller than the specified value.
	LOW	Lower limit test Select this key to accept (pass) all data larger than the specified value.
	HIGH/LOW	Upper and lower limits test Select this key to accept (pass) all data belonging to the specified range (upper limit > data > lower limit).
	LEVEL	All data test Select this key to test all data within the specified range.
	PEAK	Peak value test Select this key to test the peak value within the specified range.
	OVERAL	Overall value test Select this key to test the overall value within the specified range.

- **Upper limit test (HIGH)**

If there is any data exceeding the upper limit, the comparison result is FAIL (NOGO). If there is no data exceeding the upper limit, the comparison result is PASS (GO).
When FUNC is set to LEVEL, whether any data exceed the line defined by the 2 points (START X, START Y) and (START X + DELTA X, START Y + DELTA Y), within the specified frequency range, is tested.

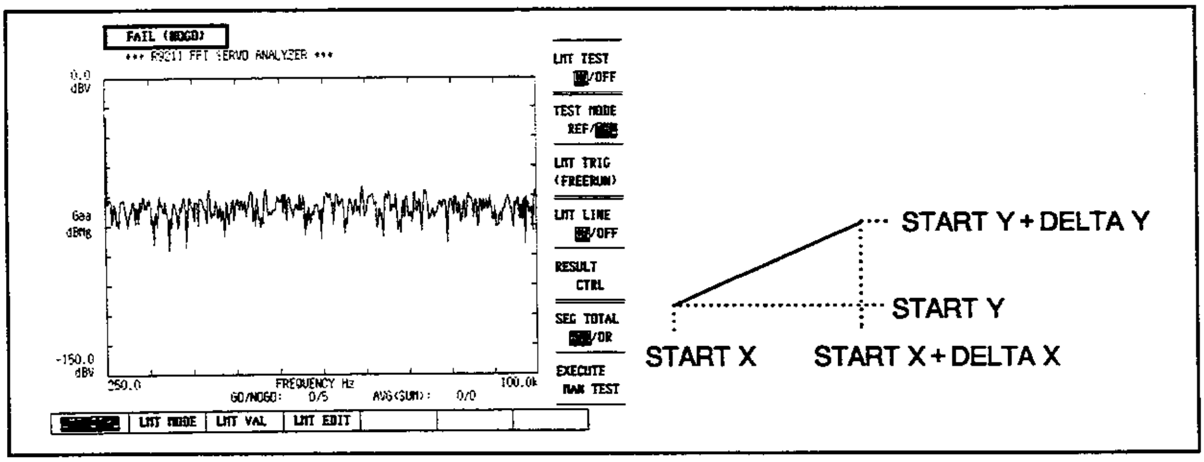


Figure 13-4 Upper Limit and LEVEL

When FUNC is set to PEAK or OVERALL, whether the peak value (or overall value) exceeds the START Y value, is tested. In this case, the DELTA Y value is ignored.

- **Lower limit test (LOW)**

If any data is under the lower limit, the comparison result is FAIL (NOGO). If all data are above the lower limit, the comparison result is PASS (GO). The range specification is the same as that of the upper limit.

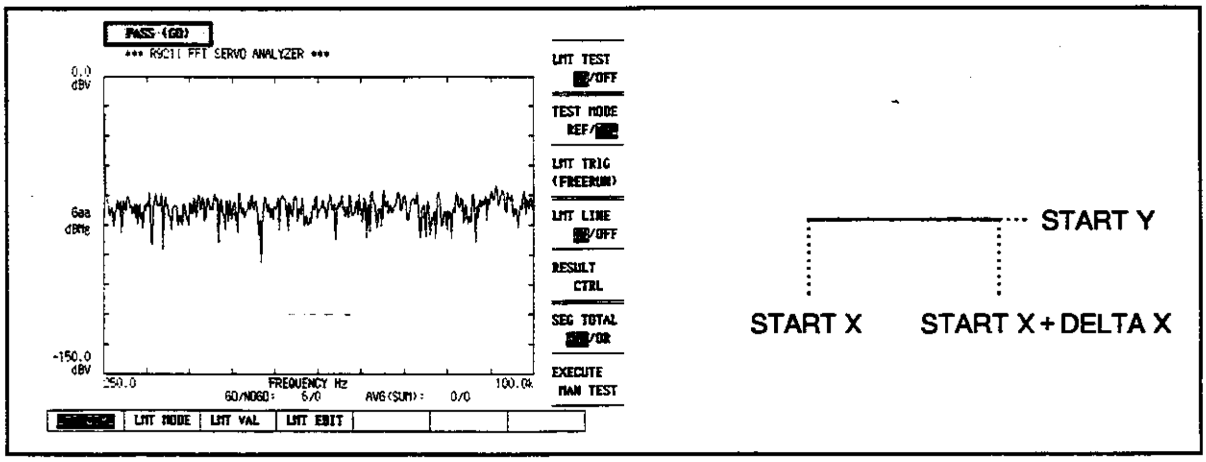


Figure 13-5 Lower Limit and Peak or Overall Value

- **Upper and lower limits test (HIGH/LOW)**

Four values must be specified: START X, DELTA X, START Y, and DELTA Y. If the data are included in the square whose vertexes are determined by these four values, the comparison result is PASS (GO). If the data are outside the square, the comparison result is FAIL (NOGO).

When FUNC is set to LEVEL, whether all data between START X and START X + DELTA X lays between the top and bottom sides, is tested.

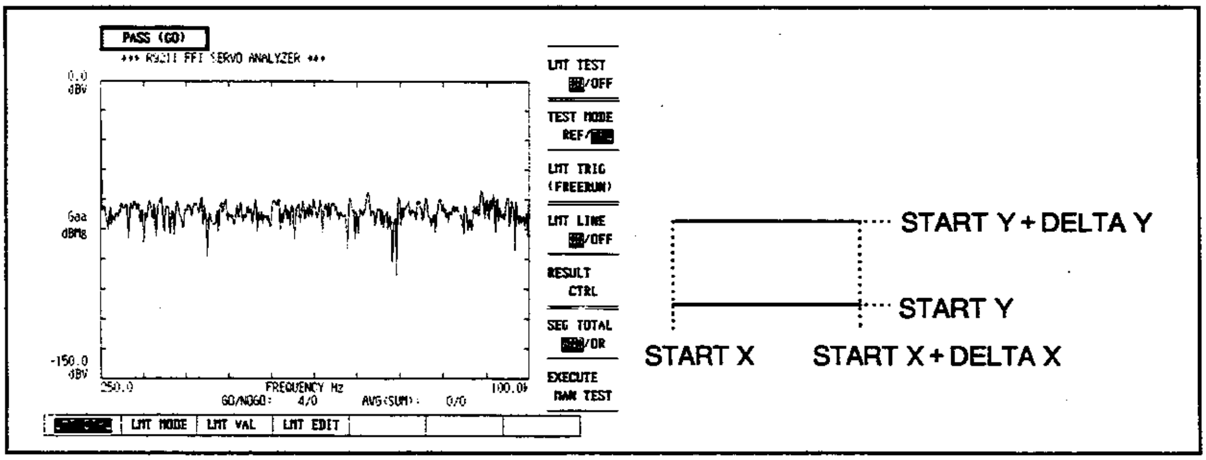


Figure 13-6 Upper and Lower Limits Comparison and LEVEL

When FUNC is set to PEAK, the local peaks are identified between START X and START X + DELTA X and, whether these local peaks lays between the top and bottom sides, is tested.

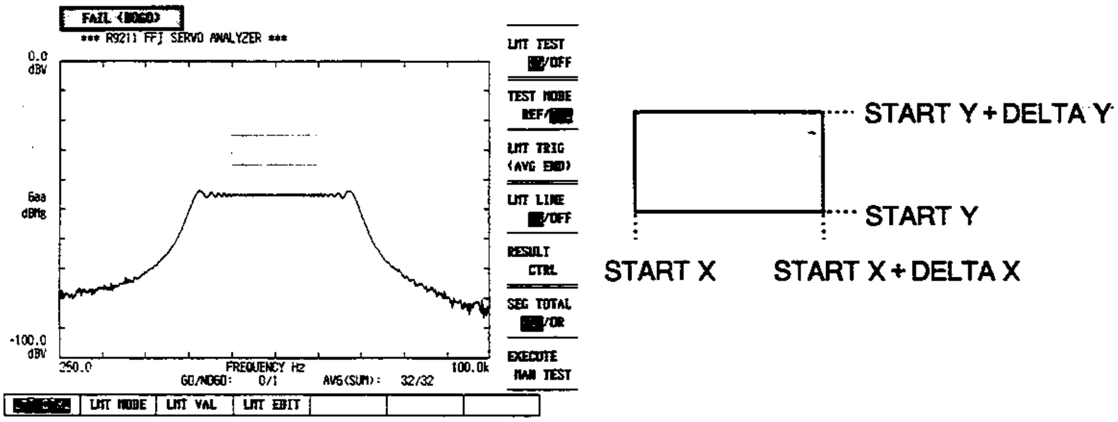


Figure 13-7 Upper and Lower Limits and Peak

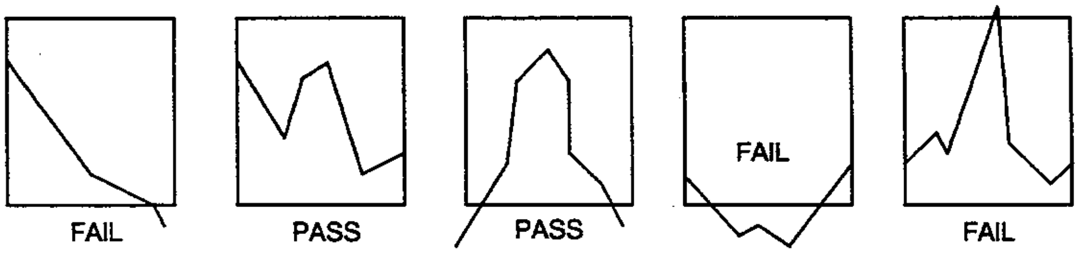


Figure 13-8 PASS and FAIL Examples of Upper and Lower Limits Judgement with Peak

When FUNC is set to OVERAL, the overall value between START X and START X + DELTA X is estimated and judged. In Figure 13-9, the peak value does not lay between the top and bottom sides but the overall value lays between them, thus the comparison result is PASS (GO).

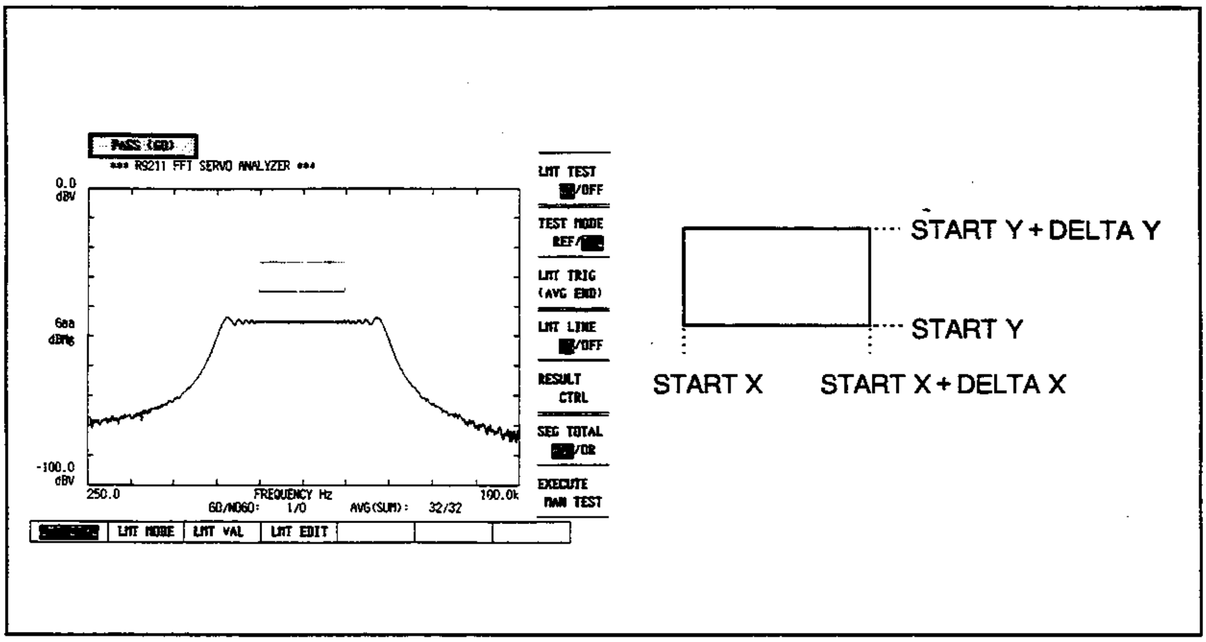


Figure 13-9 Upper and Lower Limits Judgement and Overall Value

ADVICE

The overall value of a power spectrum is estimated with the following formula:

$$\sum_{f_{\text{START X}}}^{f_{\text{START X+DELTA X}}} \{Re^2(f) + Im^2(f)\}$$

Re : Real part of the complex spectrum
Im : Imaginary part of the complex spectrum

6 Edit the comparator table.

Enter values with the numeric keys followed by a "unit" key.
(Specification of frequency and level ranges)

LEVEL		START X 10k	Set the comparison start frequency (Hz).
PEAK	⇒	DELTA X 20k	Set the comparison frequency band width (Hz).
OVERAL		START Y 100	Enter the comparison level lower value.
		DELTA Y 10	Enter the comparison level width.
		k (×1000) (×1) m (/1000)	Unit keys

7 Modify the comparator table.

LMT EDIT	⇒	EDIT SEG 1	Specifies the segment to be modified.
		INSERT ON/OFF	Toggles between insertion and overwrite edition modes.
		DEL SEG	Deletes the segment specified with the EDIT SEG key.
		DEL END	Deletes all segments following the segment specified with the EDIT SEG key.

8 Specify the start and end segments.

LMT EDIT	⇒	START SEG 1	Set the start segment's ID number.
		STOP SEG 3	Set the end segment's ID number.

9 Exit the comparator table edition mode.

LMT EDIT	⇒	DONE	Exit the comparator table edition mode (validates the table setting).

10 Select the comparator function execution timing.

LMT CTRL ⇒ LMT TRIG ⇒

FREERUN	The comparison is executed according to the internal timing.
AVG END	The comparison is executed at the end of the averaging process.
HOLD	The comparison is executed when the trigger is in the hold state, in the arm or auto arm mode.
MANUAL	The comparison is executed when the "EXECUTE MAN SET" Y softkey is pressed.

11 Specify a logical operation.

LMT CTRL ⇒

SEG TOTAL AND/OR	Select either to execute a logical AND, or to execute a logical OR over all segments.

12 Specify how many times the comparison must be executed (COUNT NO) and what output method to use.

LMT CTRL ⇒ RESULT CTRL ⇒

COUNTER ON/OFF	Determines whether the comparator function is to be executed the number of times specified with the "COUNT NO" key.
COUNT NO 1	Specifies how many times the comparison must be executed.
TTL ON/OFF	Determines whether the comparison result is to be output to the DIGITAL I/O connector at the rear panel.
LOW LEVEL GO/NOGO	In the TTL ON mode, determines whether a low level (in the output), represents the GO or the NOGO status of the comparison results.

13 Display the comparison domain.

LMT CTRL ⇒

LMT LINE ON/OFF	Determines whether the comparison domain must be displayed.

14 Allow the comparison function to process.

LMT CTRL ⇒	LMT TEST ON/OFF	Specifies whether the comparison process is to be started or aborted.
	EXECUTE MAN TEST	When LMT TRIG is set to MANUAL, press this key to start the comparision process.

■ How to Use the Reference Mode

An example, in the SPECTRUM mode, where 2 sets of measurement data are compared, is given below.

1 Save the measurement data which will be used as reference.

MODE ⇒ MEAS ⇒ SPECTRUM	Select the spectrum mode.
VIEW ⇒ INST VW ⇒ CH-B SPECT	Display the power spectrum of channel B.
VIEW ⇒ MEM VW ⇒ DATA SAVE 1	Store the reference measurement data in the memory 1.

2 Select the comparator function.

PRESET ⇒ LMT MENU

3 Select the reference mode.

MATH ⇒ LMT CTRL ⇒ TESTMODE REF/TBL	The "TEST MODE REF/TBL" key switches between the table mode and the reference mode (toggle). The reference is selected if REF is displayed in inverse mode.

4 Specify the judgement method.

LMT MODE ⇒ HIGH	Judges only the upper limit.
⇒ LOW	Judges only the lower limit.
⇒ HIGH/LOW	Judges both upper and lower limits.

- **Upper limit judgement (HIGH)**
If no measurement data exceeds the signal obtained by additioning the reference signal and the value specified with +OFFSET , the comparison result is PASS. Otherwise, the comparison result is FAIL.

- **Lower limit judgement (LOW)**
If no measurement data is lower than the signal obtained by substracting the value specified with - OFFSET to the reference signal, the comparison result is PASS. Otherwise, the comparison result is FAIL.

- **Upper and lower limits judgement (HIGH/LOW)**
If all measurement data lays between the signal defined as upper limit (reference signal + +OFFSET) and the signal defined as lower limit (reference signal – - OFFSET), comparison result is PASS. Otherwise, the comparison result is FAIL.

5 Enter the frequency range and offsets with the numeric keys and a unit key.

LMT VAL ⇒

START X	Enter the frequency domain start frequency.
DELTA X	Enter the frequency domain width.
+ OFFSET	Enter the positive offset. (upper limit)
- OFFSET	Enter the negative offset. (lower limit)
k (×1000)	Unit keys
(×1)	
m (/1000)	

From now on, the procedure is the same as the table mode procedure.

3. How To Output The Comparison Result

The comparison result can be output through the DIGITAL I/O connector. The comparison result is output at the TTL level; timing pulses are output at the time a comparison is executed.
Besides you can determine whether the low level will correspond to GO or NOGO (comparison result).
The comparison result is output from pin 21 and the timing pulse is output from pin 49. About the configuration of the DIGITAL I/O connector pins, see Chapter 14 "DIGITAL I/O AND MEASUREMENT".

1 Output the comparison results from the DIGITAL I/O connector.

MATH ⇒ LMT CTRL ⇒ RESULT CTRL

⇒ TTL ON/OFF Switches the comparison results output on or off (toggle). To output the results on must be displayed in inverse mode.

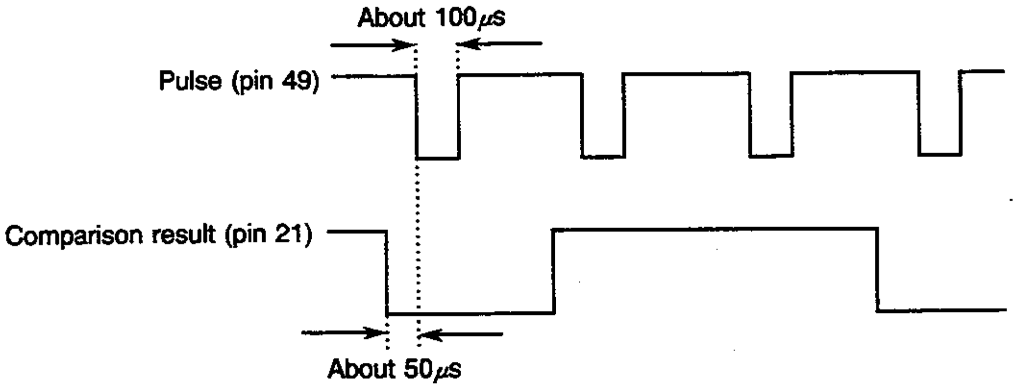
2 Specify to what state the TTL low level is to correspond.

MATH ⇒ LMT CTRL ⇒ RESULT CTRL

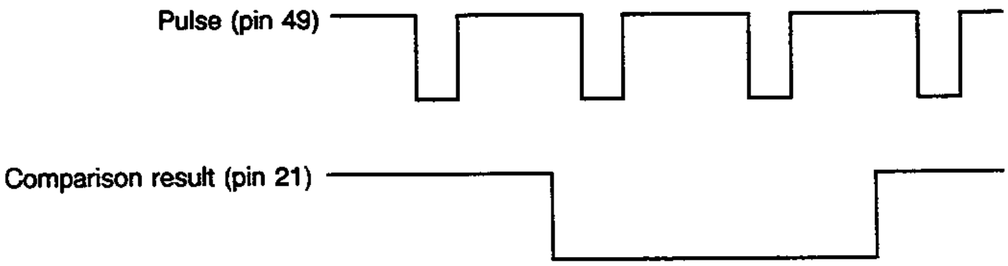
⇒ LOW LEVEL GO/NOGO Switches between the GO and NOGO status (toggle).

Example of External Output (GO → NOGO → NOGO → GO)

- **When the low level corresponds to GO**



- **When the low level corresponds to NOGO**



CHAPTER 14

DIGITAL I/O AND MEASUREMENT

This chapter describes the digital I/O functions and explains how to use it.

CONTENTS

1. Outline

The R9211 is equipped with a digital I/O function. (For some models, this function is provided as an option.) The digital I/O function has a digital input mode and digital output mode. When it is combined with the digital output function of the built-in SG, the performance of D/A and A/D converters can be evaluated. Moreover, analog SG signals can be converted to digital signals via the A/D converter.
The comparator function control signal is also output from the DIGITAL I/O connector on the rear panel of the R9211.

(1) Example of utilization of the digital input mode
Figure 14-1 shows an example of A/D converter evaluation.

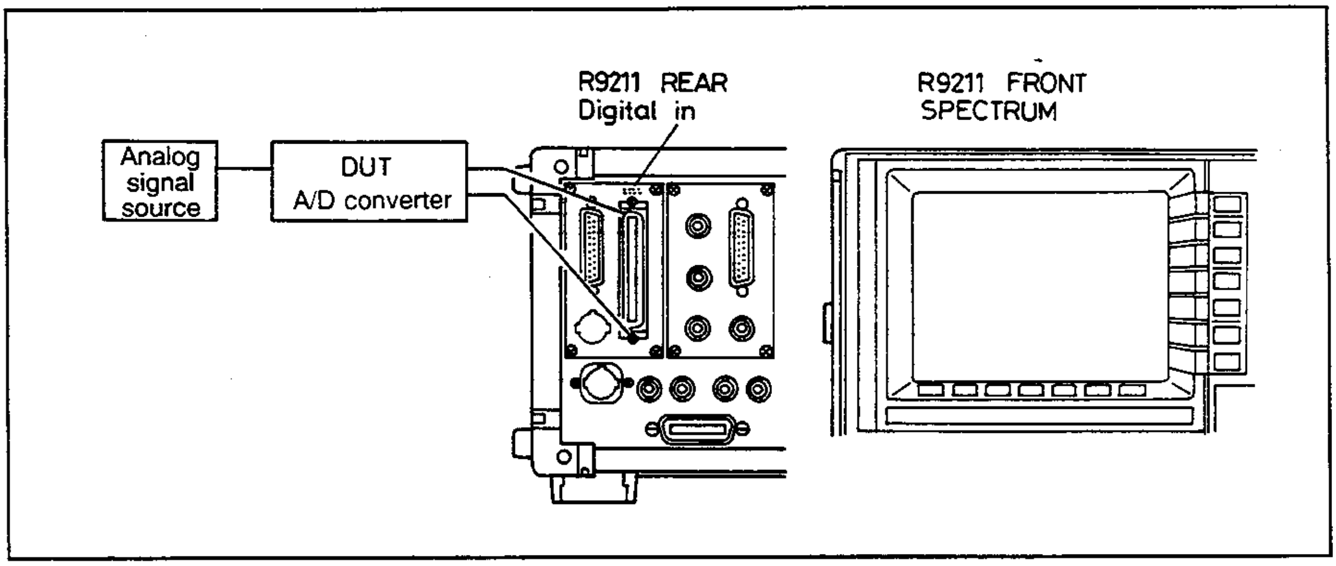


Figure 14-1 Example of A/D Converter Evaluation

(2) Example of utilization of the digital output mode
Figure 14-2 shows an example of conversion of an analog signal source to a digital signal source.

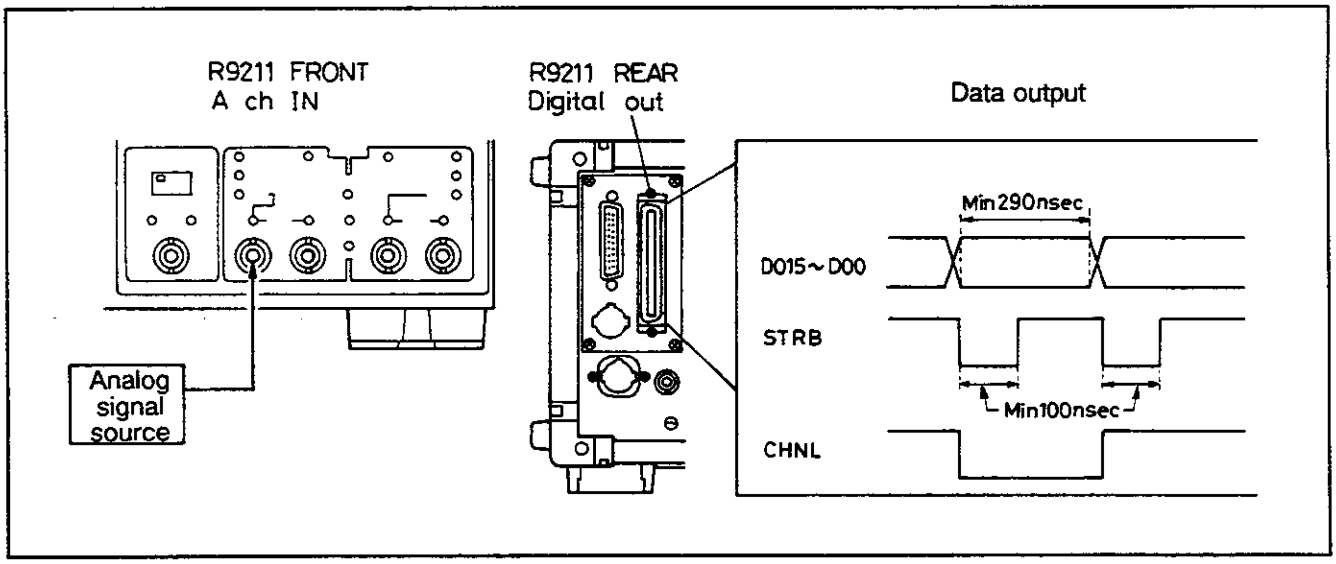
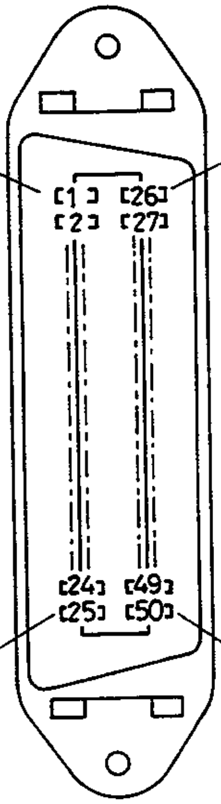


Figure 14-2 Conversion of an Analog Signal Generator to a Digital Signal Generator

■ Digital I/O Connector Pin Configuration

Figure 14-3 shows the pin configuration of the I/O connector at the rear panel of the R9211.

Signal name	Pin No.
GND	1
EOC	2
DI0	3
DI2	4
DI4	5
DI6	6
DI8	7
DI10	8
DI12	9
DI14	10
STRB	11
DO0	12
DO2	13
DO4	14
DO6	15
DO8	16
DO10	17
DO12	18
DO14	19
+5V	20
CMP0	21
	22
	23
	24
GND	25



Signal name	Pin No.
26	GND
27	
28	DI1
29	DI3
30	DI5
31	DI7
32	DI9
33	DI11
34	DI13
35	DI15
36	CHNL
37	DO1
38	DO3
39	DO5
40	DO7
41	DO9
42	DO11
43	DO13
44	DO15
45	+5V
46	
47	
48	
49	CMP7
50	GND

DI15 to DI0 : Input (DI15 is the MSB and DI0 is the LSB.)
DO15 to DO0 : Output (DO15 is the MSB and DO0 is the LSB.)

STRB	:	Strobe signal for digital output data
CHNL	:	Digital output channel identification signal
EOC	:	Strobe signal for digital input data
CMP0	:	Comparator function measurement
CMP7	:	Strobe signal of measurement results obtained with the comparator function

Figure 14-3 DIGITAL I/O Connector Pin Configuration

NOTE

- ***EOC and DI15 to DI0 are inputs equivalent to those of the 74LS TTL series.***
- ***STRB, CHNL, and DO15 to DO0 are open collector outputs (without pull-up resistor) equivalent to those of the 74LS series.***
- ***Available connector: 57FE-30500-20N(D8) or equivalent (Daiichi Electronics Corp.)***
- ***Do not connect any signal to unused pins.***

2. Digital Input

■ How to Use the Digital Input Function

(1) To use the digital input function, the following requirements must be satisfied:
  (a) Using the menu, select the digital input mode for channel A.
  (b) Using the menu, set the R9211 in external sampling mode.
  (c) Input the digital data and strobe signals to the R9211 through the connector at the rear panel.
  (d) Input the external sampling clock signal to the R9211 through the connector at the rear panel.

(2) You must also be careful about the following points:
  (a) When the digital input "switch" in the R9211 menu is activated, the DIGITAL I/O connector at the rear panel of the analyzer is identified to channel A. Therefore, the results of analyses on digital inputs becomes CH-A data and the analog CH-A inputs through the front panel are ignored.

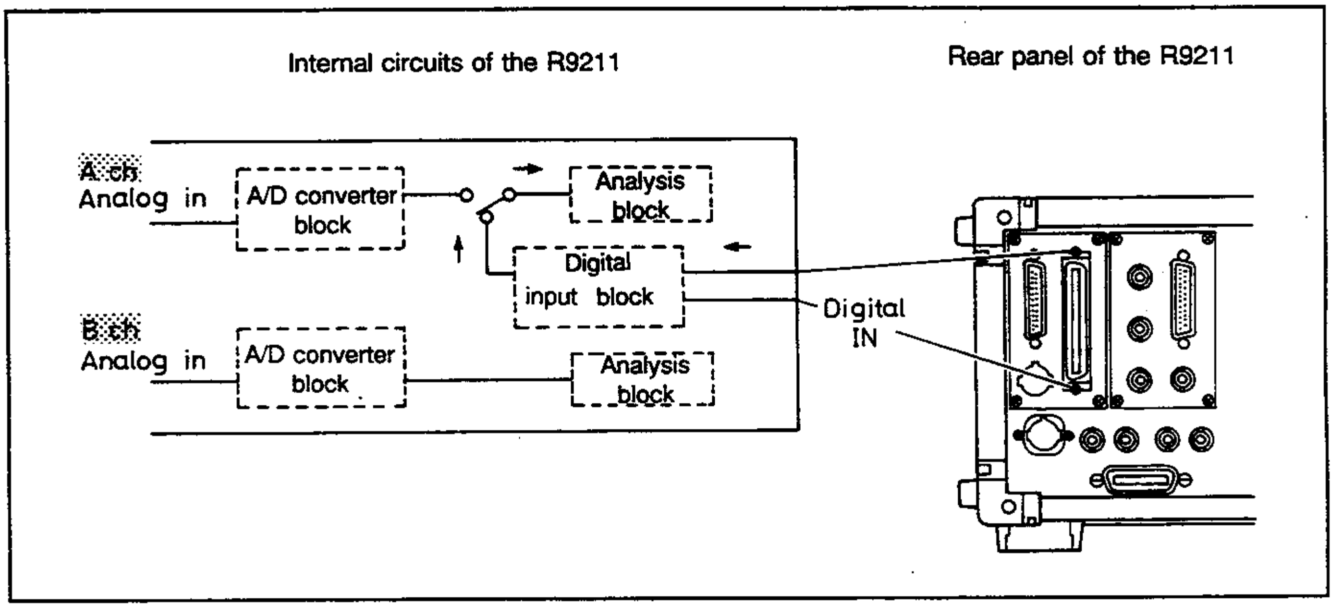
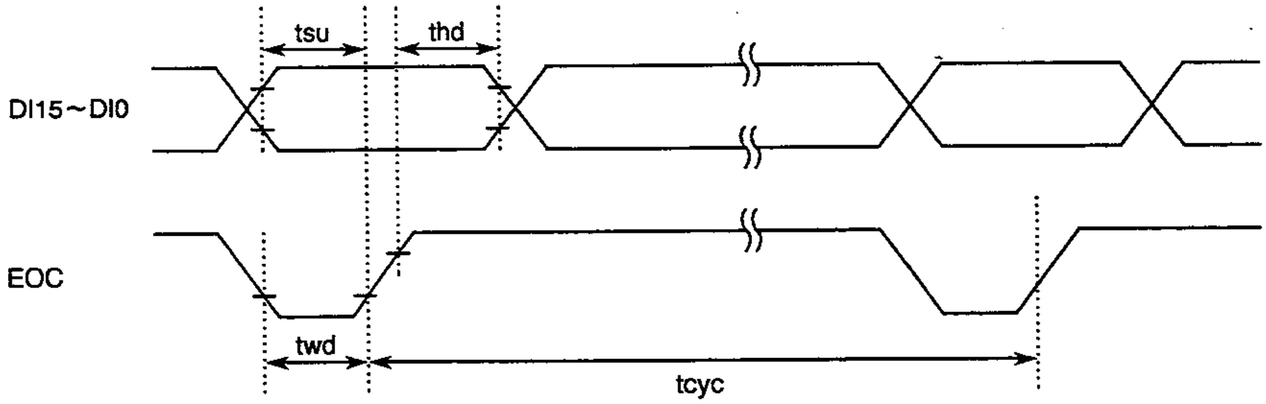


Figure 14-4 Block Diagram for Digital Inputs

  (b) When the digital input function is used, X- and Y-scales are not automatically converted. See "■ Scale Conversion for Digital Input".
  (c) In the zoom mode, the digital input mode is disabled (R9211C).
  (d) In the SERVO mode, the digital input mode is disabled.
  (e) The digital input level is a TTL level.

■ Digital Input Signal and Timing

16-bit parallel signals can be input to channel A through the DIGITAL I/O connector.
Data are loaded into the internal register at the rising edge of the EOC (strobe signal). The data is input in the offset binary format.
(2's complement).
Figure 14-5 shows the digital input timing.

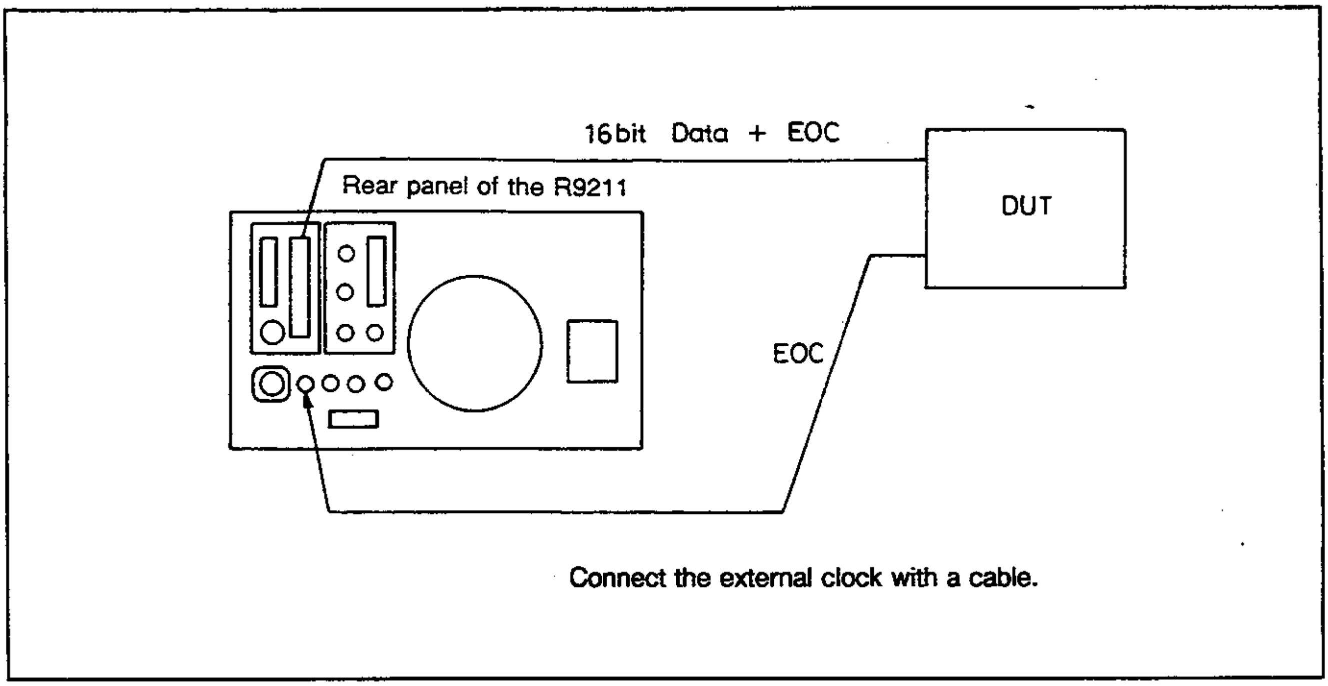


Data setup time (tsu) : 50ns (MIN)
Data hold time (thd) : 50ns (MIN)
EOC pulse width (twd) : 20ns (MIN)
EOC repetition cycle (tcyc) : 3.90652μs (MIN)

Figure 14-5 Digital Input Timing

Digital Input Connections

When the digital input function is used, you must connect the 16-bit digital signal and the EOC signal to the appropriate pin of the I/O connector, and you must also input the EOC signal through the external SMPLG CLK input connector at the rear panel (digital input is enabled in the zoom mode). Figure 14-3 shows the DIGITAL I/O connector pin configuration.



Connect the external clock with a cable.

Figure 14-6 Connections for Digital Input

After the connections shown figure 14-6 have been made, set the R9211 as follows:

1 Specify that the sampling clock is to be an external one.

(When MODE = TIME)

SETUP ⇒ **RANGE** ⇒ SAMPL CLK INT/EXT

Switch the sampling clock from internal to external.

(When MODE = SPECT/TIME - FREQ/FRF)

SETUP ⇒ **RANGE** ⇒ f RESOLN (LIN f)

⇒ SAMPL CLK INT/EXT

2 Switch channel A to digital input mode.

(When MODE = TIME/SPECT/TIME-FREQ/FRF)

SETUP ⇒ **FUNC** ⇒ DIGITAL in **ChA**/OFF

Make channel A to correspond to the digital input connector, at the rear panel, instead of the analog input connector at the front panel.

Thus, digital signals can be displayed on the screen of the R9211.

■ Scale Conversion for Digital Input

● Frequency axis scale conversion

Since the scale annotation displayed on the screen for digital input does not take into consideration the external sampling clock, you must perform the following correction.

$$\text{Actual frequency} = \frac{\text{External sampling frequency}}{2.56 \times \text{Analysis frequency range}} \times \text{(Annotation on screen)}$$

● Ordinates axis scale conversion

When a 16-bit full scale value is input digitally, the data displayed on the screen change according to the set input range.
When the input range is set to 0dBV (1Vrms), the full scale value corresponds to (1.414×2) V.
When the input range is set to 10dBV (3.16 Vrms), the full scale value corresponds to (4.472×2) V.
The voltage resolution per bit (when the input range is XdBV) is as follows:

When the unit is Vrms, the voltage resolution per bit is found by:

$$\text{Voltage per 1-bit} = \frac{2\sqrt{2}\cdot 10^{x/20}}{2^{15}} \quad \text{(V)}$$

When the unit is Vlt, the voltage per bit is found by:

$$\text{Voltage per 1-bit} = \frac{2\cdot 10^{x/20}}{2^{15}} \quad \text{(V)}$$

3. Digital Output

■ How to Use the Digital Output Function

In the R9211C, an analog signal input through one of the front panel connectors to the analyzer is first transformed into a digital signal by an A/D converter.
This obtained digital signal can then be output through the rear panel connector.

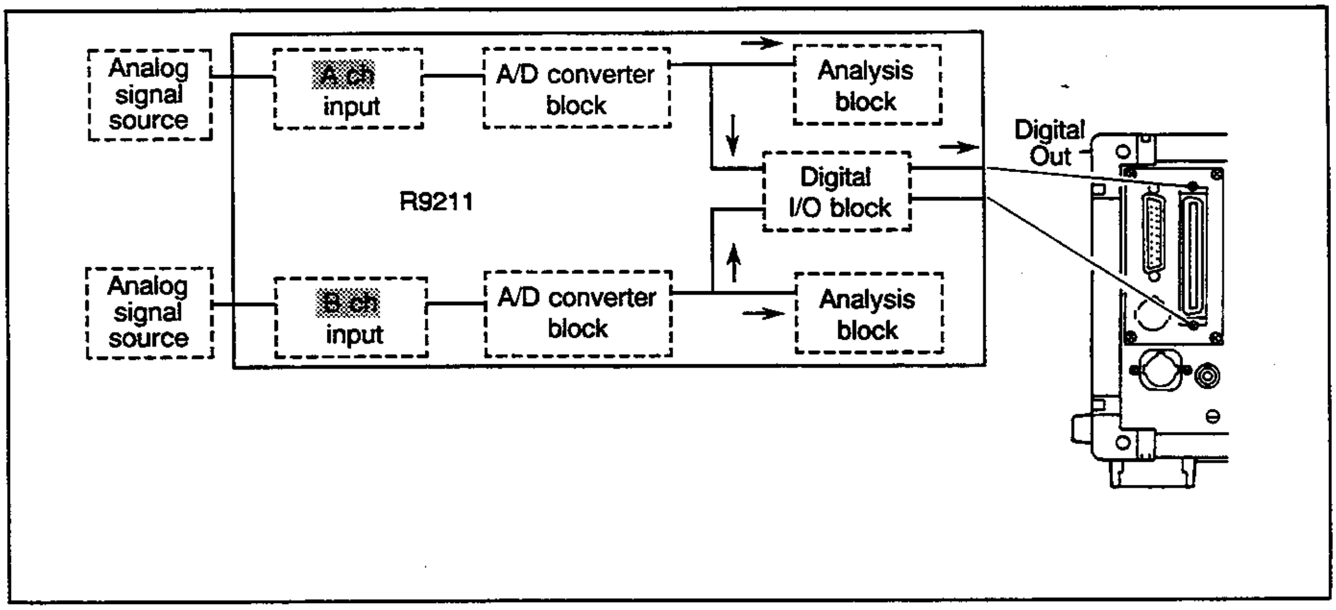


Figure 14-7 Digital Output Block Diagram

No menu settings are necessary in order to use the digital output function, unlike the digital input function.

CAUTION !

- ***When the digital output function is used, the Y scale is not converted automatically. See "■ Scale Conversion for Digital Input".***
- ***In the zoom mode, the sampling rate is fixed to 256kHz.***

Digital Output Signal and Timing

Figure 14-18 shows the timings of CH-A and CH-B digital outputs from the DIGITAL I/O connector.

The data output from the digital I/O connector correspond alternately to the data output from the A/D converter of channel A and channel B.

The digital output consists of a data output signal, channel switching signal, and strobe signal. The data output signal is a 16-bit signal. The output format is the same as the input format (offset binary format).

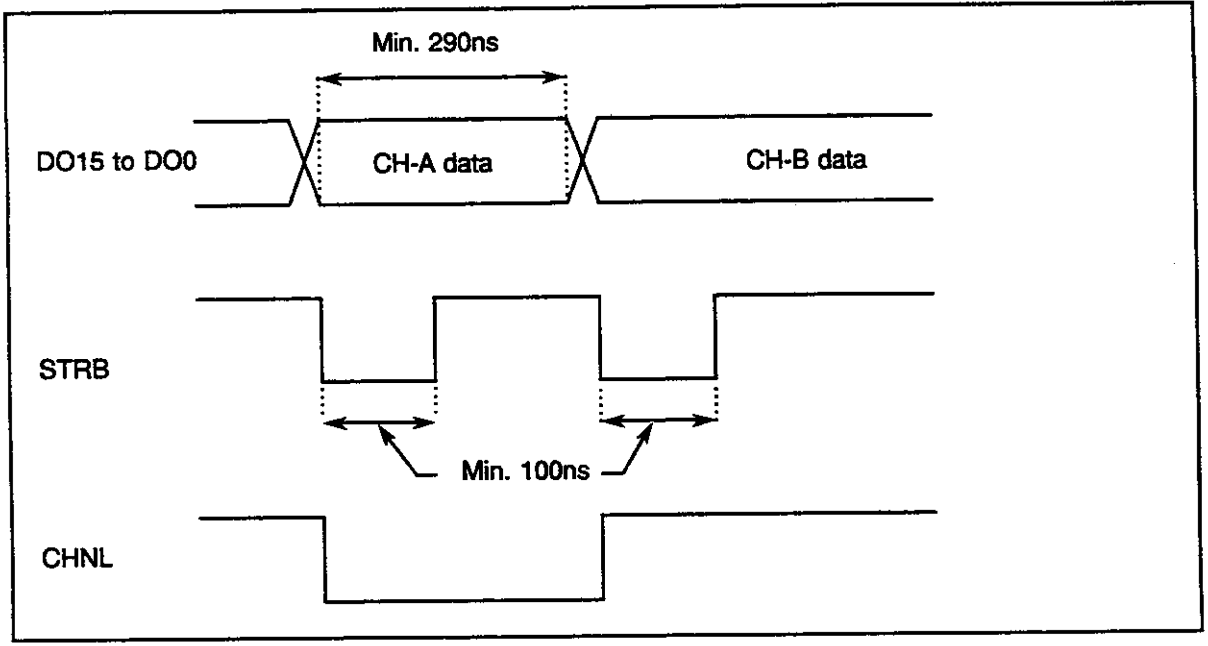


Figure 14-8 Digital Output Timings

■ Digital Output Connections

Figure 14-3 shows the DIGITAL I/O (input/output ports) connector pin configuration. Since the digital outputs are open collector outputs, connect them to pull-up resistors.
No menu setting is required for digital outputs.
Figure 14-9 shows pull-up resistor constants and CH-A/CH-B data separator circuit.

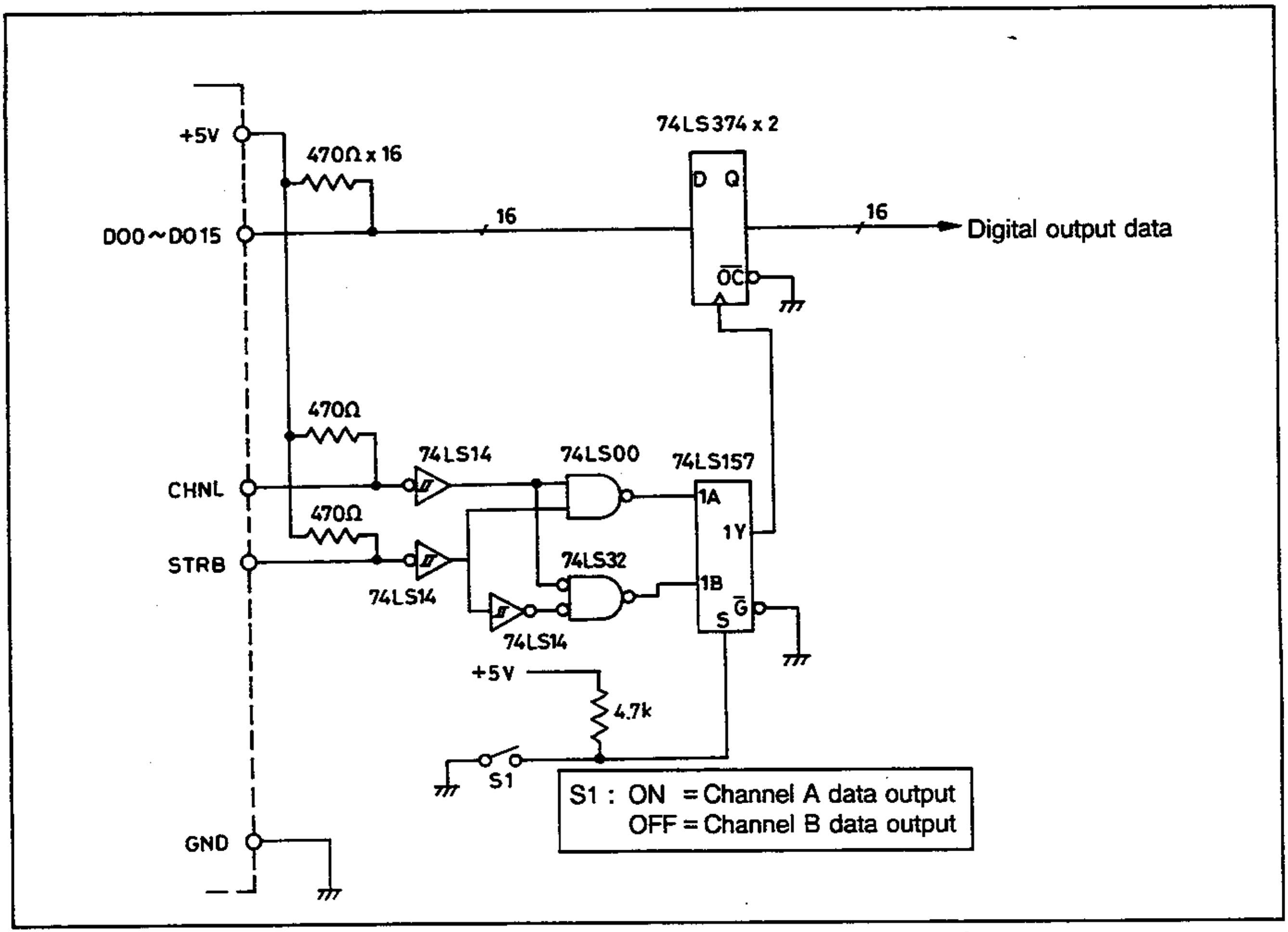


Figure 14-9 CH-A/CH-B Data Separator Circuit for Digital Output

■ Scale Conversion for Digital Output

The voltage per output bit depends on the input sensitivity setting.
For example, if a 1Vrms sine-wave is input through the analog input connector and the input sensitivity is set to 0dBV, a 16-bit full-scale value is output through the digital output connector.
However, a full scale value is not output when the input sensitivity is set to 10dBV.
When the input range is XdBV, the voltage resolution per bit is the following one:
If the unit is Vrms, the voltage per bit is found by:

$$\text{Voltage per 1-bit} = \frac{2\sqrt{2}\cdot 10^{x/20}}{2^{15}} \quad (V)$$

If the unit is Vlt, the voltage per bit is found by:

$$\text{Voltage per 1-bit} = \frac{2\cdot 10^{x/20}}{2^{15}} \quad (V)$$

The output sampling rate corresponds to (analysis range) × 2.56.
For instance, if the analysis range is 20kHz, the output sampling rate is found by:

20kHz × 2.56 = 51.2kHz

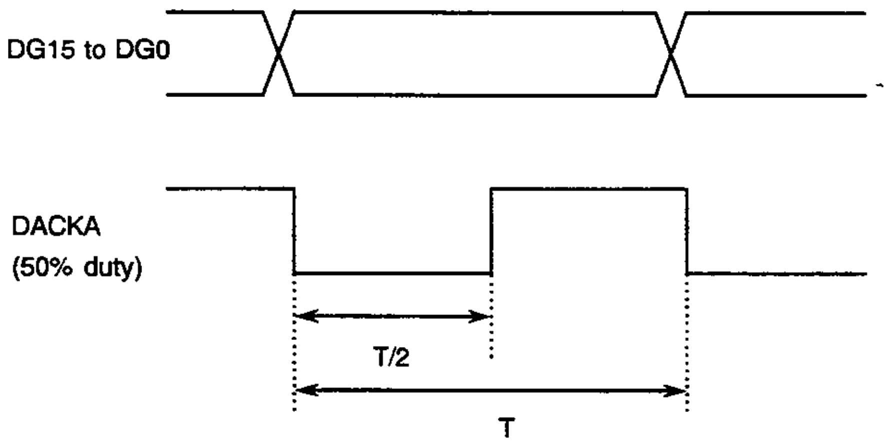
In the zoom mode, the sampling rate is fixed to 256kHz.

4. Digital Output From The Built-In SG

The SG incorporated in the R9211 can output a 16-bit parallel digital signal through the digital ouput connector at the rear panel. The data are output is the 2's complement format.

■ Digital Output Timing

Figure 14-10 shows the SG digital output timing.



Frequency range	T
20kHz to 100kHz	0.5μs
10kHz	1μs
$\leq$ 5kHz	3μs

Figure 14-10 SG Digital Output Timing

The frequency of the strobe signal (DACKA) depends on the analysis frequency range (See Table 14-1). For some applications, the partition ratio of the strobe signal must be changed according to the analysis frequency range.

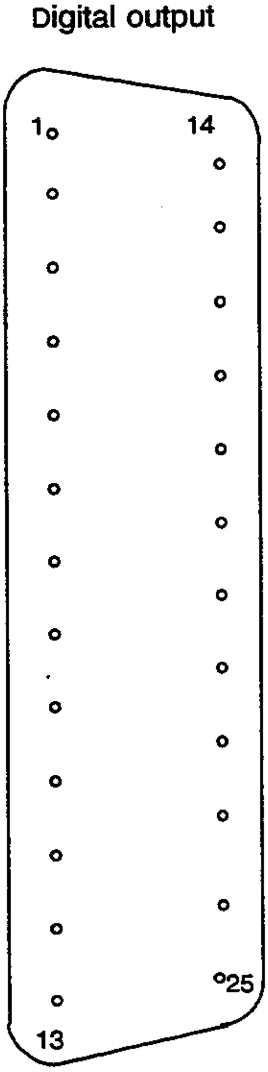
Table 14-1 Relationships between the Analysis Frequency Range and the Strobe Signal Frequency (DACKA)

Analysis frequency range	Strobe signal frequency	Sampling clock frequency
100kHz	2.048MHz	256kHz
50kHz	2.048MHz	128kHz
20kHz	2.048MHz	51.2kHz
10kHz	1.024MHz	25.6kHz
5kHz	409.6kHz	12.8kHz
2kHz	409.6kHz	5.12kHz
1kHz	409.6kHz	2.56kHz
500Hz	409.6kHz	1.28kHz
200Hz	409.6kHz	512Hz
100Hz	409.6kHz	256Hz
50Hz	409.6kHz	128Hz
20Hz	409.6kHz	51.2Hz
10Hz	409.6kHz	25.6Hz
5Hz	409.6kHz	12.8Hz
2Hz	409.6kHz	5.12Hz
1Hz	409.6kHz	2.56Hz
500mHz	409.6kHz	1.28Hz
200mHz	409.6kHz	512mHz
100mHz	409.6kHz	256mHz
50mHz	409.6kHz	128mHz
20mHz	409.6kHz	51.2mHz
10mHz	409.6kHz	25.6mHz
ZOOM	2.048MHz	–

The strobe signal frequency depends on the current analysis frequency irrespective of the generated waveform.

■ SG Digital Signal Output Names

Signal name	Pin No.
GND	1
DACKA	2
GND	3
DG15	4
DG13	5
DG11	6
DG9	7
DG7	8
DG5	9
DG3	10
DG1	11
GND	12
*	13



Signal name	Pin No.
GND	14
GND	15
GND	16
DG14	17
DG12	18
DG10	19
DG8	20
DG6	21
DG4	22
DG2	23
DG0	24
GND	25

- DG15 to DG0 : (DG15 is the MSB and DG0 is the LSB), TTL level
- DACKA : Strobe signal (synchronized on the rising edge of the signal) of digital output data, TTL level
- Available connector : JAE DB-25P or equivalent (maker: JAE = Japan Aerial Electronics)
- * : Do not connect this pin.

Figure 14-11 SG Digital Output Pin Configuration

■ Output Scale

The SG digital output value does not contain an offset value. A 16-bit full-scale value is output irrespective of the SG output voltage setting.

5. Examples Of Measurement Using The Digital I/O Function

■ Measurement of a Frequency Response Function (I)

(Example of measurement of a DUT (digital → analog) using the R9211's digital input function and built-in SG's digital output function)

In the measurement system shown in Figure 14-12, the SG's digital output is sent to the latch circuit, then it is sent both to the input digital I/O connector of the R9211 and to the DSP.
The data is processed in the DSP, converted to analog data in the D/A, then input to channel B.
The SG's strobe signal (DACKA) is divided according to the specified analysis range. (See Figure 14-13.)

■ Measurement of a Frequency Response Function (II)

(Example of conversion of an analog signal sent from an external SG and of measurement of a DUT (digital → analog) using the R9211's digital output function)

In the measurement system shown in Figure 14-14, an external SG's (the built-in SG can also be used) output is sent to channel A, then the digital output corresponding to this channel is input to the DUT. To output channel A's data, a strobe signal is generated for channel A's digital data, using a gate based on CHN and STRB.
The data input to the DUT is processed in the DSP, then converted to analog data in the D/A, and input to channel B.
Since, usually the external SG used output analog signals, the digital output function of the R9211 is used to analyze the DUT so that there is no need to connect an external A/D converter to the external SG.

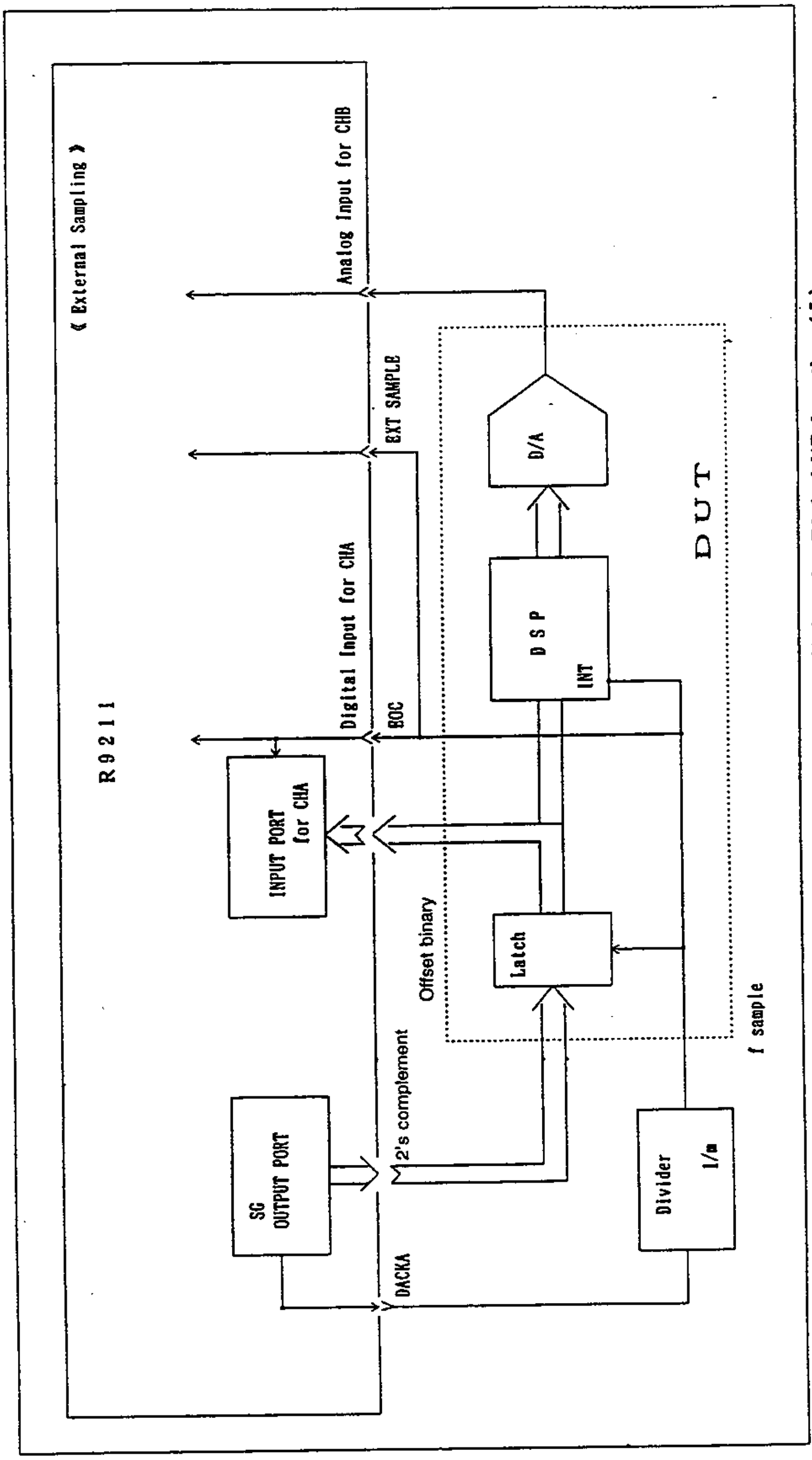


Figure 14-12 Example of Measurement Using the Digital I/O function (I)

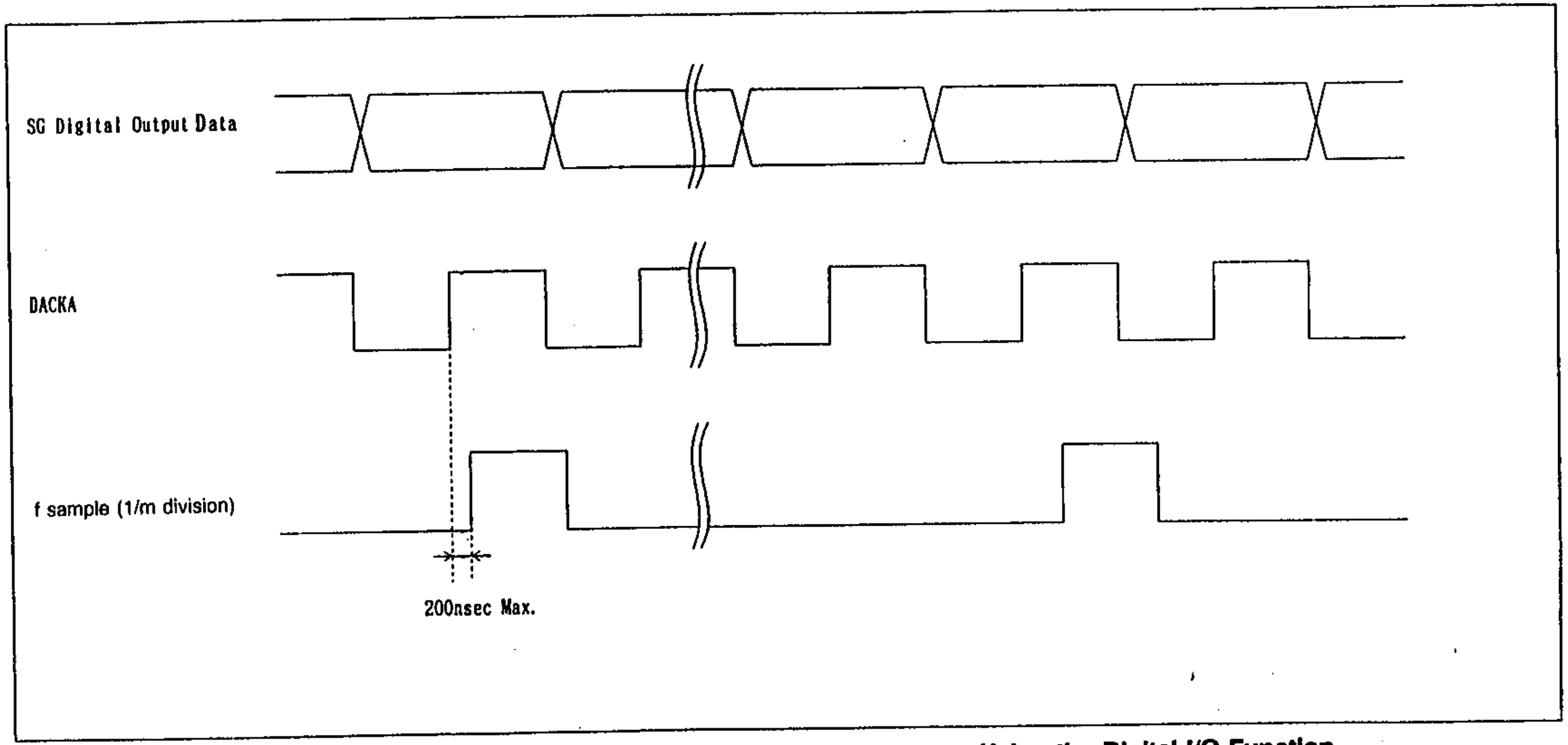


Figure 14-13 Timing Chart for Example (I) of Measurement Using the Digital I/O Function

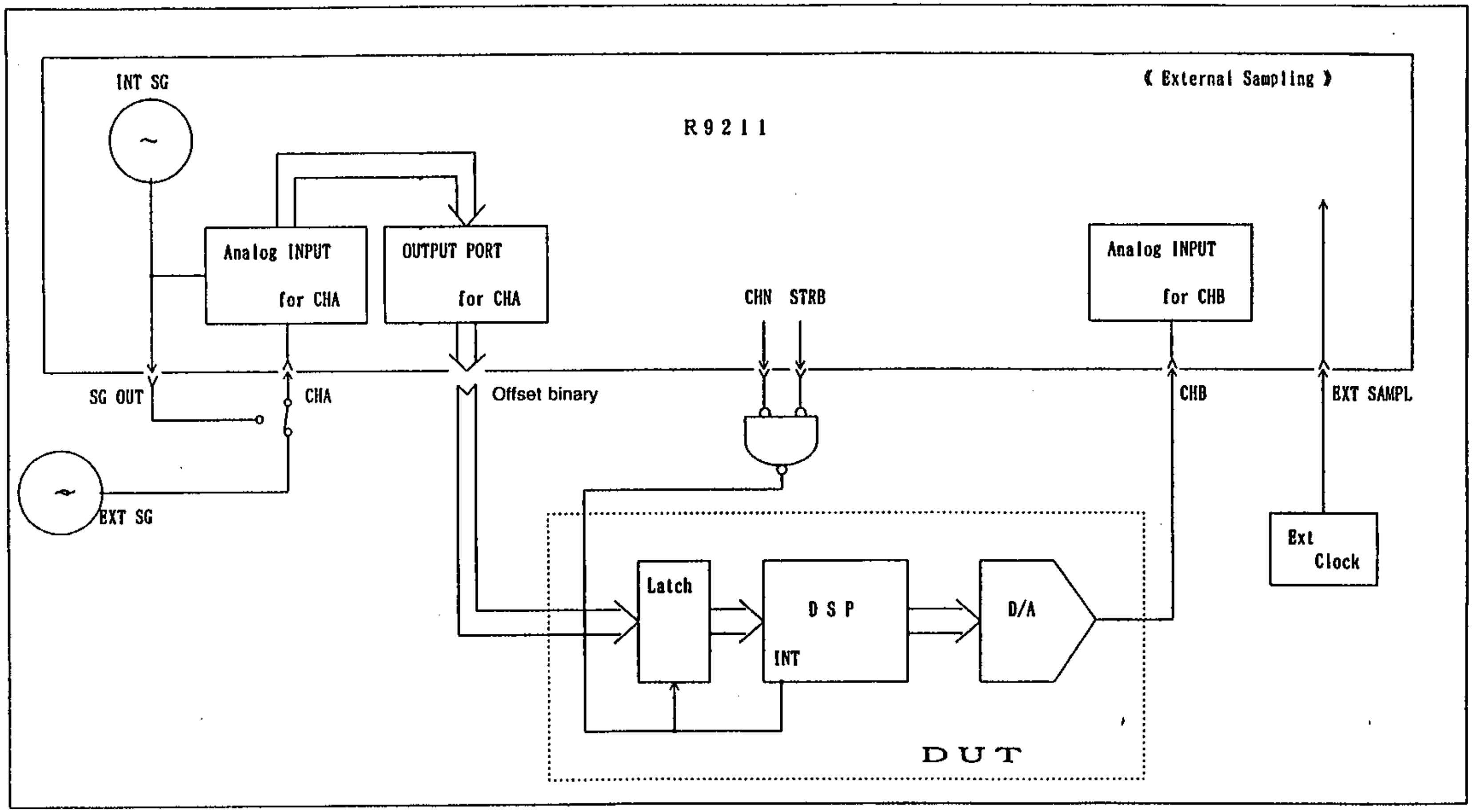


Figure 14-14 Example of Measurement Using the Digital I/O Function (II)

CHAPTER 15

FLOPPY DISK

This chapter explains how to save and retrieve data from the floppy disk.

CONTENTS

1. Outline

A floppy disk can be used to save and retrieve measured data setup comditions and table information. Up to 100 files can be stored on a floppy disk. Since the data format conforms to the MS-DOS format (binary data format), data saved on a floppy disk through the R9211 can be retrieved by a MS-DOS based personal computer.

■ Specifications of the Floppy Disk Drive

Drive : 3.5-inch micro-floppy disk drive
Floppy disk : 2DD(Double-sided double-density)
2HD(Double-sided high-density)
Storage capacity after formatting
: 720KB(2DD)/1MB(2HD)
Recording format : 2DD IBM/NEC compatible format
2HD NEC format
Number of files that can be stored
: Maximum 100 files/disk

2. How To Use A Floppy Disk

■ How to Handle a Floppy Disk

Here are given some basic notions about floppy disks handling:

- **Write protection**

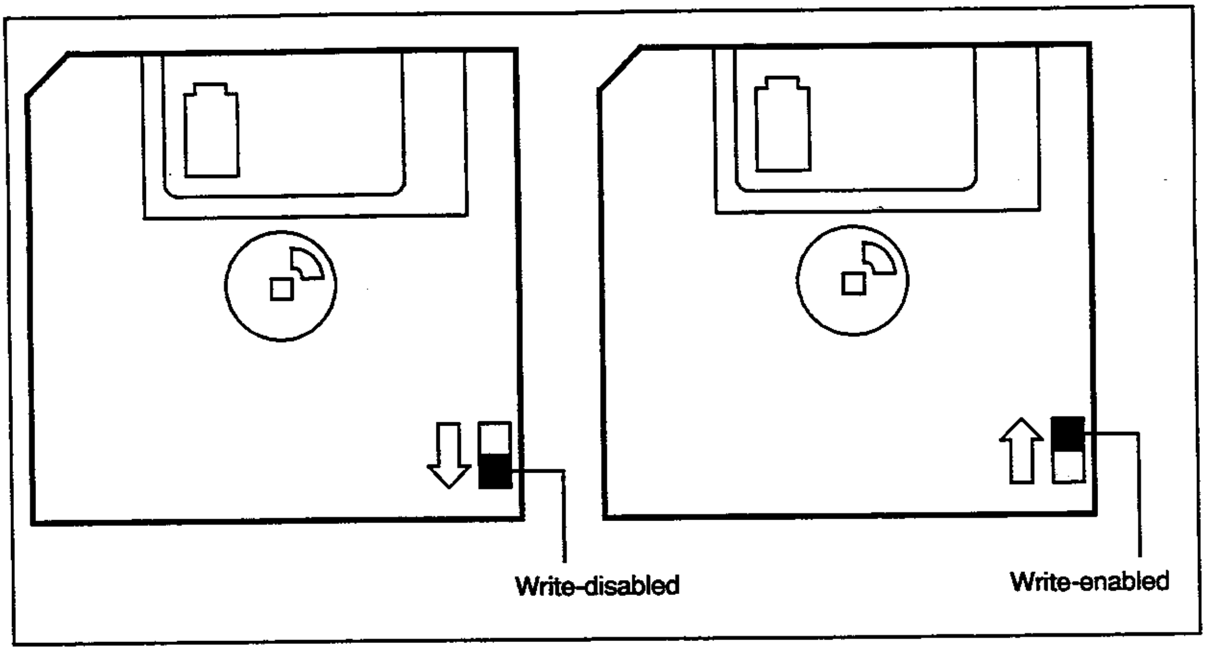


Figure 15-1 Floppy Disk Write Protection

A 3.5-inch micro-floppy disk can be write-protected so that valuable data cannot be erased by mistake. To write-protect the disk (that is to say to forbid all writing on the disk), you just have to change the position of the write-protection slider, as shown on Figure 15-1

- **Floppy disk drive handling advices**
- Do not use the floppy disk with the analyzer's front panel or side panel (left, right panel) up.

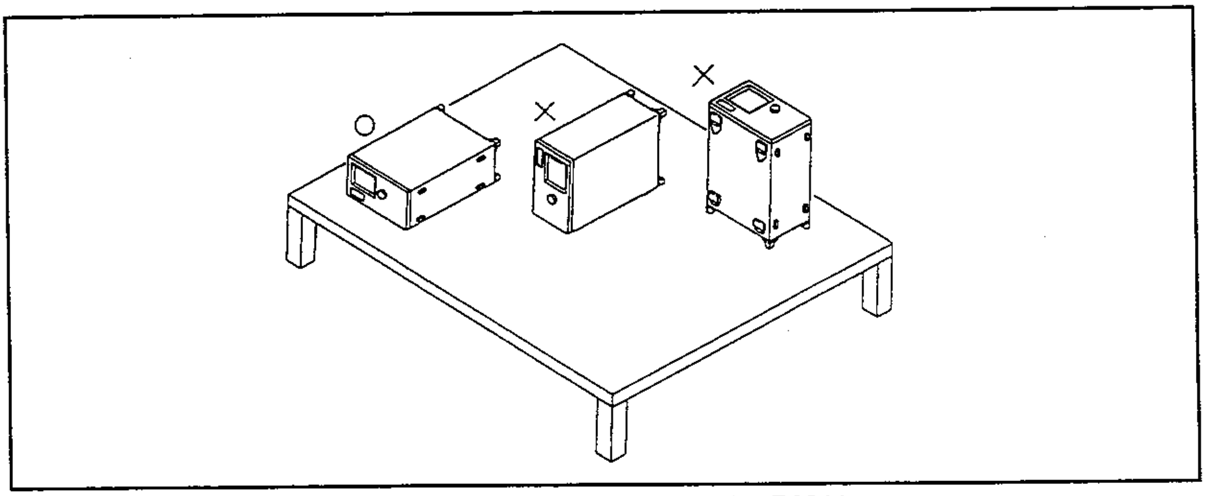


Figure 15-2 Use Position of the R9211

- An excessive shock to the floppy disk drive may damage the drive head or the floppy disk.
- If the floppy disk is removed before it is ejected completely, the drive head may be damaged by the disk shutter window.
- To insert a half ejected floppy disk back may damage the drive head.
- Before switching on the analyzer, remove the floppy disk from the drive. Otherwise, a write protection state may be detected incorrectly.

● **How to insert a floppy disk**

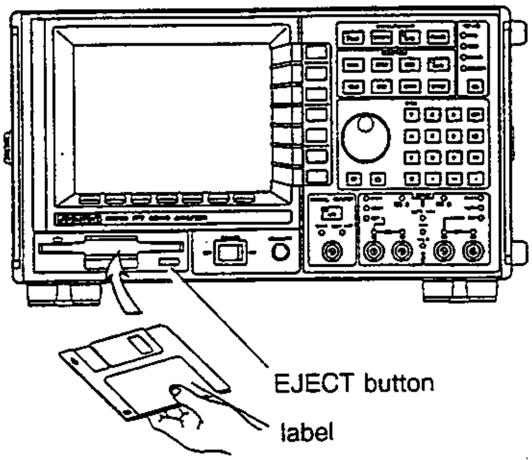


Figure 15-3 How to Insert a Floppy Disk

Figure 15-3 shows the correct insertion method of a floppy disk in the drive. Insert a floppy disk in the slot with the label up.
Insert the floppy disk fully until it is locked in the slot.
To remove the floppy disk, press the EJECT button. Any incorrect operation among those listed below may damage the floppy disk.

CAUTION !

- ***Never press the EJECT button when the red lamp of the disk drive is on.***
- ***If the analyzer is switched on without removing the floppy disk, the disk contents may be read incorrectly. Remove the floppy disk, switch on the analyzer, then insert the floppy disk again.***

■ MEAS File (Data File/View File)

Measurement data, setup conditions or table information can be saved and retrieved from the floppy disk by the R9211; however, the file type depends on the saved information. In this section, we will describe the saving and retrieving operations for measurement data and setup conditions:MEAS FILE.
The MEAS file can be of data file format or view file format.
In a DATA FILE, the original data and the setup conditions of the currently displayed waveform are saved. Because the original data of the current waveform are saved, the data format can be changed by pressing the INST VW or AVG VW menu key. (For example, you can display the spectrum and then switch to the time waveform.)
Note that the measurement mode cannot be changed.
In the VIEW FILE mode, the data format cannot be changed because the waveform displayed on the screen is saved as an image (one-to-one correspondence).

NOTE
In the SERVO mode, the F-table can be saved in a DATA/VIEW FILE together with the measured data.

- **Differences between DATA FILE and VIEW FILE**

Table 15-1 lists the differences between DATA FILE and VIEW FILE.

Table 15-1 Differences between DATA FILE and VIEW FILE

	DATA FILE	VIEW FILE
Instantaneous logarithmic/octave frequency resolution data	×	○
Operation results	×	○
Numeric list	×	×
T-F analysis results	×	○
Selected screen in a multi-screen configuration	○*	○*

○ : Enabled × : Disabled

* : Since only one screen (selected with the SEL key at saving) is displayed during regeneration, the number of screens must be respecified with the TYPE menu (VIEW menu).

● Data saved in a DATA FILE

Table 15-2 lists the data saved in a DATA FILE.

Table 15-2 Data Saved in a DATA FILE

Displayed data			Saved data		
	MODE	FUNC	Active Ch		
			ChA	ChB	ChA & B
Instantaneous data	Not related to MODE	Not related to FUNC	Xa	Xb	Xa, Xb
Average data	WAVEFORM	TIME	<Xa>	<Xb>	<Xa> <Xb>
		AUTO CORR	—	—	<Raa> <Rbb>
		CROSS-CORR	—	—	<Rab>
		HISTOGRAM	<Pa>	<Pb>	<Pa> <Pb>
	SPECTRUM & TIME-FREQ	POWER SPECT	<Gaa>	<Gbb>	<Gaa> <Gbb>
		CROSS-SPECT	—	—	<Gab>
		COMPLX SPECT	<Sa>	<Sb>	<Sa> <Sb>
	FRF	FRF	—	—	<Gaa> <Gbb> <Gab>
	SERVO	SERVO	—	—	<Hab> <Coh> <Imp>

CAUTION!

- ***T-F, logarithmic frequency, and octave analysis data cannot be saved. (The source data cannot be saved.) However, the data displayed on the screen can be saved in a VIEW FILE as an image.***
- ***Do not save retrieved data, which were previously saved in a VIEW FILE in a DATA FILE.***

● **MEAS FILE operation procedure**

DEVICE ⇒ FILETYPE ⇒	MEAS FILE (DATA) *	Selects a MEAS FILE. * The currently selected file type is indicated within parentheses.
⇒	DATA FILE	Specifies that the MEAS FILE is to be of type DATA FILE.
⇒	VIEW FILE	Specifies that the MEAS FILE is to be of type VIEW FILE.
⇒ ACCESS ⇒	SAVE	(Example:to save data on the floppy disk) After specifying the file type, enter the data saving menu.
⇒	EXECUTE SAVE	Save data in the specified file type.

For further details, see Section 3 "Operation Method".
The file type and set-up function specified at saving are described by the file name. For further details, see "■ Catalog Display and File Names".

■ PANEL FILE

When user records/reproduces the manual setting and the measurement condition set at the GP-IB, or the display setting only on the floppy disk, PANEL FILE is used.
The record/reproduce of measurement data uses DATA FILE or VIEW FILE.

● **How to operate PANEL FILE**

DEVICE ⇒ FILETYPE ⇒	PANEL FILE	Set file type to panel file.
⇒ ACCESS ⇒	SAVE	Save the present measurement condition/display condition.

The input methods of file name is reffered to "SAVE" Operation Procedure for specification of Floppy File Name.

⇒	EXECUTE SAVE	When the file name is not input, performs "SAVE" by the file name which R9211 specifies inside.

- **Setting unabled to SAVE/RECALL**

SET UP	⇒	SENS	⇒	CH-A/CH-B	Set to MANUAL.
		INPUT	⇒	ICP	Set to OFF.
			⇒	TEST	Set to OFF.
		ARM/HLD			Set to FREE RUN.
MATH	⇒	TR MATH			Set to all OFF.
		REAL TIME			Execution stops.
SG CONT	⇒	OUT CTRL	⇒	GENERATOR STOP	Stop amplitude.
OPR					Reset is not performed by the recall.
MKR	⇒	X MKR	⇒	X MARKER DO ESTIM	The marker performs the reproduce of the setting, however, can not execute the estimation and the calculation. In executing this, press the DO ESTIM key.

CAUTION !
When reproduce the panel file recorded by different options and device types, the mode of the device type to reproduce which has no functions is changed into WAVEFORM mode.

■ Table File (R9211C Only)

A table file (TBL FILE) is used to save/retrieve the following table information (R9211C):

(1) Comparator table
(2) Table of poles/zeros, poles/residues, and polynomials obtained through curve fitting
(3) Synthesis edit table (poles and zeros table) and table of poles, residues, and polynomials obtained through synthesis

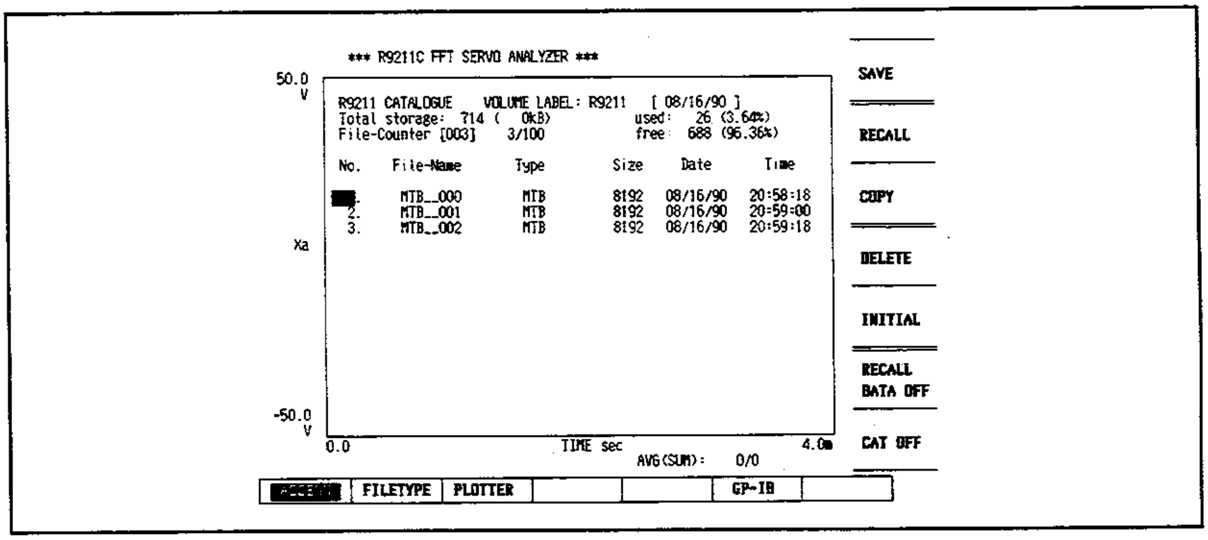
NOTE

- ***The servo mode F-table cannot be stored in a table file. Save it in a MEAS file.***
- ***Waveform data cannot be stored in a table file.***
- ***Table files are classified into comparator, curve fitting, and synthesis tables . All these tables are saved similarly independently of their type.***

● TBL FILE Operation Procedure

DEVICE ⇒ FILETYPE ⇒ TBL FILE	Selects table file as file type.
⇒ ACCESS ⇒ SAVE	(Example:to save data on the floppy disk) After selecting the file type, enter the saving menu.
⇒ EXECUTE SAVE	Save the data in a file of the selected type. (Waveform data cannot be stored in a table file.)

When some data are recorded in a table file, the file name type is automatically set to "MTB".

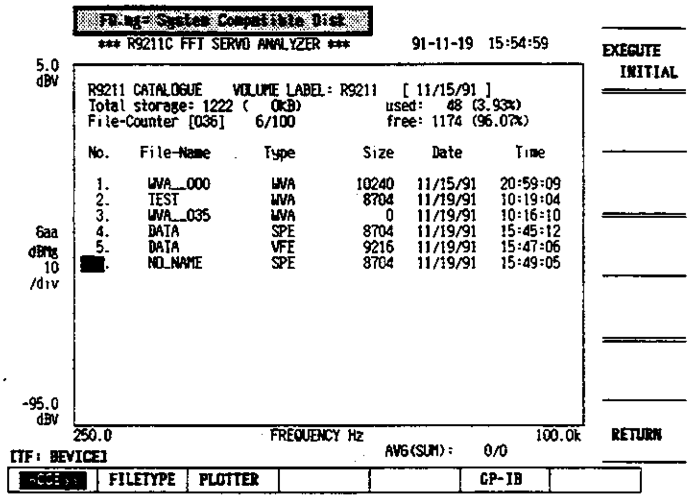


```
R9211 CATALOGUE    VOLUME LABEL: R9211    [ 08/16/90 ]
Total storage:  714 (   0kB)          used:   26 (3.64%)
File-Counter [003]    3/100           free:  688 (96.36%)

No.    File-Name       Type        Size    Date       Time

  .     MTB__000        MTB        8192   08/16/90   20:58:18
 2.     MTB__001        MTB        8192   08/16/90   20:59:00
 3.     MTB__002        MTB        8192   08/16/90   20:59:18

                                  AVG(SUM):    0/0
```

Figure 15-4 Display of a Table Files Catalog

Catalog Display and File Names

When some data are saved on a floppy disk through the R9211, all necessary information are automatically provided as shown in Figure 15-5. This table is called a catalog. When the RECALL , COPY , DELETE , or INITIAL menus are selected, the floppy disk is analyzed to display this catalog.



```
*** R9211C FFT SERVO ANALYZER ***          91-11-19  15:54:59

R9211 CATALOGUE    VOLUME LABEL: R9211    [ 11/15/91 ]
Total storage: 1222 (   0kB)             used:   48 (3.93%)
File-Counter [036]    6/100              free: 1174 (96.07%)

No.   File-Name      Type      Size    Date       Time

 1.    WVA__000       WVA      10240   11/15/91   20:59:09
 2.    TEST           WVA       8704   11/19/91   10:19:04
 3.    WVA__035       WVA          0   11/19/91   10:16:10
 4.    DATA           SPE       8704   11/19/91   15:45:12
 5.    DATA           VFE       9216   11/19/91   15:47:06
   .   NO_NAME        SPE       8704   11/19/91   15:49:05
```

Figure 15-5 File Catalog Display

● Signification of each information displayed on the catalog

No.	: The file number. Up to 100 files can be created.
File-Name	: Display the file name.
Type	: The code indicating the mode, SETUP-FUNC setting, or the file format

(1) Signification of the type item

(a) Table file (R9211C only)

File Type	Code
TBL FILE	MTB

(b) MEAS file

X X Y (3 characters)

MODE code (2 characters)

File Type	MODE	Code
DATA	WAVEFORM	WV
	SPECTRUM	SP
	TIME-FREQ	TF
	FRF	FR
	SERVO	SV
VIEW	VIEW FILE	VF

SETUP-FUNC code (1 character)

SETUP-FUNC	Code
TIME	A
AUTOCORR	B
CROSS-CORR	C
HISTGRAM	D
POWER-SPECT	E
CROSS-SPECT	F
COMPLX-SPECT	G
FRF	K

Size : Data size
Date : Date of saving
Time : Time of saving
To exit from the catalog, press ACCESS ⇒ CAT OFF .

(c) PANEL file

File Type	Code
PAN FILE	PAN

Saving Settings

The settings made with the MODE and SETUP keys can be saved and retrieved (and only these).
The settings made with the MKR or MATH key cannot be saved.
As for the MODE key, the settings of the MEAS softmenu can be saved.
As for the SETUP key, the settings listed in Table 15-3 can be saved.

Table 15-3 Menus Set Conditions of the SETUP Key which can be Saved

X menu	Y menu
FUNC	All settings except DIGITALin
RANGE	All settings except SAMPL CLK
SENSE	All settings (For AUTO, when RECALL DATA switches off, AUTO is automatically set to MANUAL)
INPUT	All settings (For TEST, when RECALL DATA switches off, TEST automatically switches to off)
TRIG	SOURCE setting only
ARM/HLD	No settings can be saved
WEIGHT	All settings
AVG	All settings except REJECT and OVERLAP
UNIT	No settings can be saved
chDELAY	No settings can be saved

Data Compatibility between Models

There are five models of R9211 series analyzers: R9211A, B, C, E, and F, so that you can select the model which is provided with the special features you need.
Data obtained by using a special function are compatible only with the analyzers provided with this function. (The analyzers which do not implement this function can not retrieve the data). Data obtained by using a common function are compatible with every model.
The special functions together with the models provided with them are listed below:

(1) Zoom function
    R9211A/C
(2) SERVO function
    R9211B/C
(3) Curve fitting function
    R9211C only
(4) Comparator function
    R9211C only
(5) Table file
    R9211C only

■ Menus Related to the Floppy Disk

Figure 15-6 lists the menus related to the floppy disk operations.

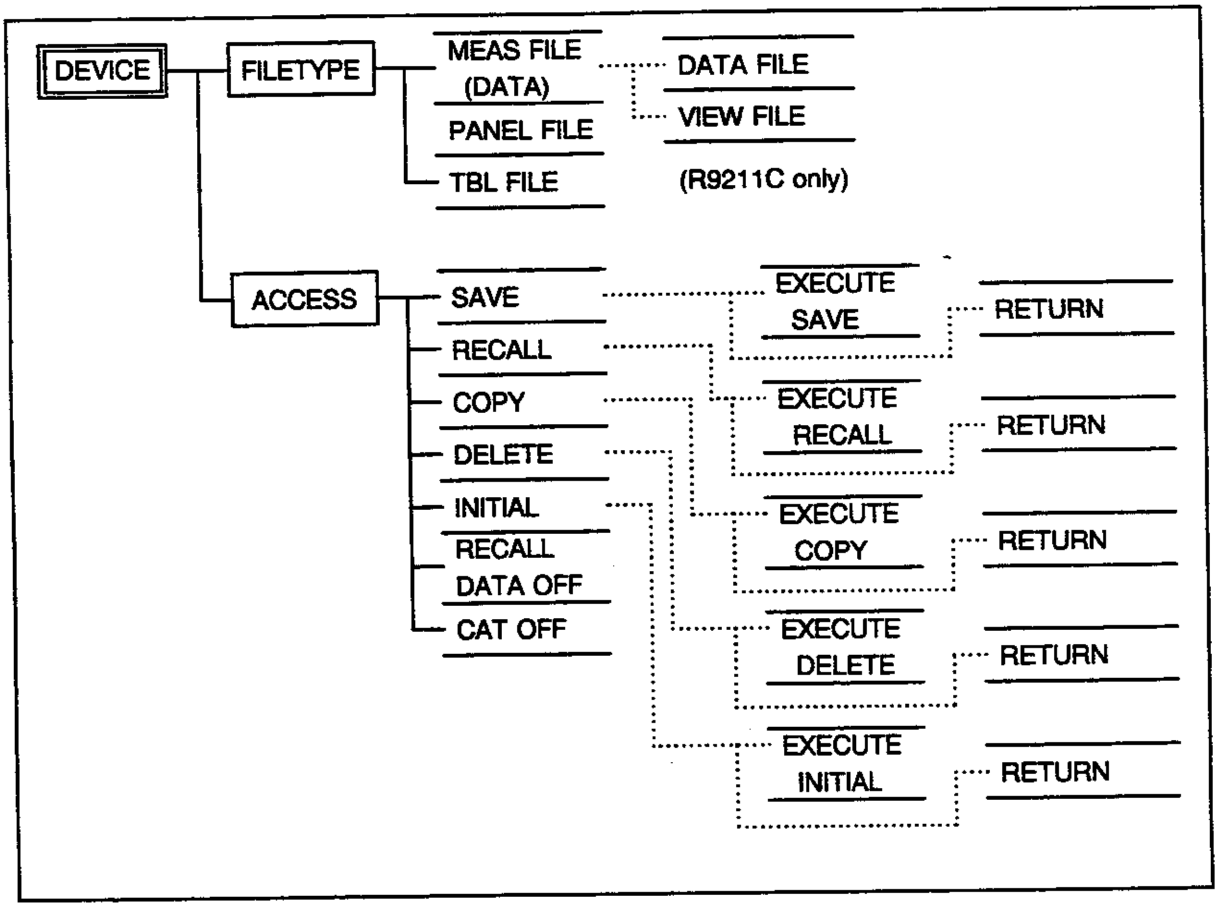


Figure 15-6 Floppy Disk Operation Menus

MEAS FILE	: Selects the measurement data saving format.
PANEL FILE	: Specifies only to record Displaying condition and Setting condition.
TBL FILE	: Selects the information table saving format. (R9211C only)
SAVE	: Saves data or table information in files of the specified format.
RECALL	: Retrieves data saved on the floppy disk.
COPY	: Copies a file to another area on the same floppy disk.
DELETE	: Deletes data from the floppy disk.
INITIAL	: Initializes the floppy disk.
RECALL DATA OFF	: Stops displaying, on the screen, data retrieved from the floppy disk to display real time data.
CAT OFF	: Clears the floppy disk catalog screen.

3. Operation Method

■ Floppy Disk Initializing Operation Procedure

In this section, how to use the floppy disk functions, is explained through an example.
In the following procedure, a new floppy disk is initialized.

1 Initialize a new floppy disk.

Insert a new floppy disk in the disk drive.

DEVICE ⇒ ACCESS ⇒ INITIAL	Enter the floppy disk initialization menu.
(Displayed at the upper left) FD.mg = Reading the Disk Status .... FD.er = Badly Formatted/Badly Mounted Disk : Check	This message is displayed for a new floppy disk or while the floppy disk status is being checked.
⇒ EXECUTE INITIAL	Initialize the floppy disk. (NOTE)
FD.mg = Disk Initialization Completed	This message is displayed when the initialization is completed.
⇒ RETURN	Exit from the initialization menu.
⇒ CAT OFF	Exit from the catalog display mode in which floppy disk files information are displayed.

NOTE

Before initializing the floppy disk, remove the write-protection from the floppy disk (write enabled). (See Figure 15-1.)
If an attempt is made to initialize a write-protected disk, initialization fails and the message FD.mg = Disk Initialization Completed is displayed.
In the R9211, you can only use floppy disks initialized by the R9211.

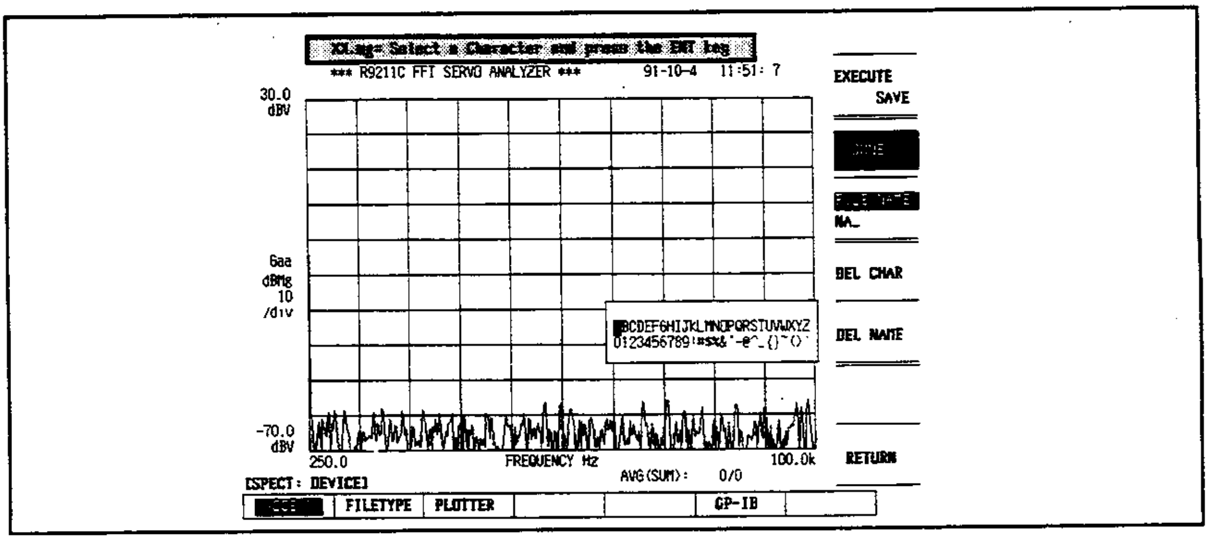
"SAVE" Operation Procedure for Floppy File Specification

When perform data access (SAVE/RECALL/COPY/DELETE) to the floppy, the file name of user's specification can execute.
When file name is not specified in SAVE, R9211 gives file name to be determined inside to execute SAVE. The way of file name specification is common to DATA FILE/VIEW FILE/PANEL FILE.

1 **Set floppy disk to disk drive.**

DEVICE ⇨ **ACCESS** ⇨ SAVE	Select the item to execute.
⇨ FILE NAME NO NAME	Alphabet window is displayed. The previous used file name is remained.
⇨ DEL CHAR	Delete the file name which has already been set.

2 **Enter the file name with the knob and the ENT key. (Specify up to 7 characters)**



⇨ DONE	Close the alphabet window.
⇨ EXECUTE SAVE	Execute SAVE.

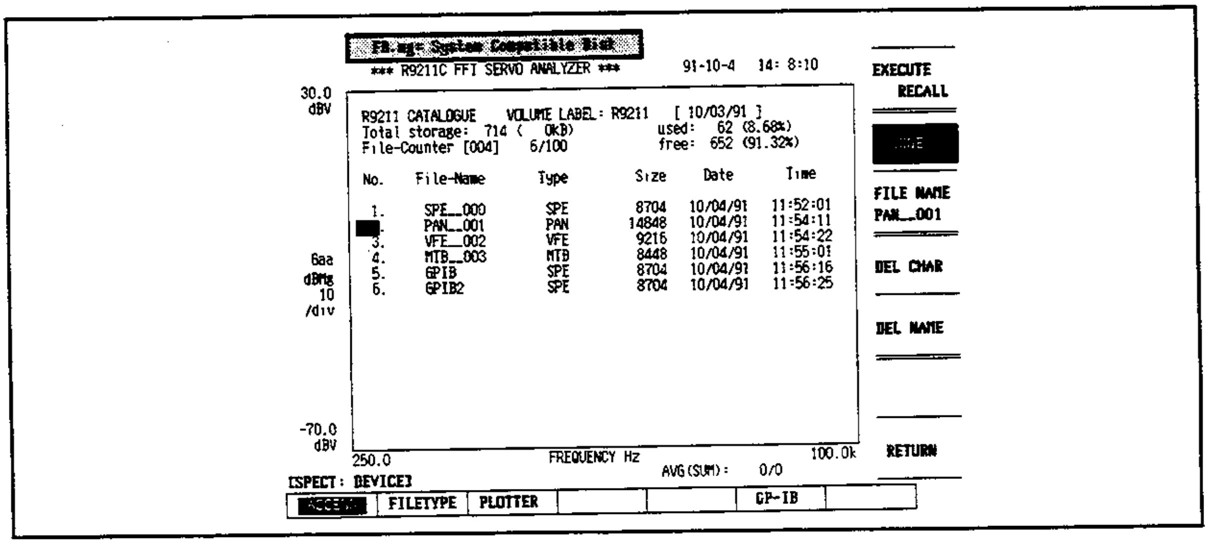
"COPY" Operation Procedure for Floppy File Specification

When perform data access (COPY) to the floppy, the file name of user's specification can execute.
When file name is not specified in SAVE, R9211 gives file name to be determined inside to execute SAVE. The way of the file name specification is common to DATA FILE/VIEW FILE/PANEL FILE.

1 Set floppy disk to disk drive.

DEVICE ⇒ **ACCESS** ⇒ COPY

Select the item to execute.
Specify the file to perform COPY with the knob.

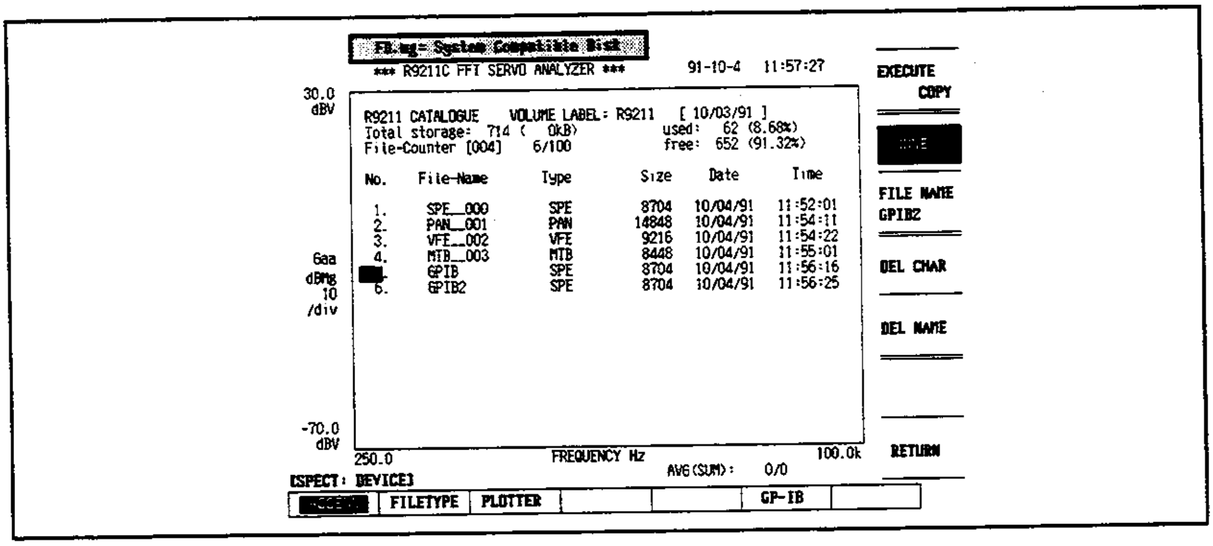


```
*** R9211C FFT SERVO ANALYZER ***        91-10-4   14: 8:10

R9211 CATALOGUE    VOLUME LABEL: R9211    [ 10/03/91 ]
Total storage:  714 (   0kB)          used:   62 (8.68%)
File-Counter [004]    6/100           free:  652 (91.32%)

No.    File-Name     Type      Size    Date       Time

 1.     SPE__000      SPE      8704   10/04/91   11:52:01
 2.     PAN__001      PAN     14848   10/04/91   11:54:11
 3.     VFE__002      VFE      9216   10/04/91   11:54:22
 4.     MTB__003      MTB      8448   10/04/91   11:55:01
 5.     GPIB          SPE      8704   10/04/91   11:56:16
 6.     GPIB2         SPE      8704   10/04/91   11:56:25

FREQUENCY Hz          AVG(SUM):   0/0
[SPECT: DEVICE]
```

2 Enter the file name for the COPY.

⇒ FILE NAME / NO NAME — Alphabet window is displayed. The previous used file name is remained.

Enter the file name with the knob and the ENT key.



```
FD.mg= System Compatible Disk
*** R9211C FFT SERVO ANALYZER ***          91-10-4   11:57:27

R9211 CATALOGUE    VOLUME LABEL: R9211    [ 10/03/91 ]
Total storage:  714 (   0kB)             used:   62 (8.68%)
File-Counter [004]    6/100              free:  652 (91.32%)

No.   File-Name      Type       Size    Date       Time

 1.    SPE__000       SPE        8704   10/04/91   11:52:01
 2.    PAN__001       PAN       14848   10/04/91   11:54:11
 3.    VFE__002       VFE        9216   10/04/91   11:54:22
 4.    MTB__003       MTB        8448   10/04/91   11:55:01
 5.    GPIB           SPE        8704   10/04/91   11:56:16
 6.    GPIB2          SPE        8704   10/04/91   11:56:25

250.0                 FREQUENCY Hz                 100.0k
                                AVG(SUM):    0/0
[SPECT: DEVICE]
```

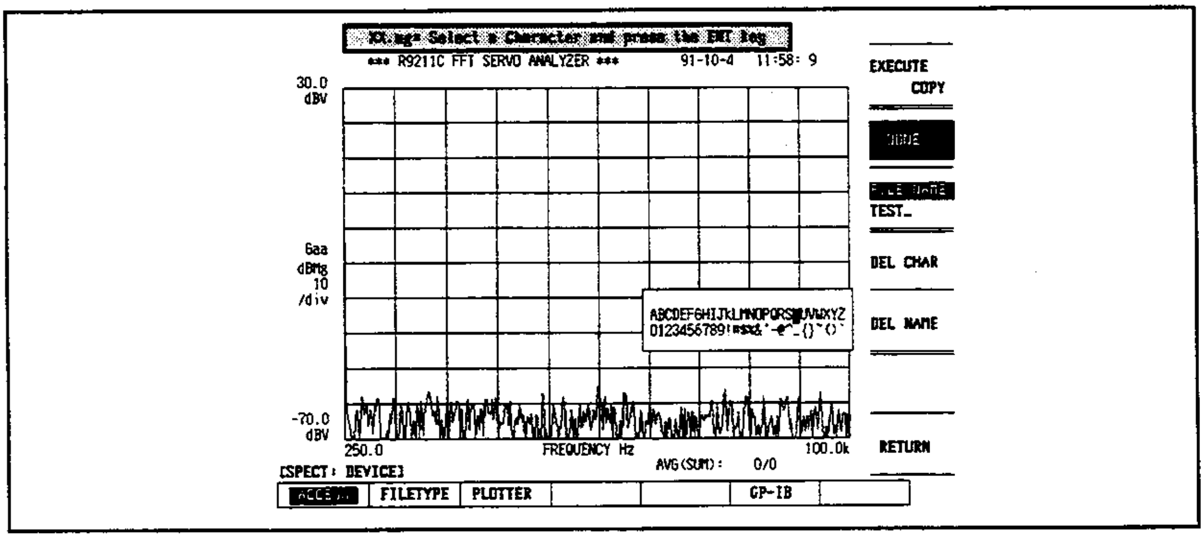
"RECALL/DELETE" Operation Procedure for Floppy File Specification

When perform data access (COPY) to the floppy, the file name of user's specification can execute.
When file name is not specified in SAVE, R9211 gives file name to be determined inside to execute SAVE. The way of file name specification is common to DATA FILE/VIEW FILE/PANEL FILE.

1 Set floppy file to disk drive.

DEVICE ⇒	**ACCESS** ⇒	RECALL		Select the item to execute.
	⇒	DELETE		
	⇒	FILE NAME NO NAME		Alphabet window is displayed
	⇒	DEL CHAR		Delete the file name which has already been set.

2 Enter the file name with the knob and the **ENT** key. Extension is not entered.



Msg: Select a Character and press the ENT key

*** R9211C FFT SERVO ANALYZER *** 91-10-4 11:58: 9

FILE NAME TEST_

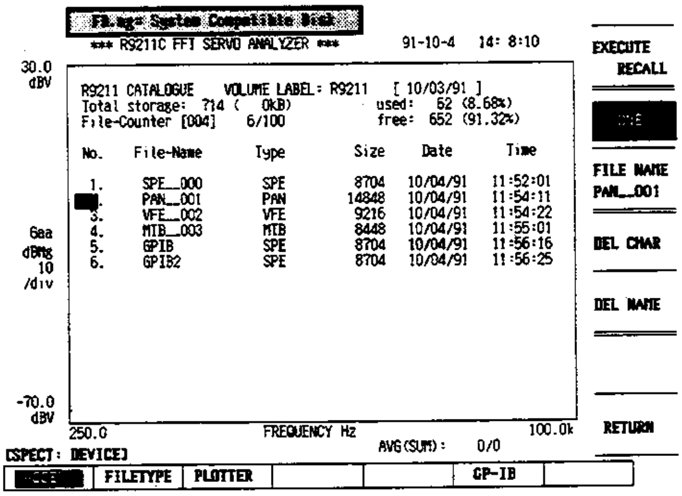
ABCDEFGHIJKLMNOPQRSTUVWXYZ
0123456789!#$%&'-@^_{}~()`

AVG(SUM): 0/0

[SPECT: DEVICE]

⇨ DONE	Close alphabet window.
⇨ EXECUTE RECALL	Execute RECALL or DELETE when the same file name is not multiple.
⇨ EXECUTE DELETE	Display the corresponding file when the same file name is multiple.

3 **Specify the file to perform RECALL (DELETE) from the displaying file with the ◎ knob.**



```
*** R9211C FFT SERVO ANALYZER ***          91-10-4   14: 8:10

R9211 CATALOGUE    VOLUME LABEL: R9211    [ 10/03/91 ]
Total storage:  714 (   0kB)           used:   62 (8.68%)
File-Counter [004]    6/100            free:  652 (91.32%)

No.   File-Name     Type        Size    Date       Time

 1.    SPE__000     SPE         8704   10/04/91   11:52:01
 2.    PAN__001     PAN        14848   10/04/91   11:54:11
 3.    VFE__002     VFE         9216   10/04/91   11:54:22
 4.    MIB__003     MIB         8448   10/04/91   11:55:01
 5.    GPIB         SPE         8704   10/04/91   11:56:16
 6.    GPIB2        SPE         8704   10/04/91   11:56:25

                                   AVG(SUM):   0/0
[SPECT: DEVICE]
```

⇨ EXECUTE RECALL	Execute RECALL (DELETE) for the file specified with the knob.
⇨ EXECUTE DELETE	

Notes on the Retrieving Procedure

- Recalled data are displayed on one screen (single screen configuration).
- To return from the retrieved data analysis screen to the measurement screen after data have been recalled from the floppy disk, press the RECALL DATA OFF key.
- After a view file is recalled, the following operations are inhibited until the RECALL DATA OFF key is pressed.

  Screen configuration modification and monitor function
  Three-dimensional display
  Display of instantaneous data, average data, memory saved data, operation result or t-f analysis result
  In the SERVO mode, the view file data remains displayed, even after the RECALL DATA OFF key is pressed until the START key is pressed.

  In this case, the above inhibitions are released and contradictory data is displayed on the screen.
  For example, if <Hab> is retrieved from a view file in the SERVO mode, pressing the RECALL DATA OFF key releases the inhibitions.

  Select the double screen mode and display the coherence function on the other screen.
  The coherence data appears as if it corresponded to <Hab>, retrieved from a view file. However, since the <Hab> data are not generated anew, correct data will not be displayed until the START key is pressed.
- When power spectrum or complex spectrum data are recalled from a view file, do not press the VIEW ⇒ COORD sequence.
  If the coordinates are changed, incorrect data will be displayed.
- Even after the RECALL DATA OFF key is pressed, the analyzer starts operating according to the settings of the recalled file.

How to Compare New Data with Retrieved Data

To compare data retrieved from the floppy disk with the current measurement data or to compare two pieces of data retrieved from the floppy disk, store one data series (floppy disk data) in the internal memory of the R9211 and set RECALL DATA to OFF. The comparison procedure is the following one:

DEVICE ⇒ ACCESS ⇒ RECALL   Using the knob, select the file to be recalled.

⇒ EXECUTE RECALL

VIEW ⇒ MEM VW ⇒ DATA SAVE 1

DEVICE ⇒ ACCESS ⇒ RECALL DATA OFF

VIEW ⇒ TYPE ⇒ DUAL

⇒ SEL ⬓
⇒ INST VW ⇒ CH-A TIME
} Select the data to be compared.

⇒ SEL ⬒
⇒ MEM VW ⇒ DATA RECALL 1
} Recall from the internal memory the data retrieved from the floppy disk.

⇒ Y SCALE   Set the Y SCALE parameters, UPPER and LOWER, so that the Y-axis of the upper screen match that of the lower screen.

⇒ FORMAT ⇒ OVERLAY ON

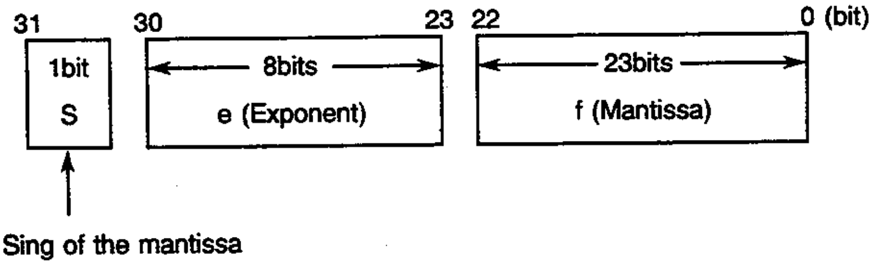
4. Regenerating Floppy Data With An IBM-PC

■ Floppy Disk Data Types and Data Format

The R9211 offers 2 types of files : data files and view files.
In a data file all the information usted in Table 15-4 are stored. In a view file, only the displayed screen is saved. When such a file is retrieved, the screen can not be modified with the COORD menu. However, the data format is the same for both file types.

Table 15-4 summarizes the relationships between the file types and data types.

● **<IEEE floating format>**
The IEEE floating point format is represented on 32 bits.



$$\text{Numeric value} = (-1)^{S} * 2^{(e-127)} * \underbrace{1.f}_{\text{Binary}}$$

NOTE
Mantissa "f" indicates the decimal data only. Therefore, "1" of the integer part must be added when it is converted to a numeric value.

Table 15-4 Data Arrays Saved on Disk

Mode	Function	Instantaneous	Average
Waveform	Time * Auto Corr * Cross Corr Histogram	Time (16bit) Time (16bit) Time (16bit) Time (16bit)	Time (32bit) Auto Corr (IEEE float) Cross Corr (IEEE float) Hist (32bit)
Spectrum T-F	Power Spect * Cross Spect Complex Spect	Time (16bit) Time (16bit) Time (16bit)	Power Spect (IEEE float) Cross Spect (IEEE float) Complex Spect (IEEE float)
FRF		Time (16bit)	ChA Power Spect (IEEE float) ChB Power Spect (IEEE float) Cross Spect (IEEE float)

(* In the 2-channel operation mode only)

NOTE

- ***If two channels (A and B) are active, ChA data and ChB data are saved in the data array block in this order.***
- ***Instantaneous data : The waveform data is saved.***
- ***Average data other than FRF : The average data is saved.***
- ***FRF average data : The input and output power spectra and cross spectrum are saved in the order of "Gaa", "Gbb", and "Gab".***

R9211 View File Reading Program

Abstract

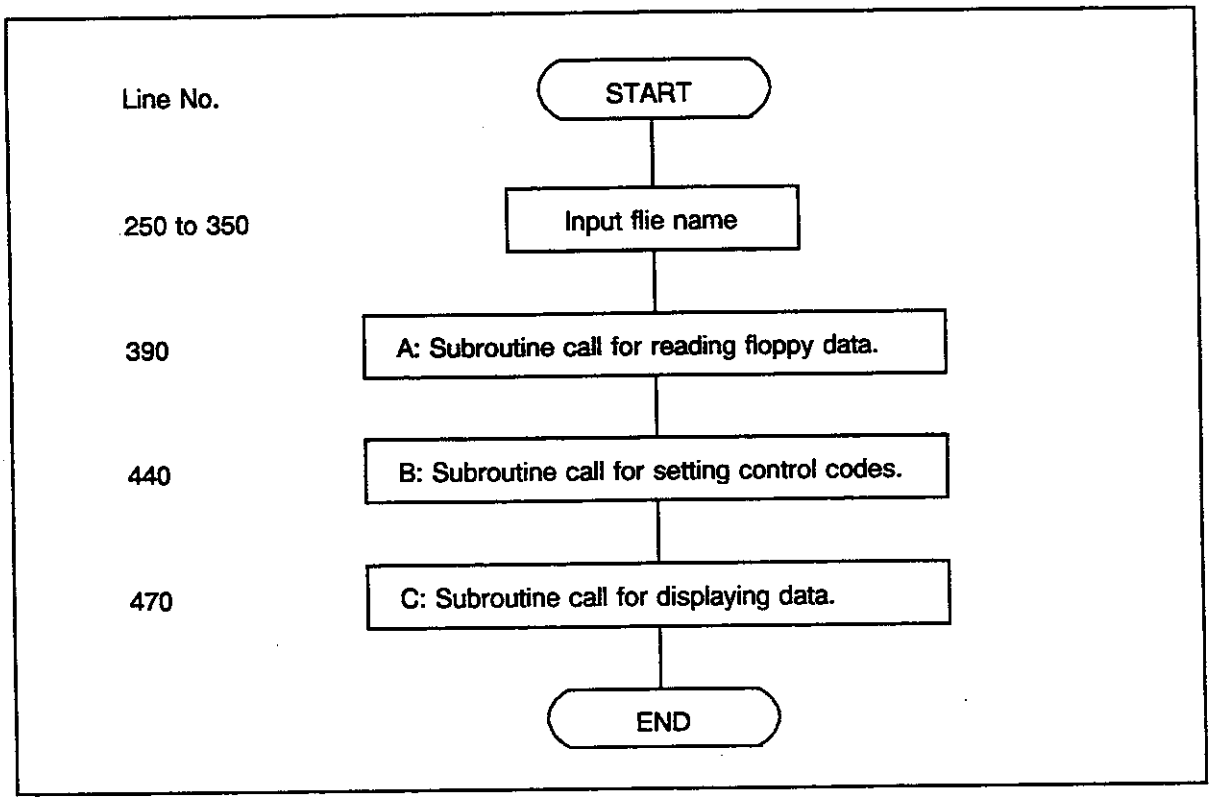
This program reads View files created on the R9211 and displays the date on an IBM-PC.

Language

GW-BASIC (Micro Soft)

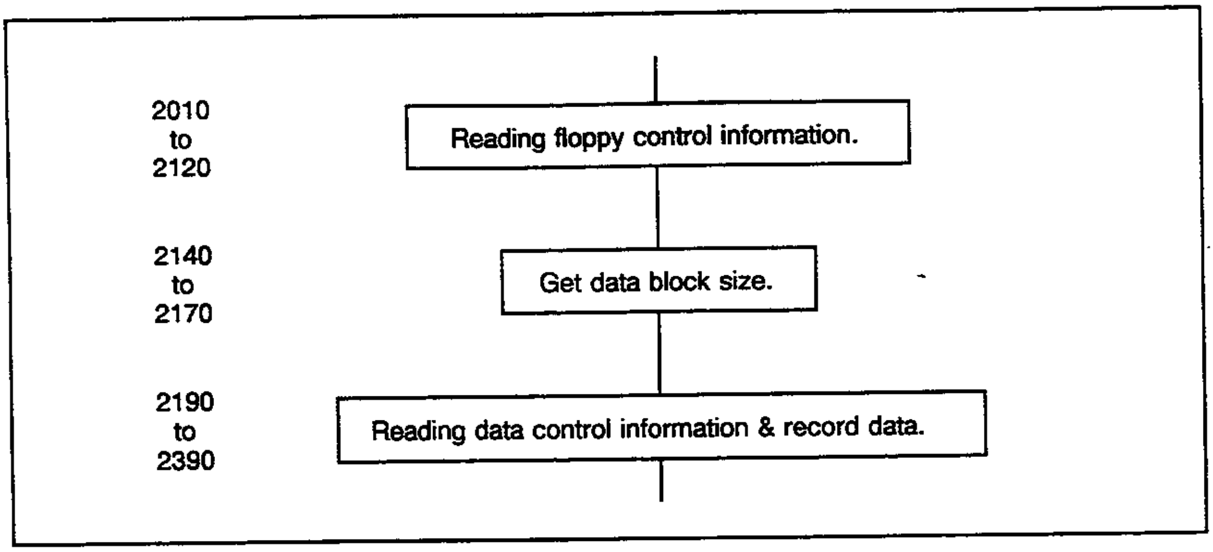
Flowchart of the program

(1 of 4)



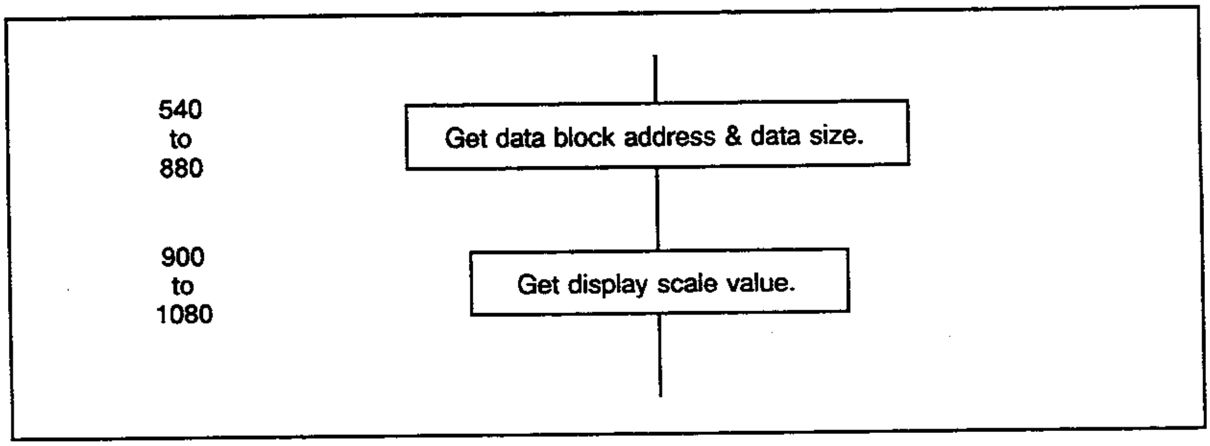
A : Subroutine for reading floppy data. (2000 to 2400)

(2 of 4)



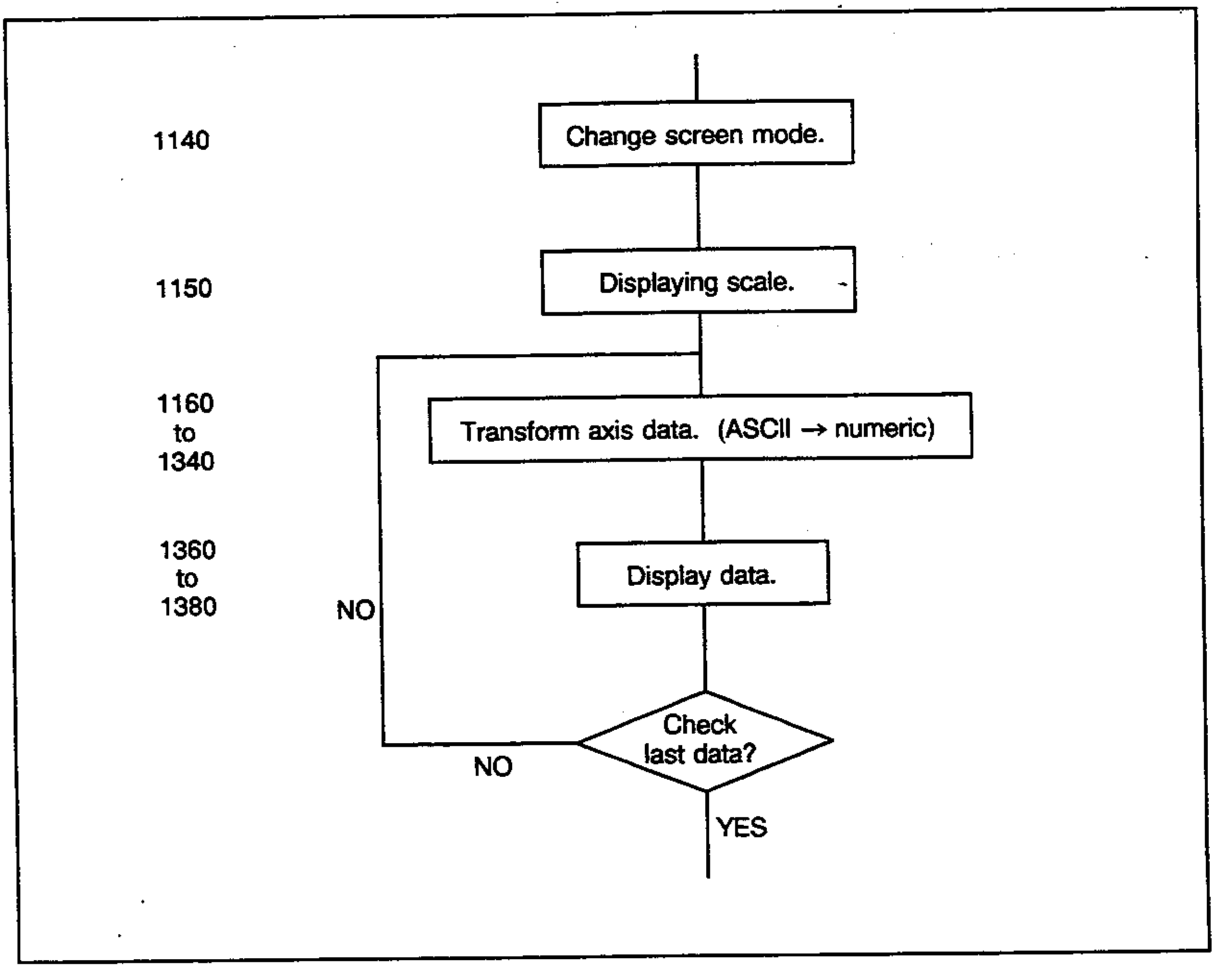
B : Setting control codes. (510 to 1100)

(3 of 4)

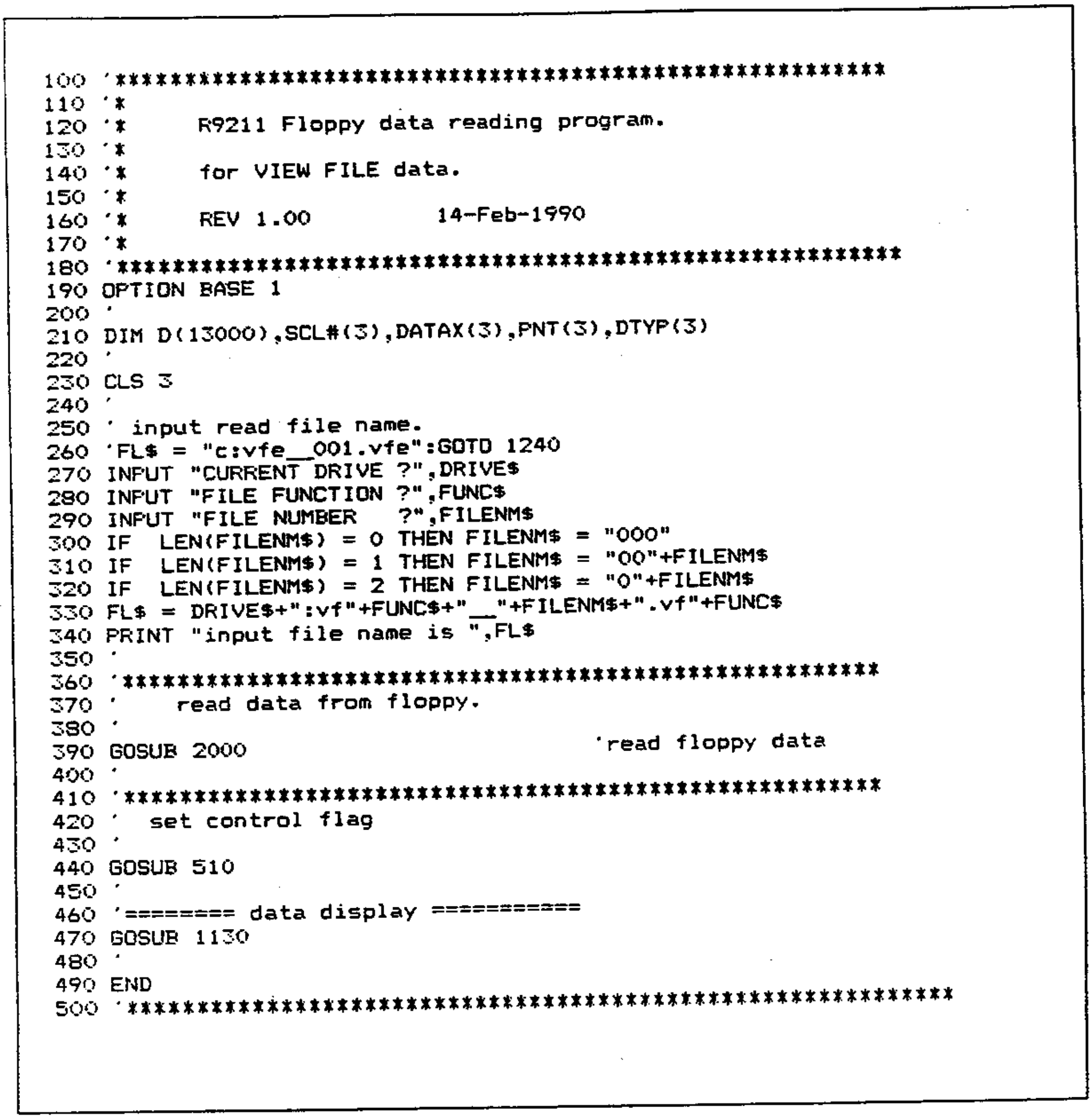


C : Displaying data (1100 to 1400)

(4 of 4)



- **Example of program**



```
100 '********************************************************
110 '*
120 '*      R9211 Floppy data reading program.
130 '*
140 '*      for VIEW FILE data.
150 '*
160 '*      REV 1.00          14-Feb-1990
170 '*
180 '*********************************************************
190 OPTION BASE 1
200 '
210 DIM D(13000),SCL#(3),DATAX(3),PNT(3),DTYP(3)
220 '
230 CLS 3
240 '
250 ' input read file name.
260 'FL$ = "c:vfe__001.vfe":GOTO 1240
270 INPUT "CURRENT DRIVE ?",DRIVE$
280 INPUT "FILE FUNCTION ?",FUNC$
290 INPUT "FILE NUMBER   ?",FILENM$
300 IF  LEN(FILENM$) = 0 THEN FILENM$ = "000"
310 IF  LEN(FILENM$) = 1 THEN FILENM$ = "00"+FILENM$
320 IF  LEN(FILENM$) = 2 THEN FILENM$ = "0"+FILENM$
330 FL$ = DRIVE$+":vf"+FUNC$+"__"+FILENM$+".vf"+FUNC$
340 PRINT "input file name is ",FL$
350 '
360 '******************************************************
370 '    read data from floppy.
380 '
390 GOSUB 2000                          'read floppy data
400 '
410 '******************************************************
420 '  set control flag
430 '
440 GOSUB 510
450 '
460 '======== data display ===========
470 GOSUB 1130
480 '
490 END
500 '***********************************************************
```

(cont'd)

```
510 '*****************************************************
520 ' set control flag
530 '
540 AOF = 513
550 '
560 '=== top of X axis data array ==
570 '
580 P= 145
590 GOSUB 1680                  ' 32bit integer
600 XTOP = INTX*256 + 1
610 '
620 '=== size of array ==
630 P = 149
640 GOSUB 1680                  ' 32 bit integer
650 DATAN = INTX/4
660 '
670 '=== X axis scale and offset value ==
680 N = 153
690 GOSUB 1420             ' IEEE floating format --> floating data
700 XSCALE# = A#
710 '
720 N = 157
730 GOSUB 1420                  ' IEEE floating format --> floating data
740 XOFSET# = A#
750 '
760 '=== top of Y axis data array ==
770 P = 161
780 GOSUB 1680                  ' 32 bit integer
790 YTOP = INTX*256 + 1
800 '
810 '=== Y axis scale and offset value ==
820 N = 169
830 GOSUB 1420                  ' IEEE floating format --> floating data
840 YSCALE# = A#
850 '
860 N = 173
870 GOSUB 1420                  ' IEEE floating format --> floating data
880 YOFSET# = A#
890 '
900 '======= display scale ==========='
910 AOF = 513
920 VW = AOF + D(AOF)*256 + D(AOF+1) + 768 + 112        'VIEW INFORMATION
930 '
940 N = VW + 60
950 GOSUB 1550                  ' IEEE 64 bit floating format --> float data
960 XMAX = ID#
970 '
980 N = VW + 68
990 GOSUB 1550                  ' IEEE 64 bit floating format --> float data
1000 XMIN = ID#
1010 '
1020 N = VW + 76
1030 GOSUB 1550                 ' IEEE 64 bit floating format --> float data
1040 YMAX = ID#
1050 '
1060 N = VW + 84
1070 GOSUB 1550                 ' IEEE 64 bit floating format --> float data
1080 YMIN = ID#
1090 '
1100 RETURN
```

(cont'd)

```
1110 '******************************************************************
1120 '  display view file data.
1130 '
1140 CLS:CLS 2:SCREEN 2,0,0        ' graphics mode ON
1150 GOSUB 1730                    ' display scaling
1160 DMAX = -YMAX: DMIN = YMAX
1170 STPN = 4
1180 XN = XTOP : YN = YTOP
1190 N = XN
1200 GOSUB 1420     ' IEEE floatin format --> floating data
1210 NX = A#* XSCALE# + XOFSET#
1220 '
1230 N = YN
1240 GOSUB 1420          ' IEEE floatinf format --> floating data
1250 NY =    A#* YSCALE#  - YOFSET#
1260 '
1270 FOR I = 1 TO DATAN-1
1280   N = XN + I* STPN
1290   GOSUB 1420                'IEEE format --> 32 bit floating data.
1300   XP = A# * XSCALE# + XOFSET#
1310   '
1320   N = YN + I* STPN
1330   GOSUB 1420                'IEEE format --> 32 bit floating data.
1340   YP =    A#* YSCALE#  - YOFSET#
1350   '
1360   LINE (XP,YP)-(NX,NY),2
1370   NX = XP : NY = YP
1380 NEXT I
1390 '
1400 RETURN
```

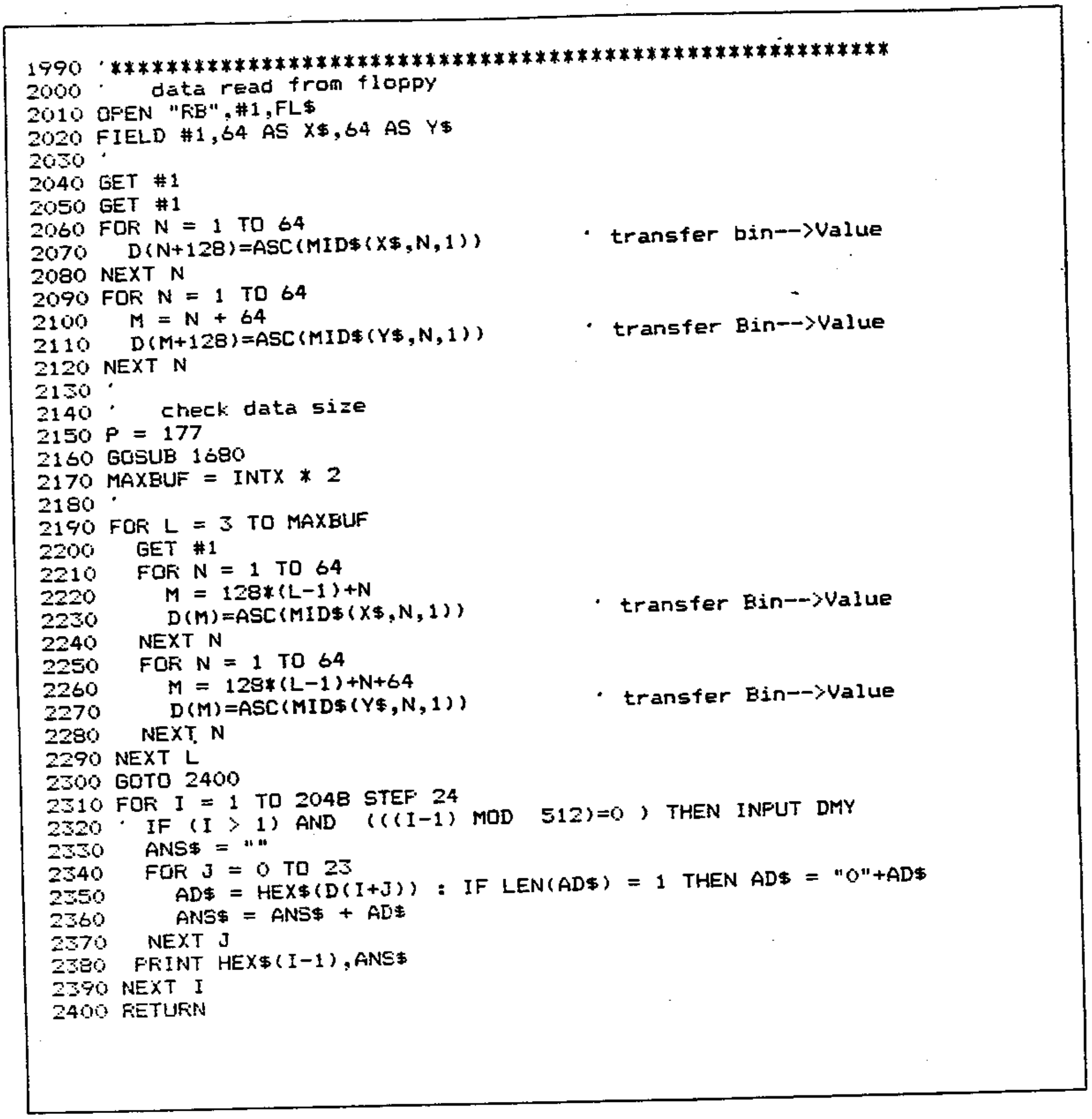
(cont'd)

```
1410 '**********************************************************
1420 '  IEEE 32 bit floating format --> floating data
1430 '
1440 X1 = D(N) : X2 = D(N+1) : X3 = D(N+2) : X4 = D(N+3)
1450 IF (X1 = 0) AND (X2 = 0) AND (X3 = 0) AND (X4 = 0) THEN 1460 ELSE 1480
1460   A# = 0!
1470 GOTO 1530
1480 SIGN = (-1)^(( X1 AND 128)/128)
1490 EXP1 = ((X1 AND 127)*2 + (X2 AND 128)/128)-127
1500 EXPO#= 2^EXP1
1510 FRAC# = ((X2 OR 128)+(X3 + X4/256)/256)/128
1520 A# = SIGN*EXPO#*FRAC#
1530 RETURN
1540 '**********************************************************
1550 '  IEEE 64 bit floating format --> double data
1560 X1 = D(N) : X2 = D(N+1) : X3 = D(N+2) : X4 = D(N+3)
1570 X5 = D(N+4):X6 = D(N+5) : X7 = D(N+6) : X8 = D(N+7)
1580 IF(X1=0)AND(X2=0)AND(X3=0)AND(X4=0)AND(X5=0)AND(X6=0)AND(X7=0)AND(X8=0)THEN
 1590 ELSE 1610
1590 ID# = 0!
1600 GOTO 1660
1610 SIGN = (-1)^((X1 AND 128)/128)
1620 EXP1 = ((X1 AND 127)*16 + (X2 AND 240)/16)-1023
1630 EXPO#= 2^EXP1
1640 FRAC#= (((((((X8/256)+X7)/256+X6)/256+X5)/256+X4)/256+X3)/256+((X2 AND 15)
OR 16))/16
1650 ID# = SIGN * EXPO#* FRAC#
1660 RETURN
1670 '***********************************************************
1680 '  32 bit integer data
1690 '
1700 INTX = ((D(P)*256+D(P+1))*256 + D(P+2))*256 + D(P+3)
1710 RETURN
1720 '
```

(cont'd)

```
1730 '*********************************************************
1740 '  view scale
1750 WINDOW (XMIN,YMIN)-(XMAX,YMAX)
1760 VIEW (50,40)-(600,160),,1
1770 LINE (XMIN,YMIN)-(XMAX,YMIN)
1780 LINE (XMAX,YMIN)-(XMAX,YMAX)
1790 LINE (XMAX,YMAX)-(XMIN,YMAX)
1800 LINE (XMIN,YMAX)-(XMIN,YMIN)
1810 FOR X = XMIN TO XMAX STEP (XMAX-XMIN)/10
1820  LINE (X,YMIN)-(X,YMAX)
1830 NEXT X
1840 FOR Y = YMIN TO YMAX STEP (YMAX-YMIN)/10
1850  LINE (XMIN,Y)-(XMAX,Y)
1860 NEXT Y
1870 '
1880 '----- scale ----
1890 LOCATE 6,2
1900 PRINT YMAX
1910 LOCATE 20,2
1920 PRINT YMIN
1930 LOCATE 5,2
1940 PRINT XMIN
1950 LOCATE 5,60
1960 PRINT XMAX
1970 LOCATE 1,1
1980 RETURN
1990 '*********************************************************
```

(cont'd)



```
1990 '************************************************************
2000 '    data read from floppy
2010 OPEN "RB",#1,FL$
2020 FIELD #1,64 AS X$,64 AS Y$
2030 '
2040 GET #1
2050 GET #1
2060 FOR N = 1 TO 64
2070   D(N+128)=ASC(MID$(X$,N,1))           ' transfer bin-->Value
2080 NEXT N
2090 FOR N = 1 TO 64
2100   M = N + 64
2110   D(M+128)=ASC(MID$(Y$,N,1))           ' transfer Bin-->Value
2120 NEXT N
2130 '
2140 '    check data size
2150 P = 177
2160 GOSUB 1680
2170 MAXBUF = INTX * 2
2180 '
2190 FOR L = 3 TO MAXBUF
2200   GET #1
2210   FOR N = 1 TO 64
2220     M = 128*(L-1)+N
2230     D(M)=ASC(MID$(X$,N,1))             ' transfer Bin-->Value
2240   NEXT N
2250   FOR N = 1 TO 64
2260     M = 128*(L-1)+N+64
2270     D(M)=ASC(MID$(Y$,N,1))             ' transfer Bin-->Value
2280   NEXT N
2290 NEXT L
2300 GOTO 2400
2310 FOR I = 1 TO 2048 STEP 24
2320 ' IF (I > 1) AND  (((I-1) MOD  512)=0 ) THEN INPUT DMY
2330   ANS$ = ""
2340   FOR J = 0 TO 23
2350     AD$ = HEX$(D(I+J)) : IF LEN(AD$) = 1 THEN AD$ = "0"+AD$
2360     ANS$ = ANS$ + AD$
2370   NEXT J
2380  PRINT HEX$(I-1),ANS$
2390 NEXT I
2400 RETURN
```

CHAPTER 16

PLOTTER AND PRINTER

This chapter explains how to make a hard copies of some data with a plotter or a printer.

CONTENTS

1. Outline

A plotter or a video printer (See Figure 16-1) can be connected to the R9211. Besides an optional built-in printer is also available.

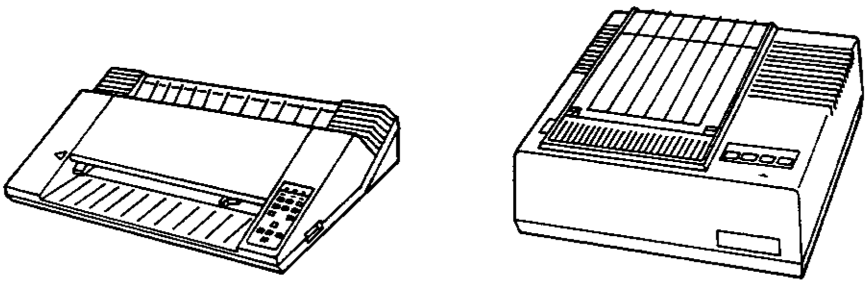


Figure 16-1 Plotter and Video Printer

(1) The plotter is used to plot, on paper, data sent through the GPIB.
The paper size depends on the plotter type. But the R9211, accepts A4 and A3 size paper for data plotting. Waveform data, labels, and scales can be output ; however, the menu settings shown on the screen cannot be output.
The advantage of using a plotter is that data such as a waveform can be output onto a A4-size paper directly. Such data can be used in a report without any change. Moreover, several curves can be written, with no information pass, on the same piece of paper, by chaning the pen (different colors are available!), thus facilitating data comparison.

(2) A video printer and the optional built-in printer output the whole data displayed on the screen.
Unlike a plotter, these devices cannot print several curves on the same piece of paper. However, since the output time is short, any intermediate data, which must be recorded, can be printed out handily.

CAUTION !
Data printed on thermosensible paper (used by the printers) may disappear depending on the temperature and storage period.
You should take a photocopy of such printed out data when you want to keep them for a long time.

2. How To Use A Plotter

■ Connectable Plotters and Connection Method

To output measured data to a plotter, you must connect the plotter to the R9211's GPIB connector. Table 16-1 lists the plotters which can be connected. Figure 16-2 shows the plotter connection diagram.

Table 16-1 Connectable Plotters

Manufacturer	Plotter
ADVANTEST	R9833
HP	7470A, 7475A, 7550A

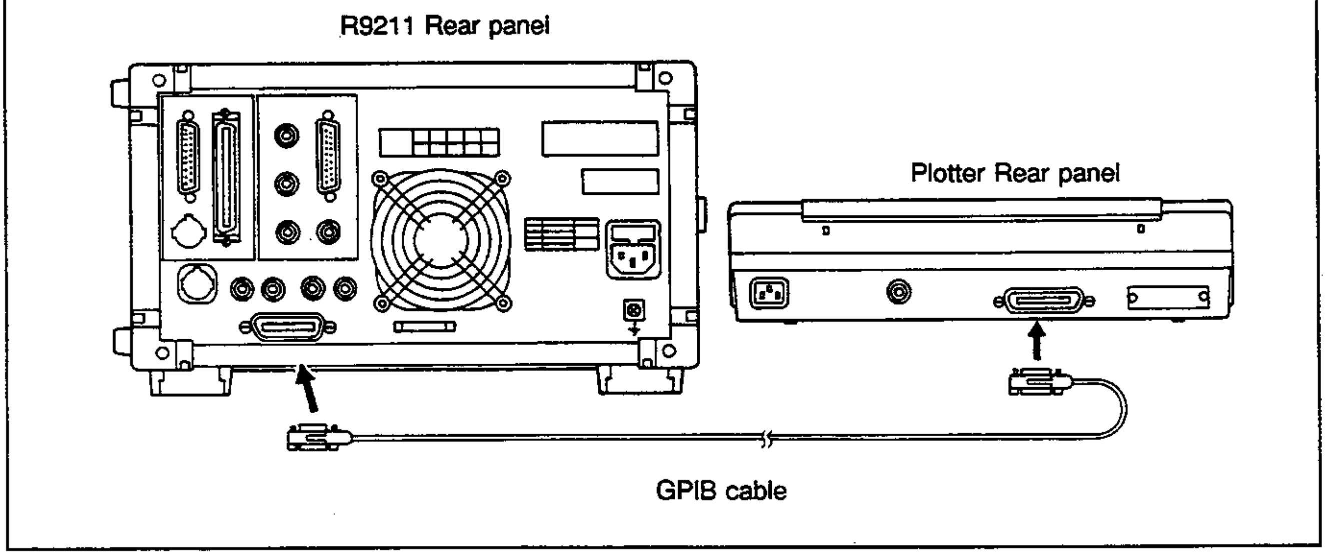


Figure 16-2 Plotter Connection Diagram

CAUTION !

- ***Before connecting a plotter to the R9211, switch them both off.***
- ***Read the Instruction Manual of the plotter carefully before using it.***

Plotter Setting

For the plotter address, set the dip switches to the listen only mode. Some types of plotters require settings other than the address setting. For further details, refer to the Instruction Manual of the plotter.

- **Example of settings when using horizontally A4-size paper, on the R9833 (ADVANTEST)**

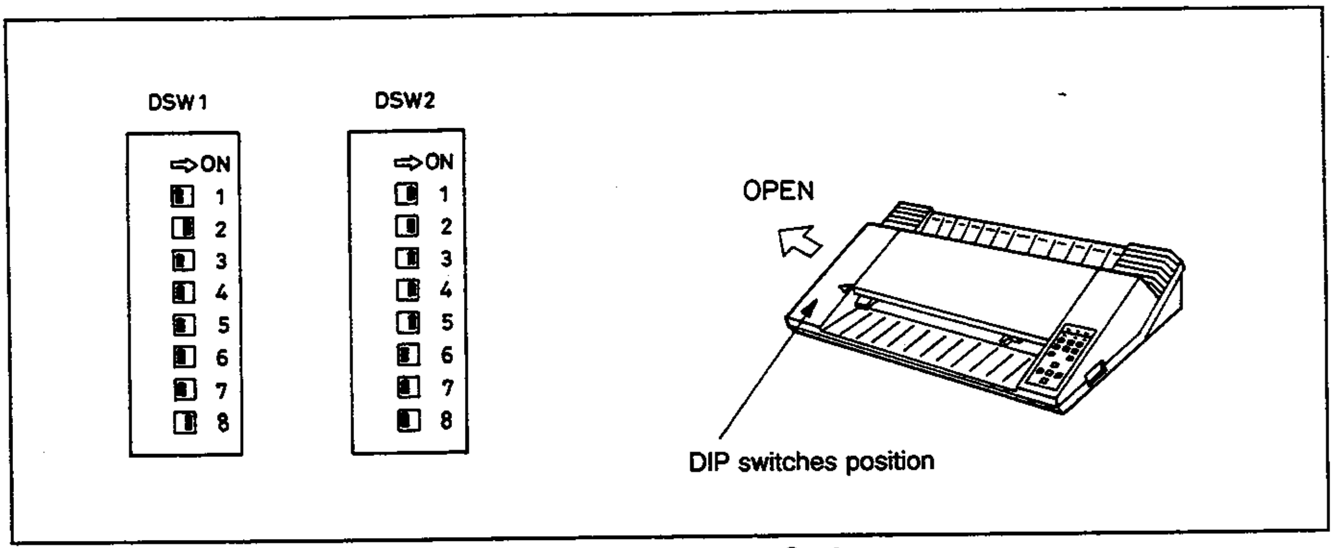


Figure 16-3 DIP Switches Settings

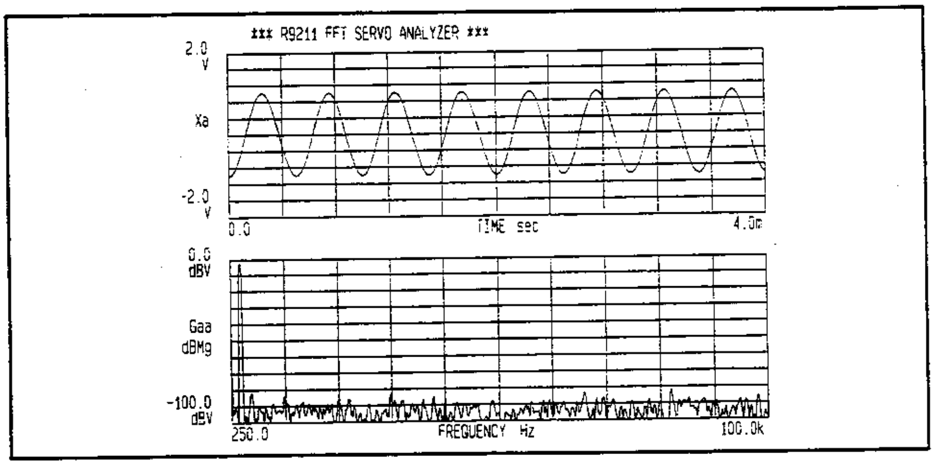


Figure 16-4 Plotter Output Example

Operation Procedure

In the operation procedure below, two screens are plotted on different areas of one A4-size piece of paper with a plotter (R9833).

Connect the plotter to the R9211 via a GPIB cable and set the plotter address to listen only mode. The steps marked with * are set during initialization but execute them at least once to remember these items.

1 Set the GPIB.

DEVICE ⇒ GPIB ⇒ TALK ONLY ON/OFF	To output data to the plotter through the GPIB, set the GPIB mode of the R9211 to "talk only".

2 Specify the information to be output.

⇒ PLOTTER ⇒ PLOT WHAT (ALL)	* Select the information (waveform, scales, label) to be output to the plotter.
⇒ ALL	* Output all possible information: waveform, scales, and label.
⇒ RETURN	*

3 Select a pen mode.

⇒ PEN MODE (AUTO)	* Determine whether the pen color is to be changed according to the information type.
⇒ AUTO PEN SELECT	* Switch pens automatically to plot data in different colors.
⇒ RETURN	*

4 Select the paper size.

⇒ PAPER SIZ (OFF)	Set the size of the paper to be used. (OFF: A4-size)
⇒ A4	Set the paper size to A4.
⇒ RETURN	

5 Specify the plotter command format.

⇒ PLOT TYPE AT/HP	Specify the command format of the plotter to be used. You can select either AT (ADVANTEST) or HP (Hewlett Packard). If the DIP switches of the R9833 are set as shown in Figure 16-3, select HP.

6 Specify a division pattern (lower).

⇒ MACRO PLT (OFF)	Determine whether the data are to be plotted on different areas on the paper.
⇒ Mnm	Specify paper partitioning.
⇒ nm ? 21	* Specify the position of the partition.
⇒ 21 ⇒ ENT	* Specify the lower area of a twice partitioned, A4, vertical paper.

7 Display, on the CRT, the data to be plotted.

Actually plot these data (in the lower paper area).

COPY	Plot.

Specify the next paper area (upper area).

DEVICE ⇒ PLOTTER ⇒ MACRO PLT 21	Change the position of the area.
⇒ nm ? 21	Specify the divided area position.
⇒ 22 ⇒ ENT	Specify the upper area of a twice partitioned, A4, vertical paper.

8 Display, on the CRT, the data to be plotted.

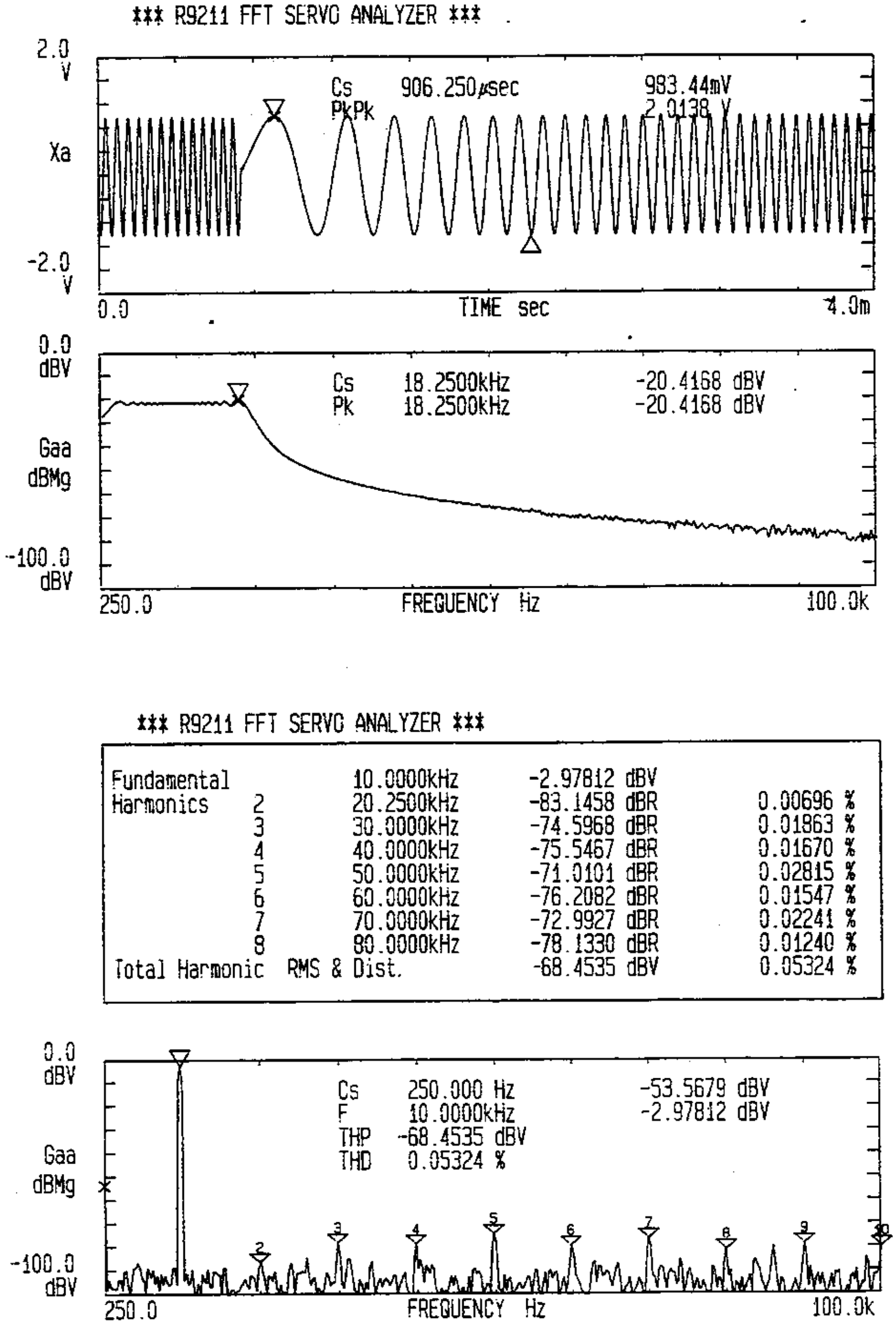
Actually plot these data (in the upper paper area).

COPY	Plot.

Thus, data are plotted on the upper and lower areas of a A4 vertical piece of paper. (See Figure 16-5.)

CAUTION !

If you press the COPY key while data are being plotted, plotting is aborted. However, the data which have already been sent, are nevertheless plotted.



```
Fundamental              10.0000kHz      -2.97812 dBV
Harmonics     2          20.2500kHz      -83.1458 dBR          0.00696 %
              3          30.0000kHz      -74.5968 dBR          0.01863 %
              4          40.0000kHz      -75.5467 dBR          0.01670 %
              5          50.0000kHz      -71.0101 dBR          0.02815 %
              6          60.0000kHz      -76.2082 dBR          0.01547 %
              7          70.0000kHz      -72.9927 dBR          0.02241 %
              8          80.0000kHz      -78.1330 dBR          0.01240 %
 Total Harmonic  RMS & Dist.             -68.4535 dBV          0.05324 %
```

Figure 16-5 **Plotting Example: 2 Double Screen Figures Are Plotted an a A4 Vertical Piece of Paper Partitionned in 2 Areas**

Scale Plot Operation Procedure

This operational explanation shows the procedure to plot in the point specified by one A4-size piece of paper with a plotter.

Conned the plotter to the R9211 via a GPIB cable and set the plotter address to listen only mode. The step marked with * are set during initialization but execute them at least once to remember these items.

1 Set the GPIB.

DEVICE ⇒ GPIB ⇒ TALK ONLY ON/OFF	To output data to the plotter through the GPIB, set the GPIB mode of the R9211 to "talk only".

2 Set output information.

⇒ PLOTTER ⇒ PLOT WHAT (ALL)	* Select the data information (waveform, scale, label) to be output to the plotter.
⇒ ALL	* Output all possible information: waveform, scale, and label.
⇒ RETURN	*

3 Select a pen mode.

⇒ PEN MODE (AUTO)	* Determine whether the pen color is to be changed according to the information type.
⇒ AUTO PEN SELECT	* Switch pens automatically to plot data in different colors.
⇒ RETURN	*

↓

4 Select the paper size.

⇒ PAPER SIZ (OFF)	Set the size of the paper to be used. (OFF : A4-size)
⇒ USER SIZE	Set the paper size to USER SIZE.
⇒ RETURN	When setting USER SIZE, Plot the specified area in SCALE PLOT menu.

5 Specify the plotter command format.

⇒ PLOT TYPE AT/HP	Specify the command format of the plotter to be used. You can select either AT (ADVANTEST) or HP (Hewlett Packed). If the DIP switches of the R9833 are set as shown in Figure 16-3, select HP.

6 Set the drawing area.

⇒ SCALE PLT	Set the drawing area.
⇒ Xmin 0mm	Set each value with the ENT key.
⇒ Ymin 0mm	
⇒ Xmax 225mm	
⇒ Ymax 162mm	
⇒ SCALE 100%	Set the rate of reduction.

7 Confirm the plot area.

When select the TEST SCALE to plot on the PLOT WHAT menu, the area to be plotted is confirmed.

The plotted line displays the sheet size in the range of the standard for the scale plot.
The solid line displays the area to be drawn by the scale plot.

⇒ PLOT WHAT (ALL) Select the object to be drawn.

8 Display, on the CRT, the data to be drawn.

Execute the plot (in the upper paper area).

COPY	Execute the drawing.

Thus, data are plotted on the upper and lower areas of a A4 vertical piece of paper.
(See Figure 16-5)

CAUTION !

If you press the COPY key while data are being plotted, plotting is aborted.

However, plot the data which have already been sent.

Plot Area for Scale Plot

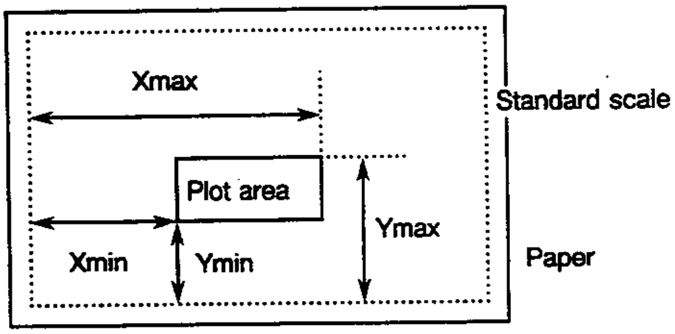
DEVICE ⇒ **PLOTTER** ⇒ SCALE PLOT ⇒ Xmin 0mm

⇒ Ymin 0mm

⇒ Xmax 342mm

⇒ Ymax 225mm

Enter the area to be plotted with the numeric key and the "ENT" key. This value specifies the place for the starting point of the standard box in the area to be plotted.



Graph and list are plotted in the scale which inidicates the plot area. Refer to "TEST SCALE" for the plot of the standard scale which indicates the standard scale and the plot area.
The plot area to be set is as follows:

	Plot area to the X axis Xmin, Xmax	Plot area to the Y axis Ymin, Ymax
A4 (width)	0 to 250mm	0 to 180mm
A3 (width)	0 to 380mm	0 to 250mm
A4 (vertical)	0 to 175mm	0 to 246mm
A3 (vertical)	0 to 266mm	0 to 385mm

However, the difference between Xmax and Xmin, Ymax and Ymin needs 10mm or more than.
When plot, the offset of 1mm for A4 paper, and 3mm for A3 paper occurs in some cases.

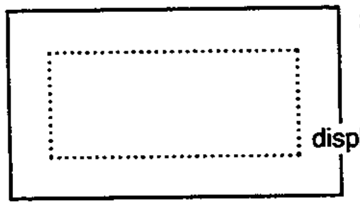
When Xmax≤250mm and Ymax≤180mm in the width (ROT 90 OFF), plot the standard scale according to A4 paper.
When either of the above is larger than each value, plot the standard scale automatically according to A3 paper.

Similarly when Xmax≤175mm and Ymax≤266mm in the vertical (ROT 90 ON), plot the standard scale according to A4 paper.
When either is larger than each value, plot the standard scale automatically according to A3 paper.

■ Set the Rate of Reduction for Scale Plot

DEVICE ⇒ PLOTTER ⇒ SCALE PLOT ⇒ SCALE 100%

Enter the rate of reduction in the actual plot for the area specified by the 「Specification of Plot Area」
Enter the value with the numeric key and the ENT key.
The setting range goes to 100 from 10%.
The reduction is the standard for the center of the scale which indicates the plot area. The X and Y axis is performed at the same rate for the reduction.



At this time, the scale size to be plotted in "TEST SCALE" is not changed.
The following page shows the scale and the graph in the 100% plotting and the 50% plotting.

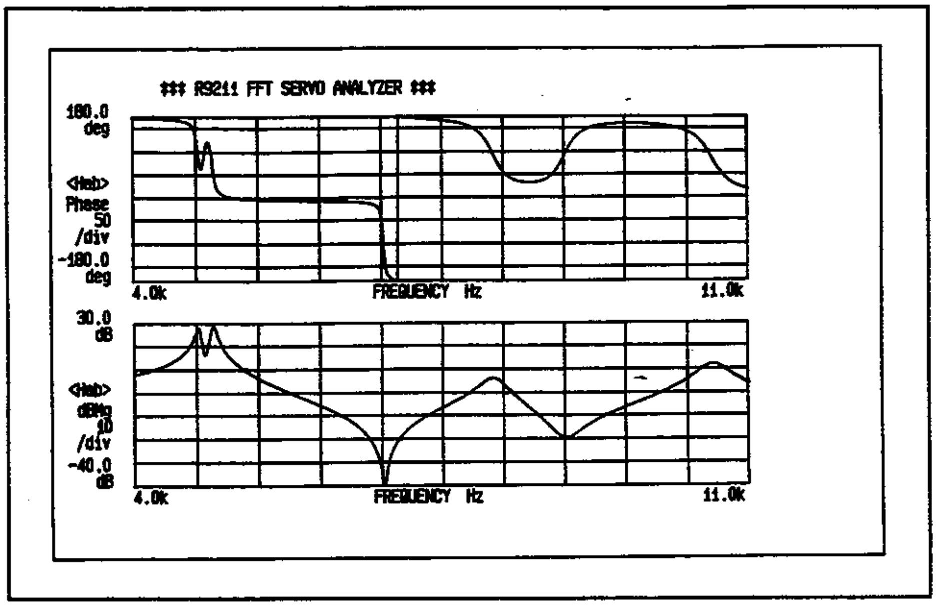


Figure 16-6 Scale and Gragh in 100% Plotting

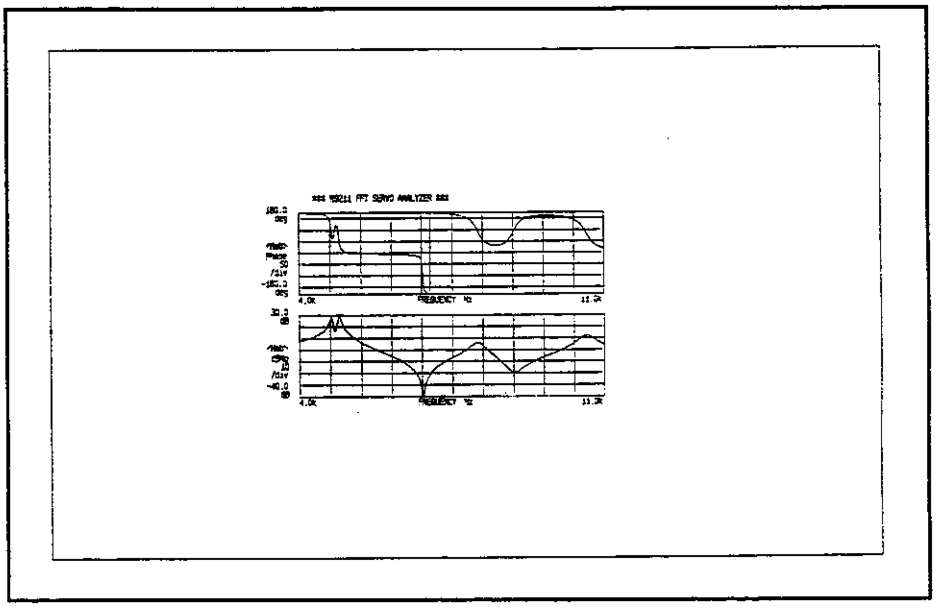


Figure 16-7 Scale and Gragh in 50% Plotting

Precautions

- **Specifying pen colors**

With the R9211, you can specify a different pen color for each information to be plotted by using the PEN SELECT key.

Pen type (related to the information it draws)	Color default value
GRID PEN	1
ANNOT PEN	2
TRACE PEN	3
READOUT	4

In the R9833, pen 1 is used if there is no pen at the specified position. The plotter must move to exchange pens, thus, in such cases, it must repeat unnecessary operations.
Attach a pen or change the R9211 default pen specification made.

- **How to change the pen color. (Example: TRACE PEN from 3 to 1.)**

DEVICE ⇒ PLOTTER ⇒ PEN SELECT — Used to specify the color of the pens for drawing the grid, the scale values, and the waveform.

⇒ TRACE PEN 3 — Specifies the color of the trace pen which is used for drawing the waveforms. (the current value is 3.)

⇒ 1 ⇒ ENT — Sets the TRACE PEN to 1.

- **How to specify TRAC LINE**

Using the TRAC LINE key in the PEN SELECT menu, you can specify a solid, dashed, or dotted line to plot waveform data.

○ **Modification example: How to change TRAC LINE from solid to dashed**

DEVICE ⇒ PLOTTER ⇒ PEN SELECT	Used to specify the color of the pens for drawing the grid, the scale values, waveform respectively.
⇒ TRAC LINE (SOLID)	Specifies the type of the which is used line to plot waveform data. (default: solid line is the default.)
⇒ DASHED LINE	Specifies a dashed line.

○ **Plotter Output Example**

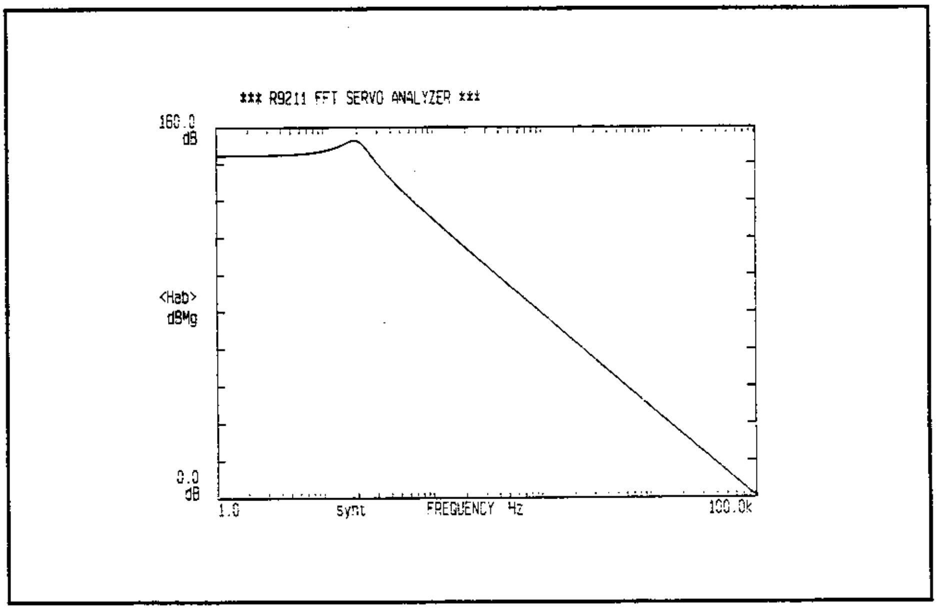


Figure 16-8 Example: TRAC LINE = SOLID LINE

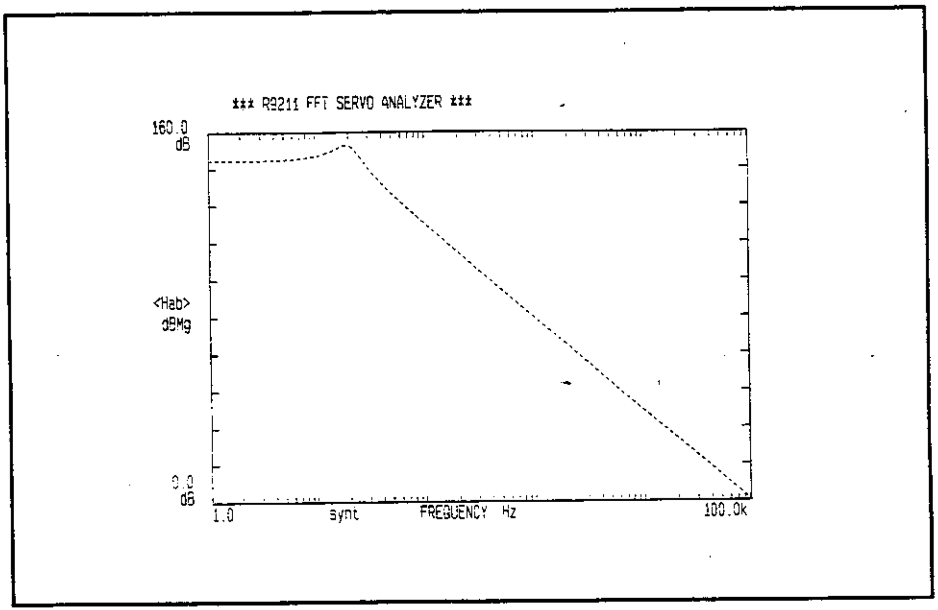


Figure 16-9 Example: TRAC LINE = DASHED LINE

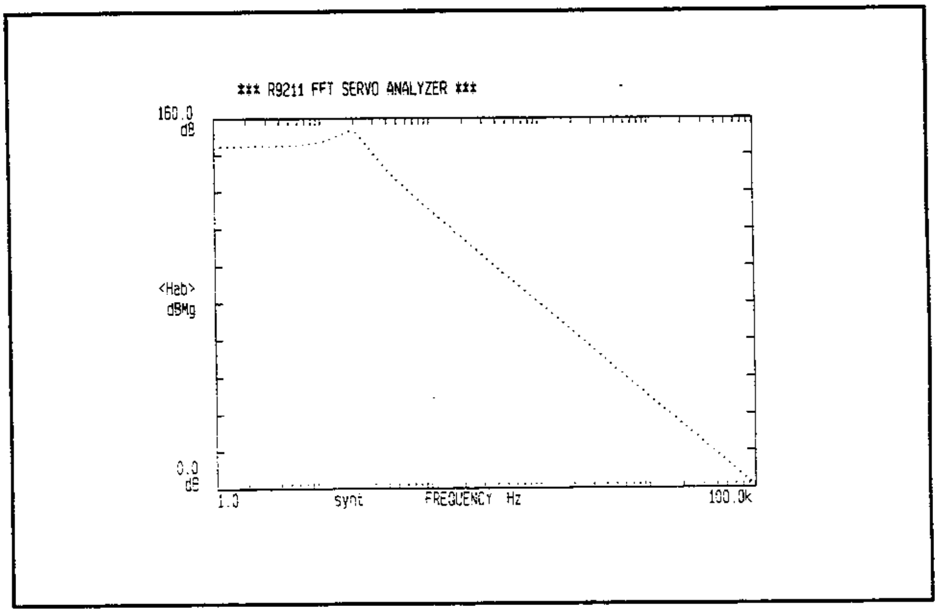


Figure 16-10 Example: TRAC LINE = DOTS LINE

- **How to specify the position of a plotting area when th paper sheet is partioned (MACRO PLT)**

There are four division patterns and each divided area is assigned a number. Choose the appropriate combination for Mnm to specify a plotting position.

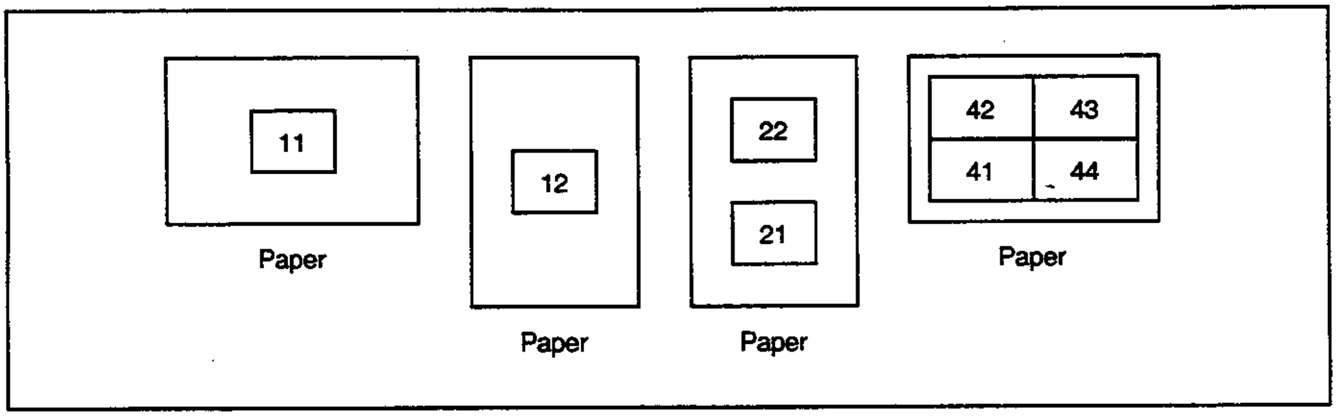


Figure 16-11 MACRO PLT Partition's Area Positions

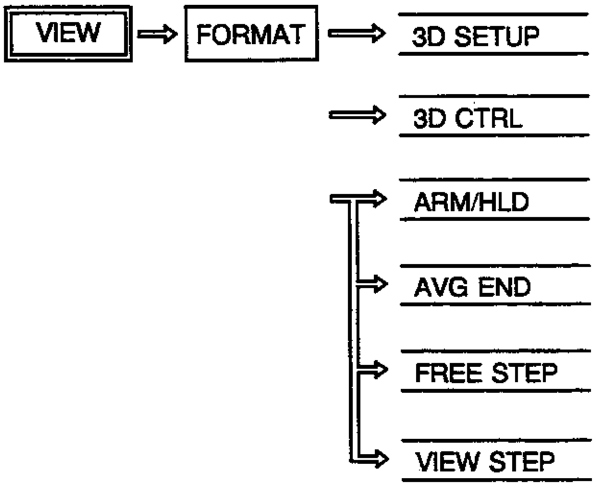
- **How to plot 3-dimensional graphs**

It is impossible to store whole 3-dimensional data in the memory. Therefore, 1-line data is output to the plotter each time 1-line data is displayed on the screen. The plotting procedure is slightly different from those in other screen modes.

○ **Procedure**

(1) Set carefully the appropriate parameters in the GPIB and PLOTTER menus.

(2) Set the timing for 3-dimensional data plotting.



(3) Press the following keys:

VIEW ⇒ FORMAT ⇒ 3D DISPLAY

(4) Press the COPY key.

(5) When FREE STEP is selected, pressing the COPY key will start plotting.

(6) When ARM/HLD is selected, the following menu will be displayed:

SETUP ⇒ ARM/HLD ⇒ AUTO ARM
⇒ ARM

Select AUTO ARM or ARM .

When AUTO ARM is selected, data are plotted at each trigger event.

When ARM is selected, data are plotted each time ARM is pressed.

(7) When you selected AVG END , press the START key.
After completion of averaging, data plotting starts.

(8) When VIEW STEP is selected (only in the T-F mode), the following menu will be displayed:

VIEW ⇒ INST VW ⇒ DATA VIEW ON/OFF

⇒ VIEW STEP

⇒ AUTO RIGHT

⇒ AUTO LEFT

⇒ MANUAL STEP

Select AUTO RIGHT, AUTO LEFT, or MANUAL STEP.
When AUTO RIGHT or AUTO LEFT is selected, plotting starts.
When MANUAL STEP is selected, data is plotted each time the MANUAL STEP key is pressed.

For further details, see "● Three-dimensional Display in T-F Mode" in Chapter 7.

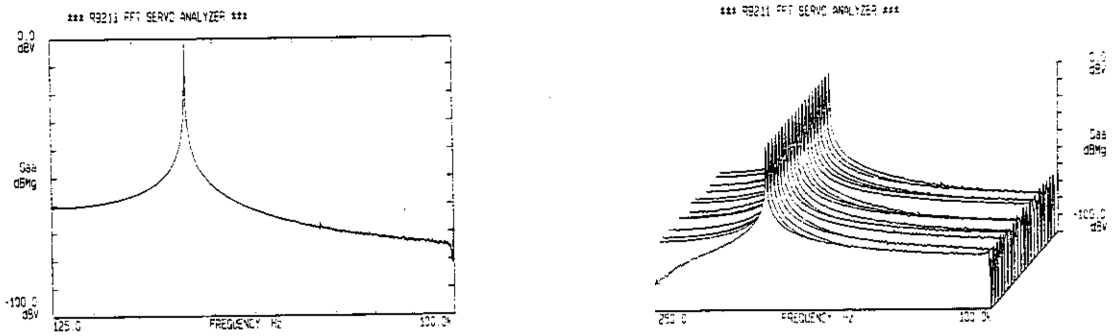
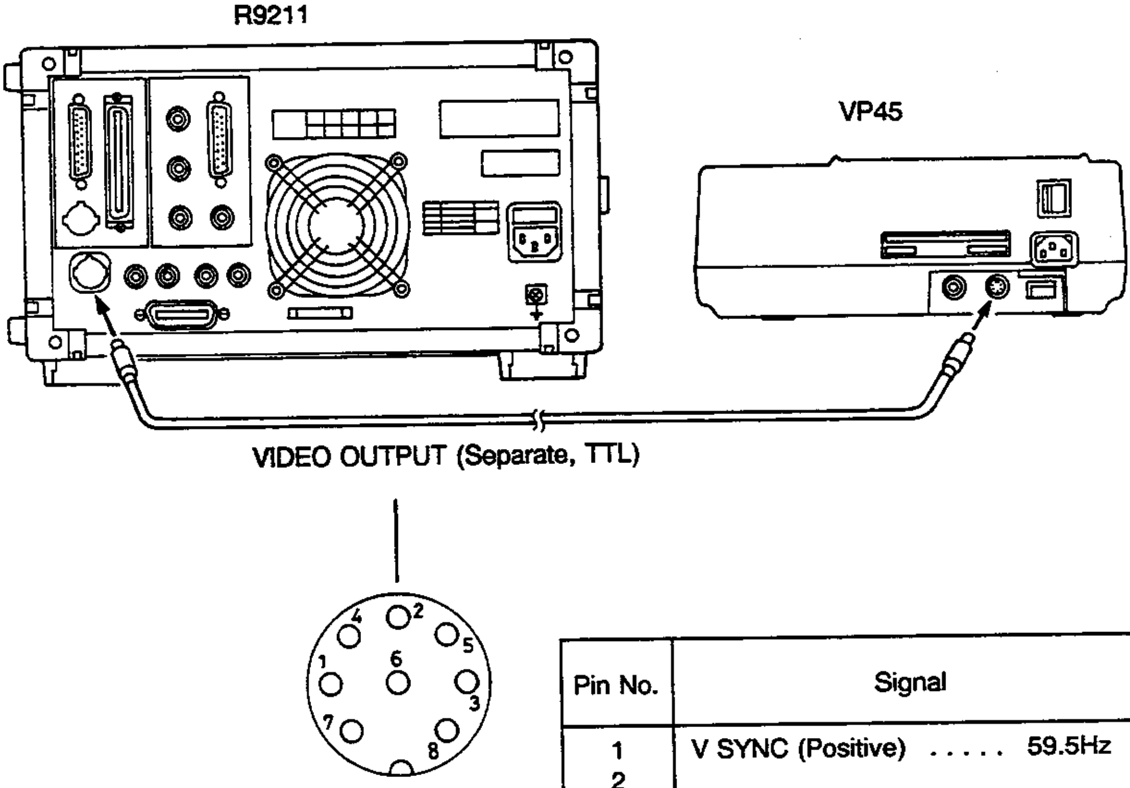


Figure 16-12 3D DISPLAY Plotter Output Example

3. How To Use A Video Printer

■ Video Printer Connection Method

You can output the displayed waveform to a video printer using the VIDEO OUTPUT connector at the rear panel of the R9211. An external CRT monitor permitting separate signal input can also be connected.
Use a dedicated cable (A01236) when connecting a video printer. Separate signals are output. Figure 16-11 shows the DIN connector pin numbers (1-8) associated signals.
The recommended video printer is the VP-45 (SEIKO).



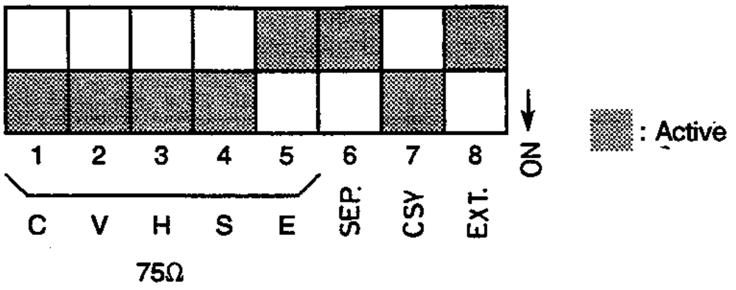
Pin No.	Signal
1	V SYNC (Positive) 59.5Hz
2	
3	EXT CLOCK (IGM) 16MHz
4	SEPARATE VIDEO (Positive)
5	
6	GND
7	HSYNC (Positive) 15.6kHz
8	

Figure 16-13 Video Printer Connection Diagram

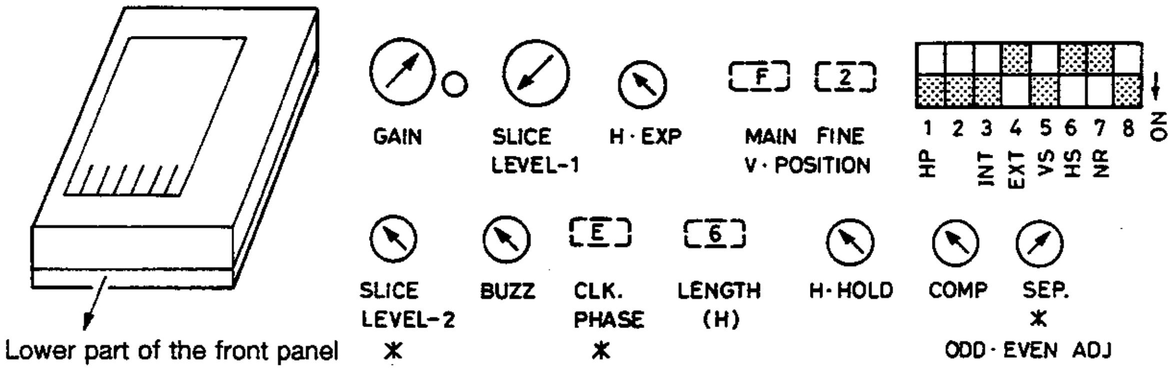
Video Printer Setting

When you use the recommended VP-45 (SEIKO), set its switches and controls volumes as follows:

- **Setting rear panel DIP switches**



- **Set switches and controls in the lower part of the front panel**



* These switches and controls must be correctly set for each product.

Precautions

- When you use a VP-45, adjust the SLICE LEVEL-2, CLK PHASE, and SEP controls finely for each product.
- When a video printer is used, set the CRT screen in the hold state; otherwise, updated screen data will be output.
- An external CRT monitor connected to the VIDEO OUTPUT connector must permit separate signal input.

4. How To Use The Built-In Printer

This printer is designed to print all information displayed on the CRT on the thermosensible paper. It is also designed to feed the print paper. Use the switches on the top of the printer to start printing or to feed the print paper.

Operation speed : Data transfer time from the R9211 to the printer .... Max. 3 seconds
Print time .... Max. 10 seconds
Print paper : A09075 (Order No.)
5 rolls/box (Order unit : 1box.)
Thermosensible paper length : ... 30 m
Paper width : .... 114 mm

CAUTION !
Use only the specified paper.

[How to load the Print Paper]

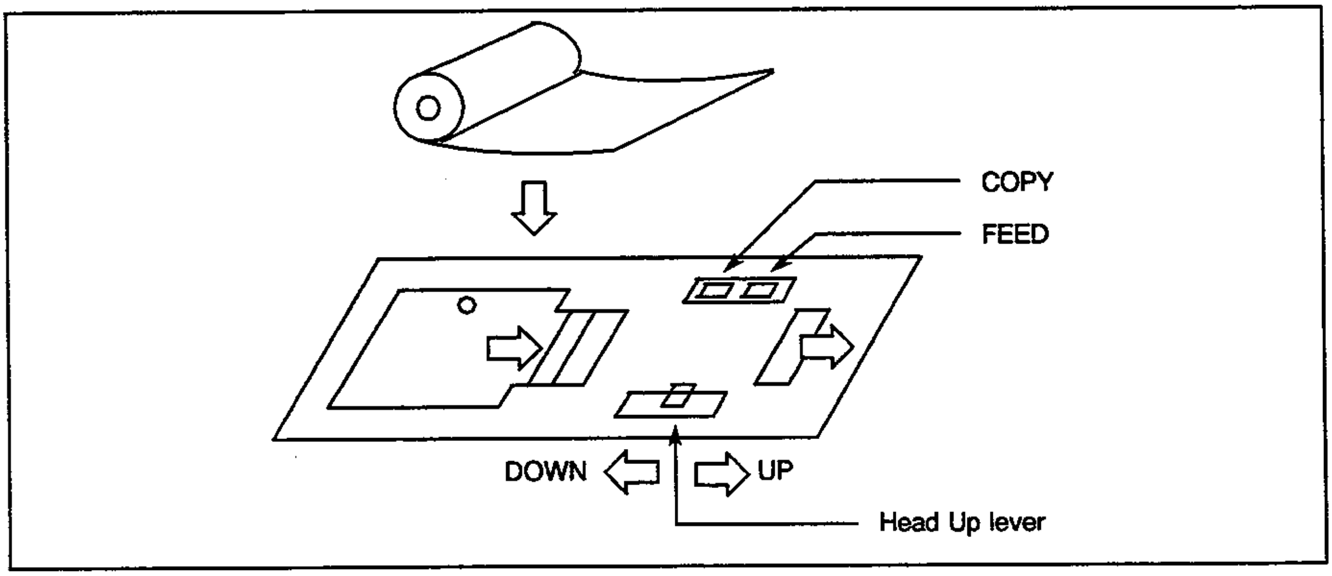


Figure 16-14 Built-in Printer

(1) Put the HEAD UP lever in the UP position.
(2) Load the roll paper in the holder with the outside of the paper roll down.
(3) Set the paper over the printer mechanism toward the front side.
(4) Put the HEAD UP lever in the DOWN (hold) position.
(5) Feed the paper to check whether it was correctly installed.

CAUTION !
The R9211 stops while it is sending data to the thermal printer (for about 3 seconds). The R9211 functions while the printer is printing.

APPENDIX

In this appendix, you will find the analyzer's specifications, a description of the accessories, a glossary, a quick operation guide, and a list of the error messages.

CONTENTS

1. SPECIFICATIONS AND ACCESSORIES DESCRIPTION

■ Specifications

☐ Input and Analysis Characteristics

Number of input channels : 2

Input method : Differential input, single ended input

Input impedance : About 1MΩ/100pF (single ended)

Input coupling : AC, DC, GND

A/D converter resolution : 16 bits

Frequency range : 10mHz to 100kHz, 22 ranges (1, 2, 5-step)

Frequency accuracy : ±50ppm of the frequency range ±measurement resolution (at 23°C±5°C)

Input filter : An antialiasing filter (roll-off characteristic of −148dB/octave) is automatically set for each frequency range. In the ranges lower than 1kHz, an analog filter is combined with a digital filter.

Common-mode signal rejection ratio (CMRR)
: more than 50dB (DC coupling, 50Hz/60Hz)

Maximum differential input voltage
: ±200V

Maximum common-mode input voltage
: ±200V

Input range : +30dBV to −60dBV (variable in 1dB steps)
in Volt ; 44.7V to 1.41mV,
in Vrms ; 31.6V to 1mV

Maximum common-phase signal voltage
: ±14V (−60dBV range to −6dBV range),
±140V (−5dBV range to +14dBV range),
±200V (+15dBV range to +30dBV range)

Maximum input sensitivity : −125dBV (Approx. 0.56μ Vrms) (−140dBV for a 2kHz range)

Dynamic range : Dynamic range is measured with reference to the full scale in the spectrum mode. It is measured under the conditions: frequency range of 0-90%, input of a sine wave with an amplitude of −3dB, averaging number of 32, rectangular weighting, filter on, and 400 spectrum lines.
1/f noise and excluded. (23°C±5°C)
85dB (+30dBV to −40dBV) (Central value : 90dB)
75dB (−41dBV to −50dBV)
60dB (−51dBV to −60dBV)

Residual noise : The residual noise is measured with reference to the full scale in the spectrum mode. It is measured under the conditions: averaging number of 32, rectangular weighting, filter on, and 400 spectrum lines.
1/f noise is excluded. The frequency range is 0 to 90%.(23°C±5°C)
−85dB (+30dBV to −40dBV)
−75dB (−41dBV to −45dBV)
−60dB (−46dBV to −60dBV)

Amplitude linearity : ±0.2dB (within −40dB of full scale, 23°C±5°C)

Frequency flatness : ±0.3dB (23°C±5°C, within 0 to 90% of the frequency range), Approx. 0.2Hz, −3dB point when AC coupling

Amplitude accuracy : Amplitude linearity + Frequency levelness (23°C±5°C)

Amplitude (phase) difference between channels
: ±0.1dB/±1.0deg (at 23°C±5°C)
In the same sensitivity range and within 0 to 90% of the frequency range

Power supply to accelerometer
: Input coupling ; AC only
Source current of 4mA ; Ach/Bch, +side
Maximum operating voltage ; +18V
Open circuit voltage ; +24V or less

Test signal (in the frequency range from 100kHz to 2kHz)
: Amplitude level; Approx. −4dBV
Frequency; 8% of frequency range (sine wave)

Overload display : Indication by LED

☐ Trigger

Trigger mode : Free run, manual trigger, external trigger, input trigger, input signal trigger, and auto repetition trigger modes

Trigger level : Input signal trigger ; Resolution of 1/256 of the amplitude range (set with the numeric keypad)
External signal trigger level ; TTL

Trigger slope : +, −, ± (input signal trigger)

Trigger position : −128K to +1M samples in 1-channel operation mode
−64K to +1M samples in 2-channel operation mode

☐ Averaging

Averaging modes in the frequency domain
: Summation (SUM), subtraction (SUB), exponential function move (EXP), peak detection (PEAK)

Averaging mode in the time domain
: Summation (SUM)

Averaging number : From 1 to 32767 times

Overlapping : 0%, 50%, 75%, and MAX

Start stop control : Start, stop, +1, continue (Excepted under servo mode where deletion is automatically executed at when starting)

☐ Servo Analysis Mode

Measurement function : Frequency response function, group delay, coherence function, power spectrum, cross spectrum, time waveform

Sweep mode : Linear sweep, logarithmic sweep

Frequency table servo function
: Output waveform, output voltage, DC offset, measurement frequency range, and averaging may be combined with analysis. (Up to 20 combinations)
Linear f-table
Logarithmic f-table

Signal source for servo analysis
: Linear/logarithmic sine sweep signal, linear multi-sine sweep signal, logarithmic multi-sine signal
Output impedance ; 1Ω or less
Maximum output voltage ; ±15V (output impedance of 1Ω or less)
Maximum output current ; 100mA (output impedance of 1Ω or less)
DC offset ; ±10V (0.1V resolution)
Summing amplifier for loop characteristic measurement
; ON/OFF toggle.

Frequency resolution :
Linear ; 25 to 800 lines
Logarithmic ; 1 to 6 decades (25 lines/decade to 200 lines/decade) (In fact, when the frequency resolutión is 200 lines/decade, only up to 5 decades may be set.)

Marker analysis function : Peak, next peak, band, harmonics, sideband, overall power, partial power, average power, variance, +peak, −peak, XdB, shape factor, ripple, open loop Bode diagram, and closed loop gain markers

Operation function : Addition/subtraction/multiplication/division, unlapped phase, $j\omega$, $1/j\omega$, inverse, impulse response, equalization, phase compensation, COP (coherent output power), open/closed loop conversion

Display function : Frequency-amplitude, frequency-phase, frequency-real part, frequency-imaginary part, frequency-group delay, frequency-coherence function, Nyquist diagram, cole-cole diagram, Nichols diagram

Conversion function : Engineering unit

☐ Frequency Response Function Measurement Mode

Measurement function : Frequency response function, group delay, coherence function, time waveform, power spectrum, phase spectrum, impulse response function

Averaging : Frequency domain averaging

Number of data for analysis : 64 to 2048 points

Frequency resolution :
Linear ; 25 to 800 lines

Window function : Rectangular, hanning, minimum, flat-pass, and force/response

Waiting : A-/B-C-waiting, C-message waiting

Marker analysis function : Peak, next peak, band, harmonics, sideband, overall power, partial power, average power, variance, +peak, −peak, XdB, shape factor, and ripple markers

Operation function : Addition/subtraction/multiplication/division, unlapped phase, $j\omega$, $1/j\omega$, inverse, impulse response, equalization, phase compensation, COP (coherent output power)

Display function : Frequency-amplitude, frequency-phase, frequency-real part, frequency-imaginary part, frequency-group delay, frequency-coherence function, Nyquist diagram, cole-cole diagram, Nichols diagram

Conversion function : Engineering unit

☐ Curve Fitting Function (R9211C only)

Up to 20 poles/zeros can be obtained from the frequency response function data.

Weighting : Auto, uniform, or user weighting

Conversion function : The poles/zeros representation can be converted into the residues or polynomial representation.

☐ Synthesis Function (R9211C only)

A frequency response function, impulse response, and step response can be generated from the poles/zeros that were obtained or input with the numeric keypad.

☐ Spectrum Measurement Mode

Measurement function : Complex spectrum, power spectrum, cross spectrum, time waveform

Averaging : Frequency domain averaging

Analysis data count : 64 to 8192 points (1 channel), 64 to 4096 points (2 channels)

Frequency resolution :

Linear ; 20 to 3200 lines (1 channel)
25 to 1600 lines (2 channels)
Logarithmic ; Max. 3 decades, 80 lines/decade
Others ; 1/3 octave, 1/1 octave

Window function : Rectangular, hanning, minimum, flat pass, force/response
* The window function is set to the minimum or rectangular function in the logarithmic frequency or octave analysis mode.

Waiting : A, B, C-waiting, C-message waiting

Marker analysis function : Peak, next peak, band, harmonics, sideband, overall power, partial power, average power, and variance markers

Operation function : Addition/subtraction/multiplication/division, pre-envelope, liftered spectrum, power cepstrum, $j\omega$, $1/j\omega$, smoothing

Display function : Frequency-amplitude, frequency-phase, frequency-real part, frequency-imaginary part, Nyquist diagram

Conversion function : Engineering unit

☐ Time-Frequency Analysis Mode

Basic measurement function : Time waveform, complex spectrum, power spectrum, cross spectrum

Time-frequency analysis function : Amplitude, phase, or frequency monitor

Averaging : Frequency domain averaging

Frequency resolution :

Linear ; 25 to 800 lines
Logarithmic ; Max. 3 decades, 80 lines/decade
Others ; 1/3 octave, 1/1 octave

Window function : Rectangular, hanning, minimum, flat pass, force/response
* The window function is set to the minimum or rectangular function in the logarithmic frequency or octave analysis mode.

Waiting : A, B, C-waiting, C-message waiting

Marker analysis function : Peak, next peak, band, harmonics, sideband, overall power, damping power, partial power, average power, and variance markers

Operation function : Addition/subtraction/multiplication/division, pre-envelope, liftered spectrum, power cepstrum, $j\omega$, $1/j\omega$, smoothing, level monitor cumulation

Display function : Frequency-real part, frequency-imaginary part, frequency-amplitude, frequency-phase, Nyquist diagram, time-amplitude, time-phase, time-frequency

Conversion function : Engineering unit

☐ Waveform Measurement Mode

Measurement function : Time domain instantaneous data, time domain average data, auto correlation function, cross correlation function, probability density function

Averaging : Time, delay, or amplitude averaging

Analysis data count : 64 to 8192 points (1 channel)
64 to 4096 points (2 channels)

Delay data count : 64 to 2048 points

Marker analysis function : Peak, rise time, fall time, pulse width, effective value
Operation function : Differentiation, integration, smoothing, trend removal, addition/subtraction /multiplication/division, pre-envelope
Display function : Time-amplitude, amplitude-probability density, orbit
Conversion function : Engineering unit

☐ Signal Generator (except servo analysis mode)

Output waveform : Sine wave (spot), swept sine, multi-sine, impulse, random, arbitrary waveform (maximum memory size: 64kilowords)
Maximum output voltage : ±15V (Output impedance = 1Ω or less)
Maximum output current : 100mA (Output impedance = 1Ω or less)
DC offset : ±10V (0.1V resolution)
Output impedance : 1Ω or less, 50Ω, 600Ω
Output mode : Continuous, internal, external, external gate, manual
Tape function : Max. 200msec
Summing amplifier for loop characteristic measurement : ON/OFF toggle

☐ Running Zoom Function (R9211C only)

When the stop frequency is 10kHz or less, the minimum span is 10mHz. When the stop frequency is higher than 10kHz, high-resolution spectrum analysis is enabled with a minimum span of 100mHz. The frequency range is set with the start and stop frequencies.

☐ Comparator Function (R9211C only)

Mode : Table or reference mode
Table mode : Up to 20 comparison ranges may be set
Reference mode : Comparison with reference waveform
Waveform to be compared : Data in the frequency domain
Comparison result :
- Display of PASS or FAIL on screen
- Buzzer
- TTL-level open collector output at the rear

☐ Display Specifications and Functions

Display unit : 8-inch raster scan CRT
Engineering unit : Marker read-out values and vertical axis scale values are indicated with physical quantities.
Scaling ; Linear/logarithmic scaling
Scaling for each channel is enabled
Unit ; Up to two of the specified characters can be set
Display mode : Single, dual, triple, and quadruple screen display modes
Overlapping : Data in the same domain and same analysis range can be overlaid
Dispay of grid : Display and deletion are enabled
Three-dimensional display : Any data can be displayed in up to 50 lines in the 3-dimensional mode
Display of bar : Overall power, partial power, average power, or the distribution of power is displayed at the right of the screen with a bar.

Label : Up to 40 characters including alphanumeric, numeric, and special characters can be displayed and moved vertically

List mode :

Single mode ; Twenty frequencies and amplitude values from a spectrum, after being set with the cursor, can be displayed.

Harmonics mode ; When a fundamental frequency is input with the numeric keypad, the amplitude values of the harmonics can be displayed. As well as the THD (total harmonics distortion) and the THP (total harmonics power) after computation.

Sideband mode ; When carrier wave and harmonics frequencies are input with the numeric keypad, the power of up to 10 upper and lower sidebands are computed and displayed.

Horizontal axis : Linear, logarithmic
Vertical axis : Set with the numeric key pad

☐ Built-in Floppy Disk Drive Functions

Type : 3.5-inch micro-floppy disk drive
Medium : 2DD or 2HD type (automatically detected)
Capacity : 720K/1.2M bytes (at formatting)
Formatting : MS-DOS format
File type : Data, view, and table files
Data file handling : Listing, creation, deletion, copy

☐ Input/Output Functions

Video signal output : Separate, TTL level
GPIB interface : Standard equipment
Plotter output : The plotter, having the HP-GL equipment, is directly connected to the analyzer with a GPIB cable
External sampling clock input : BNC type, TTL level
External trigger input : BNC type, TTL level
Sampling clock output : BNC type, TTL level
Trigger output signal : BNC type, TTL level

☐ General Specifications

Operating environment : Ambient temperature ; +5°C to +35°C
Relative humidity ; up to 80%
Storage environment : Ambient temperature ; −20°C to +60°C
In voltage change : The supply voltage is set according to your order.

Option No.	Standard	Option 32	Option 42	Option 44
Voltage	90 to 110VAC	103 to 132VAC	198 to 242VAC	207 to 250VAC

Power frequency range : 48 to 66Hz

Power consumption : (Standard)

R9211B ·	R9211C
Up to 170VA	Up to 190VA

Dimensions : Approx. 330 (W) × 177 (H) × 450 (D) mm (R9211B/C)

Weight : (Main unit)

R9211B	R9211C
Up to 16kg	Up to 16kg

☐ Options

Option 07 : Built-in printer

Hard copy of data on screen

Printing method : Thermal line/dot printing

Dot matrix : 640 dots

Print paper : A09075 (5 rolls/box)

Paper width : 114mm

Option 10 : CMOS memory

1M-word (2M-byte) battery back-up memory

Option 11 : I/O memory card (In the R9211C, it is standard equipment.)

This optional board has the following characteristics:

Extended memory : 1megawords (2MB)

Digital input : Digital signals can be received from outside.
(Maximum sampling rate: 256kHz)
Data format: 16bits + EOC signal (offset binary)

Digital output : Data is output from the built-in A/D converter.
Data format : 16bits + Channel identification signal + Strobe signal
(Offset binary)

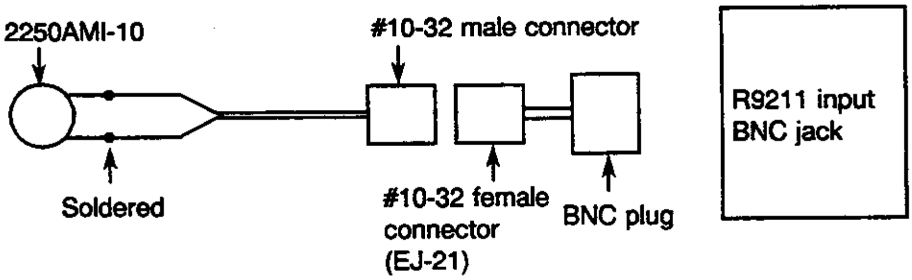
Accessories

(1) R9833 digital plotter
(2) HP-GL plotter (Hewlett Packard 7470A, 7475A 7550A, or 7225A)
(3) Accelerometer (Endebco or Dytran) ..... See Tables A-1 and A-2.

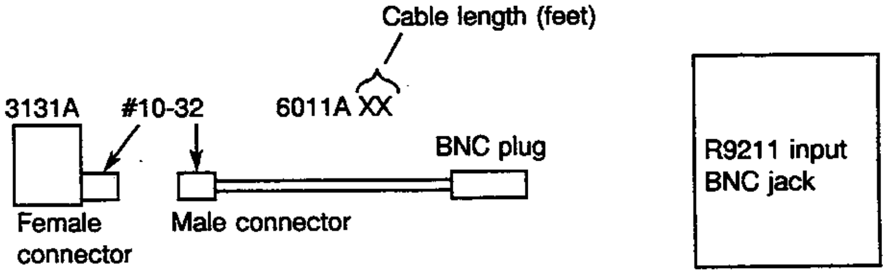
● How to connect the Accelerometer

The R9211 can output an approximately 4mA current from the + input sockets of channels A and B, to power the acceleration sensor. Thanks to this ICP function, you can avoid using a signal conditioner.
When acceleration sensor, provided with an amplifier or an impedance converter circuit is directly connected and if the ICP function is set to ON, current is supplied to the electric circuit of the sensor.
The input terminal of the R9211 is a BNC connector. When an acceleration sensor with a #10-32 type connector, is used, the following conversion is needed:
#10-32 male connector —— BNC plug (Cable: 6011A XX)
#10-32 female connector —— BNC plug (Conversion connector: EJ-21)

Example 1 : Connection of the Endebco 2250AMI-10 to the R9211E

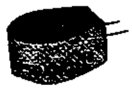
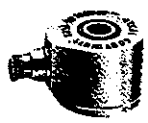


Example 2 : Connection of the Dytran 3131A Piezodyne acceleration sensor to the R9211



1. SPECIFICATIONS AND ACCESSORIES DESCRIPTION

Table A-1 Endebco Accelerometers

						
Model	2250A-10/ 2250AMI-10	7250A/ 7250AMI	7254-10, -100	7259A-1, -10	7251-10, -100	2256-10, -100
Sensitivity (mV/g)	10	2/10	10/100	1/10	10/100	10/100
Response frequency (Hz)	4 to 15,000	4 to 20,000	1 to 10,000	5 to 30,000 ± 1dB	1 to 10,000	1 to 5,000
Resonance frequency (Hz)	80,000	85,000	45,000	150,000/100,000	45,000	20,000
Anti-G (G)	2,000	10,000	5,000	10,000	5,000	2,000
Operating temperature range (°C)	−55 to +125	−55 to +125	−55 to +125	−55 to +125	−55 to +125	−55 to +125
Case	Ground	Ground	Ground	Ground	Ground	Ground
Case mounting plane	Insulated	Insulated	Ground	Ground	Insulated	Insulated
Size (mm)	5.8×3.8	9.5×5.8	15.9×16.0	9.5×12.0	15.3×10.7	11.1×10.1
Weight (g)	0.4	1.8	20	4.4	11	5
Mount	Adhesion	2-56 screw	10-32 stud	10-32 stud	6-32 screw	Adhesion
Seal	Epoxy	Welded	Welded	Epoxy	Welded	Epoxy
Accessory cable	3006-120	3091E-120	3090C-120	3091E-120	3090C-120	3060A-120

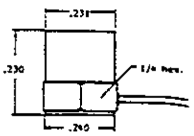
Conversion connector EJ21 (For conversion from microdot to BNC)

Table A-2 Dytran Accelerometers

Model Specifications	3115A	3121A	3110A	3131A	3132A	3134A
Weight grams	1.5	7	19	17	17	56
Sensitivity (mV/g)	15 (±10%)	50 (±5%)	100 (±5%)	100 (±2%)	100 (±2%)	500 (±5%)
Measurement range (5V output) (g)	333	100	50	50	50	10
Frequency range Hz±5%	2 to 10k	1 to 5k	1 to 5k	1 to 5k	1 to 5k	1 to 3k
Frequency range ±3dB	0.66 to 12k	0.5 to 8k	0.5 to 8k	0.5 to 8k	0.5 to 8k	0.5 to 8k
Resonance frequency (when mounted) kHz	100	30	30	25	25	20
Noise level gRMS	0.007	0.003	0.0009	0.0009	0.0009	0.00028
Strain sensitivity (250 μstrain) (g/μ)	0.03	0.01	0.004	0.008	0.015	0.012
Maximum vibration resistance (g)	±1000	±1000	±1000	±1000	±1000	±200
Maximum impact resistance g peak	1500	2500	2500	2000	2000	500
Temperature range (°C)	−51 to +121					
Temperature coefficient %/°F	0.06					
Temperature coefficient %/°C	0.108					
Discharge constant seconds	0.5			1.0		
Connector type	#10-32					
Seal	Epoxy			Welding/Epoxy		
Case material	303 S. S.					
Mounting method (at calibration)	Adhesion	#10-32, Integrated type	#10-32, Detachable	Adhesion	#10-32, Integrated type	#10-32, Detachable
Dimensions (Hex × H) inches	1/4×.230	5/16×.495	1/2×1.10	1/2×0.70	1/2×.70	5/8×1.13
(m × m)	6.4×5.8	7.9×12.6	12.7×27.9	12.7×17.8	12.7×17.8	15.9×28.7
Cable type	6016A	6014A	6010A, 6016A	6010A, 6016A	6010A, 6016A	6010A, 6016A
Ground insulation	–	–	–	–	–	–
Accessories	–	–	6200 stud	–	–	6200 stud
Options	–	3121AC adhesion type	–	–	–	–
Common specifications	Power supply : 2 to 20mA, 18 to 30VDC			Linearity : ±2% full scale		
	Bias level : 9 to 12VDC			Maximum horizontal sensitivity : 5%		
	A test report (with NBS traceability) is attached to each acceleration sensor.					

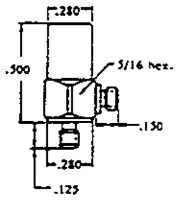
1. SPECIFICATIONS AND ACCESSORIES DESCRIPTION

3115A



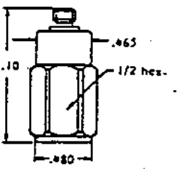
- Very small 1.5g
- Adhered

3121A



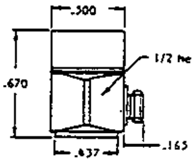
- small 7g
- Side connector

3110A



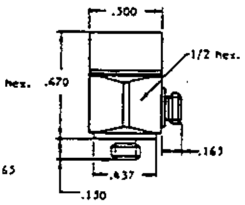
- General-purpose
- Top connector

3131A



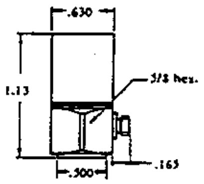
- For modal
- Adhered

3132A



- For modal
- Fixed screw type

3134A



- For seismic wave
- Side connector

2. GLOSSARY

■ Terms related to the analysis itself

Xa : A channel time waveform data
A signal input to the analyzer is first digitalized (A/D converter), then truncated to a time length corresponding to the frame time which is estimated according to the frequency range. The resulting, finite, digital serie constitutes Xa.

<Xa> : Averaged Xa (time averaging or signal enhancement)
Averaging in the time domain is performed to improve the SNR of noisy signals and to detect signals repeated rhythmically.
To average time series data, a trigger signal is required (synchronization). This trigger signal secures the relative phase of the sampled series.

$$<Xa(t)> = \frac{1}{N}\{Xa_1(t) + Xa_2(t) + \cdots\cdots + Xa_N(T)\}$$

The SNR is improved by N times when averaging is executed N times. This is expressed in decibels (dB) as follows:

$$20 \log_{10}\sqrt{N}\text{db}$$

Sa : Fourier spectrum of Xa (Complex spectrum of Xa)
The complex spectrum Sa(f), results from the conversion to the frequency domain of the time waveform Xa(t), by the Fourier Transform.

$$Sa(f) = \int_{-\infty}^{+\infty} Xa(t)\{\cos(2\pi ft) - j\sin(2\pi ft)\}dt$$

Sa(f) consists of a real part and an imaginary part. These real and an imaginary parts can also be observed as an amplitude and a phase. To average a complex spectrum, a trigger signal is required as it was for time averaging (<Xa>). This function can be effectively used to extract the signal components generated by rotation from random noise or to extract signal elements from background noise.

Gaa : Auto power spectrum (Auto Spectrum)
Auto power spectrum is a representative term used of the frequency spectrum. It is expressed in the square amplitude unit: V^2.
To calculate the auto power spectrum, Sa(f) is multiplied by its complex conjugate Sa(f)*. The auto power spectrum is expressed as follows:

$$\begin{aligned} Gaa &= Sa \cdot Sa^* \\ &= [Re(f) + jIm(f)] \cdot [Re(f) - jIm(f)] \\ &= Re^2(f) + Im^2(f) \end{aligned}$$

The power spectrum, Gaa is a real function carrying only amplitude information. Since it has no imaginary part, it does not carry any phase information. For this reason, averaging can be executed regardless of the trigger position without using a synchronization signal.

<Gaa> : Averaged Power Spectrum

Given a certain frequency, the averaged power spectrum at this frequency corresponds to the average of the values that the different available estimations of the power spectrum take at this frequency. The amplitude of the spectrum at a certain frequency is expressed as follows:

$$\sqrt{<Gaa\ (fx)>} = \sqrt{\frac{1}{N}\{Gaa_1\ (fx) + Gaa_2\ (fx) + \cdots\cdots + Gaa_N\ (fx)\}}$$

It corresponds to the RMS value (effective value) at this frequency. Note that this averaging smoothes the random components but that it does not reduce the noise level.

Gab : Cross-spectrum

At each frequency, the amplitude indicates the product of the amplitude of two signals and the phase indicates the relative difference of those two signals. To obtain the cross-spectrum, the Fourier spectrum (Sb) of Xb is multiplied by complex conjugate Sa* of the Fourier spectrum (Sa) of Xa:

$$\begin{aligned} Gab &= Sb \cdot Sa^* = [Re\ (b) + jIm\ (b)\ ] \cdot [Re\ (a) - jIm\ (a)\ ] \\ &= [Re\ (b) \cdot Re\ (a) + Im\ (b)\ Im\ (a)] + j[Im\ (b) \cdot Re\ (a) - Re\ (b) \cdot Im\ (a)\ ] \end{aligned}$$

The cross-spectrum is not a serie of positive real numbers as the power spectrum but a serie of positive or negative complex numbers.

The cross-spectrum, in the frequency domain, corresponds to the cross-correlation function, in the time domain. It can be used to measure time delays like the cross-correlation function. If the signal transfer speed and path depend on the frequency, the delay time (τ) can be obtained from the phase (θ) at the specified frequency (f):

$$\tau = \frac{\theta}{2\pi f}$$

<Gab> : Averaged cross-spectrum

The averaged cross spectrum Gab(f) at each frequency is computed by:

$$<Gab\ (f)> = \frac{1}{N}\{Gab_1\ (f) + Gab_2\ (f) + \cdots\cdots + Gab_N\ (f)\ \}$$

<Hab> : Frequency response function (FRF)

Frequency response characteristics such filter characteristics are estimated with the system input/output signals.

Two types of information (amplitude and phase) are obtained. The frequency response function corresponds to the ratio of the Fourier spectrum of the output signal to the Fourier spectrum of the input signal.

$$<Hab> = <Sb/Sa>$$

or

$$<Hab> = <\frac{Sb \cdot Sa^*}{Sa \cdot Sa^*}> = \frac{<Gab>}{<Gaa>}$$

The frequency response function can also be expressed as the ratio of the cross spectrum to the system input power spectrum.

This past evaluation method presents the following characteristics:

- Since the cross spectrum <Gab> is used, both amplitude and phase can be analyzed.
- The FRF can be estimated whatever the input signal.

The Inverse Fourier transform of the frequency response function is called impulse response. The frequency response function can be represented by three types of diagrams: Bode, Nyquist, and Nichols.

<COH> : Coherence function

The coherence function characterizes the relationship between input and output. It takes its values between o and 1

$$<COH> = \frac{<Gab><Gab>^*}{<Gaa><Gbb>}$$

The coherence function is computed by dividing the square amplitude of the cross-spectrum by the product of the input and output power spectrum.

When the coherence value at a certain frequency is equal to 1, the output is caused only by the input. When it is equal to 0, the output is absolutely not related to the input. When it is between 0 and 1, for example 0.3, it means that the influence of the specified input upon the output is equal to 0.3 and that the influence of other inputs or additional noise upon the output is equal to 0.7.

Thus, if the coherence function is smaller than 1.0, it may be because:

(1) the measurement is affected by additional noise,

(2) the DUT is a nonlinear system (e.g., too large input signal amplitude),

(3) the output is related to an input other than the input currently being observed (e.g., time delay between input and output signals), or

(4) the frequency resolution is poor (e.g., sharp resonance point).

Therefore, it is recommended that the coherence function be studied whenever a frequency response function is estimated.

The traditional servo analyzers cannot conduct this test.

Since the closer the coherence function is to 1.0, the more accurate the frequency response function is shown to be, you can easily check the validity of your measurement method and measurement points. The coherence function can also be used to choose the number of averages.

When the number of averages is only 1, the coherence function is forced to 1. As the number of averages increases, it converges toward the true value. If the coherence function varies greatly from one averages number to the next, the number of averages is insufficient.

<Hab>Gly : Group delay obtained from <Hab>

The phase of the frequency response function, <Hab>, is differentiated to calculate the group delay of the system (envelope time delay).

$$\tau g\ (f) = -\frac{1}{2\pi}\frac{d\phi(f)}{df} \qquad \phi(f) : \text{phase (radian)}$$

This group delay corresponds to the phase inclination. Thus, if the phase linearly varies, the group delay is constant.

2. GLOSSARY

<SNR> : Signal-to-noise ratio
The ratio of the power spectrum of the signal components to the power spectrum of the noise components is calculated according to the coherence function as follows:

$$<SNR> = \frac{<Gss\ (f)>}{<Gnn\ (f)>} = \frac{<C.O.P.>}{<Gbb> - <C.O.P.>} = \frac{<COH>}{1 - <COH>}$$

<COP> : Coherent output power
The coherent output power is obtained by multiplying the coherence function by the auto power spectrum of the output of the system. It represents the power spectrum of the part of the output that corresponds only to the input.

$$<C.O.P.> = <COH> \cdot <Gbb>$$

<IMP> : Impulse response
The impulse response represents the system output (in the time domain) caused by in putting a unit impulse. Note that when a signal Xa(t) is input to a system characterized by its impulse response hab (τ), the output is expressed as follows:

$$Xb\ (t) = \int_{-\infty}^{+\infty} hab(\tau)\ Xa(t-\tau)\ d\tau$$

The impulse response is obtained through inverse Fourier transformation of the frequency response function.

$$<IMPLS\ (\tau)> = IFFT\{<Hab>\}$$

> The impulse response may indicate the time delay between input/output signals with a higher sensitivity than the cross correlation function.

Raa : Auto-correlation function of Xa
For random time signals, 2 points are strongly correlated if the time difference between them is small, and the larger the time difference (τ) the weakest the correlation. If a periodic signal is buried in a random signal, there is a time difference (the period of the periodic signal) at which the correlation between 2 points is strong.
The auto correlation function is expressed as the function of the time difference (τ). It is used to analyze the characteristic of a random signal (degree of irregularity) and to improve the SNR of a periodic signal buried in a random signal.

Mathematically, the auto correlation function can be obtained through inverse Fourier transformation of the auto power spectrum Gaa. Generally, it is expressed by the following equation:

$$Raa\ (\tau) = \int_{-\infty}^{\infty} Gaa(f)\ e^{j2\pi f\tau} df$$

The R9211 FFT analyzer computes, and provides you with normalized autocorrelation functions (normalization factor: the sum of the squared time serie elements).

$$Raa\ (\tau) = \frac{\sum_{t} Xa(t) \cdot Xa(t+\tau)}{\sum_{t} \{Xa(t)\}^2}$$

CAUTION!

The autocorrelation function does not directly correspond to the IFFT of the auto power spectrum because of the FFT periodicity; it corresponds to the IFFT of the cross-spectrum of 2 series obtained by adding particular zeros patterns to the original time serie.

The R9211 computes autocorrelation functions according to this method.

Rab : Cross-correlation function

The cross-correation function enables the study of the similarity between two points of two different signals when the time difference between these points is τ. It is used to measure transmission speeds, transmission distances, and to determine transmission paths according to the measured time delay.

Mathematically, the cross correlation function corresponds to the IFFT of the cross-spectrum Gab. It is usually expressed as follows:

$$Rab\ (\tau) = \int_{-\infty}^{\infty} Gaa(f)\ e^{j2\pi f\tau} df$$

The R9211 FFT analyzer computes a cross-correlation function normalized with the product of the sums of the square components of the input and output series.

$$Raa\ (\tau) = \frac{\sum_{t} Xa(t) \cdot Xb(t+\tau)}{[\sum_{t} \{Xa(t)\}^2 \cdot \sum\{Xb(t)\}^2]^{1/2}}$$

CAUTION!

The cross-correlation function does not directly correspond to the IFFT of the cross-spectrum because of the FFT periodically; corresponds to the IFFT of the cross-spectrum of 2 series obtained by adding particular zeros patterns to the original time series.

The R9211 computes cross-correlation according to this method.

2. GLOSSARY

Cx : Real cepstrum of Gaa

It corresponds to the transformation to the quefrency domain, by Fourier transform of the logarithmic amplitude of the power spectrum Gaa.

$$Ca\ (\tau) = IFFT\ \{Log\ Gaa\}$$

The low-level area are enlarged because the performed operation was non linear (logarithmic); eventual cyclic patterns in the power spectrum are effectively extracted because they correspond to peaks in the quefrency domain.
Complicated power spectrum envelopes can be obtained through filtering in the quefrency domain (short pass filter) and conversion to the frequency domain.

Zxx : Pre-envelope of Xa

The real part of a pre-envelope corresponds to the original time series and the imaginary part corresponds to the Hilbert transform of this time series.

$$\hat{Xa}\ (t) = -\frac{1}{\pi}\int_{-\infty}^{\infty} Xa(\tau)\frac{d\tau}{\tau - t}$$

$$Za\ (t) = Xa\ (t) + j\hat{Xa}\ (t)$$

Zaa corresponds to the sum of the real part squared and of the imaginary part squared of Za. It is the envelope of the original time series and its unit is V^2 (energy). The transient response energy damping time can be calculated from the envelope.

Pa : Histogram or probability density function

The amplitude probability density function is used to analyze the statistical features of the signal.
It describes the probability for a time signal to exist in a specified amplitude range.
In the case of the computation of the probability density of a random signal, the probability for the signal to take its amplitude between Xa and Xa $+\Delta Xa$, is expressed, using the data sample at time T, as follows:

$$Pa = Prob\ [Xa < \tilde{Xa} < (Xa + \Delta Xa)]$$

A cumulative distribution function (CDF) can be obtained by integrating the amplitude probability density function. It indicates the probability that the instantaneous value of the signal be under a particular amplitude value.

<Pa> : Average histogram or average probability density function

The closer T becomes to infinity (in the expression used for calculation Pa), the closer to the true value the estimated values Pa becomes.

Audio Weights Characteristics

Figures A-1 to A-4 show the audio weights (WEIGHT (f)) characteristics: A, B, and C and C-message characteristic.

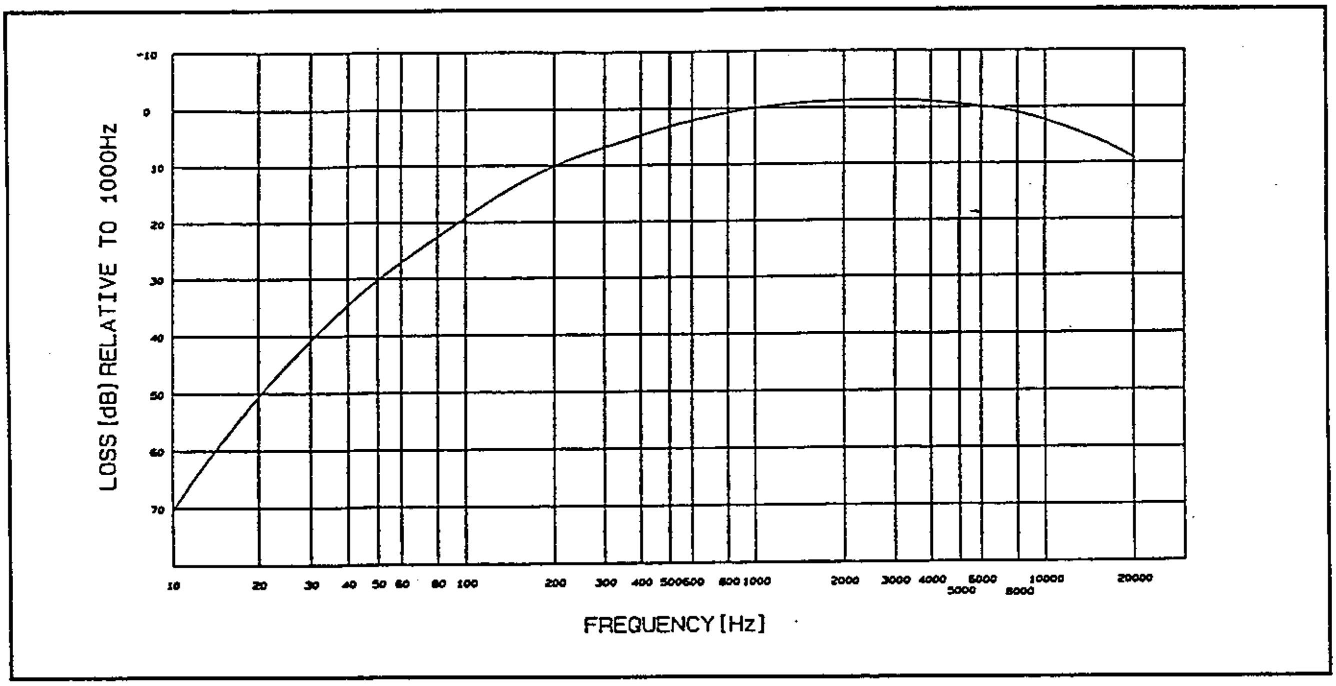


Figure A-1 A Characteristic

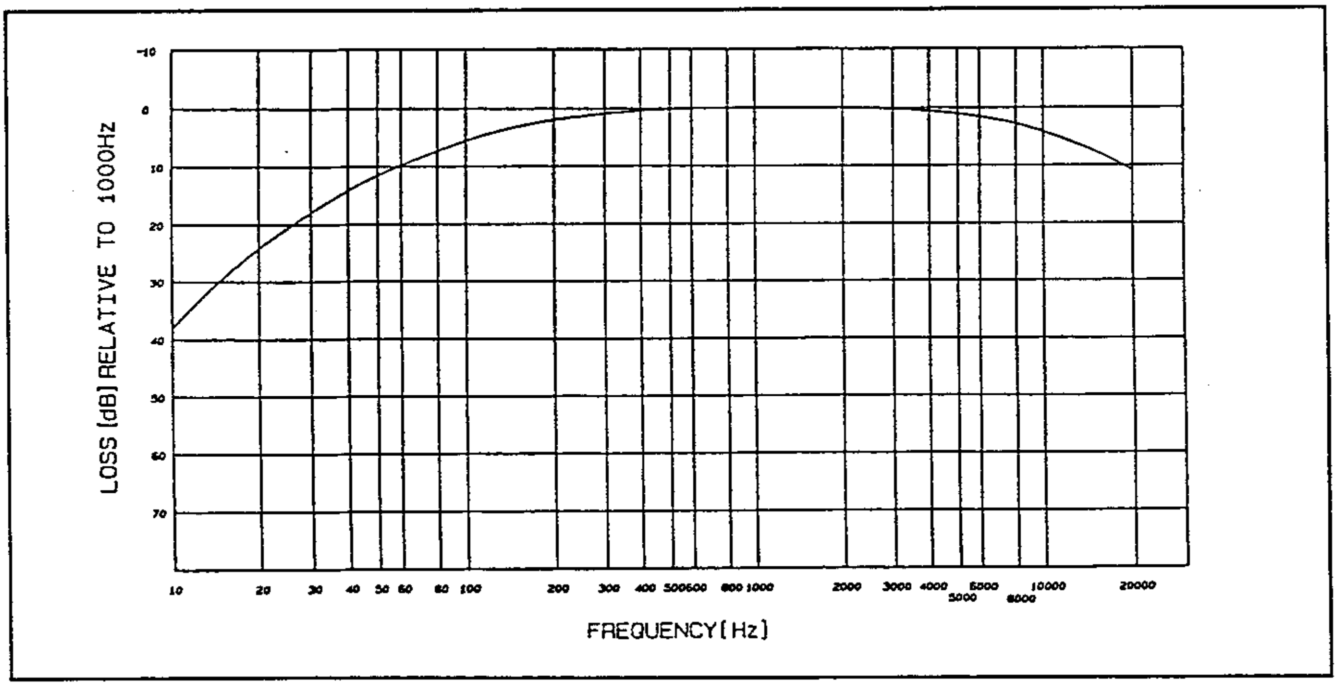


Figure A-2 B Characteristic

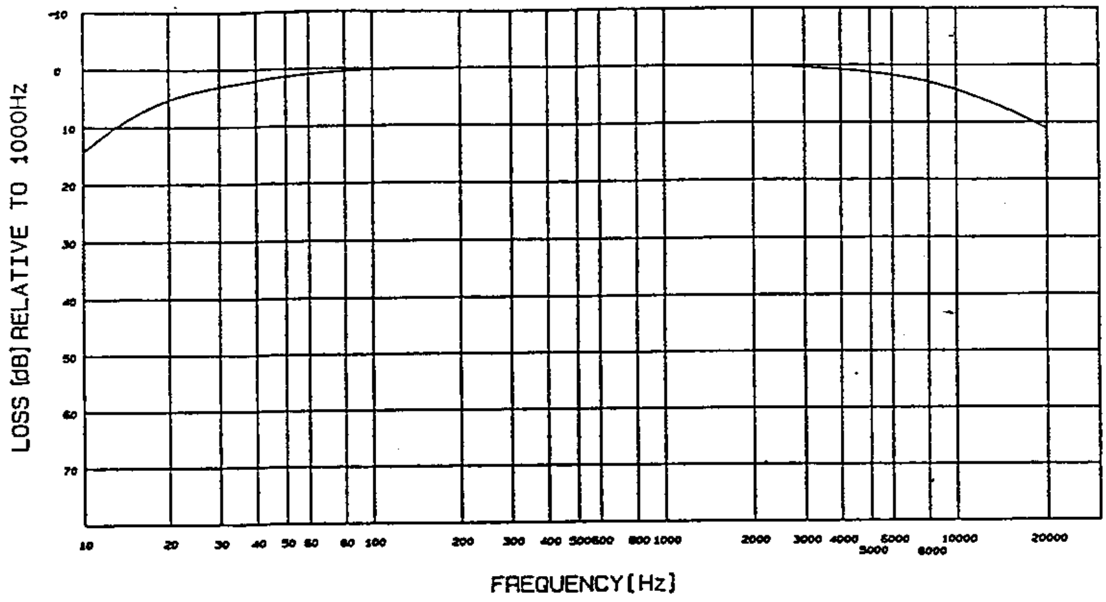


Figure A-3 C Characteristic

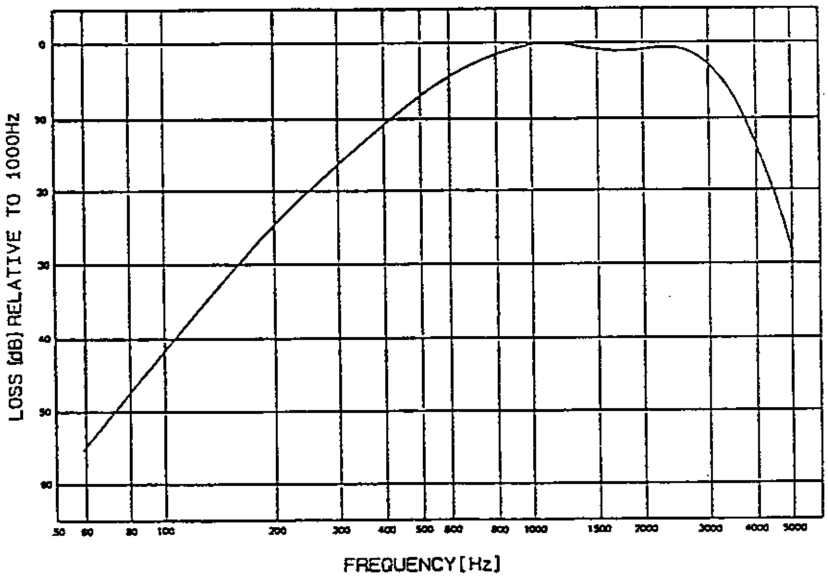


Figure A-4 C-message Characteristic

Octave filter No., Relation between Center Frequency and Setting Frequency Range

Table A-3 Octave filter No., Relation between Center Frequency and Setting Frequency Range

Filter No.	Center frequency	OCTAVE		Setting frequency range					
	Hz	1/1	1/3	100k	50k	20k	10k	5k	2k
49	80 K		←	↑					
48	63 K	←	←	│					
47	50 K		←	│					
46	40 K		←	│	↑				
45	31.5 K	←	←	│	│				
44	25 K		←	│	│				
43	20 K		←	│	│				
42	16 K	←	←	│	│	↑			
41	12.5 K		←	│	│	│			
40	10 K		←	│	│	│			
39	8 K	←	←	│	│	│	↑		
38	6.3 K		←	│	│	│	│		
37	5 K		←	│	│	│	│		
36	4 K	←	←	│	│	│	│	↑	
35	3.15K		←	│	│	│	│	│	
34	2.5 K		←	│	│	│	│	│	
33	2 K	←	←	│	│	│	│	│	
32	1.6 K		←	│	│	│	│	│	↑
31	1.25K		←	│	│	│	│	│	│
30	1 K	←	←	│	│	│	│	│	│
29	800		←	│	│	│	│	│	│
28	630	←	←	│	│	│	│	│	│
27	500		←	│	│	│	│	│	│
26	400		←	│	│	│	│	│	│
25	315	←	←	│	│	│	│	│	│
24	250		←	│	│	│	│	│	│
23	200		←	│	│	│	│	│	│
22	160	←	←	│	│	│	│	│	│
21	125		←	│	│	│	│	│	│
20	100		←	↓	│	│	│	│	│
19	80		←		│	│	│	│	│
18	63	←	←		↓	│	│	│	│
17	50		←			│	│	│	│
16	40		←			│	│	│	│
15	31.5	←	←			↓	│	│	│
14	25		←				│	│	│
13	20		←				│	│	│
12	16	←	←				↓	│	│
11	12.5		←					│	│
10	10		←					│	│
9	8	←	←					↓	│
8	6.3		←						│
7	5		←						│
6	4	←	←						│
5	3.15		←						│
4	2.5		←						│
3	2.0	←	←						↓

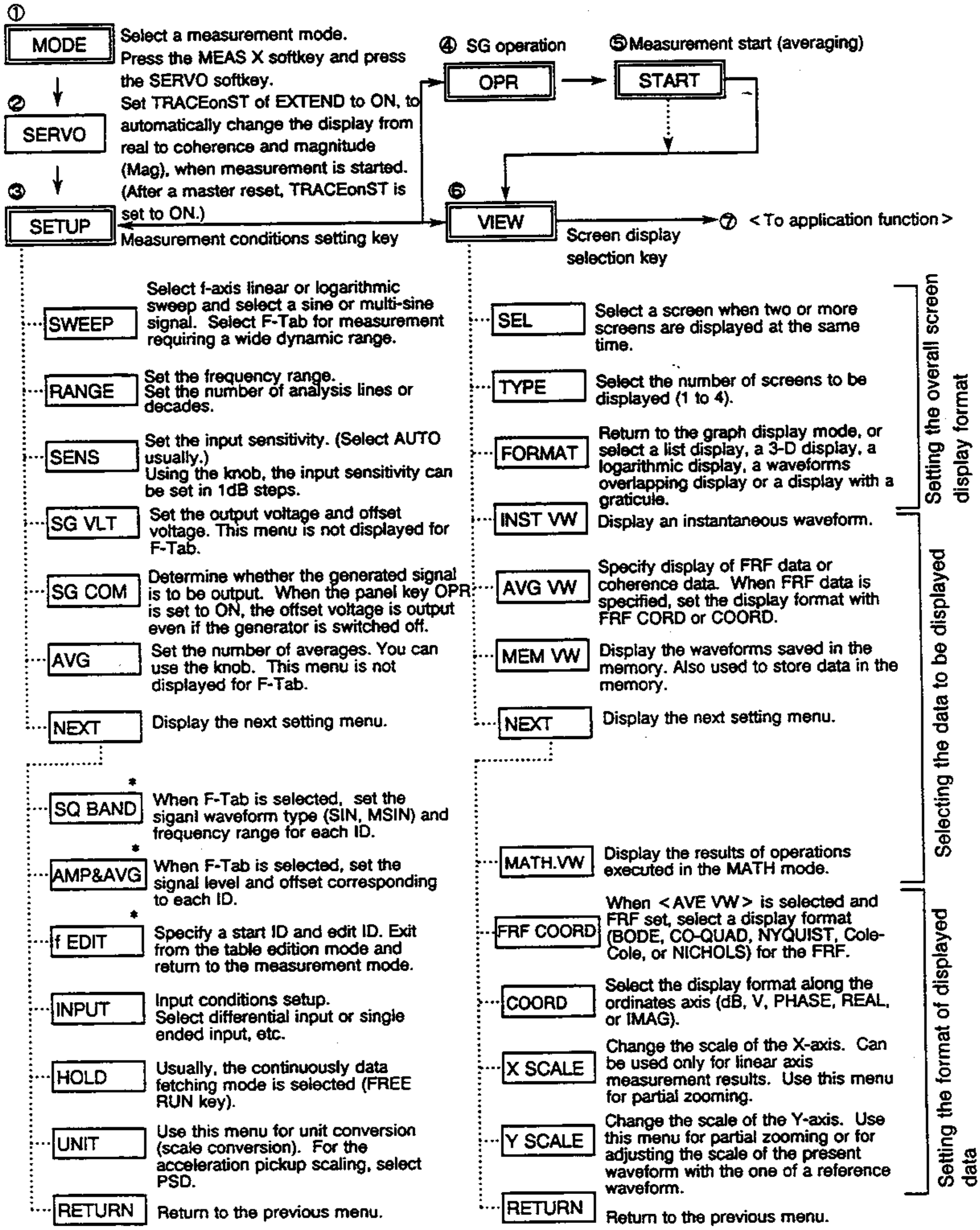
3. QUICK OPERATION GUIDE

■ Servo Mode

[HOW TO] : In the servo mode, a frequency response function is computed by the sweep method. The dynamic range is wide and logarithmic frequency analysis can be executed to enhance the resolution at low analysis frequencies.

: In the servo mode, panel key SG CONT is not used.

: The analizer initialization (master reset), is performed by pressing the RESET key twice while the message "R9211X" is displayed with large characters after the power is turned on.



① MODE: Select a measurement mode. Press the MEAS X softkey and press the SERVO softkey.

② SERVO: Set TRACEonST of EXTEND to ON, to automatically change the display from real to coherence and magnitude (Mag), when measurement is started. (After a master reset, TRACEonST is set to ON.)

③ SETUP: Measurement conditions setting key

⑥ VIEW: Screen display selection key

SWEEP	Select f-axis linear or logarithmic sweep and select a sine or multi-sine signal. Select F-Tab for measurement requiring a wide dynamic range.
RANGE	Set the frequency range. Set the number of analysis lines or decades.
SENS	Set the input sensitivity. (Select AUTO usually.) Using the knob, the input sensitivity can be set in 1dB steps.
SG VLT	Set the output voltage and offset voltage. This menu is not displayed for F-Tab.
SG COM	Determine whether the generated signal is to be output. When the panel key OPR is set to ON, the offset voltage is output even if the generator is switched off.
AVG	Set the number of averages. You can use the knob. This menu is not displayed for F-Tab.
NEXT	Display the next setting menu.
SQ BAND *	When F-Tab is selected, set the siganl waveform type (SIN, MSIN) and frequency range for each ID.
AMP&AVG *	When F-Tab is selected, set the signal level and offset corresponding to each ID.
f EDIT *	Specify a start ID and edit ID. Exit from the table edition mode and return to the measurement mode.
INPUT	Input conditions setup. Select differential input or single ended input, etc.
HOLD	Usually, the continuously data fetching mode is selected (FREE RUN key).
UNIT	Use this menu for unit conversion (scale conversion). For the acceleration pickup scaling, select PSD.
RETURN	Return to the previous menu.

SEL	Select a screen when two or more screens are displayed at the same time.
TYPE	Select the number of screens to be displayed (1 to 4).
FORMAT	Return to the graph display mode, or select a list display, a 3-D display, a logarithmic display, a waveforms overlapping display or a display with a graticule.
INST VW	Display an instantaneous waveform.
AVG VW	Specify display of FRF data or coherence data. When FRF data is specified, set the display format with FRF CORD or COORD.
MEM VW	Display the waveforms saved in the memory. Also used to store data in the memory.
NEXT	Display the next setting menu.
MATH.VW	Display the results of operations executed in the MATH mode.
FRF COORD	When <AVE VW> is selected and FRF set, select a display format (BODE, CO-QUAD, NYQUIST, Cole-Cole, or NICHOLS) for the FRF.
COORD	Select the display format along the ordinates axis (dB, V, PHASE, REAL, or IMAG).
X SCALE	Change the scale of the X-axis. Can be used only for linear axis measurement results. Use this menu for partial zooming.
Y SCALE	Change the scale of the Y-axis. Use this menu for partial zooming or for adjusting the scale of the present waveform with the one of a reference waveform.
RETURN	Return to the previous menu.

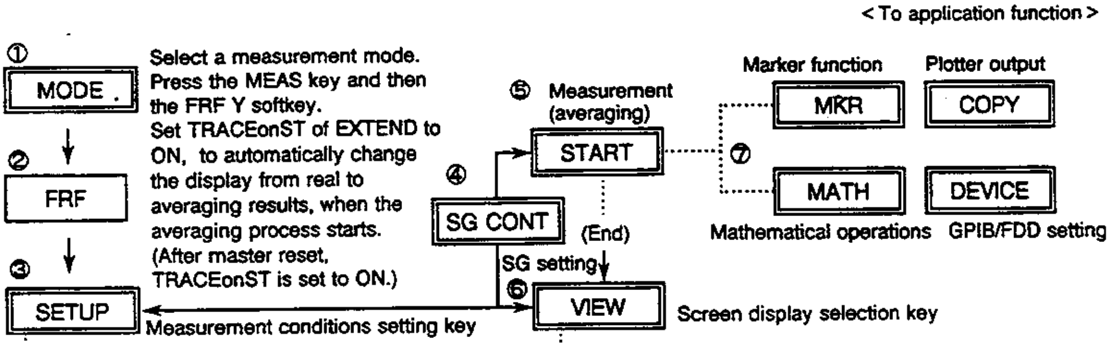
* : If this soft key is pressed when F-Tab is selected, a table is displayed and the table edition mode is entered into. To exit from the table edition mode, press ⇒ f EDIT ⇒ DONE

■ FRF Mode

[HOW TO] : Do not forget that X softkeys must be pressed first and then Y softkeys.

: If the dynamic range of the DUT inferior to 70dB, select the FRF mode. If the dynamic range is superior to 70dB or the resolution at the low analysis frequencies must be enhanced, select the servo mode.

: The analyzer initialization (master reset) is performed by pressing the RESET key twice while the message "R9211X" is displayed with large characters after the power is turned on.



Select a measurement mode. Press the MEAS key and then the FRF Y softkey. Set TRACEonST of EXTEND to ON, to automatically change the display from real to averaging results, when the averaging process starts. (After master reset, TRACEonST is set to ON.)

SETUP: Measurement conditions setting key

VIEW: Screen display selection key

FUNC	In the FRF mode only, a single channel cannot be selected as active channel (dual channel mode only).
RANGE	Set the frequency range. Only for linear analysis is the maximum resolution of 800 lines/span.
SENS	Using the knob, set the input sensitivity in 1dB steps.
INPUT	Set input conditions and determine whether the test signal is to be switched on/off. You can also switch off the antialiasing filter here.
TRIG	Set the trigger conditions. When using an impulse hammer, select +1AVG for effective measurement.
ARM/HLD	Actual triggering conditions are set here! Select AUTO ARM when using an impulse hammer with +1AVG. Select FREE RUN to analyze a continuous waveform.
NEXT	Display the next menu.
WEIGHT	Select a window. Select a force/response or rectangular window for a damped transient waveform generated with, for example, an impulse hammer. Select a rectangular window when using the built-in SG. Use a hanning window when using an external signal source. An audio weight can also be applied.
AVG	Set the averaging conditions (mode and number of averages). Usually, you need only set the number of averages you can use the knob). Select +1AVG, in this example.
UNIT	Use this menu to change the unit (scale conversion). Select PSD when using a device like an acceleration pick up.
ChDLEY	Set the time delay between both input channels, taking channel B as reference.
RETURN	Return to the previous menu.

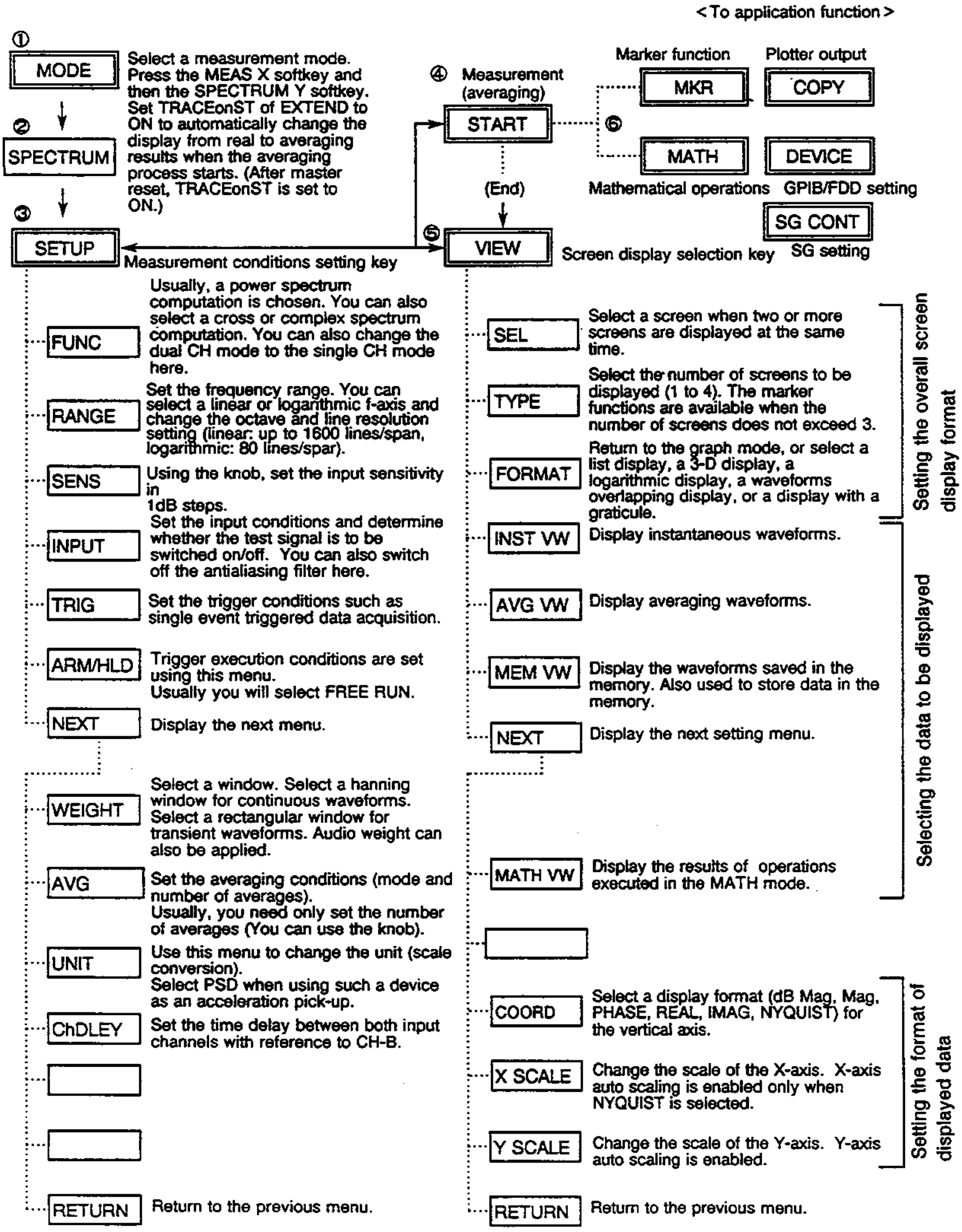
SEL	Select a screen when two or more screens are displayed at the same time.	Setting the overall screen display format
TYPE	Select the number of screens to be displayed (1 to 4). The marker functions are available when the number of screens does not exceed 3.	
FORMAT	Return to the graph display mode, or select a list display, a 3-D display, a logarithmic display, a waveform overlapping display, or a display with a graticule.	
INST VW	Display instantaneous waveforms.	Selecting the data to be displayed
AVG VW	Display average waveforms. Select FRF, coherence, or impulse response display here.	
MEM VW	Display the waveforms saved in the memory. Also used to store data in the memory.	
NEXT	Display the next setting menu.	
MATH VW	Display the results of operations executed in the MATH mode.	
FRF CORD	When <AVG VW> is selected and FRF set, select a display format (BODE, CO-QUAT, NYQUIST, Cole-Cole, or NICHOLS) for the FRF.	Setting the format of displayed data
COORD	Select the display format along the ordinates axis (dB, V, PHASE, REAL, IMAG or NYQUIST).	
X SCALE	Change the scale of the X-axis. X-axis auto scaling is enabled only when NYQUIST is selected.	
Y SCALE	Change the scale of the Y-axis. Y-axis auto scaling is enabled.	
RETURN	Return to the previous menu.	

■ Spectrum Mode

[HOW TO] : Do not forget that X softkeys must be pressed first and then Y softkeys.

: One-frame data is stored in the input buffer for spectrum analysis (simple spectrum analysis). The maximum resolution is 1600 lines/span.

: The analyzer initialization (master reset), is performed by pressing the RESET key twice while the large message "R9211X" is displayed after the power is switched on.



Select a measurement mode. Press the MEAS X softkey and then the SPECTRUM Y softkey. Set TRACEonST of EXTEND to ON to automatically change the display from real to averaging results when the averaging process starts. (After master reset, TRACEonST is set to ON.)

FUNC	Usually, a power spectrum computation is chosen. You can also select a cross or complex spectrum computation. You can also change the dual CH mode to the single CH mode here.
RANGE	Set the frequency range. You can select a linear or logarithmic f-axis and change the octave and line resolution setting (linear: up to 1600 lines/span, logarithmic: 80 lines/spar).
SENS	Using the knob, set the input sensitivity in 1dB steps.
INPUT	Set the input conditions and determine whether the test signal is to be switched on/off. You can also switch off the antialiasing filter here.
TRIG	Set the trigger conditions such as single event triggered data acquisition.
ARM/HLD	Trigger execution conditions are set using this menu. Usually you will select FREE RUN.
NEXT	Display the next menu.
WEIGHT	Select a window. Select a hanning window for continuous waveforms. Select a rectangular window for transient waveforms. Audio weight can also be applied.
AVG	Set the averaging conditions (mode and number of averages). Usually, you need only set the number of averages (You can use the knob).
UNIT	Use this menu to change the unit (scale conversion). Select PSD when using such a device as an acceleration pick-up.
ChDLEY	Set the time delay between both input channels with reference to CH-B.
RETURN	Return to the previous menu.

SEL	Select a screen when two or more screens are displayed at the same time.
TYPE	Select the number of screens to be displayed (1 to 4). The marker functions are available when the number of screens does not exceed 3.
FORMAT	Return to the graph mode, or select a list display, a 3-D display, a logarithmic display, a waveforms overlapping display, or a display with a graticule.
INST VW	Display instantaneous waveforms.
AVG VW	Display averaging waveforms.
MEM VW	Display the waveforms saved in the memory. Also used to store data in the memory.
NEXT	Display the next setting menu.
MATH VW	Display the results of operations executed in the MATH mode.
COORD	Select a display format (dB Mag, Mag, PHASE, REAL, IMAG, NYQUIST) for the vertical axis.
X SCALE	Change the scale of the X-axis. X-axis auto scaling is enabled only when NYQUIST is selected.
Y SCALE	Change the scale of the Y-axis. Y-axis auto scaling is enabled.
RETURN	Return to the previous menu.

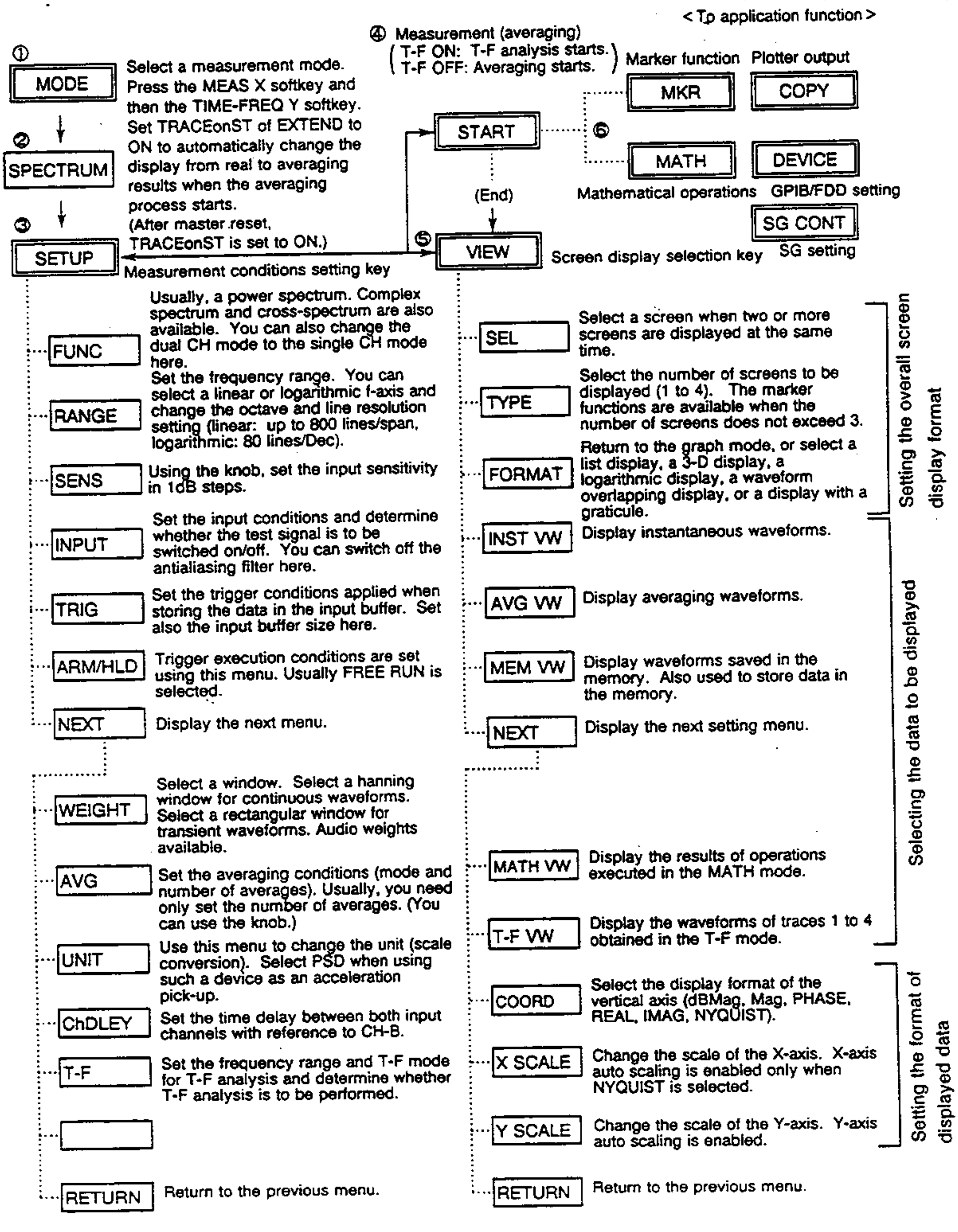
■ TIME-FREQ Mode

[HOW TO] : Do not forget that X softkeys must be pressed first, and then Y softkeys.

: A large input buffer, longer than 1 frame is used, for either TF analysis or data view. The maximum resolution is 800 lines/span.

: The analyzer initialization (master reset) is performed by pressing the RESET key twice while the message "R9211X" is displayed with large characters after the power is switched on.

* Input buffer size: R9211C	: Standard,	512Kw	(single channel, 1024Kw)
R9211A/B/E	: Standard,	64Kw	(single channel, 128Kw)
I/O or CMOS	: Option,	512Kw	(single channel, 1024Kw)
I/O + CMOS	: Option,	1024Kw	(single channel, 2048Kw)



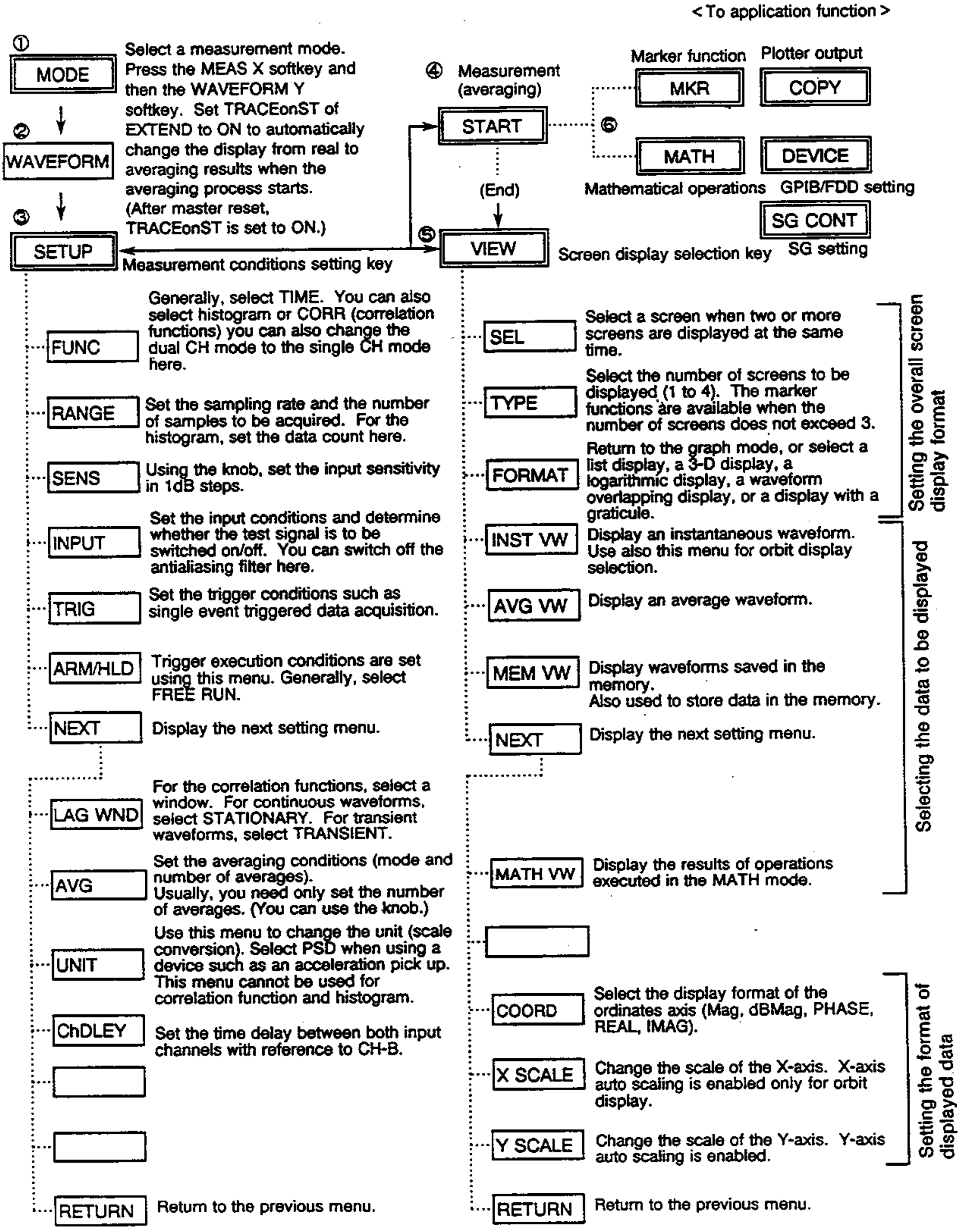
MODE	Select a measurement mode. Press the MEAS X softkey and then the TIME-FREQ Y softkey. Set TRACEonST of EXTEND to ON to automatically change the display from real to averaging results when the averaging process starts. (After master reset, TRACEonST is set to ON.)
SETUP	Measurement conditions setting key
START	④ Measurement (averaging) (T-F ON: T-F analysis starts. T-F OFF: Averaging starts.)
VIEW	Screen display selection key
MKR	Marker function
COPY	Plotter output
MATH	Mathematical operations
DEVICE	GPIB/FDD setting
SG CONT	SG setting
FUNC	Usually, a power spectrum. Complex spectrum and cross-spectrum are also available. You can also change the dual CH mode to the single CH mode here.
RANGE	Set the frequency range. You can select a linear or logarithmic f-axis and change the octave and line resolution setting (linear: up to 800 lines/span, logarithmic: 80 lines/Dec).
SENS	Using the knob, set the input sensitivity in 1dB steps.
INPUT	Set the input conditions and determine whether the test signal is to be switched on/off. You can switch off the antialiasing filter here.
TRIG	Set the trigger conditions applied when storing the data in the input buffer. Set also the input buffer size here.
ARM/HLD	Trigger execution conditions are set using this menu. Usually FREE RUN is selected.
NEXT	Display the next menu.
WEIGHT	Select a window. Select a hanning window for continuous waveforms. Select a rectangular window for transient waveforms. Audio weights available.
AVG	Set the averaging conditions (mode and number of averages). Usually, you need only set the number of averages. (You can use the knob.)
UNIT	Use this menu to change the unit (scale conversion). Select PSD when using such a device as an acceleration pick-up.
ChDLEY	Set the time delay between both input channels with reference to CH-B.
T-F	Set the frequency range and T-F mode for T-F analysis and determine whether T-F analysis is to be performed.
RETURN	Return to the previous menu.
SEL	Select a screen when two or more screens are displayed at the same time.
TYPE	Select the number of screens to be displayed (1 to 4). The marker functions are available when the number of screens does not exceed 3.
FORMAT	Return to the graph mode, or select a list display, a 3-D display, a logarithmic display, a waveform overlapping display, or a display with a graticule.
INST VW	Display instantaneous waveforms.
AVG VW	Display averaging waveforms.
MEM VW	Display waveforms saved in the memory. Also used to store data in the memory.
NEXT	Display the next setting menu.
MATH VW	Display the results of operations executed in the MATH mode.
T-F VW	Display the waveforms of traces 1 to 4 obtained in the T-F mode.
COORD	Select the display format of the vertical axis (dBMag, Mag, PHASE, REAL, IMAG, NYQUIST).
X SCALE	Change the scale of the X-axis. X-axis auto scaling is enabled only when NYQUIST is selected.
Y SCALE	Change the scale of the Y-axis. Y-axis auto scaling is enabled.
RETURN	Return to the previous menu.

■ Waveform Mode

[HOW TO] : Do not forget that X softkeys must be pressed first, and then Y softkeys.

: Time waveforms, auto correlation functions, cross-correlation functions, and histograms are measured.

: The analyzer initialization (master reset), is performed by pressing the RESET key twice while the message "R9211X" is displayed with large characters after the power is switched on.



Select a measurement mode. Press the MEAS X softkey and then the WAVEFORM Y softkey. Set TRACEonST of EXTEND to ON to automatically change the display from real to averaging results when the averaging process starts. (After master reset, TRACEonST is set to ON.)

SETUP: Measurement conditions setting key

VIEW: Screen display selection key

FUNC: Generally, select TIME. You can also select histogram or CORR (correlation functions) you can also change the dual CH mode to the single CH mode here.

RANGE: Set the sampling rate and the number of samples to be acquired. For the histogram, set the data count here.

SENS: Using the knob, set the input sensitivity in 1dB steps.

INPUT: Set the input conditions and determine whether the test signal is to be switched on/off. You can switch off the antialiasing filter here.

TRIG: Set the trigger conditions such as single event triggered data acquisition.

ARM/HLD: Trigger execution conditions are set using this menu. Generally, select FREE RUN.

NEXT: Display the next setting menu.

LAG WND: For the correlation functions, select a window. For continuous waveforms, select STATIONARY. For transient waveforms, select TRANSIENT.

AVG: Set the averaging conditions (mode and number of averages). Usually, you need only set the number of averages. (You can use the knob.)

UNIT: Use this menu to change the unit (scale conversion). Select PSD when using a device such as an acceleration pick up. This menu cannot be used for correlation function and histogram.

ChDLEY: Set the time delay between both input channels with reference to CH-B.

RETURN: Return to the previous menu.

SEL: Select a screen when two or more screens are displayed at the same time.

TYPE: Select the number of screens to be displayed (1 to 4). The marker functions are available when the number of screens does not exceed 3.

FORMAT: Return to the graph mode, or select a list display, a 3-D display, a logarithmic display, a waveform overlapping display, or a display with a graticule.

INST VW: Display an instantaneous waveform. Use also this menu for orbit display selection.

AVG VW: Display an average waveform.

MEM VW: Display waveforms saved in the memory. Also used to store data in the memory.

NEXT: Display the next setting menu.

MATH VW: Display the results of operations executed in the MATH mode.

COORD: Select the display format of the ordinates axis (Mag, dBMag, PHASE, REAL, IMAG).

X SCALE: Change the scale of the X-axis. X-axis auto scaling is enabled only for orbit display.

Y SCALE: Change the scale of the Y-axis. Y-axis auto scaling is enabled.

RETURN: Return to the previous menu.

Mathematical Operations

Basic procedure followed in the MATH mode
(the 4 basic arithmetic operations)

I. When TR MATH is selected

MATH ⇨ SEL	Display and select the operand.
⇨ TR MATH ⇨ xxx ON / OFF	Set the operator you are going to use to ON.
	The operation result is displayed on the same screen (real-time operation).

II. When TR MATH is not selected

MATH ⇨ SEL	Display and select the first operand.
⇨ MATH SEL	
⇨ OPERAND	Register the first operand.
⇨ ☐ ⇨ xxx	Select an operator.
⇨ ΔΔΔ	Set conditions on the operator execution, if required.
⋮	
⇨ SEL	Display and select the second operand, if required.
⇨ MATH SEL	
⇨ 1st OPRTR	Save the operator and second operand at the same time.
⇨ DO MATH	Execute the operation.

When the operation is completed, "MATH Completed!!" is displayed.
The operation result is displayed with the VIEW key.
If other operators are selected, and the 2nd and 3rd OPRTRs are set before execution of the first operation, a sequence of three operations can be executed.

MATH Four Basic Arithmetic Operations

When MATH MENU is selected with the PRESET key

SEL	Select the data displayed on the screen as the operand.
jw	SPECTRUM/TIME-FREQ/FRF/SERVO modes: Integrations and differentiations in the frequency domain, time delay estimations, and frequency shit executions.
CEPSTUM	SPECTRUM/TIME-FREQ modes: Cepstrum operations and liftering operations.
FRF MTH	FRF/SERVO modes: Conversions between open and closed characteristics of feedback loops equalizer function, and SNR estimations.
t MATH	WAVEFORM mode Four basic arithmetic operations, operations with a constant, inversions (1/x), negations (-X) and conjugations (a + ib →a - ib)
DOMAIN	Transformation into another domain, Hilbert Transformation, FFT, and IFFT
MOD f	SPECTRUM/TIME-FREQ/FRF/SERVO Band-pass, band-stop operation.
TR MATH	Smoothing, cumulative display, time waveform differentiation and integration, and waveform trend removal.

MATH Comparator Function

When LMT MENU is selected with the PRESET key

LMT CTRL	Execution control of the comparator function. Set a test mode and upper and lower display limits.
LMT MODE	Select a comparison mode between upper limits, lower limits, or upper/lower limits.
LMT VAL	Set each comparison level.
LMT EDIT	When the table mode is selected as the test mode, edit each table segment.

MATH Curve Fit

When Curve Fit MENU is selected with the PRESET key

Fit	Start or abort curve fitting execution and select the data subject to curve fitting. Also set the evaluation of the time delay.
sEDIT	Display the results of curve fitting execution: poles and zeros display.
sSCALE	Display the results of curve fitting execution: scale frequency and gain.
sWEIGHT	Specify the curve fitting frequency range and auto weighting.
☐	
sCONV	Change and display the Laplace parameter format for the curve fitting results.
to SYNTH	Transfer the Laplace parameters (obtained through curve fitting) to a synthesis table.

MATH Synthesis

When FRF Synth MENU is selected with the PRESET key

SYNTH	Start or abort synthesis execution.
sEDIT	Edit the Laplace parameters or input parameters for the synthesis execution.
sSCALE	Set the scale frequency and gain for synthesis execution.
☐	
☐	
sCONV	Change and display the format of the edited or input Laplace parameters.
☐	

Note

Average the data before curve fitting or synthesis execution.

SG and Output Devices

SG CONT (Not to be used in the servo mode)

- **SIGNAL** Select the waveform to be generated. Arbitrary waveforms are also selected here.
- **SG VLT** Set the amplitude and offset of the waveform to be generated. The output limit can also be set here.
- **CONNECT** Select the type of connection for waveform output. Use this menu to use a summing amplifier.
- **OUT CTRL** Start/abort waveform generation. You can also choose to start/abort signal generation synchronously with averaging process start/abort timming.
- **OUT MODE** Select a signal generation mode: internal or external trigger.
- **NEXT** Display the next setting menu
  - **IMPEDANC** Select the output impedance.
  - **SYNC OUT** Determine the relationship between the output synchronization signal and the frame time.
  - **TAPER** Determine whether the waveform output is to be tapered and set the taper time.
  - **RETURN** Return to the previous menu

DEVICE

- **ACCESS** Save, retrieve, copy, or erase the type file selected with TYPEFILE. Initialize the floppy disk. Clear the retrieved data screen and catalog screen.
- **FILETYPE** Select a MEAS FILE (DATA or VIEW FILE) or a table file (TBL FILE). Set the plotter output
- **PLOTER** Set the plotter output. Select "TALK only" with the GPIB in advance. Press the COPY key to start hardcopy.
- **GPIB** Select "TALK only", for the GPIB set the header, and address.

Marker Operations

MKR

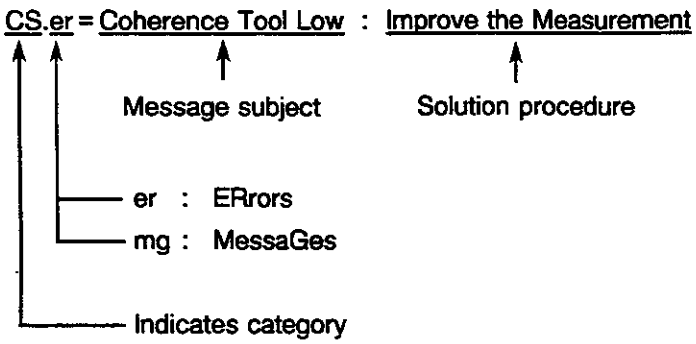
- **SEL** Select the screen where you want to display markers.
- **MKR VAL**
- **X MKR** Select automatic display of markers on the X axis. Since the markers displayed automatically depend on the the displayed data, see the table below.
- **CTL SYS** In the FRF and SERVO modes, you can display Bode markers on open feedback loop characteristics and closed loop markers on closed feedback loop characteristics.
- **FIX X** Specify the X-axis cursor markers displacement method.
- **FIX Y** Specify the Y-axis cursor markers displacement method.
- **MKR REF** Set, change, or call a reference point. Align and simultaneously move cursor markers on all screens.

Marker type		Function	Type of the data displayed on the selected screen						
Group	Marker name		Time waveform	Correlation	Histogram	Spectrum	t-f analysis	Frequency response function	Impulse response function
PK	•PKPK'	Searches for the maximum and minimum values.	○						
	•SINGLE PK'	Searches the maximum value.		○	○	○	○	○	○
	•NEXT RIGHT PK'	Searches for the next peak value at the right of the current X axis cursor.	○	○	○	○	○		○
	•NEXT LEFT PK'	Searches for the next peak value at the left of the current X axis cursor.	○	○	○	○	○		○
	•NEXT RIGHT MIN'	Searches for the next minimum value at the right of the current X axis cursor.	○	○					○
	•NEXT LEFT MIN'	Searches for the minimum value at the left of the current X axis cursor.	○	○					○
	• + PK'	Searches for the peak value (higher than the specified level) on both sides of the center.						○	
	• – PK'	Searches for the next minimum (lower than the specified level) on both sides of the center.						○	
BAND	•PKPK'	Searches for the maximum and minimum values between two X axis cursors.	○						
	•RMS'	Searches for the effective value between two X cursors.	○						
	•PK'	Searches for the maximum value between two X cursors.		○		○	○		○
	•OVERALL'	Adds the signal amplitude of the points within the interval, delimited by 2 X axis cursors, and displays the results in the "bar" format.		○		○	○		○
	•MEAN'	Computes the average of the whole data between two X axis cursors and displays it in the "bar" format.		○		○	○		○
	•VARIANCE'	Computes the variance and the normalized standard error of the whole data between 2 X axis cursors and displays them in the "bar" format.		○		○	○		○
PULSE PAR	•RISE TIME'	Computes the rise time of the waveform between two X axis cursors.	○						
	•FALL TIME'	Computes the fall time of the waveform between two X axis cursors.	○						
	•PULSE WIDTH'	Checks the pulse width of the waveform between two X axis cursors.	○						
DAMP PWR	•DAMP PWR'	Displays the damping coefficient of the waveform between two X axis cursors.		○			○		
	•DAMP PWR'(IMP)	Displays the damping coefficient and damping ratio of the waveform between two X axis cursors.							○
•HARMONIC'		Searches for the harmonics corresponding to the specified frequency.				○			
•SIDE BAND'		Searches for the sideband corresponding to the specified frequency.				○			
•XdB BWD'		Points out (and computes) the parameters of the band over which the signal level belong to the interval defined by the specified level (maximum) and the specified level difference (minimum = maximum-difference)						○	
•SHAPE'		Estimates the ratio of the band width of the band described above.						○	
•RIPPLE'		Estimates the difference between the maximum value (peak) and minimum value (trough).						○	
For servo analysis	•BODE'	Displays the phase margin and gain margin.						☆	☆
	•CLOSE LOP'	Displays the frequency, gain, and band width of the maximum value (peak).						☆	☆
Cursor	① SINGLE X X1 Y1' ② X1 Y1 X2 Y2' ③ X1 Y1 X2 ΔY' ④ Y1 Y2' ⑤ YA ΔY'	Evaluates the coordinates (position & level) of the X axis cursor. Evaluates the levels of two X axis cursors, simultaneously. Evaluates the levels and the difference (Y) between cursors, X axis simultaneously. Evaluates the levels and difference (Y) between two cursors. ※ The cursor marker is used to specify the band width, points, and level for X MKR. Of course, it can be used independently.							

4. ERROR MESSAGES

■ Meaning of Error Messages

The messages on upper screen have the following meaning.



CS.er = Coherence Tool Low : Improve the Measurement

Message subject

Solution procedure

er : ERrors

mg : MessaGes

Indicates category

CS : Curve-fit & Synthesis
DY : DisplaY
FD : Floppy Disk
GN : Go-Nogo
GP : GP-ib
MK : MarKer
MT : MaTh
PL : PLot
RS : Recall & Save
SG : Signal Generation
SM : Servo-Mode
SU : SetUp
TF : Time-Frequency
WL : WeLcode
XX : Miscellaneous

■ Curve-fit & Synthesis Errors [CS.er]

```
CS.er= Coherence Too Low: Improve the Measurement
```

[Problem]
The coherence of the measurement (FRF) is too low to execute a curve-fit.

[Solution]
Using a finer sweep method, improve the measurement precision.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Operation Procedure, Caution of 6: Executes curve fitting.

```
CS.er= Invalid USR WGT Frequency Range: Check it
```

[Problem]
The frequency range of the USR WGT (user weight) is too small. There are not enough lines to execute a curve-fit.

[Solution]
Check the frequency range.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Operation Procedure, 4:Sets a Weight function.
Chapter 12, 4. Know-How Of Use, ■ Ten or More Positive or Negative Peak Values in the Fitting Range.

```
CS.er= No Source Data: Execute a FRF Measurement
```

[Problem]
You tried to start curve-fit execution, although there is no FRF measured.

[Solution]
Execute a FRF measurement.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Curve Fitting Function

4. ERROR MESSAGES

```
CS.er= No Table Data: Check Settings, Create One
```

[Problem]
Although no curve-fit operation has been executed (may be you did not wait for its completion), you tried to access the curve-fit table.

[Solution]
Create a curve-fit table by executing a curve-fit operation.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Operation Procedure, 7:Displays the table of poles/zeros, pole/residues, or polynomials.

```
CS.er= Settings Exceed Lower Limit: Try New Ones
```

[Problem]
The curve-fit settings (start or stop frequencies) or the synthesis settings (time delay ···) are invalid: they exceed the lower limit of their value.

[Solution]
Set the invalid parameter(s) again, respecting the lower limit of these parameters, which are:

- Pole-Zero : $-1.0e^{+11}$
- Scale f : $1.0e^{-5}$kHz to 100kHz
- Time delay : 0sec
- Gain : -10^{36}
- Fit frequency domain : 0Hz

```
CS.er= Settings Exceed Upper Limit: Try New Ones
```

[Problem]
The curve-fit settings (start or stop frequencies) or the synthesis settings (time delay ...) are invalid: they exceed the upper limit of their value.

[Solution]
Set the invalid parameter(s) again, respecting the upper limit of these parameters, which are:

- Pole-Zero : $1.0e^{+11}$
- Scale f : $1.0e^{-5}$kHz to 100kHz
- Time delay : 80000sec
- Gain : 10^{36}
- Fit frequency domain : 100kHz

■ Curve-fit & Synthesis Messages [CS.mg]

```
CS.mg: TO SYNTH Operation Completed
```

This message is displayed when all the curve-fit table's poles and zeros are transferred to the synthesis table.

```
CS.mg= ABORT? Really?: Press STOP once more!
```

[Problem]
This message is displayed when the STOP key is pressed while either curve-fitting or synthesizing.

[Solution]
If you press the STOP key a second time, the curve-fit (resp. synthesis) process will be aborted.

If you don't, the process will keep on running.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Operation Procedure, 6:Executes curve fitting.

```
CS.mg= All Checked: CURVE FIT Starting
```

This message is displayed when the curve-fit process actually starts, after all necessary tests have been processed.

```
CS.mg= All Checked: SYNTHesis Starting
```

This message is displayed when the synthesis process actually starts, after all necessary tests have been processed.

```
CS.mg= CURVE FIT Operations All Completed
```

This message is displayed on completion of the curve-fit process.

```
CS.mg= FRF Evaluation: Succeeded
```

This message is displayed when the FRF (Frequency Response Function) evaluation is successfully completed.

```
CS.mg= IMPulse Evaluation: Failed
```

This message is displayed when the impulse response function cannot be evaluated because the real parts of all poles are superior or equal to zero. The step response will not be computed either.

This message is related to the messages:
"CS.mg = STEP Evaluation: Failed"
"CS.mg = IMPulse, STEP can't be computed"

```
CS.mg= IMPulse Evaluation: Succeeded
```

This message is displayed when the impulse response function evaluation is successfully completed.

Had the evaluation not been possible the message "CS.mg = IMPulse Evaluation: Failed" would have been displayed.

```
CS.mg= IMPulse, STEP responses can't be computed
```

This message is displayed when the impulse response function and the step response function cannot be computed because the real parts of all poles are superior or equal to zero.

This message is related to the messages:
"CS.mg = STEP Evaluation: Failed"
"CS.mg = IMPulse Evaluation: Failed"

```
CS.mg= Pole-Residue & Polynomials: Failed
```

[Problem]
This message is displayed when the number of poles & residues or polynomials obtained from the poles & zeros exceed the tables limits (20 lines maximum). In such a case, you cannot open the pole-residue table nor the polynomials table.

[Solution]
You should then transfer the obtained poles & zeros to the synthesis working area (to SYNTH), get rid of the unnecessary poles and zeros by editing the pole-zero table, and execute a synthesis operation. Thus, you can obtain pole-residue and polynomials tables.

[Reference]
Chapter 12, 2. How To Use The Curve Fitting Function, ■ Operation Precedure, 6:Executes curve fitting and CAUTION.

```
CS.mg= Pole-Residue & Polynomials: Succeeded
```

This message is displayed when the pole-residue table and the polynomials table can be opened.
This message is opposed to the message:
"CS.mg = Pole-Residue & Polynomials: Failed"

```
CS.mg= Pole-Zero Evaluation: Failed
```

This message is displayed when no pole and zero can be estimated. It happens when the FRF on which curve-fit is applied is too noisy for an estimation.

```
CS.mg= STEP Evaluation: Failed
```

This message is displayed when the step response function could not be evaluated, because the real parts of all poles are superior or equal to zero. Note that this message is only briefly displayed and is replaced right away by the message: "CS.mg = IMPulse, STEP responses can't be computed".

This message is related to the messages:
"CS.mg = IMPulse Evaluation: Failed"
"CS.mg = IMPulse, STEP responses can't be computed"

```
CS.mg= STEP Evaluation: Succeeded
```

This message is displayed when the step response evaluation is successfully completed.

Had the evaluation not been possible, the message "CS.mg = STEP Evaluation: Failed" would have been displayed instead.

```
CS.mg= SYNTHesis Operations All Completed
```

This message is displayed on completion of the synthesis process.

■ DisplaY Errors [DY.er]

```
DY.er= A Marker is Used: screens<4
```

[Problem]
① You attempted to use a marker function while the display is composed of 4 screens.
② You attempted to set the display type to 4 screens while using a marker function.

[Solution]
Reduce the screen number to at most 3 screens.

```
DY.er= Can't OVERLAY ON in NUMERIC LIST: try GRAPH
```

[Problem]
You were displaying 2 screens, one of them in NUMERIC LIST format and you tried to overlay them with the VIEW ⇨ FORMAT ⇨ OVERLAY ON/OFF key.

[Solution]
You should display both screens in GRAPH mode.

[Reference]
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display mode(OVERLAY)

```
DY.er= Invalid from 3D Display: Select GRAPH
```

[Problem]
While the display format is the tridimensional format (3D Display):
① You pressed a forbidden key.
② You tried to change the display format to NUMERIC LIST.

[Solution]
You should return to the GRAPH format and then proceed to what you wanted to do.

[Reference]
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display format

```
DY.er= Invalid from CATalog Display: Set CAT OFF
```

[Problem]

While the floppy disk catalog is displayed, only the Y softkeys of the DEVICE ⇨ ACCESS Y softmenu can be used.

[Solution]

Switch the catalog display off by pressing:

DEVICE ⇨ ACCESS ⇨ CAT OFF

[Reference]

Chapter 15, 2. How To Use A Floppy Disk, ■ Menus Related to the Floppy Disk
Chapter 15, 3. Operation Method, ■ Floppy Disk Operation Procedure

```
DY.er= Numeric List Displayed: All screens to GRAPH
```

[Problem]

While the display format of at least one screen is the NUMERIC LIST format:
① You tried to change the display format to 3D display.
② You pressed a forbidden key.

[Solution]

You should return to the GRAPH format for All screen and then proceed to what you wanted to do.

[Reference]

Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display format

```
DY.er= Multi-screen Not Allowed: Select SINGLE
```

[Problem]

When more than 1 screen are displayed, you tried to:
① Change the display format to 3D DISPLAY.
② Edit a label (LABEL).
When more than 2 screens are displayed, you tried to:
③ Change the display format to NUMERIC LIST.

[Solution]

You should display only 1 screen (or 2 screens in the NUMERIC LIST case), by pressing:

VIEW ⇨ TYPE ⇨ SINGLE (resp. DUAL)

[Reference]

Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display format

About LABEL:

Chapter 9, 2. MODE KEY OPERATION, ■ Label

```
DY.er= ORBITAL not displayed in 3D: try new COORD
```

[Problem]
While orbital data are being displayed (VIEW ⇨ INST VW ⇨ ORBITAL), you tried to select the 3D Display format.

[Solution]
Either change the displayed data type (VIEW ⇨ INST VW menu) or choose another display format (GRAPH).

```
DY.er= OVERLAY Invalid: Check Domain and Resolution
```

[Problem]
The screens that you attempted to OVERLAY do not have:
① the same frequency resolution
② the same X axis domain

[Solution]
Check the characteristics of each screen, and make sure they have same X axis domain and same frequency resolution.

[Reference]
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display mode(OVERLAY)

```
DY.er= Too many Points on Too Many Screens: Adjust
```

[Problem]
You selected a number of screens too large for the number of points on which your data are studied.

[Solution]
Reduce either the number of displayed screens, or the number of lines. Note that if you are displaying more than the allowed number of screens and that you setup a "forbidden" amount of samples or lines, then the number of screens is automatically modified!

[Reference]
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Related Modifications, ● Changing the number of screens

```
DY.er= Recalled data are LOG scaled: screens<3
```

[Problem]
While the number of displayed screens is at least 3 (3 or 4), you tried to recall from the memory (VIEW ⇨ MEM VW ⇨ DATA RECALL #) some LOG scaled data.

[Solution]
Reduce the number of displayed screens to 1 or 2 screens.

[Reference]
About Memory View:
Chapter 9, 4. VIEW KEY OPERATION, ■ How to Display Various Data, ● Saving and retrieving data

```
DY.er= Too many points: Reduce the number of points
```

[Problem]
① You tried to display some data in NYQUIST format on too many lines.
② You tried to save in the analyzer memory too large a data series (too many points) ···.

[Solution]
Reduce the number of lines, so that it becomes strictly inferior to the maximum limit. Remember that the number of lines is specified in:

SETUP ⇨ RANGE ⇨ f RESOLN (LIN f) ⇨ LINE/SPAN

[Reference]
Chapter 9, 4. VIEW KEY OPERATION, ■ Selection of the Various Data Display Formats, ● Nyquist diagram display

■ DisplaY Messages [DY.mg]

```
DY.mg= +MONITOR UNDO: Can't Return to MATH VW
```

[Problem]

This message tells you that even if you toggle the VIEW ⇨ TYPE ⇨ +MONITOR DO/UNDO key to UNDO, the original MATH VW display cannot and will not be restored.

[Reference]
Chapter 5, 3. Toward Better Measurement, ■ Monitor Function
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Related Modifications, ● Instantaneous data monitor

```
DY.mg= +MONITOR UNDO: Can t Return to MEM VW
```

[Problem]

This message tells you that even if you toggle the VIEW ⇨ TYPE ⇨ +MONITOR DO/UNDO key to UNDO, the original MEM VW display cannot and will not be restored.

[Reference]
Chapter 5, 3. Toward Better Measurement, ■ Monitor Function
Chapter 9, 4. VIEW KEY OPERATION, ■ Display Related Modifications, ● Instantaneous data monitor

```
DY.mg= Before Changing VIEW STEP, Press PAUSE
```

[Problem]

This message tells you to press the VIEW ⇨ INST VW ⇨ VIEW STEP ⇨ PAUSE key before any attempt to modify the STEP TIME.

[Reference]
About VIEW STEP:
Chapter 9, 4. VIEW KEY OPERATION, ■ How to Display Various Data, ● VIEW STEP(data view function)

```
DY.mg= Set DATA VIEW OFF, Please!
```

[Problem]
This message tells you to switch the VIEW STEP mode off. To do this you must press the

VIEW ⇨ INST VW ⇨ DATA VIEW ON/OFF so that the OFF position be selected.

[Reference]
About VIEW STEP:

Chapter 9, 4. VIEW KEY OPERATION, ■ How to Display Various Data, ● VIEW STEP(data view function)

```
DY.mg= UNIT Settings have NO Effect on MATH RESULT
```

This message is displayed, when a mathematical operation is executed on data to which an Engineering Unit, together with a scaling factor, have been associated. It indicates that even if you decide to represent your data in Engineering Unit, because of limitations of the Analyzer, the MATH RESULT will be displayed with no consideration with your Engineering Unit settings, even though the display will bear the notation "EU" (or whatever you may have set as unit name).
You should take extreme caution in your interpretation of the math results when the operands are not expressed in Volt Root Mean Square Value!

```
DY.mg= VIEW TYPE is changed to SINGLE Display
```

[Problem]
This message warns you that, for some reasons, the display format has been automatically changed to SINGLE, that is only one screen is displayed.

[Reference]

Chapter 9, 4. VIEW KEY OPERATION, ■ Display Format, ● Changing the display format

4. ERROR MESSAGES

```
DY.mg = Warning: NO DATA yet!
```

There is not yet any data in the buffers corresponding to the type of data you have just tried to display.
The different cases, you might encounter are:

① Average data : VIEW ⇨ AVG VW menu (no average processed has been executed yet)

② Memory data : VIEW ⇨ MEM VW ⇨ DATA RECALL # key (no data has been saved yet)

③ Math data : VIEW ⇨ MATH VW ⇨ RESULT ARREY key (no math operation has been executed yet)

④ Time Frequency trace : VIEW ⇨ T-F VW ⇨ t-f TRACE# key (the trace number# is still empty)

⑤ Curve Fit or Synthesis data : VIEW ⇨ MATH VW menu when the PRESET setting is on Curve Fit or Synthesis settings (no curve fit or synthesis process has been executed yet)

In such a situation you might want to create the appropriate data.

For example, you might have forgotten to press the START key to start an average process.

■ Floppy Disk Errors [FD.er]

```
FD.er= Already Existing File: Change File Name
```

[Problem]
You tried to write data under an already used file name. There is already a file, on the disk currently inserted in the drive, with such a name.

[Solution]
Give a different name to your file.

[Reference]
Chapter 15, 2. How to Use A Floppy Disk, ■ Catalog Display and File Names, ● Signification of each information displayed on the catalog

```
FD.er= Badly Formatted / Badly Mounted Disk: Check
```

[Problem]
① The disk currently inserted in the drive has not been correctly formatted: it was not initialized with the R9211.
② The disk inside the drive is not correctly mounted.

[Solution]
① The R9211 can only access disks it has itself initialized. Since the initialization operation will DESTROY any information on the disk, if you care for the data that may be on your disk, use another one, one that has never been used yet.
② Try to insert it again.

The sequence for initializing a disk is:

DEVICE ⇨ ACCESS ⇨ INITIAL ⇨ EXECUTE INITIAL

[Reference]
Chapter 15, 3. Operation Method, ■ Floppy Disk Initializing Operation Procedure, 1:Initialize a new floppy disk

```
FD.er= Can't find FILE: Check File Name
```

[Problem]
No file with the name you specified, can be found on the disk. Most probably, you misspelled the name.

[Solution]
Check the spelling of the file name you specified, and if there is any mistake correct it. Otherwise, check that you inserted the intended disk in the drive!

[Reference]
Chapter 15, 3. Operation Method, ■ Floppy Disk Initializing Operation Procedure,1:Initialize a new floppy disk

```
FD.er= File Access Impossible: Check size (<32KB)
```

[Problem]
The specified file is too large to be accessed. Practically the file size exceeds 32 KB.

[Solution]
No Solution!

```
FD.er= File Access Impossible: Check size (>512B)
```

[Problem]
The specified file is too small to be accessed. Practically the file size is smaller than 512B.

[Solution]
No Solution!

```
FD.er= Illegal Disk Type: Change Disk
```

[Problem]
The disk inserted in the drive cannot be used by the R9211 analyzer.

[Solution]
Use another disk, whose format will be compatible with the R9211 analyzer.

[Reference]
Chapter 15, 1. Outline

```
FD.er= Invalid Change: RECALL DATA OFF First
```

[Problem]
You cannot change the measurement conditions on data recalled from the disk. Furthermore, you are considered in the recall data mode until the time when you clearly specify you want to quit this mode.

[Solution]
To specify you want to quit the recall data mode press the DEVICE ⇨ ACCESS ⇨ RECALL DATA OFF key. Then you can proceed to the desired measurement mode changes.

[Reference]
Chapter 15, 3. Operation Method, ■ Notes on Retrieving Procedure

```
FD.er= Invalid File Header: Check File Type
```

[Problem]
① The file which you want to access has not been created by the R9211 analyzer.
② The file which you want to access has not the appropriate format, for the specified operation.

[Solution]
You should check the file type and origin.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Data Compatibility between Models

```
FD.er= Invalid File Name: Check it
```

[Problem]
A file name such as the one you have specified is incorrect. For example, it might not correspond to the file type.

[Solution]
You should check the file name, and correct it so that it matches the file type.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Catalog Display and File Names, ● Signification of each information displayed on the catalog

```
FD.er= Invalid File or Disk Format: Try new Disk
```

[Problem]
The file format or the disk format is not correct.

[Solution]
Check the file or disk format, and eventually try to use another disk.

```
FD.er= Invalid Format Selection: Try new one
```

[Problem]
Such a file format cannot be selected for the type of data considered here.

[Solution]
Check the file format and the data type, and select a file format that will match this data type.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ MEAS File(Data File/View File) + ■ Table File (R9211C Only)

```
FD.er= Invalid Operation: RECALL DATA OFF First
```

[Problem]
While you are in the recalled data mode (You recalled data from the disk, and you did not press the RECALL DATA OFF key), the following operations are forbidden:

① changing the number of scr eens
② using the + Monitor function
③ selecting the 3D display format
④ modifying the instantaneous data (INST VW)
⑤ modifying average data (AVG VW)
⑥ modifying memory data (MEM VW)
⑦ modifying math result data (MATH VW)
⑧ modifying T-F analysis data (T-F VW)
⑨ executing a MATH operation
⑩ executing a Limit Tests operation (GO-NOGO)
⑪ executing a curve-fit or synthesis operation

[Solution]
Before executing any of these operations, press the DEVICE ⇨ ACCESS ⇨ RECALL DATA OFF key.

[Reference]
Chapter 15, 3. Operation Method, ■ Notes on Retrieving Procedure

```
FD.er= No Data to Save: Check it
```

[Problem]
There is no data at all on the screen you attempted to save on a floppy disk.

[Solution]
You should check what you are trying to save. Remember for example, that only ONE screen can be saved at a time, therefore be sure the desired screen is actually selected (SEL key).
An empty screen is characterized by the display of the following message: "DY.mg = Warning: No DATA yet", You cannot save such a screen on the floppy disk!

```
FD.er= No Disk: Insert! a Disk
```

[Problem]
You tried to use a floppy disk function, while the drive contains no disk!

[Solution]
Insert your floppy disk in the drive and try again.

```
FD.er= Non-Formatted Disk: Format it on the R9211
```

[Problem]
① The disk actually inserted in the drive has not yet been initialized.
② The disk actually inserted in the drive is not correctly initialized.

[Solution]
① If there is no data you care for on the disk, initialize it with the R9211 analyzer. Be careful that all the data that may be on the disk, will be thus erased!
② If you want to keep the disk as it is, you must use another disk, possibly a new one and initialize it with the R9211 analyzer.

[Reference]
Chapter 15, 3. Operation Method, ■ Floppy Disk Initializing Operation Procedure, 1:Initialize a new floppy disk.

```
FD.er= Read Error (LOAD) !
```

[Problem]
During the loading process of the specified file, an error occurred. Possibly the file contains some garbage, so that the analyzer cannot correctly read it.

[Solution]
Check the file. Check also the load operation parameters.

```
FD.er= Unknown File Name: Check File Name
```

[Problem]
The specified file name is not a valid file name.

[Solution]
Check :
① the spelling of the name you have specified.
② whether the file has been created by the R9211.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Catalog Display and File Names, ● Signification of each information displayed on the catalog

```
FD.er= Write Error (SAVE) !
```

[Problem]
During the saving process of the specified file, an error occurred. The disk might be damaged, or there might have been some perturbations during the operation.

[Solution]
Check :
① the disk status.
② the saving parameters
Try to save the file again.

```
FD.er= Write Protected Disk!
```

[Problem]
You are trying to write on a write protected disk.

[Solution]
① Use another disk if you actually do not want to write on this disk.
② Temporary remove the write-protection from the disk.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ How to Handle the Floppy Disk, ● Write protection

Floppy Disk Messages [FD.mg]

```
FD.mg= Copying: #####.### To #####.###
```

This message is displayed during a file copy operation. It tells you that the first file of the message is copied to the second file of the message. The message is equivalent to: "FD.mg= Copying: Source_file To Destination _file"

```
FD.mg= Delete Operation Completed
```

The file delete operation is completed, you can proceed to the next operation you want to execute.

```
FD.mg= Deleting: #####.###
```

This message is displayed while the file, whose name is specified in the message, is being deleted from the disk.

```
FD.mg= Disk Changed
```

You changed the disk inside the drive.

```
FD.mg= Disk Files > 100, invalid CATalogue Display
```

[Problem]
This message is displayed when the disk inserted in the drive contains more than 100 file entries, which the maximum number of file entries the R9211 can access on a disk. Therefore, the catalogue display cannot correct.

[Solution]
You should partition the files on your disk between two disks, so that each disks will contain less than 100 file entries.

```
FD.mg= Disk Initialization Completed
```

The initialization procedure is completed. The disk is ready for use.

```
FD.mg= Disk Initialization in Progress
```

The disk is being initialized. Wait until the message "FD.mg= Disk Initialization Completed" is displayed.

```
FD.mg= Empty Disk!
```

This message is displayed when you try to access an empty disk (contains NO file).
You should delete this useless file entry.

```
FD.mg= File Copy Completed
```

The file copy operation is completed, you can proceed to the next operation you want to execute.

```
FD.mg= Loading: #####.###
```

This message is displayed while the file, whose name is specified in the message, is being loaded from the disk to the R9211 memory.

```
FD.mg= Load operation Completed
```

The load operation is completed. You can proceed to the next operation you want to execute.

```
FD.mg= Overwrite #####.###? Yes=EXECUTE No=Any key
```

[Problem]
This message is displayed when the operation you have specified causes the file, whose name is specified in the message, to be overwritten.

[Solution]
If you actually want this file to be overwritten, press the EXECUTE XXXXXX key, where xxxxx represents the operation you are trying to execute.
If you do not want the file to be overwritten press any other key.

```
FD.mg= Reading the Disk Status
```

The disk is analyzed, and the disk information are read. Thus the status of the disk can be known. If the disk is not compatible, you will be told so by a specific message.

```
FD.mg= Save Operation Completed
```

The specified was saved to the disk and this operation is completed. You can proceed to the next operation you want to execute.

```
FD.mg= Saving: #####.###
```

This message is displayed while the file, whose name is specified in the message, is being saved onto the disk.

```
FD.mg= System Compatible Disk
```

The disk is compatible with the R9211 analyzer. It has the correct specifications and it was correctly initialized.

```
FD.mg= the Disk is FULL
```

[Problem]
This message is displayed when the disk is full. The disk capacity is exceeded. Remember that the disk capacity is:

- 100 file entries
- 720KB (2DD)
- 1MB (2HD)

[Reference]
Chapter 15, 1. Outline

```
FD.mg= the Disk is FULL, can't SAVE
```

[Problem]
This message is displayed when the disk is full, so that no more file can be saved onto it.Remember that the disk capacity is:

- 100file entries
- 720KB (2DD)
- 1MB (2HD)

[Reference]
Chapter 15, 1. Outline

```
FD.mg= the Disk is FULL, can't SAVE or COPY
```

[Problem]
This message is displayed when the disk is full, so that no more file can be saved or copied onto it.
Remember that the disk capacity is:

- 100file entries
- 720KB (2DD)
- 1MB (2HD)

[Reference]
Chapter 15, 1. Outline

Go-Nogo Errors [GN.er]

```
GN.er= Before SEG EDITion or EXIT: INSERT OFF
```

[Problem]
You tried to EDIT a segment of the table, or you tried to EXIT the table edition mode, although the INSERT ON mode was selected.

[Solution]
First, you should switch OFF the INSERT mode.

[Reference]
Chapter 13, 2. Operation Method

```
GN.er= Can't EXEC-MAN-TEST: Set LMT TEST ON
```

[Problem]
A manual test (EXEC-MAN-TEST) cannot be executed when LMT TEST is OFF.

[Solution]
You should set LMT TEST ON.

[Reference]
Chapter 13, 2. Operation Method

```
GN.er= Can't EXEC-MAN-TEST: Set LMT TRIG to MANUAL
```

[Problem]
A manual test (EXEC-MAN-TEST) cannot be executed when LMT TRIG is not in the MANUAL mode.

[Solution]
You should set the LMT TRIG to MANUAL.

[Reference]
Chapter 13, 2. Operation Method

```
GN.er= Can't LMT TEST ON: Check X axis Settings
```

[Problem]
There settings which stands outside the displayed X-axis range, thus preventing any test execution. In such a case, LMT TEST cannot be set to ON.

[Solution]
You should check the X-axis setting (DELTA X, ···)

[Reference]
Chapter 13,

```
GN.er= Comparison Points > 4096: Set Fewer of Them
```

[Problem]
The number of Low or High level comparisons points exceeded the maximum allowed (4096).

[Solution]
You should change the settings so that this maximum limit is not exceeded.

[Reference]
Chapter 13,

```
GN.er= DATA SAVE 1 Empty or Invalid REF: Check It
```

[Problem]
The reference value for a comparison has to be saved beforehand, in memory 1 of the analyzer (DATA SAVE 1). You stand in either one of the following situations:

① There is no data saved in memory 1.
② The data saved in memory cannot be used as reference value (invalid frequency range, …)

[Solution]
You should save an appropriate reference value in memory 1, using the DATA SAVE 1 key

[Reference]
Chapter 13,

```
GN.er= Invalid Change: set LMT LINE OFF First
```

[Problem]
You tried to change the waveform display, while the MATH ⇨ LMT CTRL ⇨ LMT LINE ON/OFF was ON.

[Solution]
Switch the LMT LINE ON/OFF key OFF.

[Reference]
Chapter 13, 2. Operation Method, ■ How to Use the Table Mode, 13:Display the comparison domain.

```
GN.er= Invalid Change: set LMT TEST OFF First
```

[Problem]
You tried to change the waveform display, while the MATH ⇨ LMT CTRL ⇨ LMT TEST ON/OFF was ON.

[Solution]
Switch the LMT TEST ON/OFF key OFF.

[Reference]
Chapter 13, 2. Operation Method, ■ How to Use the Table Mode, 14:Allow the comparison function to process.

```
GN.er= Invalid Data Type: Frequency Domain Only
```

[Problem]
You set LMT TEST ON or LMT LINE ON, while the displayed data are not frequency domain data.

[Solution]
Select frequency domain data.

[Reference]
Chapter 13,

```
GN.er= Invalid Display Format: Select GRAPH
```

[Problem]
You set LMT TEST ON or LMT LINE ON, while the display format is not GRAPH (3D,···).

[Solution]
You must select GRAPH.

[Reference]
Chapter 13,

```
GN.er= Invalid Display Type: set SINGLE Display
```

[Problem]
You set LMT TEST ON or LMT LINE ON, while more than one screen are displayed.

[Solution]
You must select the single screen display format: VIEW ⇨ TYPE ⇨ SINGLE

[Reference]
Chapter 13,

```
GN.er= Invalid Setting if LMT LINE ON: Set it OFF
```

[Problem]
You cannot execute this setting or modification while LMT LINE is ON.

[Solution]
Switch LMT LINE OFF.

[Reference]
Chapter 13,

```
GN.er= Invalid Setting if LMT TEST ON: Set it OFF
```

[Problem]
You cannot execute this setting or modification, while LMT TEST is ON.

[Solution]
Switch LMT TEST OFF.

[Reference]
Chapter 13,

```
GN.er= Limit-Table SEG not Found: set SEG
```

[Problem]
During TEST mode, with LMT TEST ON, a segment in the comparison TABLE that was not completely or correctly set, was found.

[Solution]
You should check the segments settings and correct the invalid or incomplete ones.

[Reference]
Chapter 13,

```
GN.er= Lower Limit Exceeded: Try New Setting
```

[Problem]
The value you just entered is incorrect. It exceeds the lower limit of the corresponding parameter.

[Solution]
Check the setting and adjust it.

[Reference]
Chapter 13,

`GN.er= OVERAL in SEG: Delete SEG or Display Gyy`

[Problem]
LMT TEST is ON (or LMT LINE is ON), and one segment contains an OVERAL (OVA) computation although the displayed data are not power spectrum data.

[Solution]
You can either delete the segment containing an OVERAL computation, or display power spectrum data.

[Reference]
Chapter 13,

`GN.er= Servo mode: Average Data Only`

[Problem]
In the servo mode, while instantaneous data are displayed, you tried to set LMT LINE ON or LMT TEST ON.

[Solution]
In the servo mode, you should display average data (AVG VW menu)

[Reference]
Chapter 13,

`GN.er= Upper Limit Exceeded: Try New Setting`

[Problem]
The value you just entered is incorrect. It exceeds the upper limit of the corresponding parameter.

[Solution]
Check the setting and adjust it.

[Reference]
Chapter 13,

■ Go Nogo Messages [GN.mg]

```
GN.mg= EDIT SEG > max (20), INSERT ON Invalid
```

The number of edited segments has reached its maximum (20). You cannot INSERT ON any new segments. You might want to delete all the unnecessary segments.

```
GN.mg= Invalid Setting => DELTA X is modified
```

The modification you performed on START X caused the value of DELTA X to be automatically modified, to match the settings.

```
GN.mg= Invalid Setting => DELTA Y is modified
```

The modification you performed on START Y caused the value of DELTA Y to be automatically modified, to match the settings.

```
GN.mg= Invalid Setting => START, STOP SEG modified
```

The modification you performed with the DONE key, caused the value of START SEG and STOP SEG to be automatically modified, to match the settings.

```
GN.mg= Invalid Setting => STOP SEG is modified
```

The modification you performed with the DONE key or on the START SEG setting, caused the value of the STOP SEG to be automatically modified, to match the settings.

```
GN.mg= LIMIT TEST ON => TRACEonST OFF
```

[Problem]

While running the TRACEonST feature, you tried to start the LIMIT TEST feature (MATH ⇨ LMT CTRL ⇨ LMT TEST ON/OFF). TRACE on ST ON/OFF cannot be ON while LMT TEST is ON also.

This message indicates that the TRACEonST mode was automatically terminated.

```
GN.mg= LMT LINE is switched OFF
```

LMT LINE was automatically switched OFF.

```
GN.mg= LMT TEST is switched OFF
```

LMT TEST was automatically switched OFF.

```
GN.mg= Test Status: FAIL (NOGO)
```

The tested signal did not pass the test. It failed!

```
GN.mg= Test Status: PASS (GO)
```

The tested signal did successfully pass the test.

■ GPib Errors [GP.er]

```
GP.er= [%s] Invalid: Check the PRESET menu
```

[Problem]
The command, whose name is specified in the message, cannot be executed because it does not match the PRESET menu settings. For example, if the MATH menu is actually selected under the PRESET menu (PRESET ⇨ MATH KEY ⇨ MATH MENU) you cannot execute any function belonging to the Curve-Fit menu.

[Solution]
Check the settings in the PRESET menu, and change them to match with what you want to do.

[Reference]
Chapter 9, 1. PRESET KEY OPERATION

```
GP.er= [%s] Invalid on the Selected Data
```

[Problem]
You cannot execute the command, whose name is specified in the message, on the data which are selected.

[Solution]
Check the data type versus the specified command, and correct the settings.

```
GP.er= [%s] Invalid= CH-A ANALOG
GP.er= [%s] Invalid= CH-A and B ANALOG
GP.er= [%s] Invalid= CH-A and B DIGITAL
GP.er= [%s] Invalid= CH-A DIGITAL
GP.er= [%s] Invalid= CH-B ANALOG
GP.er= [%s] Invalid= CH-B DIGITAL
```

[Problem]
With the input block status (for example CH-A ANALOG input), the command, whose name is specified in the message, cannot be executed. These error messages are only displayed on the version provided with the digital input functionality.

[Solution]
Check the input block status versus the specified command and correct the settings.

```
GP.er= [%s] Invalid= Incorrect Machine Type (2)
```

[Problem]
The analyzer you are using is not a R9211A , B, C or F, and the command, whose name is specified in the message, cannot be executed on it.

[Solution]
The only solution to your problem is to get the appropriate analyzer version ···.

```
GP.er= [%s] Invalid= Incorrect Machine Type (3)
```

[Problem]
The analyzer you are using, is not provided with the functionality required by the command, whose name is specified in the message. You cannot execute this command on this version.

[Solution]
The only solution to your problem is to get the appropriate analyzer version ···.

```
GP.er= [%s] Invalid= Measurement Mode Mismatch
```

[Problem]
The command, whose name is specified in the message, does not match the selected measurement mode.

[Solution]
Check the measurement mode actually selected. Eventually, change to fit what you want to do.

```
GP.er= [%s] Invalid= No FDD Option
```

[Problem]
Though your analyzer is not equipped with a Floppy Disk Drive (FDD), you tried to execute the command, whose name is specified in the message, which is a floppy disk utility command.

[Solution]
You should consider the installation of a floppy disk drive option on your analyzer.

```
GP.er= [%s] Invalid= No IO Board
```

[Problem]
Although your analyzer is not equipped with an I/O Board, you tried to execute the command, whose name is specified in the message, which is an I/O board related command.

[Solution]
You consider the installation of an I/O board option on your analyzer.

```
GP.er= [%s] Invalid= No SG option
```

[Problem]
Although your analyzer is not equipped with a Signal Generation block (SG), you tried to execute the command, whose name is specified in the message, which is a signal generation related command.

[Solution]
You consider the installation of a signal generation block option on your analyzer.

```
GP.er= [%s] Invalid= Printer Error n %d
```

[Problem]
A printer error occurred. The printer error codes are:

- %d = 1 => "Printing"
- %d = 2 => "No Paper in the printer"
- %d = 3 => "Printer Head UP"
- %d = 4 => "The printer is not connected"

[Solution]

- %d = 1 => Wait until job completion
- %d = 2 => Put some paper in the paper!
- %d = 3 => Position the printer's head down
- %d = 4 => Check whether the printer is correctly connected

```
GP.er= [%s] Invalid= SG ANALOG
```

```
GP.er= [%s] Invalid= SG DIGITAL
```

[Problem]
With the signal generation (SG) block status (for example SG ANALOG), the command, whose name is specified in the message, cannot be executed. These error messages are only displayed on the version provided with the digital input functionality.

[Solution]
Check the signal generation block status versus the specified command and correct the settings.

■ MarKer Errors [MK.er]

```
MK.er= invalid X MARKER: Match Marker and Waveform
```

[Problem]

① The X MARKER utility you have selected cannot be applied on the type of waveform displayed.

② While no marker function is selected, you press the MKR ⇨ MKR REF ⇨ SEL to OTHER key.

[Solution]

① Check the X MARKER function you have selected and the type of data which are displayed, and match one with the other.

② Select a marker function before pressing the SEL to OTHER key.

[Reference]

Chapter 10, 2. SEARCH MARKERS, ■ Relationships between Search Makers and Waveform Types

```
MK.er= No Marker Function Selected: Select One
```

[Problem]

Even though no X MARKER function was selected, you pressed the MKR ⇨ X MKR ⇨ X MARKER DO ESTIM key.

[Solution]

Make sure that a X MARKER function is selected before pressing the X MARKER DO ESTIM key.

[Reference]

Chapter 10, 2. SEARCH MARKERS, ■ Operating the Search Markers

■ MarKer Messages [MK.mg]

```
MK.mg= Press X MARKER DO ESTIM !
```

This message is displayed when the selected marker you have selected is not an automatic marker.

In such cases, it tells you to press the [MKR] ⇨ [X MKR] ⇨ X MARKER DO ESTIM key, to start the marker estimation.

[Reference]
Chapter 10, 2. SEARCH MARKERS, ■ Operating the Search Markers

■ MaTh Errors [MT.er]

```
MT.er= Bad *** Operand: Check!
```

[Problem]
The operation type, whose name is specified in the message (***) cannot be executed on the data selected as operand.

[Solution]
The different operation types can be:

***	The operand must be
FFT	Xa or Xb
jw	Frequency Response Function (FRF) or spectrum
ROTATION	Sa, Sb or <Hab>
CEPSTRUM	Power spectrum
LIFTERING	Cepstrum
FREQ SHFT	Frequency Response Function (FRF) or spectrum
BANDPASS	Frequency Response Function (FRF) or spectrum
BANDSTOP	Frequency Response Function (FRF) or spectrum
OpnCls	Frequency Response Function (FRF)
ClsOpn	Frequency Response Function (FRF)
EQUALIZE	Frequency Response Function (FRF)
SNR	Coherence Function
NOP	Coherence Function
COP	Coherence Function or Power spectrum
lnCOP	Coherence Function or Power spectrum

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= *** math Can't be executed: OperandS Check
```

[Problem]
The operation, whose name is specified in the message (***), cannot be executed because the operands do not match. For example, when you try to add Gaa and Gab.

[Solution]
Check the operands types and choose operands of identical type.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= A *** OPERATOR Can't be Selected: Clear it
```

[Problem]
You cannot set any operation after a domain transformation. For example, if Xa being the operand, you select "to FFT" as first operator, you cannot set a second operator, and if you do, the message "MT.er= A 2nd OPERATOR Can't be selected: Clear it" will be displayed.

[Solution]
You must clear the specified operator.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Different f-RANGE Operands: Adjust Ranges
```

[Problem]
You tried to execute an operation on two operands which do not have the same frequency range.

[Solution]
Check the operand's frequency ranges, and adjust them so that they are equivalent.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Different Modes Operands: Choose ONE Mode
```

[Problem]
You tried to execute an operation on two operands, which are one a <Hab> obtained through the FRF mode, the other one a <Hab> obtained through the servo-mode.

[Solution]
Choose <Hab> data coming from the same one mode.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Different Sizes Operands: Try New Settings
```

[Problem]
You tried to execute an operation on operands that do not have the same size. The number of samples is not the same. For example, this message is displayed when you try to add a Xa studied on 512 points and a Xa studied in 1024 points!

Note that this error message might hide another worse error. Indeed if you were trying to add a Xa type waveform with the corresponding Sa type waveform, it is possible that this message will be displayed, because the size is what will be tested first. Xa is studied on 512 points, Sa is represented on 200 lines (real part + imaginary part).

[Solution]
You should select the same number of points for both operands! To do this you must set the SETUP ⇨ RANGE menu correctly.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Different Sweeps Methods: Adjust Sweeps
```

[Problem]
You tried to execute an operation on operands obtained in the servo mode with 2 different sweep methods.

[Solution]
You should select data obtained with the same sweep method.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er = Different X-axes Operands: Check Them
```

[Problem]
The operands selected for the current operation do not have the same X axis. For example, this message is displayed when you try to add together an autocorrelation function (Raa) and a time waveform (Xa), since the axes units are time for Xa and LAG for Raa.

[Solution]
You should check the operands and set the operation again with compatible operands.

```
MT.er= fMATH Can t be Executed on Coherence Data
```

[Problem]
You tried to execute a fMATH operation on Coherence data.

[Solution]
There is no real solution. It is just not possible to execute any fMATH operation on coherence data.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Invalid IFFT Operand: Select Sa or Hab
```

[Problem]
You tried to apply the IFFT (Inverse Fast Fourier Transform) operation on an incompatible type operand. For example, this message is displayed when you select IFFT as operator when the operand is Gaa!

[Solution]
The only compatible types are Sa or <Hab>

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Invalid on Log-f Data: Choose Lin-f
```

[Problem]
You tried to execute a domain transformation (to FFT) on some logarithmic frequency data.

[Solution]
The operand of a domain transformation must be linear frequency data.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Invalid on Zoom Data: Set Zero-Start Mode
```

[Problem]
You tried to execute a domain transformation (FFT, IFFT) on zoom analysis data.

[Solution]
Select the zero-start analysis mode: cancel the zoom analysis mode.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Invalid Operand: Choose another lin-f SWEEP
```

[Problem]
You tried to execute a domain transformation (FFT, IFFT) on some data obtained in the servo mode, with a linear frequency table.

[Solution]
You should select a linear sweep method other than a frequency table.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= No Computation Allowed on ORBITAL Data
```

[Problem]
You selected ORBITAL data as operand.

[Solution]
There is no solution: no operation is allowed on ORBITAL data.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= No Computation Allowed on T-F Data
```

[Problem]
You selected T-F analysis (Time-Frequency) data as operand.

[Solution]
There is no solution: no operation is allowed on T-F data.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= No Operand Selected: Select ONE
```

[Problem]
You forgot to select some data as operand!

[Solution]
You just have to select an operand. Remember that to select the first operand of an operation you must select, with the SEL key, the screen where the desired data are displayed. Then you must press the MATH SEL key and the OPERAND key. In the case of a second operand you must select the data with the SEL key before selecting the operator and once both have been selected, you must press the xxx OPRTR key (xxx standing for 1st or 2nd or 3rd depending on the operator you are setting.

[Reference]
Chapter 11, 2. BASIC PROCEDURES, ■ Basic Operation Procedure(Example of "X+Y")

```
MT.er= No Operator Selected: Select ONE
```

[Problem]
You forgot to select an operator.

[Solution]
Select the desired operator. You must press the operation key, then you must press the xxx OPRTR key.

[Reference]
Chapter 11, 2. BASIC PROCEDURES, ■ Basic Operation Procedure(Example of "X+Y")

```
MT.er= On Correlation: No tMATH op. but CMP CNJ
```

[Problem]
You tried to execute a forbidden tMATH operation on Correlation data.

[Solution]
The only allowed tMATH operation on Correlation data is the COMPLEX CONJUGATE operation (COMPLEX CONJUGATE key).

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Operand can't be MATH result: Check Operand
```

[Problem]
You tried to execute an operation on a MATH operation result.

[Solution]
You cannot select a MATH operation result as an operand. To bypass this problem, you should use the combination operation feature of this analyzer. That is to say that instead of specifying one operation, getting the result and executing a new operation on the result, you are going to specify both operations at the same time, once as 1st OPERATOR, the other as 2nd OPERATOR. Note however that there are limits to this feature.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Operand Type Invalid for this Operation
```

[Problem]
The operand type you specified for this operation is not allowed.

[Solution]
Check the operand type and make sure it matches the operation type.

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Too Many Lines (Points): Try a New Size
```

[Problem]
The operand you have selected is too large for a MATH operation.

[Solution]
The maximum operand size is 1024 samples (→ 400 complex spectrum lines).

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathemataical Operations

```
MT.er= TR MATH Can't be Executed: Set Lin-f
```

[Problem]
You tried to apply a TR MATH utility (smoothing, trend removing) on non-linear frequency resolution data.

[Solution]
Set the frequency resolution to lin-f:
press the following key sequence: SETUP ⇨ RANGE ⇨ f RESOLN ⇨ LIN f

[Reference]
Chapter 11, 1. MATHEMATICAL OPERATIONS, ■ Restrictions on the Mathematical Operations

```
MT.er= Window Error: Select Rect, Hanning, Minimum
```

[Problem]
You tried to execute an IFFT on data for which a window other than the Rectangular, the Hanning or the minimum window is selected.

[Solution]
Select one of the allowed windows : RECT (Rectangular), HANNING, or MINIMUM.

■ MaTh MessaGes [MT.mg]

```
MT.mg= Calculate by Exchanging Upper f and Lower f
```

In the MATH menu, (BANDPASS, BANDSTOP, jw ···), you set a larger value for the Lower Frequency than for the Upper Frequency. Since such a setting makes no sense, the actual computation is performed considering that the value you set as upper frequency is in fact the lower frequency value, and reciprocally. This exchange is not mirrored on the frequency menu, thus if you look at this menu again, you will not see any settings modification. This message is displayed because you might not want such an exchange to happen, and you had better check back your settings. Particularly, do not mistake the kHz, Hz and mHz keys.

```
MT.mg= Real Time Math Process Interruption !
```

Because you press one of the keys that interrupts the real time math process, this process was interrupted. It will start again, in the new conditions you are about to set, when you will press the DO MATH key. To definitely stop it, you must switch the REAL TIME ON/OFF key (in the MATH menu).

■ PLot Errors [PL.er]

```
PL.er= No Plotter is available!
```

[Problem]
No plotter is available: either no plotter is connected to the analyzer, or the connected plotter is switched off.

[Solution]
Connect the plotter and switch it on.

[Reference]
Chapter 16, 2. How To Use A Plotter, ■ Connectable Plotters and Connection Method
Chapter 16, 3. How To Use A Video Printer, ■ Video Printer Connection Method

```
PL.er= Plotting Process Abnormally Completed!
```

[Problem]
The currently running plotting process was abnormally terminated. Perhaps the power was shutdown during plotting.

[Solution]
Check the plotter condition and try to plot again.

■ PLot Messages [PL.mg]

```
PL.mg= Plotting (List Display)
```

This message is displayed when a list display is being plotted.

```
PL.mg= Plotting: Wait a moment Please
```

[Problem]
This message is displayed when:
① You press a forbidden key while the plotter is busy.
② You try to open the alphabetical window while the plotter is busy.

[Solution]
You just have to wait until completion of the plotting process.

```
PL.mg= Press once more the COPY key: 3D Display!
```

[Problem]
This message tells you to press a second time the COPY key to start a hard-copy of a tridimensional display (3D display).

[Reference]
Chapter 16, 2. How To Use A Plotter, ■ Precautions, ● How to plot 3-dimensional graphs

■ Recall & Save Errors [RS.er]

```
RS.er= Can't Save POLAR data: Change Coordinates
```

[Problem]
POLAR data cannot be saved to the analyzer memory. It includes ORBITAL data, NYQUIST diagram data, Cole-Cole diagram data···.

[Solution]

You should change the displayed data, in the INST VIEW menu (for ORBITAL), or in the COORD menu (for the other types).

[Reference]
About Memory Save and Recall:

Chapter 9, 4. VIEW KEY OPERATION, ■ How to Display Various Data, ● Saving and retrieving data

```
RS.er= MATH results can't be saved in Memory
```

[Problem]
You cannot save math operations results into the analyzer memory.

[Solution]
There is no solution. You just cannot do it!

```
RS.er= No Data to be Recalled: Use DATA SAVE X
```

[Problem]
Although no data have been saved into the analyzer memory number X, you tried to recall some data from this memory.

[Solution]

Try again, without forgetting to save the desired data in the memory with the DATA SAVE X key.

[Reference]
About Memory Save and Recall:

Chapter 9, 4. VIEW KEY OPERATION, ■ How to Display Various Data, ● Saving and retrieving data

```
RS.er= No Servo Option: Data Loaded as WAVEFORM
```

[Problem]
You tried to load Servo Data from the disk, on an analyzer not provided with the servo option. Such data cannot be loaded as such. Thus, these data are loaded and displayed in the waveform mode.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ● Data Compatibility between Models

```
RS.er= No Zoom Option: Data Loaded as Zero-Start
```

[Problem]
You tried to load Zoom Data from the disk, on an analyzer not provided with the zoom option.

[Solution]
Such data cannot be loaded as such. Thus, these data are loaded and displayed in the zero-start mode (non-zoom mode).

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Data Compatibility between Models

```
RS.er= ORBITAL data RECALL: Only on 1st SEL screen
```

[Problem]
You tried to recall from the analyzer memory some orbital data, on a screen other than the first screen.

[Solution]
Orbital data can only be recalled on the 1st screen. Thus, make sure that the 1st screen is selected before recalling orbital data from the memory.

```
RS.er= Servo Data Can't Be Loaded on this Version
```

[Problem]
Although, the analyzer you are actually using is not provided with servo-mode features, you attempted to recall some servo mode data from the disk.

[Solution]
There is no real solution. These servo mode data can only be recovered from a version provided with the servo mode feature.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Data Compatibility between Models

```
RS.er= Such Data Can't be Saved on Disk!
```

[Problem]
You tried to save unallowed data on the disk.

[Solution]
Check the type of the data you wish to save on disk. And make sure this type can be saved on the disk.

[Reference]
Chapter 15, 2. How To Use Floppy Disk, ■ MEAS File(Data File/View File) + ■ Table File(R9211 Only)

```
RS.er= Zoom Data Can't Be Loaded on this Version
```

[Problem]
Although, the analyzer you are actually using is not provided with zoom features, you attempted to recall some zoom data from the disk.

[Solution]
There is no real solution. These zoom data can only be recovered from a version provided with the zoom feature.

[Reference]
Chapter 15, 2. How To Use A Floppy Disk, ■ Data Compatibility between Models

■ Recall & Save Messages [RS.mg]

```
RS.mg= Damaged File: Changed to Waveform Display
```

This message is displayed when a damaged is accessed (load). In such a case, the valid portion of the file is read from the disk, and displayed in the WAVEFORM format by default.

```
PL.er= Plotting Process Abnormally Completed!
```

This message is displayed to indicate you the completion of the data saving to memory operation. The memory number is also indicated in the message.

■ Signal Generation Errors [SG.er]

```
SG.er= AUTO ARM invalid on XFER: Change ARM mode
```

You cannot select the AUTO ARM mode with arbitrary data of the type XFER (memory transfer).

[Solution]
You should select another ARM mode. Key sequence:

SETUP ⇨ ARM/HOLD ⇨ HOLD

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ Selection of the Waveform to be Generated,

● How to control the arbitrary waveform memory

```
SG.er= Can't START, CONNECT=to ChB: Change CONNECT
```

[Problem]

It is not allowed to use the START key when the connection method is "connect to channel B"

[Solution]
You should choose another connection method. Key sequence:

SG CONT ⇨ CONNECT ⇨ to Ch A (for example)

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Internally Connect the Signal Generator Output, ● How to select the signal generator output connection method

```
SG.er= f Range < 10Hz: Can't set TAPER ON
```

[Problem]
The TAPER function cannot be set to on, if the frequency range is smaller than 10Hz.

[Solution]
Increase the frequency range.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Taper Function

```
SG.er= GEN. MAN. TRIG.: Select MANUAL Output Mode
```

[Problem]
You selected an output mode other than the MANUAL mode, although the GENERATOR MANUAL TRIGGER function is selected.

[Solution]
You must select the MANUAL mode to match with the GENERATOR-MAN-TRIG function.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Control the Signal Generation

```
SG.er= Invalid AMPLITUDE: Respect LIMIT VOLTage!
```

[Problem]
The amplitude value you have just set does not respect the specified limit voltage value. You have : |AMPLITUDE| + |OFFSET| > LIMIT VOLT

[Solution]
Check the limit voltage value, the offset value and the amplitude value and adapt the settings so that the limit voltage is not exceeded.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Amplitude and the Offset of the Waveform to be Generated

```
SG.er= Invalid OFFSET: Respect LIMIT VOLTage!
```

[Problem]
The offset value you have just set does not respect the specified limit voltage value. You have : |AMPLITUDE| + |OFFSET| > LIMIT VOLT

[Solution]
Check the limit voltage value, the offset value and the amplitude value and adapt the settings so that the limit voltage is not exceeded.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Amplitude and the Offset of the Waveform to be Generated

```
SG.er= SG Lower Limit Exceeded: Check Settings
```

[Problem]
The value you have just set exceed the Signal Generator lower limit.

[Solution]
Check the setting as well as the Signal Generator limit setting.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Amplitude and the Offset of the Waveform to be Generated

```
SG.er= SG Upper Limit Exceeded: Check Settings
```

[Problem]
The value you have just set exceed the Signal Generator upper limit.

[Solution]
Check the setting as well as the Signal Generator limit setting.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Amplitude and the Offset of the Waveform to be Generated

```
SG.er= TAPER ON: Select CONTINUE output mode
```

[Problem]
You set the TAPER function ON, while the output mode is not the CONTINUE mode.

[Solution]
You must select the continue mode.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Taper Function

```
SG.er= TEST ON when OPR On: Set OPR Off
```

[Problem]
While the OPR function is ON, you can not set the TEST function ON.

[Solution]

First set the OPR function OFF, then press the SETUP ⇨ INPUT ⇨ TEST ON/OFF key ON.

[Reference]
About the TEST feature:

Chapter 9, 3. SETUP KEY OPERATION, ■ Setting of the Signal Input Block, ● Generation of a test signal

About Signal Generation Control:

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Internally Connect the Signal Generator Output, ○ Relationships between the OPR key and the signal start/stop

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Control the Signal Generation

```
SG.er= TEST ON when SG running: GENERATOR STOP!
```

[Problem]
While the signal generator is running you cannot set the TEST function ON.

[Solution]

First stop the generator, by pressing the SG CONT ⇨ OUT CTRL ⇨ GENERATOR STOP key.

Then press the SETUP ⇨ INPUT ⇨ TEST ON/OFF key ON.

[Reference]
About the TEST feature:

Chapter 9, 3. SETUP KEY OPERATION, ■ Setting of the Signal Input Block, ● Generation of a test signal

About Signal Generation Control:

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Internally Connect the Signal Generator Output, ○ Relationships between the OPR key and the signal start/stop

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Control the Signal Generation

```
SG.er= Too many Points: CONTINUE output only
```

[Problem]
① You tried to select a mode other than CONTINUE, when the number of lines is larger than 1600.
② When the output mode is not the CONTINUE mode, you tried to set the number of lines to more than 1600.

[Solution]
① Select the CONTINUE mode.
② Reduce the number of lines.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ Selection of an Output Signal Generation Mode

```
SG.er= Too many Points: SINE, RANDOM, ARBIT only
```

[Problem]
① You tried to select SWEPT, M-SINE or IMPULSE as generated signal, when the number of lines is larger than 1600.
② While the generated signal is SWEPT, M-SINE or IMPULSE, you tried to set the number of lines to more than 1600.

[Solution]
① Select SINE, RANDOM or ARBITRAY.
② Set the number of lines to less than 1600.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ Selection of the Waveform to be Generated

```
SG.er= XFER+TRACE WAV: Select a Time Domain screen
```

[Problem]

You tried to execute a memory transfer of a displayed waveform(TRACE WAVEFORM) to the signal generator memory, by pressing the XFER key, even though the screen selected by the SEL key is not in the time domain.

[Solution]

Check the selected screen, and choose a screen displaying a time domain waveform.

[Reference]

Chapter 9, 5 SG CONT KEY OPERATION, ■ Selection of the Waveform to be Generated

```
SG.er= Zoom Analysis: GENERATOR MAN TRIG invalid
```

[Problem]

You cannot select the GENERATOR MANual TRIGger function in the zoom analysis mode.

[Solution]

You might want to switch off the zoom analysis mode.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ Selection of an Output Signal Generation Mode

■ Signal Generation Messages [SG.mg]

```
SG.mg= Amplitude Change=> Offset Change (auto)
```

This message is displayed when, while the selected impedance is 600Ω, the OFFSET value is internally changed to match an amplitude modification (by the user).

```
SG.mg= (ARM) Wait for the Hold LED Then Press XFER
```

This message is displayed to indicate that, once you have pressed the ARM key, you must wait for the Hold LED (at the front panel) to light, and then press the XFER key.

```
SG.mg= Conflict: Out Mode ≠ Continue => TAPER OFF
```

[Problem]
This message is displayed when the TAPER function is internally switched off, because you change the output mode to a mode other than the continue mode.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Taper Function

```
SG.mg= Impedance Change=> Offset, Amplitude Change
```

This message is displayed when the amplitude setting or the offset setting is internally changed to match an impedance modification (by the user)

```
SG.mg= Press the GENERATOR START key
```

[Problem]

This message is displayed when you press the GENERATOR MAN TRIG key, while the GENERATOR is stopped (GENERATOR STOP). It indicates that you must press the GENERATOR START key first. 0

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Control the Signal Generation

```
SG.mg= Press the GENERATOR STOP key First
```

[Problem]

This message is displayed when you try to set the TAPER function ON, or when you try to set the value of the Taper Time while the Generator is running (GENERATOR START). It indicates that you must press the GENERATOR STOP key before those settings.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Set the Taper Function

```
SG.mg= The Generator has been STOPPED
```

This message indicate that, for one of the following reasons, the generator has been stopped:

① You selected the Servo mode from another mode, or you selected another mode from the servo mode.

② While the signal being generated was an IMPULSE or an ARBITRA(r)Y signal, you switched ON the Zoom feature.

③ You retrieved some data from the floppy disk.

```
SG.mg= The Sine Frequency is Changed
```

This message indicates that the SINE wave frequency was automatically corrected to match with the last setting modification you executed. This modification could be that:

① You changed the f-Range or the line number, while the resolution feature is on (RESOLN ON/OFF)

② You set the resolution feature on (RESOLN ON/OFF).

This message is displayed if, because of such a modification, one of the following situation occurs:

① (SINE f) > (f-Range) / (Line)

② (SINE f) > (f-Range)

```
SG.mg= The Swept START Frequency is changed
```

This message indicates that the SWEPT SINE wave START frequency was automatically corrected to match with the last f-Range or line number setting you executed, if this setting lead to one of the following situation:

① (START f) < (f-Range) / (Line)

② (START f) > (f-Range)

```
SG.mg= The Swept STOP Frequency is changed
```

[Problem]
This message indicates that the SWEPT SINE wave STOP frequency was automatically corrected to match with the last f-Range or line number setting you executed, if this setting lead to one of the following situation:
① (STOP f) < (f-Range) / (Line)
② (STOP f) > (f-Range)

```
SG.mg= The TIME PERIOD is increased (auto)
```

[Problem]
This message is displayed when the OUTPUT mode is INTERNAL and when one of the following conditions is satisfied:

① When the signal is a SINE wave, by changing SINE f or the number of cycles, the following situation is reached:
(PERIOD t) < (cycle count + a) / (SINE f)

② When the signal is not a SINE wave, by changing f-Range or the number of lines, the following situation is reached:
(PERIOD t) < (frame count + a) / ((f Range) / (Line)).

In both cases, the Time Period is automatically changed, as the message indicates.

Note that a is equal to:
1/5 if the number of lines is 25
1/2 if the number of lines is 50
1/10 in all other cases

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ Selection of an Output Signal Generation Mode

```
SG.mg= XFER: Memory Transfer in Process
```

This message indicates that a signal is being transferred to the Signal Generator memory.

```
SG.mg= XFER: Memory Transfer completed
```

This message indicates that the signal transfer to the signal generator memory is completed.

```
SG.mg= XFER: Set ARM or HOLD, wait for the Hold LED
```

[Problem]

You cannot select FREE RUN or AUTO ARM during a XFER operation. The only possible modes are ARM or HOLD. This message indicates that you must press either the ARM key or the HOLD key. In either case you must wait for the Hold LED to light, and only then can you press the XFER key.

[Reference]

Chapter 9, 5 SG CONT KEY OPERATION, ■ Selection of the Waveform to be Generated,

● Transfer of waveform data stored in the input buffer

```
SG.mg= You Must Set the SG Amplitude Level
```

[Problem]

This message is displayed to tell you that you forgot to specify the amplitude of the signal you want the Signal Generator (SG) to generate. You just have to set it.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to set the Amplitude and the Offset of the Waveform to be Generated

■ Servo-Mode Errors [SM.er]

```
SM.er= All Table Filled, IDmax (20) Reached!
```

[Problem]
While editing the servo mode frequency table, in the INSERT ON mode, you reached the maximum table line number, which is 20.

[Solution]
Stop inserting new lines in the table. Eventually destruct some useless lines.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.er= INSERT ON Disabled, IDmax (20) Reached!
```

[Problem]
Although the servo-mode frequency table is full (20 lines), you press the INSERT ON/OFF key, which is forbidden, since no more line can be added to the table.

[Solution]
Eventually delete all useless lines, or let the table as it is.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION,■ Edition of the Frequency Table in the Servo Mode

```
SM.er= INSERT ON, Can't EDIT IDs: Set INSERT OFF
```

[Problem]
You tried to EDIT an ID in the servo mode frequency table, while in the INSERT ON mode.

[Solution]
Switch off the INSERT mode (INSERT ON/OFF)

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.er= Invalid ID Frequency Setting: Check Them
```

[Problem]
Because the frequency setting of the START ID or of the STOP ID are not correct, the servo analysis cannot start.

[Solution]
Check the START and STOP IDs frequency settings.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.er= Invalid StartID, StopID: Set new Ones
```

[Problem]

Because you deleted some lines in the servo mode frequency table with the DEL ID or DEL END keys, you ended up with invalid START and STOP IDs.

[Solution]
Check the START ID, the STOP ID and the MAX ID, and make the necessary changes.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.er= Invalid StopID: Set a New One
```

[Problem]

Because you deleted some lines in the servo mode frequency table with the DEL ID or DEL END keys, you ended up with an invalid STOP ID.

[Solution]
Check the START ID, the STOP ID and the MAX ID, and make the necessary changes.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.er= No 3D Display for Log SWEEP: Try Lin SWEEP
```

[Problem]
You cannot display in the tridimensional format Log sweep servo mode data.

[Solution]
If you really want to display your data in the tridimensional format, change the sweep method to a linear one.

```
SM.er= Servo_Lower_Limit Exceeded: Check Settings
```

[Problem]
The value you have just set, is not compatible with the servo lower limit for this parameter.

[Solution]
Check your setting and adjust it so that it fits with the servo limits.

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ Setting of the Amplitude and of the Offset of Signals in the Servo Mode

```
SM.er= Signal>Servo_Upper_Limit: Lower the Signal
```

[Problem]
The value you have just set, is not compatible with the servo upper limit for this parameter.

[Solution]
Check your setting and adjust it so that it fits with the servo limits.

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ Setting of the Amplitude and of the Offset of Signals in the Servo Mode

■ Servo-Mode Messages [SM.mg]

```
SM.mg= Servo analysis completed: SG VLT changed
```

This message indicates that the servo analysis is completed. It also warns you about the modification of the SG VLT (Signal Generator Voltage) value, inherent to the servo analysis.

```
SM.mg= Servo Process Aborted by GENERATOR STOP
```

[Problem]

This message warns you that the current servo mode process was aborted because the GENERATOR STOP key was pressed.

[Reference]

Chapter 9, 5. SG CONT KEY OPERATION, ■ How to Control the Signal Generation

```
SM.mg= To Start a Servo Analysis: GENERATOR START
```

[Problem]

This message is displayed when you forget to press the GENERATOR START key to start the servo analysis process.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.mg= To Start a Servo Analysis: OPR ON
```

[Problem]

This message is displayed when you forget to press the OPR key (to ON) to start the servo analysis process.

[Reference]
Chapter 5, 4. Typical Measurement Examples, ■ Advanced Measurement: How to Use the f-table

Chapter 9, 3. SETUP KEY OPERATION, ■ Edition of the Frequency Table in the Servo Mode

```
SM.mg= You Must Set the START ID Amplitude Level
```

This message is displayed when you forget to set the START ID signal amplitude level.

```
SM.mg= You Must Set the STOP ID Amplitude Level
```

This message is displayed when you forget to set the STOP ID signal amplitude level.

■ SetUp Errors [SU.er]

```
SU.er= Invalid DECADE (frequency<10mHz)!
```

[Problem]
Because of a decade or of a frequency modification, the smaller studied frequency became smaller than the smallest allowed frequency (=10mHz).

[Solution]
Check your frequency and decade settings.

[Reference]
Chapter 5, 3. Toward Better Measurement, ■ Setting the Frequency Range and the Resolution of the Measurement

```
SU.er= Invalid Input Signal: Make a New Input
```

[Problem]
The signal acquisition which was just performed, is invalid and cannot be trusted.

[Solution]
This error usually occurs at the beginning of an acquisition phase, and is not very dangerous. You have to be aware that the signal for which the message was displayed is not correct. The following acquisition should correct.

```
SU.er= Log/Oct f Invalid: Set Lin f
```

[Problem]
You cannot select a logarithmic nor an octave frequency resolution on such data.

[Solution]
You may only choose the linear frequency resolution.

```
SU.er= Lower Limit Exceeded: Check Settings
```

[Problem]

In one of the Y softmenus accessed by the SETUP key, the value you have set exceeds the lower limit for the considered parameter. For example, you tried to set the SAMPLE number to less than 64.

[Solution]
Check your setting.

```
SU.er= No ICH DELAY on 1 Channel: ACTIVE CH= CHA&B
```

[Problem]
You selected the interchannel delay (ICH DELAY) functionality, but only one channel is active so that an interchannel delay is meaningless.

[Solution]
Make both channels active.

[Reference]
About Interchannel delay:

Chapter 9, 3. SETUP KEY OPERATION, ■ Setting of the Interchannel Delay

```
SU.er= SENS=AUTO: Select MANUAL if SAMPL CLK= EXT
```

[Problem]
You tried to select the external sampling clock mode (SAMPL CLK INT EXT), while the sensitivity setting is on automatic.

[Solution]
You should change the sensitivity mode to MANUAL.

```
SU.er= SAMPL CLK=EXT => Operation Invalid
```

[Problem]
Because the sampling clock is external, the operation you just attempted is forbidden. For example:
① You cannot execute a zoom analysis.
② The sensitivity mode cannot be automatic.

[Solution]
You could choose the internal sampling clock.

```
SU.er= Upper Limit Exceeded: Check Settings
```

[Problem]
In one of the Y softmenus accessed by the SETUP key, the value you have set exceeds the upper limit for the considered parameter. For example, you tried to set the SAMPLE number to more than 8192.

[Solution]
Check your setting.

■ SetUp Messages [SU.mg]

```
SU.mg= Condition Already Selected
```

This message is displayed when you are attempting to set a condition that is already selected.

```
SU.mg= Conflict: SINGLE channel => ICH DELAY OFF
```

This message is displayed to warn you that because you selected a single channel mode, the interchannel delay functionality is automatically cancelled.

```
SU.mg= Digital Input: SENS is set to MANUAL
```

[Problem]
The automatic sensitivity function cannot be used on digital input. Thus, the analyzer automatically selected the MANUAL SENSitivity mode when you chose a digital input.

[Reference]
About Digital Input/Output:
Chapter 14

```
SU.mg= FREE RUN must be selected
```

For one of the following reasons the free run mode must be selected:

① You selected the calibration mode (MODE ⇨ CAL ⇨ SINGLE DC CAL).

② You modified the measurement mode (MODE ⇨ MEAS).

③ You changed the setting of one of the following menus:

- SETUP ⇨ RANGE
- SETUP ⇨ SENS
- SETUP ⇨ INPUT

To select the free run option, press the following key sequence:

SETUP ⇨ ARM/HLD ⇨ FREE RUN

```
SU.mg= SENSitivity is changed from AUTO to MAN!
```

This message tell you that the sensitivity (SETUP ⇨ SENS menu) has automatically been changed from automatic mode to manual mode.

```
SU.mg= SENS=AUTO Invalid
```

[Problem]
For one of the following reasons you cannot use the automatic sensitivity mode of the analyzer:
① The frequency range is smaller than 2Hz.
② You are doing a zoom analysis.
③ The frequency resolution is logarithmic or octave.

[Solution]
Choose the manual sensitivity mode of the analyzer or cancel the forbidding measurement condition.

```
SU.mg= Zooming => Force/Resp. To HANNING
```

This message tells you that, because the zooming function is started, the force/response window cannot be used. Thus the window is automatically changed from force/response to Hanning.

■ Time-Frequency Errors [TF.er]

```
TF.er= Data Freq. Outside f Domain: Check Settings
```

[Problem]
The TF analysis frequency of the just recalled data is outside the analysis frequency domain.

[Solution]
Check the settings and correct them so that the data frequency is inside the analysis frequency domain.

```
TF.er= Invalid Change if INST t-f ON: Set it OFF
```

[Problem]
You tried to change one of the following parameters, while the INST t-f mode is ON:

① SETUP ⇨ T-F ⇨ t-RANGE
② SETUP ⇨ T-F ⇨ t-f MODE

[Solution]

You should first set INST t-f to OFF, then you can change the t-RANGE and t-f MODE parameters.

Remember that to set INST t-f OFF you only have to toggle the SETUP ⇨ T-F ⇨ INST t-f ON/OFF key.

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ T-F Analysis setup

```
TF.er= Log/Oct f Invalid: Set Lin f
```

[Problem]
With the settings you have made, logarithmic and octave frequency resolution are not allowed.

[Solution]
You should select the linear frequency resolution (lin-f).

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ T-F Analysis setup

```
TF.er= NON-Active Channel: Activate Both Channels
```

[Problem]
You tried to perform a Time-Frequency (T-F) analysis on a non-active channel. For example, if channel A only is active, you cannot perform a T-F analysis on channel B.

[Solution]
Activate both channels: press the following key sequence:

SETUP ⇨ FUNC ⇨ ACTIVE CH (******) ⇨ CH-A&B

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ T-F Analysis setup

```
TF.er= TF running: STOP key then set INST t-f OFF
```

[Problem]
This message is displayed in the following conditions: in the T-F mode, the INST t-f functionality being ON, you start a measurement by pressing the START key. Then, and here comes the error, you try to switch off the INST t-f functionality, even though the t-f analysis is still running.

[Solution]

You must stop the t-f analysis, by pressing the STOP/C key, and only then can you toggle off the INST t-f ON/OFF key.

[Reference]

Chapter 9, 3. SETUP KEY OPERATION, ■ T-F Analysis setup

Time-Frequency Messages [TF.mg]

```
TF.mg= All Changes Ignored: TF data in 3D Display
```

This message is displayed when you attempt to modify the settings of the VIEW ⇨ INST VIEW menu while the display is tridimensional and the measurement mode is the T-F mode.

```
TF.mg= Conflict: DATA VIEW ON => INST t-f OFF
```

This message tells you that because you switch on the DATA VIEW mode the INST t-f mode is automatically switched off. These two modes are in conflict.

```
TF.mg= Conflict: INST t-f ON => DATA VIEW OFF
```

This message tells you that because you switch on the INST t-f mode the DATA VIEW mode is automatically switched off. These two modes are in conflict.

WeLcome Errors [WL.er]

```
WL.er= Self Test -> Memory Error
```

[Problem]
This message warns you that a memory error was detected during the self test operation.

[Reference]
Chapter 3, 2. After Turning the Power ON

```
WL.er= System Error => DEFAULT Settings
```

[Problem]
This message tells you that a system error has occur when the power was switched on, and that the default settings were consequently selected.

[Reference]
Chapter 3, 2. After Turning the Power ON

■ Welcome Messages [WL.mg]

```
WL.mg: Option Change
```

[Problem]
This message reminds you that the option for which this message is displayed was recently changed.

[Reference]
Chapter 3, 2. After Turning the Power ON

```
WL.mg= Default Configuration
```

[Problem]
This message is displayed on the first display of the analyzer, after power on, when you press the PRESET key.

[Reference]
Chapter 3, 2. After Turning the Power ON

■ Miscellaneous Errors [XX.er]

```
XX.er= Didn't Exit the LABEL Menu: Press DONE
```

[Problem]
You pressed a key which does not belong to the LABEL edition menu, although you did not exit the label menu.
Note that the term "label menu" includes:

- the LABEL menu
- the UNIT-LABEL menu
- the FLOPPY-File Name menu

[Solution]
You must explicitly specify that you exit the LABEL menu, by pressing the MODE ⇨ LABEL ⇨ DONE key, before proceeding to some other tasks.

[Reference]

Chapter 9, 2. MODE KEY OPERATION, ■ Label, (4)Label Validation

```
XX.er= FATAL ERROR: Switch the Power OFF then ON
```

[Problem]
A device driver error occurred, and cannot be recovered.

[Solution]
You should switch the power off then on again.

```
XX.er= LABEL Maximum Size Reached: Exit(DONE)
```

[Problem]
The labels have a certain size limit depending on their nature. If you reach this limit and try to input new characters nonetheless, this message will be displayed.

[Solution]
You should either accept the label you have just entered, and exit the label menu by pressing the DONE key, or change it so that it satisfies you, always bearing in mind that the size is limited.

```
XX.er= Invalid for Zoom analysis: set ZOOM off
```

[Problem]
For on of the following reasons, the zoom analysis is not valid anymore:

① You have tried to select an external sampling clock (SAMPL CLK INT/EXT).

② You have tried to modify a setting such the lines number or the measurement function.

③ You have tried to switch the filter off.

[Solution]
You should cancel the zoom analysis mode and switch on the zero start analysis mode.

[Reference]
Chapter 7, 3. Toward Better Measurement, ■ Zoom

```
XX.er= Invalid Key!
```

This message indicates that the key you have just pressed is invalid in the actual measurement conditions.

```
XX.er= NON-Active Channel: Activate it
```

[Problem]
You tried to modify the setting on a non-active channel. These settings can be:

① INPUT ⇨ COUPLING AC/DC
② INPUT ⇨ + INPUT IN/GND
③ INPUT ⇨ – INPUT ON/GND
④ INPUT ⇨ FILTER ON/OFF
⑤ INPUT ⇨ ICP ON/OFF
⑥ INPUT ⇨ TEST ON/OFF
⑦ TRIG ⇨ SOURCE (****)

[Solution]
You should activate the channel of which you are trying to modify the setting.

■ Miscellaneous Messages [XX.mg]

```
XX.mg= Averaging Process not yet Completed: Wait
```

This message is displayed when, although the averaging process is not completed, you try to execute one of the following modifications:

(1) During a simple average process:

① You tried to toggle INST t-f ON/OFF.

② You tried to modify either the MODE or SETUP menus setting.

(2) During a curve-fit process:

① You pressed the CREATE FIT key to start a new curve-fit process.

(3) During a servo mode measurement:

① You tried to modify the SETUP ⇨ RANGE menu setting.

② You tried to modify the MODE or SETUP menu setting.

You should wait for the averaging process to be completed.

```
XX.mg= Avg Already started: START Ignored!
```

This message is displayed when you press the START key (a second time) while an averaging process is being executed. The second START key pressing will be ignored.

```
XX.mg= LABEL Limits Exceeded!
```

This message is displayed when you try to go beyond the LABEL limits with the ⇨ softkey and the ⇦ softkey.

```
XX.mg= Select a Character and press the ENT key
```

[Problem]
This message is displayed when the alphabetical window is being used.

[Solution]
It indicates how to proceed: you must select a character within the window and press the ENT key to transfer it to the text you are editing.

```
XX.mg= Selection IGNORED!
```

This message tells you that the selection you just made, being, for some reasons, invalid, is ignored.

```
XX.mg= This Key is NOT AVAILABLE on this version
```

This message is displayed when you tried to use a functionality which is not available on the analyzer you are using. The version of your analyzer is not provided with these features.

```
XX.mg= Wait a moment, Please!
```

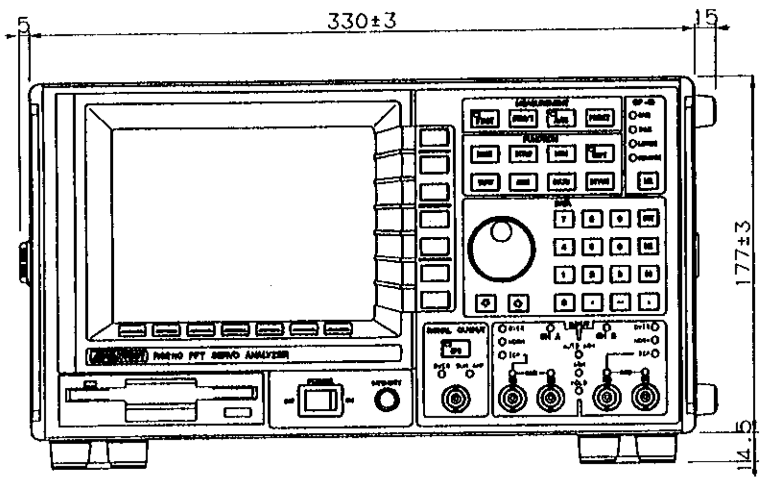
This message is displayed when you do not wait long enough between two settings. The former selection has not yet been updated.

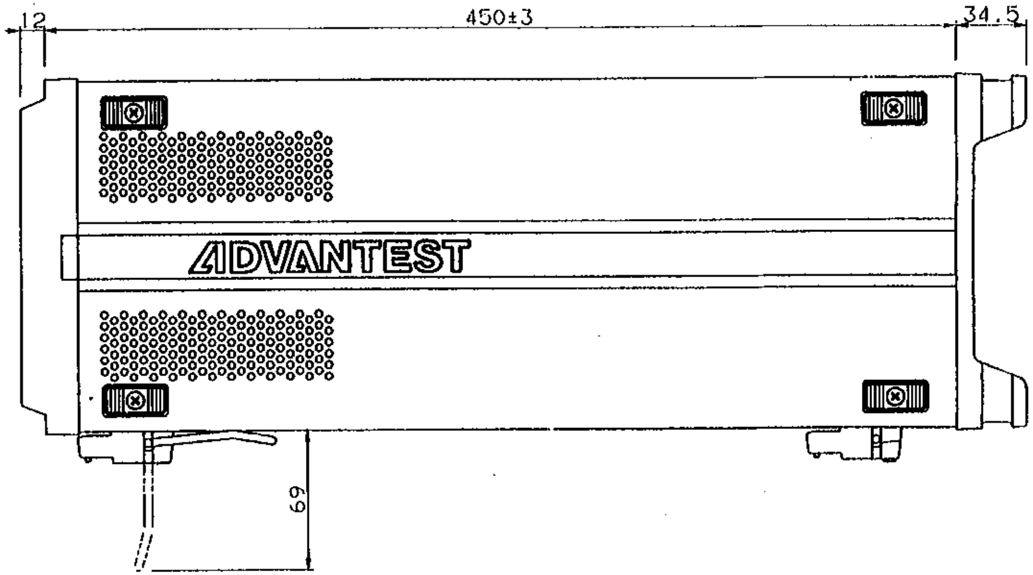
```
XX.mg= Zoom mode is switched OFF
```

For some reasons the Zoom mode is automatically switched OFF. It happens when you change the measurement mode.

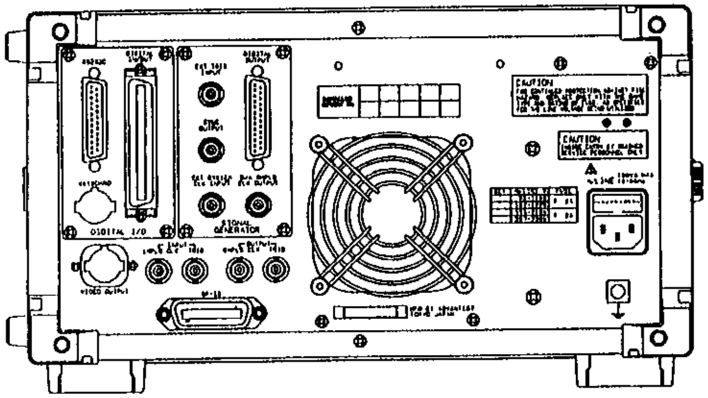
INDEX

A words surrounded by [ ] (square) indicates the X or the Y soft menu.





Unit : mm



R9211B/9211C
EXTERNAL VIEW

R9211B/CEXT1-9010-A

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SALES & SUPPORT OFFICES

Advantest Korea Co., Ltd.
22BF, Kyobo KangNam Tower,
1303-22, Seocho-Dong, Seocho-Ku, Seoul #137-070, Korea
Phone: +82-2-532-7071
Fax: +82-2-532-7132

Advantest (Suzhou) Co., Ltd.
Shanghai Branch Office:
Bldg. 6D, NO.1188 Gumei Road, Shanghai, China 201102 P.R.C.
Phone: +86-21-6485-2725
Fax: +86-21-6485-2726

Shanghai Branch Office:
406/F, Ying Building, Quantum Plaza, No. 23 Zhi Chun Road,
Hai Dian District, Beijing,
China 100083
Phone: +86-10-8235-3377
Fax: +86-10-8235-6717

Advantest (Singapore) Pte. Ltd.
438A Alexandra Road, #08-03/06
Alexandra Technopark Singapore 119967
Phone: +65-6274-3100
Fax: +65-6274-4055

Advantest America, Inc.
3201 Scott Boulevard, Suite, Santa Clara, CA 95054, U.S.A
Phone: +1-408-988-7700
Fax: +1-408-987-0691

ROHDE & SCHWARZ Europe GmbH
Mühldorfstraße 15 D-81671 München, Germany
(P.O.B. 80 14 60 D-81614 München, Germany)
Phone: +49-89-4129-13711
Fax: +49-89-4129-13723

ADVANTEST®

http://www.advantest.co.jp

ADVANTEST CORPORATION
Shin-Marunouchi Center Building, 1-6-2 Marunouchi, Chiyoda-ku, Tokyo 100-0005, Japan
Phone: +81-3-3214-7500